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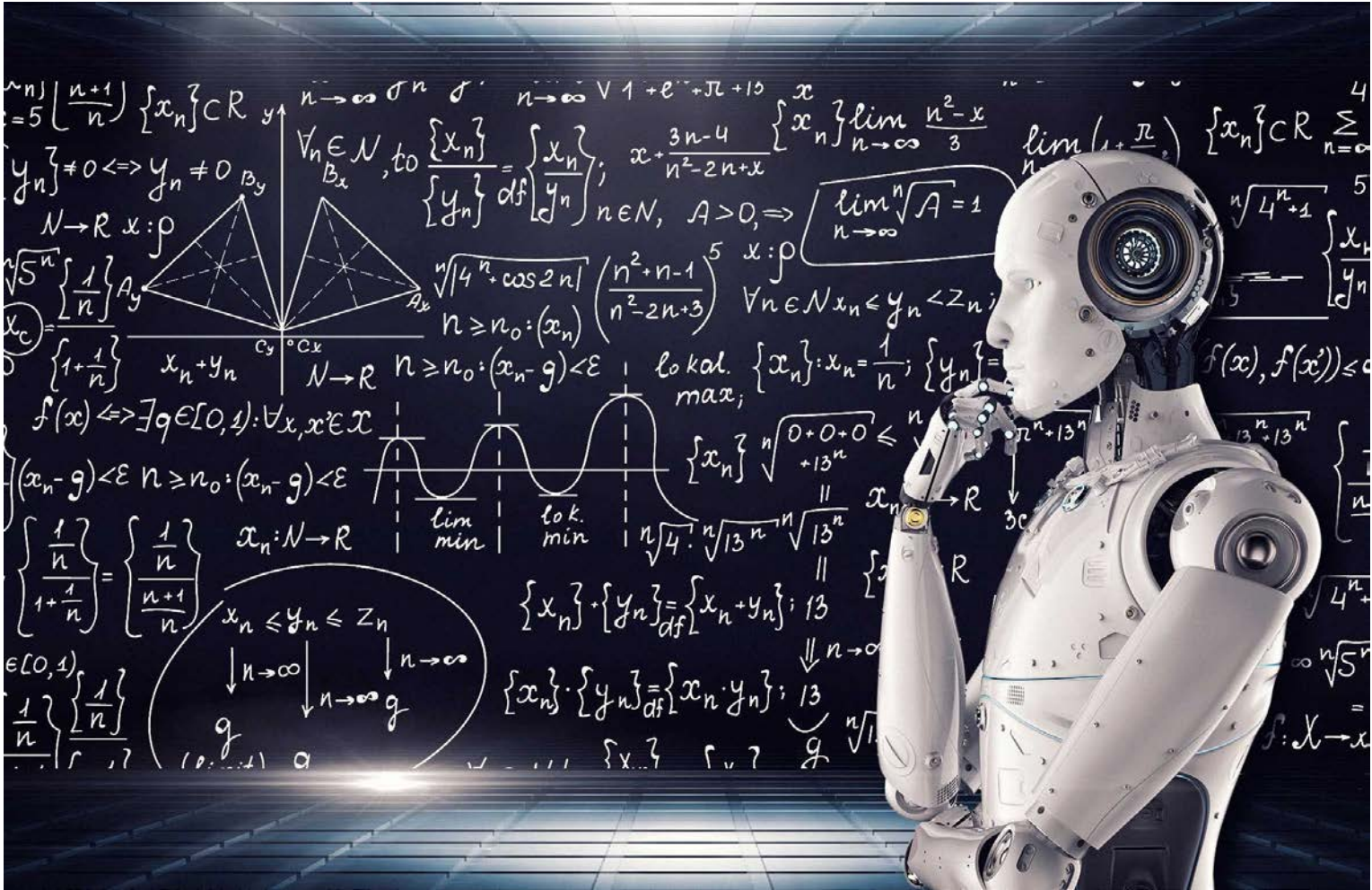
# QUANTUM MACHINE LEARNING IN CYBERSECURITY

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05.09.2023



# QUANTUM SOCIETY AUSTRIA



$\{x_n\} \subset \mathbb{R}$ ,  $y_n \neq 0 \Leftrightarrow y_n \neq 0$ ,  $N \rightarrow \mathbb{R} x: \rho$ ,  $\sqrt[n]{5^n} \left\{ \frac{1}{n} \right\} A_y$ ,  $\{x_n\} \subset \mathbb{R}$ ,  $\lim_{n \rightarrow \infty} \frac{n^2 - x}{3}$ ,  $\lim_{n \rightarrow \infty} \left(1 + \frac{\pi}{n}\right)$ ,  $\{x_n\} \subset \mathbb{R}$ ,  $\sum_{n=0}^4$

$\forall n \in \mathbb{N}$ , to  $\{x_n\} = \{y_n\}$ ;  $x + \frac{3n-4}{n^2-2n+x}$ ,  $\lim_{n \rightarrow \infty} \sqrt[n]{A} = 1$ ,  $\sqrt[n]{4^{n+1}}$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

$N \rightarrow \mathbb{R} x: \rho$ ,  $\sqrt[n]{4^n \cos 2n}$ ,  $\left( \frac{n^2+n-1}{n^2-2n+3} \right)^5$ ,  $x: \rho$ ,  $\forall n \in \mathbb{N} x_n < y_n < z_n$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

$\{x_n\} \subset \mathbb{R}$ ,  $x_n + y_n$ ,  $N \rightarrow \mathbb{R} n \geq n_0: (x_n - g) < \epsilon$ ,  $\text{lokal. } \{x_n\}: x_n = \frac{1}{n}$ ;  $\{y_n\} =$ ,  $f(x), f(x') \leq c$

$f(x) \Leftrightarrow \exists q \in [0, 1]: \forall x, x' \in X$ ,  $\{x_n\} \subset \mathbb{R}$ ,  $\sqrt[n]{0+0+0} \leq \frac{n}{n+13^n}$ ,  $x_n \rightarrow \mathbb{R}$ ,  $\sqrt[n]{4^n} \cdot \sqrt[n]{13^n} \cdot \sqrt[n]{13^n}$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

$(x_n - g) < \epsilon$ ,  $n \geq n_0: (x_n - g) < \epsilon$ ,  $\lim_{n \rightarrow \infty} \min$ ,  $\text{lok. min}$ ,  $\sqrt[n]{4^n} \cdot \sqrt[n]{13^n} \cdot \sqrt[n]{13^n}$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

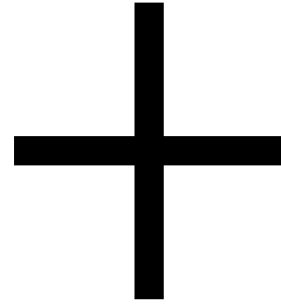
$\left\{ \frac{1}{n} \right\} = \left\{ \frac{1}{n+1} \right\}$ ,  $x_n: N \rightarrow \mathbb{R}$ ,  $x_n \leq y_n \leq z_n$ ,  $\{x_n\} + \{y_n\} \stackrel{\text{df}}{=} \{x_n + y_n\}; 13$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

$\in (0, 1)$ ,  $\left\{ \frac{1}{n} \right\}$ ,  $\left\{ \frac{1}{n+1} \right\}$ ,  $\downarrow n \rightarrow \infty$ ,  $\downarrow n \rightarrow \infty$ ,  $g$ ,  $\{x_n\} \cdot \{y_n\} \stackrel{\text{df}}{=} \{x_n \cdot y_n\}; 13$ ,  $\downarrow n \rightarrow \infty$ ,  $\left\{ \frac{x_n}{y_n} \right\}$

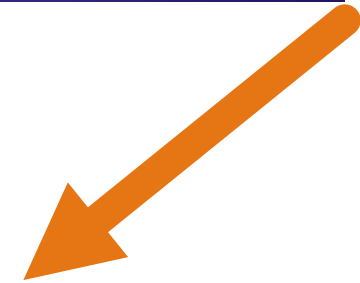
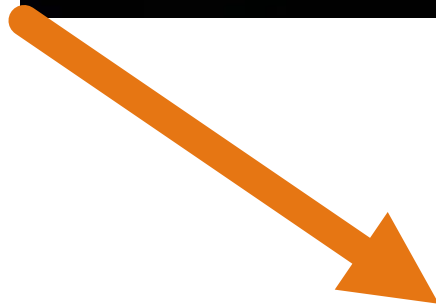
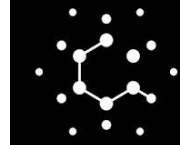
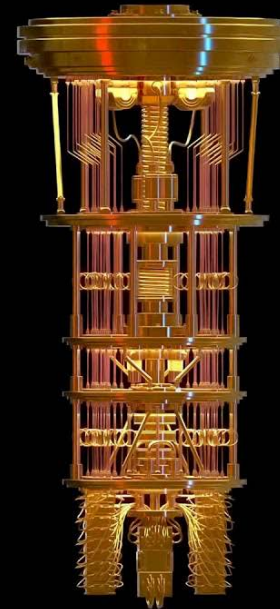
$\left\{ \frac{1}{n} \right\}$ ,  $\left\{ \frac{1}{n+1} \right\}$ ,  $g$ ,  $\sqrt[n]{13^n}$ ,  $f: X \rightarrow X$

# QUANTUM MECHANICS

# COMPUTING

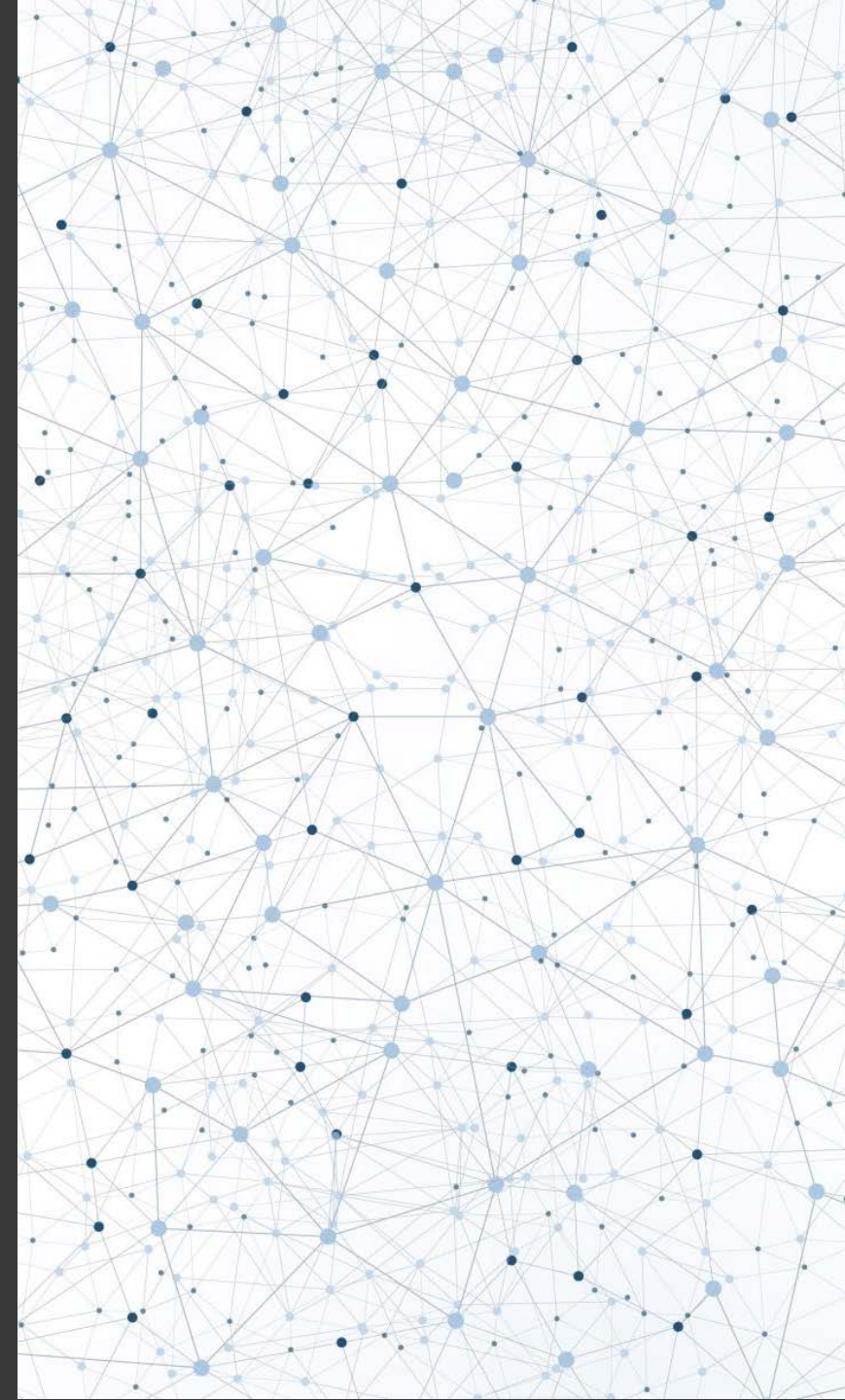


**QUANTUM  
COMPUTING**



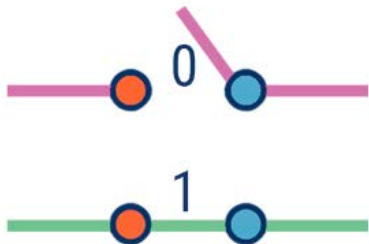
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# CLASSICAL VS QUANTUM COMPUTING



# CLASSICAL COMPUTING

DISKRETE ZUSTÄNDE  
0 oder 1



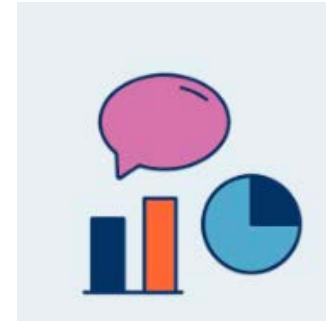
LINEARER  
ANSTIEG



NIEDRIGE  
FEHLERQUOTE

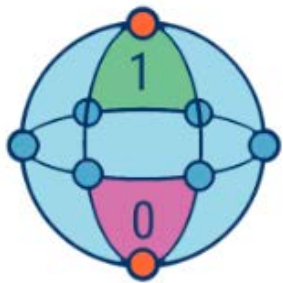


ALLTÄGLICHE  
PROZESSE



# QUANTUM COMPUTING

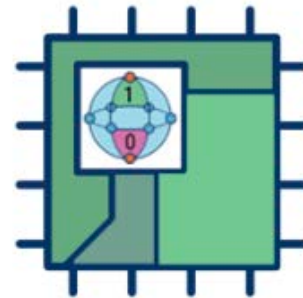
QUBITS  
SUPERPOSITION



EXPONENTIELLER  
ANSTIEG



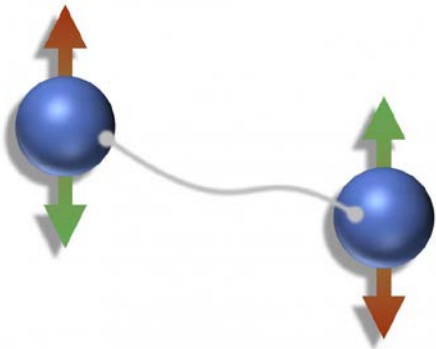
HOHE  
FEHLERQUOTE



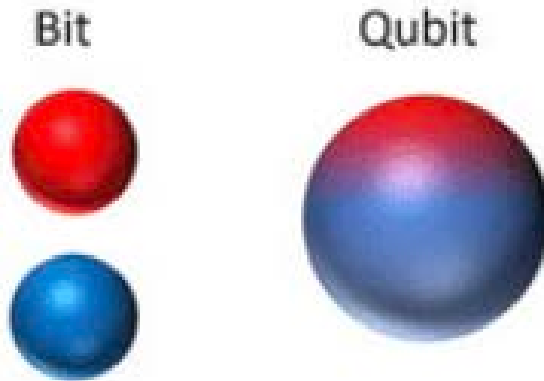
OPTIMISIERUNG,  
SIMULATIONEN,  
MACHINE LEARNING



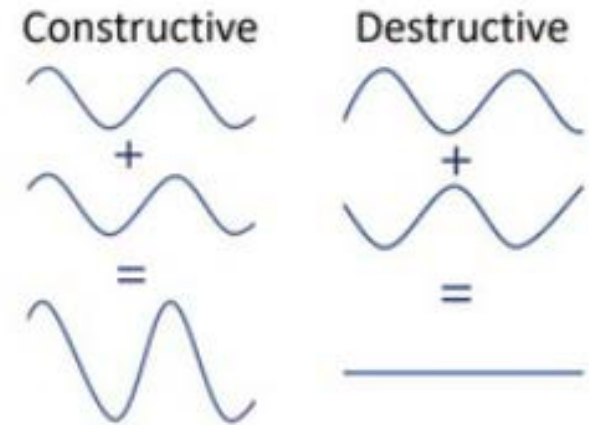
# WICHTIGSTE QUANTEN PHÄNOMÄNE



VERSCHRÄNKUNG



SUPERPOSITION



INTERFERENZ

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# QUANTUM MACHINE LEARNING: HYBRID MODELS





# QUANTUM MACHINE LEARNING : HYBRID MODELS

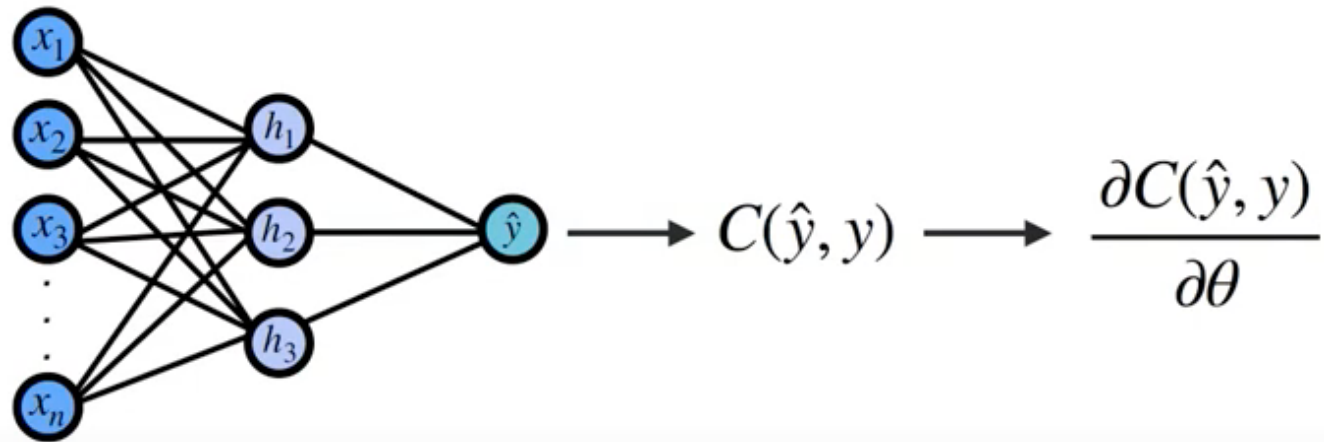
		Type of algorithm	
Type of data	Classic	CC	CQ
	Quantum	QC	QQ

Data: Classic or Quantum

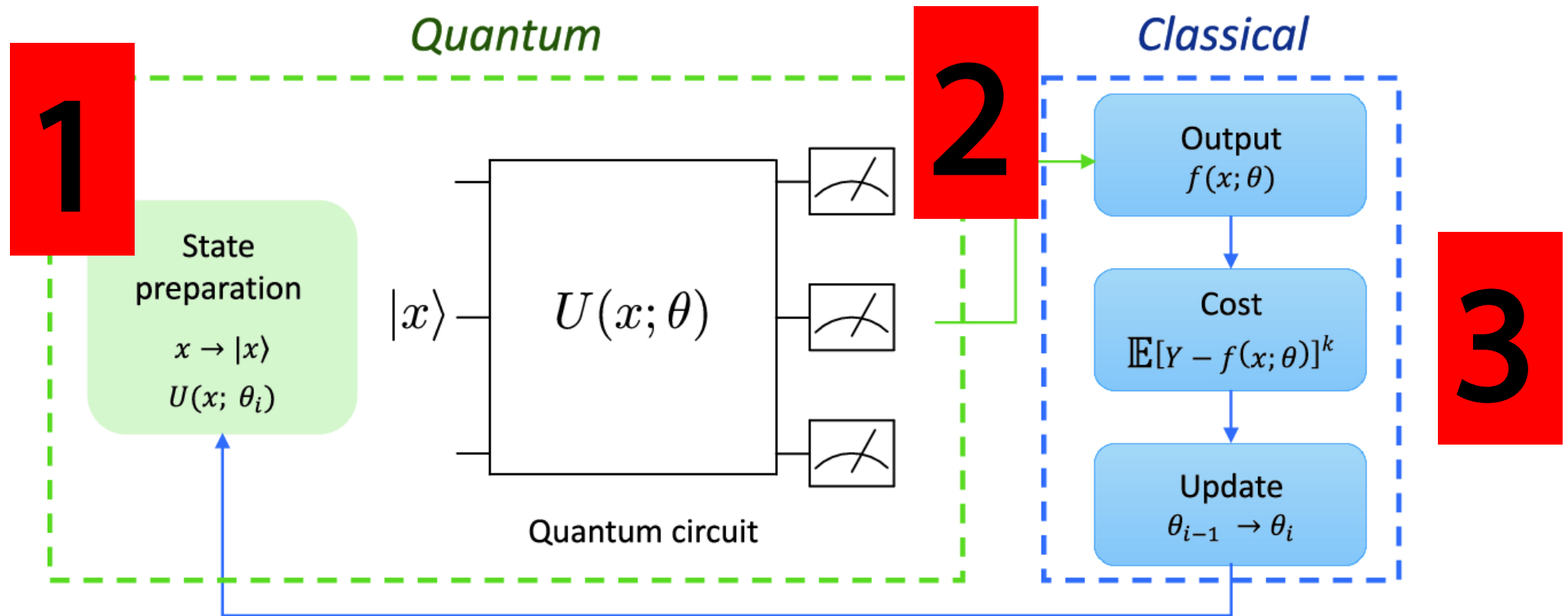
Algorithm: Classic or Quantum

**CQ: Classical Data for Quantum Algorithm**

# CLASSICAL NEURAL NETWORK

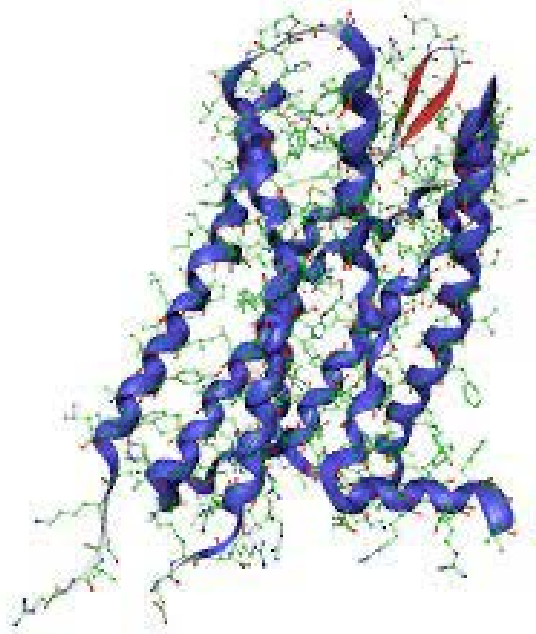


# QUANTUM NEURAL NETWORK QNN:



VARIATIONAL QUANTUM EIGENSOLVER (VQE)

# TOP QML RESEARCH APPLICATIONS



DRUG SIMULATION  
Molecular Simulations

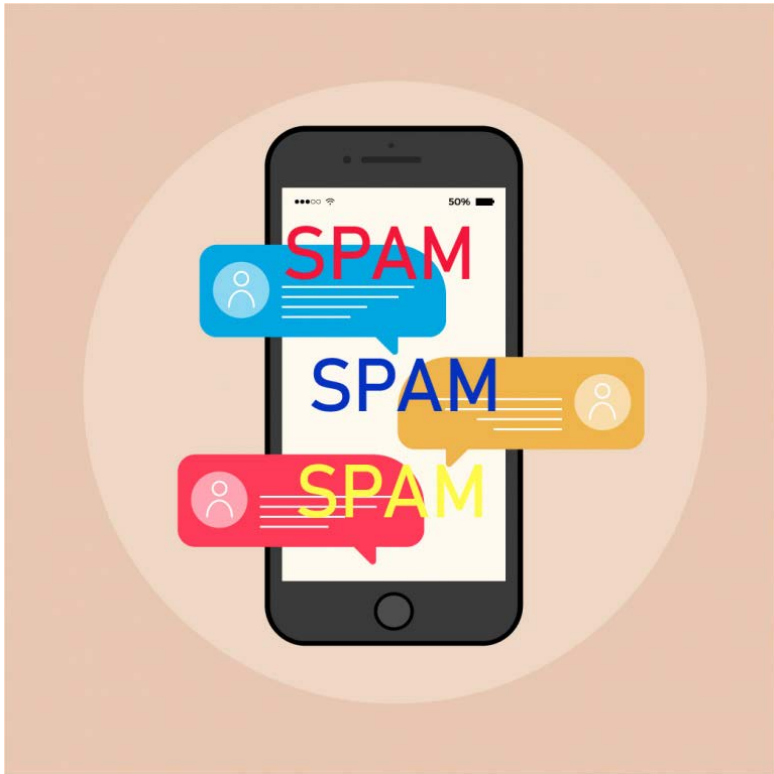


FINANCE  
Predictions



CYBERSECURITY  
Classification, Encryption

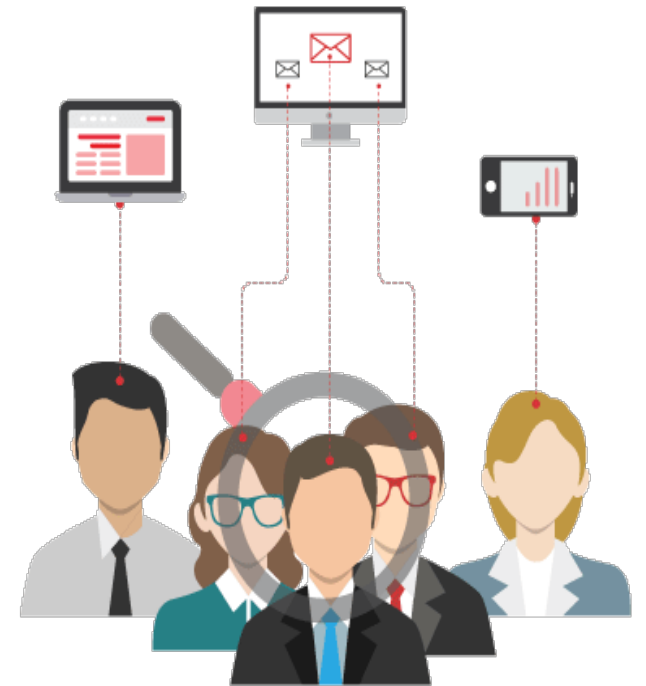
## QML IN CYBERSECURITY:



Spam message detection



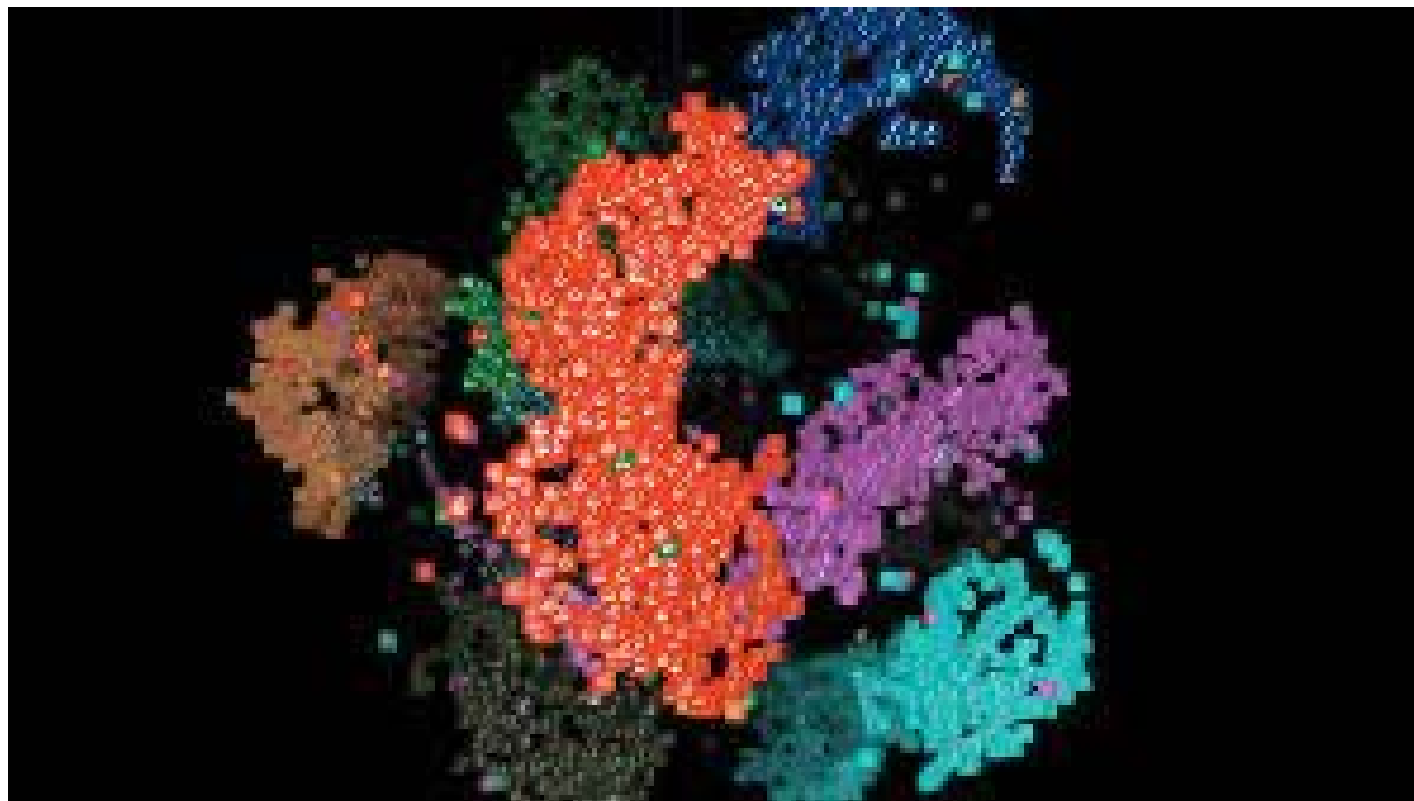
Malware detection



Network analysis

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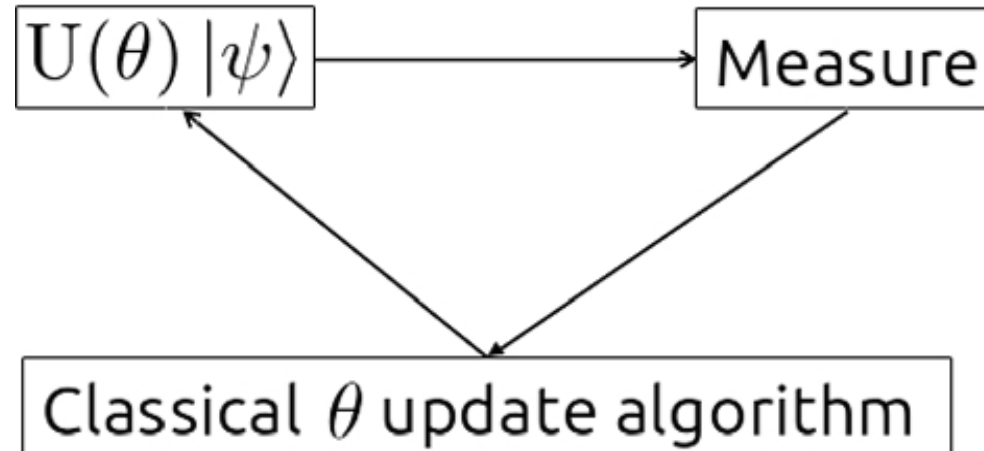
## PROBLEMS IN CLASSICAL ML MODELS



# SPAM DETECTION: HYBRID MODELS

D. Baronia. "Hybrid Quantum-Classical Neural Networks for Text Classification". In: TechRxiv. Preprint. (2021).

- 4 VQEs with same number of inputs
- 1 model showed higher accuracy
- **Conclusion: hybrid models 10% more accurate and 20% more efficient than classical**



## MALWARE DETECTION: HYBRID MODELS



**Feature  
Selection**

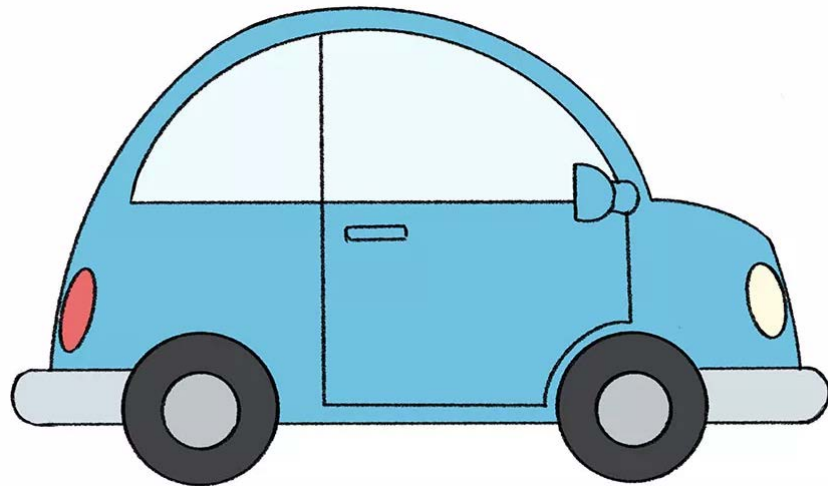
**Image-Based  
Analysis**

**Dimensionality  
Reduction**



# QUANTUM MACHINE LEARNING IST ...

- KEIN ERSATZ, SONDERN EINE ERGÄNZUNG



INTENSIVERE ANALYSIS



GESCHWINDIGKEIT





INDUSTRIE IN  
ÖSTERREICH

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