Dr. Marcin Abram

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PROFESSIONAL EXPERIENCE

University of Southern California, Los Angeles, CA, USA

Postdoctoral Scholar – Teaching Fellow   *July 2020 – Present*

◇ I conduct research on machine learning applications for scientific concept discovery. My research focuses on several areas, including knowledge distillation, model robustness, out-of-domain generalization, interpretability of machine learning models, and uncertainty estimations in deep neural networks.

◇ I serve as a group leader for the *Emulating Quantum Dynamics with Neural Networks* project. My group and I have recently proposed a schema based on knowledge distillation, and we demonstrated its capabilities by learning quantum dynamics. As a result, our research was published by *Frontiers in Materials*.

◇ I instruct physics and computer science classes on both undergraduate and graduate levels, which include Mechanics, Statistical Physics, and Machine Learning for Data Science.

◇ I also provide mentoring services in my department and serve on various committees, including Physics Ph.D. qualifying exam committees. I have mentored several senior projects for the physics/computer science majors, and each year I supervise a number of graduate research internship projects.

Visiting Researcher at the Information Sciences Institute (ISI)   *July 2020 – Present*

◇ I am a research member in the ISI's *Machine Intelligence and Data Science* (MINDS) group and a lead researcher in the collaborative project with Sandia National Laboratories. In response to the needs of our research partners from Sandia, I have proposed a self-supervised method for discovering driving factors of complex dynamical processes. The result of the work has allowed our partners to optimize the synthesis process of functional materials. We have published our work in a prestigious Nature-partner journal.

◇ I contribute to the *SHELFI: Secure Heterogeneous Learning Federation with Information-Theoretic Guarantees* project. The work of our team aims to increase the efficiency and robustness of federated learning protocols. My team and I have proposed a novel elastic-weight consolidation schema. We have demonstrated an improved accuracy compared to a baseline approach that simply ignores corrupted updates.

Fetch.ai, Cambridge, UK

Machine Learning Scientist → Lead Research Scientist *(from January 2019)*   *July 2018 – May 2020*

◇ I have developed a novel consensus protocol and I have proposed several machine-learning applications to work with a multi-agent decentralized system. I have published two articles, registered one commercial patent, and presented the results of my work at several conferences (Toronto 2019, Paris 2019, Cambridge 2019).

◇ In addition to my technical role, I led a group of four researchers and conducted about 20 technical interviews. I have been also representing the company in bi-weekly contacts with our investor (Outlier Ventures).

TypeScore, London, UK

Machine Learning Engineer   *August 2016 – June 2018*

◇ I was one of the two main developers at TypeScore, a financial risk assessment startup in London.

◇ I was responsible for collecting raw data, testing different machine learning algorithms, software development, and final deployment. I also monitored the newest developments in machine learning and proposed new research directions for the company.

Jagiellonian University, Kraków, Poland

Ph.D. Graduate Researcher   *October 2011 – August 2016*

◇ I was a research member in two EU-funded projects focused on correlations and coherence in quantum materials and structures, and fundamental properties of strongly correlated systems. During this time, I published seven peer-reviewed articles in leading international journals and presented the results of my work at several international conferences.

◇ In addition to my research, I led practical sessions for *Physics with Biophysics Elements*, *Statistical Physics*, and *Physics Laboratory*. I was also the main organizer of the *Physics Classes for Gifted High-School Students* outreach program in 2012-2014.

Jagiellonian University, Kraków, Poland

Ph.D. in Physics
2011 – 2016

⋄ Research on approximation methods for modeling strongly-correlated quantum systems. In my work, I focused on high-performance computing techniques and numerical methods for high-fidelity scientific simulations.

⋄ Dissertation title: *Nonstandard Representation of Correlated-Fermion Models and its Application to Description of Magnetism and Unconventional Superconductivity.* Supervisors: Prof. J. Spałek and Dr. M. Zegrodnik. Degree conferred with Distinction.

Interdisciplinary Studies: Society–Environment–Technology (3-year program)
2012 – 2015

⋄ This competitive, application-only program for top Ph.D. students, consisted of three years of coursework and independent research using social science, natural science, and humanities research methods in English.

B.Sc. in Computer Science (3-year program)
2009 – 2012

⋄ Obtained independently from the Physics program as a second degree. The outcomes of my final project contributed to ongoing research in my department and resulted in a peer-reviewed publication.

M.Sc. in Theoretical Physics (5-year program)
2006 – 2011

⋄ I finished an interdisciplinary 5-year Master's program that allows students to compose an individual program of study from the offer of the mathematics, computer science, and natural science departments.

⋄ Dissertation title: *Selected methods of correlated particles applied to atomic systems in optical lattices.* Supervisor: Prof. J. Spałek. Final mark: 5.0 (maximum 5.0).

PUBLICATIONS AND PATENTS

1. M. Abram, J. Kaczmarczyk, J. Jędrak, and J. Spałek, *d-wave superconductivity and its coexistence with antiferromagnetism in t–J–U model: Statistically consistent Gutzwiller approach*, Phys. Rev. B **88**, 094502 (2013).

2. M. Abram, *t–t'–J–U Model in mean-field approximation: Coexistence of superconductivity and antiferromagnetism*, Acta. Phys. Pol. A **126**, 25 (2014).

3. A. Kapanowski and M. Abram, *Model of hard spheroplatelets near a hard wall*, Phys. Rev. E **89**, 062503 (2014).

4. M. M. Wysokiński, M. Abram, and J. Spałek, *Ferromagnetism in UGe_2: A microscopic model*, Phys. Rev. B **90**, 081114(R) (2014).

5. M. M. Wysokiński, M. Abram, and J. Spałek, *Criticalities in the itinerant ferromagnet UGe_2*, Phys. Rev. B **91**, 081108(R) (2015).

6. M. Abram, M. M. Wysokiński, and J. Spałek, *Tricritical wings in UGe_2: A microscopic interpretation*, J. Magn. Magn. Mater. **400**, 27–30 (2016).

7. M. Abram, M. Zegrodnik, and J. Spałek, *Antiferromagnetism, charge density wave, and d-wave superconductivity in the extended t–J–U model*, J. Phys.: Condens. Matter **29**, 365602 (2017).

8. M. Abram, D. Galindo, D. Honerkamp, J. Ward, and J.-M. Wong, *Democratising blockchain: A minimal agency consensus model* (a working paper presented at Tokenomics 2019, Paris), arXiv:2006.05390 (2020).

9. Y. Ye, D. Qiu, J. Ward, and M. Abram, *Model-free real-time autonomous energy management for a residential multi-carrier energy system: A deep reinforcement learning approach*, Proceedings of the Twenty-Ninth International Joint Conference on Artificial Intelligence (IJCAI) (2020).

10. J. Ward, M. Abram, and D. Honerkamp, *Distributed computer system and method of operation thereof*, European Patent no. EP3929742, Bulletin 2021/52 (December 29, 2021).

11. Y. Yao, C. Cao, D. Khanna, M. Agarwal, S. Haas, and M. Abram, *Emulating quantum dynamics with neural networks via knowledge distillation*, Front. Mater. **9**, 1060744 (2022).

12. M. Abram, K. Burghardt, R. Dingreville, G. Ver Steeg, and A. Galstyan, *Inferring topological transitions in pattern-forming processes with self-supervised learning*, Npj Comput. Mater. **8**, 205 (2022).

13. D. Stripelis, M. Abram, and J.-L. Ambite, *Performance weighting for robust federated learning against corrupted sources*, arXiv:2205.01184 (2022).

University of Southern California, Los Angeles, USA

Thermodynamics and Statistical Mechanics (PHYS 316, Upper-Undergraduate Level)	*Spring 2023*
Fundamentals of Physics I: Mechanics and Thermodynamics (PHYS-151, Undergraduate Level)	*Fall 2022*
Mechanics (PHYS-304, Upper-Undergraduate Level)	*Fall 2020, Fall 2021, Fall 2022*
Machine Learning for Data Science (DSCI-552, Graduate Level)	*Spring 2021*
Senior Project (PHYS-495, Upper-Undergraduate Level)	*Spring 2021, Fall 2021*

Jagiellonian University, Kraków, Poland

Physics Laboratory (Undergraduate Level)	*Spring 2015*
Statistical Physics (Upper-Undergraduate Level)	*Spring 2013, Spring 2014*
Physics with Biophysics Elements (Undergraduate Level)	*Fall 2013*

Additional Teaching Experience

Leading the Physics Classes for Gifted High-School Students Outreach Program, Kraków, Poland	*2012 – 2014*
Math tutor in the Center for the Blind and Visually Impaired, Kraków, Poland	*2012 – 2014*

FELLOWSHIPS, SCHOLARSHIPS, AND MERIT AWARDS (SELECTION)

A sponsored research award ($20,000)   *2021*
A sponsored research award by the Department of Energy, via Sandia National Laboratories.
Project title: *Using Machine Learning to Understand Material Science.*

Outstanding Reviewer Award by the IOP Journal of Physics: Condensed Matter   *2020*

A fellowship in a Research Grant   *2015 – 2016*
Fundamental Properties of Strongly Correlated Systems: Unconventional Superconductivity, Quantum Critical Behavior, and Complex Electronic Structure, funded by the National Science Centre (NSC).

The Exceptional Doctoral Performance Award   *2013 – 2015*
Awarded to the top 15% of Ph.D. students departmentally at Jagiellonian University in Kraków, Poland.

A fellowship in a Research Grant   *2011 – 2015*
A Ph.D. Student Member in *Correlations and coherence in quantum materials and structures (CCQM) – unique properties on macro and nano scale*, funded by the Foundation for Polish Science (FNP).

Scholarship: Interdisciplinary Ph.D. studies in English Program   *2012 – 2015*
Awarded to the top Ph.D. students at Jagiellonian University in Kraków, Poland.

Scholarship: Study Abroad   *January – June 2010*
Erasmus Scholarship in Niels Bohr Institute in Copenhagen, Denmark.

Academic Achievement Scholarship   *2008 – 2009*
Awarded to the top students departmentally at Jagiellonian University in Kraków, Poland.

Finalist (top 60 in the country) in the LV Polish Physics Olympiad   *April 2006*

Finalist (the 9th place in the country) in the XLIX Polish Astronomy Olympiad   *March 2006*

ADDITIONAL TRAINING (SELECTION)

◇ *Geometry of Data* (AMAH 797 / MATH 797), Yale University, New Haven, CT, USA	*January – April 2020*
◇ *Theory of Deep Learning* (S&DS 670), Yale University, New Haven, CT, USA	*January – April 2020*
◇ *Topics in Cryptography & Security* (CPSC 767), Yale University, New Haven, CT, USA	*January – April 2020*
◇ *Topics in Foundations of ML* (CPSC 464/564), Yale University, New Haven, CT, USA	*January – April 2020*
◇ *Economics and Computation* (CPSC 455/555), Yale University, New Haven, CT, USA	*August – December 2019*
◇ *STAQ Quantum Ideas Summer School*, Duke University, Durham, CT, USA	*June 17-21, 2019*

ADDITIONAL SERVICE

Reviewer for *New Journal of Physics* (3), *Journal of Physics: Material* (3), *Journal of Physics: Condensed Matter* (6), *Physica Scripta* (1), *Machine Learning: Science and Technology* (5), *IOP SciNotes* (2) and, *Superconductor Science and Technology* (2).