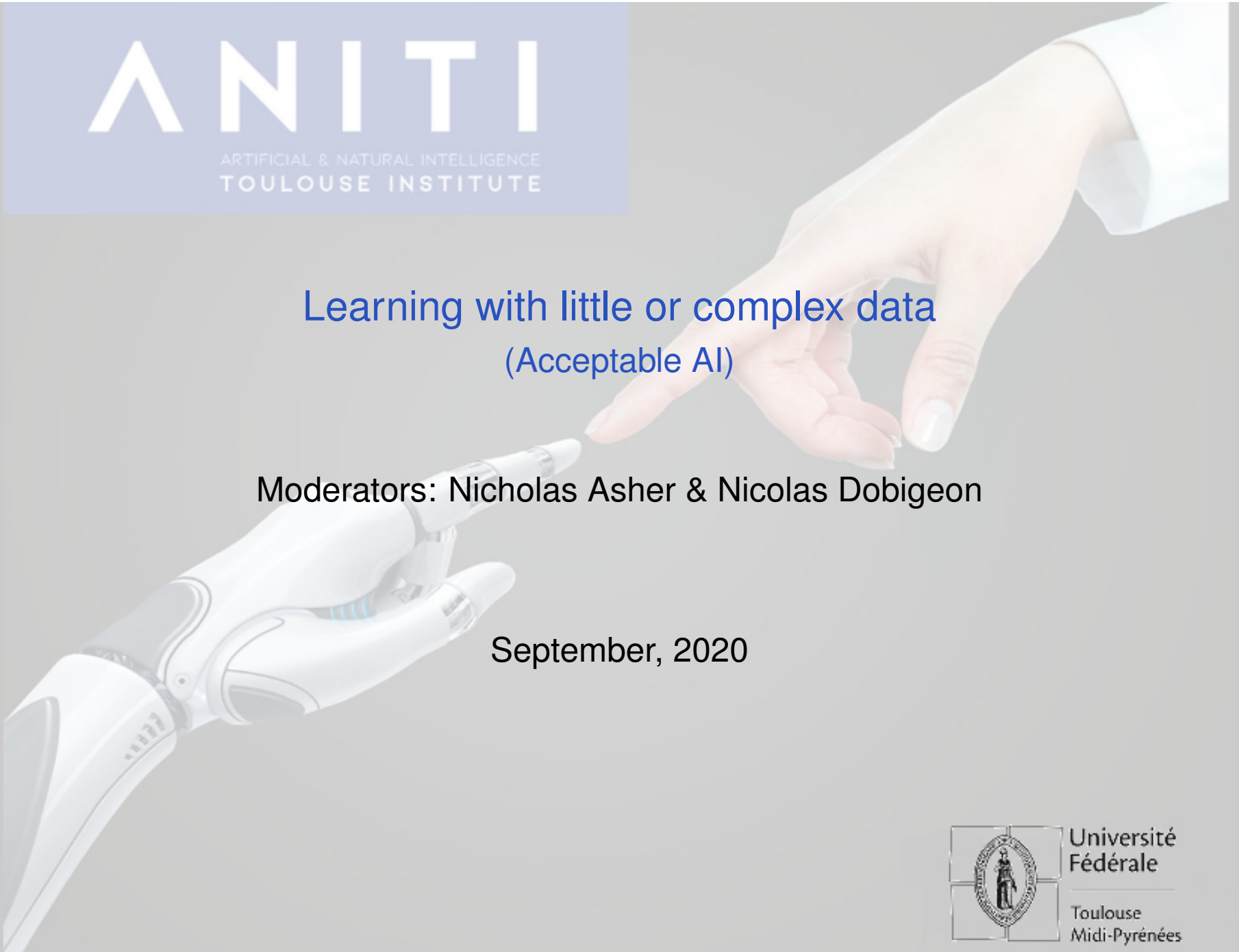

Learning with little or complex data

(Acceptable AI)

Moderators: Nicholas Asher & Nicolas Dobigeon

September, 2020

Université Fédérale
Toulouse
Midi-Pyrénées

Members

Chairs (+ *co-chairs)*

- Daniel Delahaye (TBC)
- Nicolas Dobigeon (*Th. Oberlin, C. Févotte, M. Fauvel, J. Inglada*)
- Fabrice Gamboa
- Jean-Bernard Lasserre (*V. Magron*)
- Thomas Serre
- Thomas Schiex (*S. Barbe*)
- Rufin VanRullen (*L. Reddy, T. van de Cruys, G. Faye*)

Other people involved

- Sylvain Cussat-Blanc (co-chair) [Castets-Renard]
- Philippe Muller (co-chair) [Amgoud]
- Nicholas Asher (ANITI Scientific Director)
- Édouard Pauwels (co-chair) [Bolte]
- Paul Monsarrat (MCU-PH UT3) [Castets-Renard]
- Silvia Valero (MCU UT3) [Dobigeon]

Members

ANITI resources

- 2 PhD [VanRullen], 2 PhD [Serre], 1 PhD [Serre & VanRullen], 1 PhD [Dobigeon], 1 PhD [Fauvel], 1 PhD [Inglada], 1 PhD [Oberlin & VanRullen]
- 2 Post-doc [Serre]
- 1 engineer CS [Fauvel]

Other resources

- CIFRE grant (Linagora) [Asher]: 1 PhD, 1 researcher
- ANR grant (Linagora/IRIT/LPL/Polytechnique) [Asher]: 1 PhD (distant learning for conversation projected)
- ANR Grant [VanRullen]: 1 PhD (adversarially robust vision models), 1 research engineer, 2 post-doc
- Brown Univ. [Serre]: 2 post-doc
- Ministry of Research [Schiex]: 1 PhD
- Occitanie Region Grant [Cussat-Blanc]: 1 PhD
- Industrial contract [Cussat-Blanc]: 1 PhD

Positioning within ANITI

- main home IP: Acceptable AI
  + hosting activities from Collaborative AI and Certifiable AI
- related to other themes
  Language and multimodality; AI and physical models;
  Data, bias and fairness; Optimisation
  Robustness and theoretical guarantees for optimization and generalization;
- deals with different aspects of modern machine learning
  in particular face to ***unfavorable learning contexts***

Main threads

- Low resource learning (from no, scarce and/or noisy data)
- Representation learning of/for complex models
- Multi-source multi-scale data

Scientific perimeter of the theme

Thread 1: Low resource learning

Law, accountability and social trust in AI [Castets-Renard]

- Cartesian Genetic Programming (CGP) for life and medical sciences
  → analyzing biological images and in symbolic regression use cases
- agent-based models to represent in-vitro cell culture
  → building in-silico models to optimize experimental protocol

[Asher]

- extracting semantic information from natural language text and conversations
- investigating how biases affect learning from written materials or testimony

DL with semantic, cognitive and biological constraints [VanRullen]
Reverse-engineering the brain [Serre]

- multimodal embeddings (e.g. text, audio, brain activity...) for computer vision
  → improving zero- or few-shot learning
- developing brain-inspired recurrent neural network architectures
  → improving representation learning for computer vision

Scientific perimeter of the theme

Thread 2: Representation learning of/for complex models

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AI for physical models with geometric tools [Gamboa]

- design and study of sensitivity analysis methods (expensive complex data)
  $\rightarrow$ model reduction

Polynomial optimization [Lasserre]

- investigating the interest empirical Christoffel function
  $\rightarrow$ data analysis and ML tasks

Design with intuition and logic [Schiex]

- learning additive decomposable & contextual energy function
  $\rightarrow$ protein design

Scientific perimeter of the theme

Thread 2: Representation learning of/for complex models (cont'd)

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[Asher]

- extracting semantic information from natural language text and conversations
- investigating how biases affect learning from written materials or testimony

DL with semantic, cognitive and biological constraints [VanRullen]
Reverse-engineering the brain [Serre]

- developing brain-inspired recurrent neural network architectures
  $\rightarrow$ improving representation learning for computer vision
- developing bio-inspired neural network architectures
  $\rightarrow$ restoring motor functions in patients with spinal cord injury

Fusion-based inference from heterogeneous data [Dobigeon]

- change detection between time series of remote sensing images
  $\rightarrow$ deep generative models to infer a common latent space
- deriving Monte Carlo methods for unspecified observation models
  $\rightarrow$ coupling likelihood-free methods and deep generative models

Fusion-based inference from heterogeneous data [Dobigeon]

- fusing time series of remote sensing images
  → handling images of different spatial, spectral and temporal resolutions
- change detection between time series of remote sensing images
  → deep generative models to infer a common latent space
- developing hybrid AI approaches based on analytical/biophysical models
  → reducing algo dependence on learning sets
  → including multi-source and multi-scale remote sensing data
  → providing explainable and interpretable models
- building ML frameworks specifically tailored to radar data
  → detect, identify and track objects in complex environments

On-going work

On-going collaborations between chairs

- N. Asher
  $\leftrightarrow$ L. Amgoud (empowering data-driven AI by argumentation)
- R. VanRullen (deep learning with semantic, cognitive and biological constraints)
  $\leftrightarrow$ Th. Serre (reverse-engineering the brain)
  $\leftrightarrow$ Th. Oberlin (co-chair) [Dobigeon]
- J. Bolte & E. Pauwels (large scale optimization for AI)
  $\leftrightarrow$ C. Févotte (co-chair) [Dobigeon]

On-going work

On-going collaborations with ANITI Industrial partners

- NXP [VanRullen & Oberlin] : 1 PhD
- Linagora [Asher]: 1 PhD
- Airbus [VanRullen] (see Theme 10: Language)
- CS & CNES [Fauvel]: 1 PhD
- CNES [Inglada]: 1 PhD
- Airbus AI lab [Cussat-Blanc]

On-going work

On-going collaborations with external projects

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- ANR SLANT [Muller]
- PIA LINTO [Asher]
- ANR SUMM-Re [Asher]
- ERC FACTORY CoG [Févotte]
- ANR MAESTRIA [Inglada]
- ANR-NSF OSCI-DEEP [VanRullen & Serre]
- ANR DeepChange [Valero]
- Industrial contract with BMS [Cussat-Blanc]
- Occitanie Region Grant [Cussat-Blanc]

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Ph.D. students (10)

- Benjamin Devillers & Romain Bielawski [VanRullen]
- Mohit Vaishnav & Aimen Zerroug [Serre]
- Mathieu Chalvidal [VanRullen & Serre]
- Colin Delcourt [VanRullen & Oberlin]
- Clément Benesse [Gamboa & Loubes] (TBC)
- Yoel Zerah [Inglada]
- Valentine Bellet [Fauvel]
- Florentin Coeurdoux [Dobigeon]

Post-doc (2)

- Victor Boutin & Amor Ben Tanfous [VanRullen]

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- Roustant, O., Gamboa, F., & Iooss, B. (2020). Parseval inequalities and lower bounds for variance-based sensitivity indices. Electronic Journal of Statistics, 14(1), 386-412.
- Fraiman, R., Gamboa, F., & Moreno, L. (2020). Sensitivity indices for output on a Riemannian manifold. International Journal for Uncertainty Quantification, 10(4).
- S. Badene, C. Thompson, J.P. Lorré & N. Asher, “Weak Supervision for Learning Discourse Structure”, EMNLP 2019, Hong Kong.
- S. Badene, C. Thompson, J.P. Lorré & N. Asher, “Data Programming for Learning Discourse Structure”, ACL 2019, Florence Italy.
- C. Thompson, N. Asher, P. Muller, & J. Auguste, “Analyse faiblement supervisée de conversation en actes de dialogue”, TALN 2019,Toulouse, France.
- S. Badene, C. Thompson, J.P. Lorré & N. Asher, “Apprentissage faiblement supervisé de la structure discursive” TALN 2019,Toulouse, France.
- Asher, Nicholas; Hunter, Julie; “Interpretive blindness and the impossibility of learning from testimony”, submitted to Coling 2020.

Highlights

Publications (cont'd)

- VanRullen, R., & Reddy, L. (2019). Reconstructing faces from fMRI patterns using deep generative neural networks. Communications biology, 2(1), 193.
- Mozafari, M., Reddy, L., & VanRullen, R. (2020). Reconstructing Natural Scenes from fMRI Patterns using BigBiGAN. Int. Joint Conf. Neural Networks (IJCNN 2020)
- Alamia, A., Luo, C., Ricci, M., Kim, J., Serre, T., & VanRullen, R. (2020). Differential involvement of EEG oscillatory components in sameness vs. spatial-relation visual reasoning tasks. In revision at eNeuro
- E. Pauwels, M. Putinar, J.B. Lasserre. Data analysis from empirical moments and the Christoffel function. Found. Comput. Math., 2020
- S. Marx, E. Pauwels, T. Weisser, D. Henrion, J.B. Lasserre. Tractable semi-algebraic approximation using Christoffel-Darboux kernel, Constructive Approximation. Accepted.

Highlights

Publications (cont'd)

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- Linsley, D., Ashok, A. K., Govindarajan, L. N., Liu, R., & Serre, T. (2020). Stable and expressive recurrent vision models. NeurIPS 2020
- Chalvidal. M., Ricci, M., VanRullen, R. & Serre, T. (2021). Neural optimal control for representation learning. Submitted to ICLR 2021.
- Choksi, B., Mozafari, M., Biggs O'May, C., Ador, B., Alamia, A. & VanRullen, R. (2021). Brain-inspired predictive coding dynamics improve the robustness of deep neural networks. Submitted to ICLR 2021.
- Gaillard, C., Hassen, S. B. H., Di Bello, F., Bihan-Poudec, Y., VanRullen, R., & Hamed, S. B. (2020). Prefrontal attentional saccades explore space rhythmically. Nature communications, 11(1), 1-13.
- Reddy, L., Cichy, R. & VanRullen, R. (2020). Representational content of oscillatory brain activity during object recognition. In revision at eNeuro
- Alamia, A., Luo, C., Ricci, M., Kim, J., Serre, T., & VanRullen, R. (2020). Differential involvement of EEG oscillatory components in sameness vs. spatial-relation visual reasoning tasks. In revision at eNeuro

Highlights

Publications (cont'd)

- A. Lagrange, M. Fauvel, S. May, J. M. Bioucas-Dias and N. Dobigeon, "Matrix cofactorization for joint representation learning and supervised classification - Application to hyperspectral image analysis," Neurocomputing, vol. 385, pp. 132-147, Apr. 2020.
- A. Lagrange, M. Fauvel, S. May and N. Dobigeon, "Matrix cofactorization for joint spatial-spectral unmixing of hyperspectral images," IEEE Trans. Geoscience and Remote Sensing, vol. 58, no. 7, pp. 4915-4927, July 2020.
- C. Guilloteau, Th. Oberlin, O. Berné, É. Habart and N. Dobigeon, "Simulated JWST datasets for multispectral and hyperspectral image fusion," The Astronomical Journal, vol. 160, no. 1, June 2020.
- V. Ferraris, N. Dobigeon and M. Chabert, "Robust fusion algorithms for unsupervised change detection between multi-band optical images - A comprehensive case study," Information Fusion, vol. 64, pp. 293-317, Dec. 2020.
- C. Guilloteau, Th. Oberlin, O. BernÃ© and N. Dobigeon, "Hyperspectral and multispectral image fusion under spectrally varying spatial blurs - Application to high dimensional infrared astronomical imaging," IEEE Trans. Computational Imaging, vol. 6, pp. 1362-1374, Sept. 2020.
- M. Vono, N. Dobigeon and P. Chainais, "Asymptotically exact data augmentation: models, properties and algorithms, Journal of Computational and Graphical Statistics, 2020, to appear.

Highlights

Scientific events

- joint Serre/VanRullen lab meeting (monthly) [Serre & VanRullen]
- mini-workshop on “Optimization and Statistics” (2019) [Dobigeon & Bolte]
- doctoral school on Data Sciences for Geosciences (2020) [Dobigeon]

Patents [Schiex]

- Vincent Tournier, Helene Texier, Marie-Laure Desrousseaux, Christopher Topham, Isabelle Andre, Sophie Barbe, Sophie Duquesne, Alain Marty. Esterases and uses thereof. US Patent 10,590,401, 2020
- Christopher Topham, Helene Texier, Vincent Tournier, Marie-Laure Desrousseaux, Sophie Duquesne, Isabelle Andre, Sophie Barbe, Alain Marty. Esterases and uses thereof. US Patent 10,584,320, 2020
- Florence Bordes, Coraline Rigouin, Alain Marty, Marc Gueroult, Isabelle Andre, Sophie Barbe, Benjamin Percheron, Christian Croux, Fayza Daboussi. Mutant yeast strain capable of producing medium chain fatty acids. US Patent App. 16/476,401, 2020

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Between chairs

- J.-B. Lasserre (Moments and Positive Polynomials for Machine Learning)
  $\leftrightarrow$ J. Renaut & S. Gerchinovitz (Game Theory and Artificial Intelligence)
- J.-B. Lasserre (Moments and Positive Polynomials for Machine Learning)
  $\leftrightarrow$ F. Gamboa (AI for physical models with geometric tools)

With industrial partners

- Th. Schiex (Design with intuition and logic)
  $\leftrightarrow$ DEEL (on optimizing DNN with semidefinite program)
  $\leftrightarrow$ CARBIOS, Enobraq (via Toulouse White Biotechnology)
- N. Dobigeon (Fusion-based inference from heterogeneous data)
  $\leftrightarrow$ AI4GEO (on remote sensing image analysis)
  $\leftrightarrow$ Schlumberger (TBD)
  $\leftrightarrow$ ATOS (TBD)
  $\leftrightarrow$ ADS (TBD)
- S. Cussat-Blanc (Agent-based modeling of cancer cell proliferation)
  $\leftrightarrow$ Transgene (CIFRE soon to be submitted to ANRT)

Roadmap

Agenda

TBD?