ANNUAL REPORT 2022

idiap
RESEARCH INSTITUTE

Cover page: A quadruped robot, customizable thanks to its open-access platform. More on page 22.

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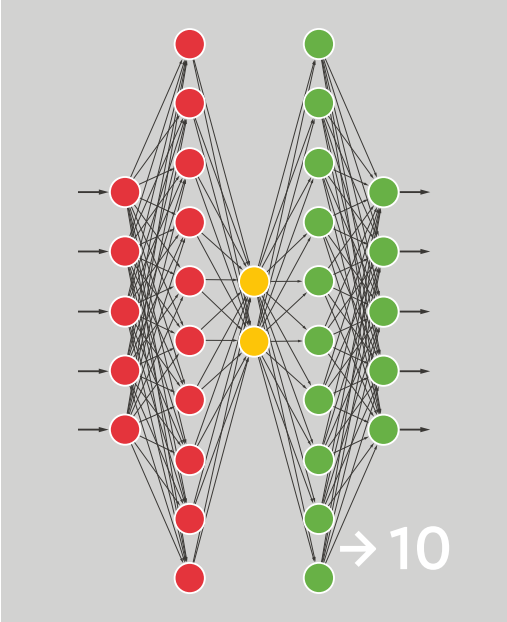
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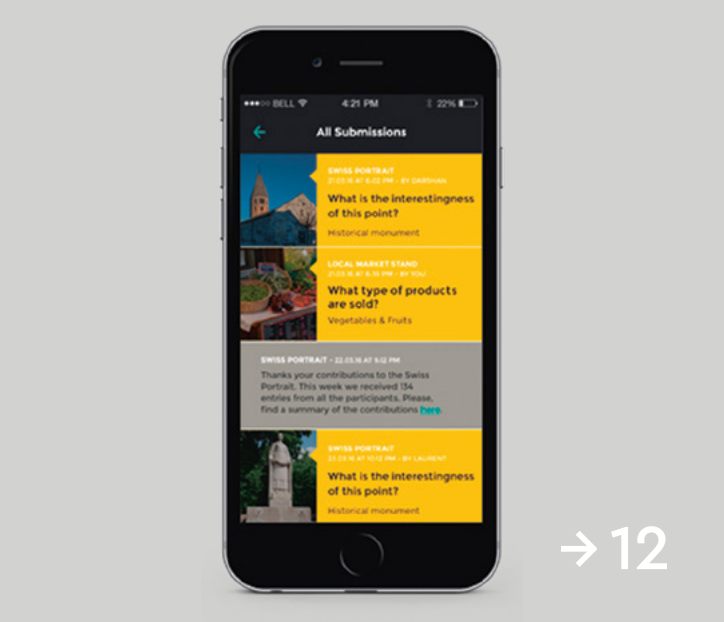

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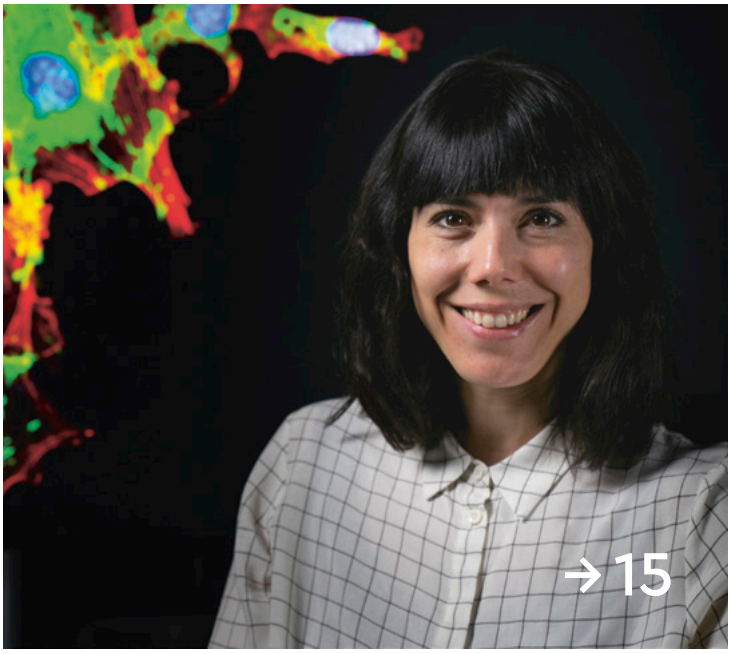
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"Idiap commences a new chapter"

Anne-Laure Couchepin Vouilloz
President of the Foundation Board

While it is ChatGPT's recent achievements that are making the headlines, we must not forget that they are founded on decades of scientific research in the field of artificial intelligence. An indispensable, long-term contributor to this effort, Idiap also exemplifies the need for in-depth work based on human and local values.

Anchored in this way, the Institute is able to invest in the very fabric of the region, whether that be via collaborations with Valais companies such as InflamAlps or by hosting internships for students from EPFL. The strong point of these exchanges is their impact. In these two—of many—examples, the health ecosystem benefits from research into the development of new antibiotics and from the interns' contribution to research related to neurodegenerative diseases.

This vision has long been the charge of Hervé Bourlard, who directed the Idiap Research Institute until February 2023. On behalf of the Foundation Board, I would like to take this opportunity to thank him wholeheartedly for his work and his commitment. We are likewise extremely pleased to welcome Professor Andrea Cavallaro, the new head of the Institute. We wish him every success in writing what will be a new chapter for Idiap.

Developing artificial intelligence for the benefit of society is an exciting mission. The Foundation Board and I look forward to supporting Professor Cavallaro in this endeavor.

"It is amazing to have such a density of international talent in Martigny"

Andrea Cavallaro
Director

I am delighted to have joined the Idiap Research Institute and honored to have the opportunity to serve the Idiap community. Idiap has a very long history of research excellence and success in technology innovation. This has been made possible by a team of highly talented researchers and by an operational effectiveness that is second to none.

It is amazing to have such a density of international talent in Martigny. And I feel privileged to be among so many creative individuals, and inspired by their research endeavors.

This report is a short summary of selected achievements of Idiap researchers in 2022 under the leadership of my predecessor, Professor Bourlard. I hope these stories will encourage you to join us in the near future.

I look forward to helping create an environment that Idiap researchers will thrive in, so that they in turn may make a positive impact on society and the environment.

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

"I have a friend who worked at Idiap and who spoke very highly of the Institute. As Idiap was looking for interns, I sent in my application." → *More on page 25.*

Lena Loye
student at EPFL and Idiap intern

"Academic research can't always compete with Big Tech. And the solutions will not be technological alone." → *More on page 12.*

Daniel Gatica-Perez
head of the ***Social Computing*** research group

"This partnership will also better position our activities at the intersection of industry and clinical research." → *More on page 15.*

Raphaëlle Luisier
head of the ***Genomics & Health Informatics*** research group

Publications and patents in 2022

Contributions to
152 peer-review publications

95
conference articles

44
scientific articles

7
book chapters

6
theses completed

6
patents recognized

3
further patents filed

Human resources

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

Scientific staff

18 lead scientists
29 permanent researchers
106 research assistants
23 postdocs
4 trainees/visitors
18 students

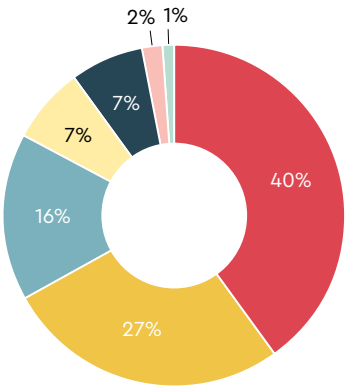
Engineers & technical staff

16 R&D engineers
11 system staff
15 technical assistants/students

Administrative staff

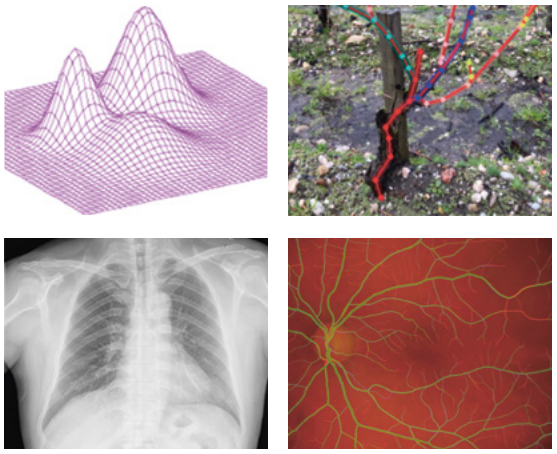
15 Administrative staff

30 nationalities are represented at Idiap

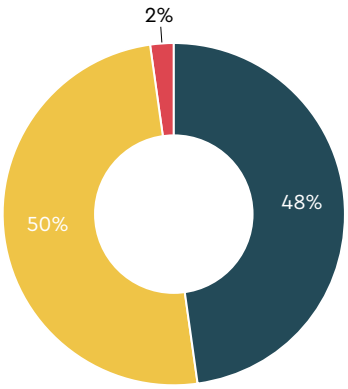


Switzerland
Europe
Asia
Middle East
Americas
Africa
Australia
5 robots

Take a look at our Scientific Report

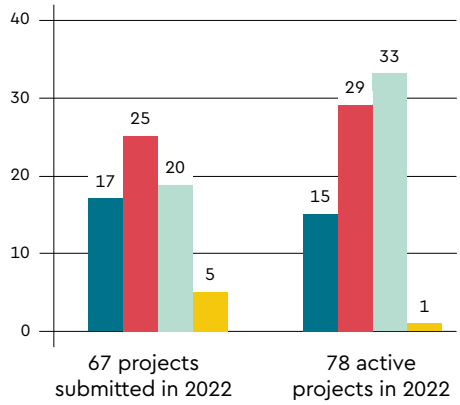


Funding sources



Research projects
Public funds
Other

Number of research projects, 2022



European Union
Switzerland
Industrial
International

Employees

Scientists

Abid Ali
David Alonso Del Barrio
Ravinithesh Reddy Annapureddy
Matheus Armani Renzo
Karim Assi
Chantal Basurto Davila
Melika Behjati
Imen Ben Mahmoud
Sushil Bhattacharjee
Cem Bilaloglu
Matteo Bilardo
Alexandre Bittar
Roberto Boghetti
Andrea Bontempelli
Emma Bouton-Bessac
Lucas Braud
Rudolf Braun
Victor Bros
Gabriele Brunini
Sergio Burdisso
Cécile Chavane
Haolin Chen
Xuemin Chi
Giacomo Cillari
Laurent Colbois
Andrei Coman
Louise Coppieters De Gibson
Alessandro Costa
Evann Courdier
Gianna Larissa Crovetto
Ruben De Campos
Tiago De Freitas Pereira
Maxime Délitroz
Maxime Delmas
Yifei Dong
Christophe Ecabert
Martin Fajčík
Arya Farkhondeh
Fabio Fehr
François Fleuret
Alessandro Fornaroli
Lisa Fournier
Julian Fritsch
Juan Garcia Giraldo
Guilherme Garcia Schu Peixoto
David Geissbuhler
Anjith George
Lara Gervaise
Louis Gevers
Mickael Gindroz
Hakan Girgin
Mathieu Giroud
Maya Guido
Anshul Gupta
Meghan Harrington
Mutian He
Enno Hermann
Nina Hosseini Kivanani
Sevada Hovsepyan
Junduan Huang
Mathias Ibsen
Parvaneh Janbakhshi
Julius Jankowski
Côme Jaubert
Shasha Jiang
Xiaowen Jiang
Oscar Jiménez Del Toro
Seyed Mohammad Mahdi Johari
Selen Kabil
Nathan Kammoun
Rabeeh Karimi Mahabadi
Driss Khalil
Haeeun Kim
Edouard Erwan Koehn
Alain Komaty
Pavel Korshunov
Ketan Kotwal
Vedrana Krivokuća Hahn
Emilie Kuhn
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Teguh Lembono
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Junhong Li
Yuanhui Lin
Tobias Löw
Lena Loye
Luis Santiago Luévano García
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Srikanth Madikeri
Florian Mai
Mekki Malek
François Marelli
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Alexandre Marguet
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Kyle Matoba
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Alireza Mohammadshahi
Nitin Mohan
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Antonio Morais
Zohreh Mostaani
Kashif Munir
Skanda Muralidhar
Amanda Muscat
Adolf Niederberger
Hatef Otroshi Shahreza
Arnaud Pannatier
Shantipriya Parida
Giuseppe Peronato
Molly Petersen
Maxime Pillet
Florian Piras
Timothy Piton
Valentin Pocard
Amrutha Prasad
Tilak Purohit
Mattia Racca
Parsa Rahimi Noshanagh
Behrooz Razeghi
Amirreza Razmjoo Fard
Paula Dolores Rescala
Atreyee Saha
Sina Sajadmanesh
Chloé Salamin
Saeed Sarfjoo
Eklavya Sarkar
Christelle Schneuwly
Suhan Shetty
Rémy Siegfried

João Silverio
Muskaan Singh
Prabhu Sivaprasad
Marco Sousa Ewerton
Lucas Stel
Samy Tafasca
Neha Tarigopula
Mehrdad Tavassoli
Mokanarangan Thayaparan
Iuliia Thorbecke (Nigmatulina)
Boyang Ti
Jakub Tkaczuk
Sandrine Tornay
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Alex Unnervik
Marco Valentino
Karine Vaucher
Michael Villamizar
Esaú Villatoro Tello
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Pierre Vuillecard
Sargam Vyas
Apoorv Vyas
Teng Xue
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Yan Zhang
Marie Zufferey
Juan Pablo Zuluaga Gomez

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François Foglia
Christophe Rossa

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Phil 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

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research
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No artificial intelligence without a complete mastery of math and statistics

Neural network technologies are very popular but have a downside—they are very energy hungry. Two Idiap researchers have shown that sometimes classical mathematics is preferable to artificial intelligence.

In 2022, artificial intelligence is seen as a cutting-edge technology, and terms like "neural networks" often seem synonymous with technological achievement. The approach is not new. Already in the 1980s scientists working with digital imaging and audio—both new fields at the time—hoped to use a particular neural network architecture, referred to as autoencoders, to encode and transmit the relevant information contained in a signal. This process seemed promising not only for transmitting information, but also for potentially increasing the quality of the decoded output signal.

In 1988, Hervé Bourlard and his then colleague Y. Kamp published a landmark paper in the field. In it, they demonstrated that signal encoding with neural networks could be performed just as well using the common mathematical tools of linear algebra. This discovery not only explained how autoencoders work. It also put an end to speculation that autoencoding neural networks could extract, as if from nothing, certain key features of an encoded signal.

Future progress

Autoencoders are still around, and are used in many fields, from facial recognition to image processing. And this is why Bourlard and his colleague Selen Hande Kabil decided to continue the research that constituted the foundation of that seminal 1988 paper.

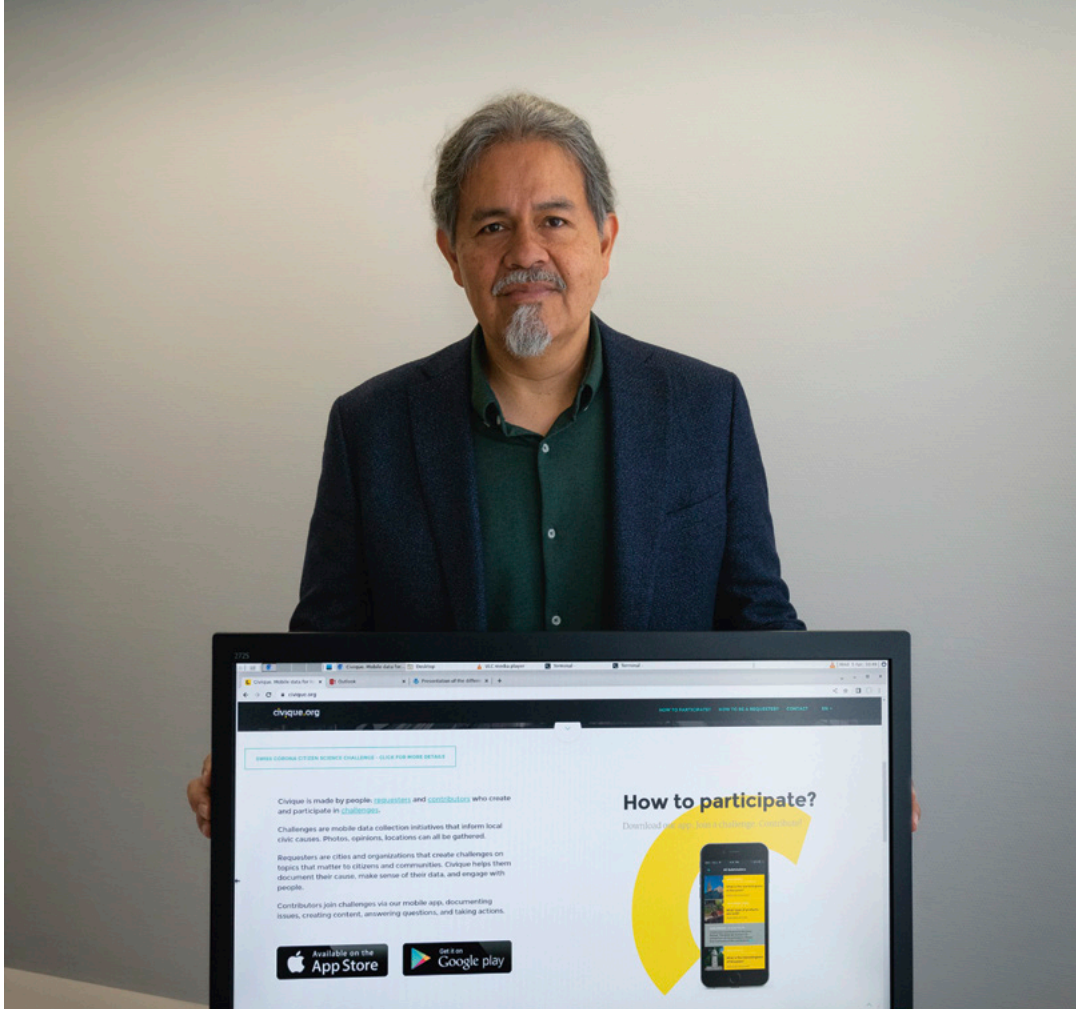
The two researchers extended the mathematical approach used to other commonly used techniques with more complex autoencoder architectures. They also included another type of signal, called discrete inputs. This generalization is relevant because these discrete inputs are used, for example, in natural language processing. The goal there is to analyze the semantic proximity between words in a given context to determine their relationship to one another.

By analyzing their results, the two scientists reconfirmed that linear algebra often generates optimal solutions or allows for a better understanding and improvement of neural networks. "This is a small step, but one that is crucial for efforts to make artificial intelligence more explainable," Bourlard comments. "This technology is usually a black box, and the impossibility of understanding the mechanisms at play undermines confidence in the final result."

Beyond cementing the theory of neural networks, the two researchers hope that this approach will inspire the next generation of scientists to question the tools that they use every day. "If mathematics and statistics are an alternative to the energy-intensive autoencoders currently used for certain tasks, there's potential for more energy-efficient technological solutions," Bourlard concludes.

Original paper:

New paper:



"Today's challenges call for human-centered approaches"

Head of the Social Computing research group, Daniel Gatica-Perez has been closely involved in Idiap's vision of artificial intelligence at the service of society for two decades. In 2022 he received two awards in recognition of his long-term contribution at the interface between technology and society.

Today, smartphones are widely used as standard scientific tools for the collection and analysis of real-world field data. Twenty years ago when Daniel Gatica-Perez—fresh from his doctoral studies in the United States—joined Idiap, the first iPhone was still years away in the future. His career at Idiap is inextricably interwoven with the digital and mobile revolutions that have transformed society.

Why, back in the early 2000s, did you choose to join Idiap?

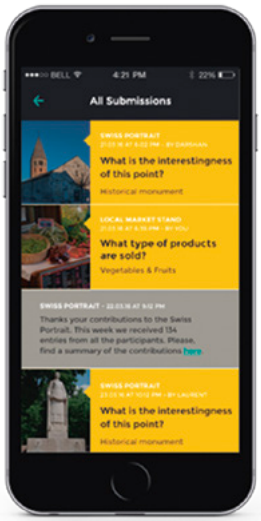
The context of my joining the Institute was the national research cluster Interactive Multimodal Information Management, also known as IM2. The project was crucial to Idiap's development. IM2 allowed the Institute to federate around an integrative vision, a multi-sensor conference room that brought together technologies such as speech recognition, computer vision, and text mining. At the time, I was interested in studying small groups of people working together with the support of technology. This work was an opportunity to evolve approaches involving people and technology from a human-centered perspective.

And from that perspective, how have mobile devices changed what you do?

The early days of smartphones meant an opportunity to get out of the lab and conduct field research. It's important to understand how phones are used in everyday life. A decade ago, in collaboration with Nokia, we managed and shared a mobile database that has since been used by hundreds of researchers from all over the world for academic work. And this topic is still relevant today. A lot of research in the field of health, especially mental health, is carried out thanks to platforms or smartphone apps.

This also created privacy risks, didn't it?

Absolutely, yes. Privacy is one of the fundamental challenges of human-centric computing, but today's research extends beyond simple privacy. Another key element is diversity. When a technology only serves and reflects the interests of certain groups in society, there's a risk of reproducing and deepening existing divides. Some of these risks can be mitigated by designing technologies for and with people. In this respect, the smartphone is a valuable tool with which to conduct participatory research that really involves the citizen.



Mobile, social technologies have given people a voice and allow us to get involved in common interest issues such as health or urban planning. This is especially true in the southern hemisphere. This means that we have to move beyond the current infatuation with AI and deal with the fact that there is only a limited amount of local, contextualized, valid data on which to train machine learning models. For example, more than half of the images in the most popular databases used to train visual recognition systems come from only two countries: the USA and the UK. We need to systematically increase the diversity levels of our data.

Big Tech plays a major role in this field. Is there a place for public research that shapes these technologies in a more inclusive way?

Yes, I believe that we researchers have a role to play here. Academic research can't always compete with Big Tech, which has—for example—almost unlimited computational resources. And at the same time, research into computing with a societal focus has its own goals. We have to understand that when it comes to major challenges such as public health or climate change, there are no quick fixes, and that the solutions will not be technological alone. There is also a need to understand social conditions as well as individual experiences, and ultimately we need to involve people in that process.

We should also be aiming for multidisciplinary, human-centered approaches. For example, in the SenseCityVity project, launched in the mid-2010s, we worked with local partners in Mexico. We designed an urban challenge, and invited participants to use their smartphones to collect multimedia data to map and document urban issues they felt were relevant. Thanks to its success, the project has been extended to other countries. In Switzerland meanwhile, we created the mobile platform civique, which has enabled several local projects. These include Corona Citizen Science, in which people shared their experiences of COVID-19 in 2020 Switzerland. Participatory, multidisciplinary research is needed if we are to address all these challenges, and human-centered computing has a contribution to make here.

View project
SenseCityVity research

View project
Corona Citizen Science

Idiap creates new cross-functional research groups to address societal challenges

Created in 2022, the Institute's cross-research groups will foster collaboration across fields of research. The goal? Long-term, positive societal impact through a combination of business-oriented solutions and fundamental interdisciplinary research.

Already a number of years ago Idiap's management was planning to implement a new type of research structure. The idea was to strengthen the Institute's capacity to stimulate collaboration, while increasing technology transfer and having a greater positive impact on society. Part of the Institute's 2021–2024 research program, these cross-research groups (CRGs) were approved and launched in 2022. We met with the researchers leading the first three CRGs: Andre Freitas, from the Neuro-symbolic AI group, Sebastien Marcel, from the AI for Trust group, and Emmanuel Senft, from the Human-Centered Robotics & AI group.

What is the specific objective of your group, and why have you chosen this particular approach?

Andre Freitas (AF): Developing models that can learn more efficiently and seamlessly from little heterogeneous data emerged as a strategic priority of the Institute's vision—so, doing more with less. The Neuro-symbolic AI CRG was created to reflect the strategic theme of integrating the flexibility of neuron-based models and the interpretability and controllability of symbolic systems. Blending these two properties to allow current neural models, such as ChatGPT, to be safely adapted and transferred to industry, this is what drove the choice of approach.

Emmanuel Senft (ES): With my background in robotics, I see things from a very similar perspective. My research field is inherently multidisciplinary, so I see the need to connect together different technical expertise. For example, robots can be used for therapeutic purposes, but such uses require advances in computer vision and language analysis that are outside my areas of expertise. Close collaboration with the medical community is required. Bringing on board other researchers specializing in artificial intelligence and the users of the technologies we are developing helps us to find new solutions in robotics, and in other fields. That's why—with my inherently multidisciplinary approach—when I saw the ad for the CRG position, I applied immediately.

Sébastien Marcel (SM): As I already head a research group, in the shape of the Biometrics Security & Privacy group, I should already stress that the CRG AI for Trust goes beyond biometrics. The goal is to address the threats that are emerging due to our application of artificial intelligence by providing tools to increase trust. I was inspired by an internal symposium we held, during which I highlighted the need to address current and future challenges, including the threat of climate change, energy shortages, and planetary limits. One current challenge is the need to combat misinformation, fraud, blackmail, and defamation by detecting deepfakes or

Left to right:
A. Freitas, S. Marcel et E. Senft

automatically generated texts, such as those "authored" by ChatGPT. Future challenges include trafficking, business intelligence, criminal policing, national security, and humanitarian aid. Clearly then there is a role for collaborative approaches involving different scientific and technical domains.

How do you intend to position your own CRG compared to traditional research groups?

SM: I believe CRGs are like hubs operating in specific impact areas. We are complementary to Idiap's technology transfer service given our comparatively broader approach. By definition CRGs involve other research groups.

ES: I agree. CRGs will go beyond meeting any given technical need in isolation. We bring more to projects thanks to our multidisciplinary perspective. A good example of the potential of this approach is our collaboration with Lausanne's Musée de la Main. Several groups together are working to meet the scientific–didactic needs of the museum.

AF: In addition to these elements, I also think that CRGs will improve the strategic cohesion of the Institute and help us to address even greater challenges.

Speaking of the contributions CRGs can make, what results do you expect from your CRG?

AF: Part of the thinking behind CRGs is to integrate research carried out inside and outside of Idiap. We hope this will catalyze the number of collaborative projects that take place and maximize the positive long-term impact of our strategic themes.

SM: Alongside that positive long-term impact, I also expect a very pragmatic approach, resource-aligned with the scale of our individual groups. The goal is to respond to immediate needs and at the same time be very proactive in creating new tools. This could, who knows, be an opportunity for Idiap to establish a new software framework, like the famous Torch [editor's note: an Idiap-developed software library that has laid the foundations of many AI-based tools].

ES: All this will also increase Idiap's visibility. I very much look forward to starting new projects with external partners and other Idiap researchers. We also have to keep in mind that CRGs are still a work in progress. The recruitment of a fourth group is ongoing.

The Swiss Institute of Bioinformatics and Idiap sign a partnership deal

Idiap Research Institute and the Swiss Institute of Bioinformatics (SIB) signed, in 2022, an agreement that will accelerate the adoption of artificial intelligence (AI) in the scientific analysis of biological and biomedical data. AI is gaining traction in bioinformatics. At the same time, it requires very high quality data and expertise in the domain to which it is being applied. The same is true of bioinformatics itself. The agreement reached by the two institutes paves the way for future inter-institutional collaborations.

The first Idiap researcher to join forces with SIB is Raphaëlle Luisier, since 2019 head of the Genomics & Health Informatics group at Idiap. Her research aims to apply the potential of AI to solve biological questions related to disease, particularly neurodegenerative disease. Luisier's group will benefit from SIB's national network of expertise. The collaboration between the two institutions is also reflected at the governance level, SIB welcoming a representative of each partner institution to its foundation board.

A speech analysis system inspired by the human brain

Researchers at Idiap have unveiled a speech analysis system inspired by properties of the human brain. Their approach matches current standards for performance, and is more energy efficient. And their work can be replicated thanks to their use of open-access software.

Without realizing it, you have almost certainly already used speech analysis technologies. They lie at the heart of all voice-activated devices. While already widespread, they are constantly being improved. One popular approach uses computer systems called artificial neural networks. These systems use real numbers with an arbitrarily large number of decimal places. This delivers a high degree of accuracy but has a drawback: accuracy is high, but so are computational costs. To overcome this, Idiap researchers have developed an alternative method, one that mimics the functioning of the human brain.

Artificial neurons vs. humans

Even the human brain has limits to its computational capacities. But this doesn't stop it excelling at speech analysis, and we humans are even able to listen to someone while at the same time performing other tasks. To do this the brain works with so-called discrete signals rather than with energy-hungry real numbers. When a neuron reaches a stimulation threshold, it sends an electrical signal, transmitting binary information.

To analyze passages of speech, which consist of many consecutive sounds, humans' neurons must process a series of individual electrical signals. Transposing this approach to artificial neural networks is a challenge, because while a significant amount of information is encoded in the signal itself the sequence of signals is also significant. "We wanted to recreate a similar method and compare it to classical neural networks in terms of performance and reliability," explains Alexandre Bittar, research assistant at Idiap.

The functioning of a classical artificial neuron can be seen as an approximation of a biological neuron's signal rate. This rate contains information. And to better take into account variations in the rate, researchers use another type of artificial neuron, called a spiking neuron. The main shortcoming of these spiking neurons is their poorer performance. "By meticulously selecting appropriate techniques, we have established a method that—in addition to being compatible with current deep learning standards—is able to compete with conventional artificial neural networks when applied to the same speech processing tasks, while at the same time retaining its advantage with regard to energy efficiency," explains Phil Garner, senior researcher in Idiap's Speech & Audio Processing group.

A tool for modeling the brain

In addition to the paper in which they describe this new approach, the researchers have also published the software used to test their method. Their goal? To provide an open-access tool that others can use to improve the method, and to lay the foundations for multidisciplinary applications.

Beyond speech analysis, the approach can help in further exploration of the functioning of the brain. "We're not aiming to say anything about biological mechanisms. But the approach does show that biological neurons' ability to represent a sensory stimulus can be used to solve the same problems as those solved by artificial neurons, which are known to often exceed human abilities. This lays down a strong hypothesis for our future understanding of the biological mechanisms of the brain," Garner concludes.

Scientific paper

innovation

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A partnership to accelerate antibiotic research

Using artificial intelligence to accelerate the selection of potential sources of antibiotics is one of the objectives of ABRoad. The project is the fruit of a partnership between Idiap and the pharmaceutical R&D specialist InflamAlps. Supported by the Ark Foundation, the project aims to develop a dedicated digital platform.

Support drug discovery, identify substances with similar effects, find new antibiotics—these are the objectives of the project ABRoad. The collaboration brings Monthey-based company InflamAlps and the Idiap Research Institute together with the shared goal of designing a software interface to help in the exploration of biomedical data. Thanks to the automated processing of natural language, this interface will be able to analyze large textual scientific databases that include papers and patents. It will also contribute to the development of a model for the comparison of chemical formulas in their written form.

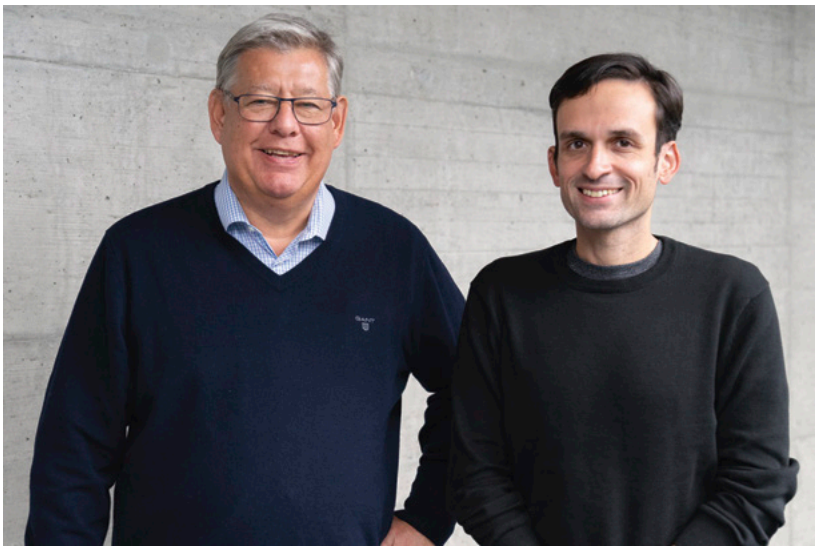
Identifying and selecting potential sources of antibiotic substances that can then be validated experimentally involves interpreting the scientific literature on a large scale. Given the size of the scientific corpus concerned, this is a titanic task. “How do we know if what we’re looking for doesn’t even exist?” asks Vincent Mutel, CEO of InflamAlps. Thanks to recent advances in natural language processing important parts of this process can now be automated. “The stakes are high. It’s about avoiding unnecessary research and therefore accelerating the discovery of new antibiotics,” Mutel explains.

A transferable technology

Using methods developed by Idiap specifically for ABRoad, the project aims to develop a textual interpretation platform. Effectively supporting biomedical research involves taking into account the logical links in the content analyzed. “In recent years, these methods have evolved dramatically and now enable the interpretation of textual evidence on a grand scale. With ABRoad, we will demonstrate their value by reinforcing the antibiotic discovery process,” says Andre Freitas, head of the Neuro-symbolic AI cross-research group at Idiap.

The software infrastructure developed for the ABRoad project is a very real demonstration of the feasibility of applying today’s natural language processing methods. It will give a real strategic boost to biomedical companies in Valais and beyond, and the project will strengthen the central position of Valais in the field of natural language processing

Written in collaboration with Frédérique Brunner, The Ark.



Vincent Mutel, InflamAlps (left) and Andre Freitas, Idiap (right).

An interactive video projector that will revolutionize presentations

Sylvain Calinon demonstrates the intelligent projector.

The team LaternaMagica won the 11th edition of the Idiap Create Challenge (ICC). This nine-day AI super hackathon organized and hosted by the Institute offers participants the opportunity to go from idea to prototype. This year's edition also featured two challenges from the Banque Cantonale du Valais.

With its interactive video projector that can project content onto a range of different surfaces, LaternaMagica took the ICC first prize. To facilitate presenter-device interaction, the team combined various artificial intelligence (AI) techniques, including motion recognition and gaze tracking. The device is designed such that a motorized mirror coupled to a camera can project images in any direction, all the while compensating for image distortion. It was the demonstration of this prototype during the final presentation that convinced the members of the jury.

Other participants included LightAI4Comfort, who developed an AI-driven lighting control system adaptable to different office spaces, MHTI, who presented a predictive model of potential mental health disorders for the general public, and BISS, who proposed a simple interface to a semantic search tool to help employees find important information on their company's intranet.

New applications of artificial intelligence

For the 2022 edition, the ICC joined forces with the Banque Cantonale du Valais (BCVs) to propose two new challenges related to artificial intelligence—one in the field of human resources, the other in customer service. Two teams took up these challenges. Transact worked on the targeted anticipation of customer expectations via a systematic, global approach to data. SolveHR's presentation, meanwhile, aimed to match the selection criteria of a job description with the CVs of candidates, using a flexible, AI-based model. Both teams received awards.

Discover
LanternaMagica's prototype

Idiap improves facial recognition for vehicles

Biometrics researchers at the Institute have developed tools to make the facial recognition used in the automotive industry more efficient and reliable. Their results are published as open source.

Whether it's allowing only an adult to drive a vehicle or tailoring driving settings to an individual driver's needs, facial recognition shows a great deal of promise for the automotive industry. The technical challenges of employing the technology in vehicles are specific: poor lighting conditions, the relatively constrained computational capabilities of the onboard computer, and the need for both instantaneous results and—of course—high reliability. Scientists from Idiap's Biometric Security & Privacy research group are making two significant contributions to the development of reliable facial recognition for vehicles, proposing a calculation tool "lite" based on neural networks, and a vehicle-specific database model to improve sensor reliability.

Infrared sensors and a publicly available database

In the reduced lighting conditions of a vehicle's interior, near-infrared sensors are one way to obtain good quality images of the occupants' faces. To be able to analyze these images in a reliable way, researchers usually use what are referred to as artificial neural networks, but this approach is generally computationally hungry. "Not only do tests show that our new algorithms are reliable, they are also fast and sufficiently computationally efficient to run in real time on a handheld device such as a smartphone," says Ketan Kotwal, a researcher in the Institute's biometrics group.

An Idiap staff member testing whether a facial recognition system can reject attempts at fraudulent identification.

To ensure their tools are reliable, the researchers built a database of genuine and fraudulent "identifications" in real-world conditions—so, in the passenger compartment of a vehicle and located both outdoors and indoors. This publicly available database is comprised of almost 6,000 videos of 40 individuals filmed in different conditions and nearly 1,800 fraudulent identification attempts, for example using a paper or a silicone mask, a photo, or a video on a screen. "In addition to providing a tool to validate the verisimilitude—so, the plausibility—of a face, we developed this database in parallel in order to test our tool even more thoroughly and establish a new standard in the field," explains Sébastien Marcel, head of the Group.

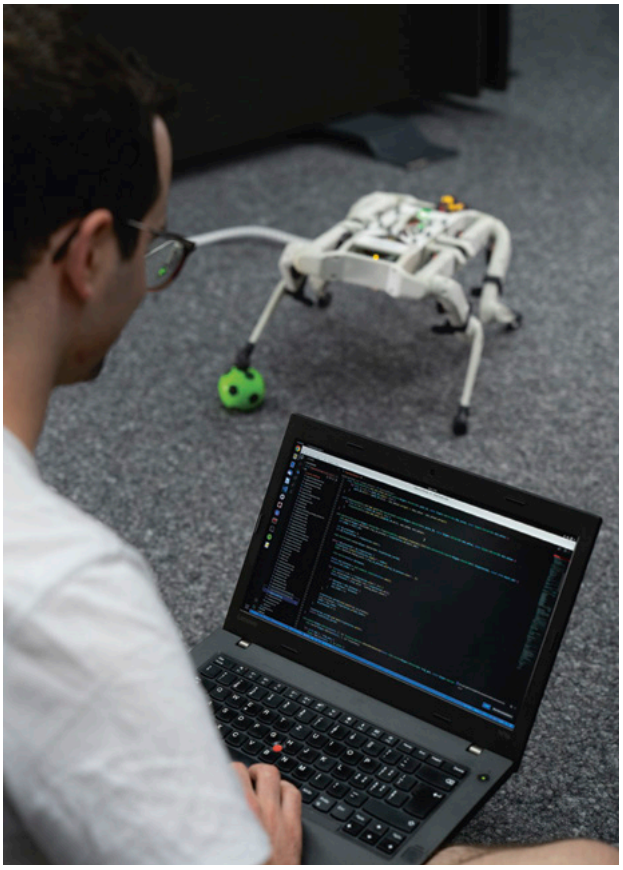
Numerous possible applications

Driver identification offers undeniable advantages in terms of safety and the personalization of the driving experience. These onboard technologies also offer significant potential for other applications. They can help facilitate access management for a vehicle fleet, and also allow us to imagine a facial recognition system that confirms the identity of the recipient of a delivery made by an autonomous vehicle. All these situations and more require reliable and affordable solutions, like those developed by Idiap.

Scientific paper

A fully customizable robot to help develop new algorithms

The Idiap Robot Learning & Interaction research group has added a new element to its toolbox: a small, kit-form, quadruped robot named SOLO12, whose mission is to enable the Institute's researchers and engineers to develop new robotic applications based on artificial intelligence.



Prior to use, the robot has to be assembled by an Idiap Master's student and programmed using open-access software.

The new addition is not confined to moving around on all fours. It can also be used to move objects around. It is noteworthy that the most advanced of today's robot demonstrators cannot be used for research because their development involves the proprietary software of the private companies that develop them.

First used in the framework of the European H2020 robotics project Memory of Motion – MEMMO, SOLO12 has the enormous advantage of being totally adaptable, modifiable, and customizable, whether with regard to its mechanical or to its software components. It is, for example, possible to add a camera, and its code is accessible, meaning that it can be modified to meet the future needs of Idiap's researchers.

Preparing a new generation of robots

The work of the Institute's robotics group will fall into two phases. For the first, a student on Idiap's applied Master's in Artificial Intelligence program will be given the mission to implement quadruped robot control models already available in the scientific literature. The objective of the second phase will then be to implement what are referred to as optimization algorithms, which allow the adaptation of the robot's movements to be improved.

This work is a continuation of Memory of Motion – MEMMO, in which Idiap participated. The goal is to create robots capable of adapting to a dynamic environment thanks to a technology that uses memory of movements. Thus, if jostled—for example, by a collision with another object—the robot will remember the movements that might help it regain its balance. And will be able to employ them rapidly and autonomously, without the need for a user to intervene with a joystick for example.

"Our work with this robot is really oriented toward research," explains Sylvain Calinon, head of the Robot Learning & Interaction research group at Idiap. "The focus is all about helping researchers with better robotic platforms for testing new algorithms. The resulting new generations of robots can then be used by industry."

View project
MEMMO

education

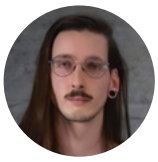
24 — 27

Idiap's scientific research supports university students

Three external students take up internships in Idiap's Genomics & Health Informatics research group. Respectively from universities in Paris and Lausanne, all choose Valais as the place to improve their skills.

For a semester, Maxime Délitroz, Lena Loye, and Côme Jaubert worked at the Institute as part of their university studies. "These students contributed to our scientific activities while gaining experience of a research institute during their work," explains Raphaëlle Luisier, the researcher who welcomed them into her group.

Can you briefly describe your academic background?



Maxime: I'm currently doing a Master's in Life Sciences at EPFL, where I'm working in the field of computer vision.

Lena: I'm doing a Bachelor's degree, also at EPFL, and work in the field of machine learning. My goal is to continue with a Master's.

Côme: I'm a medical student at Paris Descartes, where I'm doing a Master's degree. I'm currently particularly interested in data science and machine learning.

What will you be working on during your months at Idiap?

Maxime: Following up on the work of Raphaëlle Luisier and Colombine Verzat [editor's note: Colombine Verzat is an engineer at Idiap] on amyotrophic lateral sclerosis, I would like to understand how it works, how the model they use distinguishes sick neurons from healthy cells. To do this, I will have to find a way of automatically annotating their database of neurons.

Lena: My goal is to design a machine learning model based on this same database.

Côme: I'm interested in the physical and genetic characteristics of the neurons in this database, and would like to be able to sort them into specific groups, which may prove useful.

Why an internship in Valais and at Idiap?

Maxime: My main motivation comes from the "engineering" side of the life sciences. When I saw the internship offer on the Institute's website, I didn't hesitate. It's exactly what I wanted.

Lena: I have a friend who worked at Idiap and who spoke very highly of the Institute. So as Raphaëlle was looking for students for an internship, I sent in my application.

Côme: I already knew Valais because part of my family is from here and we used to spend our vacations in the Châble region. I was happy to take the opportunity to work in the area.

Further information
Classifying neurons for a better understanding of Stephen Hawking's disease

Prizes and distinctions

Awards received by Idiap researchers in 2022

12 stars of Europe 2022 award from the Minister of Higher Education and Research for the European H2020 MEMMO project, December 2022
Sylvain Calinon and his colleagues from CNRS

Best Doctoral Thesis Award in Electrical Engineering from EPFL for his PhD thesis, entitled "Stop Wasting My FLOPS: Improving the Efficiency of Deep Learning Models," November 2022
Angelos Katharopoulos

ACM ICMI Sustained Accomplishment Award 2022 at the ACM International Conference on Multimodal Interaction in Bengaluru, India, November 2022
Daniel Gatica-Perez

Ten-Year Impact Award in Ubiquitous Computing at the ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp) for the paper "StressSense: Detecting Stress in Unconstrained Acoustic Environments Using Smartphones," September 2022
Daniel Gatica-Perez and colleagues

IEEE RAS Most Active Technical Committee Award, 2022
Sylvain Calinon, Adrien Escande, Yue Hu, and Patrick Wensing

At the end of each year the Institute presents two prizes: the Student Award and the Best Paper Award. Idiap's 2022 awards went, respectively, to Teguh Lembono and Alexandre Bittar.

Teguh Lembono received his PhD in July 2022. He is now working at Amazon in Germany as an Applied Scientist in Robotics & AI. The thesis jury congratulated him on his work. His scientific research has helped address challenges at the intersection of planning, machine learning, and optimization, with applications in bi- and quadrupedal robotics. In addition to his exemplary professional achievements, while at Idiap he always took the time to help his peers when necessary.

Alexandre Bittar won the 2022 Best Paper Award for his paper, published in *Frontiers in Neuroscience*, "A surrogate gradient spiking baseline for speech command recognition." The paper represents a new research direction for the Institute and its potential impact is high given that it presents a fundamental approach to speech analysis. Alexandre Bittar is a member of Idiap's *Speech & Audio Processing* research group.

Theses completed

6 students published their theses in 2022.

Automatic Pathological Speech Assessment
Parvaneh Janbakhshi (EPFL)

Controllability and Interpretability in Affective Speech Synthesis
Bastian Schnell (EPFL)

Efficient Transformer-Based Speech Recognition
Apoorv Vyas (EPFL)

Memory of Motion for Initializing Optimization in Robotics
Teguh Santoso Lembono (EPFL)

Stop Wasting My FLOPS: Improving the Efficiency of Deep Learning Models
Angelos Katharopoulos (EPFL)

Using Synthetic Fingerprint Images to Test the Performance of an AFIS System
Alessandro Costa (Université de Lausanne)

finances

28 — 31

Balance sheet (CHF)

ASSETS	31.12.2022	31.12.2021
Cash	**4 022 695**	**5 797 782**
Accounts receivable	**1 505 232**	**322 159**
Accrued income and other	**1 185 846**	**1 520 225**
TOTAL CURRENT ASSETS	**6 713 773**	**7 640 166**
Equipment	**728 726**	**636 700**
Other assets	**1 142 246**	**1 142 246**
Patents and licenses	**9**	**9**
Financial assets	**10 000**	**10 000**
TOTAL NON-CURRENT ASSETS	**1 880 981**	**1 788 955**
TOTAL ASSETS	**8 594 754**	**9 429 121**

LIABILITIES	31.12.2022	31.12.2021
Accounts payable	**95 398**	**126 193**
Accrued expenses	**4 021 175**	**4 965 585**
Provisions	**768 538**	**768 538**
TOTAL FOREIGN FUNDS	**4 885 111**	**5 860 316**
Share capital	**40 000**	**40 000**
Research funds reserve	**1 554 478**	**1 554 478**
Special reserve	**1 700 000**	**1 600 000**
Retained earnings	**374 327**	**363 744**
Net income	**40 838**	**10 583**
TOTAL OWN FUNDS	**3 709 643**	**3 568 805**
TOTAL LIABILITIES	**8 594 754**	**9 429 121**

Profit and loss statement (CHF)

INCOME	2022	%	2021	%
Swiss Confederation Art. 15	**3 652 000**	25	**3 221 800**	23
Canton of Valais	**2 600 000**	18	**2 513 013**	18
City of Martigny	**1 002 636**	6	**700 000**	5
Capital and donations	**25 000**	0	**85 924**	1
Third-party contributions (non-competitive)	**7 279 636**	**50**	**6 520 737**	**47**
Swiss National Science Foundation	**2 100 831**	15	**2 487 045**	18
EU	**1 562 064**	11	**1 393 911**	10
Innosuisse	**929 864**	6	**886 686**	6
Others (The Ark, Hasler, industrials, bio, US, Valais Ambition)	**2 369 264**	17	**2 179 649**	16
Competitive funding	**6 962 023**	**48**	**6 947 291**	**51**
Interest	**2 968**	0	**1 432**	0
Subletting	**140 570**	1	**168 868**	1
Other incomes	**71 871**	0	**52 935**	0
Profit/exchange loss	**29 706**	0	**47 510**	0
Divers incomes	**245 115**	**2**	**270 745**	**2**
TOTAL INCOME	**14 486 774**	**100**	**13 738 773**	**100**

CHARGES	2022	%	2021	%
Personnel (including social deductions)	**11 907 686**	82	**11 781 411**	86
Operational costs	**2 438 250**	17	**2 126 579**	15
Allocation to operating reserves	**100 000**	1	**0**	0
Dissolution of reserves	**0**	0	**-179 800**	-1
TOTAL EXPENDITURES	**14 445 936**	**100**	**13 728 190**	**100**
OPERATING PROFIT/LOSS	**40 838**		**10 583**	

Accounting analysis 2022

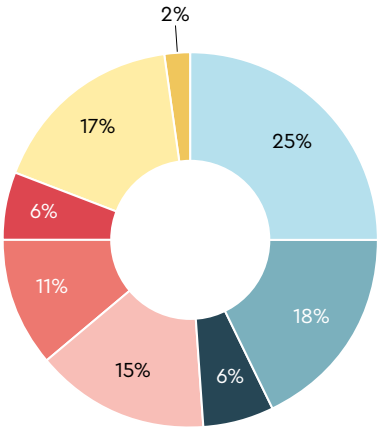
Idiap grew once more in 2022, as confirmed in the balance sheet and operating accounts. The revenue threshold of CHF 14 million was crossed, in particular thanks to the increase of more than CHF 800,000 in public backing. The operating profit amounts to CHF 40 838. The year 2023 will see the evolution of the Institute's funding continue.

Federal, cantonal, and municipal subsidies
(In thousands of Swiss francs)

YEARS	2019	2020	2021	2022
Confederation	**2 420**	**2 527**	**3221**	**3652**
Canton	**2 000**	**2 250**	**2513**	**2600**
Municipality	**700**	**700**	**700**	**1002**

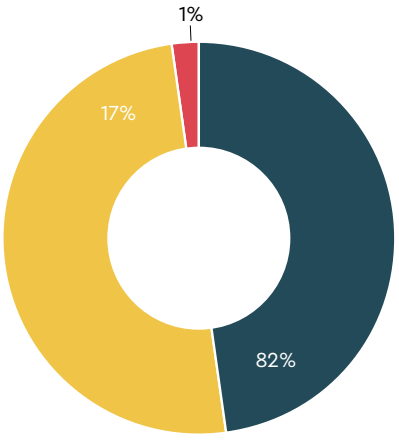
Distribution of funding sources

- Swiss Confederation
- Canton of Valais
- City of Martigny
- Capital and donations
- Swiss National Science Foundation
- EU
- CTI/Innosuisse
- Others (US, 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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