Aaron Ferber, PhD

data ≒ decisions ≒ deployment

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Education

- **Cornell University** — Ithaca, NY
  Postdoctoral Associate — *August 2023 – Present*
- **University of Southern California** — Los Angeles, CA
  Computer Science, Ph.D.; GPA: 4.0 — *December 2017 – August 2023*
- **Georgia Institute of Technology** — Atlanta, GA
  Computer Science Engineering, Ph.D. (transferred); GPA: 4.0; Presidential Fellow — *September 2017 – December 2017*
- **Cornell University** — Ithaca, NY
  Computer Science, Operations Research Double Major, BS; GPA: 3.4; Dean's list — *September 2013 – May 2017*

Experience

- **Cornell AI for Science Institute** — Ithaca, NY
  Postdoctoral Associate, Technical Coordinator — *September 2023 - Present*
  Topics: AI for Science, Large Language Models, Computer Vision, Discrete Optimization, Conservation, Chemistry, Material Science, Metabolomics, Neuroscience

  Mentors: Carla P. Gomes, Frank Schroeder

  Mentees: Laura Greenstreet, Christian Belardi, Delia Qu, Brendan Rapazzo, Yuanqi Du, Utku Umur Acikalin, Yingheng Wang, Yimeng Min, Victoria Mao, Marc Grimson, Shufeng Kong PhD

  - **Academic Project Lead**: Guide lab, implement collaborations, and manage projects for 9 PhD students, 1 postdoc, and 1 masters student. Give lectures and hold technical office hours for 17 non-CS Schmidt postdocs.
  - **Multimodal LLM for Science**: Fine-tune Multimodal LLM for classification and explanation in scientific domains. Categorize ∼10k water bodies with interactive deployment to Portuguese-speaking stakeholders in Brazil. Detects and explains Eelgrass wasting disease from ∼1k images with deployment from Southern California to Alaska.
  - **Computational Chemistry**:
    - Predicting mass spectra and metabolism from chemical structure
    - Inferring metabolome structure from mass spectra
    - Foundation models for metabolomics
    - Predicting density of states (DOS) for condensed matter
  - **Conservation**:
    - Invasive species prediction and management with citizen science data
    - Satellite detection of aquaculture ponds
    - Automatic visual detection of Eelgrass wasting disease
  - **General**:
    - AI method for microscopic imaging (Ptychography) via diffusion models
    - Decoding visual stimuli from mouse brain activity
    - Identifying neural assemblies with contrastive learning
    - Fast combinatorial optimization via unsupervised transformers
    - Accelerating vehicle routing solvers with attention models
- **USC Center for Artificial Intelligence in Society** — Los Angeles, CA
  PhD Student — *September 2017 - August 2023*
  Topics: Finance, Wildlife Trafficking, Virtual Reality, Recommendation Systems

  Mentors: Bistra Dilkina, Milind Tambe, Yisong Yue, Meredith Gore, Burcu Keskin, Bryan Wilder

- **Artificial Decision Intelligence**: Developed differentiable discrete optimization layers for training machine learning + optimization pipelines end-to-end.
- **Constrained Generative Models**: Impose constraints on generative models end-to-end during training, obtaining 100% constraint satisfaction, and up to 261% improvement in generative performance.
- **Deployments**: wildlife conservation, finance, virtual reality device design, and recommendation systems
  - 32% higher avg returns: Portfolio Optimization
  - 182x more recommendations per second: Meta Advertisement Recommendation
  - New nanoscale VR parts designed with AI + Photonics: Metaverse
  - 13% higher wildlife trafficking detection rates
- **Faster Optimization**: Improved solver speed by identifying core problem structure with deep learning
- **Social Impact**:
  - ML modeling of neighborhood crime impact on childhood stress
  - Supply chain interdiction for wildlife trafficking focusing on Pangolin trade
  - Embedded shortest path solver in deep neural network to predict wildlife trafficking routes
  - Deployed tools to interdict illegal fishing / transshipment activities

- **Meta AI FAIR** Menlo Park, CA
  Research Intern *May 2022 - Jan 2023*
  Topics: Virtual Reality, Recommendation Engines

  Mentors: Yuandong Tian, Benoit Steiner, Arman Zharmagambetov
  - **SurCO**: Developed SurCo for nonlinear combinatorial optimization using differentiable optimization, improving inverse photonic device design quality to theoretical optimality.
  - **Constrained Generative Models**: Imposed constraints on generative AI end-to-end during training, obtaining 100% constraint satisfaction for GAN and VAE models.

- **NEC Labs** Princeton, NJ
  Research Intern *May 2021 - August 2021*
  Mentor: Alexandru Niculescu-Mizil
  - **Video Object Tracking**: Designed training methodology for deep learning with differentiable reasoning modules

- **Cornell University** Ithaca, NY
  Data Scientist, Research Assistant *Jan 2014 - May 2017*
  Topics: Machine Learning, Optimization, Simulation

  Mentor: David Shmoys, Shane Henderson, David Williamson, Peter Frazier
  - **Bikeshare Optimization**: Optimized Citi Bike to increase daily capacity from $20,000$ to $> 60,000$ trips
  - **Demand Forecasting**: Designed demand prediction system to increase bike traffic prediction accuracy by 62%
  - **Math Modeling**: Constructed mathematical models to expand system by 130 stations and 2,000 bikes
  - **Code Improvement**: Reduced runtime of daily system-wide optimization from 24hr to 10min
  - **Deployed Web App**: Developed and improved web tools for Citi Bike staff with Google App Engine using Python, HTML, JavaScript, D3, and SVG

- **Microsoft Azure** Redmond, WA
  Machine Learning Intern *May - August, 2016 & 2017*
  Topics: Machine Learning, Cybersecurity

  Mentors: Malcolm Davis, Ram Shankar Siva Kumar
  - **Flagging Suspicious Accounts**: Designed and tested deep learning model to flag suspicious Azure service accounts, external logins, and privilege escalation
  - **Thread Detection**: Demonstrated a 46% increase in real threat detection for external Azure endpoints
  - **Red Team Bot**: Developed deep generative attack bot which automates penetration testing and external cybersecurity evaluation

Publications

[1] U. U. Acikalin, **A. Ferber**, and C. P. Gomes. "Learning to Explore and Exploit with GNNs for Unsupervised Combinatorial Optimization". In: *Submission* (2024).

[2] **A. Ferber**, A. Zharmagambetov, T. Huang, B. Dilkina, and Y. Tian. "GenCO: Generating Diverse Designs with Combinatorial Constraints". In: *Forty-first International Conference on Machine Learning*. 2024. URL: https://openreview.net/forum?id=DiyE6OOGBa.

[3] E. C. Griffin, **A. Ferber**, L. Lafferty, B. B. Keskin, B. Dilkina, and M. Gore. "Interdiction of wildlife trafficking supply chains: An analytical approach". In: *IISE Transactions* 56.3 (2024), pp. 355–373. URL: https://www.tandfonline.com/doi/full/10.1080/24725854.2023.2255643.

[4] T. Huang, **A. Ferber**, A. Zharmagambetov, Y. Tian, and B. Dilkina. "Contrastive Predict-and-Search for Mixed Integer Linear Programs". In: *Forty-first International Conference on Machine Learning*. 2024. URL: https://openreview.net/forum?id=zatLnLvbs8.

[5] W. Huang, T. Huang, **A. Ferber**, and B. Dilkina. "Distributional MIPLIB: a Multi-Domain Library for Advancing ML-Guided MILP Methods". In: *arXiv preprint arXiv:2406.06954* (2024).

[6] L. Kong, Y. Du, W. Mu, K. Neklyudov, V. De Bortol, H. Wang, D. Wu, **A. Ferber**, Y.-A. Ma, C. P. Gomes, and C. Zhang. "Diffusion Models as Constrained Samplers for Optimization with Unknown Constraints". In: *arXiv preprint arXiv:2402.18012* (2024).

[7] A. Parjadis, Q. Cappart, B. Dilkina, **A. Ferber**, and L.-M. Rousseau. "Learning Lagrangian Multipliers for the Travelling Salesman Problem". In: *Principles and Practice of Constraint Programming*. **Best Paper CP 2024**. Schloss Dagstuhl-Leibniz-Zentrum für Informatik. 2024.

[8] B. H. Rappazzo, **A. Ferber**, and C. Gomes. "Critic Loss for Image Classification". In: *ICMLA* (2024).

[9] B. H. Rappazzo, A. Kabra, F. S. Pacheco, L. Greenstreet, J. Fan, **A. Ferber**, M. E. Ummus, A. G. Brito, O. J. Graham, L. R. Aoki, C. D. Harvell, A. Flecker, and C. P. Gomes. "AISciVision: A Framework for Specializing Large Multimodal Models in Scientific Image Classification". In: *Submission* (2024).

[10] B. H. Rappazzo, Y. Wang, **A. Ferber**, and C. Gomes. "GEM-RAG: Graphical Eigen Memories For Retrieval Augmented Generation". In: *ICMLA* (2024).

[11] A. Zharmagambetov, B. Amos, **A. Ferber**, T. Huang, B. Dilkina, and Y. Tian. "Landscape surrogate: Learning decision losses for mathematical optimization under partial information". In: *Advances in Neural Information Processing Systems*. Vol. 36. 2024, pp. 27332–27350. URL: https://proceedings.neurips.cc/paper_files/paper/2023/hash/574f145eac328cc4aaf9358e27120eb5-Abstract-Conference.html.

[12] **A. Ferber**, E. Griffin, B. Dilkina, B. Keskin, and M. Gore. "Predicting Wildlife Trafficking Routes with Differentiable Shortest Paths". In: *International Conference on Integration of Constraint Programming, Artificial Intelligence, and Operations Research*. Springer Nature Switzerland Cham. 2023, pp. 460–476.

[13] **A. Ferber**, T. Huang, D. Zha, M. Schubert, B. Steiner, B. Dilkina, and Y. Tian. "Surco: Learning linear surrogates for combinatorial nonlinear optimization problems". In: *International Conference on Machine Learning*. **Best Paper ICML 2024 SODS Workshop**. PMLR. 2023, pp. 10034–10052.

[14] M. L. Gore, E. Griffin, B. Dilkina, **A. Ferber**, S. E. Griffis, B. B. Keskin, and J. Macdonald. "Advancing interdisciplinary science for disrupting wildlife trafficking networks". In: *Proceedings of the National Academy of Sciences* 120.10 (2023).

[15] M. L. Gore, R. Hilend, J. O. Prell, E. Griffin, J. R. Macdonald, B. B. Keskin, **A. Ferber**, and B. Dilkina. "A data directory to facilitate investigations on worldwide wildlife trafficking". In: *Big Earth Data* 7.2 (2023), pp. 338–348.

[16] T. Huang, **A. Ferber**, Y. Tian, B. Dilkina, and B. Steiner. "Local branching relaxation heuristics for integer linear programs". In: *International Conference on Integration of Constraint Programming, Artificial Intelligence, and Operations Research*. Springer Nature Switzerland Cham. 2023, pp. 96–113.

[17] T. Huang, **A. Ferber**, Y. Tian, B. Dilkina, and B. Steiner. "Searching large neighborhoods for integer linear programs with contrastive learning". In: *International Conference on Machine Learning*. PMLR. 2023, pp. 13869–13890.

[18] B. B. Keskin, E. C. Griffin, J. O. Prell, B. Dilkina, **A. Ferber**, J. MacDonald, R. Hilend, S. Griffis, and M. L. Gore. "Quantitative investigation of wildlife trafficking supply chains: A review". In: *Omega* 115 (2023), p. 102780.

[19] A. Paul, D. Freund, **A. Ferber**, D. B. Shmoys, and D. P. Williamson. "Erratum to "budgeted prize-collecting traveling salesman and minimum spanning tree problems"". In: *Mathematics of Operations Research* 48.4 (2023), pp. 2304–2307.

[20] **A. Ferber**, J. Song, B. Dilkina, and Y. Yue. "Learning pseudo-backdoors for mixed integer programs". In: *International Conference on Integration of Constraint Programming, Artificial Intelligence, and Operations Research*. Springer International Publishing Cham. 2022, pp. 91–102.

[21] M. Gore, B. Keskin, J. Macdonald, **A. Ferber**, E. Griffin, O. Prell, B. Dilkina, and R. Hilend. "Identifying datasets for global wildlife trafficking". In: (2022).

[22] U. Gupta, **A. Ferber**, B. Dilkina, and G. Ver Steeg. "Controllable Guarantees for Fair Outcomes via Contrastive Information Estimation". In: *Proceedings of the AAAI Conference on Artificial Intelligence* 35.9 (May 2021), pp. 7610–7619. DOI: 10.1609/aaai.v35i9.16931. URL: https://ojs.aaai.org/index.php/AAAI/article/view/16931.

[23] **A. Ferber**, B. Wilder, B. Dilkina, and M. Tambe. "Mipaal: Mixed integer program as a layer". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 34. 02. 2020, pp. 1504–1511.

[24] A. Paul, D. Freund, **A. Ferber**, D. B. Shmoys, and D. P. Williamson. "Budgeted prize-collecting traveling salesman and minimum spanning tree problems". In: *Mathematics of Operations Research* 45.2 (2020), pp. 576–590.

[25] A. Paul, D. Freund, **A. Ferber**, D. B. Shmoys, and D. P. Williamson. "Prize-collecting TSP with a budget constraint". In: *European Symposium on Algorithms*. Schloss-Dagstuhl-Leibniz Zentrum für Informatik. 2017.

Organization

- **Academic Project Lead**: Project lead for 11 CS researchers partnering with 17 Schmidt AI for Science postdocs.
- **LXAI Co-Organizer**: LatinX in AI NeurIPS 2023 Affinity Workshop Chair: ∼400 in-person + interface with 11 sponsors
- **Computational Sustainability Co-Organizer**: NeurIPS 2024 + CompSust DC (2018, 2019): (46, 63) in-person
- **Quant Project Manager**: Lead for QuantSC 2022 FTX market making competition team of 4
- **INFORMS Session Chair**: INFORMS 2020 Fairness in Optimization and Machine Learning: 100 virtual
- **NeurIPS Workshop Co-Organizer**: NeurIPS 2020 Learning Meets Combinatorial Algorithms (LMCA): 120 virtual

Teaching

- **Artificial Intelligence for Science ∼ Cornell**: Lecturer: Fall 2024
- **Artificial Intelligence for Social Good ∼ USC**: Lecturer, Teaching Assistant: Spring 2019, Fall 2019
- **Engineering Applications of Operations Research ∼ Cornell**: Teaching Assistant: Spring 2015, Spring 2016
- **Introduction to Analysis of Algorithms ∼ Cornell**: Teaching Assistant: Spring 2016
- **Introduction to Computing Using Python ∼ Cornell**: Tutor: Fall 2013, Spring 2014, Fall 2014
- **Object-Oriented Programming and Data Structures ∼ Cornell**: Tutor: Spring 2014, Fall 2014, Fall 2015

Service / Independent Projects

- **LXAI**: Volunteer and Co-Organizer for LXAI (LatinX in AI)
- **Hygeia Medical**: Technical advisor to Hygeia Medical, a reproductive and public health NGO in Madagascar (Link)
- **FinRL**: Mathematical optimization specialist & programmer for FinRL, a reinforcement learning for finance library
- **Omdena COVID Challenge**: Data Scientist for COVID measuring domestic violence & unemployment: (Link)
- **COVID Testing Site Placement**: Algorithm designer / data scientist for COVID testing site placement tool: (Link)

Skills

- **Areas of Expertise**: Deep Learning, Optimization, Computer Vision, Natural Language Processing, Operations Research
- **Programming Languages**: Python, C++, C, Java, Objective-C, Javascript (React), Matlab, Julia
- **Machine Learning & Data Analysis**: Tensorflow (Python + C), PyTorch, JAX, Scikit-Learn, Pandas, GeoPandas, Numpy (Python + C), Weights and Biases, Cloud Compute, Portfolio Optimization, Geocoding, PostGIS, BigQuery, FinRL, Alpaca, Qlib, LLaMA, BERT, Diffusion, Pytorch Geometric, DGL
- **Operations Research**: Linear / Nonlinear / Discrete / Semidefinite Programming, Financial Optimization
- **Languages**: English (Native), Spanish (Fluent), French (C2 Level)