

MATHIEU TULI

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WORK AND RESEARCH EXPERIENCE

Lead AI Research Scientist (L4) · LG Electronics Canada · Toronto AI Lab (TAIL) 11/2022 - Present

- Directing the digital asset R&D team, developing innovative applied research for 3D generative avatars.
- Areas of research include Generative AI, 3D reconstruction, 3D animation, Neural Rendering, and Graphics.
- Collaborating cross-functionally to deliver algorithmic solutions and integrate research into LG products.
- Lead developer maintaining the team's code base, Gitlab CI/CD, ML DevOps, and GPU servers.

Digital Human Assistants in Unreal Engine

- Built an interactive 3D avatar using audio-driven animation powered by large language models in Unreal Engine.
- Implemented ML DevOps pipelines for training, testing, and deploying models, with human-in-the-loop evaluation.
- Built a custom TCP server-client in C++ to stream animation and audio data in sync, enabling near real-time outputs.
- Developed a dynamic wrinkle texture model that predicts wrinkle activations from vertex offsets using U-Nets.

Speech-Driven 3D Facial Animation

- Developed a novel dense face tracker based on UV-space optical flow to reconstruct 3D data from 2D videos for synthetic 3D data generation. This method beats previous SOTA by as much as 54% on existing benchmarks.
- Innovated a model for automatic speaker identification that enabled training with combined datasets – while retaining speaker stylization – resulting in a 15% improvement over previous SOTA.
- Exploring diffusion-based 3D facial animation in UV space, incorporating batched denoising for real-time inference.

Digital Asset Generation

- Developed 3D asset generation prototypes utilizing GANs, NERFs, and Score Distillation Sampling algorithms.
- Explored diffusion-based and GAN-based methods for digital avatar generation from text and images.

Machine Learning Research Scientist · University of Toronto (Dissertation) 09/2020 - 10/2022

Learning to Follow Instructions in Text-Based Games: Published at NeurIPS 2022

- Designed a neuro-symbolic framework for specifying natural language instructions by an internal structured representation that enabled language model-based reinforcement learning agents to plan and better align with goals.
- Further demonstrated how to generate these representations automatically using large language models.
- Improved over SOTA by 25%, demonstrating the benefit of understanding the temporal semantics of instructions.

Machine Learning Research Scientist · University of Toronto Multimedia Lab 05/2020 - 08/2020

RMSGD: Augmented SGD Optimization

- Developed new explainability metrics based on low-rank factorization that quantified the quality of learning in CNNs.
- Applied these metrics to develop a novel adaptive optimizer that extends SGD to automatically adjust a per-layer learning rate and achieve SOTA performance across a variety of computer vision models and datasets.

Towards Robust and Automatic Hyper Parameter Tuning

- Explored how the low-rank factorization of the convolutional weights of layers in a CNN can be used to define a surrogate response surface to model performance and can be solved to perform automatic hyper-parameter tuning.

Machine Learning Research Engineer · IMRSV Data Labs 05/2018 - 08/2019

Multi-View Object Tracking on the Edge

- Built a customer traffic analyzer using multi-camera object detection and tracking to optimize employee schedules.

NLP and Audio Research for Call Centers

- Developed speaker diarization language models to transcribe audio in multi-speaker environments (e.g. call centers).

EDUCATION

MSc in Computer Science · University of Toronto (Vector Institute Affiliate) With High Distinction - cGPA: 4.0/4.0

Dissertation: [Learning to Follow Instructions in Text-Based Games](#)

BASc in Computer Engineering · University of Toronto With Honours - cGPA: 3.61/4.0

PROJECTS AND LEADERSHIP

Automated Segmentation Matting · [GitHub](#) Present

Building a general purpose, user-friendly tool for automated segmentation matting for animation.

Game Development · [website](#) 02/2023 - Present

Community moderator, playtester, and helping design game mechanics for Dimensionals RPG by Mino Games.

Game Jams · [itch.io page](#) 09/2022 & 09/2023

Developed adventure/puzzle-style games for Epic's MegaJam.

Invited Conference Reviewer 2023, 2024

NeurIPS 2023, CVPR 2023, CVPR 2024, ICML 2024.

Aligning Language Models · [paper](#) 11/2021

Investigated the use of constrained beam search on language model-based agents for improved dialogue state tracking.

UHINET · [code](#) 09/2020 - 04/2021

Developed a model for predicting urban infrastructure's impact on climate using neural image translation on satellite data.

University of Toronto Hyperloop Team (UTHT) 09/2020 - 04/2021

Co-founder and Chief Software Engineer responsible for designing the core software architecture and teaching foundational concepts such as software design and how to program in a large team.

RESEARCH PUBLICATIONS · [Google Scholar](#)

- [1] *3D Face Tracking from 2D Video through Iterative Dense UV to Image Flow*. Conference on Computer Vision and Pattern Recognition (CVPR). Felix Taubner, Prashant Raina, **Mathieu Tuli**, et al. June 2024.
- [2] *A Study of 2D-Augmented 3D Speech-Driven Face Animation*. arXiv. **Mathieu Tuli**, Felix Taubner, et al. March 2024.
- [3] *PrismAvatar: Real-time animated 3D neural head avatars on edge devices*. arXiv. Prashant Raina, Felix Taubner, **Mathieu Tuli**, et al. March 2024.
- [4] *Learning to Follow Instructions in Text-based Games*. Conference on Neural Information Processing Systems (NeurIPS). **Mathieu Tuli**, Andrew C. Li, Pashootan Vaezipoor, Toryn Q. Klassen, Scott Sanner, Sheila A. McIlraith. December 2022.
- [5] *Exploiting Explainable Metrics for Augmented SGD*. Conference on Computer Vision and Pattern Recognition (CVPR). Mahdi Hosseini*, **Mathieu Tuli***, Konstantinos Plataniotis (2022). June 2022.
- [6] *Instruction Following in Text-Based Games*. 3rd Wordplay: When Language Meets Games Workshop, at NAACL. **Mathieu Tuli**, Andrew C. Li, Pashootan Vaezipoor, Toryn Q. Klassen, Scott Sanner, Sheila A. McIlraith. July 2022.
- [7] *Towards Robust and Automatic Hyper-Parameter Tuning*. Optimization for Machine Learning Workshop, at NeurIPS. **Mathieu Tuli**, Mahdi Hosseini, Konstantinos Plataniotis. December 2021.
- [8] *CONet: Channel Optimization for Convolutional Neural Networks*. NeurArch Workshop, at ICCV. Mahdi Hosseini, Jia Shu Zhang, Zhe Liu, Andre Fu, Jingxuan Su, **Mathieu Tuli**, Konstantinos Plataniotis. October 2021.

SKILLS

Programming Languages: Proficient in Python, C, C++, CUDA, and Go. Experience in SQL, Solidity, MatLab.

ML Frameworks: Proficient in PyTorch, PyTorch3D, TensorFlow, and Hugging Face. Experience in Keras and JAX.

Game Development: Proficient in Unreal Engine and Blender. Experience in Godot and Unity.

Other: Vim, Visual Studio, Docker, Git, Linux Terminal.

Spoken Languages: Native fluency in English and French.

AWARDS

Fellowships for Excellent Academic Standing (MSc) Fall 2020, 2021 · Winter 2021, 2022

Tuition Fellowships (MSc) Fall 2020, 2021 · Winter 2021, 2022

Dean's Honour List (BASc) Fall 2016, 2017, 2019 · Winter 2016, 2018