

Presentation Slides

N009-Sasan.Ansarian



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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

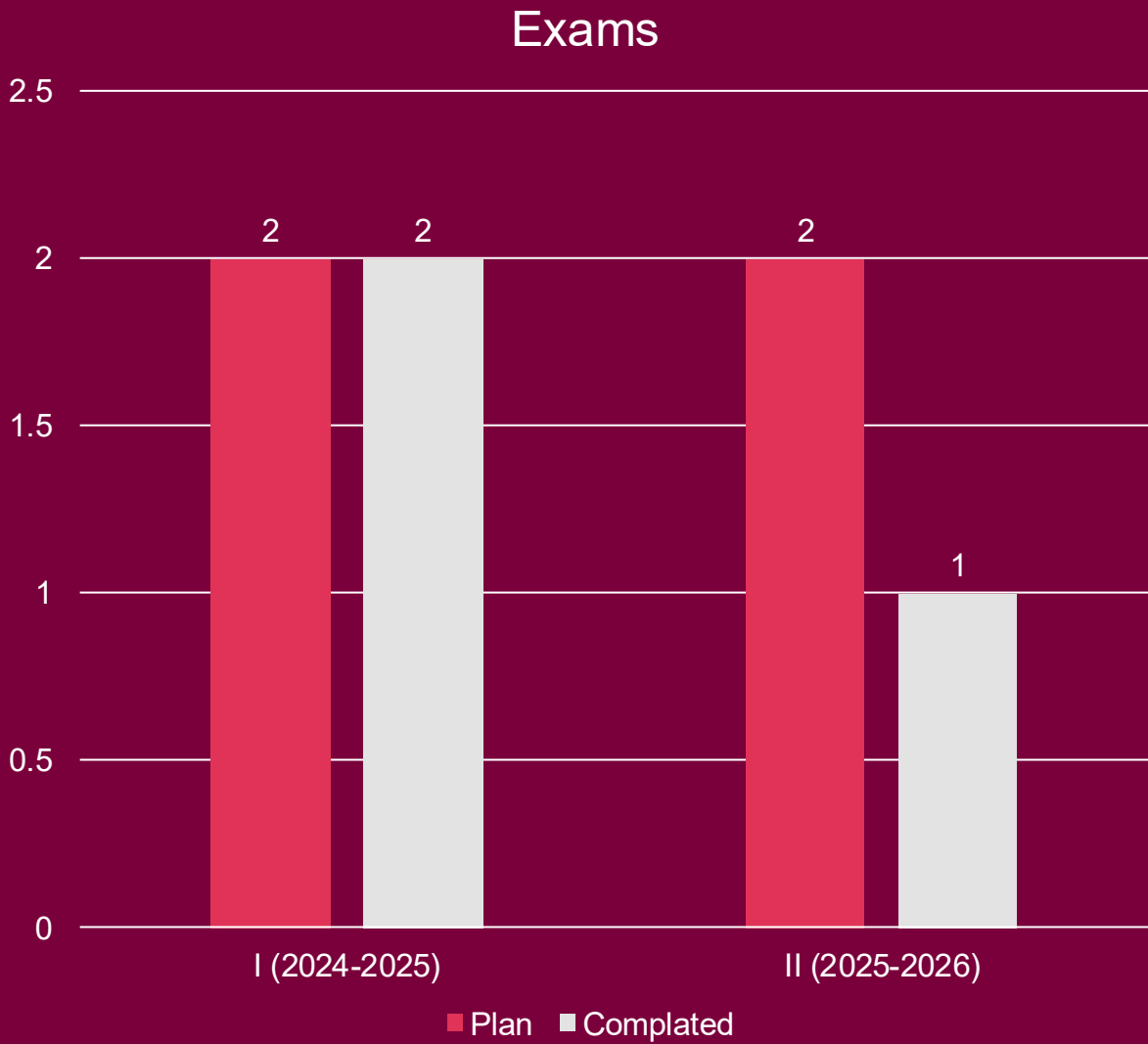
Start and End year of doctoral studies:

From 1 October 2024 To 30 September 2028.

Year of study:

2025-2026 (Fourth 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	1
III (2026-2027)	-	-
III (2027-2028)	-	-
Total	4	3



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	Attended the 16th International Conference on Parallel Processing and Applied Mathematics (PPAM), August 30 - September 2, 2026	1	Attended the 16th Conference on Data Analysis Methods for Software Systems, November 27 - 29, 2025.	1	Under Review (Submitted to Quantum Machine Intelligence, Springer,)				
III (2026-2027)	1									
III (2027-2028)			1		1					
Total	2	1	2	1	2					

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

Exams 2024/2026 (Till fourth 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 (2025 y. II quarter)	Research Methods in Informatics	Passed
Fundamental Methods of Informatics (2026 y. I quarter)	Fundamental Methods of Informatics	Passed
Deep Neural Networks (2026 y. II quarter)	Deep Neural Networks	~~Passed~~

Conference participation 2025/2026 (Fourth Semester)

Plan	Completed	Conference type
1	Attended the 16th International Conference on Parallel Processing and Applied Mathematics (PPAM), Poznań, Poland, August 30 - September 2, 2026	International

Publications 2025/2026 (Fourth Semester)

Plan	Completed	Status	Publication type
2026 y. II quarter	Under Review	Under Review	Systematic Review



Information about international events and publications that present the main results of the dissertation (Table 3).



Participation in international conferences	
	Description
1.	Presented “Revisiting Hybrid Quantum–Classical Neural Networks for Medical Image Classification under Fair Baselines” at PPAM 2026 (Parallel Processing and Applied Mathematics), Poznań, Poland, August 2026.

Publications (with citation rate only)		
	Bibliographic description	Condition
1.	Quantum Machine Learning for Medical Image Classification: A Multi-Axis Taxonomy and Systematic Review of Methods, Architectures, and Evidence. Submitted to Quantum Machine Intelligence (Springer)	Under review

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	• Implementation: Conducted a systematic literature review of QML in healthcare; a review article was prepared and submitted.
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: Experimenting with different feature maps to optimise performance for specific tasks.	2026 I quarter	Exploring hybrid quantum-classical architectures and quantum variational circuits for machine learning.
2.3.	Empirical study: Implementing quantum variational circuits for training and optimisation, and exploring techniques to mitigate noise and improve the efficiency of variational algorithms	2026 II quarter	Initiated experimental evaluation of a Hybrid Quantum-Classical CNN for medical image classification with the DermaMNIST dataset.
2.4.	Analysis of facts, summing up, drawing conclusions: 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	- Analysed experimental results using classical and hybrid models - Compared and validated using fair baselines - Found limited benefits of quantum models under specific conditions - No consistent advantages across experiments
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	- Healthcare selected as the application area - Medical image classification as the research problem - Limited data, feature compression, and fair comparison were identified as key challenges
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	



Main Academic and Research Activities (Fourth Semester)



Review Article:

- Systematic review of 153 studies (2020–2025)
- Developed a multi-axis taxonomy and identified research gaps
- Submitted to Quantum Machine Intelligence
- Status: Under review

Experimental Research:

- Implemented and evaluated an HQCNN
- Compared classical and quantum heads under fair baselines
- Investigated feature compression and limited training data
- Tested robustness across seeds and datasets



Main Academic and Research Activities (Fourth Semester)



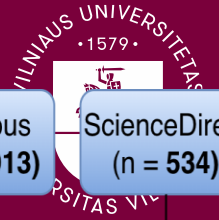
PPAM Conference:

- Poznań, Poland, August 30–September 2, 2026
- Presented: “Revisiting Hybrid Quantum–Classical Neural Networks for Medical Image Classification under Fair Baselines”
- The paper was accepted for publication in *the PPAM 2026 proceedings, in Springer’s Lecture Notes in Computer Science (LNCS) series.*

Quantum Summer Schools:

- Completed *Qiskit Global Summer School 2026 (IBM)*
- Completed Summer Program 2026: *Classical + AI + Quantum (WISER)*

Systematic Review of QML for Medical Image Classification

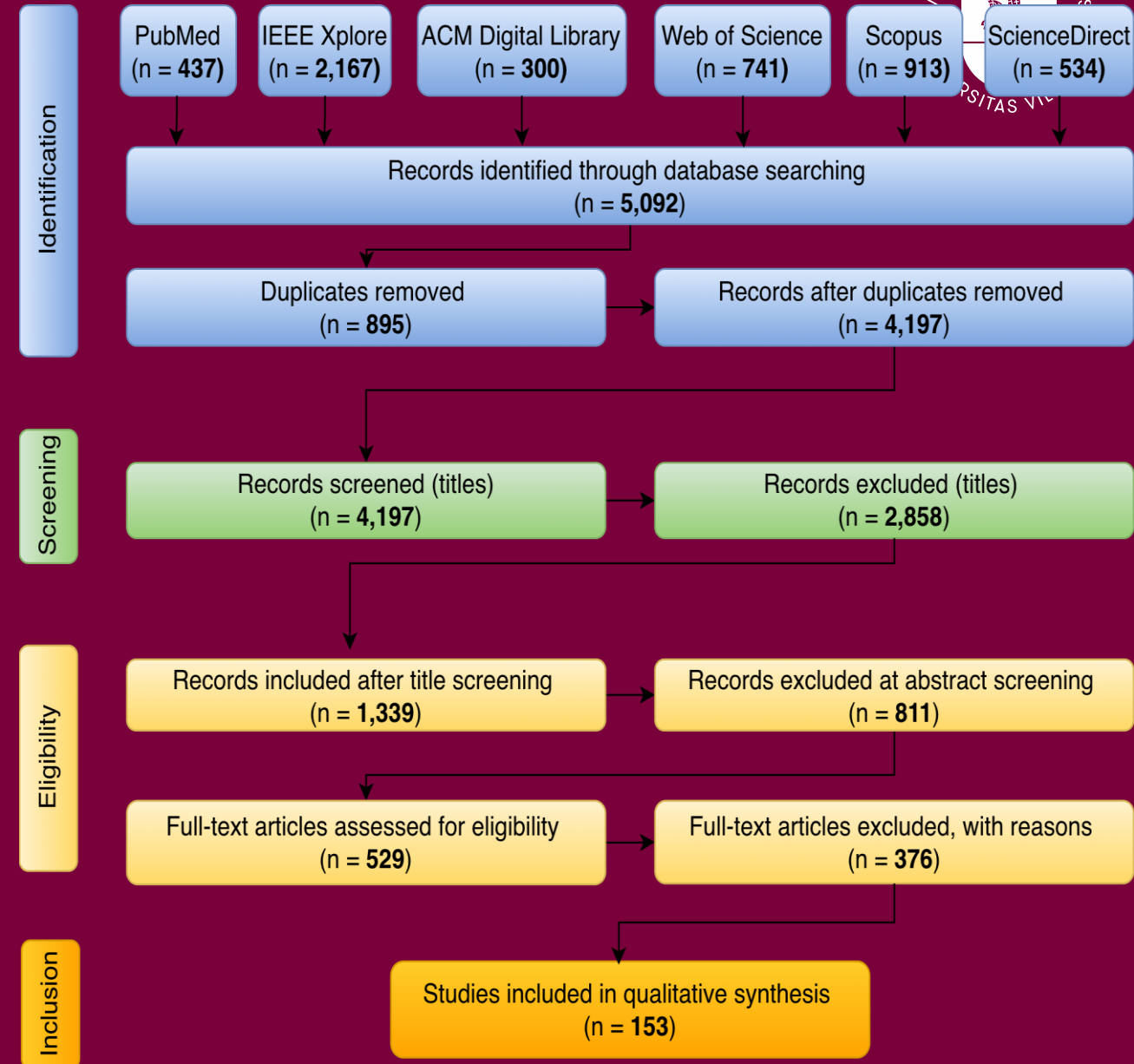


➤ Scope and contribution:

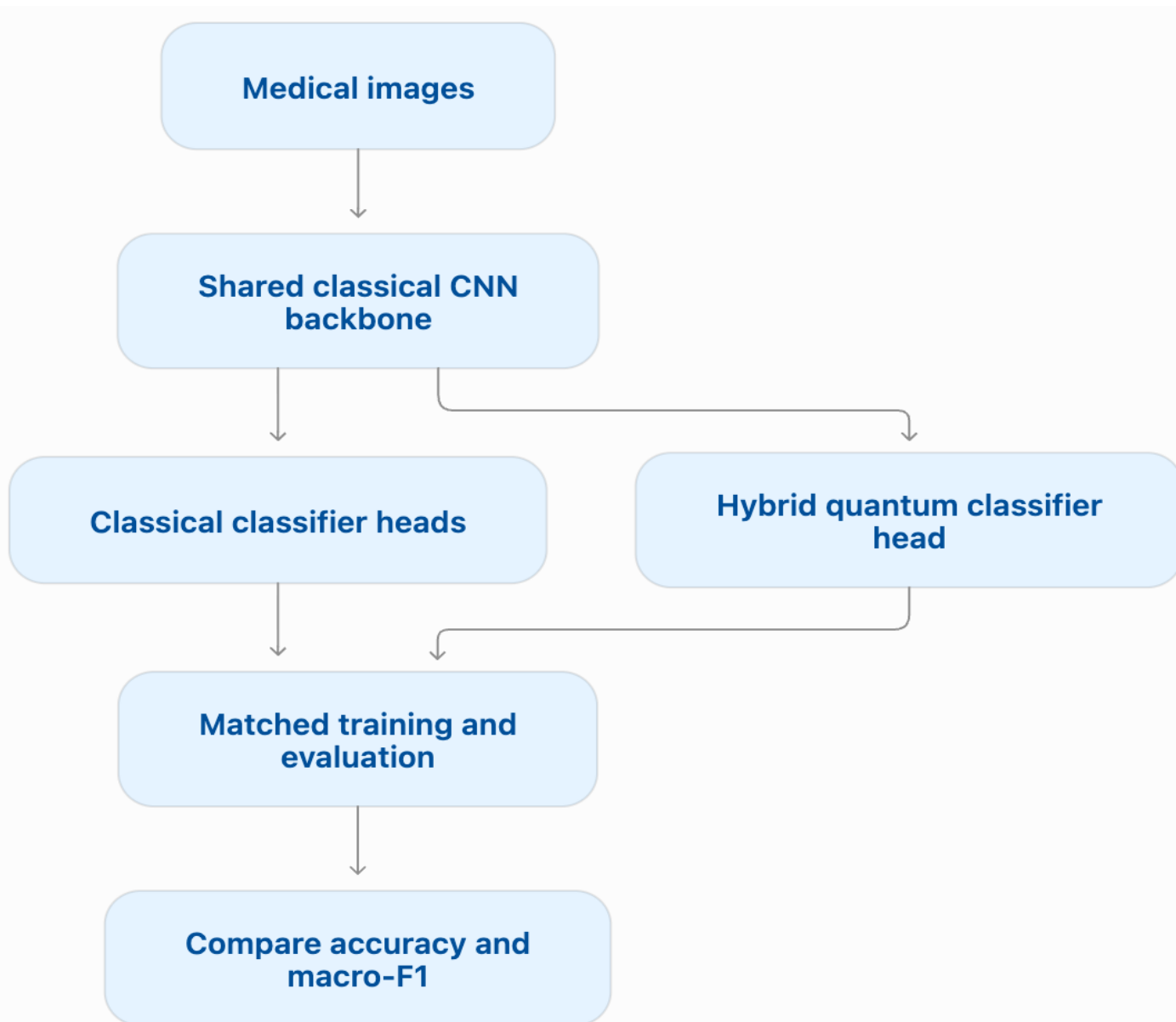
- ✓ Reviewed 153 studies published in 2020–2025
- ✓ Organised methods and evidence using a multi-axis taxonomy
- ✓ Identified gaps in fair benchmarking and reliable evaluation
- ✓ Used these gaps to guide the HQCNN experimental study

➤ Publication status:

- ✓ Submitted to **Quantum Machine Intelligence** (Springer)
- ✓ Under review



HQCNN Evaluation under Fair Baselines



- ❖ Compared **classical and hybrid quantum classifier heads**
- ❖ Used a shared **Classical CNN feature extractor**
- ❖ Matched feature compression and training conditions
- ❖ Evaluated **limited-data settings, multiple seeds, and cross-validation**
- ❖ Used **macro-F1 as the primary metric**, alongside accuracy

Main Findings and Next Research Steps



❖ Interpretation of Results

- Hybrid quantum–classical models **do not automatically provide benefit.**

❖ performance advantages.

The results indicate that performance depends strongly on:

- feature representation
- quantum circuit design
- model integration strategy (Frozen vs End-To-End)

❖ Key Insight

Quantum advantage is **not guaranteed** and must be investigated under specific conditions.

❖ Research Direction

- Explore different **quantum feature encoding methods**
- Investigate alternative **quantum circuit architectures**
- Analyse **training behaviour and optimisation dynamics**
- Study conditions where **quantum methods may provide advantages**

Contributions to My Dissertation



Contribution of This Semester:

1 Review Contribution:

- Organised QML methods for medical image classification
- Identified research gaps and benchmarking limitations

2 Methodological Contribution:

- Developed a controlled comparison framework
- Matched classical and quantum models under comparable conditions

3 Experimental Contribution:

- Evaluated hybrid models under different compression and data settings
- Identified limited benefits and training instability

Key Outcome

These findings guide the next stage of model design and optimisation in my dissertation.

Short-Term and Long-Term Research Plans



❖ Short-Term Plans (Next Semester):

- Improve how we encode and compress features.
- Find more stable methods for training.
- Plan the next study on medical image classification and get the data ready.

❖ Long-Term Plans (Aligned with Study Plan):

- Develop and optimise quantum-based and hybrid models
- Evaluate them against classical baselines
- Prepare further conference and journal papers aligned with my study plan
- Combine the findings into the dissertation



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**Thanks for your
attention**

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