ANNUAL REPORT 2023

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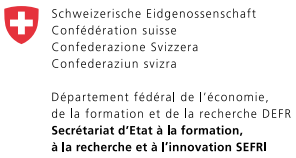

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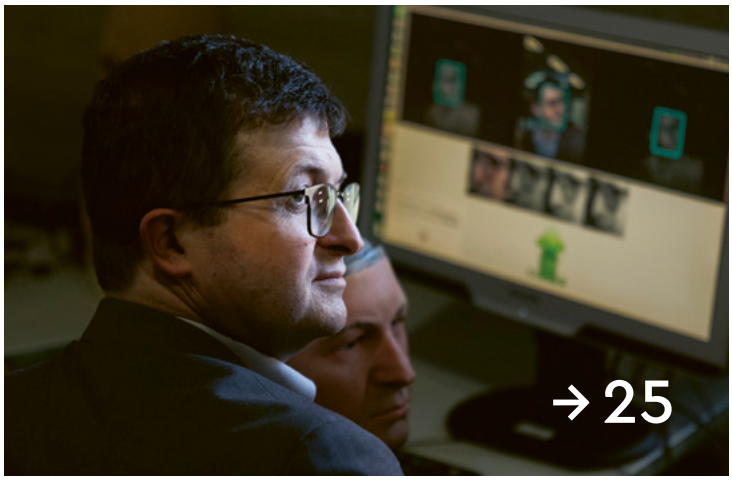
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"Artificial intelligence influences society, but the reverse is also true"

Anne-Laure Couchepin Vouilloz
President of the Foundation Council

This past year has marked a turning point in our relationship with artificial intelligence. Not a day goes by without the impact of AI being discussed by the media. The economy, health, information, politics, law—every field is concerned. Turning these technologies into ways to improve people's daily lives is a challenge, but also an opportunity. And Idiap is particularly well placed to respond.

The Institute lends its invaluable expertise to efforts to ensure that everyone benefits from these technologies. Because we have been working on these questions for decades. And because we are in close contact with all concerned, and understand their needs. Whether it's helping winegrowers to train up vine pruners or collecting field data as part of citizen science initiatives, at Idiap projects address society's needs. And I am delighted to see our scientists working on artificial intelligences that valorize collaboration with the human in us.

The year 2023 was also one of transition for Idiap, with the arrival of our new Director, Professor Cavallaro. Involved from day one in the Institute's strategic development, he is preparing for Idiap's future by positioning it ever more firmly. More and more entities are entering the field, and the resulting levels of competition illustrate, among other things, the importance of developing tools to serve the economy.

On behalf of the Foundation Council, I would like to extend my warmest thanks to all Idiap teams for their hard work and daily commitment. I look forward with great enthusiasm to discovering the next breakthroughs achieved by our Institute, and their positive impacts on society.

"AI developed at Idiap offers exciting possibilities for the future of our society"

Andrea Cavallaro
Director

With this Annual Report, I am delighted to show Idiap's commitment to using the transformative power of AI to make a positive difference in the world.

From empowering people with speech disorders to exploring the potential of large language models in genomics, the AI developed at Idiap offers exciting possibilities for the future of our society. These include novel approaches to reducing the energy footprint of AI models, and augmented reality tools to optimally prune grapevines for the best harvest.

To address critical global challenges, in 2023 Idiap mobilized its interdisciplinary expertise through four research programs. Our Human–AI Teaming program builds collaborative systems that enhance human capabilities. The Sustainable & Resilient Societies program tackles disinformation and seeks to increase the resilience of supply chains. The AI for Life program aims to improve individual well-being and quality of life, including through personalized healthcare and assistive technologies. Finally, the AI for Everyone program shapes this technology through inclusive co-creation.

These four programs draw on Idiap's unique expertise and extensive collaborations with partners and key stakeholders across Switzerland and abroad. We deeply appreciate the dedication of our partners and generous sponsors, who enable us to push the boundaries of knowledge and build a better future for all.

If you are inspired by our work, I encourage you to connect with us, for example through one of our regular Perspectives on AI events, and we can explore open research opportunities together.

Idiap, at a glance

Recognized as an institute of national importance by the Swiss federal government, with its research, training, and technology transfer Idiap promotes quality of life through scientific progress in the field of artificial intelligence.

A view of the Institute

"Our partners at Constellium quickly found new ways to use and improve model predictions. They were particularly interested in the accessibility and speed of the final software."

Rémy Siegfried
Postdoc in the Perception & Activity Understanding group

An Innosuisse project sees Idiap design AI tools to help experts study the manufacturability of new aluminum elements requested by their customers.
→ *More on page 14*

"In the future we aim to design additional features to further improve our machine learning model that helps people with speech disorders."

Ina Kodrasi
Head of the Signal Processing for Communication group

Our researchers contributed to a recent breakthrough that shows that an existing protocol allows us to differentiate which motor speech disorder a person is suffering from from among six different possible diagnoses.
→ *More on page 21*

"It's a little bit as if we were trying to analyze an 'agglutinated' text in an unknown language. We would have to extract information not even knowing when a new word starts or ends."

Lisa Fournier
PhD student in the Genomics & Health Informatics group

Our scientists are applying the expertise gained with large language models to other domains, including genomics, in order to better understand complex disorders.
→ *More on page 22*

"I hope this will allow me to help young and future researchers, to make science more open, and to ensure it works in the service of society."

Emmanuel Senft
Head of the Human-Centered Robotics & AI group

On May 1, 2023, the Board of Directors of the Swiss Academies of Arts and Sciences elected five new members to the Swiss Young Academy (SYA). Our colleague Emmanuel Senft was among them.
→ *More on page 28*

People

220 individuals in total and more than 50 posts in the start-up ecosystem

Scientific staff

- **18** lead scientists
- **117** research assistants
- **22** postdocs
- **7** trainees/visitors
- **13** students

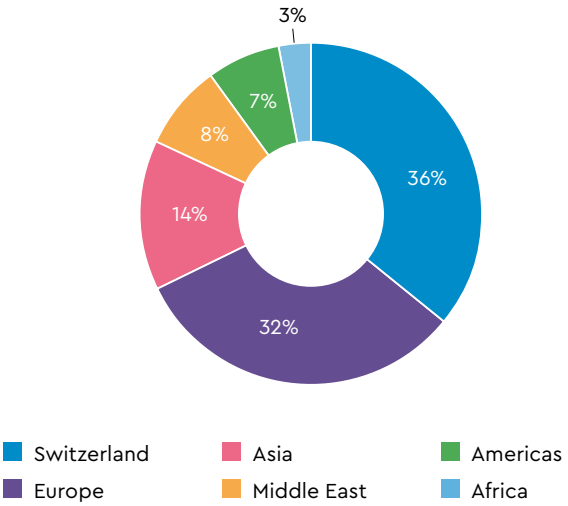
Engineers & technical staff

- **17** R&D engineers
- **12** system staff

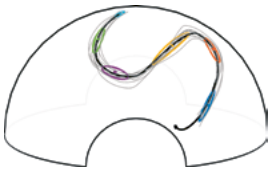
Administrative staff

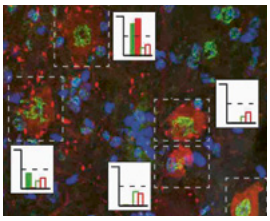
- **15** administrative staff

42 nationalities are represented at Idiap



Take a look at our Scientific Report





Publications in 2023

106
conference articles

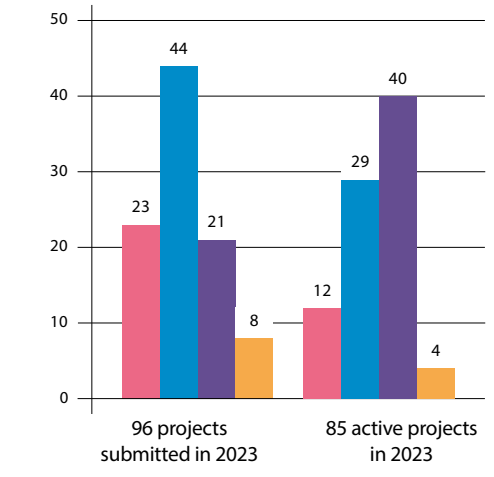
50
scientific articles

1
book

3
book chapters

11
theses completed

Number of research projects, 2023



People

Scientists

Mirko Agarla
Zineb Agnaou
Mustapha Al-Dabboussi
Abid Ali
David Alonso Del Barrio
Mahdi Amiri
Ravinithesh Reddy Annapureddy
Matheus Armani Renzo
Alina-Elena Baia
Tagore Sanketh Bandaru
Darya Baranouskaya
Melika Behjati
Imen Ben Mahmoud
Mrinmoy Bhattacharjee
Sushil Bhattacharjee
Yuhan Bi
Cem Bilaloglu
Matteo Bilardo
Alexandre Bittar
Roberto Boghetti
Andrea Bontempelli
Emma Bouton-Bessac
Giovanni Braglia
Lucas Braud
Victor Bros
Gabriele Brunini
Sergio Burdisso
Roberto Andrés Carofilis Vasco
Anna Chamot
Chuntzu Chang
Xiaoguang Chang
Cécile Chavane
Olivier Chavanne
Haolin Chen
Xuemin Chi
Dong Chu
Naravich Chutisilp
Laurent Colbois
Andrei Coman
Louise Coppieters De Gibson
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Dhairya Dalal
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Ruben De Campos
Anderson De Rezende Rocha
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Lisa Fournier
Julian Fritsch
Daniel Fuertes Coiras
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Wanying Ge
David Geissbuhler
Anjith George
Hakan Girgin
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Anshul Gupta
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Sevada Hovsepyan
Olena Hrynenko
Junduan Huang
Mahammad Ismayilzada
Julius Jankowski
Shasha Jiang
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Dana Kalaaji
Yacouba Kaloga
Rabeeh Karimi Mahabadi
Driss Khalil
Haeeun Kim
Edouard Erwan Koehn
Alain Komaty
Pavel Korshunov
Ketan Kotwal
Vedrana Krivokuća Hahn
Shashi Kumar
Jean Lesur
Yiming Li
Yu Linghu
Tobias Löw
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Florian Mai
François Marelli
Andreas Marfurt
Ante Marić
Cédric Mariéthoz
Kyle Matoba
Lakmal Meegahapola
Elisa Messori
Samuel Michel
Tobias Michel
Ioanni Mitro
Alireza Mohammadshahi
Ahad Montazeri
Zohreh Mostaani
Rafael Mozo
Skanda Muralidhar
Maryam Naderi
Armand-Mihai Nicolicioiu
Tiyam Nikray
Zhenwei Niu
Carlos Noriega Polo
Hatef Otroshi Shahreza
Gökhan Özbulak
Yik Lung Pang
Arnaud Pannatier
Jung Park
Luis Felipe Parra Gallego
Giuseppe Peronato
Molly Petersen
Florian Piras
Valentin Pocard
Amrutha Prasad
Tilak Purohit
Parsa Rahimi Noshanagh
Shalutha Rajapakshe
Leonardo Ranaldi
Pradeep Rangappa
Behrooz Razeghi
Amirreza Razmjoo Fard

Paula Dolores Rescala
Ségolène Roemer
Amina Rufai
Barbara Ruvolo
Rhéa Saber
Sina Sajadmanesh
Alejandra Sanchez Lara
Dairazalia Sanchez-Cortes
Andrea Elena Santos Revilla
Eklavya Sarkar
Christelle Schneuwly
Shakeel Ahmad Sheikh
Suhan Shetty
Rémy Siegfried
Prabhu Sivaprasad
Lucas Stel
Guillaume Syfrig
Samy Tafasca
Neha Tarigopula
Clara Tavernier
Iuliia Thorbecke (Nigmatulina)
Jakub Tkaczuk
Sandrine Tornay
Ibrahim Ulucan
Alex Unnervik
Marco Valentino
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Laura Vásquez Rodríguez
Karine Vaucher
Adrien Vauthey
Maxime Vidal
Michael Villamizar
Esaú Villatoro Tello
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Pierre Vuillecard
Oskar Wysocki
Alessio Xompero
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Teng Xue
Riccardo Zanella
Yan Zhang
Juan Pablo Zuluaga Gomez

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Andrea Cavallaro
André Freitas
Philip Garner
Daniel Gatica-Perez
James Henderson
Jérôme Kämpf
Ina Kodrasi
Michael Liebling
Raphaëlle Luisier
Mathew Magimai Doss
Sébastien Marcel
Petr Motlicek
Jean-Marc Odobez
André Rabello Dos Anjos
Emmanuel Senft
Damien Teney
Lonneke Van Der Plas

Engineers & technical staff

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Samuel Aymon
Guy Baconniere
Neven Balmer
Olivier Bornet
Annie Bornet
Nils Cajeux
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Daniel Carron
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Bastien Crettol
Yannick Dayer
Maxime Deleze
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Alissa Fellay
Gandal Foglia
Nyssa Foglia
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Magali Formaz
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Samuel Gaist
Théophile Gentilhomme
Pedro Gil Ferreira
Salim Kayal
Ragip Limani
Nazifa Limani
Jérémy Maceiras
Christine Marcel
André Mayoraz
Corentin Meier
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Mattéo Oggier
Louis-Marie Plumel
Ewan Roche
Matthieu Schösser
Nazmije Shala
Vincent Spano
Flavio Tarsetti
Laurent Tomas
Colombine Verzat
Augustin Verzat
Jules Voisin
Lou Voisin Plumel
Benno Weber
Robin Weder
Alicia Zangger

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Laura Coppey
Justine Darioly
Joel Dumoulin
Aïda El Faiz
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Our four research programs

Human–AI Teaming

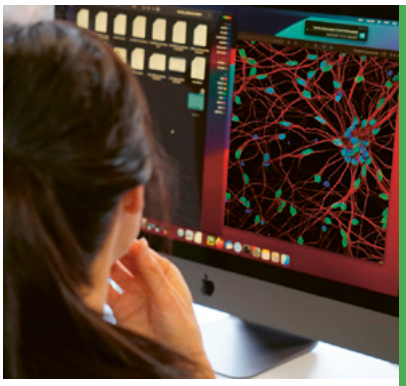
This research program capitalizes on the well-established expertise at Idiap on multimodal interaction. It leverages Idiap's unique ability to undertake in-depth multidisciplinary research across verbal and non-verbal communication, language processing, perceptual and cognitive systems, and human–robot interaction.

The aim of the program is to expand human capabilities in several fields (creativity, cognitive limitations, collaboration, knowledge). This research aims to improve machines' sensing and understanding of human activities, improve information access (e.g., through chat-bots serving as on-demand domain experts), use human feedback for improving learning systems, and use robots to assist humans in every-day tasks at work and at home.

Sustainable & Resilient Societies

Humanity is facing unprecedented challenges driven by climate change. As we cannot only count on technological solutions, people must be incentivized to contribute to more resilient and sustainable societies.

Designing and adapting artificial intelligence models to include people can help us to take on these challenges. With their multidisciplinary expertise, Idiap researchers can help to include this human dimen-sion. Their work contributes to tackling misinformation while reducing energy costs, and to identifying relevant social trends while helping us to understand our environment.



AI for Life

At Idiap, we aim to gain a deeper understanding of complex diseases and develop novel therapeutic approaches by leveraging advanced learning and inference paradigms that allow us to integrate diverse, longitudinal, interventional data and prior scientific and expert knowledge.

We embrace the complexity of individuals' health and personal care and a broad range of multimodal health and biological data.

We are dedicated to transparently and intelligibly enhancing health outcomes while ensuring democratic access to solutions.

AI for Everyone

To support individuals and communities outside mainstream Western societies, governments, NGOs, and businesses often use tools that were not designed with these users in mind. This needs to change.

Artificial intelligence should serve everyone, equitably. To achieve this, people—especially those whose voices are often not heard—need to be at the center of the design and deployment of AI systems. Through the development of participatory, trustworthy, and fair technology, research at Idiap empowers communities of users and fosters democratic, collective decision-making. The impact of our work is broad, ranging from citizen science initiatives to projects where the responsible use of AI can truly benefit communities.

Idiap Research Programs are driven by global challenges and Switzerland's societal and industrial needs. Aiming at high impact, and aligned with the UN Sustainable Development Goals (SDGs), they are the focus of the Institute's multidisciplinary expertise.

These programs contribute to the following UN SDGs:

Human–AI Teaming

RESEARCH PROGRAM

Intuitive robot programming for workers of the watch industry

Luminous paints allow us to tell the time using analog timepieces even in the dark. These compounds are still applied manually, as conventional automation solutions are unsuited to the task. This is why researchers from Idiap and Bern University of Applied Sciences (BFH) are developing a flexible robotics system that can be programmed by simply showing it what to do.

So the time can be read on analog clocks and watches even in the dark, the indices and hands are coated with a phosphorescent paint. The luminescent compound Swiss Super-LumiNova®, produced by the Swiss company RC Tritec AG, is generally used for this purpose. It is applied manually, as the process calls for a high degree of precision and cannot be automated in the conventional way due to the many product ranges and small batch sizes. As the application of the luminescent compound is a very repetitive task, the watchmaking industry is finding it increasingly difficult to recruit people to this role. This is why researchers from Idiap's Robot Learning & Interaction group and the Institute for Human Centered Engineering (HuCE) at BFH, in collaboration with the company Ciposa SA, are working to develop an innovative, flexible automation solution. The project is supported by Innosuisse, the Swiss innovation agency.

Showing robots what to do

For the robotics system under development to fulfill the watchmaking industry's specific requirements, it must work with extreme precision but also be quick and easy to reprogram for new products and designs. To address this, researchers are working on programming the robot by manually showing it what to do. By teaming with a human worker, the machine records that worker's movements and combines this information with measurement data from various sensors to achieve the required degree of precision. Machine learning will enable the robot to develop the right strategy for applying the compound in any given situation.

(Written in collaboration with BFH.)

Aluminum parts manufacturing optimized with AI

An Innosuisse project has seen Idiap design AI tools to help experts study the manufacturability of new aluminum elements requested by their customers.

With 300 new applications each year, Constellium Valais produces a vast variety of objects in aluminum. The extrusion process—shaping aluminum by pressing an aluminum bar—is very complex and versatile. Each new customer request requires a huge effort from engineers, especially to define if the desired profile can be manufactured and if so, at what cost, then to design the tool and the production formula. One of the essential tasks of their analysis is to search production history for profiles similar to that requested by the customer. The search results complement the personal experience of specialists, who study the profile's manufacturability and predict the pressure of the press during extrusion.

The goal of the Innosuisse project P3 (Press Pressure Prediction)—coordinated by the SPL research group of the Valais School of Engineering (HEI Valais) in partnership with Constellium Valais SA—was to use artificial intelligence technologies to help experts conduct these feasibility studies. This was achieved thanks to the development of powerful tools to search for similar profiles in the production history and to predict press pressure. Here at Idiap, it was the Perception & Activity Understanding group that participated in this "100%-from-Valais" collaboration.

How does such a tool work?

In order to obtain the important quantity of data necessary for the application of artificial intelligence methods, Constellium made significant efforts to retrieve all production data. This included more than 1,200 drafts of already manufactured profiles as well as data from 730,000 extrusions of these profiles in the form of extrusion parameters, such as heating temperature, and on-press measurements such as the pressure curve.

Once treated, this information made it possible to design and train two models: a neural network that extracts a characteristic signature of the shape of a profile from its image, and that then allows the expert to quickly find similar profiles in the database, and a conditional neural network that predicts the pressure during extrusion for a specific speed and temperature. Finally, a graphical interface developed by HEI was implemented to allow engineers and operators to easily incorporate the models into their daily routine.

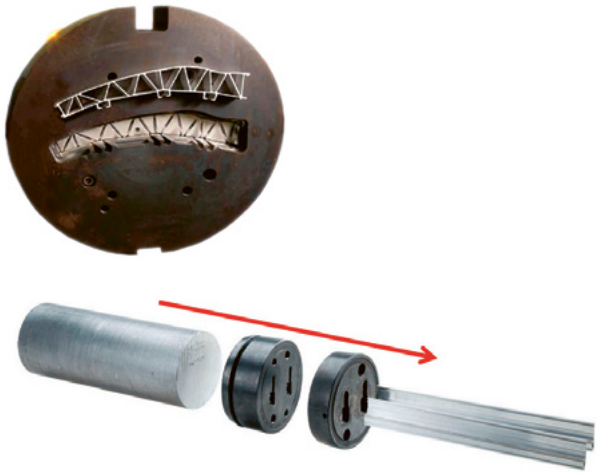
What do the experts say?

Eighteen months into the project, experts from Constellium Valais say they are very satisfied with

Project members during the project's final day. From left to right: Fabrice Balet, Raoul Rey, and Paul Robillard (Constellium), Rémy Siegfried and Michael Villamizar (Idiap), and Bruce Morère, Roland Vogel, and Alexis Bacha (Constellium). Foreground: Jean-Marc Odobez (Idiap) and Steve Devènes (HEI). Silvan Zahno (HEI), project coordinator, could not be present.

their new tool. Their tests demonstrate that they are now able to quickly find profiles similar to that requiring evaluation. And the tool also provides them with new means of analysis, allowing them to quickly simulate pressure throughout the extrusion process. A scientific paper detailing this work and its results in the framework of the P3 project is currently being submitted.

"This new tool is in the process of being adopted by our industrial partners, and undoubtedly still requires some improvements, but their level of satisfaction means we can describe this project as a fruitful collaboration between research and industry in Valais," says Jean-Marc Odobez, head of the Perception & Activity Understanding group at Idiap. *"Our partners at Constellium quickly found new ways to use and improve model predictions. They were particularly interested in the accessibility and speed of the final software, which complements their current analysis tools,"* adds Rémy Siegfried, a postdoc from Jean-Marc Odobez's team.



Manufacture of a profile in aluminum. Image courtesy of Constellium Valais.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency

Hes·so VALAIS WALLIS

Constellium

Sustainable & Resilient Societies

RESEARCH PROGRAM

Toward energy-efficient artificial intelligence models

Artificial intelligence technologies are setting new performance records daily, but their energy costs are also growing significantly. Idiap researchers are proposing a novel approach to addressing this challenge, during a period of rising energy costs.

Artificial intelligence technologies are getting better and better at understanding the meaning of natural languages. This progress makes a crucial difference for real-world applications using text analysis and speech recognition tools. Currently, the most cutting-edge technologies rely on models called transformers, which place significant demands on computing resources. As a result, the number of mathematical operations needed for analyzing longer and longer text and speech signals becomes exceedingly burdensome even in the presence of more computing power. Acknowledging this flaw, Idiap's researchers have come up with a strategy to reduce the computational and energy resources required to run these technologies—a strategy presented in an academic paper entitled "HyperMixer".

A new model

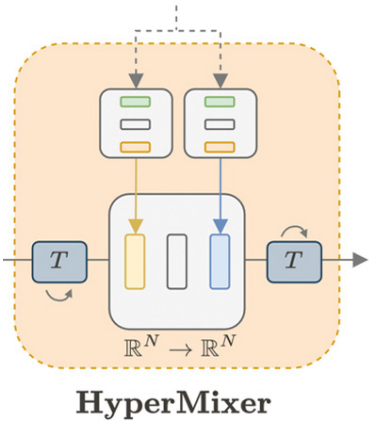
"When working with resource-demanding algorithms, researchers often have to artificially shorten their inputs to obtain results in a reasonable time frame. Cutting computing costs is crucial for research and for its applications," Florian Mai, first author of the paper and a research assistant in the Natural Language Understanding group, explains. To reduce these computing costs, Idiap researchers decided to revisit a decades-old model called multilayer perceptrons, which is usually considered unfit to process language due to its inability to handle inputs of varying length. The researchers found, however, that by switching from a static to a dynamic processing model language-related data can be processed effectively. They called this model HyperMixer.

More cost-effective AI

In addition to their modeling improvement, the researchers were also able to demonstrate empirically that their model performs on a par with or better than traditional models. So, in comparison with transformers, HyperMixer achieves these results at substantially lower computing costs in terms of processing time, training data, and parameter tuning.

Beyond this scientific achievement, HyperMixer takes an important step in the direction of diminishing the environmental impact of AI technologies. In an era in which energy costs are skyrocketing and resources are dwindling, this is a crucial research contribution. *"Idiap's motto 'AI for society' must also be reflected in algorithms,"* James Henderson, head of the Natural Language Understanding group, concludes.

"HyperMixer: An MLP-Based Low Cost Alternative to Transformers" was presented at ACL 2023 in Toronto. "HyperConformer: Multi-head HyperMixer for Efficient Speech Recognition" was presented at Interspeech 2023 in Dublin.



HyperMixer model: An MLP-based Low Cost Alternative to Transformers

Enhanced vine pruning thanks to artificial intelligence and augmented reality

Idiap and the company 3D2cut have developed a system capable of assessing vines and assisting in the pruning process, as described in yet another Idiap scientific publication. The project was supported by The Ark foundation for innovation in Valais.

Vine pruning is a complex procedure that requires in-depth knowledge and years of experience. Poor pruning can have catastrophic consequences for the health and productivity of the vine. To address the shortage of skilled and knowledgeable pruners, the start-up 3D2cut SA, located in Valais, Switzerland, asked Idiap to develop a system based on artificial intelligence and integrate it into augmented reality goggles. The resulting device identifies the different structural parts of each individual vine and recommends precise cutting points. This breakthrough was made possible thanks to the company's founders, who are world-renowned master pruners, and to the support of The Ark, a Valais-based foundation for innovation.

"Up to one-fifth of the world's vines are not productive. The International Organisation of Vine and Wine has identified wood diseases of the stump as the main cause of this problem and pruning as the main means of prevention," Massimo Guidici, co-founder of 3D2cut, explains. To ensure preventive "soft pruning," augmented reality glasses can visually pinpoint and recommend cutting points on the vine. *"To achieve this, a deep understanding of the vine and the pruning decisions for each plant is necessary,"* Marco Simonit, master pruner and co-founder of 3D2cut, explains. Meaning it is essential that the rules laid down by vineyard experts are respected.

How does it work?

The visual system developed at Idiap identifies the structure of a vine by distinguishing its nodes (so, its buds) as well as its branches and their type. *"To achieve this, we drew inspiration from the technologies used to detect human posture,"* Jean-Marc Odobez, head of the Perception & Activity Understanding group at Idiap, explains. *"But instead of predicting in an image both the key points of a human body, such as joints—wrist, elbow, knee—and what connects them, so, arms, thighs, torso, the device detects the nodes of vines and the branches that connect them. It also determines the type of branch, so, trunk, spurs, rods, and shoots, and in general all the information necessary to allow an expert system to recommend where pruning cuts should be made."*

Node and branch detection is carried out by a neural network specially designed for the task and trained on vine images annotated by specialists. The final structure of the plant is extracted from this detection thanks to a new algorithm based on research into a path of least resistivity of a graph. This method allows the system to adapt to the number of nodes and connections, unlike in the approach used to detect the posture of humans, whose articulation structure is fixed. Details of the project have been published in the journal *Computers and Electronics in Agriculture*. The images and annotations of the vines created for the project have been made accessible in open-access form for non-commercial use.

A promising tool

A first version has been integrated and deployed by 3D2cut on a tablet and tested on real-life shots. For the company's experts, the results are very encouraging, even if many challenges must still be overcome if the project is to deliver truly reliable and efficient technology. The vision system will have to work in a range of conditions and take into account aspects including variations in luminosity, a wide variety of backgrounds including other vines, and different viewing angles. Above all, the system must be able to process images very quickly on onboard equipment.

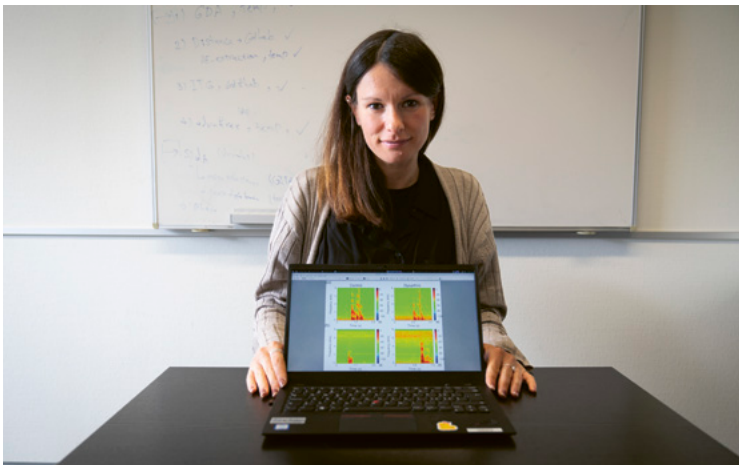
"Collaborating with Idiap has proven invaluable," Jérôme Corre, CTO of 3D2cut, explains. *"We have the technical knowledge regarding vines and the ability to collect large quantities of data; the researchers bring us the necessary expertise in AI to quickly reach a solution."* And this partnership with the Institute could prove even more "fruitful" in the future. *"Once we get a proven product for vines, this system could be applied to other fruiting plants that require pruning, such as apple, pear, orange, and even cocoa and coffee plants,"* co-founder of 3D2cut Henrico Dolfing concludes.

Result obtained by the visual system developed by Idiap applied to an image of a vine. Circles highlight nodes and buds for each branch, and red lines represent the predicted structure of the vine. The various colors seen on the nodes or buds of each branch characterize the different parts of the vine predicted by the system (trunk, spur, cane, shoots, etc.).

AI for Life

RESEARCH PROGRAM

Helping people with speech disorders



Ina Kodrasi, and an audio file from the project.

The Idiap Research Institute uses signal processing and machine learning to design tools to improve people's daily lives, especially people with communication difficulties. Ina Kodrasi, head of the Signal Processing for Communication group, is contributing to significant advances in the field of pathological speech.

It is now easier to diagnose which motor speech disorder a patient has, including hypokinetic dysarthria from Parkinson's disease or mixed dysarthria from Wilson's disease, among others. A clinical tool, the MonPaGe-2.0.s protocol, is used to check if an individual is suffering from a speech disorder. Whether it could be used to differentially diagnose between various disorders was, until recently, unknown.

Ina Kodrasi and colleagues contributed to a recent breakthrough, showing that the MonPaGe-2.0.s protocol allows us to differentiate which motor speech disorder a person is suffering from from among six different possible diagnoses. This achievement was made possible thanks to Kodrasi's expertise in machine learning applied to speech. A new model was trained using recordings of 60 speakers experiencing mild to moderate motor speech disorders. The recordings were then described using seven important acoustic features exploited to determine what type of disorder is present in each: intelligibility, articulation, voice, speech rate, maximum phonation time (i.e., the time over which an individual can sustain a sung tone), prosody (i.e., the rhythmic and intonational aspect of language), and diadochokinetic rate (i.e., how quickly an individual can accurately repeat a series of rapid, alternating sounds).

"These seven features have well-known links to motor speech disorders, but we found that only four were really relevant to discriminating between the different disorders," Kodrasi explains. *"In the future we aim to design additional features to further improve our machine learning model."* The ultimate goal of this collaboration is to provide clinicians with a tool that makes diagnosis more accurate. *"Working within such an interdisciplinary consortium has been really interesting. Participants come from their own fields, with their own points of view and their own vocabularies. It wasn't easy to understand each other at the beginning, but it really became easier afterward,"* Kodrasi concludes. The work was conducted in collaboration with phoneticians and neuroscientists from the Sorbonne Nouvelle University in Paris and the University of Geneva.

A new project on pathological speech enhancement

Currently, speech enhancement techniques in digital communication generally target neurotypical speakers, so, speakers that do not suffer from speech disorders. But a new project entitled PAuSE: Pathological Speech Enhancement will, thanks to a grant from the Swiss National Science Foundation, allow Kodrasi to grow her research group by engaging two PhD students to work on developing model-based and deep learning–based speech enhancement approaches that yield advantageous performance for pathological speakers too.

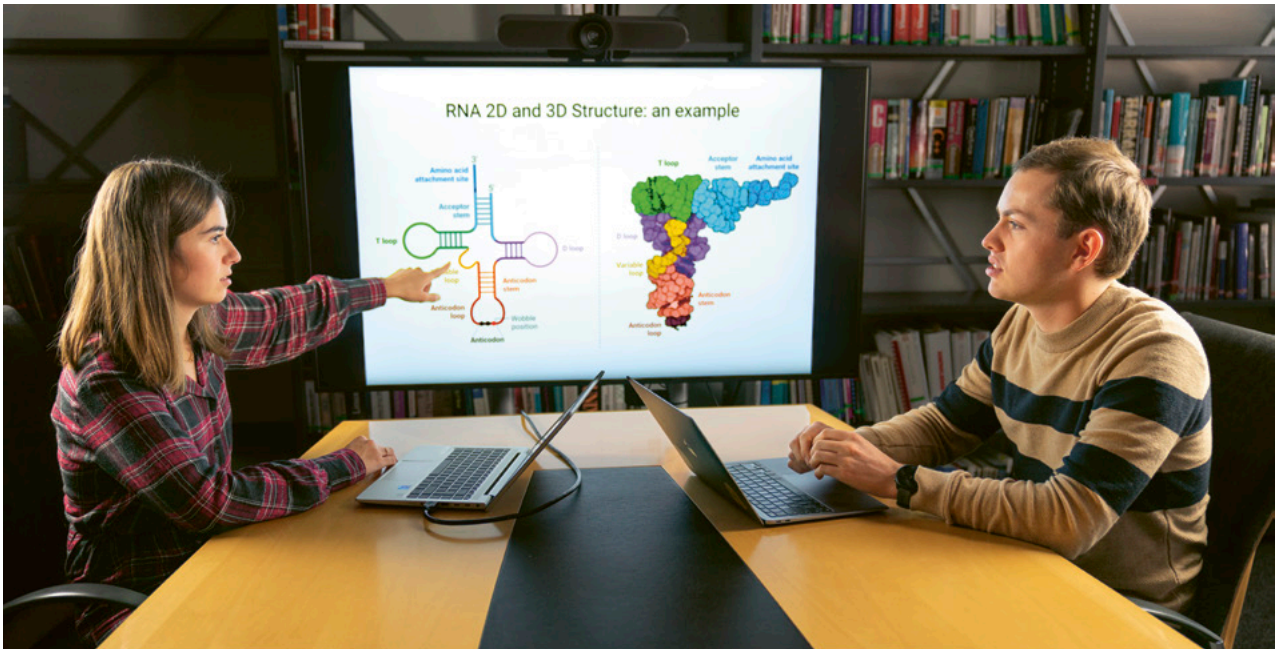
Leveraging ChatGPT-like technologies to decode the human genome

Applying the expertise gained in work with large language models to other domains, such as genomics, can bring new scientific insights and help us better understand complex disorders. Idiap's agile research teams constitute the perfect environment in which to foster such interdisciplinary collaborations.

The worlds of genes and words seem miles apart. But despite them being unrelated scientific domains, biology and linguistics can each benefit from similar artificial intelligence technologies. Indeed, large language models such as those used by ChatGPT might prove useful to an exploration and better understanding of genetic information. And part of this endeavor is playing out at Idiap. PhD students from the Genomics & Health Informatics and the Computation, Cognition & Language research groups have recently teamed up to explore whether, and if so, how technologies such as large language models can accelerate research in genomics, with impacts expected in the development of therapeutics for complex disorders. This work is paving the way to the adaptation of AI tools to other domains, and there are hopes it will contribute to cancer research.

Unfolding the role of non-coding sequences of the genome

Lisa Fournier started work in the Genomics & Health Informatics group during the writing of her Master's thesis and remained with her supervisor, Raphaëlle Luisier, to start a PhD. Her scientific interests center on comprehending the metabolism of messenger RNA in the context of cancer. Messenger RNAs are pivotal molecules within cells, carrying genetic information from DNA to specific locations in the cell to provide the instructions needed for the synthesis of particular proteins. These molecules are made of two kinds of element: coding and non-coding sequences. Fournier's interest lies in unraveling the contribution of these non-coding sequences to the emergence of resistance to anti-cancer therapies. Enhancing our understanding of these mechanisms could facilitate the identification of the most appropriate treatment for the patient. *"We are aware that certain drugs elicit better responses in some patients compared to others. The ability to identify, prior to initiating treatment, which drug or combination of drugs*



Lisa Fournier (left) and Vincent Jung (right).

will be the most effective for a patient has the potential to save crucial time and enhance the likelihood of successful therapies," Fournier explains.

A major challenge in advancing cancer treatment lies in understanding the heterogeneity of cancer cells, both across patients and within the same patient's tumor. A key opportunity to tackle this challenge stems from the abundance of available data. Researchers today are able to sequence the entire messenger RNA of individual cells, which offers a promising approach to gaining deeper insights into tumor heterogeneity. *"The data generated from sequencing across multiple laboratories amounts to thousands of terabytes,"* Fournier explains. *"We are dealing with millions of lines of text composed of the letters A, C, G, and T, representing the four fundamental building blocks of DNA and RNA. Our task is to mine this data to extract meaningful information related to how a cell responds to a drug. Studying individual nucleotides* [editor's note: corresponding to each letter] *is an emerging field."*

Large language models to avoid biases

After completing a Master's in Data Science in Zurich, Vincent Jung joined Idiap's Computation, Cognition & Language group for an internship under Lonneke van der Plas' supervision. His research interests focus on biases in large language models. Jung explains: *"For example, when you train a model to predict the number of stars from the text of Amazon reviews in multiple languages, usually you adapt a pre-trained model. What these models learn can be quite obscure due to their black-box nature. If your training dataset has a lot of bad French reviews and a lot of good German reviews, for example, your model might learn to recognize language and make predictions based on that instead of relying on positive or negative words."* But despite this, when trained with careful consideration these models can prove to be very powerful and provide valuable insights into natural language.

Intrigued by the potential that language models could offer the analysis of genomic sequences, Jung and Fournier recently teamed up to create a novel interdisciplinary working group at Idiap with the aim of learning from each other and potentially developing this technology and adapting it to RNA sequencing. Kickstarting the process was easy, as Fournier and Jung already discussed such topics over lunch. *"Actually, one of the challenges was to clarify our vocabulary. We found many similar concepts that were named differently. For example, a collection of letters or symbols we call k-mers in genomics is called n-grams in natural language processing,"* Jung observes.

Deciphering the transcriptomic code

Computer scientists and bioinformaticians have already tried to apply large language models to genomics and transcriptomics [editor's note: the study of the sum of an organism's RNA transcripts]. But while the results have been promising, these attempts lack a deeper understanding of the biological realities. Jung explains: *"For example, when we analyze sentences in English we know that we have to look for links between the words up to a certain distance in the text. Thanks to linguistics, we know that a pronoun will not refer to a noun several sentences distant from it. With genetic sequences, we don't know how far apart elements can be while still being linked."*

The challenge in this is even more complex than it seems, as Fournier explains. *"Not only do we lack a designated grammar to comprehend the connections between nucleotides, but we also need to acknowledge that only 2 percent of the human genome comprises protein-coding genes for which the lexicon for translation into proteins is understood. In contrast, for the remaining non-coding sequences the majority of those functions remain elusive. The vocabulary is yet to be established. It's a little bit as if we were trying to analyze an 'agglutinated' text in an unknown language. We would have to extract information not even knowing when a new word starts or ends."*

Researchers still do not know if large language models can be generalized to RNA sequencing. And these models still require much improvement. Jung: *"Our collaboration is our strength. As each model training round takes several weeks, you can't search blindly for improvements. We need to constrain the model to the biophysical world to ensure its alignment with real-world biological mechanisms."* Fournier: *"By starting from biology and thanks to our interdisciplinary approach, we are gaining a deeper understanding of each other's domain. Hopefully in the long run, we will also be able to better understand the biological process underlying the development of resistant cancer cells, and strategies for their treatment."*

AI for Everyone

RESEARCH PROGRAM

World leaders in biometrics meet at Idiap to discuss technological and societal challenges

In 2023, Idiap hosted a Biometrics Week. This one-of-a-kind event gathered together many hundreds of participants from a range of backgrounds including academia and industry. The organizers included the European Association for Biometrics and the US Center for Identification Technology Research. This meeting was also an opportunity to discuss ethics and fairness questions.

Dinusha Frings, CEO of the EAB.

From deepfakes to privacy and security issues, biometrics is often in the spotlight. Home to two research groups engaged in the biometrics field and to the Swiss Center for Biometrics Research and Testing, Idiap has become a world hub for researchers and stakeholders in this domain. From April 17 to 21, experts in biometrics met in Martigny to discuss a broad range of biometrics-related topics.

The main focus of the week was an event co-organized by the European Association for Biometrics (EAB) and the US Center for Identification Technology Research (CITeR). This sold-out event assembled over 160 participants from both academia and industry. The topics covered included evaluation and certification, deepfakes, and synthetic realities. A workshop was followed by a poster and demo session. Demos from Idiap and its partners ranged from known technologies, such as fingerprints, to more novel approaches such as vein recognition and age estimation.

Toward the future

In the days that followed, the CITeR held its Spring 2023 Program Review. Involving CITeR researchers, students, and affiliate members, this meeting was a closed research review. CITeR is the only US National Science Foundation Industry/University Cooperative Research Center, and focuses on serving its affiliates in the rapidly growing areas of identity science and biometric recognition through an interdisciplinary group of faculty, researchers, and students.

"Our aim was also to involve students in this Idiap Biometrics Week," Sébastien Marcel, head of the Biometrics Security & Privacy research group, explains. And two scientific projects—TReSPAsS and PRIMA—held meetings with their PhDs. *"There was an opportunity for the students to meet with other participants during the poster and demo sessions. As Idiap is involved in the TReSPAsS project, it seemed obvious there was a link to be created. And the same was true for PRIMA,"* Marcel concludes.

How urban crowdsourcing platforms draw a world map of citizen contributions

In a systematic review, Idiap researchers have analyzed urban data crowdsourcing platforms around the world. Their work highlights the growing role of these platforms in informing urban policies and sheds light on the state of development of such tools.

Cities are at the forefront of numerous challenges, ranging from mitigating the effects of climate change to mobility and security issues. Well-informed policies are crucial to taking on these challenges. Thus, cities are increasingly gathering data thanks to volunteers and crowdsourcing platforms. People use the sensors embedded in mobile phones—GPS, cameras, microphones—to contribute observations made on the ground. As this type of urban tool is being increasingly discussed in the academic literature, researchers from the Social Computing group at Idiap conducted a systematic review of such studies worldwide. Their work examined and cataloged the platforms, focusing on their geographic location and specific purposes and on the public availability of their data. The research provides a more comprehensive picture of these tools across the world, and was conducted by Alessandro Fornaroli (a former EPFL Master's student) and Professor Daniel Gatica-Perez in the context of the EU H2020 project ICARUS.

From citizen science to urbanism

Thanks to rigorous selection and classification, the researchers were able to analyze 30 studies covering 32 crowdsourcing platforms for urban data gathering that were launched and are maintained by local authorities. The geographic distribution of these platforms is wide. The cities covered in the reviewed studies are situated across five continents: Africa, the Americas, Asia, and Europe. In the systematic review, it was found that urban reporting—which allows people to report issues to city administrations or local authorities, such as potholes, garbage, or broken public assets—is indeed a popular practice.

Future endeavors

"Even if our work provides valuable insights into the state of urban platforms for citizen-contributed data gathering, there are several open questions," Gatica-Perez, head of the Social Computing group, explains. *"For example, we observed that a large majority of platforms—about 70 percent—are based in the US and Europe. As we only analyzed academic literature written in English, we cannot say whether this imbalance is a result of this methodological choice or indicates a real discrepancy in the existence of such platforms across different world regions."* The review also highlighted disparities in terms of the data that platforms make available to the public. "*Understanding why local decisions are made with respect to public availability of data is another open question. They could be the result of different legal and cultural perspectives on data, and this underlines the value of human-centered research in this domain,"* Gatica-Perez concludes.

Life at the Institute

OUR COMMUNITY

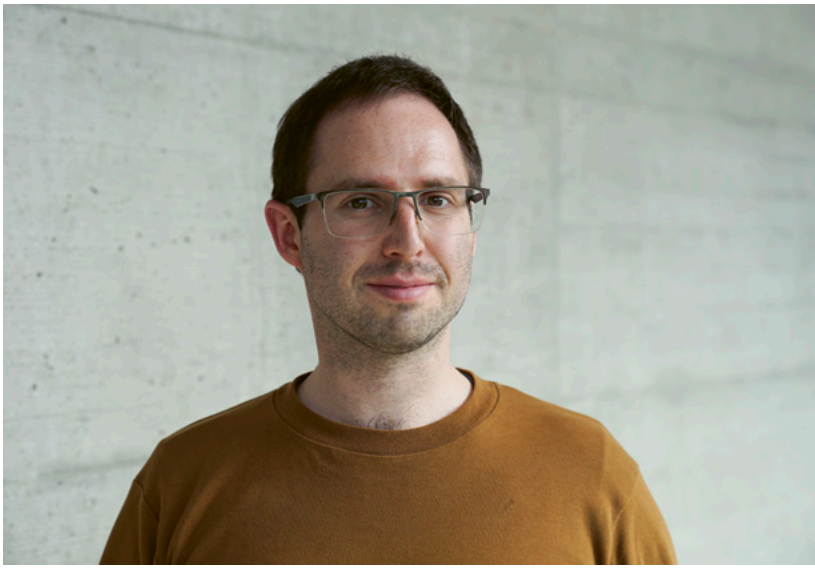
Emmanuel Senft among the new members of the Swiss Young Academy

On 1 May 2023, the Board of Directors of the Swiss Academies of Arts and Sciences elected five new members to the Swiss Young Academy (SYA). Election signifies the Academies' acknowledgment of the ideas and commitment of the newly elected members, at the interfaces between science, society, and politics.

Head of the Human-Centered Robotics & AI cross-research group, Emmanuel Senft—alongside his newly elected colleagues—will thus be able to implement innovative, inter- and transdisciplinary projects during the next five years jointly with the other 34 members of the Academy. Selecting the appropriate candidates from over 80 applications was a challenging task. *"It is impressive to receive so many great applications and to see how many young scientists and academics would like to get involved, in parallel with their careers,"* the Advisory Council stated. *"This reflects the great potential and motivation for change in this new generation of young scientists and academics."*

A high level of interest in the dialogue between science, society, and politics is a vital element for admission to the SYA. Another prerequisite for membership is the willingness and motivation to commit to inter- and transdisciplinary group projects at the abovementioned interfaces. Emmanuel comments, *"I am honored to have been elected to the Swiss Young Academy. I look forward to collaborating with the incredible people who are and will be part of it, and hope this will allow me to help young and future researchers, make science more open, and ensure it works in the service of society."*

His five-year membership of the Swiss Young Academy began on 16 June 2023 at an admission event in Bern. In addition to the project opportunities election presents, Academy members benefit from a mentoring program and other personal support measures aimed at furthering their careers.



Emmanuel Senft.

Raphaëlle Luisier appointed permanent researcher at Idiap

Drawn to Idiap by the Institute's Fellowship Program for Female Researchers, Raphaëlle Luisier has been promoted to the role of permanent researcher.

Upon her arrival, she created the research group Genomics & Health Informatics, which has allowed Idiap to grow into new area—that of bioinformatics, genomics, and transcriptomics [editor's note: the study of the sum of an organism's RNA transcripts]. Her expertise in neurodegenerative diseases has made it possible to forge new research links between health and artificial intelligence, and to better understand complex diseases such as amyotrophic lateral sclerosis (ALS), the disease that affected Professor Stephen Hawking. Raphaëlle's method for the automatic identification of pathological motor neurons in ALS and a computational analysis method for classifying images of healthy and affected motor neurons have led to new technological breakthroughs. *"Working at Idiap allows me to diversify my research activities, and in particular to combine image analysis and transcriptomic data to better understand the impact of molecular changes on cell behavior,"* Raphaëlle explains. *"All this has been possible thanks to collaborations with Idiap researchers, who are experts in artificial intelligence. I feel very privileged to be able to contribute to new advances in the field of cancer and neurodegenerative diseases while enjoying the idyllic landscape of Valais."*

Raphaëlle Luisier.

A new Idiap group bridging artificial intelligence and health research

Swiss and overseas students have joined Raphaëlle Luisier to acquire advanced knowledge in the field of bioinformatics and data science applied to health. During their studies, they carry out practical work within the Genomics & Health Informatics group. The first PhD students also arrived in the last few months. Raphaëlle's involvement has brought artificial intelligence and bioinformatics closer together in Switzerland. Idiap and the Swiss Institute of Bioinformatics (SIB) have signed a partnership to increase national synergies in this area. Raphaëlle concludes, *"I thank Idiap's management for their trust. This nomination will allow me to project myself into the development of my work and my research group, while paying particular attention to the promotion of women in the world of research."*

"We are delighted that Raphaëlle chose to conduct her research at Idiap and combine her expertise with that of other research at the Institute," observes Andrea Cavallaro, Idiap's Director. *"This is an important area of interdisciplinary research in generating new knowledge that can lead to positive impacts on society. We hope that this success will inspire other scientists to follow in her footsteps."*

Prizes and distinctions

Recognition for Idiap researchers in 2023.

Honourable Mentions for their impressive ideas regarding vulnerabilities of face recognition systems from the Pour Demain think tank, which organizes the AI Safety Prize, December 2023

Hatef Otroshi Shahreza and Sébastien Marcel

Finalist of the Gaetano Borriello Outstanding Student Award at the ACM Ubicomp/ISWC conference, October 2023

Lakmal Meegahapola

Imwut Distinguished Paper Award from the journal *Proceedings of the ACM on Interactive, Mobile, Wearable, and Ubiquitous Technologies* for their paper "Generalization and Personalization of Mobile Sensing-Based Mood Inference Models: An Analysis of College Students in Eight Countries," October 2023

Lakmal Meegahapola, William Droz, and Daniel Gatica-Perez

EAB Research Award 2023 from the European Association for Biometrics for his significant contribution to the field of biometrics research and innovations in Europe, September 2023

Hatef Otroshi

Best Paper Award at the ICJB 2023 Institute of Electrical and Electronics Engineers (IEEE) International Joint Conference on Biometrics for their paper "Vulnerability of Automatic Identity Recognition to Audio-Visual Deepfakes," September 2023

Pavel Korshunov, Haolin Chen, Philip N. Garner, and Sébastien Marcel

First in the "Compact Models" track of the "Efficient Face Recognition Competition" at the ICJB 2023 Institute of Electrical and Electronics Engineers (IEEE) International Joint Conference on Biometrics for its conference paper "EFaR 2023: Efficient Face Recognition Competition," September 2023

Idiap's Biometrics Security & Privacy Group

ISCA Award for the Best Paper Published In Speech Communication (2018–2022) at the Interspeech 2023 conference for their paper "End-to-End Acoustic Modeling Using Convolutional Neural Networks for HMM-based Automatic Speech Recognition," August 2023

Mathew Magimai-Doss and his colleagues Dimitri Palaz and Ronan Collobert

Honorable Mention Award at the IMX '23 conference for their paper "Referencing in YouTube Knowledge Communication Videos," August 2023

Haeeun Kim and Daniel Gatica-Perez

Outstanding Reviewer Recognition at the International Conference on Acoustics Speech and Signal Processing (ICASSP), June 2023

Ina Kodrasi

Title of Life Fellow from the Institute of Electrical and Electronics Engineers (IEEE), January 2023

Hervé Bourlard

PhD theses completed

11 students published their theses in 2023.

Confidence Matters: Applications to Semantic Segmentation
Prabhu Teja Sivaprasad

Data-Driven Urban Building Energy Modeling in Satom (CH): The Energy Savings Potential and Use of Available Renewable Energy Sources
Ahad Montazeri

Interpretable Representation Learning and Evaluation for Abstractive Summarization
Andreas Marfurt

Learning and Optimization of Anticipatory Feedback Controllers for Robot Manipulation
Hakan Girgin

Modeling Structured Data in Attention-Based Models
Alireza Mohammadshahi

Novel Methods for Detection and Analysis of Atypical Aspects in Speech
Julian Fritsch

On Matching Data and Model in LF-MMI-based Dysarthric Speech Recognition
Enno Hermann

Practical Computational Imaging by Use of Spatiotemporal Light Modulation: From Simulations to Applications in Biological Microscopy
François Marelli

Privacy-Preserving Machine Learning on Graphs
Sina Sajadmanesh

Sparse Autoencoders for Speech Modeling and Recognition
Selen Hande Kabil

Text Representation Learning for Low Cost Natural Language Understanding
Florian Mai

Finances

FINANCIAL REPORT

Balance sheet (CHF)

ASSETS	31.12.2023	31.12.2022
Cash	**3 505 422**	**4 022 695**
Accounts receivable	**1 449 792**	**1 505 232**
Accrued income and other	**1 835 318**	**1 185 846**
TOTAL CURRENT ASSETS	**6 790 531**	**6 713 773**
Equipment	**736 651**	**728 726**
Other assets	**1 119 401**	**1 142 246**
Patents and licenses	**9**	**9**
Financial assets	**10 000**	**10 000**
TOTAL NON-CURRENT ASSETS	**1 866 061**	**1 880 981**
TOTAL ASSETS	**8 656 593**	**8 594 754**

LIABILITIES	31.12.2023	31.12.2022
Accounts payable	**139 998**	**95 398**
Accrued expenses	**4 520 169**	**4 021 175**
Provisions	**173 500**	**768 538**
TOTAL FOREIGN FUNDS	**4 833 667**	**4 885 111**
Share capital	**40 000**	**40 000**
Research funds reserve	**1 554 478**	**1 554 478**
Special reserve	**1 800 000**	**1 700 000**
Retained earnings	**415 165**	**374 327**
Net income	**13 282**	**40 838**
TOTAL OWN FUNDS	**3 822 925**	**3 709 643**
TOTAL LIABILITIES	**8 656 593**	**8 594 754**

Profit and loss statement (CHF)

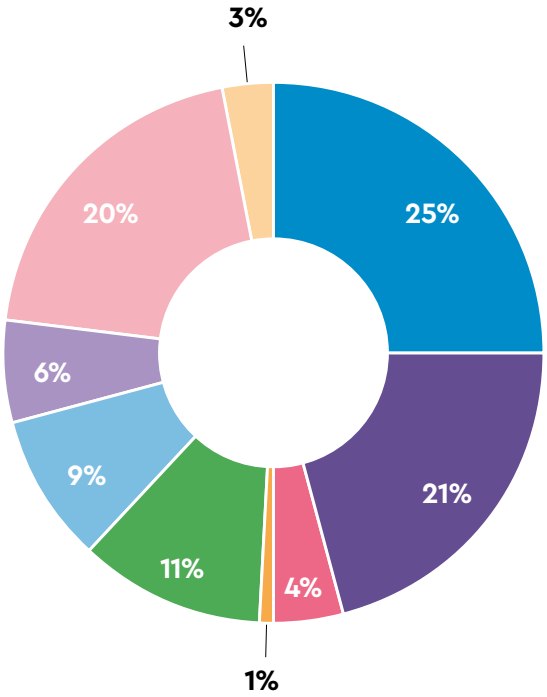
INCOME	2023	2022
Swiss Confederation Art. 15	**4 060 300**	**3 652 000**
Canton of Valais	**3 491 388**	**2 600 000**
City of Martigny	**753 466**	**1 002 636**
Third-party contributions (non-competitive)	**8 305 154**	**7 254 636**
Donations	**238 750**	**25 000**
Donations	**238 750**	**25 000**
Swiss National Science Foundation	**1 757 747**	**2 100 831**
EU	**1 404 303**	**1 562 064**
Innosuisse	**1 019 203**	**929 864**
Others (The Ark, Hasler, industrials, biometrics lab, US, Valais Ambition)	**3 070 676**	**2 369 264**
Competitive funding	**7 251 928**	**6 962 023**
Interest	**1 631**	**2 968**
Subletting	**119 072**	**140 570**
Other incomes	**224 104**	**71 871**
Value created from research	**42 159**	**29 706**
Divers incomes	**386 966**	**245 115**
TOTAL INCOME	**16 182 798**	**14 486 774**

CHARGES	2023	2022
Personnel (incl. social deductions)	**12 871 588**	**11 907 686**
Operational costs	**3 274 428**	**2 438 250**
Allocation to operating reserves	**100 000**	**100 000**
Dissolution of reserves	**-76 500**	**0**
TOTAL EXPENDITURES	**16 169 516**	**14 445 936**
OPERATING PROFIT/LOSS	**13 282**	**40 838**

Figures at a glance

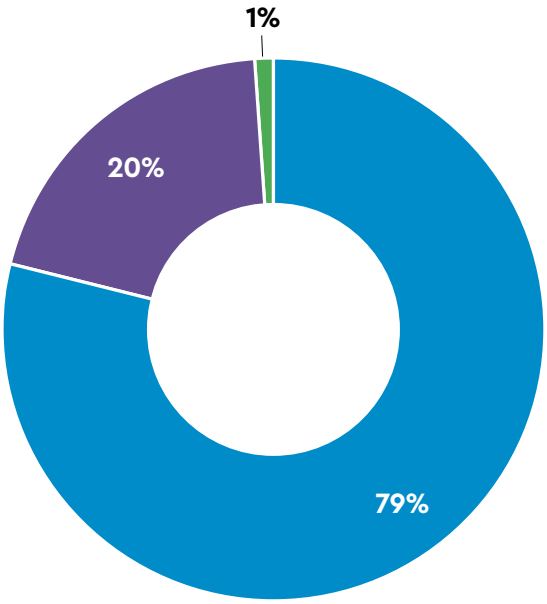
Distribution of funding sources

- Swiss Confederation
- Canton of Valais
- City of Martigny
- Donations
- Swiss National Science Foundation
- EU
- Innosuisse
- Others
  (The Ark, Hasler, industrials, biometrics lab, Valais Ambition)
- Other incomes



Distribution of costs

- Personnel expenses
- Operating expenses
- Allocation to operating reserves



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