UMR IRISA

Activity Report 2024

Team EXPRESSION

Expressiveness in Human Centered Data/Media

D6 – Signal, Image, Language

Université de Rennes | rennes | INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES | cnrs | Inria | Inserm | CentraleSupélec | IMT Atlantique Bretagne-Pays de la Loire École Mines-Télécom | Université Bretagne Sud ubs

1 Team composition

1.1 Composition

Head of the team

Pierre-François Marteau, Professor, Université Bretagne Sud

Administrative assistants

Anne Idier, Université Bretagne Sud
Martine Milcent, Université Bretagne Sud
Angélique Le Pennec, Université de Rennes
Joëlle Thépault, Université de Rennes

Permanent members

Nelly Barbot, Associate professor, Université de Rennes
Vincent Barreaud, Associate professor, Université de Rennes
Nicolas Béchet, Associate professor, Université Bretagne Sud
Giuseppe Bério, Professor, Université Bretagne Sud
Jonathan Chevelu, Associate professor, Université de Rennes
Arnaud Delhay, Associate professor, Université de Rennes
Sylvie Gibet, Professor, Université Bretagne Sud
Caroline Larboulette, Associate professor, Université Bretagne Sud
⇄ Damien Lolive, Professor, Université Rennes1 / Université Bretagne Sud
Gildas Ménier, Associate professor, Université Bretagne Sud
Vincent Segonne, Associate professor, Université Bretagne Sud
Jeanne Villaneau, Associate professor (emeritus), Université Bretagne Sud

External collaborator

Elisabeth Delais-Roussarie, Senior researcher, CNRS/LLF
Farida Said, Associate professor, Université Bretagne Sud

Non-permanent members

→ Gaëlle Vidal, Engineer, Université de Rennes (from June 2024)
Clément Reverdy, ATER, Université Bretagne Sud (ATER from November 2022 to August 2023, then postdoc since September 2023)
David Guennec, contractual assistant professor, Université de Rennes (since September 2022)
← Philippe Martin, Research Engineer, University of Rennes (from June 2023 to March 2024)
Lily Wadoux, ATER, Université de Rennes (from September 2023 to August 2025)
→ Mansour Tchénégnon, ATER, Université Bretagne Sud (from September 2024 to August 2025)

- ⇄ Sandipana Dowerah, Research Engineer, University of Rennes (from January to October 2024)
- → Emilie Daniel, Engineer, University of Rennes (since December 2024)
- → Elie-Laurent Benaroya, Research Engineer, University of Rennes (since October 2024)

PhD students

- ← Mansour Tchénégnon, Université Bretagne Sud, CDE/ARED 3rd year, defended on June 26, 2024
- ← Lily Wadoux, Université de Rennes, CDE, defended on November 21, 2024
  Danrun Cao, Université Bretagne Sud, CIFRE OctopusMind 3rd year
  Hoan My TRAN, Université de Rennes, CD22+CDE-IA, since November 2022, 3rd year
  Ulysse Oliveri, University of Rennes, CIFRE Airbus, since March 2023, 2nd year
  Pauline Mas, University of Rennes, CIFRE Voxygen, since September 2023, 2nd year
  Quentin Lemesle, University of Rennes, CDE+DGA, since October 2023, 2nd year
  Rania Bennetayeb, Université Bretagne Sud, CIFRE Rennes Metropole, since October 2023, 2nd year
- → Philippe Martin, University of Rennes, ANR EVA, since April 2024

1.2 Evolution of the staff

The composition of the permanent staff remained unchanged during this year.

2 Overall objectives

Expressivity or expressiveness are terms which are often used in a number of domains. In biology, they relate to genetics and phenotypes, whereas in computer science, expressivity of programming languages refers to the ability to formalize a wide range of concepts. When it comes to human expressivity, we will consider the following reading: expressivity is the way a human being conveys emotion, style or intention. Considering this definition, the Expression team focuses on studying human language data conveyed by different media: gesture, speech and text. Such data exhibit an intrinsic complexity characterized by the intrication of multidimensional and sequential features. Furthermore, these features may not belong to the same representation levels - basically, some features may be symbolic (e.g., words, phonemes, etc.) whereas others are digital (e.g., positions, angles, sound samples) - and sequentiality may result from temporality (e.g., signals).

Within this complexity, human language data embed latent structural patterns on which meaning is constructed and from which expressiveness and communication arise. Apprehending this expressiveness, and more generally variability, in multidimensional

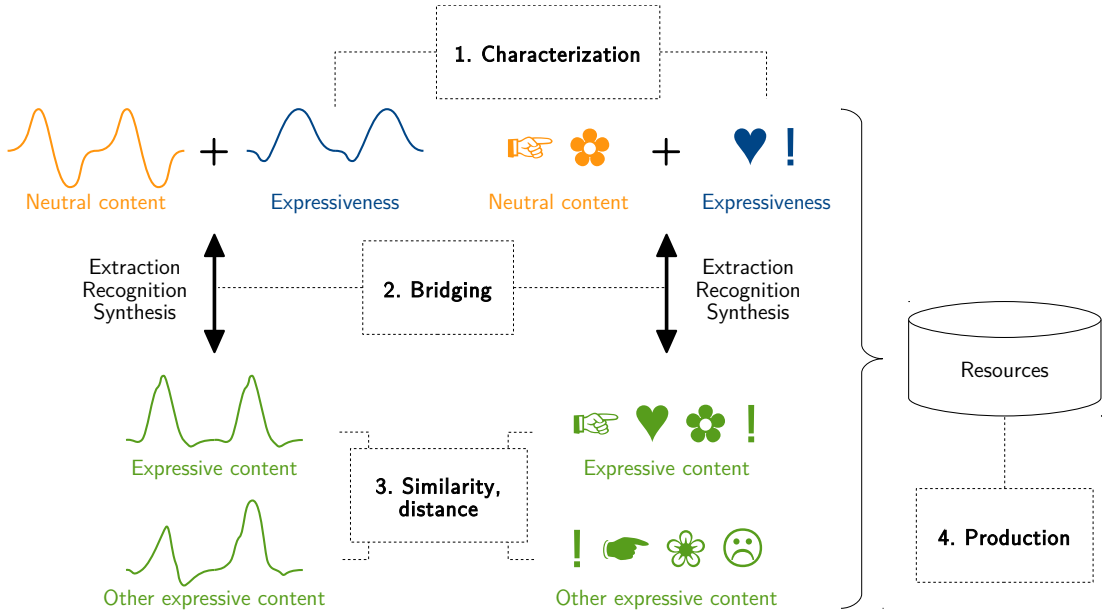


Figure 1: Overview of the main challenges considering both on continuous numerical (left) and discrete symbolic (right) data.

time series, sequential data and linguistic structures is the main proposed agenda of EXPRESSION. This main purpose comes to study problems for representing and characterizing heterogeneity, variability and expressivity, especially for pattern identification and categorization.

The research project targets the exploration and (re)characterization of data processing models in three mediated contexts:

1. Expressive gesture analysis, synthesis and recognition,
2. Expressive speech analysis and synthesis,
3. Expression in text and language.

2.1 Main challenges addressed by the team

Four main challenges will be addressed by the team.

C1: The characterization of the expressiveness as defined above in human produced data (gesture, speech, text) is the first of our challenges. This characterization is challenging jointly the extraction, generation, or recognition processes. The aim is to develop models for manipulating or controlling expressiveness inside human or synthetic data utterances.

C2: Our second challenge aims at studying to what extent innovative methods, tools and results obtained for a given media or for a given pair of modality can be adapted and made cross-domain. More precisely, building comprehensive bridges

between discrete/symbolic levels (meta data, semantic, syntactic, annotations) and mostly continuous levels (physical signals) evolving with time is greatly stimulating and nearly not explored in the different scientific communities.

C3: The third challenge is to address the characterization and exploitation of data-driven embeddings[1] (metric or similarity space embeddings) in order to ease post-processing of data, in particular to reduce the algorithmic complexity and meet the real-time or big-data challenges. The characterization of similarity in such embeddings is a key issue as well as the indexing, retrieval, or extraction of sub-sets of data relevant to user's defined tasks and needs, in particular the characterization of expressiveness and variability.

C4: The fourth challenge is to contribute to the production of resources that are required, in particular to develop, train and evaluate machine learning (statistical or rule-based) models for human language data processing. These resources are mainly corpora (built from speech, text and gesture time series), dictionaries, and semantic structures such as ontologies.

All the addressed challenges are tackled through the development of models, methods, resources and software tools dedicated to represent and manage gesture, speech or textual data. Thus we consider a complete processing chain that includes the creation of resources (corpus, thesaurus, semantic network, ontology, etc.), the labeling, indexing and retrieval, analysis and characterization of phenomena via classification and extraction of patterns (mostly sequential).

These challenges also target multi-level aspects, from digital tokens to semantic patterns, taking into account the complexity, the heterogeneity, the multi-dimensionality, the volume, and the nature of our temporal or sequential data.

We are aiming at addressing these challenges in terms of development and exploitation of machine learning and pattern discovery methods for clustering, classification, interactive control, recognition, and production of content (speech signals, texts or gestures), based on different levels of representation (captured or collected data but also knowledge that is specific to the media or the considered application). Finally, both objective and subjective (perceptive) evaluations of these models are a key issue of the research directions taken by the Expression team.

2.2 Main research focus

Five thematic lines of research are identified to carry out this research.

RF1: Data acquisition – Gesture, speech or text data are characterized by high levels of heterogeneity and variability. Studying such media requires high quality data sets appropriate to a well defined and dedicated task. The data acquisition process is thus a crucial step since it will condition the outcomes of the team research, from the characterization of the studied phenomena, to the quality of the

[1] Given two metric or similarity spaces (X, d) and (X', d'), a map $f : (X, d) \to (X', d')$ is called an embedding.

data driven models that will be extracted and to the assessment of the developed applications. The production of high quality and focused corpora is thus a main issue for our research communities. This research focus addresses mainly the fourth challenge;

RF2: Multi-level representations – We rely on multi-level representations (semantic, phonological, phonetic, signal processing) to organize and apprehend data. The heterogeneity of these representations (from metadata to raw data) prevents us from using standard modeling techniques that rely on homogeneous features. Building new multi-level representations is thus a main research direction. Such representations will provide efficient information access, support for database enrichment through bootstrapping and automatic annotation. This research focus contributes mainly to the second, third and fourth challenges;

RF3: Knowledge extraction – This research addresses data processing (indexing, filtering, retrieving, clustering, classification, recognition) through the development of distances or similarity measures, rule-based or pattern-based models, and machine learning methods. The developed methods will tackle symbolic data levels (semantic, lexical, etc.) or time series data levels (extraction of segmental units or patterns from dedicated databases). This research focus contributes mainly to the first and third challenges.

RF4: Generation – We are also interested in the automatic generation of high-quality content reproducing human behavior on two modalities (gesture and speech). In particular, to guarantee adequate expressiveness, the variability of the output has to be finely controlled. For gesture, statements and actions can be generated from structural models (composition of gestures in French sign language (LSF) from parameterized linguistic units). For speech, classical approaches are data-driven and rely either on speech segment extraction and combination, or on the use of statistical generation models. In both cases, the methods are based at the same time on data-driven approaches and on cognitive and machine learning control processes (e.g., neuromimetic). This research focus contributes mainly to the first and fourth challenges since generation can be seen also as a bootstrapping method. As parallels can be possibly drawn between expressive speech and expressive movement synthesis, the focus also contributes to the second challenge;

RF5: Use cases and evaluation – The objective is to develop intuitive tools and in particular sketch-based interfaces to improve or facilitate data access (using different modes of indexing, access content, development of specific metrics, and graphical interfaces), and to integrate our aforementioned models into these tools. As such, this focus contributes to the first challenge and has a direct impact on the fourth challenge. Furthermore, whereas many encountered sub-problems are machine learning tasks that can be automatically evaluated, synthesizing human-like data requires final perceptive (*i.e.* human) evaluations. Such evaluations are costly and developing automatic methodologies to simulate them is a major challenge. In particular, one axis of research directly concerns the development of cross-disciplinary evaluation methodologies. This research focus contributes also to the second challenge;

3 Scientific achievements

3.1 New Results by Key Issues

In accordance with the Team Project, the main outcomes for 2024 are listed into the following key issues items defined above for the team:

Data acquisition, Knowledge extraction

Enrichment of textual corpora for named-entity recognition [3] Industrial applications of Named Entity Recognition (NER) are usually confronted with imbalanced corpora. This could harm the performance of trained and finetuned models, especially when they encounter to unknown data. In this paper we develop two generation-based data enrichment approaches, in order to raise the number of examples of underrepresented entities. We compare the impact of enriched corpora on NER models, using both non-contextual (fastText) and contextual (Bert-like) embedding models, and a biLSTM-CRF as entity classifier. The approach is evaluated on a contract renewal detection task applied to a corpus of calls for tenders. The results show that the proposed enrichment significantly improves the model's effectiveness when applied on data that have not been used for training, while not degrading the model's performance on the original test set.

Data acquisition

STK-LSF: A motion capture dataset in LSF for SignToKids [11] A new bilingual corpus and dataset in written French and French Sign Language (LSF) has been created. This corpus, called *STK-LSF*, was produced as part of the SignToKids project. The aim of this corpus is to provide digital pedagogical tools for deaf children, thereby facilitating the joint learning of LSF and written French. More broadly, it is intended to support future studies on the automatic processing of signed languages. To define this corpus, we focused on several grammatical phenomena typical of LSF, as well as on tales usually studied by hearing children at Cycle II and Cycle III levels. The data in this corpus represents around 1 hour of recording, carried out with a motion capture system (MoCap) offering a spatial accuracy of less than 1 mm and a temporal accuracy of 240 Hz. This high level of precision guarantees the quality of the data collected, which will be used both to build pedagogical exercices in French and in LSF, including 3D signing avatar animations, and for automatic translation of text into gloses in LSF.

Data acquisition

Handi-Motion: Corpus and motion Dataset in disability situations [14] A new corpus has been defined and a motion dataset, called "Handi-Motion", has been created. This dataset was recorded from people with reduced mobility. The aim of this corpus is to provide data related to motor disabilities in order to experiment on AI models for motion reconstruction and action detection or recognition. These data-based models are necessary to develop applications to improve the daily life of people with disabilities in contexts such as motor rehabilitation, semi-automatic supervision by analyzing and interpreting data and facilitating therapeutic diagnosis, or assessment of the motor capacities of people with reduced mobility. The dataset represents approximately

115 minutes of recording at a sampling rate of 120Hz using an optical motion capture system.

Knowledge extraction

Deciphering Children's Social Cognition: Leveraging NLP for Deeper Insights Into Social Role Perceptions [12] The data for this research were collected as part of the COSMOS project, supported by the MSHB (Maison des Sciences de l'Homme en Bretagne), which investigates semantic construction and stereotypes in children aged 6 to 11. As part of this project, the authors conducted interviews with first- and fifth-grade children in schools across Brittany, focusing on concepts related to their social lives and environments. This article explores the concept of "friend" using a multidisciplinary approach that combines natural language processing (NLP) methods, statistical analyses, and qualitative techniques. Specialized NLP tools, developed specifically for this corpus, identified three main themes in the children's discourse: similarity, support/intimacy, and association/affection. Statistical analyses uncovered gender-and age-based variations within these themes, providing insights into how children construct and interpret this fundamental social role. This article's originality lies in its focus on the children's perspective, offering a fresh viewpoint compared to traditional studies, which predominantly reflect adult perspectives. The publication received a Best Paper Award at the conference, highlighting its innovative methodology and contribution to cognition and child development research.

Knowledge extraction, Use cases and evaluation

Complexity as a regression task [7] Our work aims to observe which are the most discriminating linguistic descriptors in order to produce an efficient regression model for text complexity in French. Text complexity is currently not an area with extensive studies in Natural Language Processing (NLP). This project tackles the problem of children from 7 y. old and 12 y. old access informational content of genre diversified texts (journalistic, fictional, encyclopedic). Thus, it is directly concerned with the question of how to evaluate complexity of texts for this type of population.

Data acquisition

WikiNER-fr-gold: A Gold-Standard NER Corpus [16] We address in this article the the quality of the WikiNER corpus, a multilingual Named Entity Recognition corpus, and provide a consolidated version of it. The annotation of WikiNER was produced in a semi-supervised manner i.e. no manual verification has been carried out a posteriori. Such corpus is called silver-standard. In this paper we propose WikiNER-fr-gold which is a revised version of the French proportion of WikiNER. Our corpus consists of randomly sampled 20

Use cases and evaluation

ParaPLUIE - an automatic evaluation measure of paraphrase generation systems semantic quality [5] Evaluating automatic paraphrase production systems is a difficult task as it involves, among other things, assessing the semantic proximity between two sentences. Usual measures are based on lexical distances, or at least

on semantic embedding alignments. The rise of Large Language Models (LLM) has provided tools to model relationships within a text thanks to the attention mechanism. In this article, we introduce ParaPLUIE, a new measure based on a log likelihood ratio from an LLM, to assess the quality of a potential paraphrase. This measure is compared with usual measures on two known by the NLP community datasets prior to this study. Three new small datasets have been built to allow metrics to be compared in different scenario and to avoid data contamination bias. According to evaluations, the proposed measure is better for sorting pairs of sentences by semantic proximity. In particular, it is much more independent to lexical distance and provides an interpretable classification threshold between paraphrases and non-paraphrases.

This work also led to a publication accepted to COLING 2025.

Generation

Controllable Text Generation to Fight Disinformation [9] During the 21st century, the global development of online platforms have led to their use in Strategic Influence Operations. These operations cause deaths and put democratic processes at risk. To counter it, governmental and nongovernmental entities emerged with analysts specialized in detecting and characterizing foreign disinformation campaigns. These analysts need constant training to be able to adopt new methodologies against the highly evolving threats landscape. Trainings take place in simulated environments reproducing the Internet, providing faithful training environment that we call infospheres. This paper is about an ongoing PhD which aims at automating content generation to populate these infospheres. We highlight key challenges in this domain which are controllable text generation, fictive writings, preventing hallucinations and evaluation protocols to assess the used methodologies. We propose an idea based on a three levels modeling which structures knowledge and social dynamics associated with a training scenario. This modeling is used in a prompting methodology to automate content production with Large Language Models. Finally, we propose directions to continue this work, including social graph modeling to mimic how information propagates as well as new evaluation protocols.

Knowledge extraction, Generation

Spoofed speech detection with a focus on speaker embedding [15] Self-Supervised Learning (SSL) models excel as feature extractors in downstream speech tasks, including the increasingly crucial area of spoof speech detection due to the rise of audio deepfakes using Text-To-Speech (TTS) and Voice Conversion (VC) technologies. To address this issue, we propose a novel approach that relies on speaker embedding using a finetuned WavLM model with layer-wise attentive statistics pooling combined to a supervised contrastive learning and cross-entropy loss. Evaluation on Logical Access (LA) and DeepFake (DF) tasks on ASVspoof 2019 and 2021 highlights its potential in detecting audio deepfakes, with the contrastive loss producing more stable results among test sets.

Knowledge extraction, Generation

Exploring Generalization To Unseen Audio Data For Spoofing: Insights From SSL Models [4] Deep learning-based speech synthesis has significantly improved realistic audio deepfakes. Despite advanced techniques such as self-supervised learning (SSL) and datasets, current state-of-the-art (SOTA) detection systems fail in out-of-domain scenarios due to the inability to generalize. This work explores the generalization problem through comprehensive experimentation on cross-data evaluation. We observed how training data impacts model generalization, revealing that even SOTA systems struggle with consistent performance across different evaluation settings. This indicates a lack of extensive generalization abilities, especially in SSL approaches. To address this problem, we propose a multi-stage training framework alongside an ensemble of different systems to enhance the robustness and reliable detection in known and unknown out-of-domain scenarios. Experimental evaluation underscores the importance of an ensemble approach to mitigate the limitations in individual systems.

Knowledge extraction, Multi-level representation

Time Elastic Neural Networks [18] We introduce and detail an atypical neural network architecture, called time elastic neural network (teNN), for multivariate time series classification. The novelty compared to classical neural network architecture is that it explicitly incorporates time warping ability, as well as a new way of considering attention. In addition, this architecture is capable of learning a dropout strategy, thus optimizing its own architecture. Behind the design of this architecture, our overall objective is threefold: firstly, we are aiming at improving the accuracy of instance based classification approaches that shows quite good performances as far as enough training data is available. Secondly we seek to reduce the computational complexity inherent to these methods to improve their scalability. Ideally, we seek to find an acceptable balance between these first two criteria. And finally, we seek to enhance the explainability of the decision provided by this kind of neural architecture. The experiment demonstrates that the stochastic gradient descent implemented to train a teNN is quite effective. To the extent that the selection of some critical meta-parameters is correct, convergence is generally smooth and fast. While maintaining good accuracy, we get a drastic gain in scalability by first reducing the required number of reference time series, i.e. the number of teNN cells required. Secondly, we demonstrate that, during the training process, the teNN succeeds in reducing the number of neurons required within each cell. Finally, we show that the analysis of the activation and attention matrices as well as the reference time series after training provides relevant information to interpret and explain the classification results. The comparative study that we have carried out and which concerns around thirty diverse and multivariate datasets shows that the teNN obtains results comparable to those of the state of the art, in particular similar to those of a network mixing LSTM and CNN architectures for example.

Summary of the contributions

3.2 Defended PhDs and HDRs

- Lily Wadoux defended her PhD on the 21st of November 2024. The subject of this PhD is "Impact of Corpus Quality and Content on Voice Cloning: Towards an

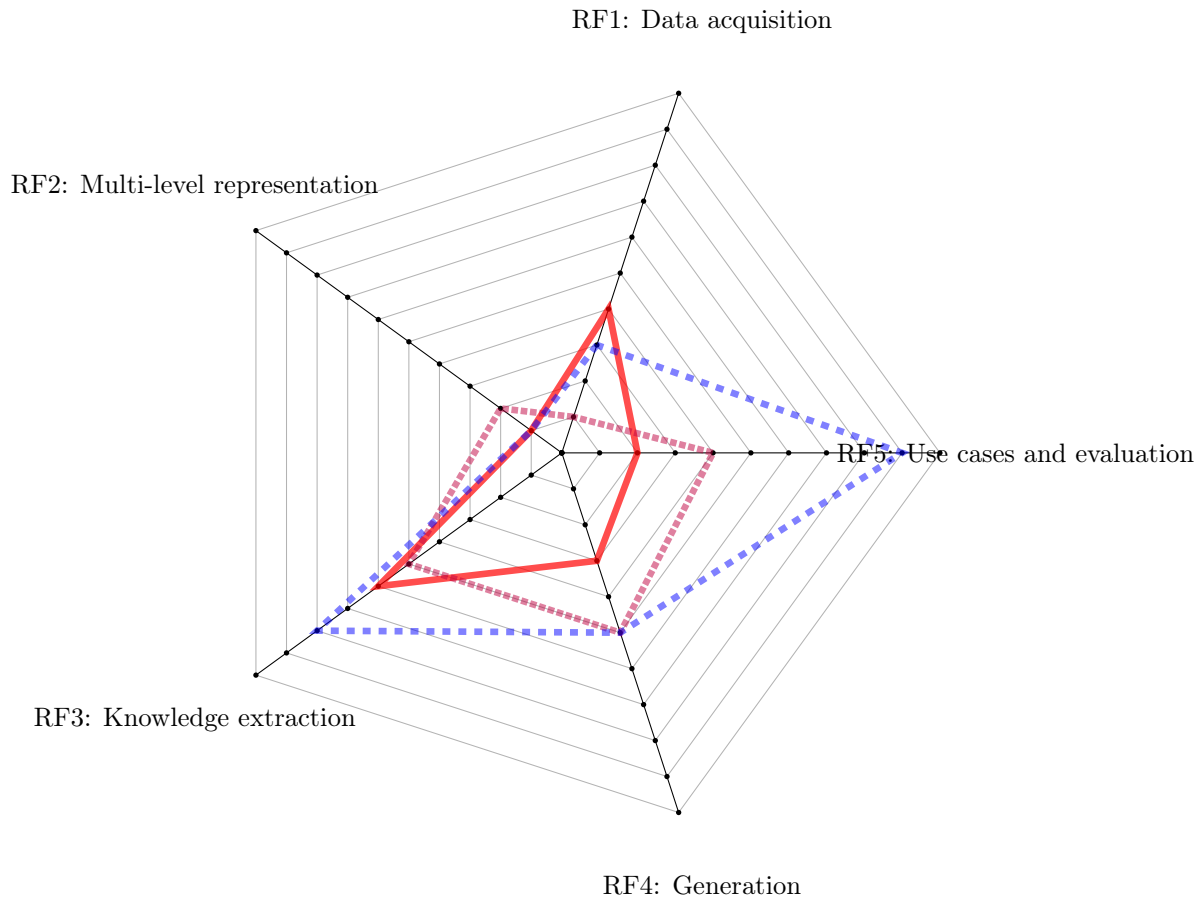


Figure 2: Contributions to each research focus of the team in 2024 (red, solid) compared to 2023 (purple, dotted) and 2022 (blue, dashed)

Application in French to Voice Disorders". This PhD was financed by the University of Rennes. The work presented aims at using voice cloning with constraints in terms of language and target speaker. The chosen language is French, which offers high quality mono-speaker corpora, but only variable-quality multi-speaker corpora. Strategies are presented to train a voice cloning model on such data. Target speaker atypicality is also explored, through expressive audiobook test speakers. A first study on the impact of the phonetic content in the target speaker corpus is also presented, aiming at an application of voice cloning to voice disorders.

- Mansour Tchénégnon successfully defended his doctoral dissertation on June 26, 2024. The focus of his thesis is titled "3D Motion Reconstruction with Deep Learning Methods: Application to Motor Disabilities." This doctoral research was supported by UniversitÃ© Bretagne Sud (CDE) and the Région Bretagne (ARED). The objective of his work was to develop a solution for motion reconstruction from video through a two-step methodology. The first step involved the estimation of 3D poses from video data, followed by the second step, which aimed to correct motion by ensuring temporal coherence and consistency of the reconstructed skeletons across a sequence of estimated poses. The proposed solution was then used to build a dataset of movements in the context of motor disability, where data was recorded by participants with reduced mobility, using an optical motion capture system.

3.3 On going PhDs

1. Danrun Cao has started her PhD in the context of an industrial CIFRE contract with Octopus Mind, located in Nantes. Her work addresses information extraction (entities and relationships) in the context of business intelligence, while exploiting multilingual call for tenders. Danrun has pubished during her first year a conference paper in the ACM DocEng conference, and a conference paper in TALN during her second year. She is currently developing state of the art Deep Learning approaches to Name Entity Recognition and semantic relation extraction for the French language.

2. Hoan My Tran started his PhD in November 2022 on the detection of deep speech fakes in the context of voice conversion and speech synthesis. The aim of this work is to propose an automatic voice fraud detection system, based on the state of the art in the field, in particular in comparison with the work proposed as part of the ASVspoof challenge. He has published two papers in the deepfake detection domain in high level conferences and workshop at Interspeech. He is now beginning his third year with a future objective that extends to multilingual deepfake detection. This PhD is co-directed by Damien Lolive and Pierre-François Marteau, and co-supervised by Arnaud Delhay and Aghilas Sini from LIUM in Le Mans.

3. Ulysse Oliveri started his PhD in March 2023 under a CIFRE contract funded by Airbus. He works on controlled generation of text to fight disinformation. This thesis is directed by Damien Lolive and Bruno Grilhères (Airbus) and co-supervised by Arnaud Delhay, Guillaume Gadek (Airbus) and Benjamin Costé

(Airbus).

4. Pauline Mas started her PhD in September 2023 under a CIFRE contract funded by Voxygen. She works on multilingual modulation of prosodic elements in Speech Synthesis. This PhD is directed by Damien Lolive and Olivier Rosec (Voxygen), and co-supervised by Jonathan Chevelu and Marion Ouédraogo (Voxygen).

5. Quentin Lemesle started his PhD in October 2023 on the constraint paraphrase generation task in a frugal approach. This PhD is directed by Damien Lolive, co-supervised by Jonathan Chevelu and Arnaud Delhay. This PhD is half funded by the DGA AID.

6. Philippe Martin started his PhD in April 2024 on fine control of voice attributes in high quality Speech Synthesis. His PhD is part of the ANR project "EVA" (Explicit Voice Attributes) and is directed by Damien Lolive and Vincent Barreaud. He is co-supervised by Nelly Barbot and David Guennec.

7. Rania Bennetayeb started her PhD in October 2023 under a CIFRE contract funded by Rennes Metropole, in collboration with B<>com. She works on "Semi-automatic construction of an ontology from textual resources related to urbanism". This thesis is directed by Giuseppe Berio and supervised by Nicolas Bechet and Majd SALAH (B<>COM, until october 2024). The main objective is to check that building permits comply with the rules in force in Rennes Métropole. The first year's work led to preliminary results submitted to GOLE 25 workshop Strasbourg.

4 Software development

Text-To-Speech system In the frame of several technology transfer projects, developments have been done in 2019 on many pieces of software involved in the team's text-to-speech system to make it usable in industrial environments. This has mainly consisted in shifting some tools from script languages (Python, Perl, shell) to C++, and setting up web services on a production server, compatibility for Android and AMR7 architectures. This has been mainly achieved in the frame of the SPAM project (maturation project funded by the transfer technology service of University of Rennes 1). Developments are going on from then in the frame of different projects such as NADINE or KALYGO-DYS.

Visual Quantum Simulator [Gildas Ménier] Most of the human behaviors involve uncertainty and fuzzy inner decisions in a way or another : Expression can be seen as a individual by-product as the top level visible artifacts of some unknown inner process. Markov models, or statistical process can be used to mimics the observable results of observable behaviors. Quantum State evolution shares also many similar features with the obfuscated or hidden way of thinking and communicating.

Not only does this (relatively) new paradigm bring some ideas related to human decision's process, it also may be a key progress for Machine Learning - Quantum

Machine Learning or QML -. Some intensive computation involved in ML may be sped-up using Quantum schemes.

We are investing some efforts in the study of Quantum Computing both as a computing potential asset and source of ideas for human inner process simulation.

A Scala DSL (domain specific) language has been developed to manage Quantum Algorithm Evaluations *(https://github.com/gmenier/VisualQuantumSimulator/wiki)*

The software has been registered by *APP* (Agence pour la Protection des Programmes) under the number Inter Deposit Digital Number IDDN.FR.001.300006.000.S.C.2021.000.10000 (06.56.11046).

This simulator is designed to allow a graphical view of the inner processing involved in Quantum computing, thus helping grasping its inner working.

It is also designed as a starting backbone for experimentation and is actually used as a support for education.

Time Elastic Neural Networks (teNN) A CPU implementation of teNN architecture written in ANSI C, along with its Python wrapper, is available under the GNU GENERAL PUBLIC LICENSE at `https://github.com/pfmarteau/time-elastic-Neural-Networks`. This implementation requires that multivariate time series have a fixed length.

5 Contracts and collaborations

5.1 National Initiatives

5.1.1 TextToKids ANR Project

Participants: Nicolas Béchet, Jonathan Chevelu, Damien Lolive, Alexis Blandin, Rashedur Rahman.

The TextToKids ANR project is the continuation of the homonymous CNRS PEPS project, previously running in 2018. It aims to facilitate the writing and the filtering of texts for children, especially but not only in order to tell them about current events (e.g., presidential elections, Brexit, reception of migrants in France, etc.) in respect of their language skills. The targeted age group is that of young readers, that is, the 7-12 age group. The consortium, which brings together linguists, computer scientists and specialized journalists, will seek to characterize the linguistic constraints to be respected for such a purpose and to propose assistive tools (automated textual analysis, search engine, reformulation, good practices). In terms of benefits, the project works in the direction of a "children's Internet" and opens a way to other modalities (speech, images).

This project is coordinated by Delphine Battistelli (MoDyCo lab), assisted by Nicolas Béchet.

5.1.2 SignToKids ANR Project

Participants: Sylvie Gibet, Clément Reverdy, Damien Lolive, Nicolas Béchet, Vincent Segonne, Pierre-Francois Marteau, Jeanne Villaneau, Farida Said.

The SignToKids project aims to improve the inclusion of deaf children in the world of education with a focus on digital accessibility. More specifically, it focuses on the creation of the first digital and pedagogical tools to facilitate the coordinated learning of LSF and written French for deaf children. By working on their signed language skills, deaf children will have a more robust native language, making the transition to written French easier. The resulting digital assistance tools (web applications, serious games, or video-books) will serve as a basis to test the skills acquired at different levels of the child's learning. This project will also contribute to the advancement of research on automatic translation from text to signed movements, using recent AI techniques, thus increasing the amount of data available in French and LSF, and ultimately it will enable additional resources and knowledge to be integrated into tools that will be used by deaf children. Practical experiments will be conducted to evaluate these innovative tools with deaf children in LSF-French bilingual schools.

This project is coordinated by Sylvie Gibet. It started in January 2023 and will end at the end of 2025.

Keywords: French Sign Language, Text-to-LSF, pedagogical tools

5.1.3 Kaligo+

Participants: Damien Lolive, Philippe Martin.

This project aims at proposing a set of digital application on tablets and using virtual reality tools (like Oculus Quest) to favor training children with oral and written troubles. In particular, our role is to work on the oral part of the problem by proposing Text-To-Speech technologies to make an oral feedback to users, and pronunciation analysis tools to develop pronunciation training methods. This project begun in 2022 and has finish in August 2024.

5.1.4 Détection de Voix de Synthèse - DVS

Participants: Damien Lolive, Vincent Barreaud, Arnaud Delhay, Sandipana DowerahDavid Guennec, Emilie Daniel, Elie-Laurent Benaroya, Lily Wadoux.

The DVS project is a part of the RAPID *Régime d'Appui à l'Innovation Duale* framework proposed by the AID *Agence Innovation Défense*. This framework provides support to innovative projects related to national security and lead with Whispeak. The aim of the DVS project is to design a strategy to detect audio deep fakes. Expression team provides a set of state of the art systems (synthesis, voice conversion and voice cloning), trained or fined tuned with 12 languages with a hundred of speakers each. This project begun in October 2023 and is expected to end in October 2025. In the frame

of this project, IRISA together with Whispeak won the DGA fake speech detection challenge in 2024.

5.1.5 Explicit Voice Attributes ANR Project

Participants: Damien Lolive, Vincent Barreaud, Philippe Martin.

The objective of this project is to crack the codes of human voices via learning explicit and structured representations of voice attributes. The realization of this main objective will have a strong scientific and technological impact, in at least two fields of application: firstly, in speech analysis, it will unlock the understanding of the complex entanglement of the characteristics of a human voice; secondly, in voice generation, it will open the way to a wide range of applications to create a voice with the desired attributes, allowing the design of so-called voice persona.

The project will leverage a substantial skill set by the partners, which include Orange, a leading telecommunication provider with strong research skills on speech processing, IRCAM, a research lab with a strong expertise in neural speech synthesis and voice conversion and three academic labs: LIA with a strong expertise in speaker analysis and anonymization, LPP, an internationally recognized laboratory, which holds a LABEX (Empirical Fundations of Linguistics), and provides the strong skills needed in phonetics, and IRISA (Expression Team) with expertise in expressive text-to-speech.

The project started in October 2023 and will end in February 2028. The project is registered under the ANR Contract Number ANR-23-CE23-0018.

5.1.6 Ethos - Automatic annotation of Horse Sound

Participants: Philippe Martin, Arnaud Delhay, Vincent Barreaud.

In June 2023, the team CIRCÉ[2] from EthoS laboratory[3] and the team EXPRESSION began collaborating on the detection and classification of sound events emitted by horses. Horses are equipped with microphones to pick up various sound events linked to their behavior (neighing, snorting, etc.) in different environments (stable stalls, outdoors). In this context, classification work enables ethology researchers to identify events in the sound continuum that may occur, and then to observe the scenes linked to these events, thus studying the well-being of the subject observed as a function of what happens in these situations.

The team CIRCÉ has recorded about 30 000 hours of sound rush from 65 horses in diverse location as meadow or stable. Each horse was recorded for 2 continuous weeks. There is a wide range of sounds with their particularities and also rarer events which make this task a complex one.

The main objective of this collaboration will be to research methods for adapting to different types of massive acoustic content, based on recordings made continuously, 24 hours a day, 7 days a week, on animals equipped with on-board loggers fitted with

[2]Communication Intra-/Inter espèces, Relation, Cognition, Émotions
[3]UMR 6552 - Ethologie animale et humaine

sensors (audio recorder and accelerometer). The aim is to develop versatile classification methods using unsupervised or weakly supervised classification methodologies, and to evaluate the ability to transfer knowledge from one model to another on ethological data.

5.1.7 CONSIODÉPA - MSHB Project

Participants: Farida Saïd, Jeanne Villaneau.

The CONSIODÉPA project, supported by the MSHB (Maison des Sciences de l'Homme en Bretagne), runs from September 1, 2024, to August 31, 2026, and builds on interviews with detainees collected during a preliminary phase in a detention center. It is part of the research axis "Democracy, Transformations, and Experimentations" of the MSHB. Its objectives are to construct a corpus based on detainees' testimonies, reflect on the ethical, deontological, and legal procedures required for its development, and analyze these data to better understand prison life, the perception of sentences, and the experience of incarceration. This corpus aims to shed light on rarely publicized experiences and contribute to public debate on sensitive issues related to the prison environment, while ensuring rigorous scientific exploitation and dissemination in a form adapted for the general public.

5.1.8 APIPreSui ANR Project

Participants: Nicolas Béchet.

The APIPreSui project (Participatory and Interdisciplinary Analysis of a Suicide Prevention Chat) is an interdisciplinary participatory research of a digital suicide prevention chat system. The analysis is co-constructed with the prevention association, its trainers, psychologists and volunteers on the one hand, and researchers in language sciences (sociolinguistics - discourse analysis - lexicometry - NLP), computer science and social psychology on the other.

5.2 National Collaborations

- We are collaborating actively with Marie Tahon, associate professor at LIUM in Le Mans, France. We shared common interests on emotions annotation, and generation in the context of speech synthesis.
- In the frame of the TREMoLo and TextToKids projects, the team works with members of the MoDyCo lab, especially Delphine Battistelli, full professor at University of Paris-Nanterre. 2 MSc interns have been co-supervised (Alexis Blandin, Aline Étienne), while Jade Mekki defended her PhD in September 2022.
- Caroline Larboulette collaborates with Laura Pouppeville, a visual artist who works at Pantin as part of the *Collectif W*, on the project Motion in Style, that has been awarded a grant from the IRISA project "1 artiste - 1 chercheur" in 2021. The aim of the project was to collect and analyse data, and use this data to

produce an art piece. This data is now used to create an immersive installation. She also collaborates with Alexandre Meyer, MCF at Université de Lyon, on the analysis of this motion data (*corpus MiS*).

- A collaboration started between Damien Lolive and Nicholas Evans (Eurecom) thanks to the RAPID DVS project. The subject of this collaboration is on Source Tracing for deep fake detection.

5.3 International Collaborations

- Since October 2021, Caroline Larboulette collaborates with Ravi Dattatreya, funder and chairman of the Margosa Group, New York, with various master students on Art and Science projects (string art in 2022, celtic knots in 2023). Since septembre 2024, they collaborate on the Kolam project that aims to create a unified/general algorithm capable of drawing Indian Kolams and Celtic Knots using the same formalism.

- Hoan My Tran, Damien Lolive and Arnaud Delhay also collaborated with Ajinkya Kulkarni (Idiap Institute, Switzerland) to build a new deep fake detection system. A publication has been accepted to ASVSpoof 2024 workshop as an outcome of this collaboration.

6 Dissemination

6.1 Involvement in the Scientific Community

- Damien Lolive is head of the Signal, Image, Language Department (formerly Media and Interaction Department) of IRISA lab from October 2021. He is part of board of directors of the French speech communication association (AFCP). He is also co-responsible for the working group on inter-modality and multi-modality of the GDR TAL (special interest group in NLP). He serves as a reviewer for the IEEE Transactions on Speech and Language processing, for the IEEE Access journal, for the *Traitement Automatique des Langues* journal, for the International conference of the International Speech Communication Association (Interspeech), the International Conference on Audio, Speech and Signal Processing (ICASSP), the international conferences LREC and Speech Prosody, as well as for the *Journées d'Études sur la Parole* conference. He regularly serves as an expert for the french research agency (ANR) and also for the Ministry of Research to expertise CIR applications in the NLP domain.

- Sylvie Gibet is a member of various program committees for international conferences: IEEE International Conference on Acoustics, Speech, and Signal Processing, LREC-COLING, Motion in Game, Computer Animation and Social Agents, Motion Computing. She serves as a reviewer for various journals (Computer & Graphics, Trans. on Visualization and Computer Graphics, Computer Animation and Virtual Worlds, The Visual Computer, Springer Nature, Universal Access in

the Information Society. In November 2024, She was in the adjudication committee (as first opponent) of Seyed-Mojtabi Karbasi in University of Oslo.

- Giuseppe Berio served as reviewer for national and international conferences. He also acts as steering committee member of the International Conference on Advances in Semantic Processing (SEMAPRO).

- Jonathan Chevelu is an elected member of the 'Conseil scientifique' (Research committee) of École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT). He has served as a reviewer for The 31st International Conference on Computational Linguistics (COLING 2025).

- Arnaud Delhay is an elected member of the 'Commission Recherche' (Research committee) of the IUT of Lannion. He has served as a reviewer for the International conference of the International Speech Communication Association (Interspeech 2024).

- Caroline Larboulette is a member of various program committees for international conferences, a member of the editorial review board of the international journal of computer graphics and creative interfaces (IJCICG) and serves as a reviewer for various journals (Computer & Graphics, TVCG, CAVW, Journal on Multimodal User Interfaces). In 2021, she joined the Editorial Board of Frontiers in Computer Science as an Associate Editor, to participate to the launch of a new section on Computer Graphics and Visualization in 2022. Since november 2019, she is co-director of the GTAS, the "Groupe de Travail Animation et Simulation" of the GdR IG-RV (Informatique Géométrique et Graphique, Réalité Virtuelle et Visualisation) of the CNRS INS2i and also member of the direction committee of the GdR.

- Nelly Barbot is a member of the 'Conseil scientifique' (Research committee) of École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT). She has served as a reviewer for the International conference of the International Speech Communication Association (Interspeech) and the IJCAI workshop "Interactions between Analogical Reasoning and Machine Learning" (IARML).

- Nicolas Béchet is a member of program committees for international conferences International Conference on Natural Language & Information Systems (NLDB) and Language Resources and Evaluation Conference (LREC). He also has served as a reviewer for the Intelligent Decision Technologies Journal (IDT), the International Conference on Computational Linguistics (COLING) and the International Journal of Machine Learning and Cybernetics.

- David Guennec served as a reviewer for the International conference of the International Speech Communication Association (Interspeech 2024) and the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP 2025).

- Quentin Lemesle, Pauline Mas and Philippe Martin are members of the board of the Lannion PhD student association since November 2024. Quentin Lemesle has been elected as the new co-president of the association, whereas Pauline Mas has

taken the charge of treasurer and Philippe Martin that of secretary. This association aims to gather and help PhD student from Lannion since 2022. It organizes networking opportunities, cultural and social events and handle the communication with various actors of the scientific research community and industrials.

6.2 Teaching

- Giuseppe Berio teaches courses on design and implementation of decision information systems at IUT Vannes and faculty of sciences (master level), Université Bretagne Sud. A project management course is also taught at IUT Vannes.

- Nelly Barbot teaches the following mathematics courses at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT): algebra and analysis basis, mathematical logic in Licence level, probability and statistics in Master level. She is responsible of the student admission processes at ENSSAT and co-responsible (50%) for the creation of a new university preparatory cycle (level L1 and L2) in collaboration with the IUT of Lannion.

- Vincent Barreaud teaches the following computer science courses at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT): Web Programming, Web Services and Distributed Algorithms in Licence level. He has been director of studies at ENSSAT until mid 2021 and is now responsible for the master 1 level of computer science.

- Nicolas Béchet teaches various computer sciences courses at the Statistique et Informatique Décisionnelle department of IUT Vannes. He is director of studies at IUT in the Data Science department.

- Arnaud Delhay teaches databases and web programming (server- and client-side) in Licence levels at IUT of Lannion, calculability and computational complexity of problems in Master level at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT).

- Jonathan Chevelu teaches the following computer science courses at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT): cybersecurity in Licence and Master level, operative systems in Licence level, natural language processing and machine learning in Master level. Jonathan Chevelu is currently the Head of the Computer Science department at ENSSAT and also responsible for the license 3 level of computer science.

- Sylvie Gibet teaches the following Computer Science courses at the faculty of sciences, Université Bretagne Sud: An introduction of Digital Signal Processing and Machine Learning (1st year master level, AIDN), and Movement and Artifical Intelligence (2nd year master level, AIDN). She was responsible for the second year of the Master's degree in Computer Science until September 2024 (AIDN program). She is a member of the Faculty of Science Council. Since October 2023, she is a member of the CNU, and since July 2024, she is a member of the CFVU at UBS.

- David Guennec teaches computer science courses at ENSSAT : Secure C Programming and Object Oriented Programming at license level at ENSSAT. He leads a project for a new Master degree at ENSSAT with a focus on cybersecurity.

- Caroline Larboulette teaches graphical user interfaces to undergraduate students as well as introduction to computer graphics (I2G) and simulation and interactive applications (SAI) at the master level (Master of Computer Science, AIDN (Interactive Applications and Data)) at the faculty of science of the Université Bretagne Sud. She co-manages both Introduction to Research teaching units for M1 students and supervises 5 M1 students on research projects. She also teaches a character animation lecture at PolyTech' Angers. Since october 2020, she has been deputy head of the MIS (Mathematics - Computer Science - Statistics) department at Université Bretagne Sud. She has been elected Head of this department in november 2022 (44 people). She is also responsible of both Computer Science degrees, bachelor and master.

- Quentin Lemesle taught Database, Advanced Database, Data Mining and tutored projects in licence level at IUT of Lannion. He now teaches Algorithmic, informatic development basics and Web development in licence level, as well as Machine Learning in master level at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT).

- Damien Lolive taught the following computer science courses at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT) until mid-2024: object-oriented programming in Licence level, compilers architecture and formal languages theory in Master level, speech and language processing in Master level, and pattern recognition in Master level. Since September 2024, he is full professor at the IUT of Université Bretagne Sud in Vannes. He now teaches NLP at the master level, and artificial intelligence, multimedia programming and databases at the licence level.

- Pierre-François Marteau teaches programming languages, logics, introduction to cryptography, information retrieval, machine learning and intrusion detection courses in computer sciences License and Master levels, mostly at École Nationale Supérieure de Bretagne Sud (ENSIBS). He is responsible of the bachelor level for the computer science program at ENSIBS.

- Philippe Martin teaches the following computer science courses at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT): Computer algorithm course and object-oriented programming course in license level and Artificial Intelligence course in master level.

- Pauline Mas teaches informatic development basics in license level and speech and language processing in Master level at École Nationale Supérieure des Sciences Appliquées et de Technologie (ENSSAT).

- Gildas Ménier teaches various computer sciences courses at the faculty of sciences, Université de Bretagne Sud.

- Hoan My Tran has taught Database introduction at IUT of Lannion, Java programming, Back-end Web Programming, Web services and Algorithmic at ENSSAT.
- Lily Wadoux teaches algorithmics, object-oriented programming and databases (licence level) at IUT of Lannion.

6.3 Conferences, workshops, invitations

6.4 Meetings, other dissemination

- Damien Lolive participated as a speaker to the "états généraux de l'information" organized in February 2024 in Lannion. The subject of the debate with the audience (80 people) was "IA: amie ou ennemie de l'information" (*artificial intelligence: friend or enemy of information*).
- David Guennec participated as a speaker to the "états généraux de l'information" organized in February 2024 in Lannion. The subject of the debate with the audience (40 people) was "Intelligence artificielle et média: aux frontières du réel" (*Artificial Intelligence and the media: on the edge of reality*).
- Sylvie Gibet wrote an online article for "The Conversation" entitled "Apprendre la langue des signes grâce à l'IA générative et aux avatars en 3D" ([4]).
- Damien Lolive wrote an online article for "The Conversation" entitled "Deepfakes vocaux : comment fabriquer des voix artificielles en quelques secondes" ([5]) viewed more than 9k times.
- Damien Lolive has been interviewed for France Culture about the advances in deep fake detection (broadcasted on 22/10/24)

6.5 Graduate student and student internship

- Étienne Cauty, a Master 2 student in computer science at ENSSAT, worked on exploring textual steganography using paraphrase generation methods and LLMs. The internship lasted 6-months, 2 days per weeks. He was supervised by Jonathan Chevelu.
- Guillaume Collet, a Master 1 student in computer science at ENIB (École Nationale d'Ingénieur de Brest). He worked on the feasibility of setting up a Kubernetes cluster to deploy and monitor services and computing tasks on the team's servers.
- Yasser El Ayyachy, a Master 2 student in computer science at ENSSAT, worked on building voice cloning models adapted to the French language based on neural

[4] `https://theconversation.com/apprendre-la-langue-des-signes-grace-a-lia-generative-et-aux-avatars-en-3d-225229`

[5] `https://theconversation.com/deepfakes-vocaux-comment-fabriquer-des-voix-artificielles-en-quelques-secondes-238259`

codec architectures (Vall-E and Bark). The internship lasted 6 months. He was supervised by David Guennec.

- Maxime Perrot, a BUT 2 student at IUT de Lannion, worked on the improvement of the team' evaluation software Flexeval during a 3 months internship. He started form a preexisting script for automatically analyzing the results of Flexeval subjective tests. He improved the process and created a results analysis dashboard inside Flexeval in order to further automatize the process. He was supervised by David Guennec.

- Louis BARRIAC, Simon LE CHANU, Dewi MONBOUSSIN, Jules NICOLAS, four BUT 2 students at IUT de Vannes, worked on improving the process of creating a Flexeval test by unifying and simplifying the input format and creating a new tool that creates a Flexeval test using a graphical interface. They were supervised by David Guennec.

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