



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

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PhD student Alessandro Di Bernardo

Quantum technology in the metrology field

Tutor: Leopoldo Angrisani

co-Tutor: Egidio De Benedetto

Cycle: XXXVII

Year: 2021/2022

My background

- MSc degree in Biomedical Engineering
- Research group: Electric and Electronic Measurements
- PhD start date: November 2021
- Scholarship type: without scholarship

Research field of interest

- **Quantum technologies (QTs)** include all those technologies based on quantum mechanics. The fields in which implementations of QT are being tested are as different as: *computing, sensors, measurements, cryptography and imaging*.
- An interesting field is that of **metrology**, in particular the possibility of improving metrological performance of sensors and instrumentation or implementing new perspectives through quantum hardware, artificial intelligence software development such as **quantum machine learning** and integration of quantum components in today's systems.



Alessandro Di Bernardo

Summary of study activities

- Briefly summarize the study activities of the academic year
 - Attended: Courses and Seminars
 - New knowledge: data mining, virtualization methods, quantum computing, Brain Computer Interface
 - New tool learning: Knime, VirtualBox, IBM Quantum Lab
 - New programming: python with quantum libraries
- Ad hoc PhD courses / schools
 - Virtualization technologies and their applications
 - Statistical data analysis for science and engineering research
 - Data science for patient records analysis
 - Metrology and Machine Learning for Brain Computer Interfaces
- Courses borrowed from MSc curricula
 - Neural Network and deep learning
- Conferences / events attended
 - Orizzonti quantistici per l'industria

Summary of study activities

	Courses	Seminars	Research	Tutorship	Total
Bimonth1	0	0.4	6	0	6.4
Bimonth2	0	1.3	7	0	8.3
Bimonth3	5	1.9	7	0	13.9
Bimonth4	4	4.9	7	0	15.9
Bimonth5	3	1.2	4	0	8.2
Bimonth6	9	0	4	0	13
TOTAL	21	9.7	35	0	65.7
<i>Expected</i>	<i>20 - 40</i>	<i>5 - 10</i>	<i>10 - 35</i>	<i>0 - 1.6</i>	

Research activity: Overview

- Problem

The question you want to answer is:

how can QT be applied in the area of metrology and how can it improve current technologies in this area?

Research activity: Overview

- Objective

Identify the way to fully exploit the potential of quantum technology in metrology, more in detail to integrate any developments in cyber-physical measurement systems (CPMSs) and in particular in healthcare field.

Research activity: Overview

- Methodology

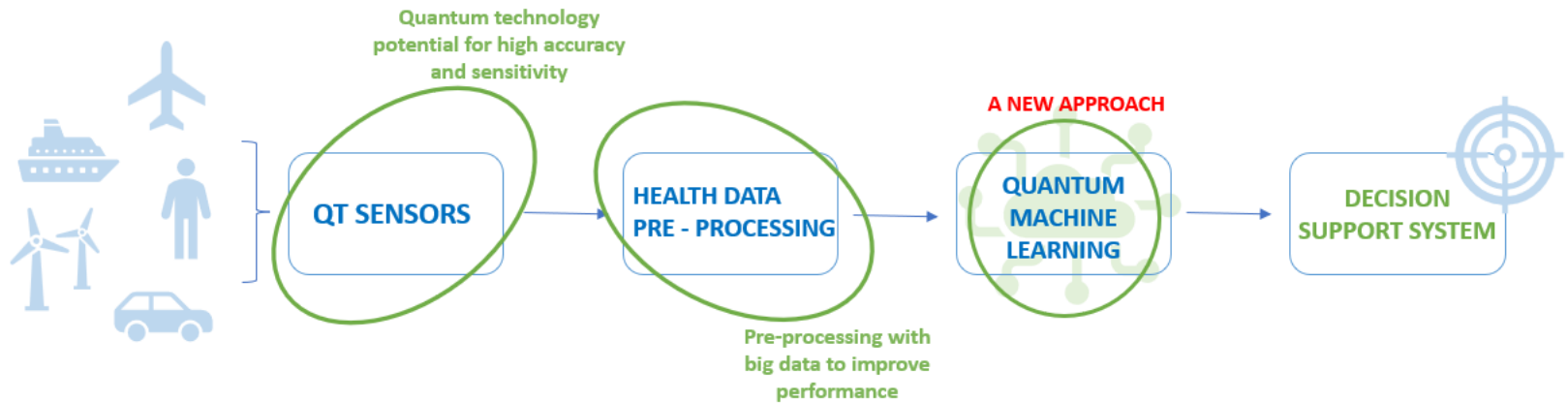
The **first step** was to analyze the state of the art and today's applications.

Second step the analysis of any developments in the hardware and software context.

Third step the addressing towards the software aspect and more specifically the QML.

Research activity: next step

- Implementation a possible proposal for application



Research activity: next step

- Use Quantum Machine Learning
 - *EEG dataset used*

How can QML improve compared to classical ML ?

Quantum Support Vector Machine
VS
Support Vector Machine

Products (if any, otherwise remove)

[P1]

• Pasquale Arpaia, Umberto Bracale, Francesco Corcione, Egidio De Benedetto, Alessandro Di Bernardo, Vincenzo Di Capua, Luigi Duraccio, Roberto Peltrini, Roberto Prevede.

“Assessment of blood perfusion quality in laparoscopic colorectal surgery by means of Machine Learning.”

Nature – Scientific Reports

Published 2022