

# Tim Cooijmans

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<https://cooijmanstim.github.io>

I am an ML&AI researcher interested in the **dynamics of learning systems**, including **meta-learning** and **self-improvement**. *Recurrent Batch Normalization* stabilized the inference of recurrent neural networks, dramatically improving training and generalization. I am currently working in the area of **multi-agent reinforcement learning**, where gradient descent fails in a way that I think can teach us something about learning in general. *Meta-Value Learning* renders differentiable games amenable to gradient descent by modeling the learning process.

## Employment history

- **DeepMind** (London, UK): research internship with James Martens (2017)
  - Designed variance reduction techniques for approximate forward-mode autodiff
  - Contributed code to the TensorFlow library for HPC&ML (see *Open-source contributions*)
- **Google Brain** (Mountain View, USA): research internship with Douglas Eck & Fred Bertsch (2016)
  - Conceived Waybackprop: BPTT in  $O(\log n)$  space ([blog post](#))
  - Conceived a generative model of Bach's chorales that later [powered Google's first AI Doodle](#)
  - Contributed code to the TensorFlow library for HPC&ML (see *Open-source contributions*)
- **Mila** (Montréal, Canada): research internship with Aaron Courville & Yoshua Bengio (2015-2016)
  - Research into deep neural networks, specifically dynamic capacity networks, recurrent attention for video and batch normalization in recurrent neural networks (see *Publications*)
  - Contributed code to the Theano library for HPC&ML (see *Open-source contributions*)
- **CERN** (Geneva, Switzerland): technical internship (2014-2015)
  - Developed tools around the Monte-Carlo radsim package FLUKA to predict radioactivity in Large Hadron Collider experiment caverns
  - Trained in radiation safety, first aid & the use of fire extinguishers & oxygen self-rescue masks
- **Ideaspool** (Maastricht, The Netherlands): software development (2011-2012, part-time)
  - Helped develop an on-line education platform
  - Developed a smartphone app for the academic hospital
- **Mapscape** (Eindhoven, The Netherlands): software development (2008-2009)
  - Developed tools to manage POI data sources
- **Compram** (Eindhoven, The Netherlands): software development (2006-2008)
  - Equipped time-tested ERP product from the 80s with a web interface
  - Assumed system administration and other all-round technical work
- **NoxLogic** (Gorinchem, The Netherlands): software development (2005)
  - Designed and implemented a billing system in PHP+MySQL
  - Rewrote a bottleneck PHP script of the main webshop product as an Apache module in C

## Education history

- PhD in Computer Science at Mila - Quebec AI Institute, Université de Montréal (2016-2023)
  - Research in generative models, recurrent neural nets, credit assignment, differentiable games
  - Reviewed for ICLR, ICML and NeurIPS
  - Internships at Brain and DeepMind (see *Employment history*)
- MSc in Operations Research at Maastricht University in The Netherlands (2013-2016)

- Cum laude, GPA 8.53 (out of 10)
- Two 12-month internships at CERN and Mila (see *Employment history*)
- BSc in Knowledge Engineering at Maastricht University in The Netherlands (2009-2013)
  - GPA 8.06 (out of 10)
  - Projects completed in the context of problem-based learning:
    - design and implementation of a realistic billiards simulator and an AI to play it
    - implementation of the board game *Ticket to Ride* and several AI strategies
    - design and implementation of a traffic simulator to study traffic light control
    - application of deep neural nets and reinforcement learning to Nao robot locomotion
  - [Dissertation in high-dimensional statistics](#) that won a Thesis Award

## Publications

- [Meta-Value Learning](#): solving **social dilemmas** with a novel general **meta-learning** framework  
Tim Cooijmans, Milad Aghajohari, Aaron Courville. Submitted to NeurIPS 2023, accepted at ICML 2023 Frontiers workshop.
- **Best-Response Shaping**: solving **social dilemmas** by differentiating through the best response  
Milad Aghajohari, Tim Cooijmans, Juan Augustin Duque, Shunichi Akatsuka, Aaron Courville. Submitted to NeurIPS 2023.
- [SUNMASK](#): Mask-Enhanced Control in Step-Unrolled **Denoising Autoencoders**  
Kyle Kastner, Tim Cooijmans, Yusong Wu, Aaron Courville. EvoMUSART 2023.
- [MIDI-DDSP](#): detailed **control** of **musical performance** via **hierarchical** modeling  
Yusong Wu, Ethan Manilow, Yi Deng, Rigel Swavely, Kyle Kastner, Tim Cooijmans, Aaron Courville, Anna Huang, Jesse Engel. ICLR 2022.
- [On the Variance of UORO](#): an analysis of **variance (reduction)** for approx **forward-mode autodiff**  
Tim Cooijmans, James Martens. 2018.
- [Harmonic Recomposition using Conditional Autoregressive Modeling](#)  
Kyle Kastner, Rithesh Kumar, Tim Cooijmans, Aaron Courville. ICML 2018 workshop.
- [Coconet: the ML model behind today's Bach Doodle](#)  
Anna Huang, Tim Cooijmans, Monica Dinulescu, Adam Roberts, Curtis Hawthorne. Blog post, 2018.
- [Memorization in Recurrent Neural Networks](#)  
Tegan Maharaj, David Krueger, Tim Cooijmans. ICML 2017 PADL workshop.
- [Counterpoint by Convolution](#): a **convolutional** model of Bach's chorales and **Gibbs sampling** strategy  
Anna Huang, Tim Cooijmans, Adam Roberts, Aaron Courville, Douglas Eck. ISMIR 2017.
- [Waybackprop](#): unlocking **long-term dependencies** with **BPTT** using only **logarithmic space**  
Tim Cooijmans. Blog post, 2017.
- [Recurrent Batch Normalization](#): the **first successful use** of **normalization** in **RNN** transitions  
Tim Cooijmans, Nicolas Ballas, César Laurent, Çağlar Gülçehre, Aaron Courville. ICLR 2017.
- [Dynamic Capacity Networks](#): models that **dynamically allocate capacity** to salient features  
Amjad Almahairi, Nicolas Ballas, Tim Cooijmans, Yin Zheng, Hugo Larochelle, Aaron Courville. ICML 2016.
- [Theano: a Python framework for fast computation of mathematical expressions](#)  
Theano development team. 2016.
- [SESAME](#): **radiation simulation** toolkit to modify geometry between irradiation and decay stages  
Tim Cooijmans, Moritz Guthoff. CERN EDMS, 2015.
- [Monte-Carlo simulations of the radiation environment for the CMS experiment](#)  
Sophie Mallovs, Igor Azhgirey, Igor Bayshev, Ida Bergstrom, Tim Cooijmans, Anne Dabrowski, Lisa Glöggler, Moritz Guthoff, Igor Kurochkin, Helmut Vincke, S Tajeda. Elba2015 13th Pisa Meeting on Advanced Detectors.
- [Technical proposal for the phase-II upgrade of the CMS detector](#)  
CMS collaboration. CERN EDMS, 2015.

## Open-source contributions

- [Meta-Value Learning](#) code repository
- [Recurrent Batch Normalization](#) code repository
- [MCTS chess engine in C++](#) (2014)
- TensorFlow: [add `stop\_gradients` argument to `tf.gradients`](#)
- TensorFlow: [fix race condition in `tf.nn.moments`](#)
- Theano: [computation graph walker that works across `Scan` boundaries](#)
- Theano: implement various batched products
  - [batched\\_tensordot without `Scan`](#)
  - [batched\\_dot](#)
  - [add CUDA streams path to `batched\_dot`](#)
  - [sharded batched GEMM](#)
  - [batched GEMM in `gpuarray` backend](#)
- Rclone: [enable Google Drive from service accounts](#)
- Ratpoison: [make keymaps switchable at runtime](#)