Institut 3iA - Artificial and Natural Intelligence Toulouse Institute

ANITI Chairs' projects and contact information

IP-A: Acceptability, Fair, representative data for AI

- SHS-Socio-Psycho: Jean François Bonnefon (DR CNRS)

  Title: Moral AI

  This project will examine and quantify judgments of ordinary citizens concerning solutions to problems that involve tradeoffs. This will bring quantitative methods to bear on well known ethical dilemmas like the Trolley problem, which are very relevant for the design of autonomous vehicles.

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- Legal Issues: Céline Castets-Renard (PR UT1C)

  Title: Law, Accountability and Social Trust in AI

  The goal of this chair is to investigate how a legal framework for making AI programs properly accountable. There are important legal issues–consumer protection, liability, and insurance—that need work before AI can gain full social trust and that is crucial to making AI widespread. French law also has a requirement on the explainability of an administrative decision, but this notion will need clarification and refinement in the face of the use of AI methods in administration

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- AI and market competition: Bruno Jullien (DR CNRS)

  Title: The effects of AI on competition in the marketplace

  This research program aims at fostering our theoretical and empirical understanding of the economics of information services using AI, with a special emphasis on the impact of AI on competition. Do AI based pricing algorithms inevitably or tend to lead to collusion, price-fixing or predatory pricing? If so, how can we control for that. Do AI programs lead to de facto monopoly behavior amongst would be competitors? How also do data driven mergers affect competitivity? Answering such questions is important for the eventual acceptance by the public of ubiquitous AI

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- Fairness/Robustness PI: Jean-Michel Loubes (PR UT3, IMT) – also in IP-B

  Title: Fair & Robust Methods in Machine Learning

  This project will analyse fair learning and bias using tools from statistics and optimal transport theory and contribute to explaining ML program behavior, anomaly detection and making ML methods more robust. It will provide means for removing biases from both data and machine learning algorithms by adding certain constraints to the learning process, for instance. By isolating the effects of a known bias and observing changes in a program's behavior after a certain bias has been removed, this work will also contribute to explaining ML program behavior and may figure also in anomaly detection and in determining whether a ML method is robust or not.

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- Hybrid Argument: Leila Amgoud (DR CNRS, IRIT)
  Title: Empowering Data-driven AI by Argumentation and Persuasion

  The project will examine argumentation structures extracted from ML program behavior to support the conclusions they arrive at, thus enhancing the explainability of data-driven AI. Another more general thread of this project will be to uncover the links of persuasion, biases, learnability and argumentation, linking with the projects of Loubes and Castet-Renard.

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- Augmented Society: Cesar Hidalgo (External, MIT, USA)
  Title: Developing AI to Improve Global Governance

  The goal of this research program is to advance the development of big data and AI tools to serve the general public and promote data driven decision making—in particular tools like public data distribution platforms, public data that have added content from computer vision and natural language processing, digital twins for daily decision making, and AI ethics.

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- Remote Sensing Data Analysis PI: Nicolas Dobigeon (PR, INP)
  Title: Data-driven approximate Bayesian computation for fusion-based inference from heterogeneous (remote sensing) data

  This project will apply approximate Bayesian computation (ABC) to problems with algorithms for extracting hidden properties (described in a latent space) in multi source, multi-scale and multi temporal data that are often heterogeneous and thus have no straightforward physical model that offers a general descriptive framework. ABC methods offer an approximate descriptive framework for various generative models including various deep learning methods (auto encoders, generalized adversarial networks).

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- Simulating Complex Environments PI: Fabrice Gamboa (PR UT3)
  Title: AI for physical models with geometric tools

  This project will look at complex computer simulations, which are used to model complicated physical, chemical or biological phenomena, and seek to improve their analysis by using the geometry or topology of the parameter space (of the computational model) or the data, with application to various data driven deep learning models.

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IP-B: Certifiable AI functions toward autonomous safety critical systems

- Data Assimilation and Machine Learning: Serge Gratton (PR INP)

  Title: Efficient algorithms and Data Assimilation for Computationally Efficient Constrained Advanced Learning

  This project will design gradient based embeddable algorithms, that are provably convergent to 2nd order stationary points, with a provable low complexity. To reach this aim we will rely on ideas that have proved efficient in more general optimization settings for problems with data: domain decomposition, multilevel methods, inexact computing, nonlinear preconditioning, randomized and quasi-static methods to escape saddle points. The project will also explore data assimilation approaches, which provide a Bayesian framework for learning under physical constraints along a time dimension.

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- Hybrid, Subsymbolic –> Symbolic: Joao Marques-Silva (external, University of Lisbon, PT)

  Title: Deep Learner Explanation & VERification.

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  This project envisions two main lines of research, concretely explanation and verification of deep ML models. It will build on the remarkable progress made by automated reasoners based on SAT, SMT, CP, ILP solvers (among others) to further explainable and robust data driven AI (Hybrid AI for proving robustness for neural networks). The reasons for these successes include improved solver technology, more sophisticated encodings, and also by exploiting key concepts that include abstraction refinement, symmetry identification and breaking among others.

- Polynomial optimization for Machine Learning: Jean-Bernard Lasserre (DR CNRS, LAAS)

  Title: Optimization for ML and the Christoffel function for data analysis
  Many ML applications such as unsupervised clustering or deep learning, are formulated as non-convex problems. In addition, from a complexity point of view, we often face average case problems where data are drawn from distributions, and a better understanding of such situations is required. This project will be looking at polynomial optimisation using approximation methods for nonconvex search spaces and various functions for data analysis.

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- Embracing non convexity: Marc Teboulle (External, Tel-Aviv University, Israel).

  Title: Pushing the frontier of nonconvex optimization to more general settings and understanding why it works.
  The main objectives are to extend the scope of algorithms that can cope with nonconvexity and the curse of dimensionality by exploiting data information and structures, to analyze their mathematical properties, to identify the determining factors of their numerical complexity, to improve their performance, and to apply them to solve high impact applied problems. Many ML problems require solving nonconvex optimization, e.g., clustering problems; dimension reduction paradigms such as sparse PCA (Principal Component Analysis), Nonnegative Matrix Factorization, to name just a few. In all these instances, the problems are highly nonconvex, huge scale and even nonsmooth, and are the source of challenging open questions.

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- Games and Adversarial Nets PI: Jérôme Renault (PR UT1C)

  Title: Game Theory, Convergence for Generalized Adversarial Nets and other ML architectures

  This project will formally study and prove properties about of one the most complex learning architectures: Generalized Adversarial Networks (GANs), and also about complex interactions of autonomous AI systems, using stochastic games.

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- Large scale optimization for AI PI: Jérôme Bolte (PR UT1C)

  This chair will study convergence properties/rates, global optimization and error bounds, design/optimization of underlying geometrical structure, optimization of adversarial models. In addition, it will explore the modeling and algorithms for large and autonomous systems using bio-inspired models. Particle swarm algorithms, which will arise out of bio inspired models for group decision/ action beyond the capacities of extant models like boids, will be considered and optimisation techniques for them.

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- Fairness/Robustness PI: Jean-Michel Loubes (PR UT3, IMT) – also in IP-A

  Title: Fair & Robust Methods in Machine Learning
  See IP-A

- Certification PI: Claire Pagetti (ONERA)

  Title: New certification approaches of AI based systems for civil aeronautics
  The work proposed consists in identifying lack of certification standards for new phenomena and proposing new approaches to help develop and certify AI applications, e.g., integrating the notion of algorithm failure, non deterministic and unpredictable behaviour, run time services to detect faulty behavior in sophisticated AI systems.

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- Mobility Management: Daniel Delahaye (ENAC)

  Title: AI for Air Traffic Management and Large Scale Urban Mobility.

  This project has two related parts: 1) investigating automation in air traffic management, 2) applying new AI algorithms to UAV large scale trajectory planning. We expect to develop new adaptive self- organization algorithms in order to adapt, in real time, the UAV demand to the actual capacity of the airspace. The main difficulty of this research is linked to the certificability of the proposed solutions in order to be implemented with real air vehicles.

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IP-C: Assistants for design, decision and optimized industry processes

- Reverse-engineering the brain: Thomas Serre (External, Brown University, US)
  Title: reverse-engineering the brain to build machines that can see and interpret the visual world as well as humans do.

  This project will develop ML algorithms that can process visual data in ways that are closer to what humans are capable of. That is, such systems will be robust and reliable though perhaps lose some of the performance of pure ML systems for certain tasks.

- Neuro-inspired Deep Learning: Rufin van Rullen (DR CNRS, CerCo)
  Title: Deep Learning with semantic, cognitive and biological constraints

  This project brings experts from several disciplines in a multi-pronged approach to cognitive/bio-inspired models. It will study multimodal interactions in human brains as a source for more robust, less data demanding ML. AI algorithms from distributed intelligence will also be developed.

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- Neuroergonomics PI: Frédéric Dehais (ISAE)
  Title : Neuro-adaptive Technology based Mixed-initiative to enhance Man-Machine Teams

  The chair intends to study flexible mixed-initiative planning and execution paradigm involving humans interacting with artificial agents. The implementation of such an interaction will presuppose to develop passive Brain Computer Interface (pBCI) also known as Neuro-adaptive technology to sense human performance. The project will especially focus on the design of Neuroadaptive technology dedicated to measure multiple users brains while interacting with each other and artificial agents.

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- Human Robot Interaction PI: R. Alami (DR CNRS, LAAS)
  Title: Human robot interactions for cobot-industry applications.
  This project will integrate AI with a robotics research program for cognitive and interactive robot partners to develop autonomous teammate robots working with humans, cognitive and interactive assistants for frail people, and highly adaptive service robots.
  Other essential aspects that will be investigated include: 1) a principled and long-term multi-disciplinary collaborative research with philosophers, development psychologists, ergonomists, and 2) project-based deployment of AI-enabled robotic systems with potential users and mainly therapists as well as manufacturing and service industry.

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- Motion PI: Nicolas Mansard (DR CNRS, LAAS)
  Title: Motion Generation for Complex Robots using Model-Based Optimization and Motion Learning

  The research proposed in this chair aims to generate complex motions for robots in real time by: 1) relying on massive off-line caching of pre-computed optimal motions that are 2) recovered and adapted online to new situations with real-time tractable model predictive control and where 3) all available sensor modalities are exploited for feedback control going beyond the mere state of the robot for more robust behaviors. The goal is to develop a unified yet tractable approach to motion generation for complex robots with arms and legs.

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- Knowledge Compilation PI: Hélène Fargier (DR CNRS, IRIT)

  Title: Techniques for reducing complexity of algorithms for solving problems with uncertainty and preferences

  This project will investigate methods for compiling computations needed to solve combinatorial decision problems with preferences and uncertainty (typically above NP) transforming them into a simpler approximation. As examples of such methods, one can exploit the preference structure, reducing the size of the problem by pruning away undesirable options, or by fusing options that are similar enough or by simplifying the description language options distinguishable in a more complex language are unified.

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- Diagnosis: Louise Travé-Massuyes (DR CNRS, LAAS)

  Title: Synergistic transformations in model based and data based diagnosis

  This project will synergistically analyze transformations from model based diagnosis to exhibit fault indicators and data transformations from data based diagnosis methods. The first objective is to highlight and understand the correspondences that may exist between them and how they could complement each other. The second objective is to be able to abstract up data configurations and map them to models suitable for diagnosis reasoning.

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- Design using intuition[1] and logic[2] PI: T. Schiex (DR INRA, MIAT)

  Title: Design using intuition[1] and logic[2]

  Associated researchers: Sophie Barbe (INSA), David Simoncini (IRIT)

  With the target of providing an enhanced toolkit for designing complex systems by combining logic and intuition, we will extend the theory, algorithms and implementation underlying our guaranteed graphical model solver (toulbar2) to address more complex reasoning problems for NP-hard problem solving from optimization, quantified reasoning or counting. To guide reasoning so that it both finds solutions faster and is able to take into account information extracted from data by Machine Learning, we will integrate ML technology inside our algorithms and models to also solve multi-criteria problems that account both for physical laws represented as logical rules or criteria as well as ML extracted information. The design of complex molecular systems such as proteins will be used as our main target throughout the project, to validate and enhance the visibility of our progresses.

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