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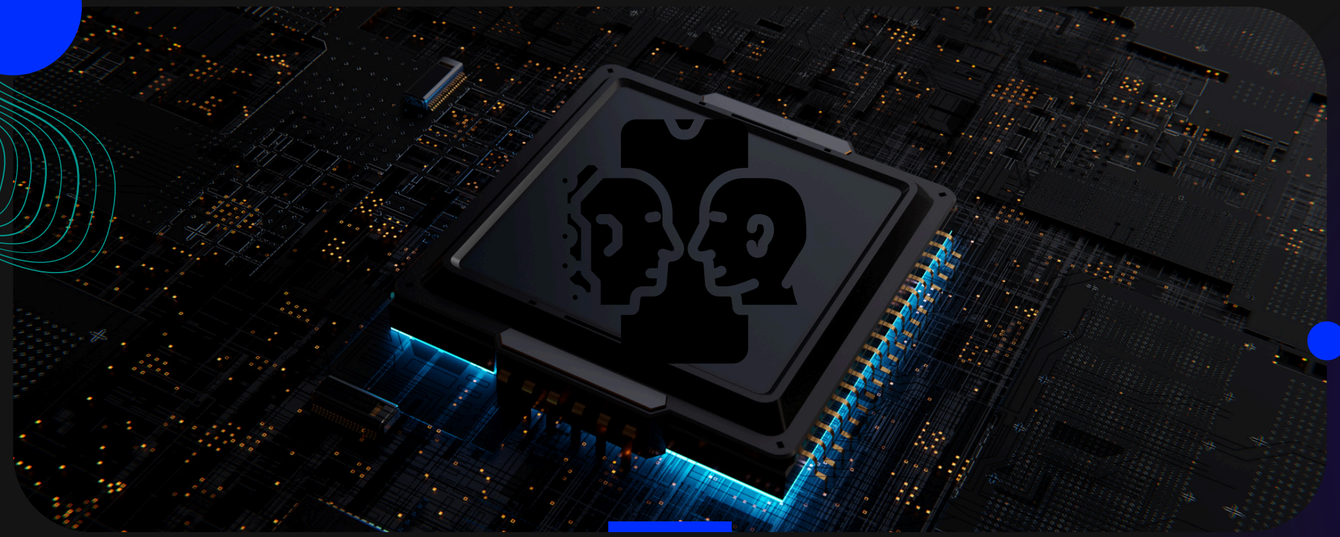
Quantum Computing:

Human Interactions at Every Layer



Maria Emine Nylund
Benedikt Mithassel

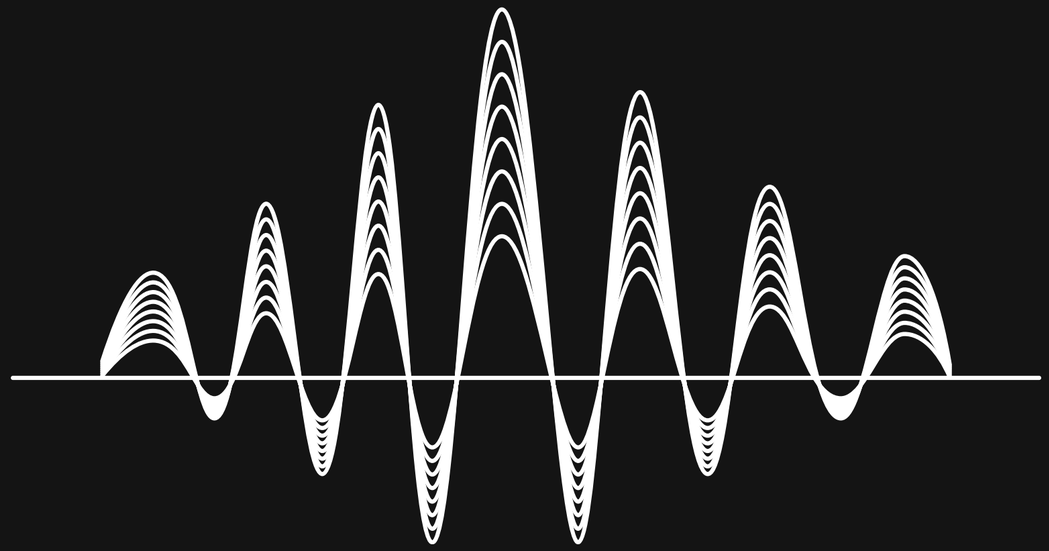
5th of December
2025

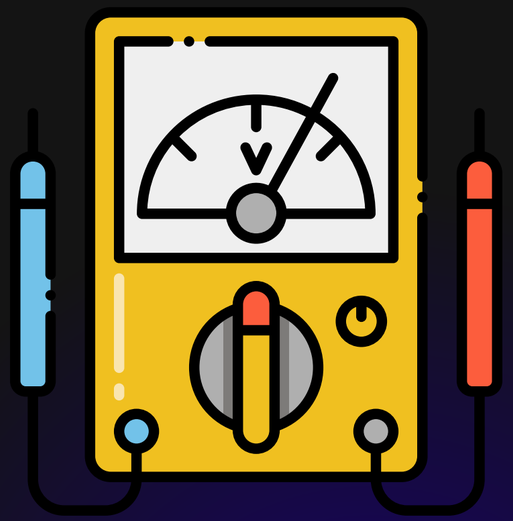
Our groups

(HCI)
Human Computer
Interaction

Sensors

Sensors
classical and quantum





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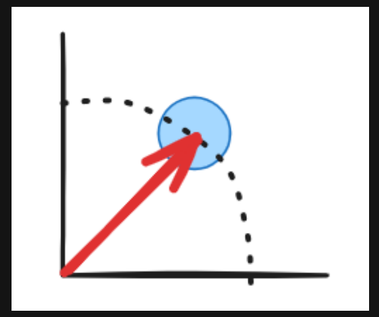
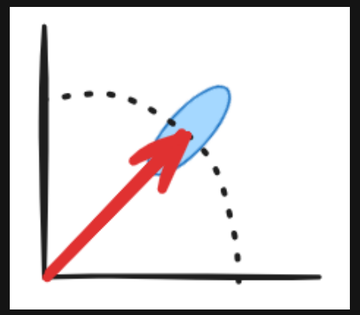
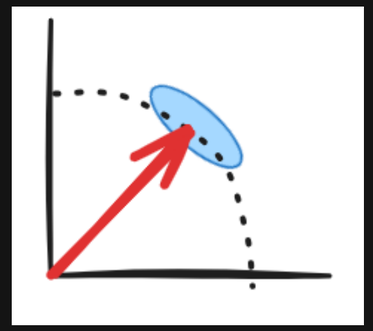
Visualizing sensors







Heisenberg Uncertainty Principle

Quantum visualizations and sensors

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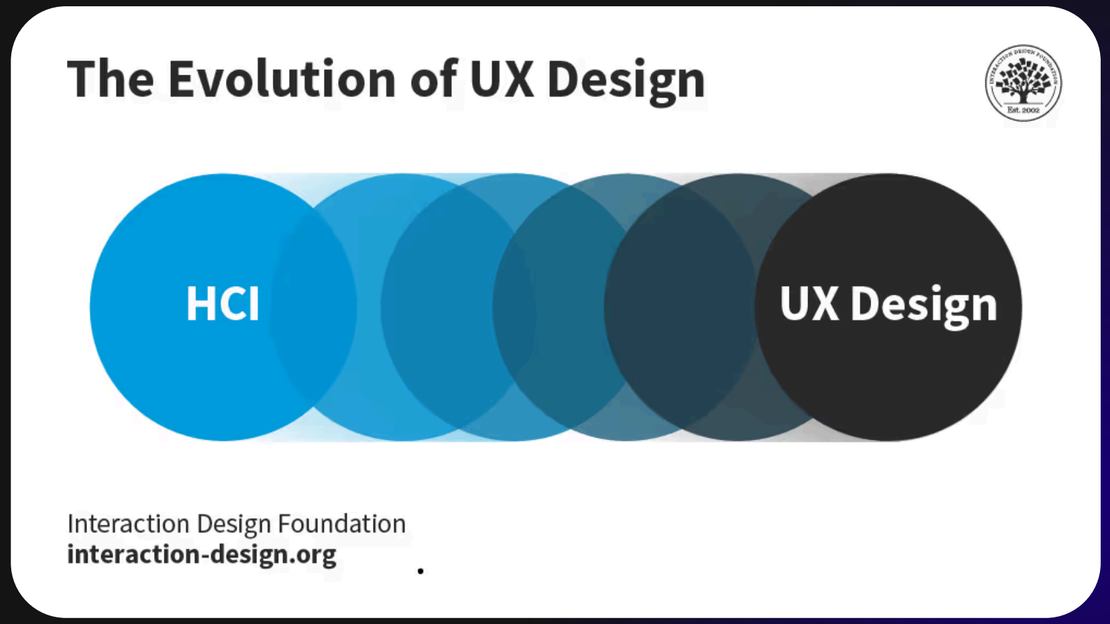
HCI – Human Computer Interaction

- In context
- Interdisciplinary
- Solves problems related to human use of computing



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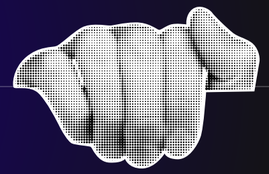
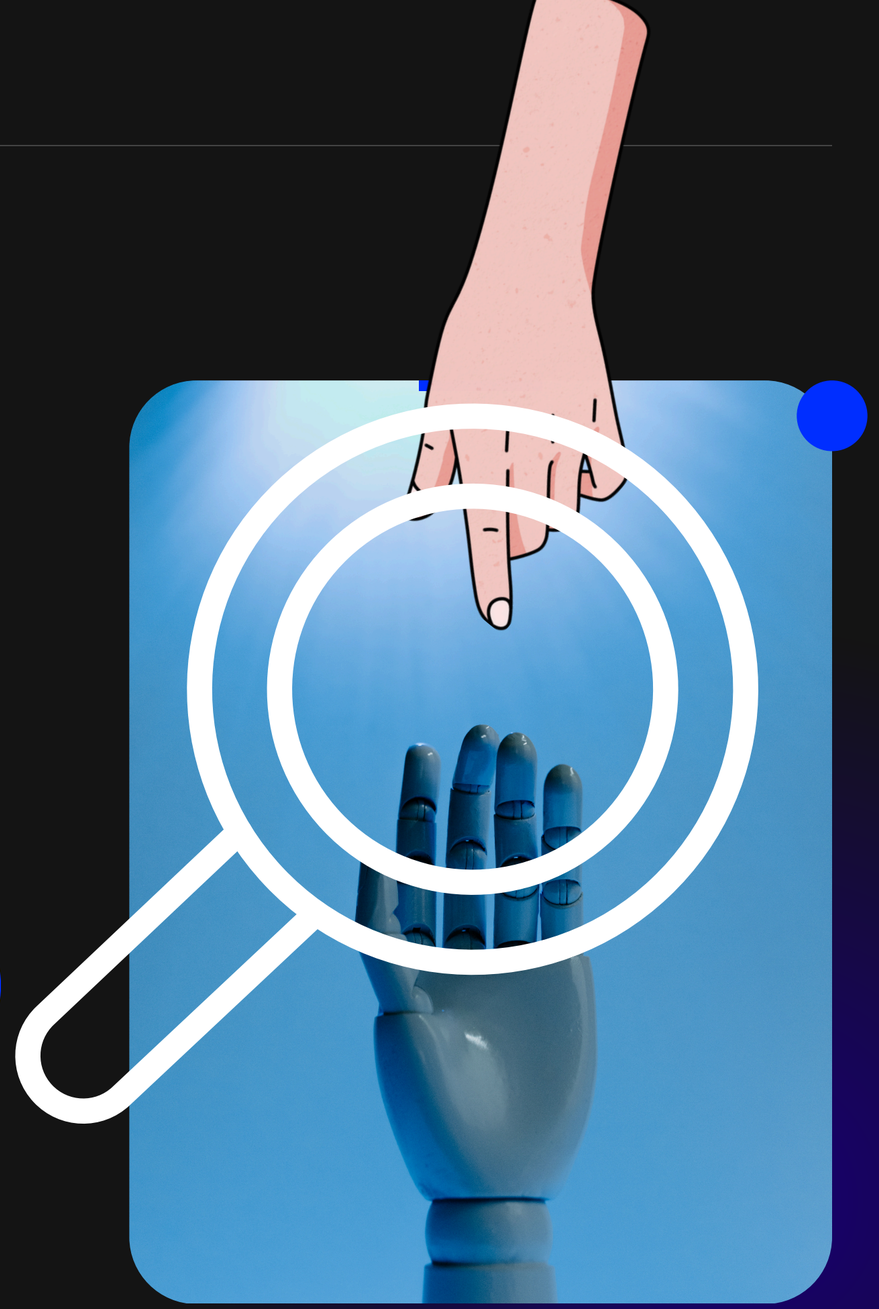
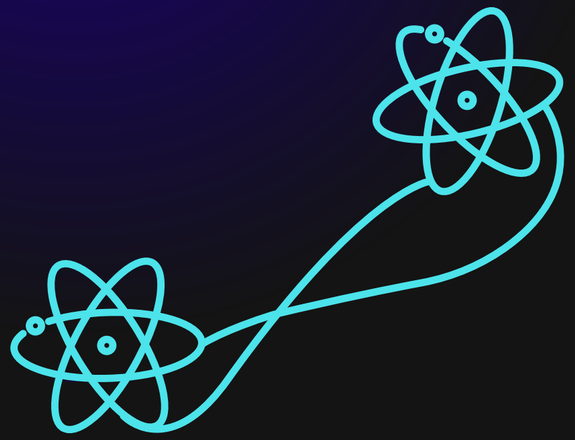


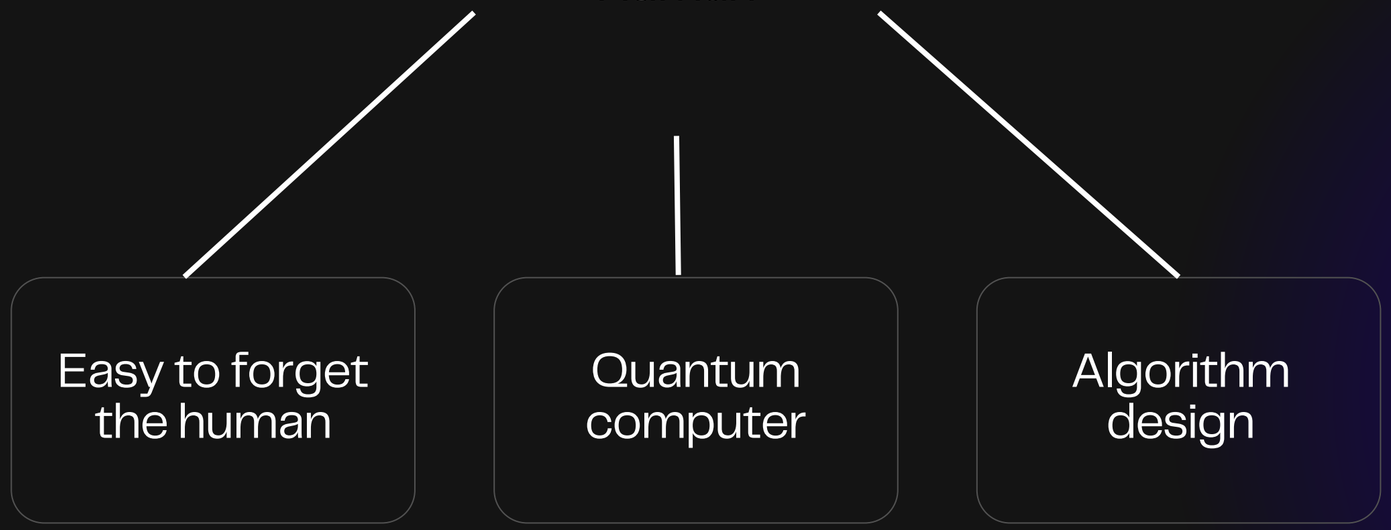
How does Quantum Computing look through an HCI lens?

What human interactions and visualisations can we find there?



Overview




Human
Easy to forget the human
Quantum computer
Algorithm design

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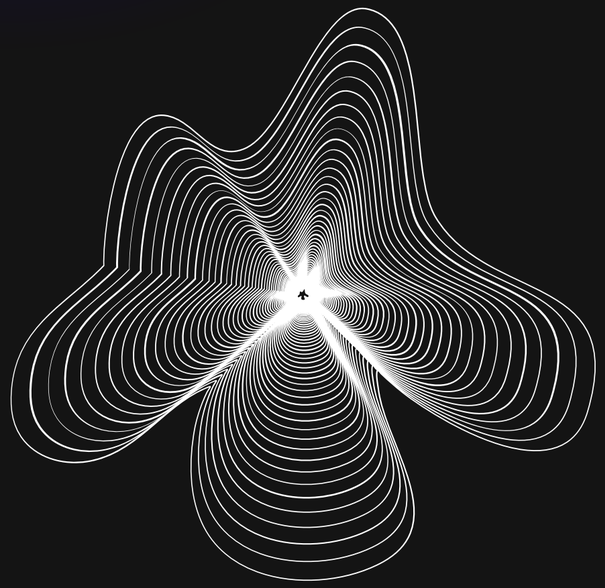
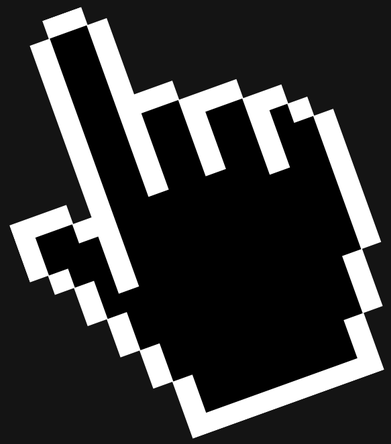
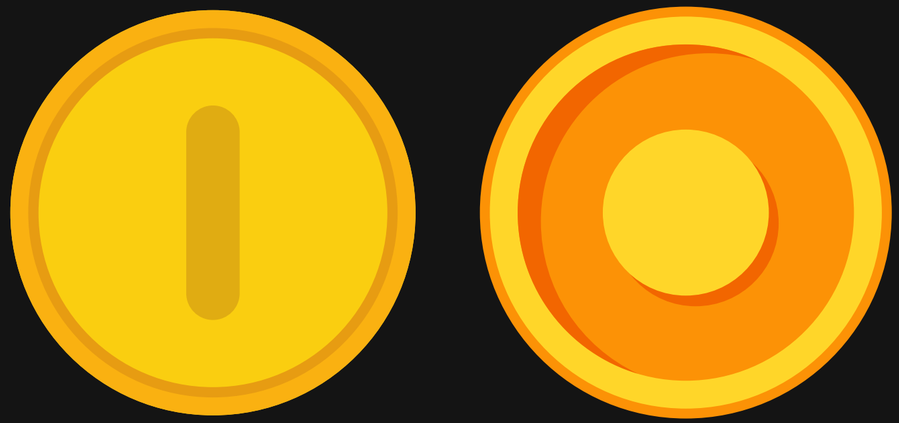
Quantum Computing vs Classical computing





What is a bit



What is an algorithm

What is a Qbit

What is a Qbit

Easy to forget the human

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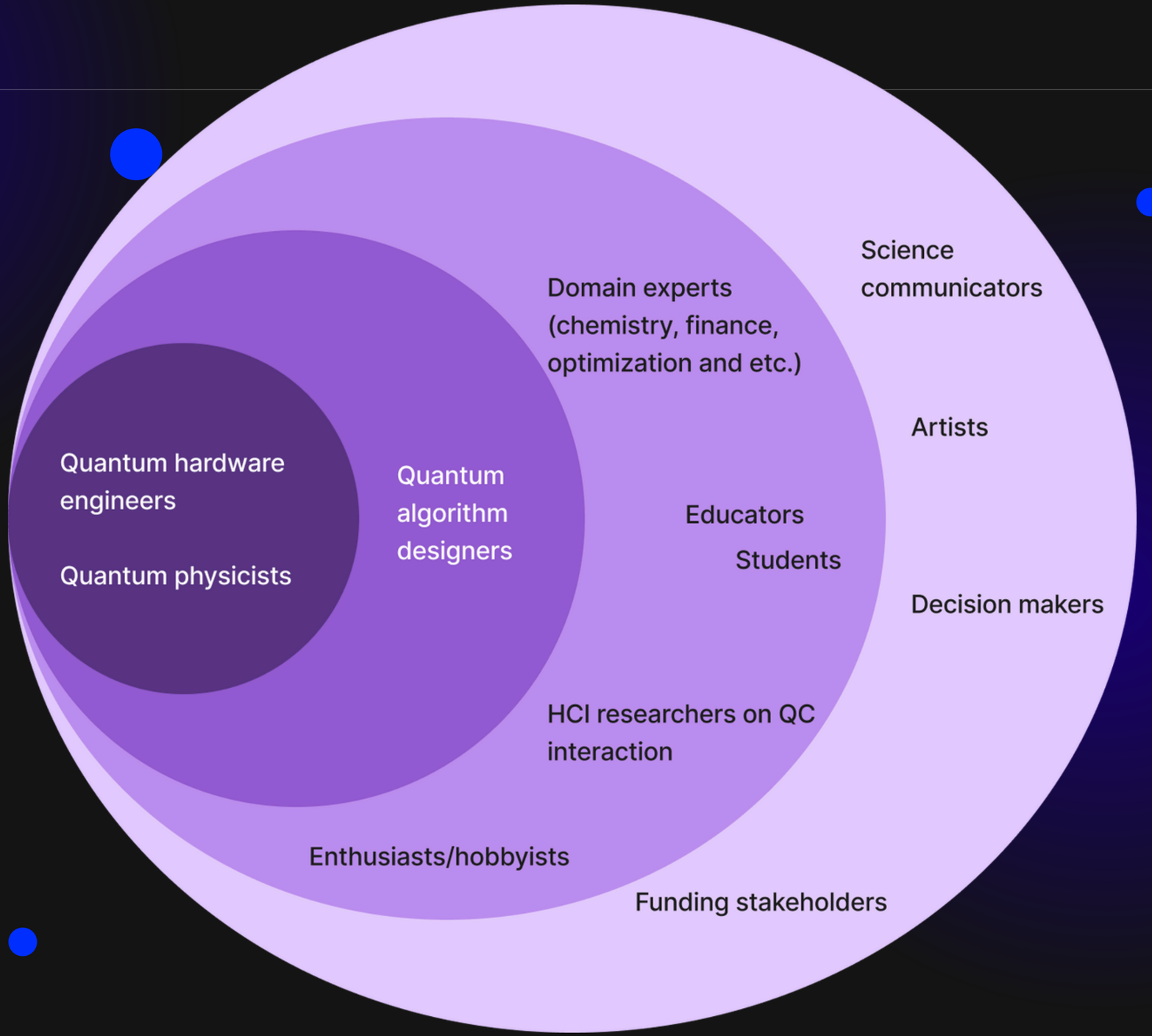
Who?


Quantum hardware engineers
Quantum physicists
Quantum algorithm designers
Domain experts (chemistry, finance, optimization and etc.)
HCI researchers on QC interaction
Enthusiasts/hobbyists
Science communicators
Artists
Educators
Students
Decision makers
Funding stakeholders

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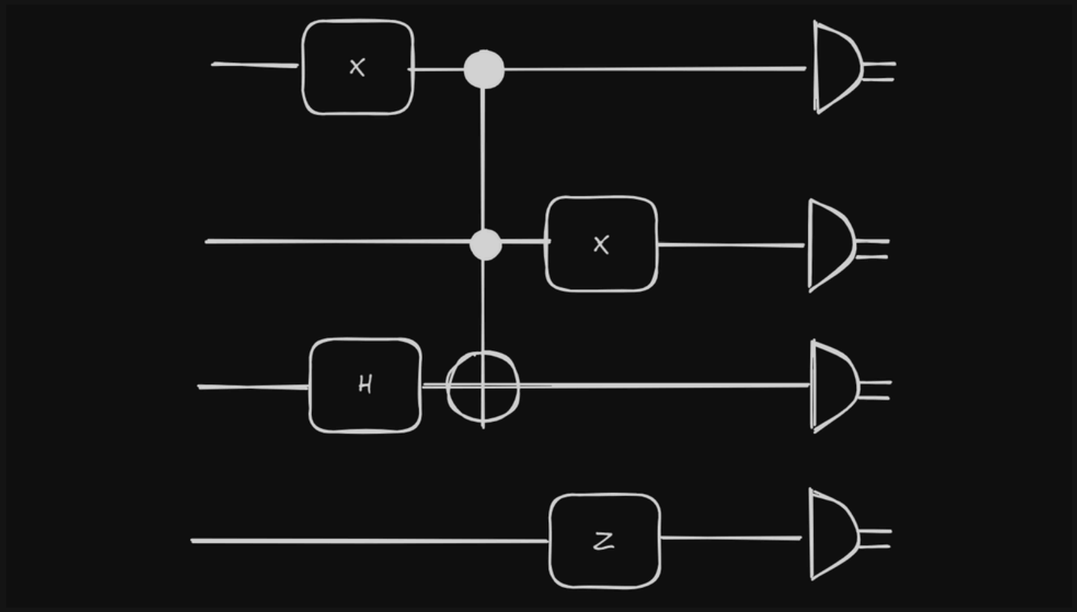
Why?



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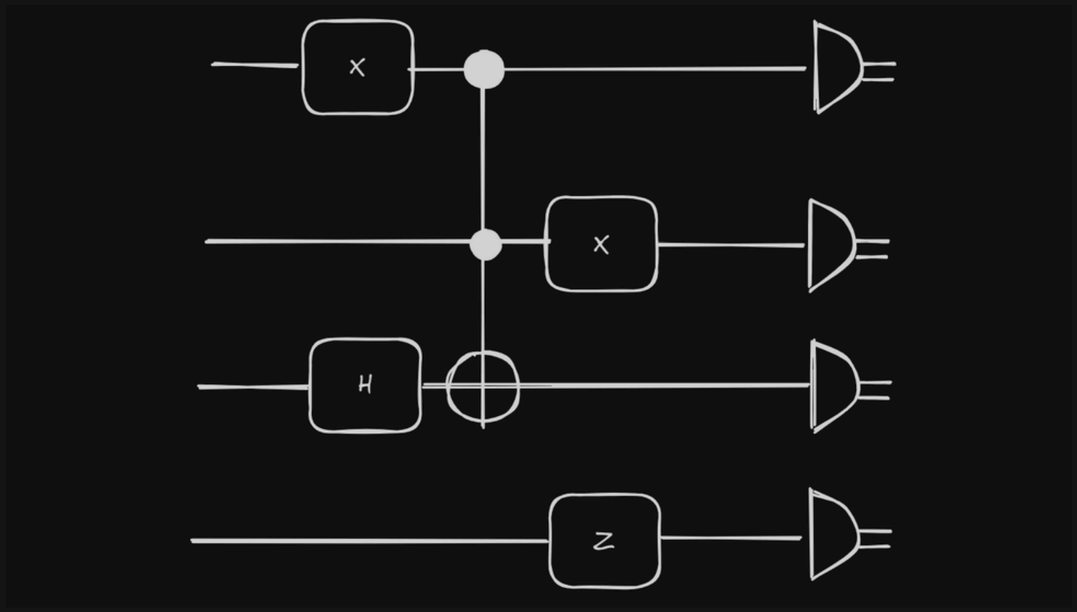
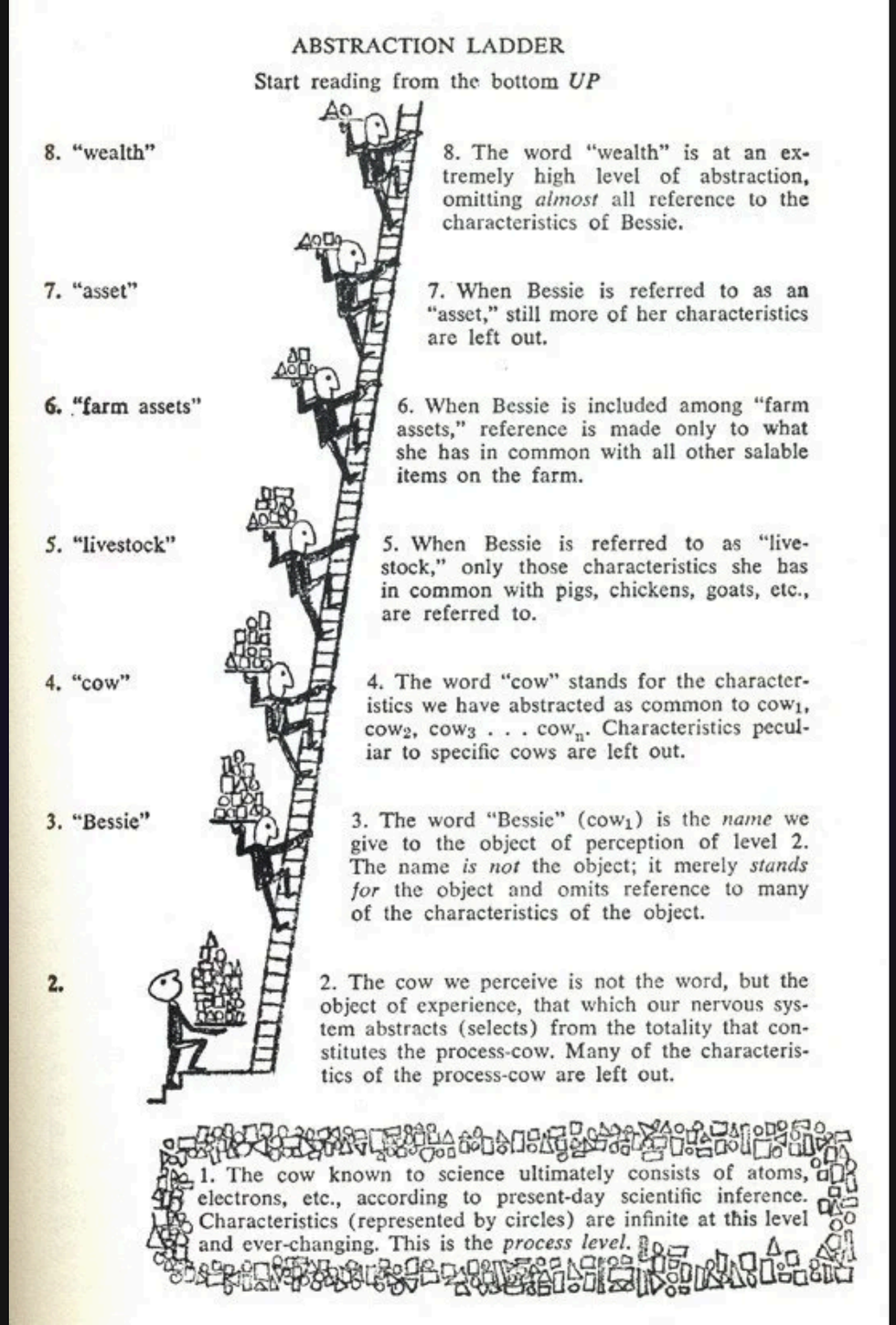
Why?

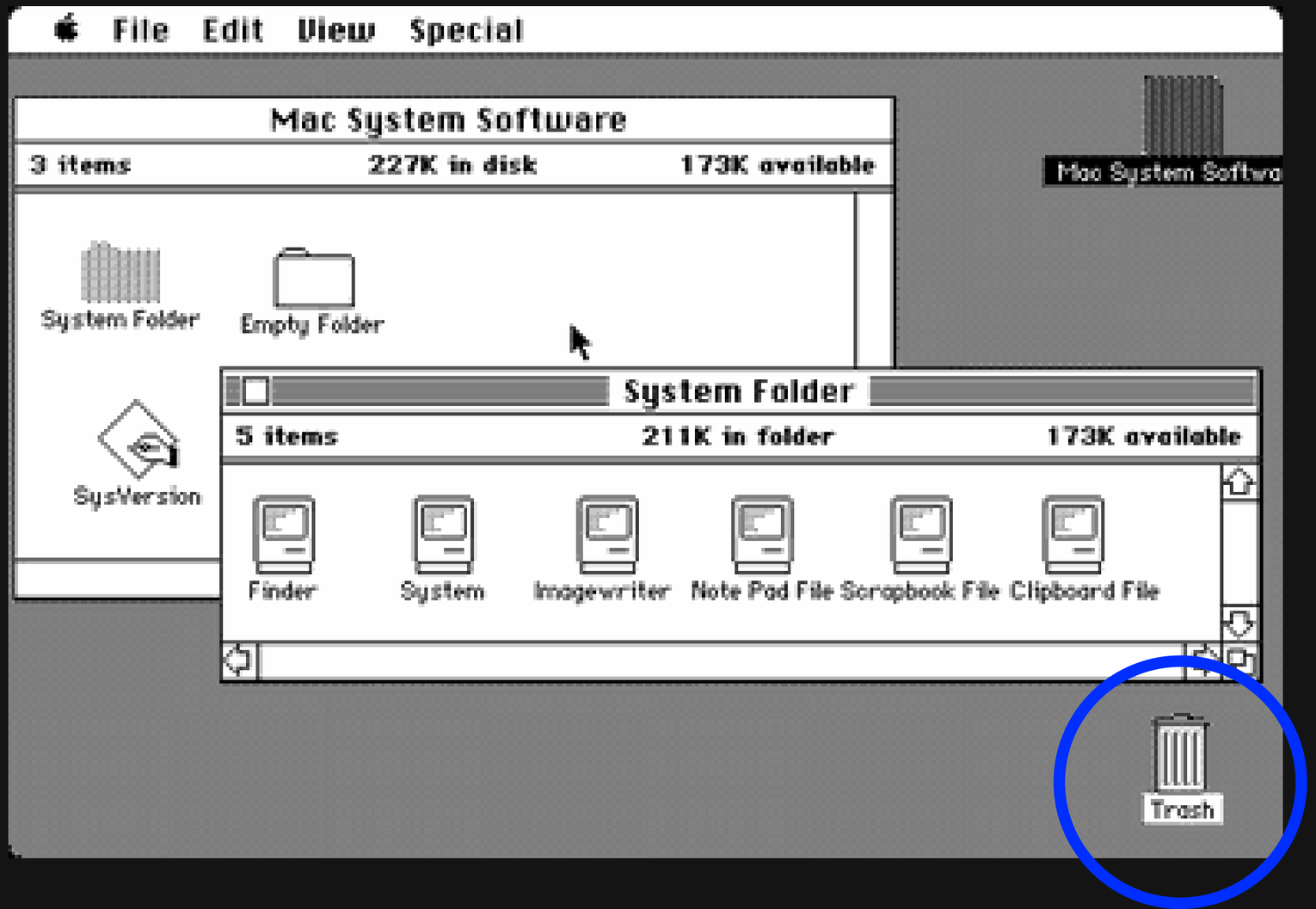


Ladder of Abstraction

- Introduced by American linguist SI Hayakawa in 1939



Example from 80s



Why?

- Working memory capacity: 3–7 chuncks by Cowan (2001)

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PROXIMITY

CLOSE OBJECTS ARE PERCEIVED AS A GROUP

SIMILARITY

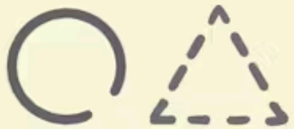
SIMILAR OBJECTS ARE PERCEIVED AS A GROUP

CONTINUITY

ELEMENTS ON A LINE OR CURVE ARE RELATED

7 GESTALT PRINCIPLES

HOW OUR MINDS ORGANISE VISUAL INFORMATION



CLOSURE

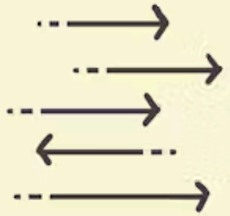
WE COMPLETE MISSING PARTS

FIGURE-GROUND

WE PERCEIVE OBJECTS IN THE FOREGROUND OR BACK

SYMMETRY & ORDER

SYMMETRICAL AND ORDERLY ELEMENTS ARE PERCEIVED AS A GROUP



COMMON FATE

OBJECTS MOVING TOGETHER ARE PERCEIVED AS A GROUP

Jono Hey

Sketchplanations

How? → External Cognition

- Take advantage of external
- Lessen the cognitive load
- Recognition over recall

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Human+ quantum computer

Foto: IT4Innovations

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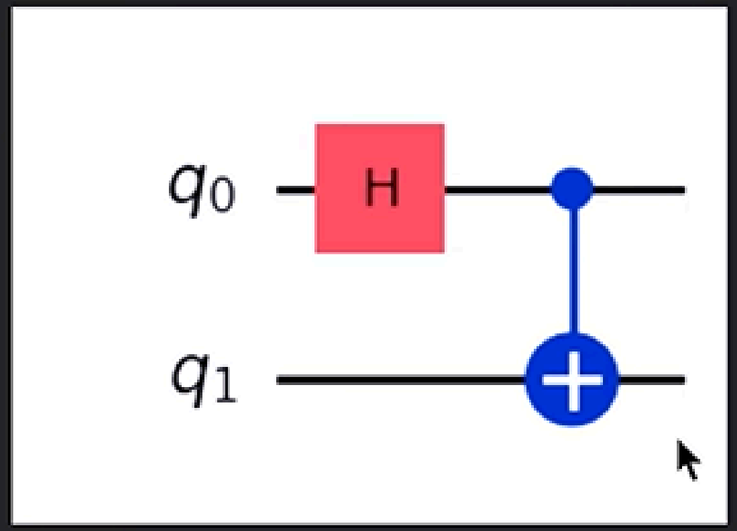
+ Code + Markdown | Run All Restart Clear All Outputs | Variables Outline ···

```
qc.h(0)
qc.cx(0, 1)

qc.draw(output='mpl')
```

[1] ✓ 0.8s



- python (notebook) in Visual Studio Code
- Qiskit library

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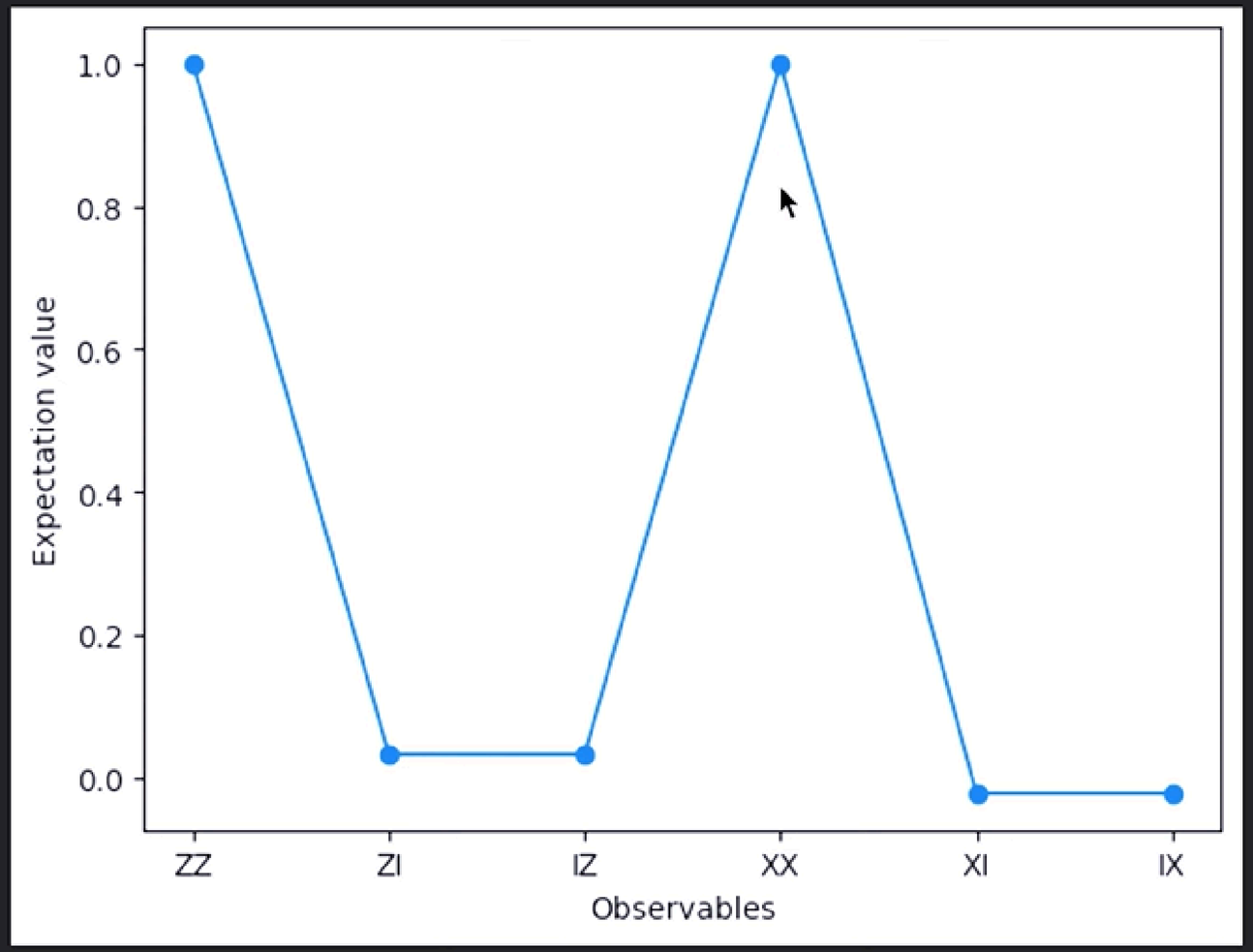
+ Code + Markdown | Run All Restart Clear All Outputs | Variables Outline ···

```
data = ['ZZ', 'ZI', 'IZ', 'XX', 'XI', 'IX']
values = job.result().values

plt.plot(data, values, '-o')
plt.xlabel('Observables')
plt.ylabel('Expectation value')
plt.show()
```

[5] ✓ 0.1s



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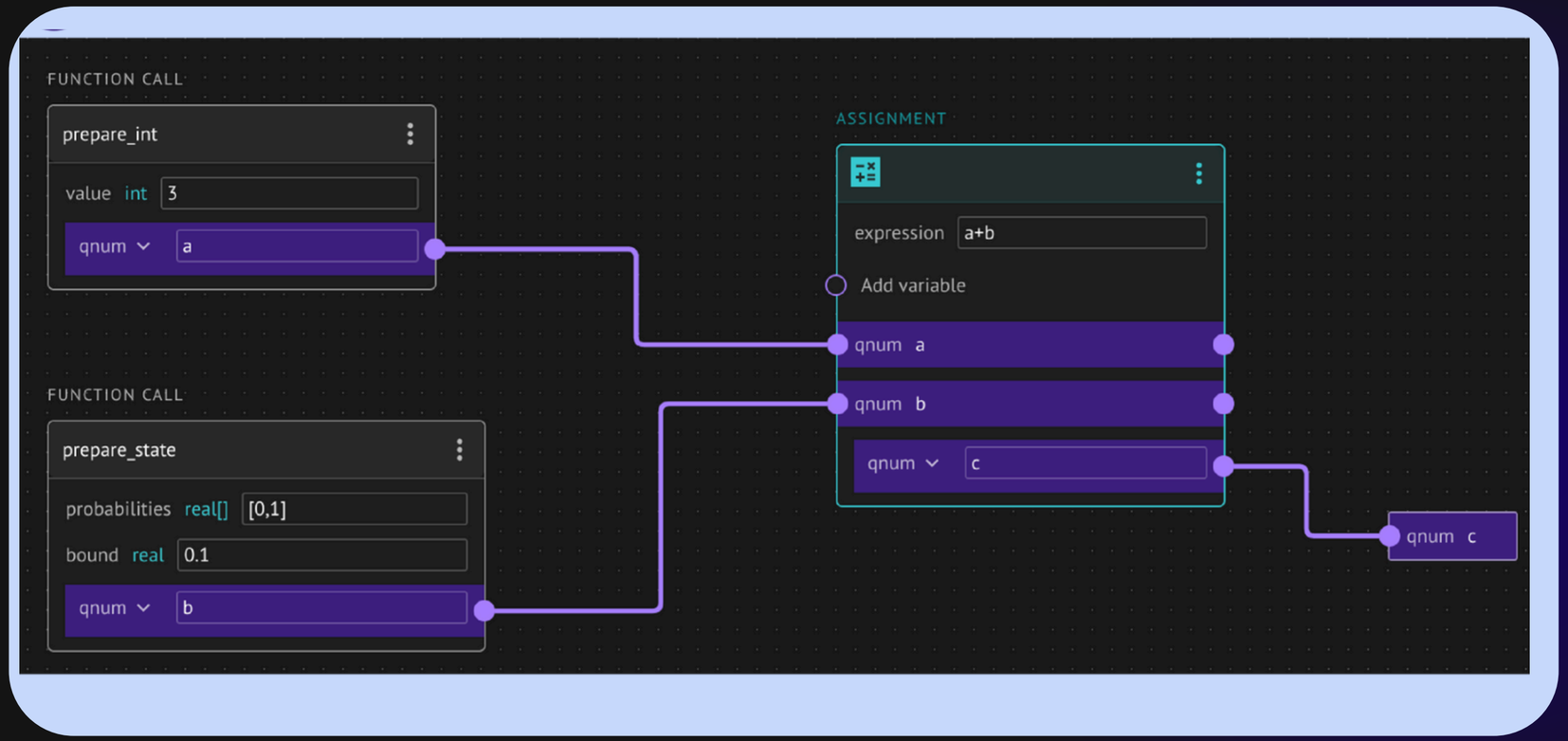
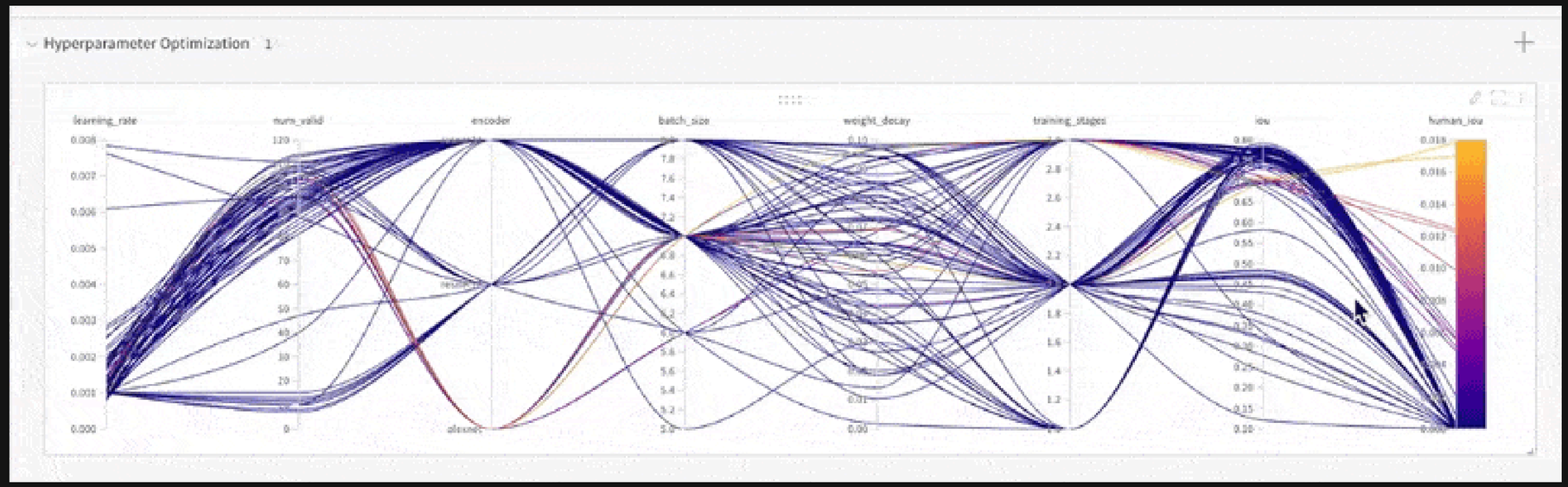
Interactive whiteboard for quantum circuits



Kim, H., Jeng, M. J., & Smith, K. N. (2025, April). Toward Human-Quantum Computer Interaction: Interface Techniques for Usable Quantum Computing. In Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (pp. 1-18).

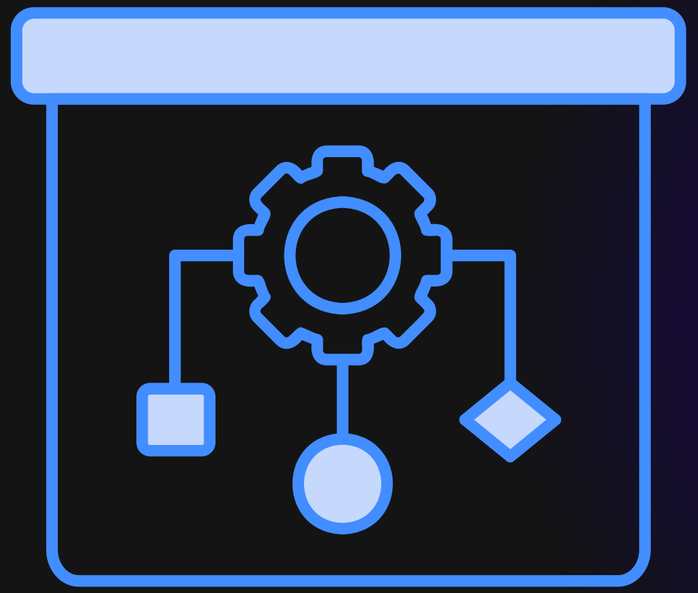
Similar interaction challenges

- Data Scientists + Machine Learning
- Experts
- High-dimensional data
- Different platforms
- Hardware optimization
- Difficult mental models → need abstractions

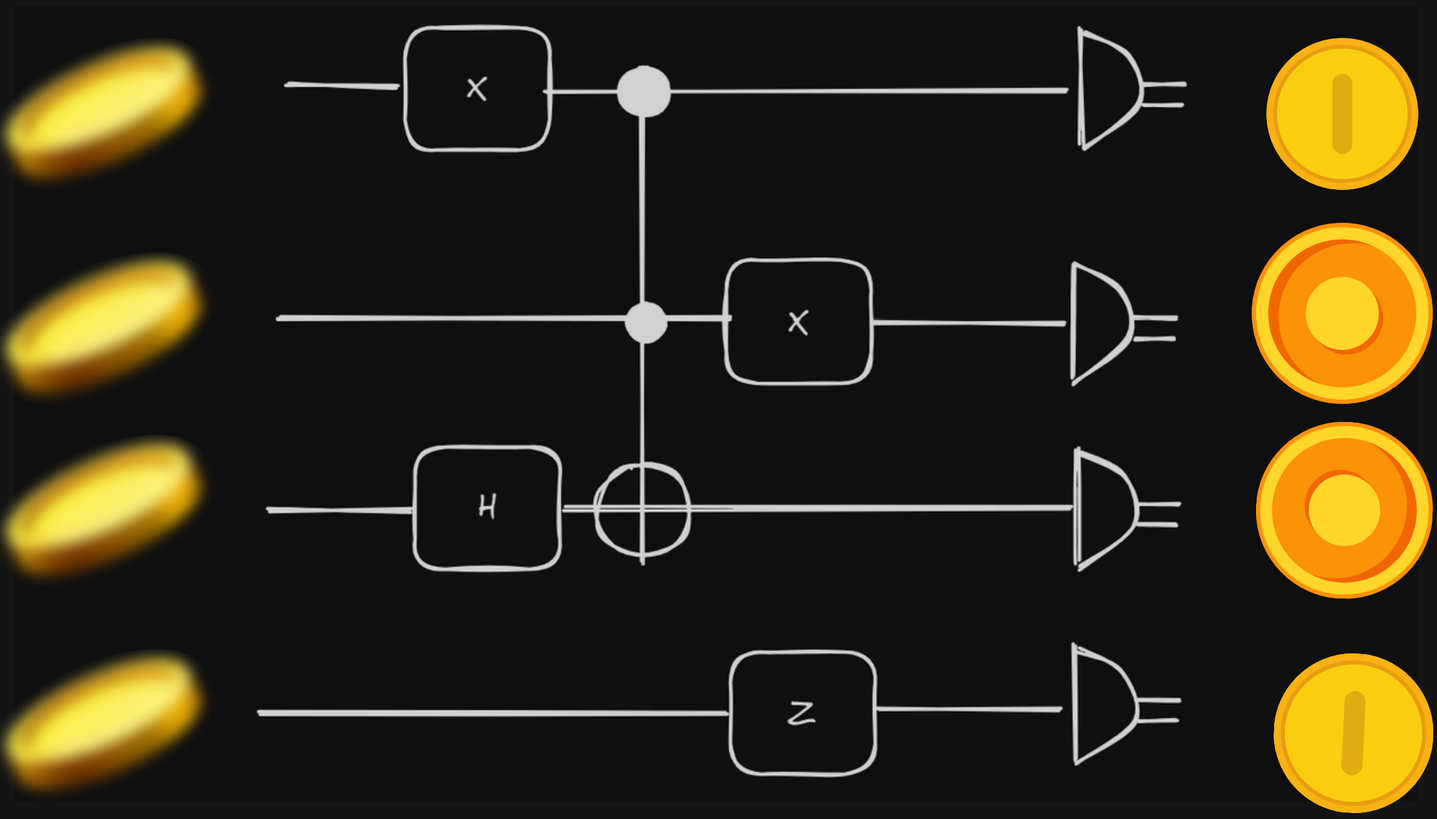


Weights & Biases www.wandb.ai

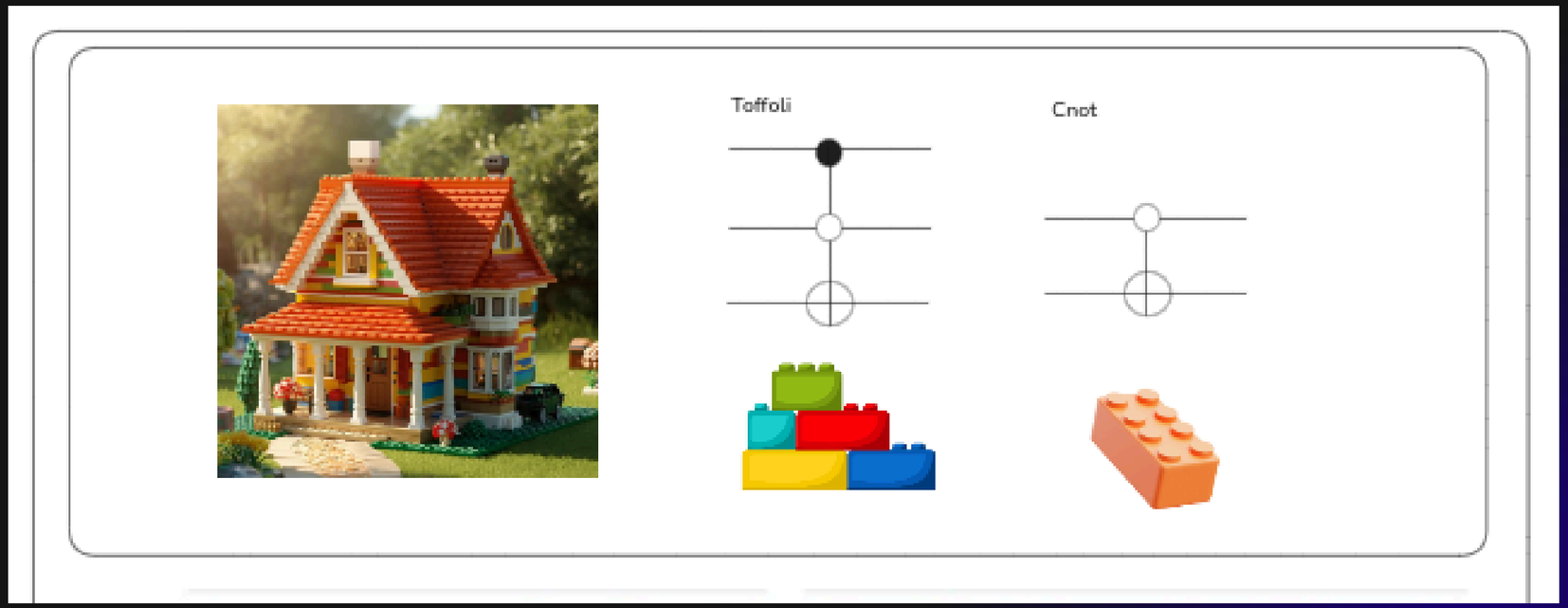
Human + algorithm design



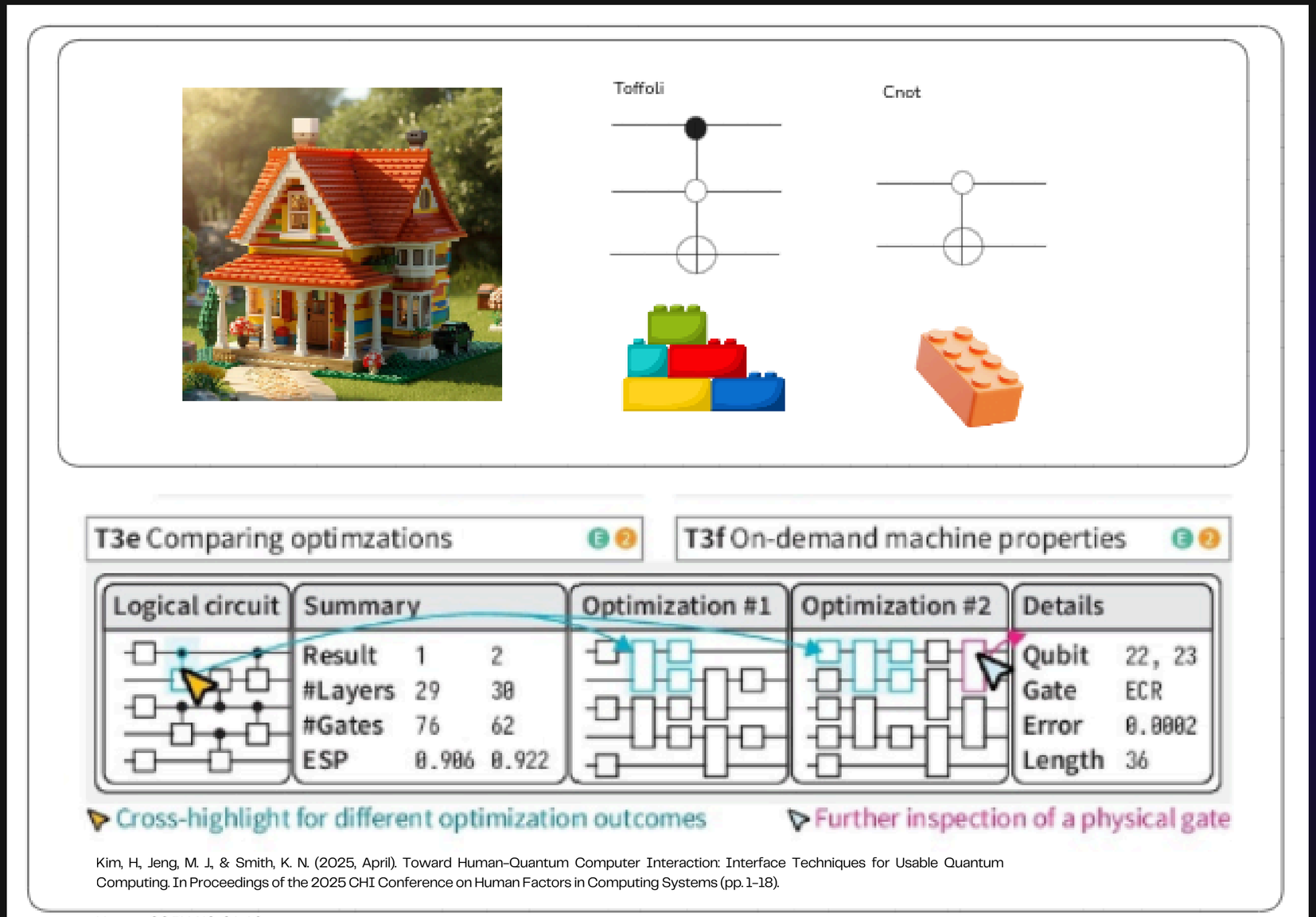
Quantum algorithms (aka quantum circuits)



Human + algorithm design



Human + algorithm design



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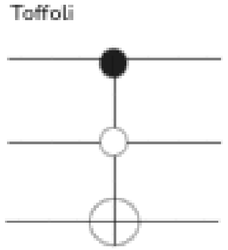

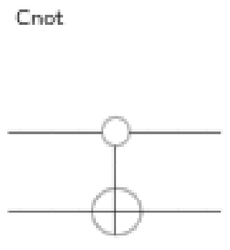

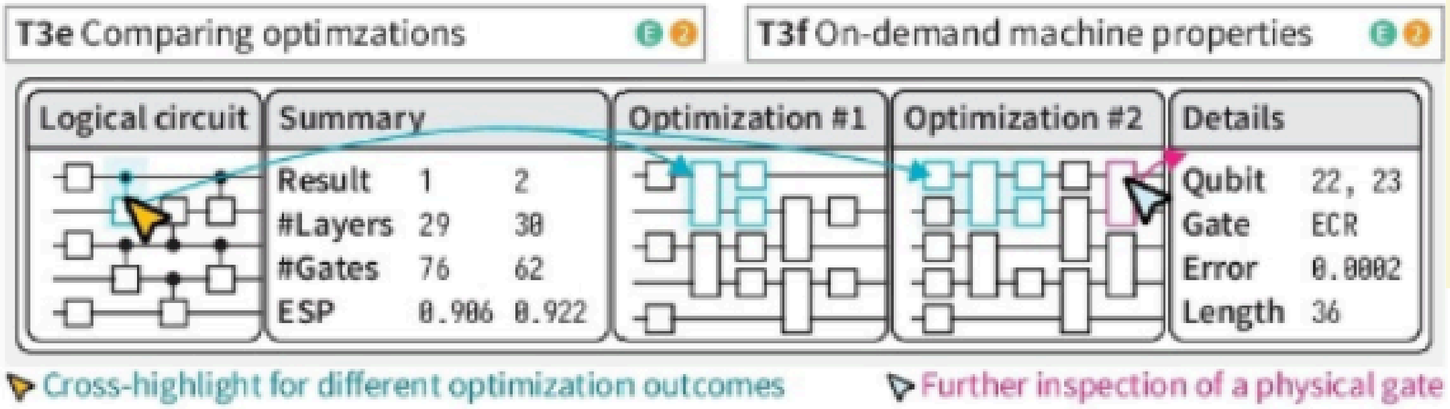

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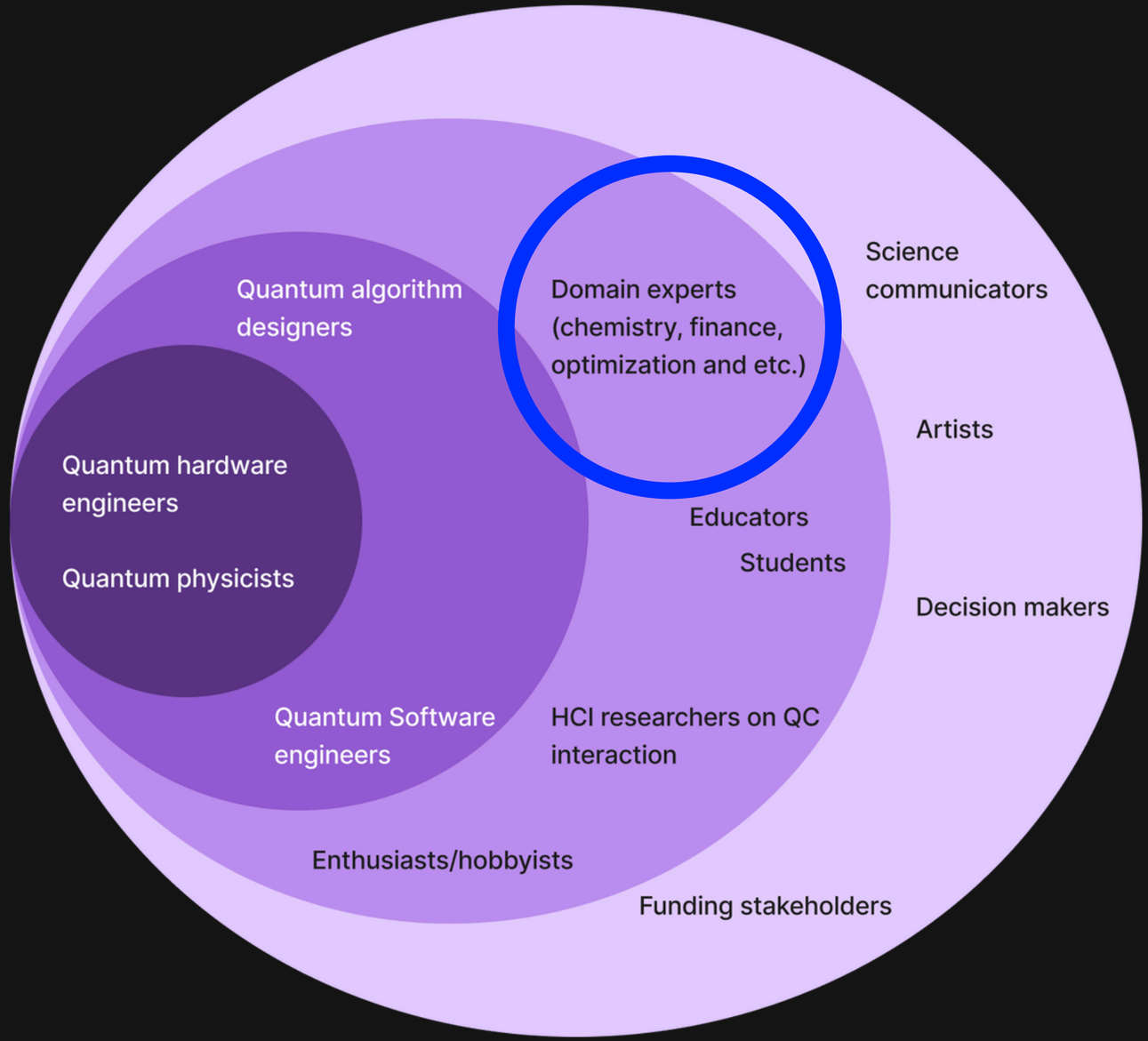
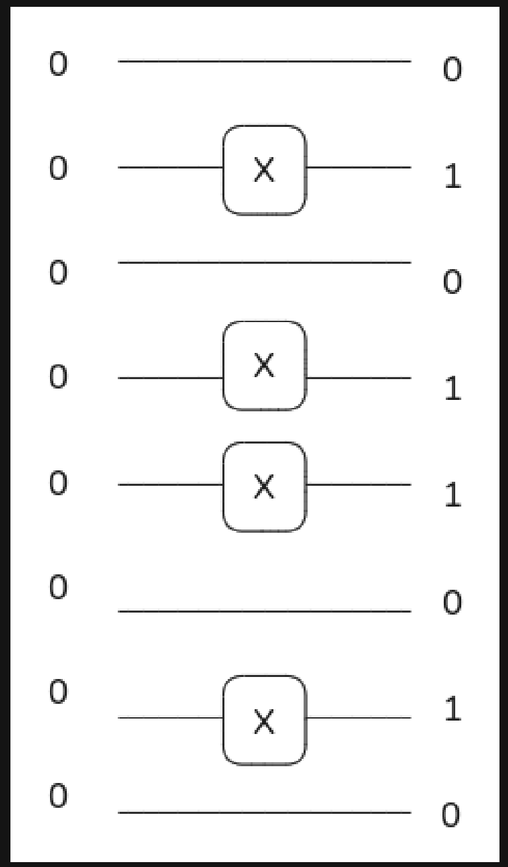
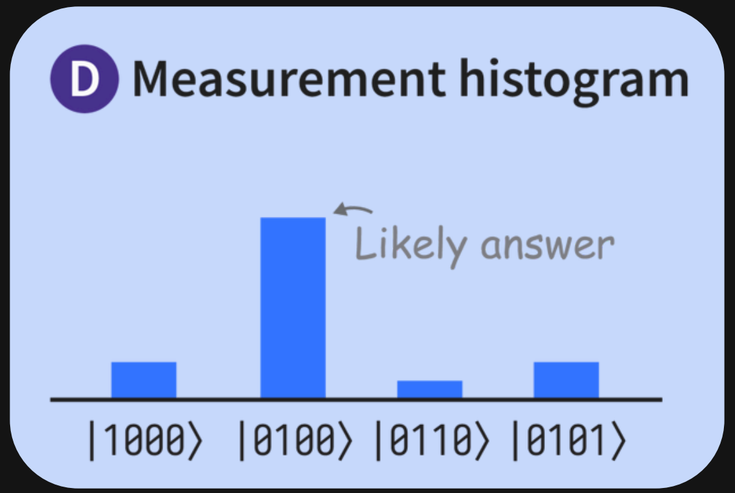
Domain specific interfaces



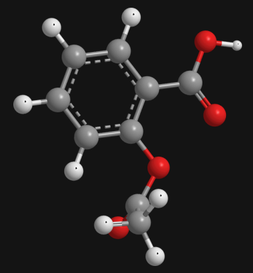
Input

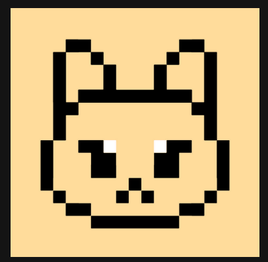


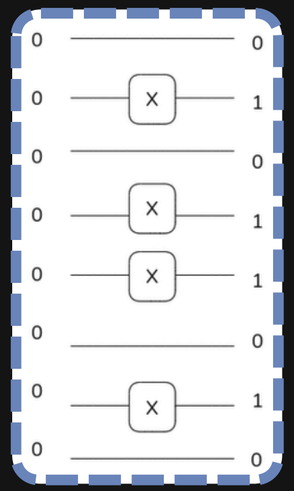
Output



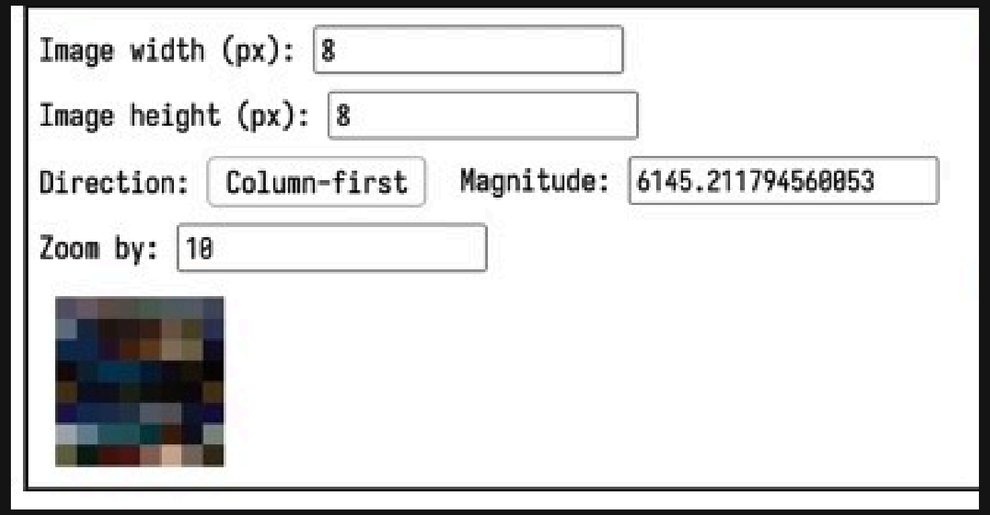
Input







Output



Take aways

Quantum sensing

Easy to forget the human

Externalising cognition

Ladder of abstraction

Algorithm design

Domain specific interfaces

Thank You!

Questions? Feedback?

WWW.SINTEF.NO/

MARIA.NYLUND@SINTEF.NO
BENEDIKT.MITHASSEL@SINTEF.NO

HCI + QC = True