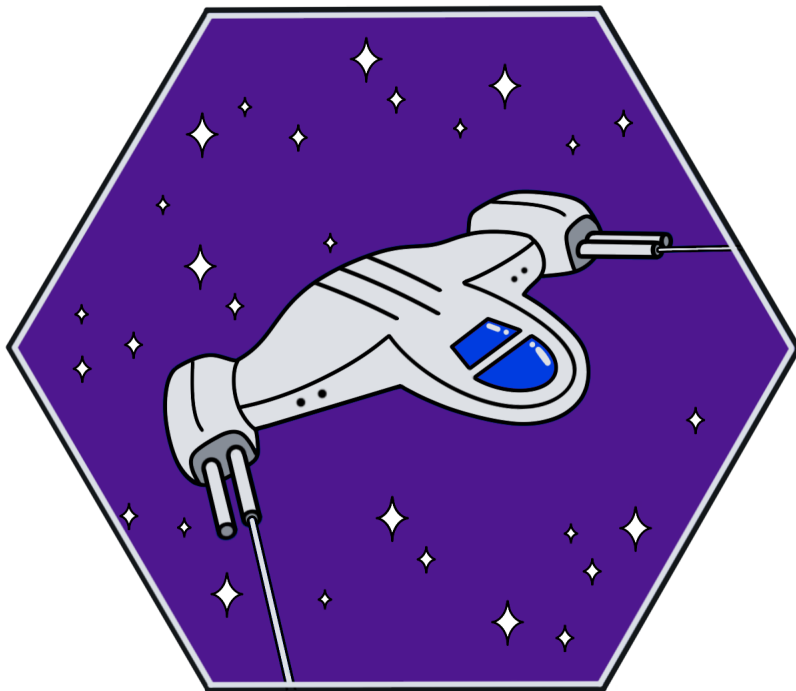


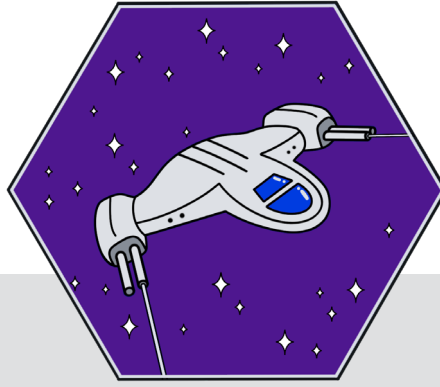
# Qiskit | Quantum Explorers

A Self-Paced Quantum Learning Journey



## **Achievement:** **SPACE COMBATANT**

Quantum Machine Learning



# QUANTUM MACHINE LEARNING

## **Achievement to unlock: Space Combatant**

This is your first space battle. There are only two choices.

You can win. Or you can be destroyed.

You encounter a rogue band of sentient starships from some distant world. The ships' AI's seem to have abandoned their organic crew and taken to piracy. They surround your starship, demand you surrender your technology and valuables, or they will blast you to smithereens. It's up to you to save your crew.

(Share your battle plans in the [#space-exploration](#) channel on Discord! Evasive maneuvers? Photon cannons? Cloaking? Share your weapons and tactics!)

Complete this module to win your first space battle, and become a Space Combatant. Your crew is counting on you.

### **In this module you will:**

- Encode data into a quantum computer
- Understand supervised quantum machine learning - variational methods and QSVM
- Understand the concept of quantum kernels, feature maps and parameterized quantum circuits
- Use Qiskit's machine learning library



# SYLLABUS

Checklist of tasks to complete and materials to learn

## Warm-up Activities

### **LIVE EVENT: Badge Kick-off - Quantum Machine Learning**

Date: September 6, 2023 [[time](#)] [[video recording link](#)]

Agenda

- What is machine learning?
- Why should we care about quantum machine learning?
- Examples of classical and quantum machine learning
- Introduction to Qiskit Machine Learning tools

[[demo notebook link](#)] [[glossary](#)]

### **Introduction to Classical Machine Learning**

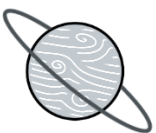
#### **VIDEO: Machine Learning Basics** [[link](#)]

The core machine learning concepts that we will be exploring further within this module.

#### **VIDEO: Computer Scientist Explains Machine Learning in 5 Levels of Difficulty** [[link](#)]

WIRED YouTube video featuring Hidden Door cofounder and CEO Hilary Mason

Online Version of Syllabus



# SYLLABUS (CONT'D)

## Main Activities

### **VIDEO: Quantum Machine Learning Explained** [\[link\]](#)

A brief introduction to quantum machine learning and feature maps.

### **QISKIT COURSE: Quantum Machine Learning** [\[link\]](#)

Please complete the “Introduction” section in this course.

### **VIDEO: Building a Quantum Classifier** [\[link\]](#)

Lecture from the QGSS 2021 by Amira Abbas explaining the core components to construct a quantum classifier.

### **VIDEO: Introduction to Qiskit Machine Learning Module** [\[link\]](#)

Demo of the Qiskit Machine Learning module by Anton Dekusar with code examples. (Starting from timestamp 31:02).

### **QISKIT COURSE: Quantum Machine Learning** [\[link\]](#)

Please complete the sections from “Parameterized quantum circuits” up to and including “Variational classification.”

### **VIDEO: Quantum Machine Learning— Programming on Quantum Computers** [\[link\]](#)

Coding with Qiskit S2E6 Video tutorial by Jin-Sung Kim on how to code up a Quantum Support Vector Machine.

### **QISKIT COURSE: Quantum Machine Learning** [\[link\]](#)

Please complete the “Quantum feature maps and kernels” section.

### **LAB: Introduction to Classical and Quantum Machine Learning** [\[link\]](#)

Jupyter notebook to practice the machine learning techniques you just learned, focusing on QSVC.

### **VIDEO: A Path to Near-term Quantum Advantage with QML models** [\[link\]](#)

Outline of the quantum advantages that quantum machine learning models could offer over classical methods by Alejandro Perdomo-Ortiz.

# ADVANCED SYLLABUS

Optional advanced additional materials

## ■ **QISKIT COURSE: Quantum Machine Learning** [\[link\]](#)

Please complete the “Unsupervised learning” section.

## ■ **VIDEO: Quantum Neural Networks Simplified** [\[link\]](#)

Video introducing classical neural networks and quantum neural networks by Sundarappan Kathiresan.

## ■ **VIDEO: Are Quantum Neural Networks Actually Relevant?** [\[link\]](#)

Video by Amira Abbas about the potential of quantum neural networks and what they have to offer.

## ■ **LAB: Introduction to Quantum Neural Network Techniques** [\[link\]](#)

Jupyter notebook to practise using the Qiskit machine learning modules for quantum neural network models.

## ■ **TUTORIAL: Neural Network Classifier & Regressor** [\[link\]](#)

Jupyter notebook tutorial showing how the NeuralNetworkClassifier and NeuralNetworkRegressor are used.

## ■ **QISKIT COURSE: Quantum Machine Learning** [\[link\]](#)

Please complete the “Quantum generative adversarial networks” section.

## ■ **VIDEO: Quantum Machine Learning from Algorithms to Hardware** [\[link\]](#)

Sona Najaf introduces novel quantum generative algorithms, theoretically proves quantum many body localized dynamics possess more expressive power than classical models, and discusses quantum neuromorphic computing.

## ■ **VIDEO: Model Capacity in Machine Learning** [\[link\]](#)

Methods to measure capacity in machine learning models by Amira Abbas. This video will not form part of the assessment - please just enjoy and take something new from it.

# ADVANCED SYLLABUS (CONT'D)

## ■ VIDEO: Barren Plateaus and Overparametrization in Quantum Neural Networks [[link](#)]

How Lie algebra can be used to help combat barren plateaus and overparameterization in QNNs by Marco Cerezo. This video will not form part of the assessment - please just enjoy and take something new from it!

## ■ VIDEO: Towards Geometric Quantum Machine Learning [[link](#)]

A more advanced video introducing the design of geometric QML architectures by Marco Cerezo. This video will not form part of the assessment - please just enjoy and take something new from it!



# RESOURCES

## Supplementary Materials

### **VIDEO: Essence of Linear Algebra** [\[link\]](#)

A great video series walk-through of linear algebra by 3brown1blue with helpful graphical visualizations.

### **VIDEO: Probability Theory** [\[link\]](#)

A video series introducing the topic of probability theory, a useful prerequisite to the probabilistic nature of quantum mechanics.

### **GLOSSARY: QML Glossary** [\[link\]](#)

Definitions of terms that you will come across when learning about Quantum Machine Learning.

### **COURSE: Introduction to Machine Learning - Udacity MOOC** [\[link\]](#)

An introductory machine learning MOOC (massive open online course) by Udacity, stepping you through the fundamental concepts of machine learning.

### **COURSE: Qiskit Global Summer School 2021** [\[link\]](#)

The QGSS 2021 was focused on quantum machine learning starting from classical machine learning techniques to advanced techniques.

### **COURSE: Quantum Machine Learning MOOC - University of Toronto** [\[link\]](#)

Quantum Machine learning course by Peter Wittek, explaining the mathematics behind the algorithms used in QML.

### **VIDEO: Quantum Machine Learning: Prospects and challenges** [\[link\]](#)

This video by Amazon highlights the applications of quantum machine learning and how to take advantage of it while the hardware catches up.



# UNLOCK YOUR BADGE

## QUIZ

Ready to test your knowledge and unlock your achievement?

Return to the Quantum Explorers portal.

Quantum Explorers Portal

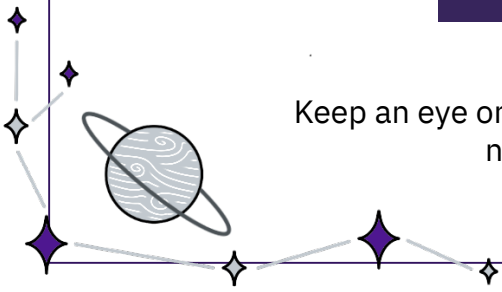
## PASSED?

### Congratulations!

Download your badge image using the password revealed on passing the quiz.

Then share your achievement in the [#level-up](#) channel on Discord.

Badge Download



Keep an eye on the [#announcements](#) channel for details about the next modules and Badge achievements.



# NOTES

