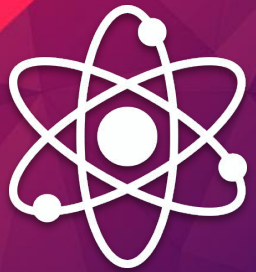
FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

NOVALINCS LABORATORY FOR COMPUTER SCIENCE AND INFORMATICS

Faculty of Sciences and Technology of
New University of Lisbon (FCT NOVA | FCT/UNL)
NOVA-LINCS (Laboratory for Computer Science and Informatics)

Learning Quantum Computing



Lecture/Lesson 0:

- *Hello Quantum World*

Rúben André Barreiro
(MSc. Computer Engineering - DI @ FCT NOVA)
Week 0 - July, 2019 | Lecture/Lesson 0

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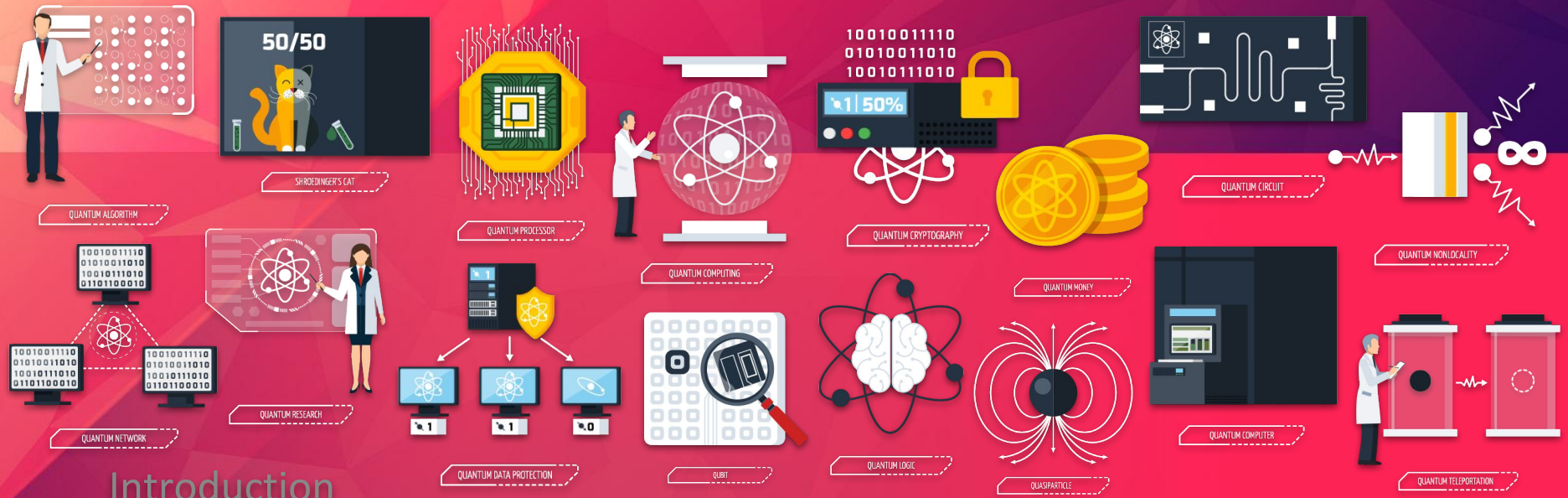
https://github.com/rubenandrebarreiro/learning-quantum-computing/



Hello Quantum World

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(MSc. Computer Engineering - DI @ FCT NOVA)

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Hello Quantum World

Brief description of this course

- This course is suited for beginners in ***Quantum Mechanics***, ***Quantum Physics*** and ***Quantum Computing***.
- If you are familiar with the basic concepts of ***Quantum Mechanics*** and ***Quantum Physics***, you are encouraged to move forward in this course, to the *Lesson/Lecture* ***TODO***.
- This course will be focused on *learning by doing*. So, don't be nervous. A little sense of humor throughout this course will help you relax.

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Brief description of this course

- Initially, it will be addressed the basic fundamentals, and concepts, of ***Quantum Mechanics***, and ***Quantum Physics***, in the basis of the study, and research on ***Quantum Computing***.
- It will be given a detailed, and complete, explanation of the ***Quantum Computing***, and its advantages, and specifications.
- It will be shown some existing prototypes of ***Quantum Computers***. It will be shown also, their specifications, and capabilities.

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Brief description of this course

- It will be explained, the architecture and components of a ***Quantum Computer***, like per examples, ***QPUs***, among others, and, how they work.
- It will be addressed how a ***Quantum Computer*** process the information, and data, making also, a reference to its processing unit, the ***Quantum Bit (or, Qubit)***, and its computation power, and capabilities.
- It will be made a comparison between ***Quantum Computing*** and ***Classical Computing***, as also, showing the differences between them.

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Brief description of this course

- It will be also addressed the history, and timeline, of the ***Quantum Computing***, as also, its current state of art, and research, in Portugal, and worldwide.
- It will be explored the many paradigm breaks that ***Quantum Computing*** promises to meet, in ***Artificial Intelligence***, ***Cryptography***, and ***Communications***, per example, and some of its applications, like ***NMRs***, among many others.

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Brief description of this course

- It will be explained some of the existing ***Quantum Algorithms***, proposed by many authors, like per example, ***David Deutsch***, ***Peter Shor***, ***Lov Grover***, among others. And it will be solved some practical exercises about them.
- It will addressed other ***Quantum Algorithms*** related to the ***QKDs***, with direct application to the ***Post-Quantum Cryptography***, proposed by ***Charles Bennett***, ***Gilles Brassard***, ***Artur Ekert***, and ***Subhash Kak***.

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Brief description of this course

- In this course, throughout its lectures/lessons, it will be used some useful programming languages like ***Riggetti's Pyquil*** (based on ***Python***), ***Microsoft's Q#***, and ***Haskell's*** host based ***Quipper***. It will be also used, the very known IBM's frameworks ***Qiskit*** and ***IBM Q Experience*** (both, also based on ***Python*** and ***Jupyter Notebook's*** environment).
- It will be resolved some exercises based on ***Quantum Computing***, using the previously mentioned tools.

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Course overview

- ***Week 0*** (***Lectures*/*Lessons 0*** and ***1***):
  - ***Lecture*/*Lesson 0*** - *Hello Quantum World (Introduction)*:
    - Brief description of this course
    - Course overview
  - ***Lecture*/*Lesson 1*** - *What is Quantum? (From Classical Physics to Quantum Physics)*:
    - Definition
    - What is an *atom*?
    - Properties of an *atom*
    - *Classical Physics/Mechanics* vs. *Quantum Physics/Mechanics*
    - Fundamentals of *Quantum Physics/Mechanics*

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Course overview

- ***Week 1*** (***Lecture/Lesson 2***):
  - ***Lecture/Lesson 2*** - *Fundamentals of the Quantum Physics (Discovering the Quantum)*:
    - *Quantum Superposition*
    - *Schrödinger's Cat Experience*
    - *Quantum Entanglement*
    - *Quantum Teleportation*
    - *Rutherford Scattering*
    - *Existence of Multiverse*
    - Interesting aspects and considerations
    - Some curiosities

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Course overview

- ***Week 2*** (***Lecture/Lesson 3***):
  - ***Lecture/Lesson 3*** - *Other Quantum properties, definitions and theories (Exploring the Quantum)* [1]:
    - *Quantum* measurement
    - State's representation
    - *Rutherford-Bohr's* model
    - Vectors and vectors' spaces
    - Operators in *Quantum Physics/Mechanics*
    - The problem of auto-vector, and auto-value
    - The physical meaning of the *Quantum* operators, as also, their auto-vectors, and auto-values

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Course overview

- ***Week 2*** (***Lecture/Lesson 3***):
  - ***Lecture/Lesson 3*** *- Other Quantum properties, definitions and theories (Exploring the Quantum)* [2]:
    - *Theory of Chaos*
    - *Quantum Chaos*

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Course overview

- ***Week 3*** (***Lectures*/*Lessons 4*** and ***5***):
  - ***Lecture*/*Lesson 4*** - *Important Quantum equations (Understanding the Quantum)*:
    - *Schrödinger's Equation*
    - *Pauli's Equation*
    - *Klein-Gordon's Equation*
    - *Dirac's Equation*
  - ***Lecture*/*Lesson 5*** - *Reviewing Quantum Physics/Mechanics (Mastering the Quantum)*:
    - Relevant contributors for the studies about *Quantum Physics/Mechanics*
    - Review about the Introduction to *Quantum Physics/Mechanics*
    - Some curiosities

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Course overview

- ***Week 4*** (***Lectures*/*Lessons 6*** and ***7***):
  - ***Lecture*/*Lesson 6*** - *What is Quantum Computing? (Beyond the Computing Limits)*:
    - *Moore Law*
    - Motivation
    - How it works?
  - ***Lecture*/*Lesson 7*** - *What is Quantum Computing? (Beyond the Computing Limits)*:
    - *Moore Law*
    - Motivation
    - How it works?

Credits and special thanks

- Ultimately, some *credits and special thanks* to:
  - TODO

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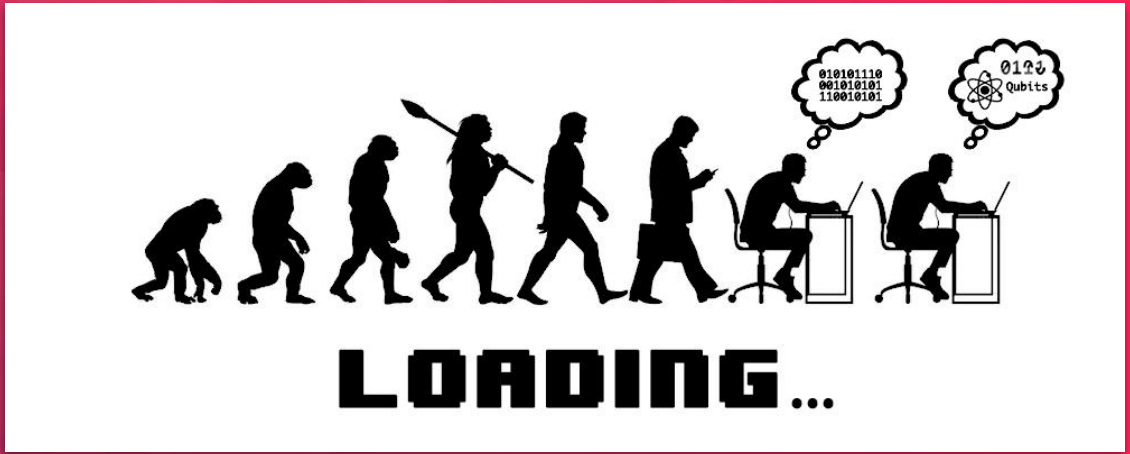
Thank you,
I hope you enjoy it!!!



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