Taylor W. Killian

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Research Interests

Techniques for efficient and effective *decision making* in the presence of uncertainty: particularly toward *generalization* within *reinforcement learning*, motivated by challenges in *healthcare*.

Education

Ph.D., Computer Science **Expected June 2023**
University of Toronto, Toronto, ON, Canada
- Current GPA: 4.0

Advisor: Marzyeh Ghassemi
Thesis: Counterfactually Guided Reinforcement Learning and State Representation Learning in Partially Observed Clinical Environments

M.Eng, Computational Science and Engineering **May 2017**
Harvard University, Cambridge, MA
- GPA: 3.92

Advisor: Finale Doshi-Velez
Thesis: Robust and Efficient Transfer Learning by Accounting for and Modeling Parameter Variation

BS, Mathematics **April 2013**
Brigham Young University, Provo, Utah
- GPA: 3.83

Skills and Languages

- Python
- Tensorflow, Pytorch, Jax
- LaTeX, MATLAB
- Java, CUDA, C++
- Fluent in Swedish

Awards

- ICML, NeurIPS, ICLR: Top Reviewer Award, 2019 - 21
- AAAI, Student Abstract Best Presentation, 2017
- MIT LL Lincoln Scholar, 2015-2017
- NDSEG Fellowship Award, 2013 (Declined)
- SMART Fellowship Finalist, 2011
- BYU ORCA Grant Recipient, 2010

Publications

- **Killian, T.**, Ghassemi, M., Joshi, S., "Counterfactually Guided Off-policy Transfer in Clinical Settings", *in Submission*
- Fatemi, M., **Killian, T.**, Subramanian, J., Ghassemi, M., "Medical Dead-ends and Learning to Identify High-Risk States and Treatments", *to appear Advances in Neural Information Processing Systems.* December 2021
- **Killian, T.**, Zhang, H., Subramanian, J., Fatemi, M., Ghassemi, M., "An Empirical Study of Representation Learning for Reinforcement Learning in Healthcare" *Machine Learning for Health Workshop, NeurIPS,* December 2020
- D'Costa, A., Denkovski, S., Malyska, M., Moon, S.Y., Rufino, B., Yang, Z., **Killian, T.**, Ghassemi, M., "Multiple Sclerosis Severity Classification From Clinical Text", *The 3rd Clinical Natural Language Processing Workshop*, EMNLP 2020.
- **Killian, T.**, Ghassemi, M., Joshi, S., "Counterfactual Transfer via Inductive Bias in Clinical Settings", *Inductive Biases, Invariances and Generalization in RL Workshop* ICML 2020

- **Killian, T.**, Subramanian, J., Fatemi, M., Ghassemi, M., "Learning Representations for Prediction of Next Patient State", *1st Annual ACM Conference on Health, Inference and Learning*, April 2020. **Workshop Spotlight**
- Silva, A., **Killian, T.**, Jimenez, I., Son, S.-H., Gombolay, M. "Optimization Methods for Interpretable Differentiable Decision Trees Applied to Reinforcement Learning", *The 23rd International Conference on Artificial Intelligence and Statistics (AISTATS)*, August 2020.
- **Killian, T.**, Goodwin, J., Brown, O. & Son, S-H., "Kernelized Capsule Networks", *1st Workshop on Understanding and Improving Generalization in Deep Learning, ICML*, July 2019.
- Yao, J., **Killian, T.**, Konidaris, G. & Doshi-Velez, F., "Direct Policy Transfer via Hidden Parameter Markov Decision Processes", *The 2nd Lifelong Learning: A Reinforcement Learning Approach Workshop, ICML*, July 2018. **Selected for Oral presentation.**
- Jones, A., **Killian, T.**, Hurley, M., & Allen, R., "Artificial Intelligence and Machine Learning for Decision Support: Recommendations for Investment", **Technical Report**, MIT Lincoln Laboratory, June 2018. *Paper not available for public release*
- **Killian, T.**, Daulton, S., Konidaris, G. & Doshi-Velez, F. , "Robust and Efficient Transfer Learning in Hidden Parameter Markov Decision Processes", *Advances in Neural Information Processing Systems*. December 2017 **Selected for an Oral presentation**
- **Killian, T.**, Konidaris, G. & Doshi-Velez, F., "Robust and Efficient Transfer Learning in Hidden Parameter Markov Decision Processes." In *AAAI* (pp. 4949-4950). February 2017.
- **Killian, T.**, Klaus, R. & Truscott, T.T., "Rebound and jet formation of a fluid-filled sphere", *Physics of Fluids* **24**, 122106 (2012), DOI:10.1063/1.4771985.

Pre-prints

- **Killian, T.**, Ghassemi, M., Joshi, S., "Counterfactually Guided Policy Transfer in Clinical Settings", arXiv preprint arXiv:2006.11654. (2020)
- Rodriguez, I., **Killian, T.**, Son, H-S. & Gombolay, M., "Interpretable Reinforcement Learning via Differentiable Decision Trees", arXiv preprint arXiv:1903.09338. (2019).
- Goodwin, J., Brown, O., **Killian T.**, & Son, H-S., "Learning Robust Representations in Active Sensing", arXiv preprint arXiv:1811.10714. (2018).
- **Killian. T.**, Konidaris, G. & Doshi-Velez F., "Transfer Learning Across Patient Variations with Hidden Parameter Markov Decision Processes." arXiv preprint arXiv:1612.00475. (2016).

Experience

Graduate Research Assistant **August 2019 - present**
Department of Computer Science, University of Toronto & Vector Institute

- Developing robust representations of patient health, incorporating measures of uncertainty
- Investigating approaches to identify and overcome detrimental treatment decisions in high-risk clinical environments
- Pursuing research to enable robust knowledge transfer between healthcare institutions by combining causal inference and reinforcement learning
- Supervising junior students for research projects focused on Reinforcement Learning

Research Intern **June 2021 - present**
Apple Inc., Health AI

- Exploring utility of self-supervised learning for representation of user health via measured physiological signals
- Establishing state-of-the-art learning architectures for broader use within the Health AI team

- Serving as in-house technical expert on sequential decision making approaches

Student Researcher / Research Intern **May 2020 - December 2020**
Google Research, Brain team

- Investigated the utility of embedding measurements of uncertainty in a Reinforcement Learning agent's state representation
- Worked alongside recognized experts in Reinforcement Learning based in Montreal, QC
- Executed large scale computational experiments on distributed servers.

Teaching Assistant **August 2019 - May 2020**
Department of Computer Science, University of Toronto

- Part of teaching staff for:
  - CSC311 Introduction to Machine Learning
  - CSC2541 Machine Learning for Healthcare
- Developed and administered assignments and exams
- Worked with and instructed students, answering questions about course material
- Coordinated projects with clinical collaborators, organized and advised student groups

Associate Technical Staff **June 2017 - July 2019**
Air, Missile and Maritime Defense Technology, MIT Lincoln Laboratory

- Led effort to identify and develop areas for Laboratory investment in Artificial Intelligence
- Developed ML algorithms for efficient and accurate performance in low-data regimes
- Fused multiple information sources to reduce false-alarms in aviation passenger screening

Assistant Technical Staff **May 2013 - May 2017**
Air, Missile and Maritime Defense Technology, MIT Lincoln Laboratory

- Evaluated the impact of technological and operational improvements to U.S. missile defenses
- Developed and performed data-driven analyses to identify U.S. DoD capability improvements
- Produced briefing materials to present to key DoD decision makers.

Undergraduate Research Assistant **June 2010 - May 2013**
Department of Mechanical Engineering, Brigham Young University

- Published research on fluid activated passive dampening as primary author
- Furnished analytical and mathematical support to experimental techniques

Office of Naval Research NREIP Intern **Summer 2011**
Naval Surface Warfare Center, Dahlgren, Virginia

- Designed and carried out experiment to study optimal nose shape for submerging projectiles.
- Presented results to division commanding officers and staff.
- Obtained U.S. Department of Defense security clearance.

Language Instructor (Swedish) **December 2009 - June 2010**
Missionary Training Center, Church of Jesus Christ of Latter-day Saints

- Collaborated with other instructors to prepare lessons to satisfy curriculum and individual student needs.
- Counseled with students to overcome individual concerns and problems.
- Instructed and evaluated language fluency and understanding of concepts.

Volunteer

Program Committee/Reviewer

- **ICML**: 2019-Present
- **ACM CHIL**: 2020-Present
- **NeurIPS**: 2019-Present
- **ICLR**: 2020-Present
- **NeurIPS ML4H Workshop**: 2017-Present
- **NeurIPS Offline RL Workshop**: 2020
- **AAAI**: 2018

Mentor **May 2020 - Present**
Black in AI

Technical Recruiter, Campus Recruiting **December 2014 - July 2019**
Human Resources, MIT Lincoln Laboratory

- Organized campus information events to introduce Laboratory mission and aims
- Served as mentor and advocate for candidates seeking employment

Committee Member; PED Seminar Series **June 2015 - December 2017**
MIT Lincoln Laboratory

- PED = Processing, Exploitation and Dissemination
- Assisted in the organization and planning of seminar series focused on leveraging modern computation techniques to extract actionable insight
- Hosted leading researchers in Machine Learning and Artificial Intelligence

President, Student Advisory Committee **January 2011-December 2011**
Department of Mathematics, Brigham Young University

- Led effort to improve curriculum and increase collaboration between students and faculty.
- Participated in department review to introduce an applied and computational concentration.
- Planned and carried out activities to promote mathematics and educate BYU community.

Missionary, Sweden Stockholm Mission **March 2007 - March 2009**
The Church of Jesus Christ of Latter-day Saints

- Managed and oversaw the work and safety of 12 other missionaries in remote areas of Sweden.
- Trained 6 newly arrived missionaries in language, culture, and proselyting skills.
- Served full-time as a church representative identifying and meeting the needs of the community.

Presentations

- **Killian, T.**, Ghassemi, M., & Joshi, S., "Counterfactual Transer via Inductive Bias in Clinical Settings", *Inductive Biases, Invariances, and Generalization in RL Workshop*, ICML 2020.
- **Killian, T.**, Subramanian, J., Fatemi, M., & Ghassemi, M., "Learning Representations for Prediction of Next Patient State", *1st Conference on Health, Inference and Learning, Workshops*, 2020
- Yao, J., **Killian, T.**, Konidaris, G. & Doshi-Velez, F., "Direct Policy Transfer via Hidden Parameter Markov Decision Processes", *The 2nd Lifelong Learning: A Reinforcement Learning Approach Workshop*, FAIM 2018.
- **Killian. T.**, Daulton, S., Konidaris, G. & Doshi-Velez, F., "Robust and Efficient Transfer Learning using Hidden Parameter Markov Decision Processes." *NIPS 2017.* Long Beach, CA. December 6, 2017. **Oral presentation in the RL, Algorithms and Applications session**

- **Killian. T.**, Doshi-Velez, F. & Konidaris, G., "Robust and Efficient Transfer Learning using Hidden Parameter Markov Decision Processes." *31st AAAI Conference.* San Francisco, CA. February 7, 2017.
- **Killian. T.**, & Doshi-Velez, F., "Accounting for Patient Variation when Predicting Effective Treatment Policies." *MIT Lincoln Laboratory PED Seminar Series.* Lexington, MA. July 12, 2016.
- **Killian. T.**, Bryson, J., Bird, JC., Huey, J., Truscott, T.T., "Self Healing Soap Films." *65th Annual Meeting of the American Physical Society Division of Fluid Dynamics.* San Diego, CA. November 21-23, 2012.
- **Killian. T.**, Klaus, R. & Truscott, T.T., "Harnessing sloshing as a passive dampener." *64th Annual Meeting of the American Physical Society Division of Fluid Dynamics.* Baltimore, MD. November 20-22, 2011.
- **Killian. T.**, Klaus, R. & Truscott, T.T. , "Sphere rebound suppression from sloshing," *75th Annual Meeting of the American Physical Society.* Dallas, TX. March 2011.

Posters/Videos

- [Poster] **Killian, T.**, Zhang, H., Subramanian, J., Fatemi, M., & Ghassemi, M., "An Empirical Study of Representation Learning for Reinforcement Learning in Healthcare", *ML4H Workshop – Proceedings Track*, NeurIPS 2020.
- [Poster] **Killian, T.**, Goodwin, J., Brown, O. & Son, S-H., "Kernelized Capsule Networks", *1st Workshop on Understanding and Improving Generalization in Deep Learning*, ICML 2019.
- [Poster] Yao, J., **Killian, T.**, Konidaris, G. & Doshi-Velez, F., "Direct Policy Transfer via Hidden Parameter Markov Decision Processes", *The 2nd Lifelong Learning: A Reinforcement Learning Approach Workshop*, FAIM 2018.
- [Poster] **Killian. T.**, Daulton, S., Konidaris, G. & Doshi-Velez, F., "Robust and Efficient Transfer Learning using Hidden Parameter Markov Decision Processes." *NIPS 2017.* Long Beach, CA. December 6, 2017.
- [Poster] **Killian. T.**, Konidaris, G. & Doshi-Velez, F., "Robust and Effective Transfer Learning using Hidden Parameter Markov Decision Processes." *31st AAAI Conference.* San Francisco, CA. February 7, 2017
- [Poster] **Killian. T.**, Konidaris, G. & Doshi-Velez, F., "Transfer Learning Across Patient Variations with Hidden Parameter Markov Decision Processes." *NIPS Workshop on Machine Learning for Healthcare.* Barcelona, Spain. December 9, 2016.
- [Poster] **Killian. T.**, & Doshi-Velez, F., "Accounting for Patient Variation in the Development of Optimal Treatment Policies." *2nd Annual Harvard IACS Project Showcase.* Cambridge, MA. May 10, 2016.
- [Poster] **Killian. T.**, Hanus, D., & Doshi-Velez, F., "Inferring missing data & accounting for patient variation to predict effective HIV treaments." *5th Annual New England Machine Learning Day.* Cambridge, MA. May 6, 2016.
- [Video] **Killian. T.**, Huey, J., Bryson, J., & Truscott, T.T., "Self healing soap films," *65th Annual Meeting of the American Physical Society Division of Fluid Dynamics.* San Diego, CA. November 18-20, 2012. **http://arxiv.org/abs/1210.3797**
- [Poster] Jafek, A., Langley, K., **Killian. T.** & Truscott, T.T., "Bouncing in puddles," *64th Annual Meeting of the American Physical Society Division of Fluid Dynamics.* Baltimore, MD. November 20-22, 2011.
- [Poster] Klaus, R., **Killian. T.** & Truscott, T.T., "Sphere rebound suppression from sloshing," *63rd Annual Meeting of the American Physical Society Division of Fluid Dynamics.* Long Beach, CA. Nov 2010.

Projects

- **Weighted k-Centers, Optimal Facility Location** Using 2010 US Census data for the state of Massachusetts, we augmented Metric k-centers and Lloyd's algorithms to optimally place a constrained number of distribution centers. https://github.com/twkillian/am205-project
- **Stochastic Inference of Boston Bike-share Data** With data from the Hubway bike-sharing system from the 2012 season, we performed second order analyses to develop intuition about how to augment or improve the system. https://github.com/am207Hubway
- **Two-Stage Supermodular Minimization for Dictionary Selection** Developed preliminary approaches to solve dictionary selection under a supermodular assumption.
- **Automated Anomaly Detection in Surveillance Video** Attempted to provide real-time processing and identification of anomalous behavior in surveillance video, utilizing contemporary methods of parallel computing. https://github.com/cs205-surveillance
- **Quantitative Evaluation of Player Performance** Evaluated the transfer market of international soccer and the perception of player value. Developed a merit-based scoring metric, used to measure player impact in matches they participated in. This impact score was used to infer what value they would have on the transfer market. https://github.com/cs109-FIFA
- **Contextual Bandits in Highly Dynamic Non-stationary Environments** Developed a novel environment with non-stationary rewards and evaluated the performance of Thompson sampling and other basic algorithms for contextual bandits. https://github.com/twkillian/nonstationary_contextual_bandits
- **Interpretable Sequence Modeling of Exercise** Analyzed state of the art sequential models to predict workout performance and type using the Endomondo dataset.