

# Sultan J. Majeed

GENERAL REINFORCEMENT LEARNING EXPERT

Canberra, Australia

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“Let the beauty of what you love be what you do.”

—Rumi (1207 - 1273)

## Summary

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- A PhD candidate working in the field of **General Reinforcement Learning (GRL)**.
- Especially, trying to lift the restrictive assumption of **Markovian State-spaces** in RL.
- Supervised and trained by **Prof. Marcus Hutter** (now at DeepMind), one of the prominent figures in the field.
- Tackling the problem of **learning a scalable representation** for every task, the goalpost for **Artificial General Intelligence (AGI)**.
- Developed a **multi-agent Python framework (arena)** which can simulate any **history-based RL setup with abstractions**.
- Demonstrated ability of conducting **theoretical research**, and publishing in **prestigious AI conferences**.
- **Lectured** a graduate course about **Universal Artificial Intelligence (UAI)** at **ANU**.
- **Co-supervised** a number of Master and Undergraduate **theses in GRL**.
- **5+ years** of software engineering and sysadmin **experience**.

## Education

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### Doctor of Philosophy (Artificial General Intelligence)

Canberra, Australia

AUSTRALIAN NATIONAL UNIVERSITY

October 2015 - August 2021

- It is already a technological feat to build machines which can outperform the human counterparts on a particular task. However for a machine to be truly intelligent, it has to beat the best human on every problem of interest. We, humans, are really good at making a scalable mental model of the world around us, which helps us to operate reasonably well on a broad range of environments. The machines, at present, lack this faculty. My PhD thesis is a step in this direction to enable machines to extract a useful model of the world from the experience.
- I also developed a Python framework, called arena, to simulate a variety of history-based multi-agent RL setups. The framework can simulate a history-based RL setup, a normal game, an extensive game, or a mix of all these decision-making paradigms. I designed it in a way that it can also be used with any deep learning architecture. The agents (and domains which are also ‘actors’ in the system) can internally use deep neural networks as long as they implement arena API.

### Master of Philosophy (Game Theory for Ad-hoc Networks)

Islamabad, Pakistan

QUAID-I-AZAM UNIVERSITY

February 2010 - April 2012

- A decision-making process based on rationality, unapologetically, leads to selfishness. Unless some incentives are set in place, the cooperative behavior is not a natural outcome. In my MPhil thesis, I showed that in a community of autonomous communication agents the strategic location of an agent can provide them leverage over the other agents. The agents could behave cooperatively if they are located at mutually useful locations in the network.

## Publications

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| 2022 | <b>Sultan J. Majeed</b> , and Marcus Hutter, “Extreme Value Aggregation Leads to Optimal Behavior,” in preparation for 36th AAAI Conference on Artificial Intelligence (AAAI)  | Global    |
| 2022 | <b>Sultan J. Majeed</b> , and Marcus Hutter, “Hierarchical Abstraction Reinforcement Learning: A Scalable Framework,” in preparation for Journal on Selected Areas in Information Theory (JSAIT)                     | Global    |
| 2022 | <b>Sultan J. Majeed</b> , and Marcus Hutter, “Non-Markovian Feature Reinforcement Learning,” in preparation for Journal on Selected Areas in Information Theory (JSAIT)  | Global    |
| 2021 | <b>Sultan J. Majeed</b> , “Abstractions of General Reinforcement Learning,” PhD thesis at the Australian National University (ANU)   | Australia |
| 2021 | <b>Sultan J. Majeed</b> , “Arena: A History-based Multiagent Decision-making Python Framework,” repository on Github available at <a href="https://github.com/sultanjm/arena">github.com/sultanjm/arena</a> (Github) | Global    |
| 2020 | <b>Sultan J. Majeed</b> , and Marcus Hutter, “Exact Reduction of Huge Action Spaces in General Reinforcement Learning,” in 35th AAAI Conference on Artificial Intelligence (AAAI)                                    | Global    |
| 2019 | Marcus Hutter, Samuel Yang-Zhao and <b>Sultan J. Majeed</b> , “Conditions on Features for Temporal Difference-like Methods to Converge,” in 28th International Joint Conference on Artificial Intelligence (IJCAI)   | China     |

2019	<b>Sultan J. Majeed</b> , and Marcus Hutter, "Performance Guarantees for Homomorphisms Beyond Markov Decision Processes," in 33rd AAAI Conference on Artificial Intelligence (AAAI)	<i>U.S.A.</i>
2018	<b>Sultan J. Majeed</b> , and Marcus Hutter, "On Q-learning Convergence for Non-Markov Decision Processes," in 27th International Joint Conference on Artificial Intelligence (IJCAI)	<i>Sweden</i>
2012	<b>Sultan J. Majeed</b> , and Hasan Mahmood, "Topological Importance as an Incentive to Cooperate in Mobile Ad Hoc Networks: A Game Theoretic Analysis," in 14th IEEE Advanced International Conference on Communication Technology (ICACT)	<i>South Korea</i>

## Academic Experience

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### Research Officer

*Canberra, Australia*

AUSTRALIAN NATIONAL UNIVERSITY

*January 2019 - PRESENT*

- Conducting research to find useful abstractions for artificial and generally intelligent agents.
- Implementing complex AI algorithms in Python.
- Optimizing machine learning algorithms to be more memory efficient leveraging my custom designed data structure(s).

### University Lecturer

*Canberra, Australia*

AUSTRALIAN NATIONAL UNIVERSITY

*July 2019 - February 2020*

- COMP4620/COMP8620 Advanced Topics in Artificial Intelligence (Semester 2, 2019)

### Co-Supervisor

*Canberra, Australia*

AUSTRALIAN NATIONAL UNIVERSITY

*July 2016 - July 2019*

- Co-supervised many master and undergraduate theses in a variety of topics in artificial intelligence.

### University Tutor

*Canberra, Australia*

AUSTRALIAN NATIONAL UNIVERSITY

*February 2016 - July 2018*

- COMP3630/COMP6363 Theory of Computation (Semester 1, 2016 & 2018)
- COMP4670/COMP8600 Introduction to Statistical Machine Learning (Semester 1, 2017 & 2018)
- COMP4620/COMP8620 Advanced Topics in Artificial Intelligence (Semester 2, 2017)

## Software Engineering Experience

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### Senior Software Engineer

*Remote, Hong Kong*

GLIDE

*May 2015 - October 2015*

- Developed web applications for different enterprises using the latest industry proven frameworks and technologies.
- Implemented a legal document search engine using open-source platforms.
- Designed and developed android application(s) which had e-commerce capabilities.

### Senior Software Engineer

*Islamabad, Pakistan*

M & F CONSULTING

*December 2014 - May 2015*

- Developed a cloud gaming solution which was performance critical and optimized for bandwidth usage.
- Extended and optimized the client and server side applications based on the open-source code base(s).

### Senior Software Engineer

*Remote, The United Kingdom*

VECTOR SOLUTIONS

*May 2014 - December 2014*

- Developed desktop applications for trading, and implemented business intelligence on humongous trade-databases.
- Managed and trained junior developers.

### Assistant System Engineer

*Islamabad, Pakistan*

QUAID-I-AZAM UNIVERSITY

*October 2012 - February 2014*

- Designed new IT infrastructure layouts for the ever-increasing population of the university.
- Designed and deployed the university identity card printing system.
- Secured and maintained legacy deployments.
- Deployed Google mail services to replace the legacy mail servers.

### Embedded System Developer

*Lahore, Pakistan*

POWERSOFT19

*August 2009 - February 2010*

- Designed and developed industrial automation embedded systems which were later deployed on enterprise freight trains.
- Revised the design of an existing controller to incorporate client specifications.

## Skills

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<b>System Programming</b>	C/C++, Java, Bash & PowerShell
<b>Scientific Computing</b>	Python, MATLAB & LaTeX
<b>Machine Learning</b>	TensorFlow, JAX & Pytorch
<b>Web Programming</b>	Python, PHP, JScript, HTML/XML, CSS & SQL
<b>Web Frameworks</b>	Django with Python, Laravel & ZendFramework with PHP
<b>Virtualization</b>	Google Cloud Platform, OpenStack, Amazon Web Services & Hyper-V
<b>Tools &amp; Technologies</b>	Git, VSCode, Nginx, NoSQL (MongoDB) & Apache Solr
<b>Protocols</b>	JSON, REST, SOAP & OAuth
<b>Methodologies</b>	TDD, Agile, Waterfall & MVC
<b>Languages</b>	English (IELTS 7.5, PTE 78) & Urdu (Native Speaker)

## Honors & Awards

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2016-21	<b>Program Committee Member</b> , Prestigious AI Conferences (NeurIPS, AAAI, IJCAI, UAI, AGI)	<i>Global</i>
2015	<b>HDR Fee Remission Merit Scholarship</b> , The Australian National University	<i>Australia</i>
2012	<b>Vice Chancellor Medal</b> , Department of Electronics, Quaid-i-Azam University	<i>Pakistan</i>

## Referees

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### Marcus Hutter

*London, UK*

GOOGLE DEEPMIND  
mhutter@google.com

### Kee Siong Ng

*Canberra, Australia*

AUSTRALIAN NATIONAL UNIVERSITY  
keesiong.ng@anu.edu.au