WiseCoder
QUANTUM COMPUTER
SVM

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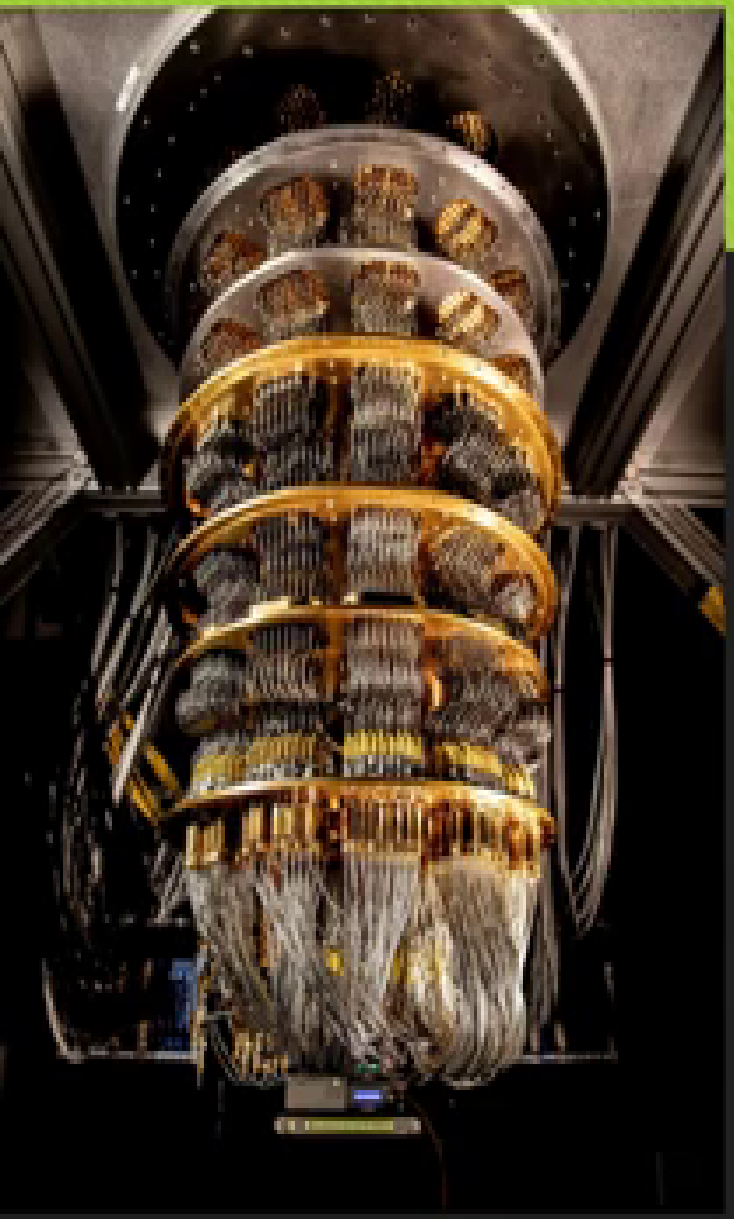
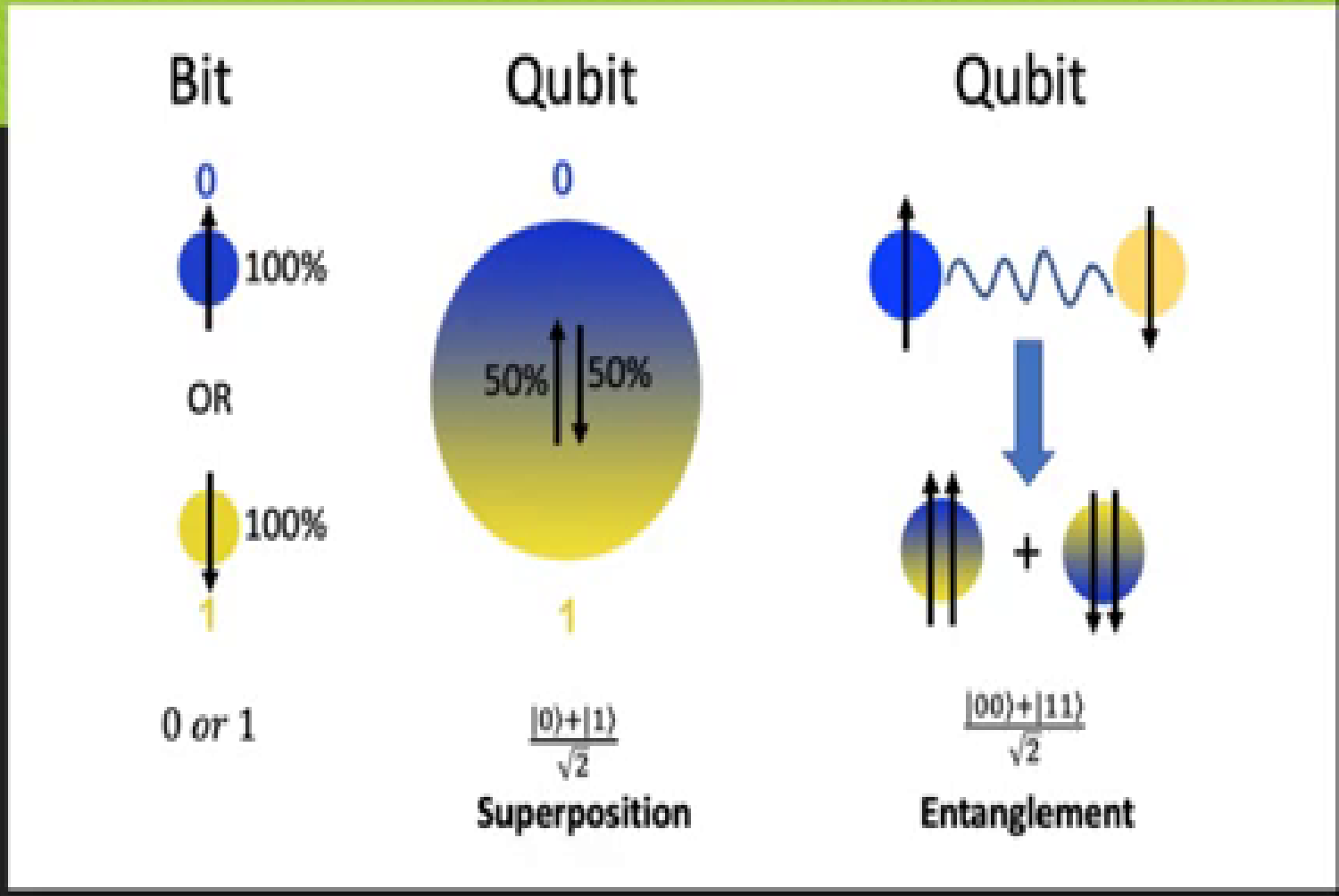
SVM

00:00:50

WiseCoder





00:01:56

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Traditional Computers Vs Quantum Computers

Feature	Traditional Computers	Quantum Computers
Basic Unit	Bit ("0" or "1")	Qubit ("0", "1", or both simultaneously)
Information Processing	Deterministic (linear)	Probabilistic (parallel due to superposition)
Computation Power	Limited to sequential or parallel	Exponentially faster for specific problems
Data Representation	Binary	Quantum states
Error Rate	Very low	High, requires error correction
Applications	Everyday tasks, complex but solvable problems	Quantum simulations, cryptography, optimization
Development Stage	Mature, widespread	Early-stage, still developing

00:02:33
WiseCoder

What is Quantum Machine Learning?

- Quantum Machine Learning (QML) combines the concepts of quantum computing with machine learning. The idea is to use quantum algorithms to enhance classical machine learning tasks, such as classification, clustering, and regression. Today, we'll focus on using quantum kernels for support vector classification.

- However, QML still faces challenges, such as hardware limitations, noise, and the need for robust algorithms that can handle practical data. While it's a promising field, most current work is in the research stage, and we're still some way from fully integrating quantum machine learning into mainstream applications.

00:02:35

QSVM_diabetes.ipynb

```
from sklearn.decomposition import PCA
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, classification_report
from qiskit_aer import Aer
from qiskit.circuit.library import ZZFeatureMap
from qiskit_machine_learning.algorithms import QSVC
from qiskit_machine_learning.kernels import FidelityQuantumKernel
```

Data Loading and Preprocessing

```
data = pd.read_csv('diabetes.csv')
data.head()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

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QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

```
data.describe().transpose()
```

	count	mean	std	min	25%	50%	75%	max
Pregnancies	768.0	3.845052	3.369578	0.000	1.00000	3.0000	6.00000	17.00
Glucose	768.0	120.894531	31.972618	0.000	99.00000	117.0000	140.25000	199.00
BloodPressure	768.0	69.105469	19.355807	0.000	62.00000	72.0000	80.00000	122.00
SkinThickness	768.0	20.536458	15.952218	0.000	0.00000	23.0000	32.00000	99.00
Insulin	768.0	79.799479	115.244002	0.000	0.00000	30.5000	127.25000	846.00
BMI	768.0	31.992578	7.884160	0.000	27.30000	32.0000	36.60000	67.10
DiabetesPedigreeFunction	768.0	0.471876	0.331329	0.078	0.24375	0.3725	0.62625	2.42
Age	768.0	33.240885	11.760232	21.000	24.00000	29.0000	41.00000	81.00

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QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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Gemini

```
[ ] !pip install qiskit qiskit-aer qiskit-machine-learning
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Requirement already satisfied: qiskit in /usr/local/lib/python3.10/dist-packages (1.2.0)
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QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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Files

..

sample_data

diabetes.csv

Disk 207.97 GB available

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Gemini

```
[ ] !pip install qiskit qiskit-aer qiskit-machine-learning
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Requirement already satisfied: qiskit in /usr/local/lib/python3.10/dist-packages (1.2.0)
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QSVM_diabetes.ipynb

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QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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```

Change runtime type

Runtime type

Python 3

Hardware accelerator

- CPU
- T4 GPU
- A100 GPU
- L4 GPU
- TPU v2

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```
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00:03:33

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QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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Gemini

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```

Importing Dependancies

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, classification_report
from qiskit_aer import Aer
from qiskit.circuit.library import ZZFeatureMap
from qiskit_machine_learning.algorithms import QSVC
from qiskit_machine_learning.kernels import FidelityQuantumKernel
```

Data Loading and Preprocessing

00:03:49

JiseCoder

QSVM_diabetes.ipynb - Colab

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QSVM_diabetes.ipynb

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Data Loading and Preprocessing

```
data = pd.read_csv('diabetes.csv')
data.head()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

```
data.describe().transpose()
```

	count	mean	std	min	25%	50%	75%	max
Pregnancies	768.0	3.845052	3.369578	0.000	1.00000	3.0000	6.00000	17.00

00:03:55
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```
data.describe().transpose()
```

	count	mean	std	min	25%	50%	75%	max
Pregnancies	768.0	3.845052	3.369578	0.000	1.00000	3.0000	6.00000	17.00
Glucose	768.0	120.894531	31.972618	0.000	99.00000	117.0000	140.25000	199.00
BloodPressure	768.0	69.105469	19.355807	0.000	62.00000	72.0000	80.00000	122.00
SkinThickness	768.0	20.536458	15.952218	0.000	0.00000	23.0000	32.00000	99.00
Insulin	768.0	79.799479	115.244002	0.000	0.00000	30.5000	127.25000	846.00
BMI	768.0	31.992578	7.884160	0.000	27.30000	32.0000	36.60000	67.10
DiabetesPedigreeFunction	768.0	0.471876	0.331329	0.078	0.24375	0.3725	0.62625	2.42
Age	768.0	33.240885	11.760232	21.000	24.00000	29.0000	41.00000	81.00
Outcome	768.0	0.348958	0.476951	0.000	0.00000	0.0000	1.00000	1.00

Splitting data into features and labels

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Splitting data into features and labels

```
# Prepare data for quantum classifier
X = data.iloc[:, :-1].values
y = data['Outcome'].values
```

```
# Normalize features
scaler = StandardScaler()
X = scaler.fit_transform(X)

# PCA for Visualization
pca = PCA(n_components=4)
X_pca = pca.fit_transform(X)

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X_pca, y, test_size=0.1, random_state=2)
```

```
# Define quantum kernel and classifier
feature_map = ZZFeatureMap(feature_dimension=2, entanglement='linear', reps=2)
quantum_kernel = FidelityQuantumKernel(feature_map=feature_map)
```

00:05:02

QSVM_diabetes.ipynb

```
# Define quantum kernel and classifier
feature_map = ZZFeatureMap(feature_dimension=2, entanglement='linear', reps=2)
quantum_kernel = FidelityQuantumKernel(feature_map=feature_map)
```

Training the QSVM Classifier (Quantum Suppport Vector Classifier)

```
# Use the kernel in a QSVC model
classifier = QSVC(quantum_kernel=quantum_kernel)
classifier.fit(X_train, y_train)
```

```
QSVC(C=1.0, break_ties=False, cache_size=200, class_weight=None, coef0=0.0,
     decision_function_shape='ovr', degree=3, gamma='scale', max_iter=-1,
     probability=False,
     quantum_kernel=<qiskit_machine_learning.kernels.fidelity_quantum_kernel.FidelityQuantumKernel object at 0x79403555e140>,
     random_state=None, shrinking=True, tol=0.001, verbose=False)
```

Model Evaluation

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Model Evaluation

```
# Make predictions and evaluate
y_pred = classifier.predict(X_test)
print(f"Accuracy: {accuracy_score(y_test, y_pred)}")
print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.6493506493506493
              precision    recall  f1-score   support

           0       0.66      0.96      0.78        51
           1       0.33      0.04      0.07        26

    accuracy                           0.65        77
   macro avg       0.50      0.50      0.43        77
weighted avg       0.55      0.65      0.54        77
```

Building Predictive Model

```
def predict_diabetes(new_data):
```

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Building Predictive Model

```
def predict_diabetes(new_data):
    # Normalize the new data
    new_data_normalized = scaler.transform(new_data)

    new_data_reduced = pca.transform(new_data_normalized)

    # Make prediction
    prediction = classifier.predict(new_data_reduced)

    # Map prediction to label
    return 'Positive' if prediction[0] == 1 else 'Negative'
```

```
# Example new data (replace with actual data)
new_data = np.array([[6, 148, 72, 35, 0, 33.6, 0.627, 50]])

# Predict and print the result
print(predict_diabetes(new_data))
```

```
Positive
```

00:06:11

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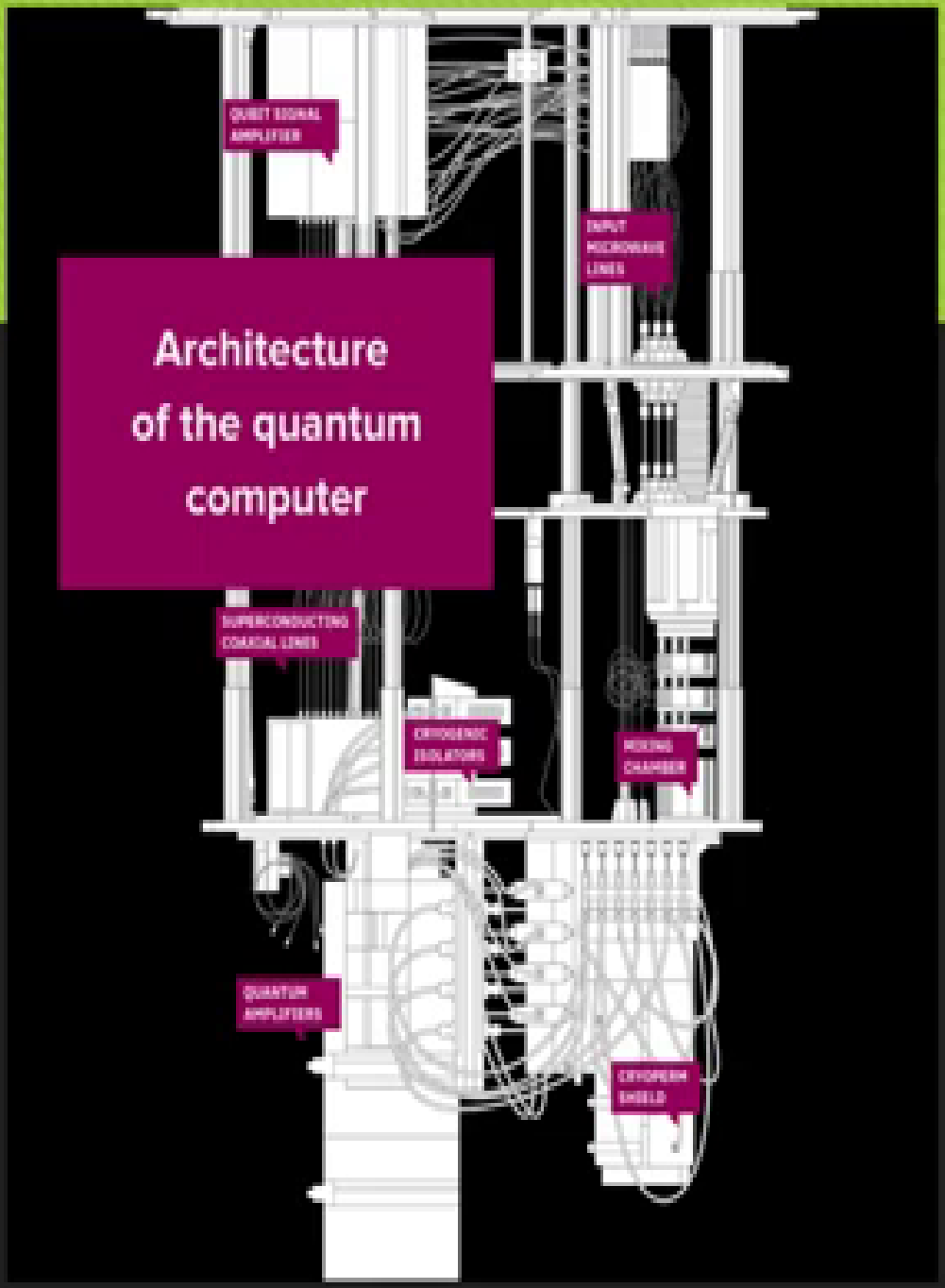
Quantum computers are still in their early stages, and issues like noise, qubit coherence, and scalability are real obstacles. Moreover, current quantum hardware is limited, so running complex machine learning models on them is challenging.

However, the future of quantum machine learning looks promising. As hardware improves and quantum algorithms become more refined, we expect to see significant advancements, especially in fields like drug discovery, optimization, and cryptography.



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Future of Quantum Computers

In future, a Quantum Computer may be capable of Simulating a virtual universe inside it and apply countless combinations to solve problems such as Cancer, Pandemic, Cryptography and firewalls, or May be Time Travel. And it can do all of them in matter of minutes or less.

00:06:39

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