# Taylor W. Killian

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## Research Interests

Computational and mathematical strategies for efficient and effective *decision making* in the presence of uncertainty: particularly toward *generalization* within *causal inference*, *reinforcement learning* and *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

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## Skills and Languages

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

## Awards

- ICML, NeurIPS: Top Reviewer Award, 2019, 2020
- CHIL, ML4H Workshop: Top Reviewer Reward, 2020
- ICLR: Top Reviewer Award, 2020, 2021
- 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

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## 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 Treatments", *in Submission*
- **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*, 2020. **Workshop Spotlight**
- Silva, A., Gombolay, M., **Killian, T.**, Jimenez, I., Son, S.-H., "Optimization Methods for Interpretable Differentiable Decision Trees Applied to Reinforcement Learning", *The 23rd International Conference on Artificial Intelligence and Statistics (AISTATS)*, 2020.
- **Killian, T.**, Goodwin, J., Brown, O. & Son, S-H., "Kernelized Capsule Networks", *1st Workshop on Understanding and Improving Generalization in Deep Learning*, ICML 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*, FAIM 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 (pp. 6245-6250). (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). (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).

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## Experience

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

- Participating in clinical collaborations with St. Michael's Hospital
- 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

**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.

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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.

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## 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.

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## 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.

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## 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.