Antoine Dedieu

Senior Research Scientist at Google DeepMind

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Education

2016–2018 **Massachusetts Institute of Technology**.
Master of Science in *Operations Research*. Advised by Prof. Rahul Mazumder. Research areas: *Optimization, Machine Learning, Statistics*. Coursework includes: *Linear Optimization*, *Statistical Learning*, *Dynamic Programming* and *Bayesian Modeling*. GPA: 5.0/5.0.

2013–2016 **École Polytechnique**.
France's premiere university for science and engineering. Master in *Probability, Statistics and Finance*. Coursework includes: *CS* and *Economics*. Ranked in the top 5% of the class. GPA: 3.96/4.

2011–2013 **Lycée Sainte-Geneviève**, *Preparatory program*.
Intensive two-year preparation program. *Maths, CS and Physics* track. GPA: 3.98/4.

Publications

Conference Articles

21. DMC-VB: A Benchmark for Representation Learning for Control with Visual Distractors [PDF]
Neural Information Processing Systems (Neurips), 2024, to appear.
A. Dedieu, J. Ortiz, W. Lehrach, S. Guntupalli, C. Wendelken, A. Humayun, S. Swaminathan, G. Zhou et al.

20. Learning Cognitive Maps from Transformer Representations for Efficient Planning in Partially Observed Environments
International Conference on Machine Learning (ICML), 2024.
A. Dedieu, W. Lehrach, G. Zhou, D. George, M. Lázaro-Gredilla [PDF]

19. Schema-learning and rebinding as mechanisms of in-context learning and emergence [PDF]
Neurips spotlight, 2023. S. Swaminathan, **A. Dedieu**, R. V. Raju, M. Shanahan, M. Lázaro-Gredilla, D. George

18. Learning noisy-OR Bayesian Networks with Max-Product Belief Propagation [PDF]
ICML, 2023. **A. Dedieu**, G. Zhou, M. Lázaro-Gredilla, D. George

17. Graphical Models with Attention for Context-Specific Independence and an Application to Perceptual Grouping.
ArXiv, 2021. G. Zhou, W. Lehrach, **A. Dedieu**, M. Lázaro-Gredilla. [PDF]

16. Perturb-and-max-product: Sampling and learning in discrete energy-based models. [PDF]
Neurips, 2021. M. Lázaro-Gredilla, **A. Dedieu**, D. George

15. Sample-Efficient L0-L2 Constrained Structure Learning of Sparse Ising Models. [PDF]
Association for the Advancement of Artificial Intelligence (AAAI), 2021. **A. Dedieu**, M. Lázaro-Gredilla, D. George

14. Query Training: Learning a Worse Model to Infer Better Marginals in Undirected Graphical Models with Hidden Variables. [PDF]
AAAI, 2021. M. Lázaro-Gredilla, W. Lehrach, N. Gothoskar, G. Zhou, **A. Dedieu**, D. George.

13. Improved error rates for sparse (group) learning with Lipschitz loss functions. [PDF]
ArXiv, 2021. **A. Dedieu**.

12. An error bound for Lasso and Group Lasso in high dimensions. [PDF]
ArXiv, 2019. **A. Dedieu**.

11. Learning higher-order sequential structure with cloned HMMs. [PDF]
ArXiv, 2019. **A. Dedieu**, N. Gothoskar, S. Swingle, W. Lehrach, M. Lázaro-Gredilla, D. George.

10. Error bounds for sparse classifiers in high-dimensions. [PDF]
Artificial Intelligence and Statistics, 2019. **A. Dedieu**.

9. Hierarchical Modeling and Shrinkage for User Session Length Prediction in Media Streaming. [PDF]
Conference on Information and Knowledge Management, 2018. **A. Dedieu**, R. Mazumder, Z. Zhu, H. Vahabi.

Journal Articles

8. PGMax: Factor Graphs for Discrete Probabilistic Graphical Models and Loopy Belief Propagation in JAX. [PDF]
   Journal of Machine Learning Research (JMLR), accepted with minor revisions, 2023.
   G. Zhou, N. Kumar, **A. Dedieu**, M. Lázaro-Gredilla, S. Kushagra, D. George.

7. Solving L1-regularized SVMs and related linear programs: Revisiting the Effectiveness of Column and Constraint Generation. [PDF]
   JMLR, 2022. **A. Dedieu**, R. Mazumder, H. Wang.

6. Subset Selection with Shrinkage: Sparse Linear Modeling when the SNR is low. [PDF]
   Operations Research, 2022. R. Mazumder, P. Radchenko, **A. Dedieu**.

5. Learning Sparse Classifiers: Continuous and Mixed Integer Optimization Perspectives. [PDF]
   JMLR, 2021. **A. Dedieu**, H. Hazimeh, R. Mazumder.

4. Clone-structured graph representations enable flexible learning and vicarious evaluation of cognitive maps. [PDF]
   Nature Communications, 2021. D. George, R. Rikhye, N. Gothoskar, J. Guntupalli, **A. Dedieu**, M. Lázaro-Gredilla.

3. Learning attention-controllable border-ownership for objectness inference and binding. [PDF]
   ArXiv, 2020. **A. Dedieu**, R. Rikhye, M. Lázaro-Gredilla, D. George.

2. A detailed mathematical theory of thalamic and cortical microcircuits based on inference in a generative vision model. [PDF]
   ArXiv, 2021. D. George, M. Lázaro-Gredilla, W. Lehrach, **A. Dedieu**, G. Zhou.

Thesis

1. Sparse learning: statistical and optimization perspectives. [PDF]
   Massachusetts Institute of Technology, 2018. **A. Dedieu**.

Work Experience

2024– **Senior Research Scientist**, *Google DeepMind*, San Francisco Area.

2022–2024 **Research Scientist**, *Google DeepMind*, San Francisco Area.
- Building sample-efficient agents which leverage on generative models of the world
- Addressing challenging planning and object-centric vision problems, which current AI models struggle with.
- Building novel generative probabilistic models and solving the associated learning and inference problems.
- Building novel transformers architecture to address inherent limitations of vanilla transformers.

2021–2022 **Senior Research Scientist**, *Vicarious AI*, San Francisco Area.

2018–2021 **Researcher**, *Vicarious AI*, San Francisco Area.
- Created a pipeline for box detection with Recursive Cortical Networks (RCNs), used 1M+ times in production.
- Created novel computational algorithms to improve the internal cutting-edge RCN vision model performance. Findings led to 40% gains in speed and accuracy on robots.
- Built new biologically-inspired probabilistic graphical models for central machine learning problems.

2017–2018 **Graduate Student Researcher**, *Pandora - MIT*, Boston.
- Predicted user session length through a new hierarchical Bayesian modeling framework.

2016 **Equity Derivative Structurer**, *Société Générale*, Paris.

2013–2014 **Teacher Assistant and Examiner**, *Jiao Tong University*, Shanghai.

Google Scholar

As of Sept. 27, 2023. Number of citations: **536**. h-index: 9. i10-index: 9. [Profile]

Selected open source projects

DMC-VB: A Benchmark for Representation Learning for Control with Visual Distractors [GitHub]

PGMax: Loopy belief propagation for factor graphs on discrete variables in JAX [GitHub]

Max-product noisy-OR [GitHub]

Perturb-and-max-product: Sampling and learning in discrete energy-based models [GitHub]

Sample-Efficient L0-L2 Constrained Structure Learning of Sparse Ising Models [GitHub]

Solving large-scale L1-regularized SVM and cousins [GitHub]

Subset Selection with Shrinkage [GitHub]

Poster presentations

Dec. 2024	Neural Information Processing Systems.
July 2024	International Conference on Machine Learning.
Dec. 2023	Neural Information Processing Systems.
July 2023	International Conference on Machine Learning [Recorded talk] .
Dec. 2021	Neural Information Processing Systems.
Feb. 2021	Association for the Advancement of Artificial Intelligence [Recorded talk] .
April 2019	Artificial Intelligence and Statistics.

Patents

US patent US2021/0125030A1, issued April 29, 2021. [Link]
Method and system for query training. M. Lázaro-Gredilla, W. Lehrach, N. Gothoskar, G. Zhou, **A. Dedieu**, D. George.

External panel

Mar. 2024	AI unveiled: Navigating Opportunities, Risks, and Governance [Event] .
Sep. 2023	Unleashing the Future of Generative AI [Event] .

Technical skills and Languages

Computing	Python, R, C++, SQL, GitHub
Languages	**French**: mother tongue. **English**: fluent. **Spanish**: fluent. **Chinese**: two years

Research summary

My research interests address two different areas of machine learning. The first part of my work lies at the intersection of optimization and statistical learning [1, 2, 4, 5, 7, 8, 9, 12] (see *Publications* for articles references). In particular, I have studied several central problems in machine learning where the estimator is sparse [2, 5, 7, 8, 9] — i.e. it has a large number of non-zeros and enables increased interpretability that can deliver actionable insights for decision-makers — and I have proposed new estimators to properly induce sparsity [4, 5, 7, 8, 12].

By bringing together techniques from different areas of optimization, I have developed novel computational algorithms to solve these sparse problems when the number of observations and/or variables is large [1, 4, 7, 8, 9, 12]. More specifically, I have shown how a non-convex penalization method, well-known for its statistical guarantees but previously thought to be unusable, can be scaled up to large problems [4, 7, 8, 12]. In addition, I have studied the empirical performance of the proposed estimators for supervised regression [1, 7, 8], supervised classification [5, 9, 12] and unsupervised learning [4] settings. Finally, I have studied the high-dimensional theoretical guarantees of these estimators [2, 4, 5, 8] . My research has been applied to the gene selection problem [8] and to media-streaming prediction [1].

The second part of my research lies at the interface between probabilistic graphical models and cognitive sciences [3, 4, 6, 11, 13, 14]. Contrary to modern data-intensive deep learning methods, I am drawing inspiration from neuroscience to build probabilistic graphical models that generalize well from a limited number of training examples [4, 6, 10, 11] while exhibiting biases similar to human cognition [6, 9, 10, 12, 13].

In particular, I have exploited a neuroscience idea that assigns different contexts for different copies of the same observation [12] and proposed a new higher-order model for sequence learning [9], which I have extended to cognitive maps learning [11]. I have also developed a two-dimensional analog of this model that can learn neurologically plausible attention-controllable representations of object boundaries [13]. In parallel, I have proposed a novel flexible graphical model for object parts interaction [14] and I currently work on combining these different pieces. The development of these models has led me to develop novel, data-efficient, methods for training undirected graphical models without [4] or with hidden variables [3].

Finally, as part of my work as a researcher for Vicarious AI, I have built new computational algorithms to improve the performance of our Recursive Cortical Network (RCN) vision model, a critical piece of the AI layer that we integrate into our robots. My algorithmic findings have led to a 30% improvement in both accuracy and speed. In addition, I have built a pipeline for robust box detection with RCN, used $1\text{M}+$ times in production. By improving the performance and increasing the range of applications of our industrial robots, my work helps robots become more versatile and reliable, which will decrease the labor costs and add significant value to society in the next decades.

References

- Miguel Lazarro-Gredilla
  VP of Research, Vicarious AI. Collaborator.
- Dileep George
  Co-founder, Vicarious AI. Collaborator.
- Rahul Mazumder
  Associate Professor of Operations Research and Statistics, MIT Sloan School. Advisor.
- Peter Radchenko
  Associate Professor of Business Analytics, University of Sydney Business School. Collaborator.
- Jean Pauphilet
  Assistant Professor of Management Science and Operations, London Business School.