Michael Painter

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8 years of experience in machine learning, with projects in *reinforcement learning*, *computer vision*, *image generation*, *natural language processing*, and experience with parallel and distributed systems. Authored first *open-source*, *parallelised* implementation of *trial-based heuristic tree search* in C++. PhD student at the University of Oxford, with research focusing on *Sequential Decision Making*, *Reinforcement Learning* and *Monte Carlo Tree Search*.

Education

Oxford University, Oxford Robotics Institute **Oct 2018 – Current**
DPhil Engineering Science (Robotics/Machine Learning) - *Supervisors: Nick Hawes & Bruno Lacerda*

- Developed THTS++ library: first open-source parallelised implementation of Trial-Based Heuristic Tree Search in C++
- Published papers on state-of-the-art methods for Monte Carlo Tree Search at NeurIPS and ICAPS
- Co-authored the *Risk-Aware Probabilistic Planning fOr Robot Teams* library used internally by GOALS research group
- Teaching: masters project supervision and teaching assistant for robotics and software engineering courses

Stanford University **Sep 2016 – Jun 2018**
MS Computer Science (AI Specialisation)

- Main courses: AI, Machine Learning, Reinforcement Learning, Robotics, Computer Vision, NLP with Deep Learning, Randomised Algorithms, Optimisation and Algorithmic Paradigms, Data Mining, Principles of Computer Systems
- Teaching assistant for Probability, Reinforcement Learning and Principles of Computer Systems courses
- Research project using Variational Autoencoders for sequential image generation in the Ermon group (SAIL)

Cambridge University, Churchill College **Oct 2013 – Jun 2016**
BA (Hons) Computer Science

- Main courses: Algorithms, AI, Computer Vision, Concurrent/Distributed Systems, Networks, Probability, Linear Algebra, Information Theory, Databases, Security, Computer Systems Modelling, Unix, Computer Architecture and Design

Work Experience

Software Engineer Intern — Google (Mountain View, US) **Jul 2019 – Oct 2019**
Display Ads Predictions Team

- Developed *Generalised Linear Mixed Models* to predict *click-through rate* (CTR) and *conversion rate* (CVR)
- Fitted models using *variational inference* on *billions of data points* to improve training efficiency and remove bias from gradient updates; built the training algorithm such that it could *distributed* to exploit *data parallelism* and *model sparsity*
- Technologies used: Python, TensorFlow, Google Borg

Applied Scientist Intern — Microsoft (Bellevue, US) **Jul 2018 – Sep 2018**
Deep Neural Networks (DNN) Frameworks Team

- Trained *Generative Adversarial Networks* (GANs) to predict 3D human pose estimates from one RGB image
- Used image *data augmentation* techniques to improve model robustness to "in the wild" images
- Incorporated *depth estimation networks* to produce global 3D pose predictions, used by *Kinect for Azure*
- Technologies used: Python, PyTorch, Horovod, NumPy, SciPy, ONNX

Software Development Engineer Intern — Amazon (Sunnyvale, US) **Jun 2017 – Sep 2017**
Alexa Domains, Lab126

- Improved delivery of alarms by removing the necessity of sound files to be stored on devices
- Technologies used: Java, AWS services such as S3, DynamoDB, EC2

Software Engineering Intern — GeoSpock Ltd. (Cambridge, UK) **Jun 2015 – Sep 2015**

- Developed an *eventually consistent cache* for a *geo-spatial* database that led to a 3x increase in throughput
- Technologies used: Java, Google App Engine, Javascrip, Go, React, NodeJS

Selected Projects

THTS++ **Oct 2022 – Ongoing**

- First open-source parallelised implementation of *Trial-Based Heuristic Tree Search* in C++, a modular library which generalises *Monte Carlo Tree Search* methods such as *Upper Confidence bound applied to Trees* (UCT)
- Enables multi-threaded tree-search and includes implementation of *UCT* and algorithms described in projects below
- (Ongoing) Implementing support for use as a Python package using *PyBind11* and the *Python/C API*
- Technologies used: C++, GTest, PyBind11, Python/C API

Using Tree Search To Integrate Skills From Multiple Agents **Jun 2023 – Ongoing**

- Training RL agents with *policy gradient* methods to perform specific skills in *Rocket League*
- Using *AlphaZero*-style algorithms for *policy improvement* to integrate knowledge from multiple agents into a single one
- Technologies used: Python, PyTorch, RLGym, RLBot

Simplex Maps For Multi-Objective Monte Carlo Tree Search **Aug 2023 – Ongoing**

- Developed *simplex map* data structure to overcome scalability issues in prior multi-objective planners

- Integrating the data structure with the algorithms developed in *MCTS with Boltzmann Exploration*
- Improved scalability with respect to size and number of objectives on baseline environments
- Technologies used: C++, qhull, THTS++, MO-Gymnasium

MCTS with Boltzmann Exploration (*NeurIPS2023*) **Jan 2022 – May 2023**
- Developed two *Monte Carlo Tree Search* (MCTS) algorithms using *Boltzmann search policies*
- Proved *exponential convergence bounds* for the performance of both algorithms using *simple regret*
- Used the *Alias method* for faster sampling and improving the *asymptotic complexity* of the algorithms
- Technologies used: C++, KataGo

Convex Hull Monte-Carlo Tree Search (*ICAPS2020*) **Apr 2019 – Jan 2020**
- Adapted *Monte Carlo Tree Search* for multi-objective planning using *convex hull backups*
- Novel analysis of *sample based multi-objective planning* algorithms using *contextual regret*
- Improved scalability over prior works, demonstrated with *Generalised Deep Sea Treasure* environments
- Technologies used: Python, NumPy, SciPy

Sequential Variational Autoencoders — *SAIL/Ermon Group* **Jan 2018 – Jun 2018**
- Work on applying *Variational Autoencoders* (VAEs) sequentially to generate "sharper" images
- Developed novel objective functions and used multiple VAE architectures to improve image quality
- Technologies used: Python, TensorFlow, NumPy

Efficient Architecture Search — *Stanford CS231N Project* **Apr 2018 – Jun 2018**
- Implemented novel *network preserving transformations* for *Convolutional Neural Networks*
- Demonstrated networks can be trained using fewer floating-point operations by first training a smaller network and using the transformations to increase the number of model parameter
- Used the transformations with *neuroevolution* and parameter sharing in an *efficient architecture search*
- Technologies used: Python, PyTorch, NumPy

BiDAF for Reading Comprehension — *Stanford CS224N Project* **Jan 2017 – Mar 2017**
- Implemented the *Bidirectional Attention Flow* model for the *SQuAD reading comprehension task*
- Explored various modifications to the model, such as using *stacked BiLSTMs* and *Quasi-RNNs*
- Technologies used: Python, TensorFlow, NumPy

MapReduce Framework — *Stanford CS110 Final Project* **Dec 2016**
- Implemented map-reduce framework in C++ to run a distributed word count program

Teaching

University of Oxford — Teaching Assistant & Project Supervisor **Oct 2018 – Apr 2023**
- Teaching assistant for the *Autonomous Robotics* course in the *AIMS CDT* program (new course in 2020)
- Developed and ran a day's worth of course material, including lecture material, coding practicals on planning
- Lab demonstrations (office hours) for Engineering Science course on Software Engineering
- Supervised a Fourth Year Project titled: *Learning How Best to Recover from Failures*

Stanford University — Course Assistant **Jan 2017 – Jun 2018**
- Courses: *Probability*, *Reinforcement Learning* and *Computer Systems* (Concurrent & Distributed Systems)
- Duties included: holding office hours and labs, writing questions for assignments and exams, organizing lecture note creation (Reinforcement Learning), grading and code reviewing

Public Speaking

Research Updates, Oxford University **Oct 2018 – Ongoing**
- Delivered frequent research updates to the *Oxford Robotics Institute* and *GOALS* research group and regularly led reading group presentations and discussions on relevant research topics

Conference Presentations
- *NeurIPS2023*: Poster presentation on *MCTS with Boltzmann Exploration*
- *ICAPS2020*: 15-minute oral presentation on *Convex Hull Monte Carlo Tree Search* in the main conference and poster presentation at the doctoral consortium

Churchill Computer Science Talk Series, Cambridge University **Oct 2014, Mar 2016**
- *Don't like the sound of your voice? You can do something about that!* - 30-minute talk covering *auto-tune*
- *An Introduction to Computerised Tomographic Imaging* - 30-minute talk covering *tomographic imaging*,

Miscellaneous

Languages:	Python, C/C++, Java, Cython, Matlab, SQL, Javascript, HTML
Packages:	PyTorch, NumPy, SciPy, TensorFlow, PyBind11, GTest, Git, SKLearn, Microsoft Azure, AWS
Activities/Interests:	Keen hiker; Ex-competitive track and field athlete; Picking up skills, such as juggling, slacklining and cocktail making; Getting lost in a novel; Struggling to find shoes that fit