TRAINEESHIP CERTIFICATE

Name of the trainee:

Tilmann Rothe Santos

Name of the receiving organisation/enterprise:

University of the Basque Country - UPV/EHU

Sector of the receiving organisation/enterprise:

Computer Science Faculty – Intelligent Systems Group **- ISG**

Address of the receiving organisation/enterprise

Paseo Manuel Lardizabal, 1

20018, Donostia / San Sebastián

Gipuzkoa, Spain

+34 943 01 50 85

joseantonio.pascual@ehu.eus

website:

http://www.sc.ehu.es/ccwbayes/

Start and end of the traineeship:

from	01.07.2023
till	16.10.2023

Traineeship title:

Research Intern in the field of Quantum Machine Learning

Detailed programme of the traineeship period including tasks carried out by the trainee:
July 3-23: Introduction to Quantum Computing and Machine Learning

- **Objective:** Build foundational knowledge in quantum computing and machine learning.
    - Welcome and orientation sessions.
    - Learn about quantum mechanics, qubits, and quantum gates.
    - Learn about quantum algorithms relevant to machine learning, such as Quantum

Support Vector Machines and Quantum Neural Networks.

July 24-August 6: Machine learning and Quantum Programming and Tools

- **Objective:** Develop practical skills in machine learning and quantum programming languages and tools.
    - Pytorch programming framework.
    - Penny Lane quantum library.

August 7-13: Research Project Initiation

- **Objective:** Comprehensively grasp and delve into the state-of-the-art aspects of the proposed project.
    - Review pertinent research papers associated with the proposed project.
    - Assess and comprehend various implementations associated with the proposed project.

August 14-October 8: Research Project Execution and Collaboration

- **Objective:** Work on the research project with regular collaboration and feedback.
    - Implement and refine the proposed quantum machine learning solution.
    - Engage in regular meetings with mentors for progress updates.

October 9-16: Final Presentation and Knowledge Transfer

- **Objective:** Conclude the traineeship with a final presentation and knowledge transfer.
    - Prepare a comprehensive presentation on the research project and its outcomes.
    - Participate in knowledge-sharing sessions with colleagues.
    - Receive feedback, address questions, and discuss potential future work.

Knowledge, skills (intellectual and practical) and competences acquired (learning outcomes achieved):

The trainee has acquired:

Knowledge:

1. **Quantum Computing Fundamentals:** Gained a comprehensive understanding of the principles of quantum mechanics, quantum gates, and qubits, forming a solid foundation for quantum machine learning endeavors.
2. **Quantum Algorithms:** Acquired knowledge of state-of-the-art quantum machine algorithms such as Quantum Support Vector Machines, Quantum Neural Networks, and variational quantum algorithms, enabling the exploration of advanced problem-solving approaches.
3. **Quantum and Machine Learning Programming:** Developed proficiency in machine learning frameworks such as pytorch and quantum programming libraries such as Penny lane.

Skills:

1. **Quantum Circuit Design:** Acquired the ability to design, simulate, and optimize quantum circuits for specific machine learning tasks, demonstrating a practical skill set in quantum algorithm implementation.

2. **Problem Analysis and Solution Design:** Developed intellectual skills in analyzing complex problems in the context of machine learning, and designing quantum solutions with the potential to outperform classical counterparts.

Learning Outcomes Achieved:

1. **Research Competence:** Successfully conducted an in-depth literature review on quantum machine learning, staying abreast of the latest advancements, and applying this knowledge to inform research directions.
2. **Collaboration and Communication:** Cultivated competences in effective collaboration within a multidisciplinary team, communicating complex machine learning and quantum concepts.
3. **Project Management:** Acquired practical competences in managing a research project, from problem definition to implementation, testing, and iterative refinement.

Overall, the undertaken research project has equipped the trainee with a well-rounded set of knowledge, skills, and competences, providing a robust foundation for further contributions to this cutting-edge field.

Evaluation of the trainee:

I am pleased to provide a positive evaluation for Tilmann Rothe Santos, who recently completed a research project as part of the Erasmus program under my supervision. Throughout the duration of the project, Tilmann exhibited exemplary qualities and contributed significantly to the overall success of the research endeavor.

The research project required a meticulous approach, and Tilman excelled in conducting thorough literature reviews, learning new technologies and implementing complex algorithms

Overall, Tilmann Rothe Santos made a substantial and positive impact on our research efforts. I have full confidence in their ability to excel in future academic and professional pursuits.

Date: November 26, 2023

Name and signature of the responsible person at the receiving organisation/enterprise:

Jose Antonio Pascual Saiz