idiap
RESEARCH INSTITUTE

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Research Programme 2017-2020

Planning document for the State Secretariat for Education, Research and Innovation (SEFRI)

www.idiap.ch

May 30, 2015

« Le progrès scientifique en général et les progrès réalisés dans l'informatique en particulier ne doit pas asservir l'homme mais au contraire être à son service. »

« Die Fortschritte der Wissenschaft im Allgemeinen und die der aufstrebenden Informatik im Besonderen den Menschen nicht unterwerfen, sondern ihm nützen sollten. »

« Scientific progress in general and progress in computer science in particular should not enslave man but on the contrary be at his service. »

Angelo Dalle Molle, philanthrope

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'économie, de la formation et de la recherche DEFR
Secrétariat d'Etat à la recherche et à l'innovation SEFRI
Division Recherche et Innovation Nationales

Contribution à des établissements de recherche d'importance nationale
Idiap Research Programme 2017-2020

S'applique aux établissements de recherche encouragés en vertu de l'art. 15, al. 3, let. a à c, LERI
(Autres bases légales: art. 20 à 23 O-LERI; art. 12 à 14 O-LERI-DEFR)

Etablissement (nom)	Institut de Recherche Idiap		
Adresse	Rue Marconi 19, Centre du Parc, 1920 Martigny		
Tél	+41 27 721 77 11	e-mail	info@idiap.ch
Coordonnées pour le paiement	UBS SA, Av. de la Gare 2, 1920 Martigny IBAN: CH71 0026 4264 6259 7401 M		
Organe de Révision	BDO SA, Rte des Arsenaux 9, 1700 Fribourg		
Directeur	Prof. Hervé Bourlard		
Tél	+41 27 721 77 20	e-mail	herve.bourlard@idiap.ch
Activités (parts)	Recherche	65.2%	
	Enseignement	5%	
	Prestations de services (Groupe Développeurs)	13.9%	
	Autres (Admin, Finance, Gestion de Projets, Groupe IT)	15.9%	

The present Research Programme was presented to the Idiap Foundation Council on June 1, and validated on June 10, 2015.

Main contact points

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Idiap Research Institute
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http://www.idiap.ch/

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Overview of facilities and human resources

The table below gives a quick overview of the staff resources and facilities (office spaces and computer resources) as of 2014.

Staff statistics (2014)	Headquarter & facilities (2014)
2 professors	Centre du Parc, Rue Marconi 19, 1920 Martigny
2 senior lecturers	**2500** m2
13 senior researchers	**4** meeting rooms
23 post doctoral researchers	**1** conference room
37 PhD students	**1** server room
14 support and development engineers	**1** library
29 internships (average/year)	**500** TB of storage
16 administration staff	**400** CPU for computing
32 nationalities	**2500** GB RAM for computing
1147 man-months	**1** Gb/s Internet connection
140 persons (arrival/departure)	
96 full time equivalent	

Keywords

Machine learning; multimodal human-machine interaction; perceptual and cognitive systems; multimedia information management; social/human behavior modeling; automatic speech and language processing; computer vision; biometric authentication; computational bioimaging; information interfaces and presentation; information-scalable inference; uncertainty quantification and optimal decision systems.

Institut de Recherche Idiap / Idiap Research Institute
VADE-MECUM 2015

Missions et thèmes de recherche / *Missions and Research Themes*

L'Idiap est un institut de recherche, indépendant, à but non lucratif, reconnu par la Confédération Suisse et le Canton du Valais, associé au domaine stratégique des Ecoles Polytechniques Fédérales (EPF/ETH) et spécialisé dans la gestion de l'information multimédia et les interactions hommes-machine multimodales.
The Idiap Research Institute is an independent, nonprofit research foundation associated with the strategic domain of the Swiss Federal Institutes of Technology (EPF/ETH), specialized in multimedia information management and in multimodal man-machine interaction.

Mission

L'Idiap a pour but de conduire des recherches fondamentales et appliquées dans les domaines de l'informatique avancée, ainsi que de contribuer à la formation supérieure et au transfert de technologie dans ces domaines.

The objectives of Idiap are to conduct basic and applied research in the fields of advanced computing, and to contribute to higher education and technology transfer in these areas.

Thèmes de recherche / Research Themes

1. Systèmes cognitifs et perceptifs / *Perceptual and cognitive systems*
2. Comportements humains et sociaux / *Social and human behavior*
3. Interfaces et présentation de l'information / *Information interfaces and presentation*
4. Reconnaissance biométrique des personnes / *Biometric person recognition*
5. Apprentissage automatique / *Machine learning*

Budget 2015

Recettes / *Income* (en millier de francs / in thousands francs)

Canton du Valais / Canton of Valais	1'720	17%
Commune de Martigny / City of Martigny	700	7%
Confédération suisse / Swiss Confederation	2495	25%
Total subventions / Total subventions	**4'915**	**49%**
Total partenaires / Total partners	**457**	**4%**
Projets suisses / Swiss projects	2'942	20%
Projets européens / European projects	1'054	13%
Projets industriels / Industrial projects	477	12%
Total projets / Total projects	**4473**	**45%**
Autres	**170**	**2%**
TOTAL	**10'015**	

Charges / *Expenses* (en millier de francs / in thousands francs)

Charges de personnel / *Personnel expenses*	8250	82%
Charges des projets / *Projects expenses*	95	1%
Charges administratives / *Admin. expenses*	536	5%
Charges informatiques / *Computer expenses*	272	3%
Charges d'immeuble / *Building expenses*	860	9%
TOTAL	**10'013**	

Personnel et infrastructure / *Staff and facilities*

Statistiques du personnel / *Staff statistics* (2014)

2	professeurs / *professors*
2	maîtres d'enseignement et de recherche (MER) / *senior lecturers*
13	chercheurs permanents et seniors et collaborateurs scientifiques / *permanent and senior researchers and scientific collaborators*
23	postdoc
37	doctorants / *PhD Students*
14	ingénieurs de développement /*development engineers*
6	ingénieurs de système / *system engineers*
29	stagiaires (moyenne/année) / *internships (average/year)*
10	personnes à l'administration / *administration staff*
4	visiteurs / *visitors*
32	nationalités / *nationalities*
1147	personnes-mois / *man-month*
140	personnes (arrivées, départs) / *Persons (arrivals, departures)*
96	équivalents plein temps / *full time equivalent (FTE)*

Siège et infrastructure / *Headquarter and facilities*

Centre du Parc, Rue Marconi 19
1920 Martigny

2500	m2 de bureaux / m2 of office space
4	salles de réunion / meeting rooms
1	salle de conférence / conference room
1	salle de serveur / serveur room
1	showroom / showroom
1	bibliothèque / library
500	TB de stockage / TB of storage
400	CPU pour les calculs / CPU for computing
2500	GB RAM pour les calculs / RAM for computing
1	Gb/s de connexion internet / internet connection

Organisation / *Organization*

Conseil de Fondation / *Foundation Council* (www.idiap.ch/the-institute/organization/foundation-council)

M. Olivier **Dumas**	Administrateur indépendant, conseiller d'entreprises
M. Jean-Daniel **Antille**	Vice-Président, Responsable de l'Antenne Régions Valais romand
Prof. Karl **Aberer**	Vice-Président pour les systèmes d'information, EPFL
M. Marc-André **Berclaz**	Directeur opérationnel de l'Antenne EPFL Valais Wallis
M. Stefan **Bumann**	Chef du service des hautes écoles, Etat du Valais
M. Marc-Henri **Favre**	Président de la ville de Martigny
M. Patrick **Furrer**	Vice-recteur Recherche et Innovation, HES-SO
M. Jean-René **Germanier**	Conseiller National
M. Jordi **Montserrat**	Directeur régional de Venturelab
Prof. Christian **Pellegrini**	Professeur honoraire à la Faculté des sciences, Université de Genève
M. Dominique **Perruchoud**	Président du Conseil d'administration de Cimark SA
M. Walter **Steinlin**	Directeur de Swisscom Outlook Swisscom Institutional Relations Président de la Commission pour la technologie et l'innovation (CTI)

Comité d'accompagnement / *Advisory Board* (www.idiap.ch/the-institute/organization/international-advisory-board)

Dr. Jordan **Cohen**	Independent Consultant, SPELAMODE, Half Moon Bay, CA, USA
Prof. Anil K. **Jain**	Distinguished Professor, Dept. of Computer Science & Engineering, Michigan State University, USA
Dr. John **Makhoul**	Chief Scientist, Speech and Signal Processing, BBN Technologies, Cambridge, MA, USA
Prof. Kenji **Mase**	Professor, Graduate School of Information Science, Nagoya University, Japan
Prof. Nelson **Morgan**	Ex-Director of the International Computer Science Institute (ICSI), Berkeley, CA, USA
Prof. Klaus-Robert **Müller**	Professor for Computer Science, TU Berlin, Director, Bernstein Focus on Neurotechnology, Berlin, Germany
Dr. David **Nahamoo**	Senior Manager, Human Language Technologies, IBM Research, Yorktown Heights, NY, USA
Prof. Gerhard **Sagerer**	Rector, Bielefeld Universität, Germany
Prof. Bernt **Schiele**	Max-Planck-Director, MPI Informatics, Professor at Saarland University, Saarbrücken, Germany
Prof. Bayya **Yegnanarayana**	Professor and Microsoft Chair, Int'l Institute of Information Technology, Hyderabad, India

Direction / *Management*

Prof. Hervé Bourlard, Directeur / Director

Dr François Foglia, Directeur adjoint / Deputy Director

Edward-Lee Gregg, Directeur financier / Financial Director

Doctorants / *PhD Students* (Etat au 31.12.14 / As of 31.12.14)

37 étudiants dont / students of which
- 6 en 1e année / *in 1st year*
- 7 en 2e année / *in 2nd year*
- 9 en 3e année / *in 3rd year*
- 8 en 4e année / *in 4th year*
- 7 terminé en 2014 / *completed in 2014*

Collège scientifique / *Scientific College*

Prof. Hervé **Bourlard**, Head of Speech & Audio Processing
Dr. François **Fleuret**, Head of Computer Vision & Learning
Prof. Daniel **Gatica-Perez**, Head of Social Computing
Dr. Jean-M. **Odobez**, Head of Perception & Activity Understanding

Comité de Recherche / *Research Committee*

Dr. Sylvain **Calinon**, Head of Robot Learning & Interaction
Dr. Barbara **Caputo**, Head of Artificial Cognitive Systems
Dr. Phil **Garner**, Group of Speech & Audio Processing
Dr. David **Ginsbourger**, Head of Uncertainty Quantification & Optimal Design
Dr. Michael **Liebling**, Head of Computational Bioimaging
Dr. Mathew **Magimai Doss**, Group of Speech & Audio Processing
Dr. Sébastien **Marcel**, Head of Biometric Person Recognition
Dr. Petr **Motlicek**, Group of Speech & Audio Processing
Dr. Andrei **Popescu-Belis**, Head of Natural Language Processing

IdeArk, liste des entreprises / *IdeArk, list of companies*

(www.ideark.ch)

Audiosearch
Cinetis - www.cinetis.ch
Edeltech - www.edeltech.ch
ESConcept - www.es-concept.com
GaiaSens - www.gaiasens.com
KeyLemon - www.keylemon.com*
Klewel - www.klewel.com*
Koemei - www.koemei.com*
Luma7 - www.luma7.com
Quantesys - www.quantesys.com
Recapp - www.recapp.ch*
Save NRJ - www.savenrj.ch
tikiCheck - www.tikicheck.ch

* spin-off de l'Idiap / *Idiap spin-off*

252 publications (2014)

all available online at http://publications.idiap.ch

Principaux projets / *Major projects*

BEAT - www.beat-eu.org
D-Box - www.d-boxproject.eu
DexROV
EUMSSI - www.eumssi.eu
ROCKIT - www.rockit-project.eu
SIIP - www.siip.eu/SIIP_Project
Valais*Wallis Digital - www.valais-digital.ch

Contents

1 Missions and Organization

1.1 Missions

Over the last 20+ years[a], and thanks to the continued support of our public institutions (SEFRI, the State of Valais, the City of Martigny, SNSF, CTI/KTI, Hasler Foundation, and LORO), as well as the support of EPFL, our key academic partner, Idiap has gained a significant scientific reputation, and is now recognized worldwide, in both academic and industrial environments, as a major center of excellence and a key player in the economic development of Valais and Switzerland.

The present proposal presents fundamental and development work to be carried out on problems of central importance to computer science in general and to human-computer as well as human-human interaction (including information management and retrieval) in particular. The proposed work is based on (1) the current status of the research potential at Idiap, and (2) the reassessment of future research directions for Idiap in well defined research areas, taking into account current strengths, academic collaborations, expertise of our permanent researchers, and anticipated future trends.

Idiap's activities cover three main objectives:

1. **Research:** Conducting fundamental research projects at the highest level in its preferred areas, thus taking its place among the best institutions on a national, European and global scale. Idiap benefits from a wide national and international network of partners and works actively with large universities, public and private research centers. This collaboration is always implemented through formal research projects, including SNSF, EU and (sometimes) US research programmes.

   This is briefly summarized below in Section 1.1.1, and presented in full detail in Section 2.2.

2. **Academic and Training Activities:** Through our academic anchoring with EPFL (and the EDEE and EDIC Doctoral Programmes), our teaching activities at EPFL, as well as our connections with numerous other academic institutions, we fund and supervise a large number of PhD students (35 per year on average), while also hosting international master and intern students. Numerous Idiap-internal activities towards improving personal research and communication skills are also provided.

   This is briefly summarized below in Section 1.1.2, and presented in full detail in Section 2.3.

3. **Technology Transfer:** Idiap is currently amongst the most important research centers in Valais that put special emphasis on research software maintenance, to facilitate technology take-up, technology transfer, creation of spin-offs, and attracting startups. As discussed later, an entire team (currently around 12 people) is devoted to these important aspects, working in close collaboration with CTI/KTI, as well as the IdeArk incubator.

   This is briefly summarized below in Section 1.1.3, and presented in full detail in Section 2.4.

Finally, as further discussed below and illustrated in **Figure 1** next page, all of our research and development activities rely upon advanced signal processing and machine learning techniques, revolving around 5 key research themes, with 11 research groups (each headed by at least one senior researcher/PI), and 10 key applications domains, identified as of key importance to the development of Switzerland and the State of Valais in particular. Our main contributions to the Swiss research and innovation activities are discussed in Section 4, page 64.

[a] Idiap will be celebrating its 25th anniversary in 2016!

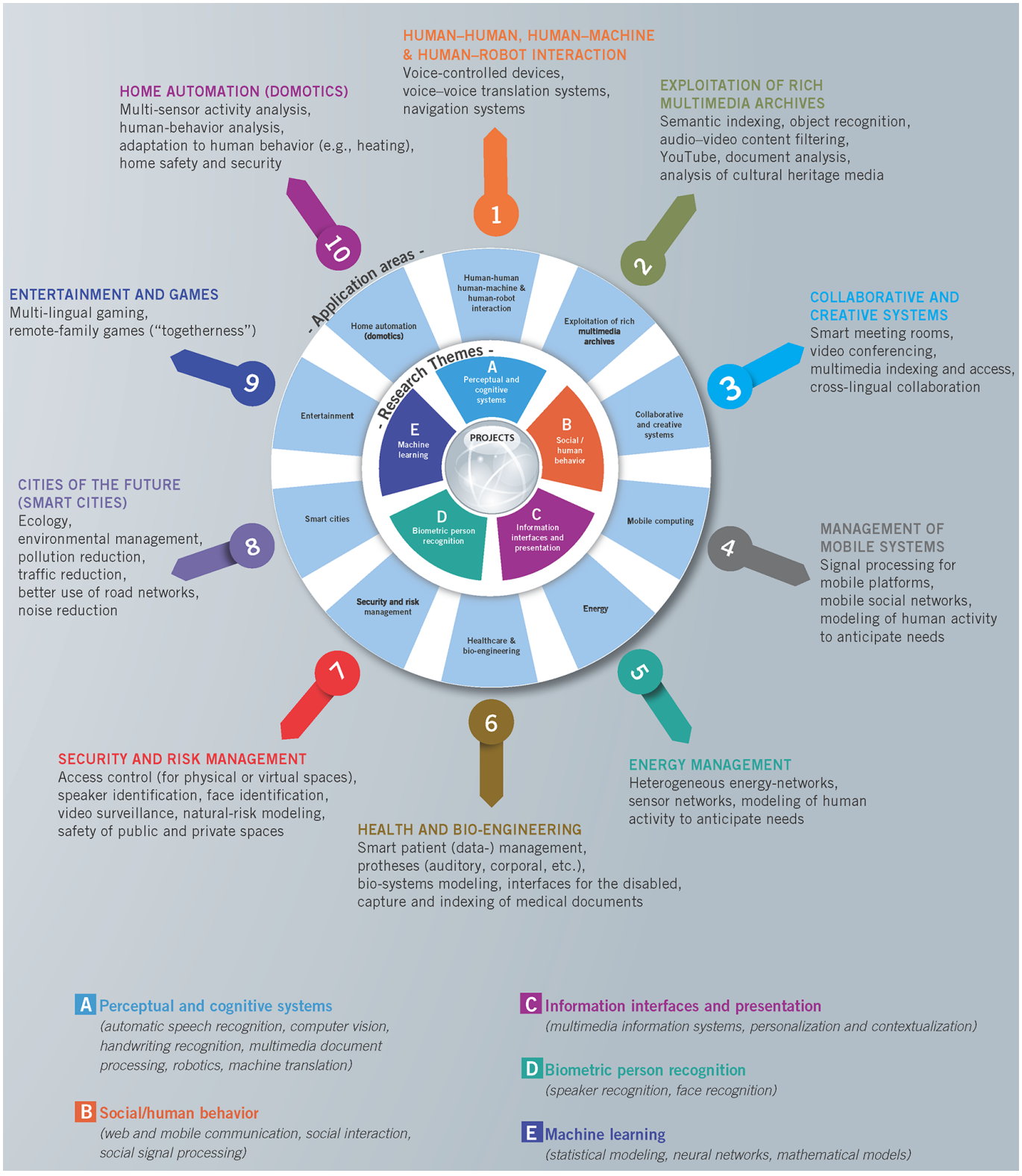

Figure 1: Illustration of Idiap research themes and application domains.

1.1.1 Research

All of Idiaps R&D activities revolve around the idea of closely-related multi-disciplinarity. This typically involves *combining advanced signal processing and machine learning* (learning from large amounts of data) with applications in complementary, but also strongly related, areas. These areas include multimodal human-machine, human-robot, and human-human interaction; multimedia information management (audiovisual, new media, knowledge engineering); social computing (also referred to as digital sciences or digital humanities); as well biometric security. The latter has resulted in the recently created "Swiss Center for Biometrics Research and Testing".

Over the last 5 years, to further encourage collaboration, to share a common branding of the Institute, while still accommodating our continuous extensions of activities, Idiap provided itself with a new institutional overarching vision, referred to as **"Human and Media Computing"**.

A quite unique, independent, research institute, sharing a common vision: Besides the recognized quality of its work, Idiap's success is also the result of the fact that it is probably one of the very few institutes of its kind where several different, but highly complementary research disciplines (in terms of technologies, as well as research and application potential) are tightly working together, sharing the same focused visions (regularly updated based on feedback and internal innovation meetings, as well as through their involvement in multiple international projects). As a consequence, we thus believe that this success is also due to the unique multi-disciplinary research, taking place in a same, dynamic, institute targeting common goals, as briefly discussed in the present document.

Main research themes: Actually, and in spite of its "diversity", all of our research themes are exploiting common, leading-edge expertise in *signal processing*, *statistical pattern recognition*, and *advanced machine learning* (including neural network modeling). As illustrated in Figure 1, the description of our current research activities can, however, be "clustered" around five big themes: (1) **Machine learning**, including statistical and (deep) neural network based machine learning, computational efficiency, targeting real-time applications, very large datasets, and online learning; (2) **Perceptual and cognitive systems**, including multilingual speech processing, natural language understanding and translation, document and text processing, vision and scene analysis, multimodal processing, cognitive systems, and robotics; (3) **Social/human behavior**: including human behavior modeling, Web social media, mobile social media, social interaction sensing, social signal processing, verbal and nonverbal communication analysis; (4) **Information interfaces and presentation**, including multimedia information systems, user interfaces, and system evaluation; (5) **Biometric user authentication**, including speaker identification/verification, face detection/identification/verification; and multimodal biometric user authentication. New activities in biometric security should also be deployed over the next years through our recently created "Swiss Center for Biometrics Research and Testing" (http://www.biometrics-center.ch/).

However, and through our recent hirings, these R&D themes should also expand towards Computational Bioimaging (Dr. Michael Liebling), Robot Learning & Interaction (Dr. Sylvain Calinon) and Uncertainty Quantification and Optimal Design (Dr. David Ginsbourger), with applications, e.g., in environmental and energy management.

Databases, platforms, and reproducibility of research: To foster science and favor reproducibility in research, Idiap will continue its policy of offering access to its databases, platforms, software, and will continue developing new tools to support research activities, including in new areas such as in Energy (EPFL Valais) or Digital Sciences (EPFL), which always seems much more difficult in the context of large institutions (as also underlined in the recent International Audit Report).

1.1.2 Training

In collaboration with EPFL, and building upon the Idiap-EPFL Joint Development Plan (initially signed in 2008 and renewed in 2012), Idiap is also strongly involved in training and education activities. Training involves the supervision of multiple PhD students, master/intern students, and students coming from diverse international visitor programmes, including, e.g., Marie-Curie exchange programmes or Swiss Government Excellence Scholarship. Education involves teaching activities mainly at EPFL (currently 1 master level and 9 doctoral level courses), but also as invited teacher/professor in different universities. We have also developed several internal skill development courses, e.g., to improve research methods, writing/presentation skills, as well as to foster the entrepreneurial spirit.

Some of these academic activities are recognized by academic titles, currently from EPFL (1 full professor, 1 adjunct professor, and 2 MERs). It is however expected that these academic titles could be generalized through other universities, as it is the case with Dr. David Ginsbourger, recently hired at Idiap and who will keep his academic affiliation with the University of Bern.

PhD students: As of this writing, Idiap is funding and directly supervising around 35 PhD students, all of them registered at EPFL and most of them enrolled in the EPFL EDEE (Electrical Engineering) Doctoral Program.

Teaching activities: Idiap's personnel teaches 10 EPFL courses (1 at the MS level and 9 at the doctoral level).

Academic titles: To further strengthen our training activities, and according to the Idiap-EPFL Joint Development Plan, new EPFL academic positions should be open for Idiap's most prominent scientists (external MER, external Adjunct Professors, Tenure Track Assistant Professor, or full Professor). Currently, in addition to the Director (full EPFL Professor), Idiap is currently hosting 1 Adjunct Professor (Prof. Daniel Gatica-Perez, "Professeur Titulaire") and two "Maîtres d'Enseignement et de Recherche" (MER), Dr. François Fleuret et Dr. Jean-Marc Odobez.

Besides our strong affiliation with EPFL, we also collaborate with many other universities. Following the recent hiring of Dr. David Ginsbourger (currently Docent at University of Bern), we intend to extend some of our academic affiliations to other universities, including University of Bern, where Dr. Ginsbourger will keep his current titles and where his PhD students will be registered.

1.1.3 Technology transfer

Idiap is very active in multiple national and international technology transfer initiatives, and is also involved in numerous projects with industries, ranging from large institutions (e.g., Samsung, Facebook, Thales) to multiple SMEs (including Idiap's spinoffs). Besides these development projects, Idiap is also involved in Valais' "The Ark" initiative through their spinoff (incubator) IdeArk SA. It is also collaborating with PolytechVenture and is currently finalizing a formal collaboration agreement with a new technology incubator, Fintech SarL (located in Geneva).

To build and maintain optimal and sustainable relationships with industry and other partners (CTI/KTI projects), Idiap maintains a dedicated multi-disciplinary team of developers and programmers who transfer software, algorithms, knowledge, and expertise. Initiation of all these activities involves the newly created *Technology Transfer Office (TTO)*, which directly works with the *Development Group*, a dozen highly-talented software developers.

The organization of this Technology Transfer activity will be discussed in detail in Section 2.4, but is revolving around two entities, the Technology Transfer Office (TTO) and the Development Engineers Group.

TTO–Technology Transfer Office (Dr. Florent Monay and Dr. Hugues Salamin): This office consists of two persons, each committing 50% of their time to TTO tasks and the other 50% to development, as part of the Development Engineers group. The TTO is responsible for bridging the gap between researchers and industry,

identifying opportunities, building joint proposals (including CTI/KTI project proposals), maintaining an up-to-date technology portfolio, and managing our IPRs. Dr. Monay and Dr. Salamin being both ex-Idiap PhD students and researchers, they are in a perfect position to fulfill these duties.

Development Engineers Group (Mr. Olivier Bornet): Once a project has been initiated through the TTO, it is then the responsibility of the Development Group to take care of its proper implementation, in collaboration with the researchers whose technologies are being transferred. Although the TT activities of the Development Group remain limited in terms of time-commitment (with support to research projects being the group's main activity), it is worth noticing that the group is nearly self-funded through its industry collaborations, as can be seen in Table 1 (internal funding distribution), page 63.

As discussed in Section 2.4, TT activities also involve many other components, including the maintenance of a technology portfolio, a corporate sponsorship program, and collaborations with multiple other TT institutions.

1.2 Organizational Management

1.2.1 Statutes

Idiap is a fully autonomous, independent, research institute, self-managed in terms of administration and financial structure, as well as in terms of research, development, and technology transfer activities. For its academic activities, Idiap is bound to EPFL though a Joint Development Plan, initiated in 2008 and renewed every 4 years.

According to our official statutes, Idiap is registered (version of 11 November 2008, slightly modified on 23.02.2010) as "Fondation de l'Institut de Recherche Idiap". The statutes indicate:

> *L'Idiap a pour but de conduire des recherches fondamentales et appliquées dans les domaines de l'informatique avancée, ainsi que de contribuer à la formation supérieure et au transfert de technologies dans ces domaines.*
>
> *Il s'agit en particulier des secteurs suivants:*
>
> - *Traitement des signaux au sens large*
> - *Apprentissage automatique statistique*
> - *Traitement et reconnaissance de la parole*
> - *Traitement de l'image et de la vidéo*
> - *Gestion de l'information multimedia*
> - *Interfaces homme-machine multimodales*
> - *Interactions sociales, signaux sociaux*
> - *Systèmes d'authentication biométriques ainsi que tous domaines convergeant ou découlant de ceux-ci.*

The officially registered statutes of the institute are given in:
Annexes/1210_Statutes.pdf.

1.2.2 Operational and management structure

Figure 2 illustrates the current operational structure of Idiap.

- The **Foundation Council**[1] is the highest management body of the institute. It is composed of representatives of the founding members, in addition to other members representing the economic, academic, or political worlds.

  The President of the Foundation Council (currently Mr. Olivier Dumas) plays an important role as the link between the Council and the Idiap Direction. He meets with Prof. Hervé Bourlard, Dr. François Foglia, and/or Mr. Ed Gregg at least once a month, and more often if required.

  The Foundation Council typically meets three times a year, with the mission to assist the institute management to reach its general goals, approving the budget, final accounting figures, and annual administrative and scientific reports. It is also responsible for the optimal implementation of all regulations, including the Idiap-EPFL Joint Development Plan, as well as the recently deployed Internal Control System (SCI, see below).

  The Foundation Council is also responsible for hiring the Director and approving the main strategic trends of the Institute, including the hiring of senior staff members.

[1] http://www.idiap.ch/the-institute/organization/foundation-council

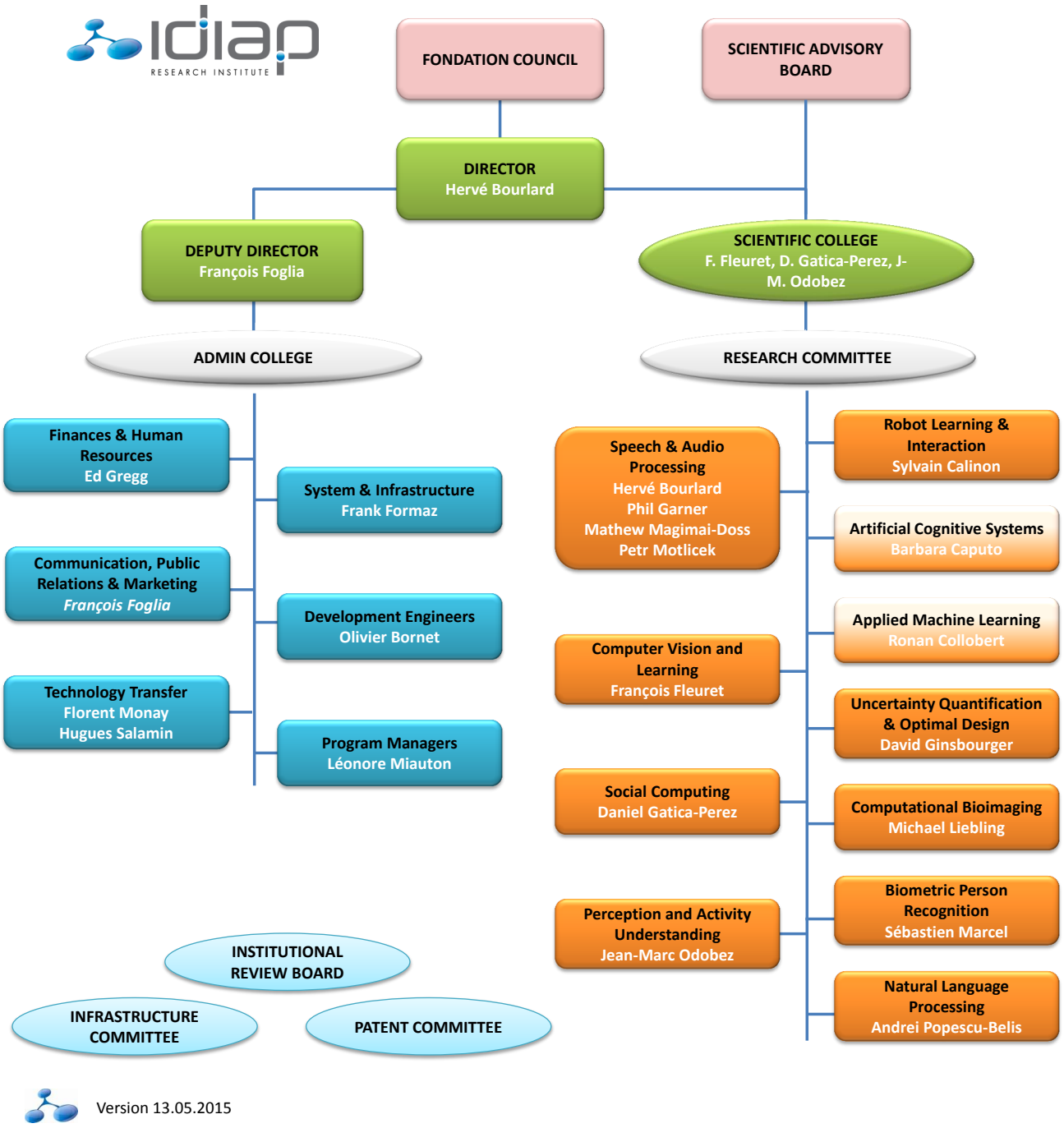

Figure 2: Idiap management and operational structure, including the main research and administrative responsibilities. For the research (right) block, managed by the Scientific College (in collaboration with the Research Committee), all names in white are key (autonomous) researchers, with clear supervision duties, who are all project PIs. On the left side, we find all the admin, IT management, and technology transfer activities, supervised by the Deputy Director, Dr. François Foglia, in collaboration with the Admin College. All those bodies are described over the next few pages (pointing to detailed job descriptions in Appendix). In additional to this management structure, we also have three "Internal bodies and processes" (Institutional Review Board, Infrastructure Committee, and Patent Committee), whose duties are described in Section 1.2.5. Finally, we also have a set of management tools and processes, all discussed in Section 1.2.6.

The list of current members of the Foundation Council, together with the description of its tasks and duties (also part of the Idiap Statutes), can be found in:
Annexes/1221_Fondation_Council.pdf.

- **Idiap Direction**: The Idiap Direction is currently composed of the Director (Prof. Hervé Bourlard), the Deputy Director (Dr. François Foglia), and the Financial Director (Mr. Ed Gregg, also supervising the Human Resources). The Direction is responsible for the day-to-day management of all Idiap activities and meets at least once a month (usually first Monday of each month) to discuss/identify open issues and/or divergence to our global planning, perform intermediate budget tracking, and evaluate the Institute performance in terms of projects, training, and technology transfer.

  Composition, tasks and duties of the Idiap Direction are given in:
  Annexes/1222_Cahiers_des_Charges.pdf#page=5, Part 1, page 5.

- **Director**: The Idiap Director, Prof. Hervé Bourlard, also Full Professor at EPFL, is hired by (and reports to) the Foundation Council through annual reports and about 3 annual face-to-face Foundation Committee meetings.

  The job description of the Idiap Director is given in:
  Annexes/1222_Cahiers_des_Charges.pdf#page=6, Part 1, page 6.

- **Deputy Director**: Dr. François Foglia, is hired by the Idiap Director, possibly in collaboration with the Scientific College, and upon approval by the Foundation Council. The Deputy Director, directly reporting to the Director, is responsible for all administrative and technology transfer activities at Idiap.

  The job description of the Idiap Deputy Director given in:
  Annexes/1222_Cahiers_des_Charges.pdf#page=7, Part 1, page 7.

- **Scientific College**: Taking collegial decisions about the general trends and key decisions about Idiap, the Scientific College is chaired by the Director and is composed of all permanent researchers with an academic title, at the Professor, Assistant Professor Tenure Track or MER level. The scientific college has large powers in the areas of research priorities, staff hiring, projects submission, etc. The Scientific College meets at least once a month, usually the first Friday of every month.

  The composition and duties of Scientific College is given in:
  Annexes/1222_Cahiers_des_Charges.pdf#page=10, Part 1, page 10.

- **Research Committee**: Composed of all permanent researchers (group leaders, senior researchers and PIs) the Research Committee is mainly there to ensure optimal communication between the Idiap Management, Scientific College, and all key researchers, primarily aiming at maximizing the collaboration potential, discussing (ongoing or future) joint projects, etc. It is also a forum for discussing and pre-approving all important issues (which are formally discussed and approved by the Scientific College), including research directions, hirings, and all internal activities promoting communication and collaboration.

  The Research Committee meets at least once a month, usually the first Friday of every month (just after the Scientific College meeting).

  The composition and duties of Research Committee is given in:
  Annexes/1222_Cahiers_des_Charges.pdf#page=11, Part 1, page 11.

1.2.3 Administration and technology transfer

The left part of Figure 2, page 7, concerns all the support activities to the core research activities, including finances, administration, and communication. However, it also concerns all the system and infrastructure activities, as well as all technology transfer activities, hence resulting in 6 groups.

1. **Admin College**: The Admin College's duties are to supervise all the administration, financial, IT and infrastructure, development engineers, technology transfer, and program management efforts. The admin college is currently composed of the Deputy Director and the head of each admin group below and meets every first Monday of the month to discuss open issues and status of previous action points.

   The composition and duties of Scientific College are given in:
   Annexes/1222_Cahiers_des_Charges.pdf#page=12, Part 1, page 12.

2. **Finance and Human Resources (Mr. Ed Gregg)**: The Human Resources Department (HR) is integrated within the financial and accounting activities of Idiap and has taken on a greater importance in the past year. With employees from over 30 different countries, the finances and HR department is continually growing to meet the needs of each employee.

   Tasks and duties of the Finance and Human Resource management are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=23, Part 3, page 23.

3. **Communication, Public Relations & Marketing (Dr. François Foglia)**: The mission of the communication, public relations and marketing department is to use all forms of media and communication to build, maintain, manage the reputation of the Institute, and to promote the Idiap services available for external institutions, such as EU project management, submission proposal tools, etc.

   Tasks and duties of the Communication and Public Relation group are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=29, Part 3, page 29.

4. **System and Infrastructure (Mr. Frank Formaz)**: The main mission of the system and infrastructure group is to provide an optimal and efficient work environment for the Idiap collaborators. The tasks can be split into three main activities covering: (1) centralized IT services for the whole Institute (network, storage, servers, workstations, high performance computing, identity management, data distribution), (2) support for collaborators (helpdesk, project specific tasks, web presence), and (3) Infrastructure (building, offices, equipments, central purchasing office).

   Tasks and duties of the System and Infrastructure group are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=24, Part 3, page 24-25.

5. **Development Engineers (Mr. Olivier Bornet)**: Technology transfer is also considered as one of Idiap's three core missions. One of the fundamental challenges is to facilitate the interface between the knowledge and the skills of the researchers and the needs of the industrial partners or potential spin-offs. To build optimal and sustainable relationships with industry and other partners (e.g. through CTI/KTI projects), Idiap maintains a dedicated multi-disciplinary team of developers and programmers who transfer software, algorithms, knowledge, and expertise. This technology transfer is usually done by granting rights on the commercial exploitation of this technology (through license).

   Tasks and duties of the Development Group are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=26, Part 3, page 26.

6. **Technology Transfer Office (Dr. Florent Monay and Dr. Hugues Salamin)**:

   This group consists of only two persons (dedicating 50% of their time to TTO and the other 50% to development, as part of the Development Engineers group), but represents the key link between researchers, development engineers, and industry. Besides maintaining Idiap's technology portfolio, and responding to industrial contact requests, they also pro-actively seek out new opportunities. In this context, they also assist Idiap researchers and companies to develop joint projects, including CTP projects. They are also responsible to maintain a clear IPR strategy and track IP status across licenses, etc.

   Tasks and duties of the Technology Transfer Office are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=27, Part 3, page 27.

7. **Program Managers (Mrs. Léonore Miauton)**: The work of the program management team is divided into two types of activities. The first is the provision of services to researchers within the framework of European and Swiss projects. The second category includes activities ranging from event organization to database management, which are not directly linked to the management of research projects but facilitate the work of Idiap researchers.

   Tasks and duties of the Programme Manager group are available at:
   Annexes/1222_Cahiers_des_Charges.pdf#page=28, Part 3, page 28.

1.2.4 Controlling bodies and instruments

- **Scientific Advisory Board**: The Scientific Advisory Board[2] is a consultative committee, which primary mission it is to offer feedback and recommendations to Idiaps Management within the framework of biannual 1-2 days meetings. The Committees recommendations address Idiaps activities, including general scientific issues, research orientations, academic activities (including affiliation and Joint Development plan with EPFL), as well as our technology transfer activities.

  The composition and duties of International Advisory Board, as well as its last evaluation report, can be found in:
  Annexes/1240_IAB_Flyer_2013.pdf.

- **Internal financial controlling**: Annual budget is submitted to the Foundation Council before the end of the current year (usually in November). Annual accounting results are also submitted to the Foundation Council, usually twice a year: provisional accounting results usually at the beginning of the year, and final (audited) accounting usually in May.

  Final (audited) accounting results for 2014 and budget for 2015 are given in:
  Annexes/1241_Accounting_2014_Revised.pdf.

- **Financial auditing**: The auditing firm is chosen by the Foundation Council, and is changed regularly (at least every 3-5 years). The current auditing company is BDO in Sion (with headquarters in Fribourg). We note here that since 2011, and given the amount of our annual budget, as well as new EC requirements for institutions managing high-budget projects, we had to move from limited ("restreint") to full ("ordinaire") auditing.

  The audit report for 2014 is given in:
  Annexes/1242_BDO.pdf.

[2] http://www.idiap.ch/the-institute/organization/international-advisory-board

- **Internal Control System ("Système de Contrôle Interne" – SCI)**: The full auditing procedure mentioned above requires the set up and regular update of an Internal Control System (SCI), defining all the internal financial and management processes. The SCI is now an integral part of the annual financial auditing, and is always subject to improvements.

  The current version of the SCI is given in:
  Annexes/1243_SCI.pdf.

- **Risk analysis**: Over about the last 10 years, Idiap management has been maintaining a detailed risk management and contingency plan document. This document currently contains about XXXX **75** items, ranked (in a 1-to-5 scale) in terms of likelihood L and "criticity" C, where all entries with a risk $R = L \times C$ higher than a certain value have to be analyzed, with suggested contingency planning. This risk analysis document is also submitted to the Foundation Council for comments and advice.

  The current version of the Risk Analysis document is given in:
  Annexes/1244_Risks_Analysis.pdf.

- **International Audit**: The performance and progress of the Institute, as well as the quality of its researchers, has regularly been screened and measured against formal indicators in a Self Evaluation Report (see below). However, as Idiap is now slowly approaching its 25th anniversary, the Idiap management took the initiative in 2013 to hold a more in depth auditing of the institute to see how to further improve our performance. The Idiap management suggested auditing guidelines, as well as the composition of the audit committee, to the Foundation Council, converging (after a few iteration) to a commonly agreed document (to guarantee quality of the audit and avoiding conflict of interest). During the February 2014 meeting of the Idiap Foundation Council, and following the request of the internal management, the implementation of an international auditing of the Institute was approved. The audit took place at Idiap in September 3-5, 2014.

  The final 2014 International Audit Report report is available at:
  Annexes/1245_Audit_Report_2014.pdf.

- **Self-Assessment Report**: In addition to our Annual Scientific Report (available as a separate document), Idiap has now been carrying out (for the second year) a self-assessment exercise, with the aim of presenting a concise, clear, and factual picture of where we stand in terms of our organization, group structure, human resources, quality of projects and research staff, academic and professional activities, publications, and technology transfer activities. The first release was part of the material provided to the Audit Committee. However, this Self-Assessment report is now updated every year, with the second release submitted in March 2015. Based on feedback from different bodies, including the Foundation Council, we aim at continuously improving it and enriching it, with the goal to make Idiap always stronger.

  The last version of the Self-Assessment Report (March 2015) is available at:
  Annexes/1246_Self_Assessment_Report_2014.pdf.

1.2.5 Other internal bodies

- **Institutional Review Board (IRB):** The Institute is currently putting in place an Institutional Review Board (IRB) that will be in charge of reviewing and approving experiments that involve humans and are conducted by Idiap research staff. This responds to the need to systematize the increased participation of Idiap in non-invasive research that requires awareness and compliance with respect to ethics, privacy, legislation, data management, and other issues. As part of the process of setting the IRB, the Institute is currently reviewing best practices and standards adopted in Switzerland (e.g. EPFL Human Research Ethics Committee[3]).
- **Infrastructure committee:** As recently suggested by the Audit Committee (2014), and recalled in Section 6, we just set up an "Infrastructure Committee" (referred to as "an advisory group" in the Audit Report) tasked with planning future infrastructure investments. The committee is chaired by Frank Formaz, the IT manager, and composed of key researchers (although all permanent scientists are invited) to discuss the future IT investments. Minutes of the meeting are also distributed to all permanent staff for feedback.
- **Patent Committee:** Over the last few years, and following the repeated suggestions from our Advisory Board, Idiap started testing the feasibility and impact of submitting patent applications. This patenting process is now officially in place at Idiap with a allotted budget of CHF 30'000.-/year (covering a maximum of 3 patents/year). After submitting a preliminary "Invention Disclosure" (see below), anybody at Idiap is welcome and encouraged to suggest patent applications, and can call for a Patent Committee meeting which will take a go/no-go decision based on several criteria, including: (1) novelty of the idea, (2) "patentability" of the idea, and potential for industrial exploitation (ideally at least one interested industrial partner should already been identified). The patent committee is chaired by the Idiap Director and composed of (at least) one representative of the Technology Transfer Office, Dr. Phil Garner (senior research at Idiap with strong experience with industrial and patenting processes) , and the "inventor".

1.2.6 Tools and processes

- **Invention Disclosure:** As a necessary first step to any patent filing, an "invention disclosure" aims to identify a technology with a certain level of maturity and some promising economic potential. This invention disclosure is also used as a key bridge between Idiap and IdeArk, and a mandatory step (part of the evaluation criteria) for IdeArk's startups to initiate research collaboration with Idiap, hence releasing some technology transfer funding from IdeArk (see Section 2.4). On average, about ten inventions are disclosed per year at Idiap.

- **Project Management System (PMS)**: To keep track of all scientific projects submitted by the researchers, Idiap has developed a database in which all important data related to a project is recorded (such as status, starting/end dates, budget, partners). With this database, Idiap can follow closely the evolution and lifespan of submitted project (funds, acceptance rate, etc.). Since the creation of the database in 2010, more than 310 projects have been recorded.

- **Customer relationship management (CRM):** To manage industrial and research partners interactions, Idiap has developed its own Customer Relationship Management (CRM) system, providing us with an up-to-date list of institutions and industries we have already worked with in the past. This list is regularly updated and currently contains 735 entries of contacts and 560 company entries.

- **Project Time Accounting (PTA):** Idiap has implemented a formal time management system, based on our own online time management tool (to record the number of hours worked by employees during a pay period), resulting in monthly time-sheets to properly track the cost of projects, supervision and teaching

[3] http://research-office.epfl.ch/page-117376-en.html

activities, as well as overheads. While this is particularly important for projects related to technology transfer, this was also important to comply with EU Framework Programme for Research and Innovation regulations. Statistics (till 2007) about the number of ORS job openings and applications received are given in Section 4.2.

- **Online Recruitment System (ORS)**: Given the large amount of job applications received every day, Idiap has developed its own "Online Recruitment System" (ORS) where (1) all the job openings are advertised at the same place (http://www.idiap.ch/education-and-jobs), (2) through which candidates have to formally apply to, filling a mandatory form, upload CV and motivation letter, and give names and email addresses of references. All applications files are available to all permanent research staff, who can mark their interest if necessary, which will then initiate a detailed selection process, while otherwise rejection letters are automatically sent after 2 weeks. The 18 posts advertised in 2014 attracted more than 500 applications.

- **Electronic Data Management (EDM) (Gestion Electronique de Documents – GED)**: Idiap is currently in the process of implementing (and moving to) a full EDM system, where all admin, financial, and project data will be digitized (when necessary, e.g., for postal mails), centralized, and managed, and made available to all the persons involved with the right permissions. Of course, this also has to be consistent with our Internal Control System mentioned above. The first phase consisted in selecting, installing and testing the most appropriate tool, which resulted in the choice of licensing "M-Files" (Enterprise Information Management Solutions, https://www.m-files.com/). We are now in the process of deploying the system across the different groups, agreeing on some form of internal standard data structure, and starting with the Project Management group (i.e., with all documents related to projects, from submission, review outcomes, reports, etc.). This deployment phase should be going on at least till the end of 2015.

- **Staff Reporting System (SRS):** SRS is an online tool running on the Idiap Intranet for the management and tracking of individual periodic progress reports. It provides an easy-to-use electronic reporting tool, allowing all the Idiap staff to complete their progress reporting by simply filling a standard template (which can also be turned into a printable .pdf document). The report is available to the supervisor who can either accept it, comment it, or reject it (for given reasons). All reports are properly archived, and each individual, as well as the supervisors, can have access to past and current reports. For PhD students, this reporting is done twice a year (and the template fits the one expected from EPFL PhD students once a year, to avoid extra work). For postdocs and permanent staff, the report is due by the end of the year and used as a basis for the annual evaluation.

1.3 Staff

1.3.1 Staff overview

Statistics

All the details regarding Idiap's personnel resources, including Idiap staff statistics (as of 2014), are summarized in the Idiap *Vade-Mecum* (February 2015), presented at the very beginning (before the Table of Content) of the present document. This Vade-Mecum is largely distributed and exploited as a short (2 pages) fact-sheet to present a quick but complete overview of Idiap, including all key information, such as missions, budget, staff and facilities, organization, advisory board, PhD students, and pointers to the IdeArk companies.

Performance measures

All staff members have regular evaluation meetings, including a bigger one at the end of the year (also linked to salary reviews). They are also all encouraged to regularly perform a self-evaluation exercise, including h-index (they are all part of GoogleScholar, including postdocs and PhD students), number of high-quality publication, competitive projects, impact of their activities on the generation of "invention disclosures", technology transfer activities, academic activities, as well as professional services (awards, board memberships, etc).

Detailed Human Resources statistics (h-index, people flow and alumni, PhD student and PhD theses, etc) are provided in the **Self-Assessment report:**
Annexes/1246_Self_Assessment_Report_2014.pdf#page=21, Section 6.

The CVs of all key staff members are given as an Appendix at:
Annexes/1310_CVs.pdf.

1.3.2 Turnover of non-permanent staff

Besides PhD students (staying between 4 and 4.5 years, depending on whether they had an opportunity to spend time abroad as intern, which is always highly encouraged at Idiap), the staff turnover is quite satisfactory, with Postdocs also staying between 2 and 4 years (4 years being the maximum time possible with a "Postdoc" status), and very limited/natural senior turnover, as discussed in more detail below.

About 2 years ago, we identified a gap between Postdocs and Permanent Researchers, with very good Postdocs forced to leave Idiap (due to the 4 years rule) despite their high degree of expertise and contributions to Idiap, and the lack of funding for creating permanent positions. We thus created a new status, called "Scientific Collaborator" for exceptional Postdocs who are willing to stay at Idiap while being able to bring their own funding, or helping (permanent) Senior Researchers to bring that required funding. Although they do not have a permanent position, they are considered as key members of the Institute to maintain key activities. This is well aligned with some of the new initiatives planned by Swiss NSF in their *Multi-Year Programme 2017-2020*[4], including the "Postdoc Bubble".

The job description of the newly created function of "Scientific Collaborators" is available at:
Annexes/1222_Cahiers_des_Charges.pdf#page=20, Part 2, page 20.

1.3.3 Turnover of permanent staff

Departures of permanent researchers

- In 2013, Dr. Barbara Caputo (Artificial Cognitive Systems) left for La Sapienza Univeristy, Roma, where she is now Associate Professor, but remains affiliated to Idiap as an External Fellow.
- In 2014, Dr. Ronan Collobert (Applied Machine Learning) left for Facebook Research US, but remains affiliated with Idiap as an External Fellow.

[4] http://www.snf.ch/SiteCollectionDocuments/mehrjahresprogramm_2017_2020_e.pdf

In both cases, the External Fellow title is there to allow them to maintain some of their activities (and respective groups) over a 2-3 year phasing-out period (to finalize PhD theses).

Newly hired permanent researchers

In 2014, 3 new senior researchers were hired at Idiap, two of them starting in 2014 (Dr. Sylvain Calinon and Dr. Michael Liebling), and one (Dr. David Ginsbourger) starting in September 2015. A brief biography and short activity description is given below:

- **Dr Sylvain Calinon**: BSc/MSc EPFL (2001/2003), PhD Robotics EPFL (2007), Postdoc EPFL (2007-2009), Team Leader Italian Institute of Technology (2009-2014).
  - Start date at Idiap: May 2014
  - Expertise and name of the new group: Robot Learning and Interaction
  - *Short CV*: Dr Sylvain Calinon is a Researcher at Idiap since May 2014. He is also a Lecturer at EPFL and an External Collaborator at the Italian Institute of Technology (IIT). From 2009 to 2014, he was a Team Leader at the Department of Advanced Robotics, IIT. From 2007 to 2009, he was a Postdoc at the Learning Algorithms and Systems Laboratory, EPFL. He holds a PhD from EPFL (2007) awarded by Robotdalen, ABB and EPFL-Press awards. He has published over 70 publications and a book in the field of robot learning and human-robot interaction.
  - *Short activity description*: Research on human-centric robot applications, with the development of probabilistic models to encode movements and behaviors in robots in unconstrained human environments. In these applications, the models serve several purposes (recognition, prediction, online synthesis), and are shared by different learning strategies (imitation, emulation, incremental refinement or stochastic optimization), which solicits tight links between robot learning, planning and control. The aim is to facilitate the transfer of skills from end-users to robots, or in-between robots, by exploiting multimodal sensory information and by developing intuitive teaching interfaces.
  - *Key scientific output*: Statistical models of manipulation skills based on task-parameterized hidden Markov models and Gaussian mixture regression have been developed to enable robots to generalize movements to new situations. This is achieved by exploiting the variability of human demonstrations (discovery of repeated structures in multiple coordinate systems) to regulate the stiffness and damping parameters of the controller.
- **Prof. Michael Liebling**: MSc Physics EPFL (2000), PhD Image Processing EPFL (2004, SSBE Research Award), postdoc at California Institute of Technology (2004–2007), Assistant Professor, University of California Santa Barbara (2007–2013), Associate Professor (with tenure), University of California Santa Barbara (2013–2014; on leave since 2015).
  - Start date at Idiap: July 2014
  - Expertise and name of the new group: Computational bioimaging group
  - *Short CV*: Michael Liebling studied at EPFL (MS Physics, 2000, PhD Image Processing, 2004). From 2004 to 2007, he was a Postdoctoral Scholar in biology at the California Institute of Technology. He then joined the Department of Electrical and Computer Engineering at the University of California Santa Barbara (UCSB), where he served as Assistant Professor (2007–2013) and Associate Professor (with tenure, 2013-2014, on leave since 2015). He joins Idiap as a senior researcher in 2014. Michael Liebling is the recipient of the 2004 Research Award of the Swiss Society for Biomedical Engineering. He was granted prospective (2004–2005) and advanced (2006–2008) researcher fellowships from the Swiss National Science Foundation. He received a Hellman Family Faculty Fellowship (2011). Michael Liebling is chair of the IEEE Signal Processing Society's Bio-Imaging and Signal Processing Technical Committee (BISP-TC 2014–2015) and was Technical Program co-Chair of the IEEE International Symposium on Biomedical Imaging in 2011 and

2013 (ISBI'11, ISBI'13). Michael Liebling is co-recipient of the 2014–2015 Northrop Grumman "Excellence in Teaching Award" at UCSB.

- *Short activity description*: Research in the Computational Bioimaging Group focuses on developing image acquisition, reconstruction and analysis algorithms to study live biological systems. Practical tools aim at (i) extending the physical limits of imaging hardware via techniques including super-resolution and multi-view, space variant deconvolution, and (ii) quantitative analysis of complex biological systems, including motion-based image analysis, cell tracking, microscopic fluid flow estimation, and integration of multi-modality images.
- *Key scientific output*: Recent milestones include the reconstruction of 3D volumes of the beating embryonic heart at frame rates equivalent to over 1000 volumes per second, temporal super-resolution for sensitive fluorescence cameras, and observation and quantitation of heart development in animal models.

- **Dr David Ginsbourger**: BSc Mathematics (2002), MSc/Dipl.-Ing. Mines Saint-Etienne and Technische Universität Berlin (2005), PhD Applied Mathematics Mines Saint-Etienne (2009), Assistant in Mathematics and then Postdoc in Stochastic Hydrology, University of Neuchâtel (2008-2010), Habilitation in Statistics and Applied Probability, University of Bern (2010-2014), Dozent at the University of Bern (2014-).
  - Start date at Idiap: September 2015
  - Expertise and name of the new group: Uncertainty Quantification and Optimal Design
  - *Short CV*: David Ginsbourger has been working as senior assistant (Oberassistent) and then Dozent at the Institute of Mathematical Statistics and Actuarial Sciences of the University of Bern since 2010, and as scientific coordinator of the ReDICE Consortium from 2011 on. He defended his Habilitation in Statistics and Applied Probability at Bern in 2014. Prior to that, he had been at the University of Neuchâtel as Postdoc in Stochastic Hydrology (2009-2010) and Assistant in Mathematics (2008-2009), and at Ecole Nationale Supérieure des Mines at Saint-Etienne (2005-2008) where he defended his Ph.D. in Applied Mathematics in 2009 under the co-supervision of Anestis Antoniadis (Grenoble I) and Laurent Carraro (Mines). His main research interests are in Gaussian Process modelling and in Bayesian global optimization and inversion, with applications in natural sciences and in engineering. He is currently involved as PI and co-PI in two further research projects funded by the Swiss National Science Foundation, and has been serving as referee for a number of scientific journals and as Associate Editor of the Journal of Statistical Computation and Simulation.
  - *Short activity description*: The Uncertainty Quantification and Optimal Design group focuses on quantifying and reducing uncertainties in the context of hi-fidelity models, with a main expertise on Gaussian Process methods and sequential design of computer experiments for optimization, inversion, and related problems. Application domains notably include energy and geosciences, with a number of collaborations ranging from safety engineering to hydrology and climate sciences.
  - *Key scientific output*: Main contributions in Bayesian optimization related to sequential and batch-sequential global optimization strategies for expensive-to-evaluate objective functions, especially Expected Improvement algorithms. Further contributions in Bayesian set estimation and uncertainty quantifications on sets, notably for the estimation of excursion sets and other implicitly defined regions of interest with Gaussian random field models. Incorporation of degeneracies and invariances within kernel methods, with applications in high-dimensional Gaussian Process modelling and function prediction under structural constraints.

2 Current and Future Activities

2.1 Introduction

Main objectives: As already introduced in Section 1.1, the main objectives of Idiap can be summarized as follows:

1. **Research activities**: Conducting fundamental research projects at the highest level in our identified multi-disciplinary and complementary areas and well targeted application domains. As confirmed by the funding distribution presented in Table 1, page 63, this research is carried on by a dozen of permanent researchers (funded *on average* on the basis of 75% of public/structural funding and 25% of soft/competitive funding), in collaboration with postdoctoral researchers, scientific collaborators, and PhD students, entirely funded on the basis of competitive projects.

   In the following, we start with Section 2.2, describing in 2-3 pages the mission of each of the research group, their recent achievements, and the foreseen research activities for the next 2017-2020 programme.

2. **Academic and training activities**: Maintaining excellence in training and academic activities in the context of our relationships with EPFL, as well as by exploiting our large academic network. Training activities mainly include the supervision of an average of 35 PhD students, in addition to visitors and master students. All those students are entirely funded by competitive projects, and supervised (or co-supervised) by one of the permanent researchers. Our academic activities are mainly developed through the Idiap-EPFL Joint Development Plan, although some of them are also part of academic networking activities (such as EU Marcie-Curie International Training Networks).

   In Section 2.3, page 45, we discuss the main academic and training activities, followed by a short discussion of how this very successful programme could be further improved.

3. **Technology transfer activities**: Besides fundamental research, training and education activities, Idiap is also contributing considerably to the economic development of Valais (and beyond), and is strongly involved in Technology Transfer (TT) activities, transferring research results (technology, software, algorithms, and more generally knowledge, know-how, and expertise) to interested industrial partners, startups or direct Idiap spin-offs. This is done on the basis of multiple instruments and processes, discussed in Section 2.4, and is specifically supported by a fully dedicated TT and development group. This group is composed of a dozen of highly talented development engineers, all interested in research, some even with a PhD, but who decided to mainly focus on prototyping and making fully operational the research outcomes.

   In Section 2.4, page 49, we describe our main technology transfer activities as we foresee them over the 2017-2020 phase.

Independence and complementarity of the different research and development units: since this may not be immediately clear from what follows in the next sections of this document, it is important to emphasize the following characteristics of Idiap's approach to the organization of research:

- All group leaders are quite autonomous, and are fully responsible for the development of their group, bringing in research projects, PhD funding, visitors, research contracts with industries, etc. The group leaders are thus entirely responsible for the sustainability of their research group, although Idiap keeps encouraging inter-group collaborations and projects involving multiple groups (which has always been one of the key strengths of Idiap). However, within these responsibilities, they are also free to adapt their research domains, as long as these remain within the scope of Idiap's core mission and, ideally, after they have been discussed within the Research Committee. Actually, as can be seen from Table 1, page 63, it is even expected that at least 25% of the PI's funding will come from projects, although Idiap's core funding will always remain available as backup to go through difficult times.

- As can also be seen from Table 1, page 63, most of our Technology Transfer activities are self-funded. And, given the high demand, it is expected that this group could significantly grow, however at a risk of jeopardizing its stability and not being able to keep/fund a larger group of people at any moment without some part of the public funding to cover the additional risks.
- As is obvious from the upcoming sections of the present document, all groups are usually working at full capacity, making it difficult, or nearly impossible, to answer new demands or, of course, to start entirely new strategic activities in areas related to energy, cyber-security, or smart cities, as often suggested by EPFL (in collaboration with EPFL-Valais-Wallis). Idiap is actually facing new demands every day, and has to reject most of them for the above reason. This is yet another reason why the 2017-2010 budget (discussed in Section 3) is seeking additional funding to provide more opportunities for incremental diversification, staying perfectly aligned with our core business, while also allowing us to be more "opportunistic" and responsive in our research and TT activities.

2.2 Research Activities

2.2.1 Speech and Audio Processing

Overview

Heads: Prof. Hervé Bourlard (MS and PhD, Polytechnic University, Mons, Belgium, 1982 and 1992), Dr. Philip N. Garner (MEng, University of Southampton, UK, 1991; PhD, University of East Anglia, UK, 2011), Dr. Mathew Magimai-Doss (MS by Research, Indian Institute of Technology Madras, India, 1999; PhD, Ecole Polytechnique Fédérale de Lausanne, Switzerland, 2005), and Dr. Petr Motlicek (MS and PhD, Brno University of Technology, Czech Republic, 1999 and 2003).

Speech processing has been one of the mainstays of Idiap's research portfolio for many years. Today it is still the largest group within the Institute, and Idiap continues to be recognised as a leading proponent in the field.

The expertise of the group encompasses statistical (multilingual) automatic speech recognition (based on hidden Markov models, or hybrid systems exploiting connectionist approaches, recently revisited under the popular name of ' Deep Neural Networks"), (multilingual) statistical text-to-speech, and generic audio processing (covering sound source localization, microphone arrays, speaker diarization, audio indexing, very low bit-rate speech coding, and perceptual background noise analysis for telecommunication systems).

Main focus over the last Research Program (2012-2016)

During this period, the group has grown to around 20 people, typically comprising 4 senior researchers, 7 doctoral students, 7 post-doctoral researchers and 2 visitors. Additionally, one or two students from other groups are jointly supervised from the speech and audio processing group, and two developers are closely associated.

Speech modelling: We have always used both neural network and Markov model based approaches, leading to the KL (Kullback-Leibler) HMM approach to fusion of neural network and HMM based speech recognition, especially for multilingual speech modelling. The Juicer WFST (weighted finite state transducer) open source speech recognition software is still widely used. Although the group has traditionally worked with English speech, many recent projects are multi-lingual in nature. This has in turn become a focus of the group; one that we are well placed to capitalise on given our geographical location.

Speech synthesis and translation: Although the group does not address translation directly, it has provided a unifying focus for work on speech synthesis. It is complementary to the general multi-ligual focus. Use of techniques from HMM based speech recognition in HMM based speech synthesis resulted from this unified approach. In turn, the combined expertise has been used to address very low bit rate coding.

General audio processing: Although the signal of interest does tend to be speech, many techniques do not analyse the speech itself. The group has made several key contributions in microphone arrays, including ad-hoc microphone arrays. Sparse model based approaches have led to novel algorithms for source separation. The agglomerative clustering approach to speaker diarization is well regarded.

Dissemination activities: Much of the group's recognition has come from contributions to the speech and audio community; these include the AMI corpus[5] and the Juicer ASR decoder[6]. More recently, the MediaParl database has been released[7]; other contributions such as ISS and SSP are on the GitHub site[8]. The group is also

[5] http://www.idiap.ch/dataset
[6] http://juicer.amiproject.org/juicer/
[7] http://www.idiap.ch/dataset/mediaparl
[8] https://github.com/idiap

very active in contributing to KALDI – open-source ASR toolkit[9]. Finally, the work in this group also resulted in a couple of spin-offs, including dev-audio, Koemei, and ReMeeting.

Main research themes over 2017-2020

Speech, audio and language technology continues to be taken up by industry. Advances such as voice search on Android, SIRI on iPhone and the forthcoming voice translation in Skype serve not only to define the state of deployment, but to guide the future of the field. The flourishing "deployment" field drives a diverse technical field along with a healthy demand for suitably qualified PhD graduates.

With numerous incremental improvements, the state of the art for the building blocks can be rather complex, raising the entry level significantly. This requires that we make use of available toolkits, and contribute to them where possible.

For 2017–2020, the foreseen leading R&D themes are briefly discussed below.

Joint ASR & TTS: The application of speech to speech translation, along with the unification of technologies for ASR and TTS, has seen TTS become as important as ASR in Idiap's technology portfolio. We envisage that this will continue as both ASR and TTS take advantage of recent "deep" neural approaches. In continuing to focus on both ASR & TTS together, the group will continue to both drive the underlying technology as well as fully benefit from advances in either domain. It is a long term goal of the speech community in general to unify the underlying representations for ASR and TTS.

One example is the recent phonological encoding work, where the symmetrical approach has led to a totally novel approach to low bit-rate speech coding. This is related to the concept of speech feature representation, where we are moving away from traditional phonetic representations.

In general, we see ASR, TTS and coding as different facets of the same underlying technology.

Multilingual ASR & TTS:

It is no longer appropriate to work simply in English, or even in the main languages of the EU (which happen to align with those of Switzerland). A defining aspect of the Swiss speech and language scenario is that it is multilingual. It is also multi-dialectical; Swiss German speakers can readily understand each other, but many voice applications have difficulty.

We intend to focus of the peculiarities of the Swiss language scenario, but in a manner that generalises to under-resourced and difficult languages worldwide. We expect that the same approaches that allow a machine to respond correctly to the German dialect in high-Valais will be the same techniques allowing news organisations to monitor developments in places such as Ukraine, Afghanistan and Yemen.

Monolingual speech recognition tends to work with a manifold defining a given language. The technical approach to multilinguality is likely to involve separating this into a language independent manifold defining the range of the human vocal apparatus, and a path within that defining a language or dialect.

Although Idiap is in a multilingual country, true multilinguality does imply collaboration. To this end, we are pursuing collaborations with British, French, Austrian, German and international partners.

Assistive speech technologies: The goal of this research theme is to build upon the fundamental speech processing research to develop assistive speech and language technologies and applications. Example areas of such applications include pathological speech processing, computer aided language learning, hearing aids, automatic assessment of online learners, speech-based clinical diagnosis, voice-enabled technologies for handicaps and

[9] http://kaldi.sourceforge.net

robot interaction. The research envisioned under this theme is of inter-disciplinary nature that goes beyond traditional stand-alone speech technology research. Specifically, we plan to conduct research that would involve perpetual interaction and collaboration between speech technology researchers at Idiap and researchers from other disciplines such as clinical medicine, teaching (pedagogy), health care, social science, computer vision.

Large data mining (Internet of things): With the advancement of communication devices and technologies, unstructured audio content is continuously exploding. The goal of this research theme is to bring together the outputs of individual fundamental speech and audio processing research areas, such as speech and music signal processing, ASR, TTS, keyword spotting, speaker recognition, speaker diarization, language recognition to develop approaches for structured storage and content linking, and efficient retrieval and mining of rapidly growing audio contents.

Massive multilingual speech and language processing (data mining): Many of the speech processing technologies have already proved their accuracy and robustness in laboratory environment when applied in an offline mode. Among them we can encounter automatic speech recognition or keyword spotting detection, and other detection and identification tasks such as the detection of language, age, accent or dialect and speaker diarization. Among them speaker recognition technologies ((a) verification – determining client's identity using voice, prevention of fraud; (b) identification – identifying persons using their voice for intelligence and investigative applications) become of large interest. Idiap intends to transfer most of these technologies to perform in a real-time mode, and to support scalable solutions.

Speaker diarization: Automatically structuring speaker related information on massive databases is also a target for Idiap in the next years. State-of-the-art speaker technologies detecting speaker turns, diarizing, linking and tracking speakers on the media need a major re-design if they are to be used on audio from big data. These technologies will emphasize building high performing and scalable systems that are able to tackle the challenges found in large speech corpora involving thousands of speakers, multiple languages and unknown recording conditions. Special attention to ever growing data will be given through the development of incremental and online approaches that can take advantage of any structuring source, such as unsupervised machine learning, together with a certain degree of supervision and even sinergy with other speech technologies such as speech and language recognition systems.

Full exploitation of big data as available from internet: As many social media sites comprise more and more video, the challenge becomes one of adding value to the new content. Such content is not expected to be professionally marked up, and is hence likely to require all the component technologies from the ASR field: language identification, speaker identification, diarisation and of course ASR. These technologies are available; the challenge is getting them to work together, and smarter. Speaker ID should track speakers across media, language ID should identify dialect as well as language, dialect ASR should not require a distinct recogniser for each dialect.

General audio processing: Thus far, the group has pursued projects where the audio signal of interest is speech. We aim to diversify from this case towards truly general audio. Cases include music data mining and classification. For instance, this could involve the Montreux Jazz Festival, which has extensive records.

Novel ASR and TTS approaches: The concepts of hands-free communication and smart spaces in general have led to the ideas behind microphone arrays and multi-channel sensing. The high dimensionality associated with arrays presents many difficulties. Recent research favours sparsity techniques. In turn we are finding that solutions based on sparsity have applications in many speech and audio processing areas.

2.2.2 Computer Vision and Learning

Overview

Head: Dr. François Fleuret (MS École Normale Supérieure de Paris and University of Paris VI, 1995; PhD, University of Paris VI, France, 2000; Habilitation, University of Paris XIII, 2006; EPFL MER)

The aim of machine learning is the design of computer techniques that modulate their behavior according to exemplar data. This ability mimics in some respects animals and humans "learning", and allows to produce models whose complexity – from a quantitative standpoint – is beyond the reach of classical human design. It has resulted in technologies at the core of many modern every-day data-processing software and apparatus.

The objective of the Computer Vision and Learning group is to develop novel machine-learning techniques, with a particular interest in their algorithmic efficiency, and applied mostly to the processing of images and video streams. The research we conduct is both method and application driven. It can be motivated by a general and fundamental problem pervasive in data-analysis at large, but can also come from a concrete industrial application (e.g. person tracking, fast object detection, alignment of components in a manufacturing process).

Over the last five years, the group has been composed on average of four PhD students, and one or two developers working on industrial applications. We also maintain a sustained collaboration with EPFL's CVLab.

Main focus over the last Research Program (2012-2016)

Feature and sample selection: One of the core problems of statistical learning is the automatic selection of informative features (e.g. the expressions of which genes carry information for predicting a particular cancer). We have developed novel approaches to estimate jointly the amount of information conveyed by a group of features under an explicit statistical model. This is in contrast with existing techniques, which either estimate the information content of features *individually*, or rely on non-parametric models difficult to interpret. In parallel, we have investigated the selection of training samples, which has never been addressed with similar strategies. As for features, we looked for their joint information content, and designed a procedure that maintains a "good" sub-set of samples picked in a endless stream, allowing to exploit very large sets of samples with a limited computer memory.

Novel Boosting techniques: Boosting allows to build a complex predicting rule from an accumulation of simple decisions, and has been used successfully since the 90s as a "meta" approach to increase performance of other techniques. We have improved this classical algorithm in several ways. The first was to adapt it to very large feature and training sets by using sampling techniques. The methods we proposed look at subsets of both to decide how to prioritize the use of the available computation. We also adapted Boosting to the context of action selection for a simulated robot, to automatically find in exemplar sequences provided by a teacher what are the implicit intermediate goals the teacher solves.

Fourier-based fast object detector: In a more applied context, we have investigated the design of fast object detection techniques. Object detection is used for instance to locate faces for camera focus, or to detect pedestrians and obstacles for self-driving cars. We have proposed to use a standard mathematical result from signal processing which states that the Fourier Transform permits the fast evaluation of linear filters. By designing carefully an algorithm able to cope with hardware constraints (e.g. memory size and bandwidth), we have gained close to one order of magnitude compared to pre-existing state-of-the-art methods.

Multi-commodity networks for tracking: In a long-lasting collaboration with EPFL's CVLab around the design of a robust multi-camera tracking system, we have investigated how to maintain targets' identities and how to model the constraints between vehicles and their passengers. We have extended a graph-based model we proposed a few years ago, in which target motions are modeled as flows along the graph edges, and pedestrians

can only appear/disappear when a vehicle is present. Contrary to alternative methods addressing similar tasks, this approach is proven to get a globally optimal set of trajectories for both pedestrians and vehicles.

Main research themes over 2017-2020

The plan for the next four-year period follows the trend we have initiated over the recent years. Our overall objective remains the quest for the ability to learn from a very small labelled training set. In practice, animals or humans are able – thanks to the knowledge inherited genetically and observations in their early age – to learn the appearance of an object from a handful of exemplar images, or even a single one.

This objective entails two main challenges. The first is the modeling in itself: What is the proper class of models of an object to incorporate changes in illumination, occlusion, and pose variations that allow transfer of observations from a set of objects to another set of objects. The second is computational: Such models will require the observation of billions of examples to be properly tuned. This is likely orders of magnitude larger than the current standards.

Playground Learning: Over the recent years we have introduced and refined the idea of pose-indexed features. Instead of designing features invariant to undesired perturbations of the signal (e.g. changes in illumination and geometrical pose), we modulate the measurement of the features with a parametrization of the said perturbations. Doing so, we maintain the joint information between measurements, and shift the difficulty from modeling to computation.

We have applied with success this approach to the detection of deformable objects in complex scenes, and more recently to the estimation of geometrical poses in noisy images. This recent work introduces the general concept of "playground learning", which mimics the development of a child, and consists of using a high-quality signal (i.e. HD focused and properly illuminated images), possibly paired with additional modalities or prior constraints (e.g. multi-view, time consistency) to build a strong model of the object of interest with a limited prior information about its shape and appearance. This strong model is then used to work in challenging conditions (i.e. small and noisy images).

We are interested in pushing this concept forward, first as a mean to obtain extremely high accuracy on well-defined applied problems such as the tracking of surgical instruments, and second to extend this idea to more complex latent parametrization. In particular to incorporate richer geometrical poses (parts positions, deformations) and a modeling of external nuisances (occlusion and illumination changes). Such extension will require dealing with a difficult optimization scheme during the evaluation of the detector, since it has to visit a high-dimension and complex latent space.

Virtual generation of examples: Humans are able to "visualize" mentally how moving, deforming, occluding, or changing the illumination of an object of interest changes its appearance. Although this ability to imagine images is probably key in our aptitude to learn from very small training sets, it has been only very partially investigated for machine learning.

The complex pose parametrization we aim at in our extension of the pose-indexed approach could provide some answers in that direction. However, to scale up to generic models of deformation, it has to be data-driver instead of hand-designed. Starting from very large training sets, the techniques we will investigate will identify key local parts in images whose appearance changes can be reliably inferred under classes of perturbations. The main challenge is to come with a joint model to combine these parts, so that a single complete image picturing an object that has never been seen before could similarly be transformed realistically, providing a sound definition of what "similar image" means.

Exploration-exploitation for large-scale training: We have started investigating large training sets using bandit techniques and "Monte-Carlo Tree Search" which provide a sound statistical approach to the optimization of sequences of decisions, and has been applied with tremendous success to the game of Go. The navigation

in a very large repository of data amounts to a succession of discrete decisions: Which database to visit, which thematic sets in that database, which subset in that set, etc. and from there we can re-cast the problem of "finding good training examples" to apply MCTS.

This strategy is particularly adequate to deal with web-scale structure data repository, for which no principled learning approach has been proposed.

Our preliminary results were obtained on the selection of "good difficult examples", to achieve sub-linear computation time, and we now want to apply the same philosophy to the learning itself. In particular we will try to extend the classical stochastic gradient descent to that context, concentrating the computation over good samples that actually impact the model, even if they represent a infinitesimal proportion of the total of available examples.

Learned model analysis: Many machine learning techniques achieve excellent performance in image recognition without incorporating an explicit modeling of a proper latent state. While there have been a few attempts at such a modelling – for instance with the deformable part models – the vast majority of learning methods avoid it, and rely instead on invariant features and on very large training sets. This often amounts to what some have called a "glorified nearest-neighbor".

Surprisingly, there has been very limited work around the analysis of the predictors obtained with machine learning methods to assess if this is indeed true. Most of the conducted experimental analysis is limited to performance evaluation through the estimation of error rates, sometimes with a crude typology of the failure modes, and the behaviors of complex predictors often remain poorly understood, and unpredictable.

An important effort in our group will be around the development of sounds analysis methods, both through the production and use of highly controlled data-sets, and through the design of statistical estimators to probe the information content of the representations that emerge during training.

2.2.3 Social Computing

Overview

Head: Prof. Daniel Gatica-Perez (PhD, University of Washington, USA, 2001; EPFL Professeur Titulaire)

Social computing is an interdisciplinary domain that integrates theory and models from mobile and ubiquitous computing, social media, machine learning, and social sciences to analyze and interpret human and social behavior in everyday life, and to create devices and systems that support interaction and communication. In the last period, the Social Computing group was composed of 8-12 members each year, including one group head, one scientific collaborator, one research fellow (Marie-Curie and SNSF Ambizione), 2-3 postdoctoral researchers, 3-5 PhD students, and 1-3 visiting faculty and students.

Main focus over the last Research Program (2012-2016)

The main focus and research themes covered over the 2012-2016 period can be summarized as follows.

Ubiquitous face-to-face interaction: We have contributed computational models to automatically analyze pair-wise and small-group interactions in the workplace, using a variety of sensors (cameras, Kinect, microphone arrays, smartphones, and wearables), and inferring people's personality, hirability, emergent leadership, and stress. This work, blending computing and social sciences, has involved collaboration with Swiss academics in social psychology.

Social video analysis: We have developed methods to automatically characterize users and audiences of conversational video in social media sites like YouTube, through the automatic extraction of behavioral features including prosody, body motion, and facial expressions, and the use of video crowdsourcing techniques to enable high-level social analysis at scale.

Mobile data mining and crowdsourcing: We have designed large-scale studies involving mobile data collection and analysis (smartphone sensor data and mobile social media data like Twitter) in Swiss and Latin American cities to discover and interpret phenomena related to everyday life patterns like human mobility and social interaction. This includes the Nokia Mobile Data Challenge initiative in Suisse Romande, the Youth@Night Campaign to document nightlife patterns in Swiss cities, and the SenseCityVity challenge to engage youth in Mexico to collect multimedia items that document urban concerns.

Analysis of cultural heritage visual collections: We have developed methods for automatic visual analysis of ancient image collections, more specifically of Maya hieroglyphic codices. Our methods are designed to support specific expert needs and include visual retrieval and classification of hieroglyphs. This work has been developed in collaboration with archeaologists in Mexico, Germany, and the US.

Main research themes over 2017-2020

The research lines envisioned for the new Research Program period are briefly described below.

Ubiquitous face-fo-face interaction: Our overarching goal is to study everyday interaction "in the wild", building upon emerging wearable and ubicomp technologies. Three fundamental problems that we plan to address are the following. First, social cognition in the wild (e.g. how people reason socially about others) is far from being completely understood; we plan to develop crowdsourcing-based experimental methodologies that allow to understand some of these aspects. Second, we plan to develop automatic multimedia analysis methods that are capable of extracting subtle human behaviors and of inferring more nuanced social attributes. Third, we plan to design and develop social sensing technologies in a sensing-analysis-feedback loop to support

interaction in real-time. Some of this interdisciplinary work will be pursued through joint projects with partners in social psychology.

Social media: Social media will continue to grow and evolve, not only in current systems like Facebook, Twitter, and YouTube, but also through the emergence of new user bases and markets, interaction paradigms, and social practices. We will develop machine learning and crowdsourcing methodologies to address the following areas: analysis of geo-localized social media, which will continue to grow worldwide given the penetration of mobile technologies, and will represent a key source of knowledge to characterize cities; analysis of social video, a medium that is rapidly diversifying both at the level of user experience and in applications ranging from marketing to learning and education, representing an open field for research to understand users and communities; and analysis of social media in the developing world with focus in Latin American and African cities, which is still an understudied subject, from which seminal work can emerge, specially if it is connected to social innovation applications.

Urban computing: We will design new data analysis and machine learning methodologies to integrate social participation and a variety of urban data to explain phenomena in cities and to develop applications for urban stakeholders. This includes subjects related to mobility, human activity, public space, and citizen participation. Data sources will expand our current areas of expertise (phone data and social media data) to include open data, as well as transportation and energy data, in partnerships we will seek to establish with government representatives and companies. Our objective is to contextualize the developed methodologies at the Swiss and European levels, and also extend them in cities in the developing world.

Crowdsourcing: Crowdsourcing is a transversal theme to all our research. Crowdsourcing spans the design of theories and algorithms to incentivize participation in social and urban experiments, to collect and label data, to understand how such data is perceived and used, and to solve practical problems. Our work will blend theoretical and empirical work and include online experiments (e.g. to label large-scale data through the web) and physical experiments (e.g. through mobile experiments that connect people to the physical world in urban computing applications).

2.2.4 Perception and Activity Understanding

Overview

Head: Dr. Jean-Marc Odobez (MEng, Ecole Nationale Supérieur des Télécoms de Bretagne, France, 1990; MSc, University of Rennes 1990; PhD, University of Rennes, France, 1994; MER, EPFL, 2011)

The Perception and Activity Understanding group conducts research in human activities analysis from multimodal data (mainly vision, depth, and audio). This entails the investigation of fundamental tasks like the representation, detection, segmentation and tracking of people, the characterization of their state, and the modeling of sequential data and their interpretation in forms of gestures, activities, behavior or social relationships.

The research finds applications in many domains: surveillance (alarm detection; understanding of equipment usage), traffic analysis, human behavior analysis (e.g. for social sciences), human-computer (HCI) and human-robot interaction (HRI), or multimedia content structuring or analysis.

We address the above tasks through the design of principled algorithms relying on and extending models and methods from computer vision, statistical learning, multimodal signal processing, information or social sciences. In particular, one of the focus over the year has been to privilege the exploitation of probabilistic graphical models which constitutes a visual and flexible tool to model knowledge often described through interaction between random variables (pixels, object parts or states, modalities, contexte, parameter priors).

Main focus over the last Research Program (2012-2016)

During this period, the group was composed on average of 3 PhD students and 3 post-doctoral members. The main focus and achievements resorting to the overal goals are listed below.

Detection and Tracking: The group expertise ranges from the use of robust statistics for motion estimation, the design of human detectors in videos leveraging the spatio-temporal nature of their appearance, and tracking. In particular, embracing the Bayesian formalism solved through sampling we made significant contributions addressing both theoretical issues (hypothesis validity, approximation), and problem modeling issues (object representations, multimodal fusion, automatic scene-specific parameter learning...). Efficiency aspects have also been investigated, and led to real-time demonstrators of face and head pose tracking in the EU TA2 project, HUMAVIPS project (HRI domain), or person tracking in the VANAHEIM project (surveillance). A research licence of the multi-person tracking software has been sold to the Canon Research Center europe.

Temporal Data Mining: We investigated the design of mining algorithms for the unsupervised discovery of recurrent activity pattern, their causal relationships or the presence of cycles, in the challenging situation where observed data are caused by the superposition of multiple phenomena. Typical situations corresponds to multiple sensors recording the activities of multiple objects/people, like multiple cameras overlooking busy traffic scenes, or multimodal sensors (proximity, water, light sensors, etc.) in domotics applications. Relying on the probabilistic framework we proposed novel methods addressing the above challenges, discovering for instance both global states (e.g. phase of a traffic cycle) and local rules (right of way) that governs the occurrence of patterns/events. The framework is generic. It was applied to cameras of traffic and public settings in the context of the EU VANAHEIM and SNSF HAI project, audio microphone array data (collaboration with the EPFL LEMA lab), and hydrology and chemistry time series (collaboration with INRA, France).

Activity analysis: Under this umbrella, several application driven systems were designed in the context of different projects through the appropriate exploitation of our generic tools (video processing, tracking, temporal models,...) For instance, in surveillance, applications ranged from the modeling of queues in public spaces, the detection of left-luggages, or the detection of abnormal situations. In another direction, we are studying the

impact of music on human behaviors through the analysis of the bobbing and gait patterns of walking people in a project whose overal goal is to reduce antisocial behaviors at night.

Behavior feature extraction and person modeling: Sensing people and their pose or characteristics has different challenges depending on the sensing situations (sensor type, image resolution and view point, scenarios), which call for different methodologies and approaches. Over the years, we have made contributions and developed algorithms for pose estimation that span a large range of tasks and setups. For instance, for the joint learning of body and head pose classifiers in low-resolution surveillance scenes, we proposed a novel and generic framework for the unsupervised learning and adaptation of classifiers with coupled outputs or/and relying on weak labels. At the other end of the spectrum, we developed robust 3D head pose tracking from RGB-D Kinect-like sensors, allowing for the high accuracy required for fine grained non-verbal behavior analysis (see below). Or, we designed novel algorithms for face representations, joint audio-visual voice and face clustering, and person naming to address the automatic annotation of large media corpus (french ANR project SODA).

Non-verbal behavior and communication analysis: The group has pioneered work on visual attention modeling since 2005. Recently, it has also developed different sensing techniques for the recognition of subtle nods in conversations, the addressee of a person in an HRI context, as well as further advanced attention monitoring along two main directions. In the HHI and HRI context, we proposed probabilistic methods exploring the coordination existing between gaze, head and body motion during gaze shifts to better predict the attention direction, or the use of different forms of social context (who is speaking, to whom, about what) to set soft priors on different attention alternatives. In addition, to achieve higher accuracy, we designed novel gaze estimation methods from cheap RGB-D sensors and addressing common issues encountered in gaze estimation: variability of eye appearance due to head pose, low eye image resolution, scarcity of training data. Methods were applied in the SNSF SONVB and UBIMPRESS projects for social experiments.

Main research themes over 2017-2020

The last years have witnessed large improvements in the sensing capabilities of people, behaviors, and activities.

Major drivers for this trend were improvements in machine learning techniques that thanks to the ability to leverage on large training datasets have lead to more robust and efficient person and face detectors and trackers, classifiers, combined with the advent of new, cheap sensors like Kinect which have facilitated visual processing of close-range natural behavior.

Nevertheless, multi-person tracking in more cluttered scenes with variable viewpoints, the lack and small amount of training data for event analysis, the handling of non-frontal head poses and the robust extraction of cues in open situation with unknown persons still remains challenges in the perception of people and natural human-interaction computing. During the next period, we will address these challenges. Examples of research directions are given below.

Deep learning: Thanks to their ability at leveraging large amounts of training data deep neural networks have obtained important success on several classification benchmark of computer vision. However, the difficulties of reproducing some of these results due to technical factors or of understanding what has been learned limit their exploitation for other tasks, especially when limited training data is available. Which training factors (filter size and numbers, network depth and layer learning strategy, training error signals, initialization) affect the most the estimated models and what they have learned? Which architectures are adapted for multi-task learning (face detection, recognition, pose estimation, attribute recognition), and how can it benefit single tasks learning (e.g. requiring less training data for face recognition), and how does it compare to other learning paradigms ? In the coming years, we will investigate some of these questions for the representation of persons. In particular we will address face recognition and retrieval in combination with other multimedia cues for large scale applications, as we are starting to to with broadcast data and large video assets in the EU EUMSSI project.

Transfer learning and adaptation: Scene understanding and behavior recognition are required for effective surveillance systems. However, most studies have so far considered single or group of adjacent scenes. Despite the proliferation of cameras, the semantic similarity that can exist between scenes (e.g. several traffic scenes often share similar layout) has often be neglected and remains largely unexploited. We plan to investigate this problem by relying on the transfer learning paradigm, addressing the main questions that it raises, like how to define scene similarities (based on pixels, viewpoint, content, activities)?, what to transfer (labels, parameters), or how selective should it be to be useful, or how to exploit the large amount of unlabeled scene data for this task.

Robust perception for HRI or HHI: Accurate perception of people and faces suffers from several limitations, including non-frontal poses, occlusions, illumination, as well as two other important practical factors. First, mobile sensors negatively impact the captured signal, creating blur and causing short or long sensing interruption due to limited field of view. This is significant in HRI, where cameras are usually placed on board of a robot head, allowing for space exploration but whose gestures affect sensing, or when using wearable sensors like google glass. Secondly, the availability of cheap RGB-Depth sensors accurate at close range and the negative impact of distance on depth measures and on image resolution has led to different and distance specific methodologies, while real scenarios often require to handle both simultaneously. We will investigate gesture-aware, distant-aware, and interaction aware sensing strategies to address these issues, improving robustness and designing systems fusing depth, vision and audio to provide HRI systems a unified perception of all people it interacts with.

Interaction models and scenarios: While improving the extraction of non-verbal behaviors in natural interactions needs further robustness, exploiting them to analysis interactions and better characterize the social state (engaged, bored, upset, annoyed), the intent (agreement) and events (when is it the moment to speak or perform a backchannel) of the communicative cues, represent another challenge that has high value for applications in HRI or HHI. We will move into this direction, investigating sequence classification methods to derive higher semantic interpretation of the multimodal streams of non-verbal features (prosody, head and body gestures, gaze) in the context of different scenarios. This research will be done in collaboration with the Social Computing group (e.g. to analyse interaction behaviors in the workplace), or with the Robot Learning and Interaction group, to build teaching interaction models for robot skills transfer.

2.2.5 Artificial Cognitive Systems

Overview

Head: Prof. Barbara Caputo (PhD, Royal Institute of Technology, Sweden, 2005; Senior Researcher Idiap (2007-2013); Associate Professor, University of Rome La Sapienza, Department of Computer, Control and Management Engineering.)

The Artificial Cognitive Systems group works on the development of multi-modal learning algorithms to enable artificial agents to act autonomously in realistic settings, with a special emphasis on the ability to autonomously detect knowledge gaps and fill them autonomously with open-ended learning strategies. This research is crucial to allow robots to perform intelligent, autonomous behavior in unconstrained settings, such as assisting trained personnel and patients in care homes, providing portering services, e.g. carrying medicine or food to patients, and keeping the environment tidy. The focus of our work has been on designing algorithms that are principled, computationally efficient, and that provide robust performance in very realistic settings while at the same time providing theoretical guarantees on the expected behavior. Application-wise, the group has a long standing expertise in the modeling and learning of perceptual and semantic object models, i.e. models of objects able to support their recognition and localization in cluttered 3D scenes, as well as supporting acting upon the same objects by the robot itself, for instance manipulating it.

Main focus over the last Research Program (2012-2016)

The group is internationally recognized for its work on life long learning applied to the adaptive control of dexterous prosthetic hands and scene understanding. During the period 2012-2016, the group was composed on average by 3 PhD students. The main focus and achievements are listed below.

Since August 2013, Prof. Caputo has moved to the University of Rome La Sapienza, and this group is now phasing out.

Adaptive control of dexterous prosthetic hands: We worked on the development of a family of algorithms able to significantly augment the dexterity, and reduce the training time, for sEMG controlled prosthesis. Indeed, current the state of the art in commercial hand prosthetics does not offer more than 2-3 degrees of freedom and a very coarse control of the force, as there is no haptic feedback. Patients interface with the prothesis via surface electromyography (sEMG), recorded using surface electrodes. Learning how to control the device through many input sEMG channels is a long and difficult process for most patients, that therefore settles for limited and very simplified movements (open/close). We developed statistical learning algorithms able to recognize reliably up to 50 hand postures, hence significantly augmenting the dexterity of such devices. At the same time, we proposed learning algorithms to better interpret the sEMG signals acquired from the users, with the ultimate goal of boosting the learning process necessary for them to effectively use the prosthesis. We achieved this by building pre-trained models of various data postures, and adapting these general models to the needs of individual users as new data became available using adaptive online learning methods. We pursued this vision in the large-margin classifiers framework, developing a transfer learning algorithm across multiple subjects that assumes that all prior models and the new models to be learned by the new subject all contain the same number and type of postures. In such conditions, it is possible to show that leveraging over priors significantly boost performance with a highly reduced number of repetitions by the new user. This was funded by the SNSF Sinergia project NINAPRO.

Scene understanding: Our work on this theme focused on the development of algorithms able to visually learn semantic concepts that characterize rooms and indoor environment, such as names referring to the activities normally performed in them (the fitness room) and the objects they contain (the bedroom). This would make it possible then to take advantage of such knowledge also in working scenarios which differ from the original ones. Taking inspiration from biological models of human perception, we have identified two main components

for the representation of indoor scenes: (1) a description of the global appearance of the image in term of image features, and (2) a description of the local landmarks present in some regions of the image. From a computational point of view the two representations could be regarded as a global appearance description of the scene, for example by means of statistics of visual features, and as a statistical representation of the co-occurrence of local concepts and scene categories. The design and integration of computational models of these two perceptual components, suitable for indoor place categorization, constitutes the core of our research. We then casted the semantic spatial modeling problem into that of learning from multiple cues. Our contributions have been a principled online Multi Kernel Learning algorithm able to combine optimally multiple features while providing theoretical guarantees on the expected performance, and a global feature representation encoding at the same time task-driven and data driven spatial information. The combination of these two contributions has led us to obtain the state of the art in the field, as measured on reference benchmark databases. We also developed a new online transfer learning algorithm for leveraging over prior semantic spatial models in a dynamic, open-ended fashion, that allows to modulate the contributions of different prior sources in a principled manner. This work has been sponsored by the SNSF projects Vision@Home and ICS –Interactive Cognitive Systems.

Main research themes over 2017-2020

Since August 2013, Prof. Caputo has moved to the University of Rome La Sapienza, where she has started the Visual and Multimodal Applied Learning Group within the ALCOR Laboratory, while maintaining a partial affiliation at Idiap in order to continue the supervision of the two ongoing PhD students and funded projects. Hence, in the period 2017-2020, the planned R&D themes will be:

Learning to learn algorithms for robot systems: The ability of learning to learn, shared by humans and animals, implies that the more categories a biological cognitive system knows, the better it gets at learning a new one. Since entering the Big Data age, the visual recognition community has moved from problems handling hundreds of categories, to the challenge of categorizing thousands and more classes. As a consequence, the learning to learn paradigm has gained increasing attention. The problem is challenging because a core assumption in machine learning methods is that training and test images are drawn according to the same probability distribution. This is not the case in the learning to learn scenario, where in general one attempts to leverage over existing source knowledge to solve a different target problem, where source and target present a distribution mismatch. The challenge increases when one attempts to leverage over visual data found from Web resources, which are typically 2D and created by humans for human use, in order to boost the learning of a new object detected by a robot in its own environment, which will be perceived with 3D sensors, and from viewpoints possibly different from those usually chosen by us. We will investigate these issues with a combination of methods for mapping 3D data into 2D representations, algorithms for partial 3D reconstruction from 2D images, and learning to learn approaches that allow to exploit prior knowledge with minimal assumptions about the nature of such knowledge with respect to the new task to learn.

Local linear learning over very large scale data: The recent dramatic success of deep learning is strongly linked to their ability to learn structures from massive amounts of data. While this is certainly a positive asset of this family of algorithms, it leads to some limitations in the classification phase, as it limits the range of possible classifiers to be used in conjunction with these models to those at least linearly scalable. This means not being able to tap into the whole body of kernel machines and non-linear statistical classifiers. We will investigate how to develop algorithms able to learn non linear decision functions while at the same time being scalable over very large data collection by exploiting the local linear learning paradigm combined with online methods. We will in particular address the problem of learning objects on the fly for intelligent systems from 2D and 3D data, using existing deep convolutional network architectures as well as training our own networks where needed.

2.2.6 Applied Machine Learning

Overview

Head: Dr. Ronan Collobert (PhD, Pierre & Marie Curie University (Paris VI), 2004)

This group is interested in computer algorithms which can "learn" a behavior in order to achieve a given task of interest, in contrast to algorithms with behavior constrained by hand-crafted rules. Research is driven by real-world applications involving large amounts of data. Domains of interest include natural language processing, computer vision, and audio processing. A particular emphasis is placed on generic machine-learning tools which require minimum a priori knowledge of the data (such as deep-learning techniques), as well as on unsupervised learning techniques which can leverage inherent semantics from large-scale, structured data.

The Applied Machine Learning group is currently phasing out, as Ronan Collobert joined Facebook in 2014.

Main focus over the last Research Program (2012-2016)

The Applied Machine Learning group has been a pioneer in applying deep learning approaches to Natural Language Processing (NLP). In that matter, the group released "SENNA", a state-of-the-art renowned tool for a collection of NLP tasks. In image processing, the group has developed a state-of-the-art recurrent deep-learning architecture for Scene Parsing, a challenging computer vision task going towards scene understanding. The group has also delivered state-of-the-art face analysis tools to KeyLemon (a spin-off from Idiap), which uses them in production. In speech processing, we have been investigating new systems which can learn on raw speech, without the need of speech-specific features.

During this period, the group was composed of 4 PhD students. The group also had strong interactions with the software engineering team, in the framework of a CTI collaboration with the KeyLemon startup. The main focus and achievements resorting to the overal goals are listed below.

Natural Language Processing: We investigated new general machine learning algorithms for various NLP tasks. We leverage semantic representations (learned on large unlabeled corpora) in a *single deep network architecture* which outputs tags for several NLP tasks ranging from syntax analysis (Part of Speech tagging, chunking, syntactic parsing) to semantic analysis (Name Entity Recognition, Semantic Role Labeling). Our architecture is state-of-the-art both in accuracy and speed performance, while having the ability to *compose* phrases while retaining both syntactic and semantic information.

Image Object Segmentation: Object segmentation can be viewed as a classification task, which assigns a label to all pixels in an image according to the class they belong to. Most systems rely on costly graphical models to take a global decision from local classifiers. We investigated new efficient end-to-end systems based on recurrent convolutional neural networks, alleviating the need of any hand-crafted feature and allowing the modeling of complex spatial dependencies with a low inference cost. Compared to existing approaches, our system can be trained using only weakly labeled data, having only the class information of the objects present in one image, rather than the full labeled segmentation. Our system has shown state-of-the-art performance, both in the supervised and semi-supervised settings.

Image Captioning: We developped a system which generates sentences according to the representation of an image provided by a deep learning model. It leverages semantic vector phrase representations. The system reaches near state-of-the-art performance, both in speed and quality of the generated sentences, while being much simpler than existing approaches.

Speech Recognition: We investigated a new deep learning system which can label phonemes (or graphemes) directly from the raw speech signal (waveform), using convolutional neural networks. We proposed new state-

of-the-art techniques for training these type of models in a end-to-end manner. We also investigated the case where no (grapheme or phoneme) segmentation is given at training time, and proposed a new structured output approach for speech recognition.

Face Technologies: In the framework of a very applied project (with the KeyLemon startup), we developped deep learning algorithms for multi-pose face detection, head pose detection, facial feature detection, and gender detection. We delivered a state-of-the-art version of our multi-pose face and gender detection system, which runs in real time with good performance even in adverse conditions.

Torch: We are maintaining Torch[10] an open-source (BSD license) fast and scalable Matlab-like system, which serve us as an efficient platform to implement all our machine learning algorithms. Torch leverages Luajit, an extremely fast scripting language, which allows us to quickly develop complex demos and prototypes. Torch is widely spread, present in many international academic and private institutions (including Facebook, Google DeepMind, or Twitter). Thanks to its open-source nature, external contributors wrote various packages for a large number of application domains.

Main research themes over 2017-2020

Given the group is currently phasing out, the research vision is very short-term, and corresponds to the work involving each finishing PhD student. The leading R&D themes will be:

Semi-supervised object segmentation: We will investigate ways to leverage temporal coherence inherent to videos to infer the segmentation of objects in a semi-supervised way. We will be interested for both the cases were cues are given (such as the flow between two consecutive frames) and the fully unsupervised setup.

Machine translation with syntactic constraints: We are interested in ways to perform machine translation via a sentence encoder-decoder system, based on the syntactic parser we developped recently. Our parser has the advantage of being able to embed phrases in a semantic vector space, a crucial asset for machine translation.

Image captioning: We will improve our current image captioning system, by investigating ways to learn a common semantic vector embedding between images and phrases.

Spoken term detection: The speech recognition system built by our PhD student will be applied to the particular case of spoken term detection. For that purpose, we will leverage recent structured output learning techniques investigated in the speech recognition framework.

[10] http://www.torch.ch

2.2.7 Biometric Person Recognition

Overview

Head: Dr. Sébastien Marcel (PhD, University of Rennes, France, 2000)
The Biometrics group investigates, develops and evaluates novel pattern recognition and machine learning methods to process measurable distinctive human characteristics (physiological or behavioral) and to improve the security of biometric recognition systems that are becoming more prevalent on personal computers and mobile devices.

More particularly the Biometrics group has expertise in face recognition (2D, 3D, and near-infrared), speaker recognition, anti-spoofing (presentation attack detection), and emerging biometric modes (EEG and vein).

The research finds applications in many areas ranging from access control, video surveillance, border control, forensics, privacy-enhancement and e-Health.

The Biometrics group is geared toward reproducible research using its own open source signal-processing and machine-learning toolbox (BOB) and using rigorous methodologies for the collection and the distribution of biometric datasets.

Main focus over the last Research Program (2012-2016)

During this period, the group was composed on average of 3 PhD students, 3 post-doctoral students and 1 scientific collaborator. The main achievements of the Biometrics group for the 2012-2016 period are briefly summarized below.

Mobile biometrics: The Biometrics group has been pioneering the work on mobile biometrics (face and speaker recognition) by sharing the first open database (MOBIO https://www.idiap.ch/dataset/mobio), organising the first International competitions and producing the first reproducible research studies in the domain. This research topic initially funded by the European project MOBIO is still very active today. As a matter of fact, early 2015 the Biometrics group was chosen by Google to participate to a confidential on-invitation-only research sprint on mobile biometrics. The Biometrics group from Idiap was the only biometrics group from Europe invited to this sprint among groups from the United State of America.

Speaker recognition: The Biometrics group has quickly established a strong reputation in the speaker recognition community by embracing probabilistic session variability modelling techniques and more precisely the i-Vector technique which is currently considered as the state-of-the-art technique in speaker recognition. In addition, the Biometrics group participated to the latest major speaker recognition evaluations (SRE) organised by NIST in 2012 and 2014. The group was ranked 1st among 130+ participants to the last evaluation (https://ivectorchallenge.nist.gov). Also more recently, the group released a speaker recognition library (https://pypi.python.org/pypi/bob.spear) used during this NIST evaluation. This research topic was funded by the Swiss National Science Foundation (LOBI project) and the European project BEAT.

Face recognition: The Biometrics group has worked for many years on unconstrained face recognition. The group demonstrated that the same probabilistic session variability modelling techniques can be applied both to speaker and to face recognition. One of the main scientific achievement was the exact and scalable formulation of Probabilistic Linear Discriminant Analysis (PLDA) that solved a major limitation of the original algorithm. More recently, the group released a face recognition library (https://pypi.python.org/pypi/facereclib) designed to perform a fair comparison of various face recognition algorithms. This research topic was funded by the European projects BBfor2 and BEAT.

Robustness to spoofing attacks: Attacks on biometric systems can be divided into two types: direct and indirect. The direct attacks (also called spoofing) are performed at the sensor level. Biometric systems are

especially vulnerable in this case since the attack is performed outside the control of the biometric system. In a spoofing attack, a person seeks to gain an illegitimate advantage by masquerading as another individual, i.e. by claiming another person's identity and by deliberately falsifying their biometric characteristics. In contrast, indirect attacks are performed within the biometric system.

Currently, the Biometrics group is pioneering the work in face, speaker and vein anti-spoofing. More particularly, in face anti-spoofing, the group demonstrated that the current trend in discriminant-based anti-spoofing is prone to over-fitting hence resulting in a lack of generalisation on unseen spoofing attacks. In the context of the European TABULA RASA collaborative research project that aimed to investigate the threat of spoofing and to develop dedicated countermeasures, the group has co-Edited one book, two special issues (IEEE Transactions on Information Forensics and Security and IEEE Signal Processing Magazine), has published 25+ papers and submitted one patent. This research topic was funded by the European projects TABULA RASA and BEAT both coordinated by Idiap.

Main research themes over 2017-2020

For 2017-2020, and besides developing the "Swiss Center for Biometrics Research and Testing"[11], the Biometrics group is planning to follow several R&D avenues, as briefly discussed below.

Secure and privacy-enhanced biometrics: Cloud computing solutions are currently explored to complement mobile biometrics. Unfortunately cloud computing suffers from a major issue: security. Any information transmitted to or stored by a third-party cloud service provider has the potential to be compromised and exposed; any IT system is potentially vulnerable to indirect attacks. In contrast to direct (spoofing) attacks, indirect attacks are performed within the biometric system and are due to intruders, such as cyber-criminal hackers, bypassing the feature extractor or the comparator, manipulating the biometric references in the biometric reference database, or exploiting possible weaknesses in the communication channels. Such vulnerabilities are of utmost importance in the case of biometric data due to legitimate privacy concerns.

There is a need for more research to create novel protection mechanisms to ensure the security of biometric computing in the cloud as well as on mobiles. This will be achieved by leveraging on innovative privacy protection techniques, including advanced cryptographic techniques such as homomorphic encryption (HE). HE techniques for instance would allow for computation (biometric comparison) to be performed in the encrypted domain.

Mobile anti-spoofing: Prior work on anti-spoofing focused only on the development of countermeasures to spoofing attacks performed in an access control scenario. Nowadays, mobile biometrics is a reality but the spoofing problem remains. Unfortunately, an access control scenario (controlled environment) is very different from a mobile scenario (nomadic and uncontrolled environment). As a consequence, existing anti-spoofing techniques need to be evaluated on this new scenario, possibly re-designed or novel techniques proposed.

Heterogeneous face recognition: One of the most challenging task in automated face recognition is the matching between face images acquired in heterogeneous environments. Use-cases can cover matching of faces in unconstrained scenarios (e.g. at a distance), with long time lapse between the probe and the gallery and faces sensed in different modalities, such as thermal infrared or near infrared images (NIR) against visible spectra images (VIS). Successful solutions to heterogeneous face recognition would be applicable to covert scenarios, such as recognition at a distance or at nighttime, or even in situations where no face even exists (forensic sketch recognition). The key difficult in matching faces from heterogeneous conditions is that images of the same subject may differ in appearance due to changes in image modality (e.g. between VIS images and NIR images, between VIS images and sketches images) introducing high intra-class variations. We will investigate machine learning methods such as manifold learning or deep learning to find a joint mapping that project face images, of different modalities, into a subspace where these projections can be compared directly.

[11] http://www.biometrics-center.ch

2.2.8 Natural Language Processing

Overview

Head: Dr. Andrei Popescu-Belis (MEng, École Polytechnique, France, 1995; MSc, Université Pierre et Marie Curie, France, 1996; PhD, Université Paris-Sud, France, 1999)

The Natural Language Processing group studies how the analysis of texts at the semantic and pragmatic levels can contribute to two important tasks: machine translation and information retrieval. Research in the NLP group aims at improving the state of the art on core semantic and pragmatic analysis problems, such as semantic relatedness, disambiguation of pronouns or connectives, keyword extraction, or sentiment analysis. However, the group equally aims at demonstrating that these improvements are relevant to end-user tasks, i.e. that they contribute in a measurable way to increase objective performance of machine translation and information retrieval (specifically, recommender systems).

Regarding the first application, the NLP group combines text-level processing techniques with phrase-based statistical MT systems to improve translation quality and coherence. This is important to improve the acceptability and cost-efficiency of translation technology, which is in particular high demand in a multilingual setting such as Switzerland. Regarding the second application, the NLP group exploits content and sentiment analysis to improve multimedia recommendation over networked repositories, as well as just-in-time document recommendation for conversations. These applications have a high potential utility given the information deluge that we are witnessing, which requires an appropriate response from search technology and recommender systems, to avoid information overload.

Main focus over the last Research Program (2012–2016)

For 2012–2016, the main research themes and achievements of the NLP group are summarized below.

Semantic analysis of discourse connectives: We have shown how the semantic analysis of discourse connectives and verb tenses across entire texts increases the quality and coherence of machine translation at the text level – an innovation that has been received with significant interest by the community.

Learning semantic similarity from networks: We have designed a method for learning semantic similarity from networks, based on the notion of visiting probability, which reached or exceeded state-of-the-art scores on several NLP tasks such as word similarity, paraphrase detection, document classification, and document ranking.

Using semantic vector spaces for recommendation: We have demonstrated that semantic vector spaces can be used for recommendation, in combination with collaborative filtering, in both cold-start and non-cold-start scenarios, over a metadata set from TED lectures that we released as a benchmark for multimedia recommendation tasks. In addition, we have shown that sentiment analysis of user comments improves recommendation, and that it is possible to predict individual sentiment aspects and relate them explicitly to text excerpts that support the predictions.

Diversity-preserving algorithms for keyword extraction and document ranking: We have designed new diversity-preserving algorithms for keyword extraction and document ranking, and integrated them into an improved content-linking system that recommends Wikipedia pages in real-time to the participants in a meeting, based on the words they pronounce.

International evaluation campaigns: The recommendation methods designed by the NLP group have been successful at the MediaEval 2013 evaluation, being ranked first on the media hyperlinking sub-task. In combination with a graph-based interface, we also won the Lecture Segmentation and Annotation Grand Challenge at ACM Multimedia 2013.

Main research themes for 2017–2020

The overall approach of the NLP group is to design new methods for semantic and pragmatic analysis of large streams of textual input, in order to overcome two types of barriers to information access: the language barrier – when streams are in a language not known by the user – and the quantity barrier – when the volume of the streams makes it impossible to find the relevant information without advanced assistance tools.

To overcome these two barriers, the major focus of the NLP group for 2017–2020 will be on the precise and robust identification of the entities that are mentioned in large text streams. On the one hand, we will ensure the coherent translation of the words and terms used to refer to the detected entities, and on the other hand, we will give a privileged role to entities in the processes of semantic search and recommendation. Therefore, the NLP group will continue to blend theoretical work in computational linguistics with applications that show a clear utility to the end-user, i.e. can be clearly evaluated and are ready for technology transfer.

We now present in more detail the main R&D themes of the NLP group for 2017–2020, structured along the two barriers to information access introduced above: the quantity barrier and the language barrier.

Semantic search/recommendation and explanation of results:

Explaining recommendations: The items suggested by existing recommender systems appear to users as nothing more than advertisements, because the reasons why they should trust them are not apparent. One of the goals of the NLP group is to use its expertise in text analysis, particularly single and multiple-aspect sentiment analysis, to generate explanations for recommended items. We intend to locate the words or sentences in user-generated texts (e.g. product reviews or comments) which best convey their sentiment, and select the most relevant ones as arguments for recommendations. We will model the users who produced these texts so that they can be identified as a source of trustful judgments.

As a result, we will be able to generate explanations such as: "*Reader_X* who found *Book_1* to be a 5-star 'unforgettable book' also wrote about *Book_2* that it is 'sometimes poetic and sometimes funny, but always compelling' ". In this example *Book_1* is a book that the current user appreciated, *Reader_X* is a user with a similar profile (preferred items), and *Book_2* is a new book recommended to the current user. Therefore, reasons for recommending items will become transparent, so that end-users will be able to decide more quickly what action to take (explore or ignore). This, in turn, will improve their trust in the system.

Content analysis for search and recommendation: One of the challenges of current large-scale search systems is that they are generally based on keywords or keyphrases, with little understanding of the meaning (semantics) of the words. For instance, synonyms or related words are not detected as such, and the allowed variation of search terms is limited to small orthographic variants. On the contrary, existing semantic search engines attempt to identify the concepts behind the words (e.g. 'Apple' can be the company or the fruit), but the analyses required by this approach are often not robust and do not scale well to large data sets.

The NLP group will explore new approaches to hybrid search, by merging keyword-based and concept-based approaches at several possible levels (queries, documents, or index) depending on where the semantic analysis of keywords into concepts is performed. The overall goal is to find a tractable solution for big data semantic indexing, i.e. for representing both queries and documents (or, for recommendations, profiles and items) into the same conceptual space, equipped with an efficient distance which returns the closest documents to a given one, building upon the NLP group's expertise in semantic relatedness.

Semantic knowledge for machine translation (MT):

Towards accurate and coherent translation of entity mentions: The translation of entire documents currently often suffers from a lack of coherence. In particular, subsequent mentions of a same entity may be translated in such different ways that the overall coherence of a text is lost. The goal of the NLP group will be to build semantic analysis models that identify sets of mentions of the same entity. The models will then be combined with MT to enhance its accuracy, taking advantage of the set-level information, and its coherence –

so that readers understand the translated mentions as referring to the same entity. While such mentions include potentially all referring noun phrases and pronouns, the initial focus will be on technical terms and proper names. Their correct translation will also have a strong impact on cross-lingual search, in relation to the first research theme presented above.

We will define a story-level coherence model, and integrate it with existing statistical MT systems (phrase-based or hierarchical). The model will be grounded in referential coherence, and will exploit multilingual semantic knowledge, but it will also integrate other phenomena that ensure text coherence, such as discourse structure, temporal coherence, and genre/style consistency.

Combining heterogeneous knowledge sources for semantic and discourse-level MT: It has become apparent that the translation of documents relies on a variety of features, whereas current phrase-based statistical MT engines are structured around a core process which leverages only a translation memory and a language model, both at the word and sentence levels. In past work by the NLP group, the semantic and discourse-level features have been implemented as pre- or post-editing processes around the computationally-intensive MT core. However, when the number of knowledge sources increases, it is no longer tractable or efficient to use such a pipeline for MT.

Instead, we will explore a principled architecture, drawing inspiration e.g. from blackboard systems, which will allow on-demand activation of pre-editing or post-editing modules for efficient knowledge-based MT. These modules will be activated when translation ambiguities that cannot be solved by the local constraints of statistical MT are detected. The main challenge is to be able to use the output of these modules efficiently within the MT core process. The cognitive relevance of the architecture will be explored, emphasizing the parallel with human translators who can translate simple sentences straightforwardly, but need to stop and leverage complex internal or external knowledge for complex translation problems.

2.2.9 Robot Learning & Interaction

Overview

Head: Dr. Sylvain Calinon (MSc, EPFL, 2003; PhD, EPFL, 2007)

The Robot Learning & Interaction group aims at transferring skills to robots with intuitive human-robot teaching interfaces. The goal is to endow robots with learning systems that can acquire rich motor skills adaptively without requiring the users to program the robots through a computer language. It requires the development of probabilistic models of movements and behaviors for robots sharing the same workspace as the users. In these applications, the models serve several purposes (recognition, prediction and synthesis), and are shared by different learning strategies (imitation, emulation, exploration and self-refinement). The developed technologies reduce the time and cost of re-programming robots, opening roads to new markets and applications in robotics, in which non-expert users can program robots for their needs.

Main focus over the last Research Program (2012–2016)

The Robot Learning & Interaction group was created in May 2014, in parallel to Prof. Caputo's group phasing out (now Associate Professor at Sapienza University of Rome). The group brings new expertise in robot skill acquisition and human-robot interaction. On one side, it exploits different types of expertise available at Idiap to consolidate human-robot skills transfer with multiple communication and interaction modalities. On the other side, the group complements Idiap's research activities with new robot platforms and applications, fostering additional opportunities for dissemination and gathering of Idiap technologies. For 2012–2016, the main research themes and achievements of Dr. Calinon's group (in its current form and previously as team leader at the Italian Institute of Technology) are summarized below.

Generative models of manipulation movements: After having collected demonstrations with various objects position, the aim is to synthesize new movements that can generalize the task to new situations. The approach encodes the observed motion in multiple coordinate systems. The different projections of the original data reveal regularities that are exploited to adapt the task to new objects position in a probabilistic manner. These developments contribute to the DexROV European Project.

Autonomous regulation of robot impedance behavior: The retrieved variability and correlation information is exploited to generate safe and natural movements within an optimal control strategy (minimal intervention principle). The approach also enables new haptic communication capability that has great potential in human-robot collaboration.

Transfer of skills at goal emulation level: We developed an approach to extract higher level intents underlying the actions (instead of transferring the actions directly). It exploits context-dependent objective functions, that contrasts with standard inverse optimal control techniques in which the same objective is defined throughout the task. The observed actions are encoded together with associated objective functions, which are then exploited to search for new solutions by stochastic optimization.

Main research themes over 2017-2020

Skill acquisition encompasses a wide range of learning strategies, including actions mimicking, goal emulation and self-refinement. Social learning, play, practice, exploration and feedback provide varied opportunities to adapt and correct actions that would have been wrongly assimilated. We will enforce the perspective that action-level and goal-level imitation can be combined to transfer skills from humans to robots, but also from robots to humans and in-between robots. For 2017–2020, the leading R&D themes will be:

Task-parameterized models of skills: Task-parameterized models of movements refer to models that can adapt to external task parameters describing the current situation in which the robot executes an action. For example, by encoding a movement from the perspective of different objects, we showed that generative models could be used to generalize manipulation skills to new positions of objects. This principle is however not limited to objects in Cartesian space and can be extended to other forms of task parameters, including projection and prioritization. A wide range of motor skills can potentially be adapted to this framework, with models learning the local structures of the task from a low number of demonstrations.

Multilinear algebra applied to task-parameterized models: A movement sample is usually stored as a matrix (2nd order tensor), where each row is a vector corresponding to a pose at a given time step. Task-parameterized models of movements store information in multiple coordinate systems (3rd order tensor), yielding different options for statistical analysis. For example, principal component analysis can respectively reveal *eigenposes*, *eigentrajectories* or *eigenframes* depending on the direction in which the tensor is flattened and analyzed. Recent advances in tensor analysis aim at exploiting the structure of the data without matrix conversion. We will exploit these recently developed tools to analyze observations in multiple frames while keeping the inherent structure of the data.

Automatized generation of motion primitives: Motion primitives refer to parts of movements that can be assembled as building blocks to create more complex behaviors. Motion primitives are typically assembled in sequence. Very few work in robotics addressed the problem of combining motion primitives in parallel, or sharing a common set of subcomponents. We have two foci in this direction: 1) extending the concept of motion primitives to a broader range of behaviors including impedance, reaction and collaboration primitives; 2) treating primitives extraction as a subspace clustering problem with sharing of components.

Online learning from partial demonstrations and corrections: Another leading research theme for 2017–2020 will be to move from batch to online learning solutions, which will allow the user to provide partial demonstrations and to correct the robot skill without interrupting the execution of the task. Such challenge addresses both the encoding strategy (e.g., autonomous dynamical systems, trajectory HMMs) and the parameters estimation strategy (e.g., online EM, Dirichlet process). This technology will for example provide industrial robots with refinement capabilities that do not require to stop the production line.

Learning and synthesis of communicative gestures: In collaboration with the *Perception and Activity Understanding* group, we will extend the use of task-parameterized models to the generation of natural adaptive communicative gestures. This includes the movement of the torso, head and eyes (extraction and reproduction of coordination patterns involved in natural gaze shifts and behaviors such as looking away, addressing people, switching role in the conversation, etc.), as well as hand gestures to accompany speech or to point at objects or locations. We will similarly explore how this generative model can be exploited for active perception. This technology aims at enabling service robots to initiate and follow conversations in a socially acceptable and intelligent way.

Learning interaction combining imitation, emulation and practice: Most efforts in robot learning are turned toward developing algorithms for specific skill acquisition strategies. While such developments are important, they often do not take into account one of the unique specificity of robot learning in that the interaction with the user can influence the quality of the collected data. The design of efficient skills transfer systems can thus advance on two fronts: 1) by providing better algorithms to extract relevant features from data; and 2) by providing better interaction mechanisms to determine which learning strategy to use in the current context. Examples of strategies include action mimicking (without understanding the objective), goal-level emulation (discovering the objectives by discarding the specific way in which a task is achieved), exploration with self-assessed rewards or feedback from the users. Each requires the design of dedicated algorithms, but the ways in which they can be organized remain unaddressed. We plan to explore this meta learning perspective by taking into account the social structure of skills acquisition, where both actors in the teacher-learner interaction can influence the success of the skill transfer.

2.2.10 Computational Bioimaging

Overview

Head: Dr. Michael Liebling (MS, EPFL, 2000; PhD, EPFL 2004); Postdoc, Caltech, 2004–2007; Assistant Professor, University of California Santa Barbara (UCSB), 2007–2013; Associate Prof., UCSB, 2013–2014.

Research in the Computational Bioimaging Group focuses on developing image acquisition devices combined with reconstruction and analysis algorithms to study live biological systems. Practical tools aim at (i) extending the physical limits of imaging hardware via techniques including super-resolution imaging and multi-view, space variant deconvolution, and (ii) quantitative analysis of complex biological systems, including motion-based image analysis, cell tracking, microscopic fluid flow estimation, and integration of multi-modality images.

Main focus over the last Research Program (2012–2016)

Dr. Liebling has been with Idiap part-time from July to September 2014 and full-time since January 2015. Recent highlights of his group's activities at the University of California Santa Barbara, during the period 2012–2014, are summarized below. These activities are now being carried over to Idiap, where they will tie in local expertise, specifically, in robotics, statistical modeling, and machine learning.

High-Speed 3D Fluorescence Microscopy: Fluorescence microscopy has become a central tool for the study of biological structures, from single molecules to whole organisms. Fluorescence light emitted by dim samples is scarce and limits the frame rate at which dynamic processes can be observed with sufficient signal-to-noise ratio or without severe motion blur artifacts. Kevin Chan, PhD Student in Liebling's lab at UCSB, has proposed an algorithm to reconstruct a high temporal resolution image sequence from multiple low temporal resolution acquisitions. Each acquisition is shifted in time by a sub-frame delay and a cost minimization is used to reconstruct the high temporal resolution sequence. Experiments on a dynamic phantom have shown that this temporal super-resolution algorithm increases the bandwidth by a factor of 1.5.

Image Processing Methods for Multi-View Microscopy: Optical microscopy offers the unique possibility of imaging living samples in 3D under conditions similar to their native state. However, most techniques suffer from anisotropic 3D resolution (worse in the axial than the lateral dimensions). This makes quantification of images more difficult. Fusion of multiple data sets acquired from different view points has the potential to overcome this limitation. Nikhil Chacko, PhD student in Liebling's lab at UCSB, developed an algorithm to spatially register two volumetric data sets related via a rigid-body transform and degraded by an anisotropic point-spread-function (PSF) as a first step towards solving the fusion task. The automatic registration, a multi-scale pixel-based registration method accounts for the anisotropic image formation process by including re-blurring in the minimization of mean squared intensity differences between the reference and test volumes.

Dynamic Time Warping for Quasi-Periodic Movies of the Beating Heart: Dynamic Time Warping (DTW) permits elastically aligning a time-dependent test signal so it matches a reference signal. This technique is at the core of dynamic 3D cardiac imaging techniques that computationally combine images acquired during multiple cardiac cycle into a 3D movie of one *standard* heart beat. Previous DTW techniques required the operator to acquire movies at each depth for at least two cardiac cycles (but usually for three or four) to ensure at least one full cardiac cycle starting at an arbitrary phase could be extracted from each movie. We developed a dynamic time wrap-warp (DTWW) method that extends DTW by allowing data to *wrap-around* during alignment, which permits reducing the required acquisition duration to a single full period. This offers potential benefits such as limiting the sample's exposure to light (making the method particularly promising for long-term imaging in developmental biology studies) and improving acquisition speed.

Main research themes over 2017-2020

Research in the Computational Bioimaging group will complement Idiap's current application areas to include a focus on optical image acquisition and biomedical imaging (processing, analysis) and pursue Swiss and international (France, Spain, United States) collaborations with biologists, biophysicists and optical engineers. It will also leverage, through internal collaborations, the strong expertise of Idiap in the related areas of statistical modeling, computer vision, robotics, and machine learning.

Image-guided Optical Microscopy Systems and Protocols: Optical microscopy setups are increasingly computer-driven, which opens the possibility to intertwine image acquisition, processing, and analysis. We plan on leveraging this capabilities and develop computational imaging systems (systems where the instrument does not produce the image directly, but rather, the data that enables reconstruction of an image) that are task-specific and optimally allocate imaging resources (to minimize sample exposure or imaging duration). The procedures could be applied in high-throughput observation systems to characterize biological function in larger sample populations. This area will particularly benefit from collaborations within Idiap in the areas of machine learning, computer vision, and robotics, specifically with the Robot Learning & Interaction group (automated microscopy platform) and the Computer Vision and Learning group (multi-view object tracking).

Development of high-speed fluorescence microscopes leveraging temporally-structured illumination: We will develop a combined hardware-software device to break the temporal resolution limit imposed by how slow sensitive fluorescence cameras are and how scarce fluorescence photons are in dim samples. To achieve this goal, we will implement a spatio-temporally-structured illumination device and super-resolution image reconstruction algorithms, inspired by spatial super-resolution techniques that have recently been shown to enable sub-diffraction-limit spatial resolution. This work will rest on statistical models of image formation (stochastic models of photon emission and detection models) and (learned) models of biomedical images.

Characterizing microscopic flow patterns in vivo: Flow within organisms and tissues plays an essential regulating role during development and disease. Our objective in this project will be to produce accurate volumetric maps of the 3D fluid flow at the cellular and organ level based on data collected by our biology collaborators. Our proposed approaches will involve multi-angle image acquisition and fusion to recover 3D flow. Conventional fluid flow estimation methods for in vivo optical microscopy have been limited to estimations from two-dimensionsal projections or in-line Doppler-type estimates. We propose to reconstruct 3D flow maps, from multiple 2D flow estimates computed from image stacks captured from different views. In addition to international collaborators we foresee collaborating with the Perception and Activity Understanding group in the areas of tracking and image stabilization.

Development of a platform combining multi-dimensional imagery with multi-modal measurements of physiology and gene expression: Systems biology and medicine use an increasingly powerful set of imaging and non-imaging tools (genomics), yet whose spatial and temporal resolution and dynamic range are highly variable. Our aim is to develop a toolbox to systematically integrate heterogeneous data (e.g. from high-throughput genomic plates, high-resolution fluorescence images or high-speed functional signals). Our toolbox will connect a hypothesis testing and simulation framework that adheres to the reproducible research framework, through adaptation of the framework developed at Idiap in the context of biometry (Biometrics group).

Computational imaging: Efficient algorithms for light propagation and image formation: Accurate algorithms to describe light propagation in optical systems, are essential for the purpose of deconvolution, lens-less imaging (such as digital holographic microscopy with partially coherent light) and image restoration. Our work will model optical systems within the context of sparse function representation spaces (wavelets, learned dictionaries), inverse reconstructions via non-linear optimization methods, statistical learning approaches, and fast implementations.

2.2.11 Uncertainty Quantification and Optimal Design

Overview

Head: PD. Dr. David Ginsbourger (Habilitation in Statistics and Applied Probability (University of Bern, 2014), Ph.D. in Applied Mathematics (Mines Saint-Etienne) 2009, MSc. in Applied Mathematics and joint degree in Engineering (Technische Universität Berlin and Mines Saint-Etienne, 2005), Bachelor in Mathematics (Université Joseph Fourier, Grenoble, 2002))

The Uncertainty Quantification and Optimal Design group focuses on quantifying and reducing uncertainties in the context of natural and artificial complex system modelling. Application domains notably include energy and geosciences, with a number of collaborations ranging from safety engineering to hydrology and climate sciences. In all these fields, the study of complex systems often relies on expensive high-fidelity experiments and/or numerical simulations depending on a number of inputs including both controlled design parameters and uncontrolled environmental variables.

Uncertainty Quantification encompasses a set of mathematical, statistical, and algorithmic approaches at the interface of complex modelling of processes and data, with the aim to elicit and characterize inherent uncertainties. Optimal Design deals with the choice of controlled design parameters relying on global optimization methods. In particular, elaborated model evaluation strategies are needed for making optimal decisions, be it for deterministic numerical simulations or for design under uncertainty. The main focus of the UQOD group is on Gaussian Processes (GP) methods and adaptive design of experiments for optimization, inversion, and related problems.

Main focus over the last Research Program (2013-2016)

The UQOD group starts at IDIAP in September 2015. While a number of UQOD's methodological approaches are inscribed in IDIAP's core competences such as machine learning and optimization, UQOD puts a focus on very complex systems stemming from contemporary societal challenges (notably arising from geo- and climate sciences, industry, etc.), for which parsimonious algorithms calling for novel mathematical and interdisciplinary developments are needed. In a previous form (at the University of Bern), the main research themes and achievements of D. Ginsbourger's group over the last years are briefly summarized below.

Extension of Bayesian Optimization algorithms: Addressed several challenges related to the extension of Bayesian Optimization algorithms (Parallelization, finite time, noisy evaluations with or without tunable accuracy, profile optima, high dimensionality, etc.).

Excursion strategies: Works on strategies for the estimation of probabilities of excursion and excursion sets (e.g., failure regions) and uncertainty quantification thereof.

Exploiting structural properties: Generalizations of Gaussian Process (GP) modelling to functions known to possess structural properties such as symmetries, additivity, and further invariances.

Water sciences: Developed a new interpolation method ("distance-based kriging") applied to solve a high-dimensional inverse problem in water sciences.

ReDICE project: Scientific coordination of the ReDICE consortium (CEA, EDF, IRSN, Renault, IfPEN, INRIA, Mines Saint-Etienne, UniBE); 2011-2015

Geo- and climate sciences: Numerous applications with geoscientists (ENSEMBLE Sinergia project; 2011-2015). Collaborations with climate scientists (Oeschger Center for Climate Change Research).

Publications: Over 15 peer-reviewed journal articles and book chapters published over 2013-2015 + a dozen of forthcoming papers in 2015-2016 .

Open source software packages: 5 (co-)developed packages in the open source programming language R

Main research themes over 2017-2020

For 2017-2020, the foreseen leading R&D themes are briefly discussed below.

High-dimensional model representation and global sensitivity: Be it in engineering design or in the geosciences, phenomena are modelled at an always finer level, and also with larger numbers of variables. Global Sensitivity Analysis (GSA) aims at statistically uncovering which variables and/or combinations of variables are the most influential, and at estimating and disentangling the effect of selected (groups) variables on a response of interest. Under costly model evaluations, GSA is often performed on top of a metamodelling step, e.g. following GP interpolation. Now the GP model used, and in particular the underlying kernel, have an impact on GSA results. Recent works of the group on understanding and taking advantage of the interplay between kernels and GSA will be extended and valorized, notably through implementations and real test cases.

Very complex input spaces: For *very complex input spaces* (e.g., geological data), it sometimes makes more sense to appeal to elaborated mathematical distances but also to non-metric notions of similarities –based for instance on expert judgement– rather than traditional analysis in terms of euclidean distances between parameter vectors. Similarity- and distance-based approaches for dimension-free approximation and experimental design will be researched on, with applications ranging from hydrology to mechanical engineering.

Exploitation of structured data: Dimension reduction in appropriate bases allow taking advantage of structured data, for instance in the specific settings where the inputs and/or outputs are curves and maps. Metamodelling with functional inputs and/or outputs will be developed further, extending initiated works on the prediction of full physics flow simulations based on low-fidelity ones. Applications abound in geosciences, e.g., decontamination of polluted soils.

Inverse problems, applied to geophysics: Inverse problems are one of the cornerstone of applied sciences, notably geophysics. For strongly non-linear phenomena, they are typically solved using Bayesian approaches, where a prior distribution on inputs is updated through (noisy) observations of some output(s). One avenue of research to be tackled concerns *speeding up Metropolis-Hastings algorithms* and alike using adapted metamodels of the likelihood, based on GPs and more.

Modeling and prediction of extreme values and abrupt changes: Characterizing and predicting extreme values is a crucial issue for society, e.g., for anticipating natural catastrophes or quantifying financial risks. A number of statistical results and tools have been developed within the Extreme Values Theory. We will work towards incorporating time and space dependencies and non-stationarities in return level estimation, with potential applications in climate sciences and beyond.

Bayesian global optimization: Bayesian global optimization has been successfully applied for moderate dimensions and number of points. Extensions to larger number of points (big data), higher dimensions (through adapted kernels), and also to noisy evaluations with unknown heterogeneous noise variance will be sought. Potential applications include engineering design, biology/pharmacology (molecule and/or protein design), robotics, and more.

2.3 Academic and Training Activities

Idiap's academic and training activities are usually acknowledged through several indicators: (1) the quality, productivity, and visibility of our PhD students; (2) our tight relationship with EPFL, reinforced through the EPFL-Idiap Joint Development Plan (initially signed in 2008 and renewed in 2012); (3) our formal teaching activities at EPFL and less formal training activities within the institute; and (4) the increasing number of joint EPFL-Idiap initiatives in terms of academic activities or joint project proposals.

2.3.1 PhD students

As a reminder, the Idiap Research Institute is hosting and supervising an average of 35 EPFL PhD students, most of them being registered at the EDEE (Electrical Engineering Doctoral Program), set up in collaboration between EPFL and Idiap. Those students are all funded by Idiap through SNSF, EU, or Hasler Foundation projects, sometime (but rarely) in the context of CTI and/or industrial projects.

As of the signature of the Idiap-EPFL Joint Development Plan (and even before), those students are fully integrated in the EDEE selection process, have all the rights and duties of any EDEE PhD students. They take (mandatory and optional) EPFL courses, including courses taught by Idiap's employees at EPFL (see below), as well as internal skill development courses.

The quality of our PhD students is usually recognized through their very high performance (h-index, publication records, best paper awards, etc), as well as a very strong alumni network (resulting in a strong international network).

More quality indicators can be found in our last Self-Assessment Report, available at: Annexes/1246_Self_Assessment_Report_2014.pdf.

As stated above, there is also an official involvement of Idiap in the EDEE Program Commission (Prof. Bourlard was a member until late 2011, Dr. Gatica-Perez was a member between 2001 and end of 2014, and Dr. Fleuret is a member since end of 2014.) This presence reflects the number of Idiap/EPFL PhD students: an average of 35 in 2013-2014, most of them registered at EDEE, and a minority at EDIC. This accounts for about 25% of the PhD student body at EDEE.

2.3.2 Relationship with EPFL (and others)

Idiap-EPFL Joint Development Plan: The anchoring of the Idiap Research Institute in the Swiss academic landscape, in particular through an increased collaboration with EPFL, has seen major achievements over the last years. After the "Convention de collaboration" signed in June 2003, a first "Idiap-EPFL Joint Development Plan" was signed in July 2008, and renewed in February 2012, where we also included new research themes of strategic importance to EPFL and VS, such as energy, EPFL-Valais, etc.

Although developing slower then expected, this Joint Development Plan is being smoothly implemented and offers a solid ground for common activities, and a good academic anchoring of Idiap and Idiap staff into EPFL, while preserving the independence of its research activities (as well as its administration).

Academic positions: Prof. Bourlard, Director of Idiap, is also "Professor ordinaire" at EPFL where he is the Director of the LIDIAP (Laboratory of Idiap) laboratory. LIDIAP is a fully operational antenna of Idiap at EPFL, with a few permanent collaborators, and was recently granted additional space to accommodate visitors from Idiap, typically Idiap's employees with academic titles and PhD students.

In addition to the Idiap's director, three permanent researchers now have an EPFL academic title:

- **One "professeur titulaire":** Prof. Daniel Gatica-Perez who was recently promoted (December 2014) from MER to "Professeur Titulaire", which should further boost the collaboration between Idiap and EPFL. For instance, discussions are currently going on to affiliate Prof. Gatica-Perez with the newly create EPFL Center for Digital Science, directly related to a field where he has now been active for about 10 years, and has build a strong group, with a strong reputation.
- **2 "Maîtres d'Enseignement et de Recherche – MER"**: Dr. François Fleuret and Dr. Jean-Marc Odobez.

In addition to this, we are also developing relationships with other universities, including the University of Bern through the hiring of Dr. David Ginsbourger (currently Docent at UniBe, and keeping his affiliation and title there), who will keep his (current and future) PhD students registered there.

2.3.3 Teaching activities

In general: Idiap was initially affiliated with the EDIC (I&C) Doctoral Programme. However, Idiap was later a key player in the setting up of the EDEE (Electrical Engineering) Doctoral Programme, to which it is now officially integrated (and very active). However, some of our students still prefer to register to EDIC programme. Today, since its inception, we believe that Idiap is playing a big role in the success of EDEE (with one representative on the EDEE Committee – currently Dr. François Fleuret – and about 25% of the PhD students), and is involved in numerous teaching activities.

All EPFL courses are taught on the EPFL campus since they were never approved to be given outside EPFL (hence at Idiap). Only internal (non-EPFL) Idiap courses are being taught at Idiap, or through other channels like Fernuni (see below) or in other universities (UniBe).

However, Idiap still has a strong teaching presence in EPFL. Idiap staff members currently teach 10 courses, nine at the doctoral/EDEE level and one at the master level:

EPFL Doctoral level courses (EDEE):

1) Machine Learning for Engineers (S. Calinon, F. Fleuret & J-M. Odobez)
2) Computational Social Media (D. Gatica-Perez)
3) Speech Signal Processing (H. Bourlard & P. Garner)
4) Human language technology: applications to information access (A. Popescu-Belis)
5) Fundamentals in statistical pattern recognition (S. Marcel & A. Anjos)
6) Cognitive Vision for Cognitive System (B. Caputo)
7) Computational perception using multimodal sensors (J-M. Odobez & O. Aran)
8) Digital Speech and Audio Coding (M. Magimai Doss & P. Motlicek)
9) Statistical Sequence Processing (H. Bourlard)

EPFL Master level course:

10) Automatic Speech Processing (H. Bourlard)

Undergraduate teaching and supervision of Master students: According to EPFL (as mentioned again in their last report), Idiap should be much more involved in undergraduate teaching. However, Idiap really does not see how more resources could ever be allotted to cover this additional overhead since this has to come from public funding and not from project money, of course! And it is really not clear whether teaching undergraduate courses is really part of Idiap's mission (as agreed by most of the Foundation Council).

However, as part of undergraduate training, it has to be mentioned here that every year, Idiap researchers are hosting and supervising master theses from EPFL students (as well as other Swiss universities).

Others: In 2014, Idiap also started working with "Fernuni" ("Unidistance", http://unidistance.ch/) to develop joint projects, but also joint distance learning courses. See the section on the Biometric Center (Section 4.3, page 67) for an example of a first course which should be implemented for the end of 2015.

With the hiring of Dr. David Ginsbourger (as already mentioned above), we are expecting to develop new courses taught at UniBe.

As listed in our annual scientific and self-assessment reports, many of the Idiap staff are also regularly teaching various courses as invited "Professors" in multiple universities worldwide.

Finally, we also encourage Idiap senior staff to teach "internal" skill development courses, e.g., on writing and presentation skills, as well as entrepreneurship (including invited speakers). For example, Prof. Hervé Bourlard occasionally teaches an internal skill development course on "Technical Writing". We believe that more courses like this should be developed in the future.

2.3.4 Joint IDIAP-EPFL initiatives

As discussed in Section 3 of the latest Idiap-EPFL Joint Development Report (March 15, 2015), and which can be found at: **Annexes/2340_Idiap_EPFL_Convention_2013_2016.pdf** , numerous joint activities are being developed between Idiap and EPFL, including:

1. Research activities of common interest: Besides the key Idiap R&D activities, we are slowly diversifying to be more complementary to existing activities at EPFL, as well as future activities at EPFL-Valais-Wallis, such as:

    - New machine learning algorithms (which seems to be highly needed and appreciated by students, and actually one of the biggest strengths of Idiap).
    - Social computing: Development of machines designed to extract and use social knowledge from sensor data and media sources from human interaction in the physical and digital worlds. As already mentioned above this research would perfectly fit into the new EPFL Digital Science Center.
    - Multilingual processing of spoken and written information: including multilingual automatic speech recognition, speech synthesis (text-to-speech) and translation. Over the last few years, Idiap became a dominant player in multilingual speech processing, with particular emphasis on "under-resourced" languages. Idiap could be the only institution is Switzerland pursing this type of ambitious goals, with a worldwide reputation.
    - Smart cities and energy.
    - Healthcare and bioengineering.
    - Digital humanities: Recently initiated through a very large scale, highly visible project, referred to as "Valais-Wallis Digital", involving social computing and many other groups at Idiap. Of course, this initiative is also very much in line with the goals of the newly created EPFL Digital Science Center.

- Security and risk management: Illustrated, for instance by (1) the creation of the "Swiss Center for Biometrics Research and Testing" and (2) the new group on "Uncertainty Quantification and Optimal Design".
- Mobile computing and social media.

2. Joint workshops and projects: Including, e.g., joint workshops on "Swiss Machine Learning Day" or 'EPFL-Idiap-ETHZ Sparsity Workshop" (each attended by around 100 participants), or joint projects in the context of (among others) CTI and SNSF Sinergia projects, as well as EPFL Center for Cooperation and Development (CODEV).
3. Joint patents: Two over the last year.
4. Submission of joint projects.
5. Joint publications: 22 over the last 2 years.

2.4 Technology Transfer (TT) Activities

Besides fundamental research, training and education activities, Idiap is also contributing significantly to the economic development of the Valais region (and beyond). To this end, it is very much involved in "Technology Transfer" (TT) activities, transferring research results (technology, software, algorithm, knowledge, know-how, and expertise) to interested industrial partners, startups or direct Idiap' spin-offs.

A dedicated Technology Transfer Office (TTO) works in close collaboration with businesses to realize joint research, and sponsored development programs, aligned with the research areas of Idiap. Today, and thanks to numerous initiatives described below, from small startups to large corporations, Idiap is often considered as an ideal partner in "avant garde" technology and research!

This technology transfer is usually done by giving the grant of rights on the commercial exploitation of this technology (through license) to industries or spin-offs (which could then have favorable and privileged access rights). We can therefore consider the process of technology transfer as a creation of economic value out of scientific discoveries. If the concept sounds simple, the path that leads from a technology demonstrator to an industrial product is highly complex. One reason is that researchers and industrialists do not speak the "same language" and their aim could be totally different. This multi-faceted, and extremely challenging, technology transfer mission thus requires numerous initiatives and instruments, including:

1. **TT-aware research environment:** A TT-aware research environment, where all employees (incl. researchers!) always keep the applications in mind, when doing research, developing software libraries and platforms.
2. **Specific dedicated development group:** A specific, fully dedicated, team of people, able to listen to the needs of the industry, society and market, aware of (and excited about) the research outcomes, and able to bridge the gap between research results and specific industry needs.
3. **Clear IPR policy**: Our technology transfer is usually done by giving the grant of rights on the commercial exploitation of this technology (through licenses). It is thus of paramount importance to have a clear IPR policy and technology transfer strategy.
4. **TT instruments and processes:** Multiple instruments and processes, including partnerships with key tech transfer players.

2.4.1 TT-aware research environment

To have a high potential, truly innovative, research institution, there is a constant need to stimulate the entrepreneurial mindsets of researchers and to create a more favorable climate for entrepreneurship. Through several instruments (some of them are being discussed below), Idiap keeps highlighting the need to embed creativity, innovation and entrepreneurship within the institution, with the goal to unleash all of its entrepreneurial and innovative capabilities.

Researchers are always in contact with industries, industrial visitors, and are always encouraged to identify the value of their work and, as often as possible, fill "Invention Disclosures", either to clarify the link between research and innovation, or also to open the door to start-ups and spin-offs through the IdeArk incubator.

Entrepreneurship refers to an individual's ability to turn ideas into action. It includes motivation and excitement, creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives.

Idiap thus continuously strives to make employees more aware of the context of their work and better able to seize opportunities, and provides a strong foundation for entrepreneurs to establish social or commercial activities. Continuously nurturing such an innovation mindset thus includes the following objectives:

- Improvement of the entrepreneurship mindset of young people to enable them to be more creative and self-confident in whatever they undertake.
- To improve their attractiveness for employers.
- Encourage innovative business start-ups and spin-offs.
- Making them fully aware of their responsibility and potential of their role in society and the economy.
- "Demystifying" startups!

2.4.2 Specific dedicated development group

Composed of a dozen highly skilled engineers, who understand our research domains, but are more motivated in bringing this into working prototypes or products (on multiple hardware platforms and OSs), this group has two main components: (1) the Technology Transfer Office (TTO) being the actual entry door to the development group, as well as the official contact point for development service/industrial requests and (2) the development group itself.

TTO – Technology Transfer Office (Dr. Florent Monay and Dr. Hugues Salamin): Idiap is very active in multiple, national and international, technology transfer activities, and is also involved in numerous projects with industries, ranging from large institutions such as Samsung, Google, Facebook, etc, as well as SMEs and startups.

The TTO group represents the key link between researchers, development engineers, and industry. Besides maintaining Idiap's technology portfolio (discussed below), and responding to industrial needs and contacts, the TTO also pro-actively investigates new opportunities. In this context, it assists Idiap researchers and industries to develop joint projects, including CTI projects. As also discussed below, the TTO is also responsible to maintain a clear IPR strategy and track IP status across licenses. The TTO is thus a key entry link between the scientists, the industries, and the Development Group discussed just below. Finally, the TTO is also responsible of the partnerships with TT institutions, as discussed in Section 2.4.4.

As already mentioned in Section 1.2.3, page 9, tasks and duties of the Technology Transfer Office is available at: Annexes/1222_Cahiers_des_Charges.pdf#page=27, Part 3, page 27.

Idiap generally acquires industrial partners as the result of three types of process. The most direct way is when a company contracts the institute to carry out research or development, in the form of a thesis for example, and finances the project. Another possibility is that the company files an application for support with the CTI, the Federal agency responsible for supporting innovation through financial assistance of combined industrial/academic projects. The third option is via The Ark Foundation which can support technology transfer projects between Idiap and a company usually established in Canton du Valais.

During an industrial partnership, the company may either finance the research work for a certain period, or buy the technology directly from Idiap. In this way it acquires use and marketing rights. It can also obtain exclusivity rights for a certain time and for its area of activity. However, in order to be able to use its results to carry out other research and therefore keep its autonomy and innovative strength, the institute has to retain the intellectual property rights to its inventions. Therefore, usually it sells non-exclusive licenses, as would the author of a book or a photograph.

Development Group (Mr. Olivier Bornet): Since the end of 2006, Idiap also maintains an active group of a dozen of highly talented developers, all working in the same office, and sharing multiple responsibilities, including:

- Industrial projects: Development of prototypes, and adaptation of research software to the needs of industries, with the goal to demonstrate feasibility of new products and systems, and in direct response to a contract with the industry or the needs of one of the Idiap' spin-offs (always in the framework of well defined projects and IPR contracts). This also includes the development part of CTI projects, where

responsibilities are then shared by the PI researchers and one of the developers (all managed by Olivier Bornet).

- Academic projects: The development group is also responsible for the development of demonstration systems, either of general interest to Idiap (in which case efforts are funded by Idiap) or in the context of projects, e.g., EU project involving specific development efforts going beyond what researchers are able or willing to do.
- Internal support: The development group is also responsible to respond to in-house requests, e.g., helping out colleagues in resolving complex code issues, contributing in research or collaborative platform development, etc. In this context, the group is also responsible for the quality control and maintenance of the open source libraries made publicly available. As discussed in Section 4.2, page 65, 31 open-source libraries are currently available from http://www.idiap.ch/technology-transfer/open-source-software. Each library has to be thoroughly tested and validated before this release, and nobody at Idiap is allowed to release open source software without prior permission of the management and without doing this through the development group, who will make sure of the quality of what is being delivered, perform version control, etc. Of course, since this distribution is done thought the Idiap platform, this is also done in close collaboration with the IT group.
- Stable software and platforms: This is not only part of the internal support discussed above but also for "close source" software which is being licensed to industries. There also, the development group is responsible for quality control, version control, and maintenance (if necessary). In collaboration with the TTO, they also have to make sure that we all follow the same IPR policy and keep track of the licensing and IPR status.

The Development Group is now a very efficient and key component of Idiap's development strategies. Indeed, based on Table 1, page 63, the Development Group today is basically self-funded, entirely busy on contract-driven development activities. Given the high demand, actually increasing everyday, we believe this group still has a big potential for expansion, with benefit to Idiap, as well as to economic development.

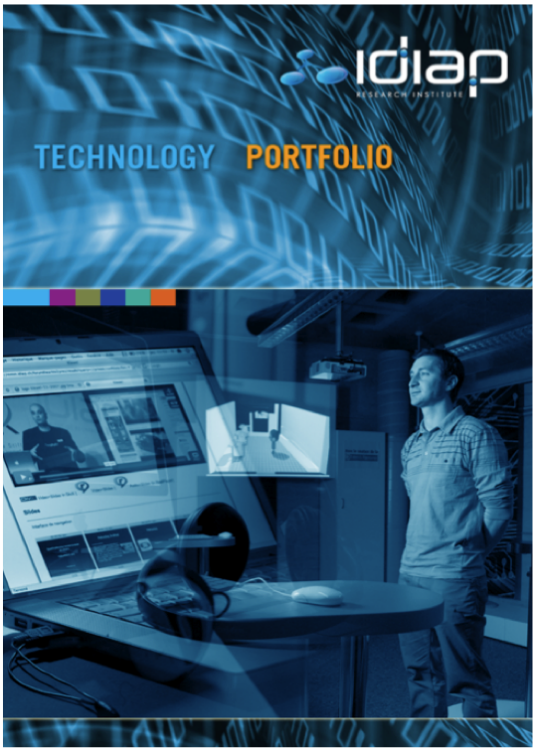

Figure 3: Idiap Technology Portfolio and Corporate Sponsorship Programme, respectively available at http://www.idiap.ch/technology-transfer/portfolio/idiap_technology_portfolio_v2.05.pdf and http://www.idiap.ch/technology-transfer/corporate-sponsorship-program.

2.4.3 Clear IPR policy

Our technology transfer is usually done by giving the grant of rights on the commercial exploitation of this technology (through licenses). It is thus of key importance to (1) keep track of our technology portfolio (technologies ready for licensing), the IPR status of those technology components, and path towards exploitations of those components by industries (e.g., through corporate sponsorship).

Our main exploitation mechanisms are thus based on the Idiap Technology Portfolio: a regularly updated list of Idiap Intellectual Property (IP), associating an IPR access policy with every IP item, from the following options: open source (for open distribution through our platform), closed source (proprietary) for licensing to third parties or to a start-up (e.g., one time fee, royalties, exclusivity, etc., to be discussed on a case-by-case basis), and services for either open source or license customers (e.g., application toolkits, custom programs, support, etc.).

Technology portfolio: As illustrated on the left part of Figure 3, and available from our web site at http://www.idiap.ch/technology-transfer/portfolio/idiap_technology_portfolio_v2.05.pdf, we also strive to maintain an up-to-date list of stable software which, we believe, are available and ready for exploitation and licensing to industry. This document currently contains 43 entries, each entry containing a *one-page* description of a technology component containing a short functionality description, keywords, innovative aspects, potential application examples, and contact researcher. During the next 4 year period, we will aim at further developing this tools, possibly linking it to patents and a few key publications, since it seems to attract a big deal of interest from industry.

Corporate sponsorship program: In addition to the above, Idiap also has a specific corporate sponsorship program to boost long-term interaction with industries through training of industrial visitors, joint research programs, etc.

While depending on the level of sponsoring and the goals being sought, the main mission of the present sponsoring programs can be summarized as follows:

- To ensure complementary funding for Idiap.
- To allow the industry to be involved with current research.
- To offer a platform for information, cooperation and interaction between industrial and research partners.
- To encourage meeting and interaction between scientific collaborators from different industrial.
- To provide privileged access to advanced research through sponsoring or exchange programs.

As illustrated on the right side of Figure 3, a full version of our Corporate Sponsorship Program can be found at http://www.idiap.ch/technology-transfer/corporate-sponsorship-program.

2.4.4 TT instruments and processes

Partnerships with TT institutions:

- **The Ark and its incubator IdeArk SA:** Since Dr. François Foglia (Deputy Director of Idiap), is also ad-interim Director of IdeArk (as also recommended by the Audit Committee), he is mainly responsible of the relationships between Idiap and IdeArk, in close collaboration with the TTO. As part of the Valais initiative The Ark, IdeArk relays the concerns of companies to the scientists, identifies market trends and facilitates the conversion of research results into innovative solutions. IdeArk's task is also to support start-ups and SMEs active in Idiap-related fields. As part of the services of the Incubator there are free office space with furniture, internet connection and coaching support. Many technologies from Idiap were developed into startups (KeyLemon, Klewel, AudioSearch, Koemei, recapp, ...) and naturally benefit from Idiap's proximity and expertise.

- **Polytech Ventures and Fintech:** After 3 years of fruitful collaboration, Polytech Ventures invited Idiap to take part in their new ambitious project; to build a complete ecosystem around the Fintech industry (economic industry composed of companies that use technology to make financial systems more efficient). To reach this objective, Polytech plans to launch, end of 2015, a new fund of 20 million with a 10 year term and the first Fintech incubator (www.fintechfusion.ch) in Geneva whose primary mission will be to identify young entrepreneurial talents with start-up projects and provide them with tools to become the next leaders in the Fintech industry .

- **VentureLab:** Since 2015, venturelab is a private initiative dedicated to entrepreneurship encouragement, also leveraging on the experience of successful entrepreneurs and VCs. Initiated in 2004 as a national training programme, it offers coaching and training tailored to support innovative start-ups and introduce young engineers to entrepreneurship, in close collaboration with Swiss high schools and universities, including Idiap. Since its inception, ventulab has organized more than 200 high-tech entrepreneurial events and 3000 training modules for particularly innovative projects.

- **Alliance:** Idiap is also part of the technology transfer group of Alliance, a national consortium which aims to create networks between academic institutions and companies in the Western Switzerland. This group meets regularly to exchange experiences and formulates "Best Practices" in technology transfer.

- **HES-SO Valais/Wallis:** In 2006, Idiap and HES-SO Valais/Wallis signed a collaboration agreement to encourage and facilitate joint projects between both institutions, especially targeting industrial applications. In 2010, an additional agreement has been signed to allow bachelor students from HES-SO to do their diploma at Idiap. Today, many projects involving development and industries are often done in collaboration with HES-SO Valais/Wallis.

- **Customer relationship management (CRM)**: As already mentioned in Section 1.2.6, page 12, Idiap has developed its own Customer Relationship Management (CRM), providing us with an up-to-date list of institutions and industries we have already worked with in the past. This list currently contains 735 entries of contacts and 560 company entries.

- **Invention disclosure**: See Section 1.2.6, page 12.

- **Patent Committee**: See Section 1.2.5, page 12.

Idiap Showroom: In order to make Idiap's work more accessible to the general public, as well as to industry, politicians, and students, Idiap is maintaining (since 2009) a fully operational showroom to demonstrate the research carried out at the Institute. More information can be found at:
http://www.idiap.ch/technology-transfer/introduction/showroom.

As illustrated in Figure 4, the showroom provides a rich environment to see, play, discuss and understand different technologies. For example, as soon as visitors enter the room, four cameras and eight microphones capture their arrival. Their presence is modelled by avatars in a three-dimensional representation of the room, displayed on a large screen. When they change position, the respective avatars move accordingly and their mouths are animated when they speak. There is no doubt that human presence is being monitored, analyzed and modeled. In this case, this demonstrates a technology developed in the field of video surveillance.

Instead of sitting visitors in front of a passive presentation, we invite them to interact with the different demonstrations. It is a space that is just as useful to well-informed partners as it is to novices. Four interactive demonstrations are currently accessible on the showroom's computers (object detection, voice activity detection, biometric access control, stone-breaker game controlled by face tracking). Visitors can also familiarize themselves with the world of Idiap via five short theme-based films. These presentations describe the Institute's different areas of research in simple and tangible terms. These tools are easy to export and can already regularly be seen at exhibitions or specialized trade fairs.

Figure 4: *Idiap showroom: The "Showroom" concept is an interactive showroom which aims to highlight and illustrate the results that emerge from Idiap's research. This "Technology Showcase" is a tool used for public communication. It focuses on the different institute's visitors such as researchers, industrialists and students. This room is interactive, which means it includes touch screens with mini-film presentation, demonstrators (using technologies such as speech processing, biometric authentication, object recognition, etc.). In addition to this, the room is equipped with microphones and cameras that record the visitors' movements and actions in order to enable the detection of people (including their mutual interactions).*

The showroom meets a considerable need for visibility and communication. Every year, it welcomes around thirty groups of visitors from all over the world. However, the showroom needs to be constantly updated, and a "mobile" version should also be available, which are all important challenges for the years to come.

International Create Challenge (ICC): Initiated by Idiap in 2012, ICC (http://www.createchallenge.org/) is a free of charge, 3-week immersive super accelerator program that gives entrepreneurs and potential entrepreneurs the opportunity to drive their projects to a "Minimum Viable Product" (MVP). It is a unique program combining state-of-art technologies, cutting edge research, mentors-led coaching, and micro-seed investment (in collaboration with VCs and KickVenture). In 2014, Idiap set up a crowdfunding portal (funding.idiap.ch) to financially support the selected projects of the ICC accelerator program in their quest to become a viable start-up. Idiap/ICC is proud to be on the map of the crowdfunding industry in Switzerland in 2015 according to the recent study of Lucerne University of Applied Sciences and Arts[12].

Organised every year in the Idiap premises, it attracts more than 100 people, mixing scientists, developers, entrepreneurs, and venture capitalists, with the sole goal of fostering collaboration, test new ideas, and boost the winning teams through diverse incentives to start their own start up. The winning team(s) share global awards amounting to more than 100'000 CHF out of which 3 × 10'000 CHF provided by Ideark (Idiap's incubator), 3 years of free access in the TheArk incubator program (around 100'000.- CHF in kind coaching, office space, etc) and seed VC money (through our partner Polytech Ventures, http://www.polytechventures.ch/en).

The ICC events in 2012, 2013 and 2015 each resulted in 3–5 startups which are still active today, including (as a few examples):

- ICC'2012: Bizvento (http://www.bizvento.com); Prevue Medical (http://www.previewmedical.com); Weather ex Machina (http://www.weatherxm.com); sight.io (http://www.sight.io); and 9-99 (http://www.9-99.ch)
- ICC'2013: Luma7 (http://www.luma7.com); HoReCast (http://www.horecast.com); and ReMeeting (http://www.remeeting.com).

[12] http://blog.hslu.ch/retailbanking/crowdfunding/?sourceurl=/crowdfunding

- ICC'2014: BioWatch (http://biowatch.ch/); Horus (http://horus.technology/en/); Anemomind (http://www.anemomind.com/); and Recapp SA (http://www.recapp.ch/en/)

2.4.5 Future activities

Besides the quality of our research activities, our technology transfer processes and instruments are also excellent and, as a result, significantly impact the growth of the economy at the regional and national levels. However, the demand is also continuously increasing and it is clear that we often have difficulties to follow-up on all opportunities. While Idiap does not want to turn into a service company and since it benefits tremendously from the availability of a stable and reliable development group, we also feel much more can be done in this area. The recent set up of a Technology Transfer Office, representing one single TT entry point at Idiap (tto@idiap.ch), is a first step in that direction. Around the TTO, and in collaboration with the development group, we now need to further strengthen the instruments discussed above, and possibly hire a few more developers, to significantly increase our efficiency. The additional funding that could be attracted through this channel could also compensate for the loss in EU funding in case the current situation happens to worsen.

3 Budget, Funding Distribution, and Financial Planning for 2017-2020

3.1 Main funding sources

Four funding "pillars": Idiap's funding is built around four main "pillars":

1. Public funding:

   - Federal funding: The Swiss Confederation provides partial funding to a limited number of research facilities of national importance under Art. 15 LERI (Loi Fédérale sur l'Encouragement de la Recherche et de l'Innovation). The main purpose of this research funding instrument is to establish a strong basis of research conducted autonomously and outside the higher education sector, but having a big potential impact in terms of research, training of your researchers, and technology transfer, all missions perfectly matching Idiap's goals.

     This funding, coming from the State Secretariat for Education, Research and Innovation (SEFRI, http://www.sbfi.admin.ch/org/), is based on 4 year budgetary periods (now synchronized with quadrennial Research Programmes from other academic bodies, including Swiss NSF, ETH Council, EPFL, ETHZ, CRUS, etc), and conditional on the approval of a "Contrat de Prestation" (Contract of service), now also linked to a synchronized Idiap-EPFL Joint Development Plan (initially signed in 2008, and renewed in 2013).

     For Idiap, this federal contribution for the 2013-2016 budgetary period amounted to 9'940'000.- CHF. **For the next 4 years (2017-2020) period, an amount of 11'910'000.- CHF is sought, which represents an average of 6% annual raise during the period**.

     Of course, and following Federal regulations, this raise will also be matched by additional funding from the State of Valais, the City of Martigny, and other public bodies (e.g., Loterie Romande–LORO). The rationale behind this budget raise is discussed in the detailed budget table in the appendix, and briefly discussed below.

     As often suggested by the Idiap Foundation Council, including the EPFL and EPFL-Valais representatives, as well as in the EPFL report relative to the Idiap-EPFL Joint Development Plan, the increase of the public/structural will be used to fulfill some minimum needs and requirements to guarantee sustainability of the institute, and the quality if its activities, including:

     - Slowly improving the wage prospects for its permanent staff:
       * For the young researchers who cannot simply be satisfied with salary raises solely linked to the cost of living.
       * It is foreseen that more academic titles should be granted to Idiap staff in the future. Hence, Idiap has to be able to financially assume this access to academic titles for one or more of its researchers, often resulting in more responsibilities, hence a fair request for wage revision. This was recently experienced with the appointment of Prof. Gatica-Perez, who required (quite fairly enough!) a major salary raise (while also being more and more busy at EPFL, soon being affiliated with the EPFL Center of Digital Science, hopefully with increased visibility and funding opportunities for *both* institutions!).
       * To remain competitive in an always more financially competitive research environments. While there will always be departures of key senior researchers, we have to make sure to remain competitive when hiring new ones, and being able to keep them long enough! Today, it is worth *and important* noting that Idiap salaries are not competitive compared with those that are practiced in Swiss universities for equivalent levels of researchers, still resulting in excellent motivations and performance. Even the salaries of PhD students and postdocs are strictly aligned with those prescribed by the SNSF, and Idiap has no structural margin to align these salaries with those in other Swiss universities. In spite of this, we are still able to attract excellent PhD students, concluding excellent PhD thesis, and hired

in the best universities, research institutes, or industries (Google, Facebook, MIT, etc. See alumni in Self-Assessment report).

- Respond to the continuously increasing needs and/or requests for collaborations, including with EPFL (even asking for more undergraduate teaching), EPFL Valais, and multiple industrial partners. Unfortunately, we currently cannot face and positively answer (or properly handle) all those requests and seize all those opportunities, resulting in a loss of funding.
- Directly related to the above, Idiap's role seems often important for the success of joint initiatives and collaborations. As mentioned in the Research Programme, and confirmed by the Audit Report, Idiap provides availability to its platforms, software, and databases, and/or develop others to support, for instance, research activities in Energy (EPFL Valais) or Digital Sciences (EPFL), which always seems much more difficult in the context of large institutions. But this significant and unique contribution also requires more and more resources (hence funding).
- Be able to deal with uncertainties and structural changes:
  * During the 2017-2020 period (as also mentioned in the SNSF Multi-Year Programme 2017 - 2020[13]) we may face funding loss (which already started significantly impacting our EU funding, for multiple reasons) and insecurities regarding Switzerland's future association with the European Research Framework Programme Horizon 2020 (as a result of the yes vote in the referendum on "mass immigration" of 9 February 2014). Should the non-association of Switzerland with Horizon 2020 become a reality, it is expected that the biggest impact would probably occur in 2017–2018, before Switzerland implements counter-measures.

    This is the first reason why we have planned a higher funding raise during the first two years.
  * Officially (but probably not a hard limit), the current Director, Prof. Hervé Bourlard, should officially retire at the end of 2021 (but is open to extensions if necessary). Ideally, and as discussed in the appendix relative to the detailed financial planning 2017–2020, it is during the 2017–2020 phase that Idiap should initiate a new Director search. It is not clear yet how and when this will take place. However, and to ensure a smooth transition, it would be most optimal if the new director could work for a few years in collaboration with the current director, and be fully involved in the development of the Research Programme for 2021–2024 (introducing his/her own research interests).

    This is the second reason why we have planned a higher funding raise during the first two years. Although this additional cost is more likely to occur at the end of the 4 years (2019–2020), we still have budgeted it over the first two years. But, again, the average funding raise over the the entire 4 years phase remains around 6%.
- To maintain a minimum diversification of our research activities to complement actions in promising and strategic domains at the cantonal and national level (energy, smart cities, digital sciences, bio-technologies, etc), as suggested by EPFL, EPFL-Valais-Wallis, as well as to answer increasing industrial demands, we will need to continue slowly expanding our team of permanent researchers (funded at 75% on public money and the rest through projects). Incrementally (over the next 4 years 2017-2020), and "opportunity-driven", Idiap thus plans/needs to expand its team of permanent researchers (currently very small in comparison to our mission, performance, and amount of non permanent staff, including and average of 35 PhD students, to supervise) by 3-4 additional permanent researchers.
- As part of the above and in continuity with past recruitements, Idiap will emphasize the hiring of young and promising researchers, offering them a career path in research and academia (which are currently lacking as identified by the SNSF[13]) as an alternative to those from educational institutions.

[13] http://www.snf.ch/SiteCollectionDocuments/medienmitteilungen/mjp_gesamtausgabe_e.pdf

  - As rightly underlined in the Audit Report, and since the end of its IM2 NCCR, as well as "giant" EU projects (like AMI and AMIDA), Idiap is strongly lacking integration in long-term research projects. We intend to work on this aspect (see last bullet point below, as one example), but it is clear that additional public funding will also help improve the stability of the institute, and be more robust to the inevitable fluctuation in the number of short-term projects.
  - Finally, although we aim at realizing this without additional public support (besides the initial seed funding of CHF 400'000.- received from the State of Valais and the City of Martigny), Idiap would also like to develop and position its *Center for Biometrics Research and Testing* (see Section 4.3, page 67) as a center of excellence at the national and international levels. Ideally, this could be part of large national initiatives, such as Cyber-Criminality[14], which was recently identified as a topic of national interest. Idiap is currently in contact with Federal representatives (Mr. Blaise Roulet) concerning this cyber security initiative, and is part of the Cyber Security Alliance (http://www.cybersecurityalliance.ch/). As a consequence, Idiap will consider to submit again an NCCR proposal on cyber-security bringing together Swiss expertise in computer security, cryptography, forensics and biometrics.

  The budget is available here:
  Annexes/Template_plan_financier_2017_2020_b_institutions_de_recherche.xlsx
  and discussed in detail in:
  Annexes/3101_2015_PlanFinancement_2017_2020.pdf.

- **State (VS) + City (Martigny) funding**: Following Federal regulations, these two state-level funding sources together should always (and always did) match the above Federal funding, **and this should also be the case for the 2017-2020 period, as discussed in:**
  Annexes/3101_2015_PlanFinancement_2017_2020.pdf.

2. Sponsored research (CH and international):

   - Swiss NSF: After the end of the IM2 NCCR, Idiap kept benefiting from many other SNSF individual/collaborative (Sinergia, Ambizione) projects, as well as international research projects (e.g., Indo-Swiss). For the future, we aim at increasing the amounts coming from this funding source, especially given the new permanent senior hiring.
   - Multiple EU projects (as coordinator or partner), although this is becoming more and more difficult, actually close to impossible (see discussion in Section 3.2). But we will keep submitting high quality proposals to all relevant EU calls, on average a dozen per call[15]. If this situation does not change we will have to focus on different funding sources, with better chance of acceptance and less overhead (given the amount of time required to prepare any single EU proposal).
   - US projects (DARPA, DTO): Although quite active in the past, even as coordinator, Idiap is currently no longer involved in such (quite unstable and politically-sensitive) projects. However, we just signed a Memorandum of Understanding with the Information Science Institute (ISI) of University of Southern California (which we didn't know at all before their Director accepted to be part of our Audit Committee).

3. International, national and local industrial collaborations:

   - Research contracts with industry: This includes or included, for instance: Qualcomm, Nokia, Logitech, NEC, Yahoo, NTT, Samsung, HP, Thales, Google, Facebook, etc. Given the instruments

[14] Where Idiap had submitted an NCCR proposal (NCCR Biometrics) last year, in collaboration with EPFL, which was rejected with no clear reasons.

[15] The last review outcome, received in May 2015, resulted in no project accepted, out of 8 high-quality proposals. And we had experienced the same outcome at the end of last year for the previous call, for 12 proposals, always submitted with very high quality collaborators. It is hard to believe that Idiap became so bad just "overnight"!

being developed towards technology transfer, as discussed in Section 2.4, we believe the funding coming from this source should increase in the future.

- Collaboration with IdeArk SA[16], our technology transfer incubator: See Section 2.4 for more information about this. Expansion of these IdeArk activities are currently a bit limited because of space, but this should be fixed very soon, providing new opportunities for developments.
- Corporate sponsorship program[17]: this has never been properly (pro-actively) exploited, but with the new TT structure and Technology Transfer Office (TTO), also discussed in Section 2.4, we believe we should be in a better position to exploit this track in the future.
- Commission for Technology and Innovation (CTI) projects involving industries, including Idiap's startups: Here too, we believe there is space for further improvement and increased funding. Actually, demands are increasing, and several project proposals are currently in the pipeline.

4. International exchanges and internships:

   - Funded visitors from other research institutions or industries: Working quite satisfactorily.
   - Funded international visitors, e.g. through EU Marie-Curie grants, was quite successful in the past, but like for all EU-related projects, this also became much more difficult over the last year.

Public/Competitive funding ratio: All the above together, the public funding used to represent about 30% to 40% of the total Idiap funding, which was considered as "excellent" by the State of Valais but "unsustainable" by EPFL (too dependent on project funding, at the risk of jeopardizing the research quality or the stability of the institute).

More recently, though, and mainly due to (1) the end of the NCCR IM2, (2) the transition between FP7 and H2020 EU framework (and related EU funding problems, resulting in sudden and major EU funding reduction, slowly reducing to nothing), and (3) some additional public funding (regulatory matching funds from VS), this ratio is now closer to 50/50 for public/competitive funding, which we aim to maintain as a (still very challenging) target.

[16] http://www.ideark.ch
[17] http://www.idiap.ch/technology-transfer/corporate-sponsorship-program

3.2 Evolution of budget and funding sources over time

As illustrated in Figure 5, Idiap's funding has been steadily increasing over the last 20-25 years, with a good "portfolio" of funding sources.

It has to be noted here that the Idiap total budget has been more or less stable over the last few years, and this in spite of **several challenging factors**, including:

1. The end (in 2013) of the IM2 NCCR: One of the key missions of NCCRs was to build a critical research mass and a sustainable research environment in the funded area. We can safely state here that this goal has been clearly reached with IM2, and Idiap in particular.
2. A difficult economic environment.
3. New challenges related to the relationships with the EC:
   - Always increasing number of Research Units, with always lower budgets, and fragmented research visions, resulting in exceptionally low acceptance rates.
   - Difficult relationships between Switzerland and the EU, which is not helping a lot in the above context.
   - Strong CH franc.
   - Based on the above, our experience so far with H2020, also confirmed by other Swiss academic institutions (as well as EU research in general, suffering from a broken system), we are currently rather pessimistic regarding the future potential of EU funding.
4. The loss of 2 key senior researchers, hence less competitive funding. This should be compensated by the recent hiring of three new senior researchers (see Section 1.3, page 14), but this may take a couple of years to take real effect.

Fortunately, this funding loss is currently being compensated by alternative funding sources, mainly targeting technology transfer projects, as discussed in Section 2.4, page 49.

As a consequence, Idiap's budget is still evolving satisfactorily, thanks to a regular increase (or, at least, renewal) of the project portfolio, both from public institutions (competitive funding) and industries (research contracts with industries), resulting in the following figures:

- Final accounting result for 2009: 9.2 MCHF
- Final accounting result for 2010: 8.9 MCHF (strong CHF impact)
- Final accounting result for 2011: 9.9 MCHF (strong CHF impact corrected)
- Final accounting result for 2012: 10.3 MCHF
- Final accounting result for 2013: 10.6 MCHF
- Final accounting result for 2014: 10.4 MCHF
- Preliminary budget for 2015: min 10.0 MCHF (budgeted, in spite of strong CHF and problems with EU projects)

However, this "constant" annual budget is currently realized through a significant increase of smaller budget projects, and a lack of longer-term projects (as also rightly underlined in the Audit Report, Section 5.4, page 69.

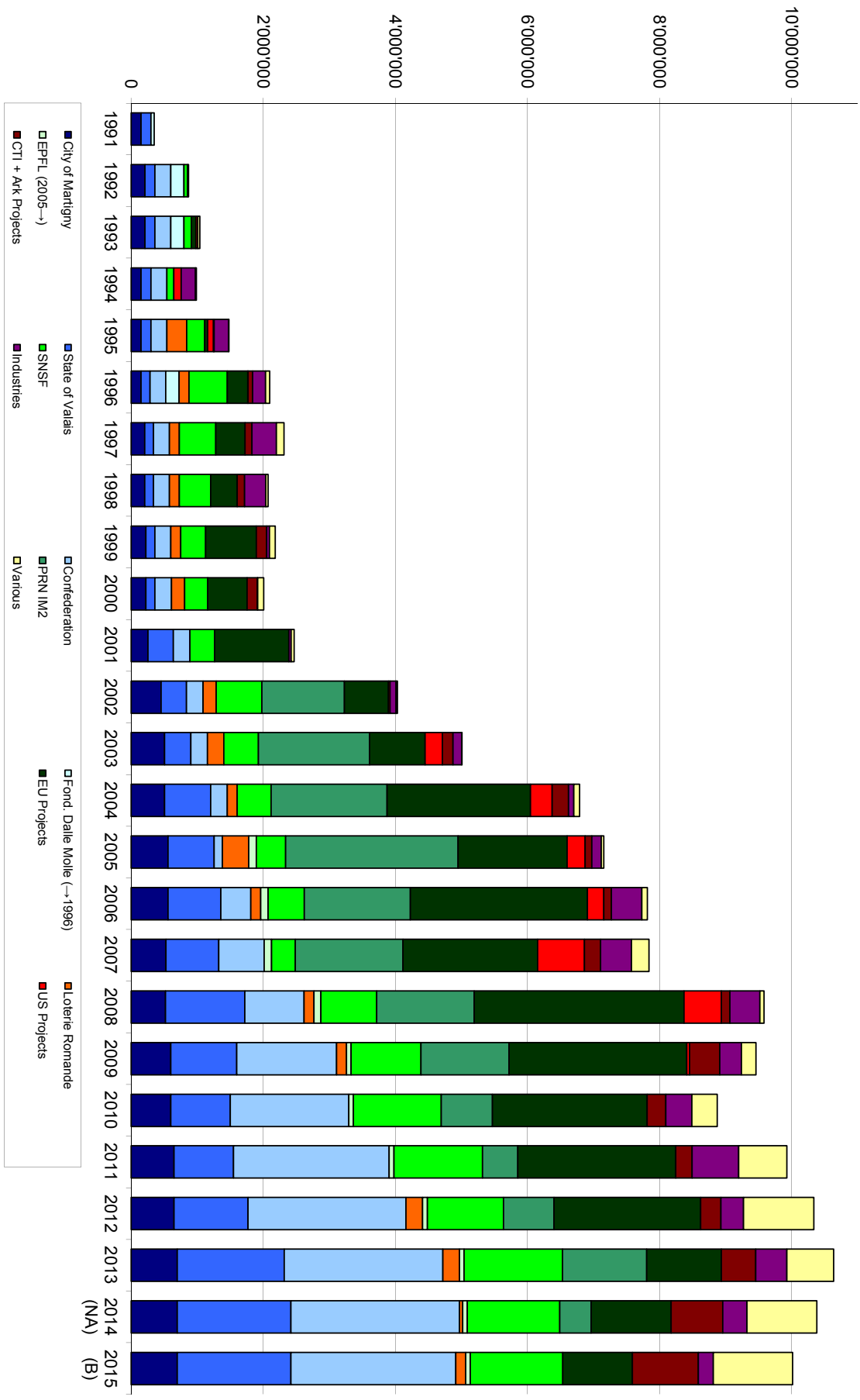

Figure 5: Evolution of budget and funding sources over time

The public/competitive (hard/soft) funding ratio is currently still around 50/50, which can be considered as excellent, given several factors:

1. This is being considered as a guideline/requirement from VS, requiring competitive funding to be always higher than public funding, which has also been adopted as an Idiap internal "rule".
2. This VS requirement is however "contradicted" in the last EPFL Evaluation Report, stating that we are relying too much on competitive funding, at the risk of decreasing the research quality, and generating additional management challenges.

Finally, the current budget evolution strongly limits:

1. The growth of Idiap, which can only be achieved through more competitive funding, although not encouraged by EPFL, and quickly becoming more and more difficult to manage, constantly increasing our overheads, while spending more and more time on writing grant proposals.
2. The potential for salary raises of permanent research staff, since we always avoid to (entirely) rely on soft funding to build salary raises, assuming that a minimum of 75% of the permanent staff salaries are covered by hard funding, as evidenced in Table 1, next page.

3.3 Internal funding distribution

As reported in Table 1, we regularly keep track of the internal distribution of the funding between the different units (Admin-Finances-HR, Admin-Services, System Admin, Developers, Permanent Researchers, and other researchers, i.e., post-docs and PhD students) to make sure that the majority of our resources are invested in added value R&D activities.

From that table, it can be concluded that most of our (hard and soft) funding actually goes to R&D activities (developers and researchers), while less than 15% (good practice recommendation), actually 7.45% (4.50% + 2.95%) in our case, goes to general admin activities, although those activities also include direct support to researchers for project submission and admin management. Furthermore, within each unit, the associated funding amount is also split between (public) structural funding and (competitive) project funding, showing that (as of March 2015) on average 83% of the salaries of permanent researchers is covered by hard funding, as opposed to only 25% for the developers.

YEAR 2014	Salary mass	Idiap/projects ratio	*Source*
Admin-Finances-HR (Ed Gregg)	4.5%	0%	*Project*
		100%	*Idiap*
Admin-Services (Léonore Miauton)	3.0%	53%	*Project*
		47%	*Idiap*
Sys Admin (Frank Formaz)	8.4%	9%	*Project*
		91%	*Idiap*
Developers (Olivier Bornet)	13.9%	75%	*Project*
		25%	*Idiap*
Permanent Researchers (Hervé Bourlard)	17.1%	17%	*Project*
		83%	*Idiap*
PhD	17.6%	87%	*Project*
		13%	*Idiap*
Post-Doc	22.8%	97%	*Project*
		3%	*Idiap*
Stagiaire/Interns	1.0%	43%	*Project*
		57%	*Idiap*
Other	11.7%	0%	*Project*
		100%	*Idiap*
Total	**100%**	**54%**	***Project***
		46%	***Idiap***

Table 1: From that table, it can be concluded that most of our (hard and soft) funding actually goes to R&D activities (developers and researchers), while less than 15% (good practice recommendation), actually 7.45% (4.50% + 2.95%) in our case, goes to general admin activities, although those activities also include direct support to researchers for project submission and admin management. Furthermore, within each unit, the associated funding amount is also split between (public) structural funding and (competitive) project funding, showing that (in 2014) on average 83% of the salaries of permanent researchers is covered by hard funding, as opposed to only 25% for the developers. The Idiap objectives of funding distribution (public/competitive) for the Developers group is 20/80 and for the Permanent Researchers group is 75/25.

4 Contribution to the Swiss Research and Innovation Activities

4.1 Idiap added value at the national level

Overview: From the content of the present 2017-2020 Research Programme, further confirmed by the recent International Audit results, it is clear that Idiap is bringing significant added value at the national level, along multiple facets, including scientific excellence, teaching and training young researchers, and in technology transfer.

Actually, we believe that our activities do not have an impact only in the realm of science and technology, but raise also a strong interest from society in general, as witnessed by the significant presence of Idiap in the Swiss and international media. See:
http://www.idiap.ch/the-institute/press/press-articles/press-today for a regularly updated list of press releases (containing 90 press releases, only since the beginning of 2015).

A complete listing of other high-impact activities at the national level is out of purpose here, but most of the relevant information can be found from the Idiap Web site, as discussed in Section 4.2).

Quite unique: It is important to note here that while most countries (to our knowledge) are encouraging the development of independent (but affiliated to one or more universities) research institutes like Idiap (the directors of three of them were part of the Audit Committee), Switzerland still seems to have difficulties to fully exploit this unique instrument, providing excellent dynamics and usually unique return on investment. This is particularly true for a non-university state like Valais.

Effective solutions to meet the needs of industry: Adapting research findings to the needs of the industry (technology transfer) is part of Idiap's mission. The institute is particularly effective in establishing influential practice (developer groups, the IdeArk business incubator, the International Create Challenge, etc.), to the great satisfaction of its partners, including industrial giants such as Nokia, Logitech, Yahoo, Samsung, and HP.

At the Service of the national and international R&D community: Attentive to local, cantonal, and federal economic development, Idiap also places its expertise at the service of the international R&D community. Highly active in the transfer of knowledge between academic and industrial institutions, Idiap creates and makes available a significant number of professional software packages—a service that a traditional university structure has more difficulty to deliver.

Innovation driver: Idiap is clearly recognized (in Valais and beyond) as a key innovation driver, and we are always adopting strategies that benefits Swiss industry first. The recently created biomedical image processing research group and Swiss Center for Biometrics Research and Testing illustrate the institute's intention of remaining in tune with contemporary economic and societal needs.

Swiss societal impact: The commitment of Idiap even goes beyond its research, training, and technology transfer missions, also aiming at having a larger potential impact on the Swiss society. This can be illustrated by two examples:

1. Dalle Molle Foundation: The central role that Idiap recently played in giving a new impetus to the Dalle Molle Foundation (see http://www.dallemolle.ch). The foundation, which has presided over the birth of Idiap about 25 years ago, has been constantly attached to quality of life; therefore, an annual competition has been created (3 years ago) to reward original ideas on how technology, and in particular information processing, can improve quality of life, balance the social system, and address environmental concerns.

2. Valais-Wallis Digital (https://www.valais-wallis-digital.ch/en/about/): In 2015, the State of Valais celebrates the 200th anniversary of its entry into the Swiss Confederation. To celebrate this

bicentenary, the State of Valais has launched a call for ideas to which the Idiap Research Institute, together with its partners (including Migros, also significantly contributing in cash to the project), has responded by submitting the "Valais-Wallis Digital" project. In March 2013, this project was selected by the State government as one of the 13 "Star Projects". "Valais-Wallis Digital" is now fully operational and active during the whole year of 2015, although its outcome should feed research and multiple initiatives over many years to come, while also directly benefiting to the society at large. Such an initiative is also in line with the "Digital Sciences" center recently initiated at EPFL.

"Valais-Wallis Digital" aims to:

- Digitize the collective memory of Valais.
- Create an Internet platform on which the population, the communities, the schools and the societies, in 2015 and beyond, will deposit archives and documents worthy of interest.
- Create and distribute a family card game which will serve as support and trigger element for the depositing of archive documents.
- Develop an interactive smartphone app for iPhone and Android. This app allows you to scan your game cards, manage your card collection and discover the historical context of the pictured event.

4.2 International Web presence and statistics

Idiap maintains a very rich Web site (http://www.idiap.ch) presenting the Institute, our research and technology transfer activities, and making multiple resources available to (and extensively exploited by) the research communities,

The statistics on the number of visits of our Web site (excluding publication, discussed later) are summarized in the table below.

Year	Sessions	Users	Visited pages
2010	57'493	31'611	184'254
2011	60'910	32'182	188'019
2012	69'993	36'569	210'772
2013	66'821	36'288	196'824
2014	65'986	38'487	184'482
2015	23'679	14'832	62'922
Total	344'839	185'546	1'027'193

From	% of visitors (over 2010-2015)
Switzerland	120'827 (35.0%)
United States	30'009 (8,7%)
France	22'908 (6,6%)
India	22'548 (6,5%)
Germany	12'799 (3,7%)
United Kingdom	12'373 (3,6%)
China	11'874 (3,5%)
Italy	8'250 (2,4%)
Iran	7'355 (2,1%)
Spain	6'853 (2.9%)

Table 2: Statistics over the number and origins of the visits of the Idiap Web site, excluding publications (below).

The Idiap Web site also includes multiple resources made available to the community:

1. **Publications:** All our publications in books, scientific (peer reviewed) journals, scientific (peer reviewed) international conferences, Idiap Research Reports (IDIAP-RR), and Idiap Communication Reports (IDIAP-COM) are always available online (and regularly synchronized with the EPFL InfoScience server). The statistics below show a very dynamic web site, attracting quite a lot of interest.

Year	Sessions	Users	Downloads
2013	17'371	10'615	42'460
2014	24'308	16'527	51'386
2015	9'009	6'692	16'396
Total	50'665	33'199	110'199

Table 3: Statistics over the number and origins of the publication downloads from the Idiap Web site.

2. **Open source libraries:** We maintain a (well advertised) list of datasets and open sources libraries at: http://www.idiap.ch/scientific-research/resources. All open-source libraries (currently 31 available) are available from http://www.idiap.ch/technology-transfer/open-source-software. However, no download statistics are currently available.

3. **Data repositories:** A total of 28 international benchmark datasets are currently distributed through the Idiap Web site from www.idiap.ch/dataset. For copyright, legal or ethical issues, all downloads are controlled and subject to approval. Just for 2014, we had 331 validated/accepted downloads, representing 23TB of data distributed to the research community, in addition to 300 more requests that had to be rejected.

4. **Online Recruitment System (ORS):** All our job openings are always published though different media, but also through our ORS system, through which candidates have to apply to allow us to manage the large number of applications. Here below we give some interesting statistics about this ORS, where "Positions" is the number of positions published during the year, "Primary App" is the number of different candidates having submitted a valid application file, and "Sub. App." is the number of second choice applications (where the valid candidates apply to multiple openings.)

Year	Open positions	Primary Apps.	Sub. Apps.
2007	17	139	461
2008	21	148	323
2009	15	257	330
2010	24	311	251
2011	16	236	362
2012	22	385	124
2013	13	251	95
2014	18	468	181
2015	3	47	0

5. **General news:** From that web site, copies of the public Annual Reports can also be found at: http://www.idiap.ch/the-institute/annual-reports, in addition to other news, such as:

   - Press review: Collected press review and several news threads are available and updated weekly at: http://www.idiap.ch/the-institute/press/press-articles/press-today;
   - Idiap general news: http://www.idiap.ch/the-institute/news/;
   - Research news: http://www.idiap.ch/scientific-research/news/;
   - Technology transfer news: http://www.idiap.ch/technology-transfer/news/.

4.3 Swiss Center for Biometrics Research and Testing

In 2014, and thanks to an initial (exceptional) support of CHF 300'000.- from the State of Valais and CHF 100'000.- from the City of Martigny, the Idiap Research Institute launched the "Swiss Center for Biometrics Research and Testing" (http://www.biometrics-center.ch), a competence center within the Institute following recent successes in coordinating International research projects in Biometrics (MOBIO, TABULA RASA and BEAT). The aim of this center is to serve as a legacy for these projects and to push for industry-driven research and testing in biometrics.

The missions of the center are (1) to carry out high quality research, (2) to train talented researchers and engineers, (3) to foster technology transfer from academia to industry, and (4) to propose a biometrics evaluation and testing service. To fulfill its missions, the center will mainly promote two instruments: (1) the coordination of a cooperative research consortium, and (2) the deployment of the BEAT evaluation platform[18].

The cooperative research consortium is an alternative industry-driven instrument inspired by a successful model running in the US: the Center for Identification Technology Research (CITeR). The main idea of this cooperative research consortium is to create an environment with mutual benefit between partners (academic researchers) and affiliates (companies or governmental organisations) where partners submit fast-track research proposals and affiliates drive and fund the research carried out by the partners.

Current situation: These instruments were presented in November 2014 to researchers and stake-holders (40+ participants), where it was decided to elevate the visibility of the cooperative research consortium to a more European level. We concluded an agreement with the European Association for Biometrics (composed of 160 members) to transform the cooperative research consortium initiated in Switzerland into a European cooperative research consortium (EAB-CITeR) but still coordinated in Switzerland by the center. We expect to attract a critical mass of partners/affiliates to fund research projects through the European cooperative research consortium. As an immediate consequence, two academic researchers (Norway and Germany) accepted to join as partners. In addition we are in discussion with two interested partners (Finland and Netherlands) as well as with interested affiliates (France and Germany).

The BEAT evaluation platform (https://www.beat-eu.org/platform/) is already functional and in beta-testing to be deployed late 2015. However, we have been contacted already by institutions and companies to use the platform for evaluation.

Future program: The "Swiss Center for Biometrics Research and Testing" has been chosen to host at Idiap in January 2016 the next meeting of the International Organisation for Standardisation (ISO) Sub-Committee "Biometrics" (SC 37 Biometrics). During one week, Idiap will host around 80 delegates from National Bodies including researchers, companies and organisations.

We plan to monetise the BEAT platform by providing commercial licenses to third-parties. More concretely, we are actively discussing with the European Joint Research Center that needs an evaluation platform for biometrics to circumvent data protection restrictions.

With respect to training, the "Swiss Center for Biometrics Research and Testing" and Idiap are preparing with UniDistance (http://unidistance.ch), a distance learning university, the program for a new Certificate of Advanced Studies (CAS) on "Biometrics and Privacy".

Finally, we plan to organise the very first partner/affiliate meeting during the Winter 2015/2016. A joint meeting is also under discussion between the EAB-CITeR and the US-CITeR and its affiliates such as the Department of Homeland Security, the Federal Bureau of Investigation, or the U.S. Army Armament Research Development and Engineering Center.

[18]The BEAT platform is an online reproducible research environment. It allows researchers to run comparative evaluations and to certify results from scientific publications.

5 Specific Requirements

5.1 Networking with academic institutions

Idiap-EPFL Joint Development Plan: As already discussed in Section 2.3, page 45, and more specifically in the context of the Idiap-EPFL Joint Development Plan (Section 2.3.4, page 47), Idiap is actively collaborating with EPFL and developing multiple joint activities, including PhD supervision, joint publications, joint projects, and teaching.

The resulting joint activities are summarized in the annual report of the Idiap-EPFL Joint Development Plan given in:
Annexes/2340_Idiap_EPFL_Convention_2013_2016.pdf.

HES-SO: There is also a collaboration agreement between Idiap and HES-SO Sion/Sierre, signed on April 10, 2006 and also very active, also resulting in multiple projects.

University of Bern: Dr. David Ginsbourger (currently Docent at UniBe) will start at Idiap on Sep.1, 2015, while keeping his affiliation, as well as the affiliation of his PhD students (although funded by Idiap in the future), with UniBe. Although all of Dr. Ginsbourger's activities will be deployed at Idiap, we will certainly keep/extend our collaboration activities with UniBe, as well as ETHZ also involved in several common projects.

5.2 Regional (VS) impact

Many points to be listed here. We should also point here to, and append the Idiap-VS "Contrat de Prestation":
Annexes/5211_Idiap_VS_Contrat_de_Prestation_2015_draft.pdf.

5.3 International positioning

There is no doubt that Idiap is contributing to the Swiss scientific positioning, as well evidenced through multiple indicators, including (among many others):

1. Our factual Self-Assessment Report: See Annexes/1246_Self_Assessment_Report_2014.pdf for the last version, updated in March 2015.

2. The conclusions of our 2014 International Auditing exercise: See Annexes/1245_Audit_Report_2014.pdf for the audit report.

3. The amount and quality of publications.

4. The amount of open source libraries (31) and distributed data repositories (28) made available (and actually exploited) by the international research community.

5. The international reputation of our senior research staff, but also of our PhD students and postdoc, as well as an impressive alumni.

6. The Idiap Web presence, content, statistics, and international visibility, as discussed in more detail in Section 4.2, page 65.

5.4 International auditing

Over the years to come (2017-2020), and with the aim to further boost the standing of the Institute, and further improve both scientific and technological excellence, while having a positive impact on society and industry, we will also fully take into account the recommendations of our 2014 International Audit report, briefly summarized, and used in a conclusion in Section 6 (Conclusions).

The fully Audit Report can be found at:
Annexes/1245_Audit_Report_2014.pdf.

6 Conclusion

In September 2014, seven of the scientific world's leading figures conducted an extensive audit of Idiap at the request of the institute's director—Hervé Bourlard. The seven experts were unanimous in highlighting Idiap's qualities, and also indicated some avenues that could lead to even further progress.

In addition to documents provided by Idiap, the committee carried out the audit thanks to three days spent on site at the institute, from 3 to 5 September 2014. On the agenda, presentations by researchers, managers, and members of the scientific college, and face-to-face interviews with young researchers, postdocs, and graduate students. A few weeks later, the committee submitted a detailed report highlighting Idiap's strengths, and made suggestions regarding further improvements.

The full audit report is available from Annexes/1245_Audit_Report_2014.pdf.

Some of the main conclusions are summarized below:

1. Research activities:
    - Scientific projects provide half of the Institute's budget: The number of projects undertaken by the institute is growing while their size and duration have decreased, large projects such as IM2 or AMI/AMIDA having come to an end. Currently, more than half of Idiap's annual budget is drawn from national and international research projects. That Idiap, in this context, continues to increase its research budget is a positive sign.
    - Quality resources and an open-source philosophy: The best specialist journals publish articles by Idiap researchers, which reflects the degree of excellence of the institute. Its researchers also contribute in a remarkable manner to the creation of quality resources, particularly databases and software, often open-source in nature.
    - Constant development of new research domains: In parallel to consolidating its pioneering activities in the field of speech recognition, now also applied to dialects, such as that of Upper Valais, for example, without lexicons, Idiap pursues its development activities in new research domains including robotics and biomedical imaging.
2. Managerial and structural activities:
    - The collegial atmosphere helps new arrivals: The friendly, collegial atmosphere, a culture of excellence, and the quality of the infrastructure present combine to make the Idiap research institute a great place to work. Students were particularly pleased with the help they received during their settling-in period in Martigny, and with the various measures aimed at encouraging social interaction.
    - High-profile and attractive: The 18 posts advertised over the last year attracted more than 500 applications. This illustrates the excellent visibility and attractiveness of Idiap, where no fewer than 34 different nationalities rub shoulders.
3. Relationship with EPFL:
    - Significant participation in EPFL's academic mission: Creating course materials, teaching, publishing scientific articles – Idiap's researchers play an important role in the academic mission of EPFL. Not to mention that they are training, at any one moment, over 40 PhD students.
    - Idiap – a unique setup that deserves a higher profile: The diversity of its scientific domains and the scope of its mission (research, technology transfer, and training) make Idiap a unique setup that deserves greater recognition from its various partners. The committee recommends, in particular, that Idiap researchers be appointed to academic positions at EPFL.

4. Knowledge and technology transfer:

    - Effective solutions to meet the needs of industry: Adapting research findings to the needs of the industry (technology transfer) is part of Idiap's mission. The institute is particularly effective in establishing influential practice (developer groups, the IdeArk business incubator, the International Create Challenge, etc.), to the great satisfaction of its partners, including industrial giants such as Nokia, Logitech, Yahoo, Samsung, and HP.
    - At the Service of the international R&D community: Attentive to local, cantonal, and federal economic development, Idiap also places its expertise at the service of the international R&D community. Highly active in the transfer of knowledge between academic and industrial institutions, Idiap creates and makes available a significant number of professional software packages – a service that a traditional university structure has more difficulty to deliver.
    - Innovation driver: By positioning itself as an innovation driver, Idiap is adopting a strategy that benefits Swiss industry. The recently created biomedical image processing research group and Swiss Center for Biometrics Research and Testing illustrate the institution's intention of remaining in tune with contemporary economic and societal needs.

In concluding its report, the audit committee presented certain recommendations for improving Idiap's productivity and impact:

- To complete its organizational structure, Idiap could establish an advisory group—including scientists—tasked with planning future infrastructure investments.
- An intensification of the relationship with EPFL can be achieved by securing EPFL academic appointments for Idiap researchers and by establishing better connectivity between the two entities.
- The committee encourages Idiap to continue its exploration of new application domains (medicine, energy, etc.) and to create a partnership with those European organizations that are likely to facilitate Idiap's integration into major projects in the long term.

« La force première de l'Idiap réside d'abord dans la qualité de ses employés mise en avant par les grandes avancées technologiques et le très bon dévloppement économique de l'institut. »

« Die entscheidende Stärke des Idiaps ist die Qualität seines Humankaptials, was durch die ausgezeichneten technischen und wirtschaftlichen Entwicklungsleistungen des Instituts bewiesen wurde. »

Idiap's key strength is the quality of its human capital, as is evidenced by the stellar technical and the econmic development accomplishments of the institute. »

International Audit Report,
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