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RESEARCH INTERESTS     **Machine learning.** Specifically, reinforcement learning, representation learning, optimization, and real-world applications.

FULL-TIME RESEARCH POSITIONS	<p><b>Research Scientist</b>     2021 – Present DeepMind</p> <p><b>Adjunct Professor</b>     2021 – Present <i>Canada CIFAR AI Chair</i> Alberta Machine Intelligence Institute (Amii) Fellow Department of Computing Science, University of Alberta</p> <p><b>Research Scientist</b>     2019 – 2021 Google Research, Brain Team</p>
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EDUCATION	<p>Doctor of Philosophy in Computing Science     2013 – 2019 <i>University of Alberta, Canada</i> Advisors: Michael Bowling and Marc G. Bellemare</p> <p>Master of Science in Computing Science     2011 – 2013 <i>Universidade Federal de Minas Gerais, Brazil</i> Advisors: Luiz Chaimowicz and Gisele L. Pappa</p> <p>Bachelor of Science in Computer Science with First Class Honors     2006-2010 <i>Universidade Federal de Minas Gerais, Brazil</i></p>
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PUBLICATIONS     **Journal Articles**

[1] [Alphabetical order] M. G. Bellemare, S. Candido, P. S. Castro, J. Gong, M. C. Machado, S. Moitra, S. Ponda, Z. Wang. Autonomous Navigation of Stratospheric Balloons using Reinforcement Learning. *Nature* 588:77–82, 2020.

[2] M. C. Machado, M. G. Bellemare, E. Talvitie, M. J. Hausknecht, M. Bowling. Revisiting the Arcade Learning Environment: Evaluation Protocols and Open Problems for General Agents. *Journal of Artificial Intelligence Research (JAIR)* 61:523–562, 2018.

[3] H. van Seijen, A. R. Mahmood, P. M. Pilarksi, M. C. Machado, R. S. Sutton. True Online Temporal-Difference Learning. *Journal of Machine Learning Research (JMLR)* 17(145):1–40, 2016.

[4] R. L. F. Cunha, M. C. Machado, L. Chaimowicz. RTSmate: Towards an Advice System for RTS Games. *ACM Computers in Entertainment (ACM CIE)*, 11(4):1–20, 2014.

### Refereed Conference Articles

[5] [Double 1st author] W. Chung, V. Thomas, M. C. Machado, N. Le Roux. Beyond Variance Reduction: Understanding the True Impact of Baselines on Policy Optimization. *International Conference on Machine Learning (ICML)*, 2021. [21.5% accept. rate]

[6] R. Agarwal, M. C. Machado, P. S. Castro, M. G. Bellemare. Contrastive Behavioral Similarity Embeddings for Generalization in Reinforcement Learning. *International Conference on Learning Representations (ICLR)*, Spotlight, 2021. [28.7% overall accept. rate, 5.6% spotlight accept. rate]

[7] D. Ghosh, M. C. Machado, N. Le Roux. An Operator View of Policy Gradient Methods. *Neural Information Processing Systems (NeurIPS)*, 2020. [20.1% accept. rate]

[8] M. C. Machado, M. G. Bellemare, and M. Bowling. Count-Based Exploration with the Successor Representation. *AAAI Conference on Artificial Intelligence (AAAI)*, 2020. [20.6% accept. rate]

[9] Y. Jinnai, J. W. Park, M. C. Machado, and G. Konidaris. Exploration in Reinforcement Learning with Deep Covering Options. *International Conference on Learning Representations (ICLR)*, 2020. [26.5% accept. rate]

[10] A. A. Taiga, W. Fedus, M. C. Machado, A. Courville, M. G. Bellemare. On Bonus Based Exploration Methods In The Arcade Learning Environment. *International Conference on Learning Representations (ICLR)*, 2020. [26.5% accept. rate]

[11] M. C. Machado, C. Rosenbaum, X. Guo, M. Liu, G. Tesauero, and M. Campbell. Eigenoption Discovery through the Deep Successor Representation. *International Conference on Learning Representations (ICLR)*, 2018. [36.0% accept. rate]

[12] C. Sherstan, M. C. Machado, P. Pilarski. Accelerating Learning in Constructive Predictive Frameworks with the Successor Representation. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2018. [46.7% accept. rate]

[13] M. C. Machado, M. G. Bellemare, M. Bowling. A Laplacian Framework for Option Discovery in Reinforcement Learning. *International Conference on Machine Learning (ICML)*, 2017. [25.4% accept. rate]

[14] Y. Liang, M. C. Machado, E. Talvitie, M. Bowling. State of the Art Control of Atari Games Using Shallow Reinforcement Learning. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2016. [24.9% accept. rate]

[15] C. Sherstan, A. White, M. C. Machado, P. Pilarski. Introspective Agents: Confidence Measures for General Value Functions. *Conference on Artificial General Intelligence (AGI)*, 2016. [38.8% accept. rate]

- [16] M. C. Machado, G. L. Pappa, L. Chaimowicz. A Binary Classification Approach for Automatic Preference Modeling of Virtual Agents in Civilization IV. *IEEE Conference on Computational Intelligence and Games (CIG)*, 2012. [51% accept. rate]
- [17] M. C. Machado, G. L. Pappa, L. Chaimowicz. Characterizing and Modeling Agents in Digital Games. *Brazilian Symposium on Computer Games and Digital Entertainment (SBGames)*, 2012. [54% accept. rate]
- [18] M. C. Machado, E. P. C. Fantini, L. Chaimowicz. Player Modeling: Towards a Common Taxonomy. *International Conference on Computer Games (CGames)*, 2011. [75% accept. rate]
- [19] M. C. Machado, B. S. L. Rocha, L. Chaimowicz. Agents Behavior and Preferences Characterization in Civilization IV. *Brazilian Symposium on Computer Games and Digital Entertainment (SBGames)*, 2011. [49% accept. rate]
- [20] M. C. Machado, L. Chaimowicz. Combining Metaheuristics and CSP Algorithms to solve Sudoku. *Brazilian Symposium on Computer Games and Digital Entertainment (SBGames)*, 2011. [49% accept. rate]

## Preprints

### Selected Magazine Articles, Extended Abstracts, and Workshop Papers

[Earlier versions of conference papers that were also presented at workshops are omitted]

- [21] J. Farebrother, M. C. Machado, M. Bowling. Generalization and Regularization in DQN. *NeurIPS Deep Reinforcement Learning Workshop & 4th Multidisciplinary Conference on Reinforcement Learning and Decision Making*, 2018.
- [22] M. C. Machado, M. G. Bellemare, E. Talvitie, M. J. Hausknecht, M. Bowling. Revisiting the Arcade Learning Environment: Evaluation Protocols and Open Problems for General Agents (Extended Abstract). *International Joint Conference on Artificial Intelligence (IJCAI)*, 2018. [Invited paper]
- [23] M. Liu, M. C. Machado, G. Tesauro, M. Campbell. The Eigenoption-Critic Framework. *NeurIPS Workshop on Hierarchical Reinforcement Learning*, 2016.
- [24] M. C. Machado, M. Bowling. Learning Purposeful Behaviour in the Absence of Rewards. *ICML Workshop on Abstraction in Reinforcement Learning*, 2016.
- [25] S. V. Albrecht, J. Christopher L., D. L. Buckeridge, A. Botea, C. Caragea, C. H. Chi, T. Damoulas, B. N. Dilkina, E. Eaton, P. Fazli, S. Ganzfried, M. Lindauer, M. C. Machado, Y. Malitsky, G. Marcus, S. Meijer, F. Rossi, A. Shaban-Nejad, S. Thiébaux, M. M. Veloso, T. Walsh, C. Wang, J. Zhang, Y. Zheng. Reports from the 2015 AAAI Workshop Program. *AI Magazine* 36(2): 90-101, 2015.
- [26] M. C. Machado, S. Srinivasan, M. Bowling. Domain-Independent Optimistic Initialization for Reinforcement Learning. *AAAI Workshop on Learning for General Competency in Video Games*, 2015.

### Patents

[27] S. Candido, J. Gong, M. G. Bellemare, M. C. Machado. Systems and Methods for Navigating Aerial Vehicles Using Deep Reinforcement Learning. US Patent App. 16/667,424, 2021.

### Theses

[28] M. C. Machado. Efficient Exploration in Reinforcement Learning through Time-Based Representations. Ph.D. thesis, University of Alberta, 2019.

[29] M. C. Machado. A Methodology for Player Modeling based on Machine Learning. M.Sc. thesis, Universidade Federal de Minas Gerais, 2013.

### AWARDS AND HONORS

#### Organizations

*Canada CIFAR AI Chair* 2021  
CIFAR Canada

*Amii Fellow* 2021  
Alberta Machine Intelligence Institute (Amii)

#### Paper Distinctions

*Best Paper: ICML Workshop on Exploration in Reinforcement Learning* 2019  
Benchmarking Bonus-Based Exploration Methods on the Arcade Learning Environment [Preliminary version of the work by Taiga et al. (2020)]

*Best Paper: ICML Workshop on Exploration in Reinforcement Learning* 2018  
Count-Based Exploration with the Successor Representation [Preliminary version of the work by Machado et al. (2020)]

*Best Paper Nominee: International Conference on Autonomous Agents and Multiagent Systems (AAMAS)* 2016  
State of the Art Control of Atari Games Using Shallow Reinforcement Learning

*IEEE CIS Outstanding Student Paper Travel Grant* 2012  
A Binary Classification Approach for Automatic Preference Modeling of Virtual Agents in Civilization IV

#### Reviewing

*Top 10% Highest-Scoring Reviewer* 2020  
Conference on Neural Information Processing Systems (NeurIPS)

*Top 33% Highest-Scoring Reviewer* 2020  
International Conference on Machine Learning (ICML)

*Top 10% Highest-Scoring Reviewer* 2019  
Conference on Neural Information Processing Systems (NeurIPS)

*Top 10% Highest-Scoring Reviewer* 2018  
Conference on Neural Information Processing Systems (NeurIPS)

	<i>Top 10 Reviewer Award</i>	2018
	International Conference on Machine Learning (ICML)	
	<i>Outstanding PC Member</i>	2016
	International Joint Conference on Artificial Intelligence (IJCAI)	
	<b>University</b>	
	<i>Nomination for Ph.D. Outstanding Thesis Award</i>	2019
	University of Alberta	
	<i>M.Sc. Early Achievement Award</i>	2012
	Universidade Federal de Minas Gerais (UFMG)	
	<i>B.Sc. First Class Honors</i>	2010
	Universidade Federal de Minas Gerais (UFMG)	
	<b>Scholarships</b>	
	<i>Provincial Alberta Innovates Technology Futures Scholarship</i>	2013 – 2018
	126,000 CAD over four years in Ph.D..	
	<i>Brazilian Research Scholarship (CNPq)</i>	2007 – 2008
	5,400 BRL over eighteen months in B.Sc..	
RESEARCH GRANTS	<b>Canada CIFAR AI Recruitment Chair</b>	2021-2025
	\$300,000 over five years. Sole PI: "Discovering Temporal and Spatial Abstractions in Reinforcement Learning".	
SUPERVISION	<b>Current Students (University of Alberta)</b>	
	Ruo Yu (David) Tao (w/ Adam White), M.Sc.	2021-present
	<b>Interns (Google Brain)</b>	
	Taylor W. Killian, Ph.D., University of Toronto	2020
	Valentin Thomas (w/ Nicolas Le Roux), Ph.D., Université de Montréal	2019
	<b>Interns (University of Alberta)</b>	
	Jesse Farebrother, B.Sc., University of Alberta	2018 – 2019
	Nicolas Carion, M.Sc., École Normale Supérieure de Lyon	2015
	<b>Ph.D. Supervisory Committee</b>	
	Abhishek Naik, University of Alberta	2021 – Present
	<i>(w/ R. Sutton, supervisor, and D. Schuurmans)</i>	
RESEARCH INTERNSHIPS	<b>DeepMind</b>	2018
	Deep learning group w/ Vlad Mnih.	
	<b>IBM Research – T.J. Watson Research Center</b>	2017
	AI Foundations group w/ Gerald Tesauro and Murray Campbell.	
	<b>Microsoft Research – New York Lab</b>	2016
	ML group w/ Alekh Agarwal, Fernando Diaz, Miro Dudik, & Robert Schapire.	
	<b>Vetta Labs LTDA</b>	2009 – 2010

TEACHING	<b>CMPUT 366: Intelligent Systems</b>	2016
ASSISTANT	<b>CMPUT 403: Practical Algorithmics</b>	2016
EXPERIENCE	<b>DCC 865: Design and Analysis of Algorithms</b>	2012
SOFTWARE	<b>Avenue Code</b>	2013
ENGINEERING	<b>Synergia: Engenharia de Software e Sistemas</b>	2011 – 2013
EXPERIENCE	<b>Ilusis Interactive Graphics</b>	2010 – 2011
SELECTED	<i>Autonomous Navigation of Stratospheric Balloons using Reinforcement Learning</i>	
TALKS	University of Alberta – Edmonton, Canada	Jan. 2021
	<i>An Operator View of Policy Gradient Methods</i>	
	University of Alberta – Edmonton, Canada	Nov. 2020
	DeepMind – London, UK	Oct. 2020
	<i>Temporal Abstraction in Reinf. Learning with the Successor Representation</i>	
	Stanford University – Stanford, USA	Feb. 2020
	<i>Purposeful Exploration in Reinforcement Learning</i>	
	Facebook AI Research – Montréal, Canada	Oct. 2018
	Google Brain – Montréal, Canada	Oct. 2018
	Microsoft Research – Montréal, Canada	Oct. 2018
	<i>Count-Based Exploration with the Successor Representation</i>	
	RLDM – Montréal, Canada	Jul. 2019
	ICML WS on Exploration in RL, Best paper – Stockholm, Sweden	Jul. 2018
	<i>Eigenoption Discovery through Diffusion Models of Information Flow</i>	
	McGill University – Montréal, Canada	Nov. 2017
	Microsoft Research – Montréal, Canada	Nov. 2017
	<i>Revisiting the Arcade Learning Environment: Evaluation Protocols and Open Problems for General Agents</i>	
	IJCAI, Journal track – Stockholm, Sweden	Jul. 2018
	IJCAI WS on Computer Games (Invited) – Stockholm, Sweden	Jul. 2018
	University of Alberta – Edmonton, Canada	Oct. 2017
	<i>A Laplacian Framework for Option Discovery in Reinforcement Learning</i>	
	ICML – Sydney, Australia	Aug. 2017
	ICML WS on Abstractions in RL – Sydney, Australia	Aug. 2017
	RLDM – Ann Arbor, USA	Jun. 2017
	University of Alberta – Edmonton, Canada	May 2017
	<i>Exploration in Reinforcement Learning: The Quest for Purposeful Behavior</i>	
	Univ. Federal de Minas Gerais (UFMG) – Belo Horizonte, Brazil	Dec. 2016
	<i>The Arcade Learning Environment: What comes next?</i>	
	IJCAI WS on General Intelligence and Game-Playing Agents (Invited) – New York, USA	Jul. 2016

SERVICE AND  
OUTREACH

**Journal Reviewer**

ACM Transactions on Autonomous and Adaptive Systems  
Adaptive Behavior  
IEEE Transactions on Computational Intelligence and AI in Games  
Journal of Artificial Intelligence Research  
Journal of Machine Learning Research (JMLR)  
Machine Learning

**Area-Chair/Meta-Reviewer**

International Conference on Learning Representations (ICLR) 2021  
Montreal AI Symposium (MAIS) 2020

**Program Committee**

Neural Information Processing Systems (NeurIPS) 2018 – 2021  
International Conference on Machine Learning (ICML) 2018 – 2021  
AAAI Conference on Artificial Intelligence (AAAI) 2018 – 2020  
International Conference on Learning Representations (ICLR) 2020  
International Joint Conference on Artificial Intelligence (IJCAI) 2016 – 2019

**Workshops Organized**

AAAI Workshop on Learning for General Competency in Video Games 2015

**Participation in Panels**

RLDM Workshop on Modeling Inductive Biases in Reinforcement Learning 2019  
w/ Anne Collins (University of California Berkeley), Todd Gureckis (NYU), Anna  
Harutyunyan (DeepMind), and Doina Precup (McGill & DeepMind) as moderator.  
ICML Workshop on Exploration in Reinforcement Learning 2018  
with Ian Osband (DeepMind), Finale Doshi-Velez (Harvard), Martha White (Uni-  
versity of Alberta), and Benjamin Van Roy (Stanford) as moderator.

**Workshop (WS) Program Committee**

ICML WS on Lifelong Learning Workshop 2020  
NeurIPS Reproducibility Challenge 2019  
NeurIPS WS on Optimization Foundations for Reinforcement Learning 2019  
Montreal AI Symposium 2019  
ICML WS on Lifelong Learning: A Reinf. Learning Approach 2019  
ICML WS on Lifelong Learning: A Reinf. Learning Approach 2018  
AAMAS WS on Adaptive Learning Agents (ALA) 2018  
NeurIPS WS on Hierarchical Reinforcement Learning 2017

**University**

President, Computing Science Graduate Student Association 2015 – 2016

CODE                   **Arcade Learning Environment versions 0.5 – 0.6**                   2015 – 2017  
RELEASED           LANGUAGES: C++ AND PYTHON. Multiple versions of the ALE, including the  
introduction of modes and stochasticity in the environment, new functions, and a  
Python interface. This code was developed collaboratively.

**Source-code for multiple published papers**                   2016 – 2019  
LANGUAGES: C++ AND PYTHON. Source-code of several published papers, in-  
cluding True-Online Sarsa, Blob-PROST features, Eigenoptions,  $DQN_e^{MMC} + SR$ ,  
and a gridworld library.

Last update: June 9, 2021.