Ksenija Kovalenka

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https://ksenijakovalenka.github.io

EDUCATION AND RESEARCH EXPERIENCE

Master of Physics, University of Manchester *September 2019 – June 2023*
First Class Degree with Honours, grade average: 80%

MPhys Project: *Modelling Quantum Lattices Using a Combination of Deep Learning and Quantum Computing Methods*
Supervisor: *Dr Mohammad Saeed Bahramy*

- Modelled topological orders in many-body electronic systems.
- Created a database for quantum phase transition at and across the quantum criticality point.
- Designed and trained a deep neural network to classify the topological quantum lattice states.
- Studied the performance of a quantum circuit within neural networks used for the same classification task.
- Animated quantum circuit performance using *Manim* package.

Main programs developed

- Minimum band gap calculation for interpolation of two adiabatically connected phases of electronic system. *(Fortran90)*
  - Developed a generalised source code together with a specific usage example for BiTeI crystal.
  - Ensured scalability by utilising the Message Passing Interface (*MPI*) standard.
  - Introduced a simulation for a finite slab of the material to extract the signature features of the quantum phase transition.
- Hybrid neural network architectures for classification of the quantum phases of the lattice. *(Python)*
  - Used *PyTorch* library to create a set of fully connected and convolutional neural networks.
  - Enhanced the available architectures by introducing a quantum circuit layer using *Pennylane*.
  - Tested the training ability of a quantum neural network with *Qiskit* in *IBM Quantum Experience*.

Relevant Modules: Object Oriented Programming in C++ (94%), Computational Physics (93%), Introduction to Programming for Physicists (88%), Quantum Computing (80%), Quantum Field Theory (86%).

Completed Computational projects

- Quantum Circuit Simulator. (*C++)*
- Monte Carlo Techniques for Modelling Penetration of Neutrons Through Shielding. (*Python)*
- Numerical Integration of Differential Equations: The Damped Harmonic Oscillator. (*Python)*
- Measuring Spreading Law: Curve fitting to experimental data for spreading of picolitre droplets. (*Python)*
- Doppler Spectroscopy: Analysis of exoplanets via transiting method using function minimisation. (*Python)*

For more detailed project descriptions and visuals please visit https://ksenijakovalenka.github.io.

Awards

- NTEC undergraduate poster competition prize. *November 2022*
- Runner-up presentation prize at the undergraduate research conference. *September 2022*
- Summer internship funded by "*Learning through Research*" programme. *July 2022*
- Best student award issued by the John Leggott College (Sixth form). *June 2019*

TECHNICAL SKILLS

Programming: Highly proficient in C++, Python and Fortran.
Widely familiar with OOP, PyTorch, Qiskit, MNIST data and MPI.
Sufficient experience with LaTeX, Jupyter, Github, Unix CLI, Pennylane and Manim.

Languages: Fluent in English, Russian and Lithuanian.

OTHER RESEARCH EXPERIENCE

Summer Research Internship, University of Manchester, UK *July 2022 – August 2022*
Project title: *Quantum Mechanics and Machine Learning*
Supervisor: *Dr Mohammad Saeed Bahramy*

- Developed knowledge of the principles of Machine Learning and Quantum Computing.
- Created a neural network to explore the potential use and functionality of machine learning.
- Researched the possible applications of the quantum neural networks in solid state physics.

Main program developed

- Quantum neural network simulation for written digit recognition. (*Python)*
    - Based on a classical fully connected neural network implementing stochastic gradient descent with efficiency of ~99%.
    - Contains a small-scale quantum circuit simulation with a CNOT gate applied.

Summer Research Project
Center for Physical Sciences and Technology, Lithuania *July 2021 – September 2021*
Project title: *Variational Quantum Eigensolver Algorithm and its Applications*
Supervisor: *Dr Audrius Alkauskas*

- Studied Hartree-Fock theory to determine the ground state separation of the hydrogen molecule.
- Compared the results to the output of variational quantum eigensolver on the Qiskit simulator.

Summer Research Project
Center for Physical Sciences and Technology, Lithuania *July 2020 – September 2020*
Project title: *Modelling Vibrational Modes in Solids, Classical Interpretation*
Supervisor: *Dr Audrius Alkauskas*

- Studied tight binding problem in 2D lattice to solve for energy bands for different configurations analytically as well as using a Python script.

TEACHING AND ADMINISTRATIVE EXPERIENCE

Physics and Maths Tutor, MyTutor and Private Practice *December 2019 - present*

- Completed over 300 lessons for ~20 students in A-level Maths and Physics.
- Prepared comprehensive study material for long-term, achievement-focused work with students.
- Described as a knowledgeable, patient and encouraging tutor by students and their parents.

Student Representative, University of Manchester, UK *September 2022 - present*

- Organised feedback collection from students for assigned courses.
- Practiced assertiveness, diplomacy, and persuasion skills by delivering comments to the lecturers.

PASS Leader, University of Manchester, UK *December 2019 - present*

- Facilitated learning of a group of 10 first year students.
- Created specialised activities to enhance the academic experience of fellow students.

OTHER INTERESTS

- Schools and Universities Polo Association (SUPA) Winter Nationals 2022 winner (B4 division), Summer Nationals 2022 2nd place (B3 division), Winter Nationals 2023 3rd place (N4 division), Summer Nationals 2023 3rd place (N4 division).
- Active Manchester University Hiking Society member. Longest hike: 7 days, ~140 km, Lithuania.
- Horse liberty training 10-day seminar attendee (Cyprus, 2021), horse sanctuary volunteer (Spain, 2018), Saint Cannat Polo Club volunteer (France 2022 and 2023).
- Physics Society art competition winner. Painting is displayed in the Schuster building, Department of Physics and Astronomy, Manchester.
- Other interests include mountain skiing, chess, beginner guitar and ukulele.