Quantum Support Vector Machine in HEALTHCARE

Réalise par:

BENBOUAZZA SOUHAIB
IKKEN NADA
SAIDI HANAN

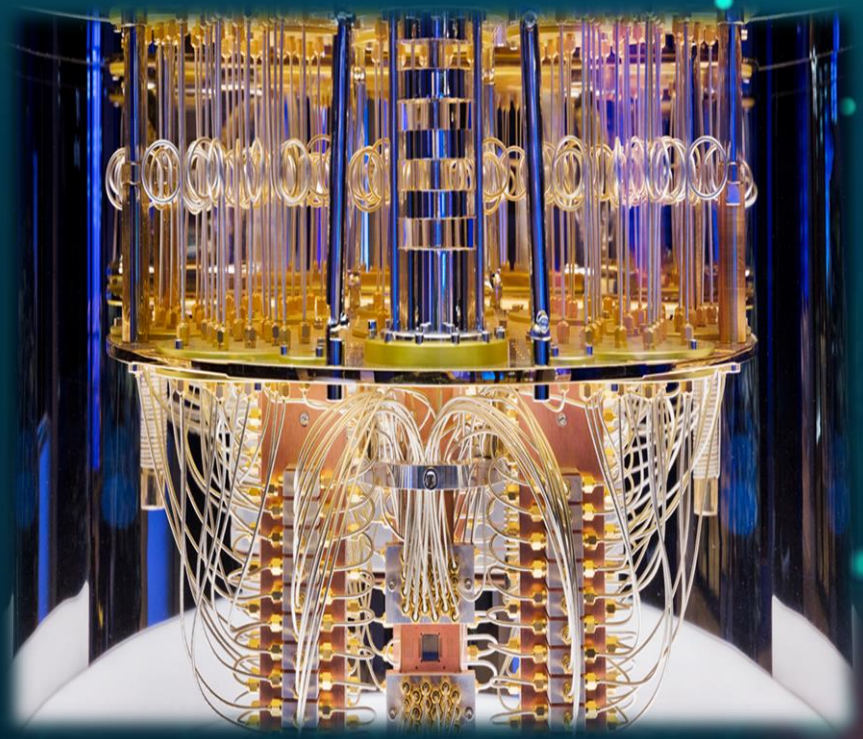
Quantum Computing

01

What is quantum computing ?

- **Quantum computing** refers to computation that uses the principles of quantum physics.

- A **quantum computer** is a machine that performs calculations based on the laws of quantum mechanics, which is the behavior of particles at the sub-atomic level.



What would a quantum computer do?

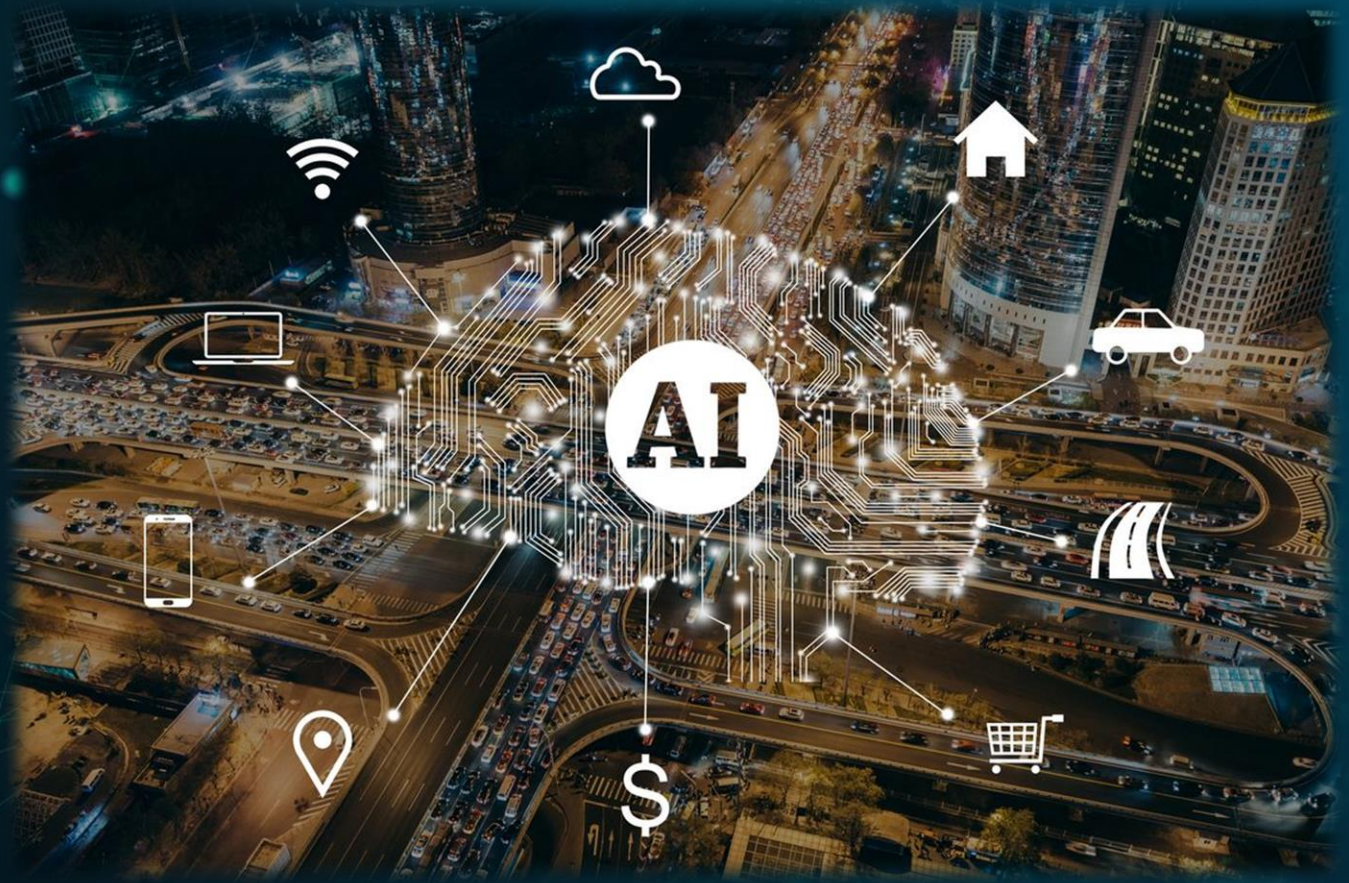
A quantum computer could handle more problems. Instead of counting the definite problem, it calculates the possible solution for that problem, regardless of the type. That possibility has a certain amplitude for it to be the right solution. For this to work, the computing system should be in the superposition state.

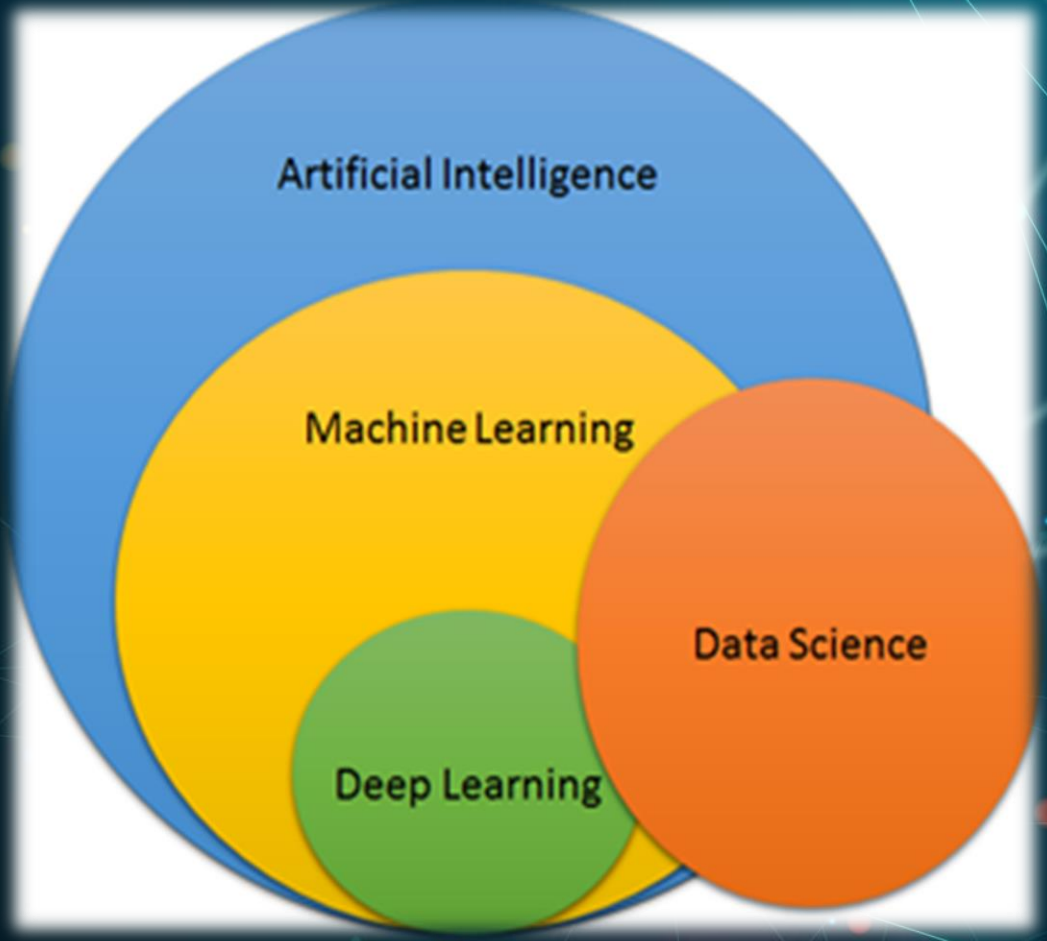
Here are the three important divisions in the computer system:

- A specific area to house the qubits
- The approach to transfer signals to the qubits
- A classical computing machine to send instructions towards the system

machine learning

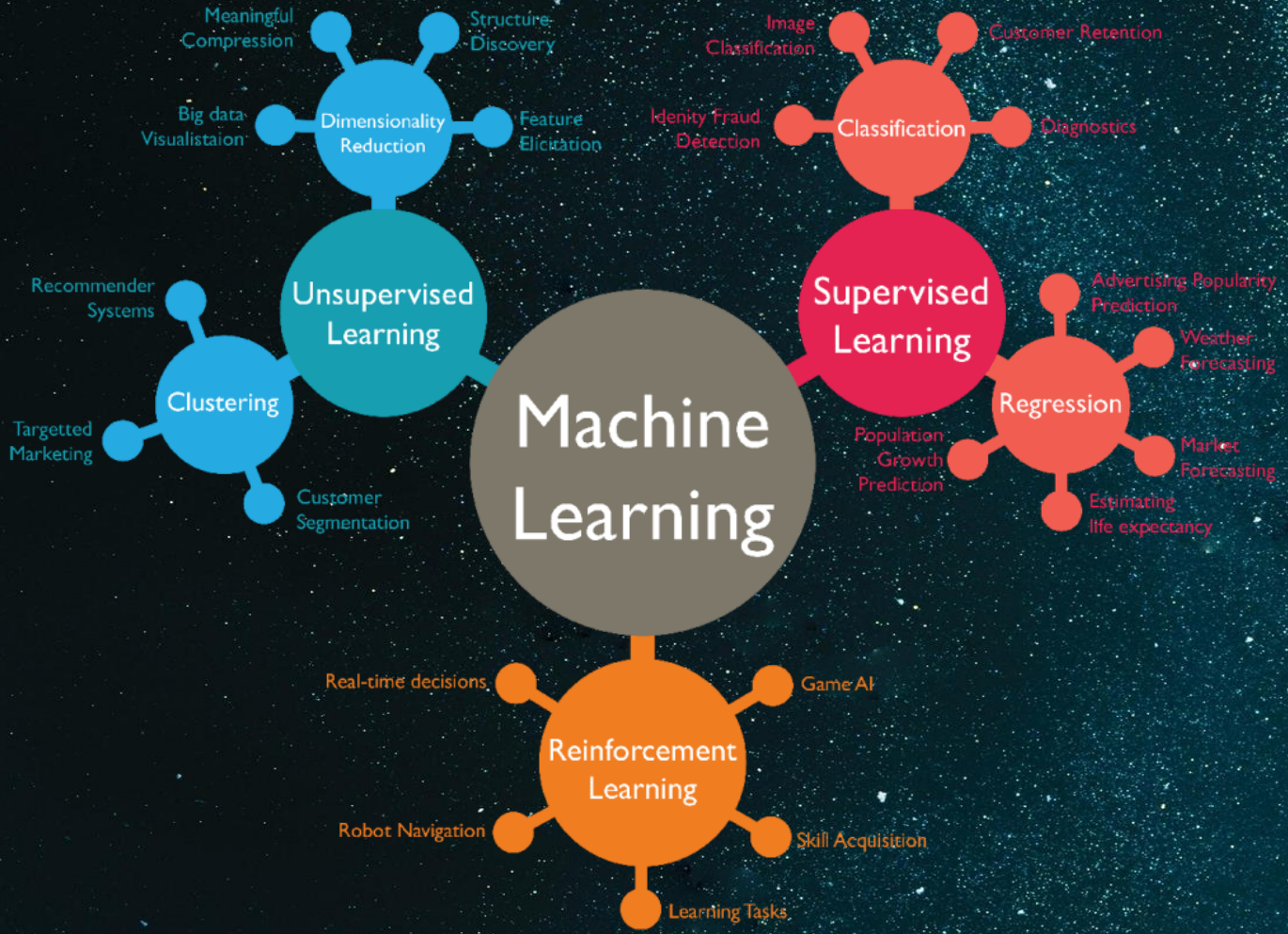
02


AI

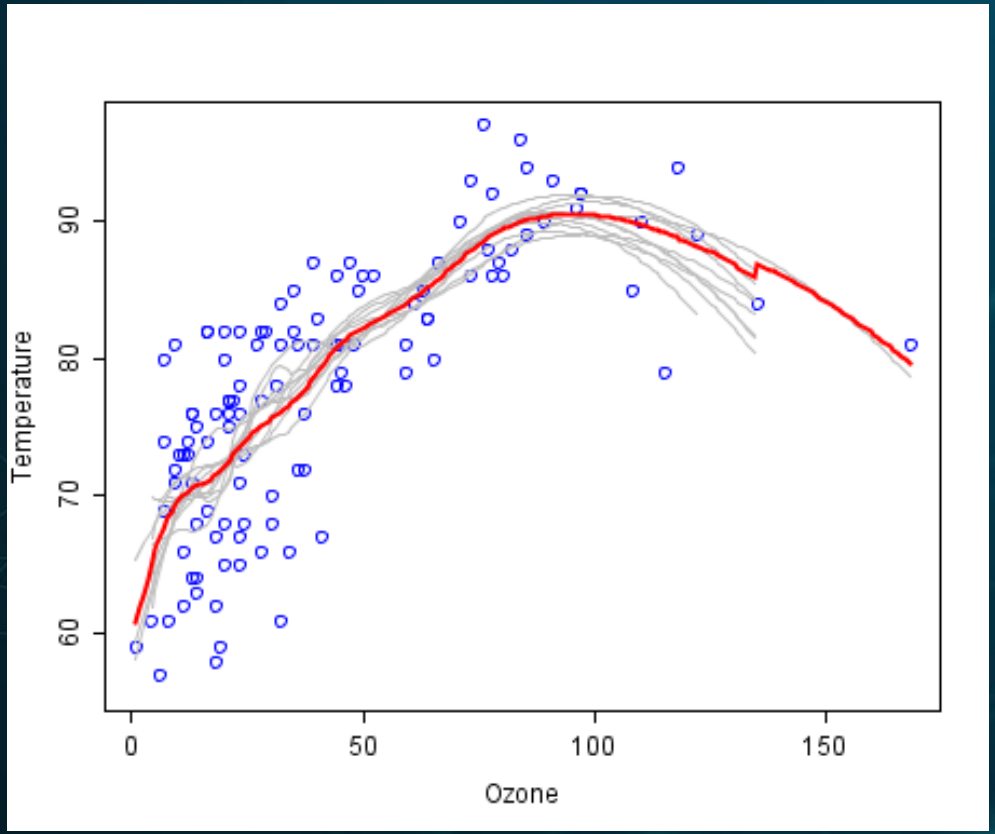

Artificial Intelligence
Machine Learning
Deep Learning
Data Science

MACHINE LEARNING

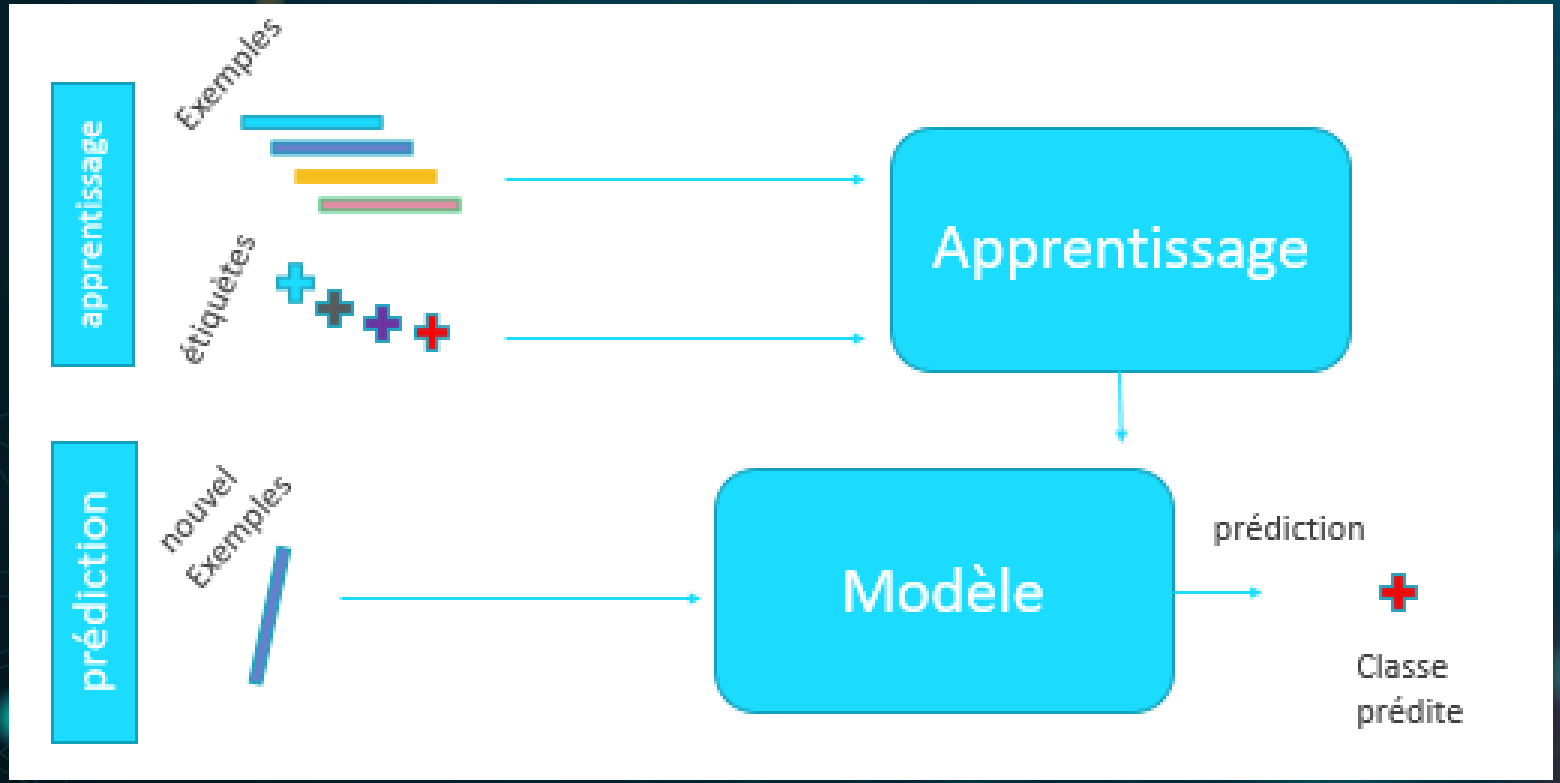
«Machine Learning is a process encompassing a set of techniques to get machines to learn from data instead of executing instructions contained in algorithms».


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Feature Elicitation
Big data Visualisaion
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Identity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Market Forecasting
Estimating life expectancy
Population Growth Prediction
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Regression

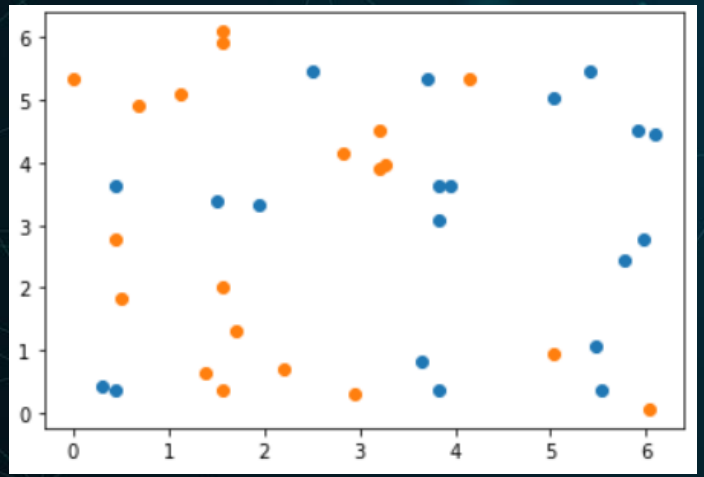


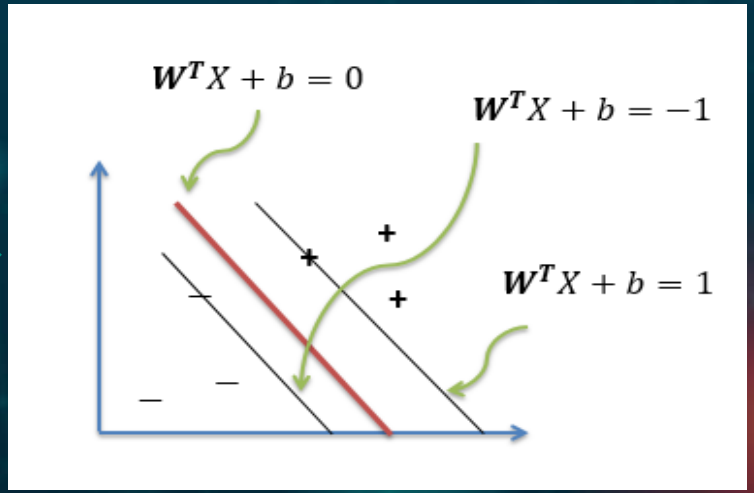
CLASSIFICATION



implementation 04

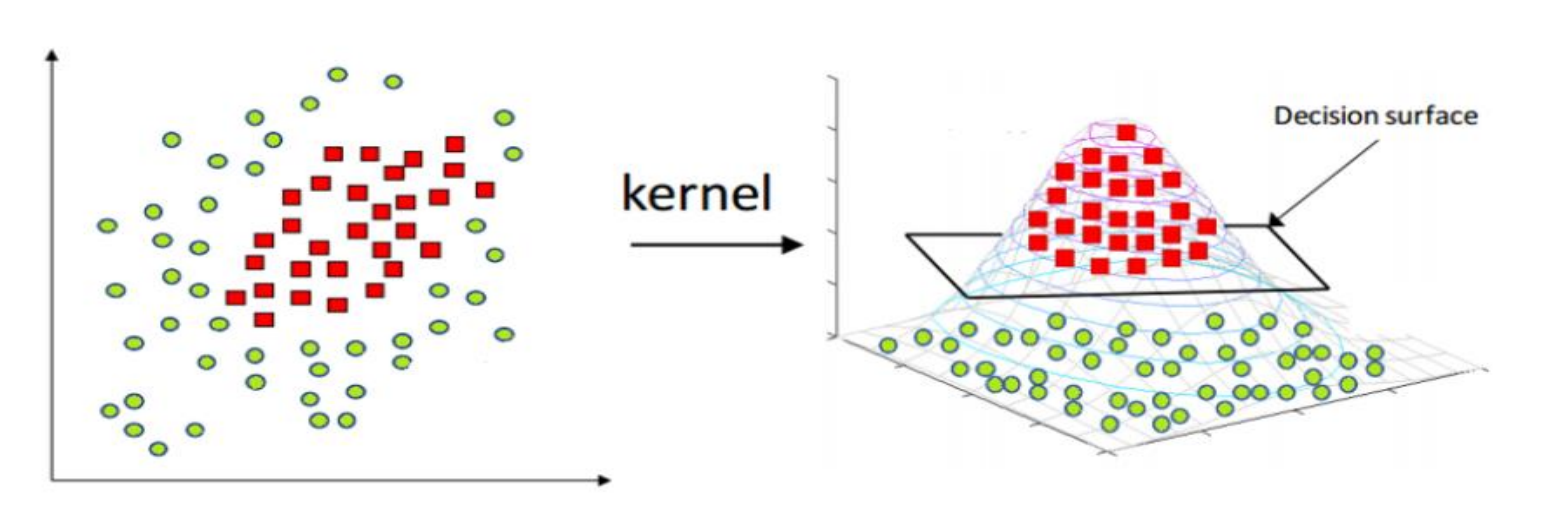
- A well-known machine learning technique for categorizing data into labels is called the Support Vector Machine (SVM). The goal of SVM, which was created in the 1960s, is to locate the hyperplane that maximizes the width of the "street" that separates the labels from the data.
- The scenario when there are two characteristics in the data is depicted in the above graphic. SVM will try to discover the optimal plane for three features, and the best hyperplane for four or more features.





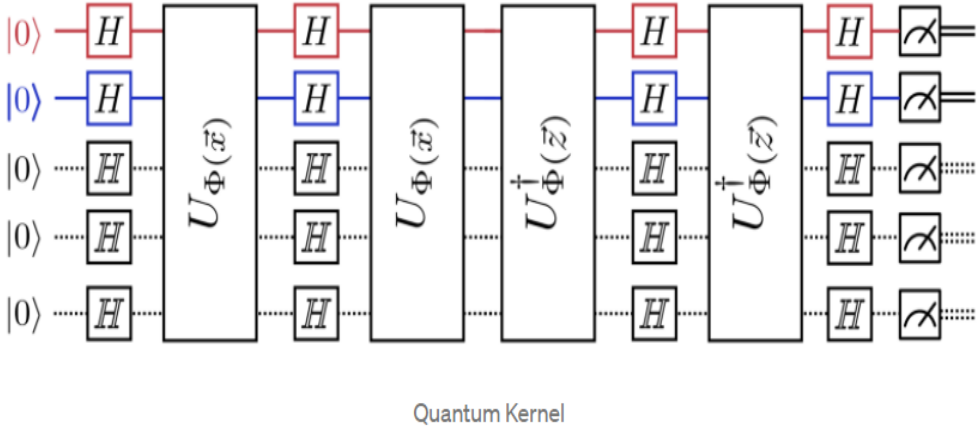
Kernel

A kernel is a mapping feature that converts data points into a different domain, making the dataset in this case easier to categorize.
SVM simply requires the dot products between the feature vector and the weight vector in the kernel function, as stated by the optimization equation, even if computing the mapping may be highly computationally intensive. Because of this, kernels are very helpful in more accurately identifying complicated datasets.



Quantum Kernel

Utilizing quantum mechanics to improve performance while mapping the feature vector is the principle behind quantum kernels.
Encoding classical data into qubits, carrying out operations (such superposition and rotations in the Bloch sphere), and then computing the dot product of the resultant states are the general rules for this type of mapping.



Quantum Kernel

$$U_{\Phi(\vec{x})} = \exp\left(i \sum_{S \subseteq [n]} \phi_S(\vec{x}) \prod_{i \in S} Z_i\right)$$

Unitary gate for a classical feature function ϕ

Here, U is a unitary gate that takes the feature vector as a parameter, where S is the test dataset:

Description

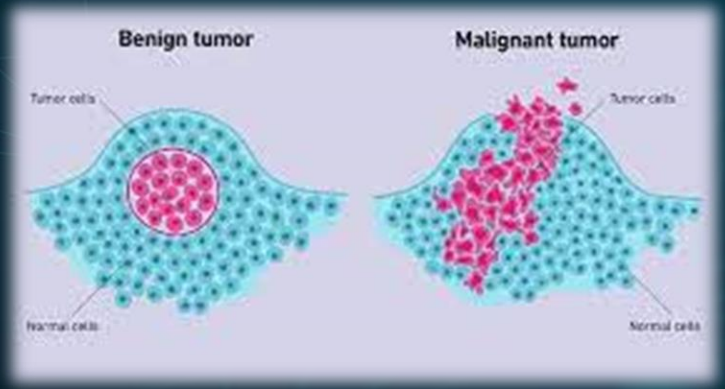
As you may already now tumors nowdays has been affected a lot of people among us (our family, friends,...) and the process to recognise them through our bodies may take a lot of time and exepnsive and sometime its been too late to do so.

and the idea of this project is to use the revolution of AI and ML algorithms and their best use cases to solve one of these problems linked to tumors (specifically Breast cancer).

in this project we are trying to impliment a Quantum machine learning algorithms based on Qiskit and IBM computing envirenement for vreast cancer classification(either is Benign tumor/Malignt tumor).

So as results it will help our patients get a medical traitement as soos as they can.

for the sake of that we are we will be using data from the sklearn library that have



	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points	mean symmetry	mean fractal dimension	...	worst radius	worst texture	worst perimeter	worst area	wor smoothne
0	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.14710	0.2419	0.07871	...	25.380	17.33	184.60	2019.0	0.162
1	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.07017	0.1812	0.05667	...	24.990	23.41	158.80	1956.0	0.123
2	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.12790	0.2069	0.05999	...	23.570	25.53	152.50	1709.0	0.144
3	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.10520	0.2597	0.09744	...	14.910	26.50	98.87	567.7	0.209
4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	0.1809	0.05883	...	22.540	16.67	152.20	1575.0	0.137
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
564	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890	0.1726	0.05623	...	25.450	26.40	166.10	2027.0	0.141
565	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791	0.1752	0.05533	...	23.690	38.25	155.00	1731.0	0.116
566	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302	0.1590	0.05648	...	18.980	34.12	126.70	1124.0	0.113
567	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200	0.2397	0.07016	...	25.740	39.42	184.60	1821.0	0.165
568	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	0.1587	0.05884	...	9.456	30.37	59.16	268.6	0.089

```
array(['mean radius', 'mean texture', 'mean perimeter', 'mean area',
       'mean smoothness', 'mean compactness', 'mean concavity',
       'mean concave points', 'mean symmetry', 'mean fractal dimension',
       'radius error', 'texture error', 'perimeter error', 'area error',
       'smoothness error', 'compactness error', 'concavity error',
       'concave points error', 'symmetry error',
       'fractal dimension error', 'worst radius', 'worst texture',
       'worst perimeter', 'worst area', 'worst smoothness',
       'worst compactness', 'worst concavity', 'worst concave points',
       'worst symmetry', 'worst fractal dimension'], dtype='<U23')
```

Rusoltes

After data preparation and all the steps the performance of our algorithm has improver from 88 % to 93 % accuracy

```
[16] from qiskit_machine_learning.algorithms import PegasosQSVC

     pegasos_qsvc = PegasosQSVC(quantum_kernel=qkernel, C=C, num_steps=tau)

     # training
     pegasos_qsvc.fit(train_features, train_labels)

     # testing
     pegasos_score = pegasos_qsvc.score(test_features, test_labels)
     print(f"PegasosQSVC classification test score: {pegasos_score}")

     PegasosQSVC classification test score: 0.9300699300699301
```

FUTURE EXPECTATION

05

Thanks For Your Attention