Presentation Slides
N009-Sasan.Ansarian

Vilnius University

Doctoral student:

Sasan Ansarian Najaf Abadi

Title of the dissertation:

Design and Optimisation of Quantum-Based and Hybrid Machine Learning Algorithms for Real-World Data Analysis Problems

Supervisor:

Dr. Ernestas Filatovas

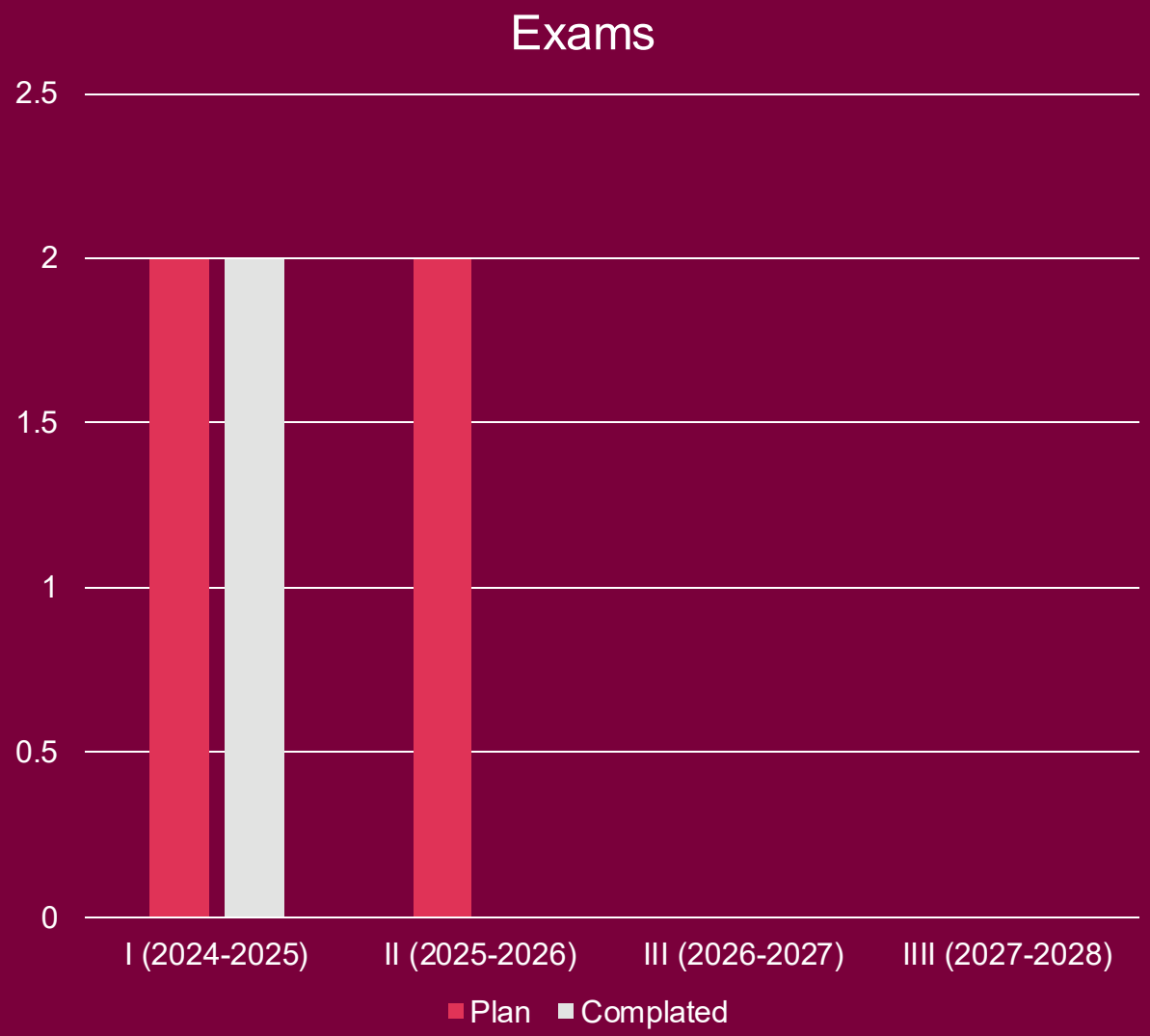
Start and end year of doctoral studies:

From 1 October 2024y To 30 September 2028y.

Year of study:

2024-2025 (The Second Semester)

The plan of all doctoral studies and research and a summary of its implementation (Table 1).



YEAR OF STUDY	EXAMS	
	Plan	Completed
I (2024-2025)	2	2
II (2025-2026)	2	
III (2026-2027)		
IIII (2027-2028)		
Total	4	2

The plan of all doctoral studies and research and a summary of its implementation (Table 1).

Study years	Participation in conferences				Publications					
	International		National		With citation rate			Without citation rate		
	Plan	Completed	Plan	Completed	Plan	Completed	Status	Plan	Completed	Status
I (2024-2025)										
II (2025-2026)			1	Will complete in the 16th Conference „Data Analysis Methods for Software Systems“, which will be held on November 27 - 29, 2025.						
III (2026-2027)	1				1					
IIII (2027-2028)	1				1					
Total	3		1		2					

The work plan for the reporting semester and its implementation (Table 2), detailing what has been done this semester.

Exams 2024/2025 (2nd semester)

Plan	Completed	Status
Machine Learning (2025 y. I quarter)	Machine Learning	Passed
How to Sell Your Research? (2025 y. I quarter)	How to Sell Your Research?	Passed
Research Methods in Informatics and Informatics Engineering (2025 y. II quarter)	Research Methods in Informatics and Informatics Engineering	Passed

Conference participation 2024/2025 (Second Semester)

Plan	Completed	Conference type
1	**Will complete in the 16th Conference "Data Analysis Methods for Software Systems", which will be held on November 27 - 29, 2025.**	

Publications 2024/2025 (Secondirst Semester)

Plan	Completed	Status	Publication type

Information about international events and publications that present the main results of the dissertation (articles with a citation index only) (Table 3). This information must be provided not only for the current year of study, but for all studies.

Participation in international conferences	
	Description
1.	

Publications (with citation rate only)		
	Bibliographic description	Condition
1.		

The stages of all doctoral research and dissertation preparation (see Table 4, it can be shortened slightly to fit 1–2 slides), detailing what has been done this semester.

	Title of the work	Due dates	Notes
1.	Review and analysis of scientific research related with the theme of doctoral thesis (in Lithuania and abroad):		
1.1.	Understanding the Foundations: Literature Review: Conducting a comprehensive review of existing research on Quantum and hybrid machine learning approaches.	2025 I quarter	• ML course completed • Literature review • Review article draft
1.2.	Quantum Computing Fundamentals: Grasping the basic principles and concepts of quantum mechanics, such as superposition, entanglement, and measurement, and studying essential quantum algorithms like Grover's search, Shor's factoring, and quantum Fourier transform. familiarising yourself with different types of quantum hardware (e.g., superconducting qubits, trapped ions) and their limitations.	2025 II quarter	•Quantum basics studied • Key algorithms reviewed • Hardware surveyed
1.3.	Machine Learning Basics: Exploring traditional machine learning techniques (e.g., linear regression, decision trees, neural networks) and their applications, and Exploring hybrid models that combine classical and quantum components	2025 III quarter	•Classical ML implemented •Hyperparameters tuned •Hybrid models explored
2.	Prosecution of scientific research:		
2.1.	Formation of study methodology:		
2.1.1.	Designing effective quantum feature maps to encode classical data into quantum states.	2025 IV quarter	• Feature maps reviewed • Encoding techniques identified

	Title of the work	Due dates	Notes
2.2.	Theoretical study:		
2.2.1.	Experimenting with different feature maps to optimize performance for specific tasks.	2026 I quarter	
2.3.	Empirical study:		
2.3.1.	Implementing quantum variational circuits for training and optimization, and exploring techniques to mitigate noise and improve the efficiency of variational algorithms	2026 II quarter	
2.4.	Analysis of got facts, summing-up, drawing conclusions:		
2.4.1.	Developing hybrid models that leverage the strengths of both classical and quantum computing and considering using quantum computing for specific subtasks within larger classical models.	2026 III quarter	
3.	Preparation of separate parts of doctoral thesis (study methodology, got facts, defended propositions, inferences, etc.):		
3.1.	Industry Selection and Problem Identification: Choosing a specific industry to explore how quantum machine learning can be applied and Identify problems or challenges in that industry that could be solved or improved with quantum solutions.	2026 IV quarter	
3.2.	Data Preparation: Collecting and preparing relevant data for training and testing quantum machine learning models.	2027 I quarter	
3.3.	Model Development and Evaluation: Developed and evaluated quantum-based and hybrid models for the selected applications.	2027 II quarter	
3.4.	Benchmarking: Benchmarking, researching, comparing, and applying best practices to evaluate and enhance products, methods, and services to measure success and improve performance.	2027 III quarter	
3.5.	The summarizing of the findings and discusses:Summarizing and highlighting the new achievement insights and the impact of its ability to influence future research and practice.	2028 I quarter	
4.	Preparation of doctoral thesis and debating at the department:	2028 II quarter	
5.	Defending of doctoral thesis:	2028 III quarter	

Brief description of scientific results obtained during the semester.

- I completed a Machine Learning course, where I worked on developing and comparing image classification algorithms such as Logistic Regression, Multi-Layer Perceptrons (MLPs), and Convolutional Neural Networks (CNNs) using the CIFAR-10 dataset. This hands-on experience also allowed me to experiment with hyperparameter tuning (learning rate, hidden layers, dropout) and reflect on how classical methods could inspire future quantum–classical hybrid models.
- In parallel, I have been conducting an extensive literature review on Quantum Machine Learning (QML), particularly its applications in healthcare. Guided by Dr. Ernestas Filatovas, I systematically collected and reviewed 74 peer-reviewed studies (2020–2025), which I categorized into three main groups: algorithms, hybrid models, and healthcare use cases. From this work, I am currently drafting a structured review article titled “Quantum Machine Learning for Image Classification in Healthcare: Algorithms, Applications, and Future Prospects.”
- To strengthen the quantum side of my research, I completed an introductory study of quantum computing fundamentals, covering quantum states, measurement, and qubits. I am also reviewing key quantum algorithms such as Grover’s search, Shor’s factoring, and the Quantum Fourier Transform, while noting their potential applications in machine learning. Additionally, I surveyed the current state of quantum hardware platforms (IBM Q, IonQ, Rigetti), with particular attention to their scalability challenges and error-rate limitations.
- Finally, I will begin exploring quantum feature mapping techniques for encoding classical data into quantum states. This effort will lead to a preliminary methodological outline for applying quantum feature maps to healthcare image classification, which will serve as the foundation for the next stage of my research.
- Also, I am involved and working on a project closely related to my PhD studies.

Brief description of scientific results obtained during the semester.

Project Title: Data center for Machine Learning and Quantum Computing in Natural and Biomedical Sciences that is one of five research projects within the Centre of Excellence:

“Development and Validation of Quantum Machine Learning Methods Using Prebuilt Datasets.”

I. **Position**: junior researcher

II. **Implementation Period:** 2023–2027

III. **Project No.:** S-A-UEI-23-11

IV. **Funding Source:** Research Council of Lithuania, under the “University Excellence Initiatives” Program of the Ministry of Education, Science and Sports (Measure No. 12-001-01-01-01 “Improving the Research and Study Environment”).

V. **My task:** working on analysis and implementation of QML for image analysis in Healthcare

Work plan for the next semester

- ✓ In the upcoming semester, I will continue strengthening my theoretical foundation by completing two courses: Fundamental Methods of Informatics and Informatics Engineering Science and Deep Neural Networks.

- ✓ On the research side, my main focus will be the empirical study of quantum variational circuits. I plan to implement and test these circuits for training and optimisation tasks.

- ✓ Building on this, I will work on developing hybrid quantum–classical models that combine the strengths of both paradigms. My aim is in areas such as healthcare image analysis.

- ✓ This combination of coursework, hands-on experimentation, and methodological development will help me progress toward forming a well-structured research framework for my doctoral thesis.

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Thanks for your attention

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