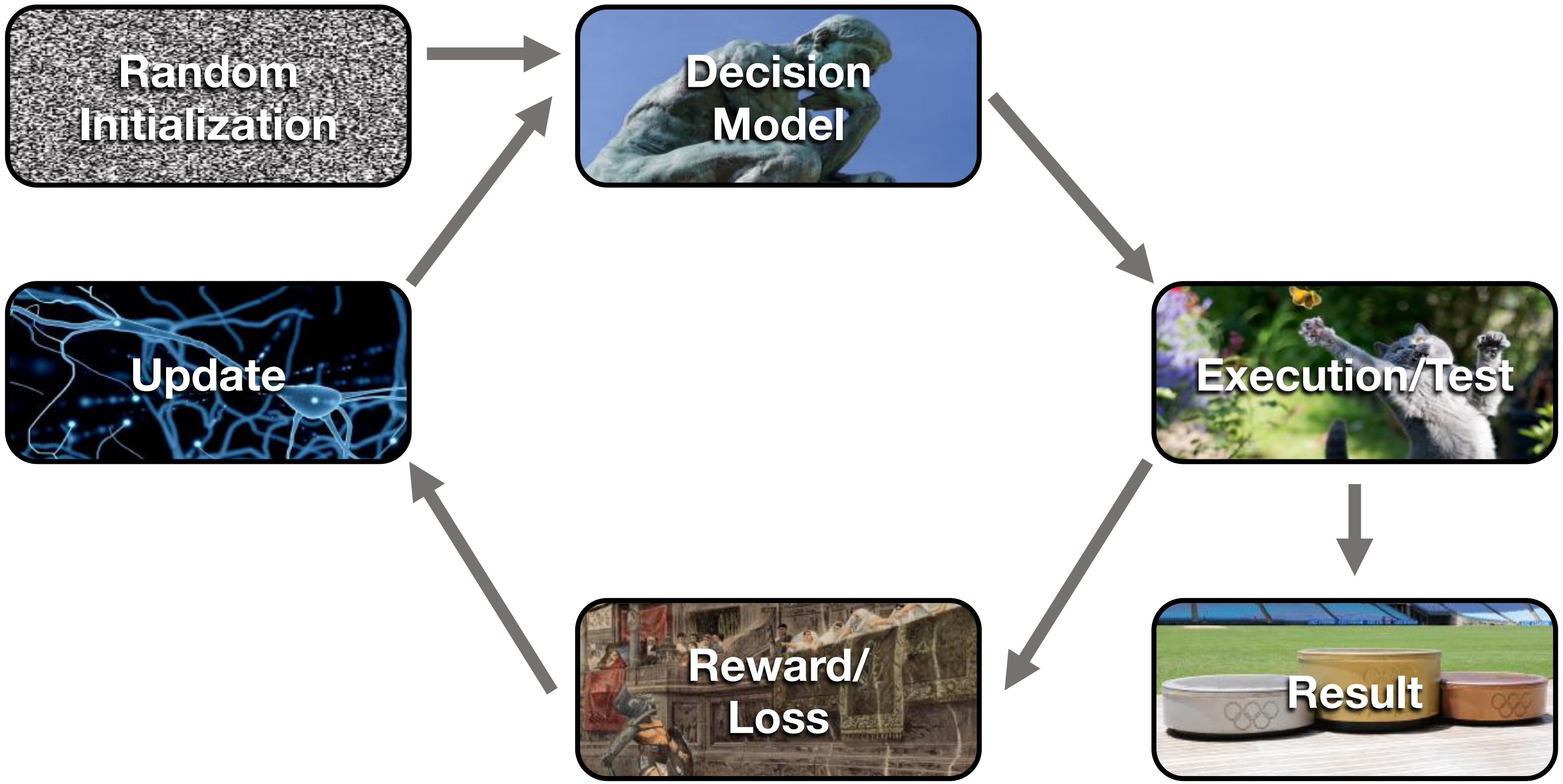
The Holy Grail of Quantum Artificial Intelligence

Thomas Gabor

QAR-Lab, LMU Munich

2 Machine Learning



[3] AI and the Compute Method

1) "AI researchers have often tried to **build knowledge** into their agents,
2) this always helps in the **short term**, and is personally satisfying to the researcher, but
3) in the long run it plateaus and even **inhibits further progress**, and
4) breakthrough progress eventually arrives by an opposing approach based on scaling computation by **search and learning**."

Rich Sutton.
The Bitter Lesson.
www.incompleteideas.net/IncIdeas/BitterLesson.html

4 AI and the Compute Method

1) "AI researchers have often tried to **build knowledge** into their agents,
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3) in the long run it plateaus and even **inhibits further progress**, and
4) breakthrough progress eventually arrives by an opposing approach based on scaling computation by **search and learning**."

"The biggest lesson that can be read from 70 years of AI research is that general methods that **leverage computation** are ultimately the most effective, and by a large margin."

Rich Sutton.
The Bitter Lesson.
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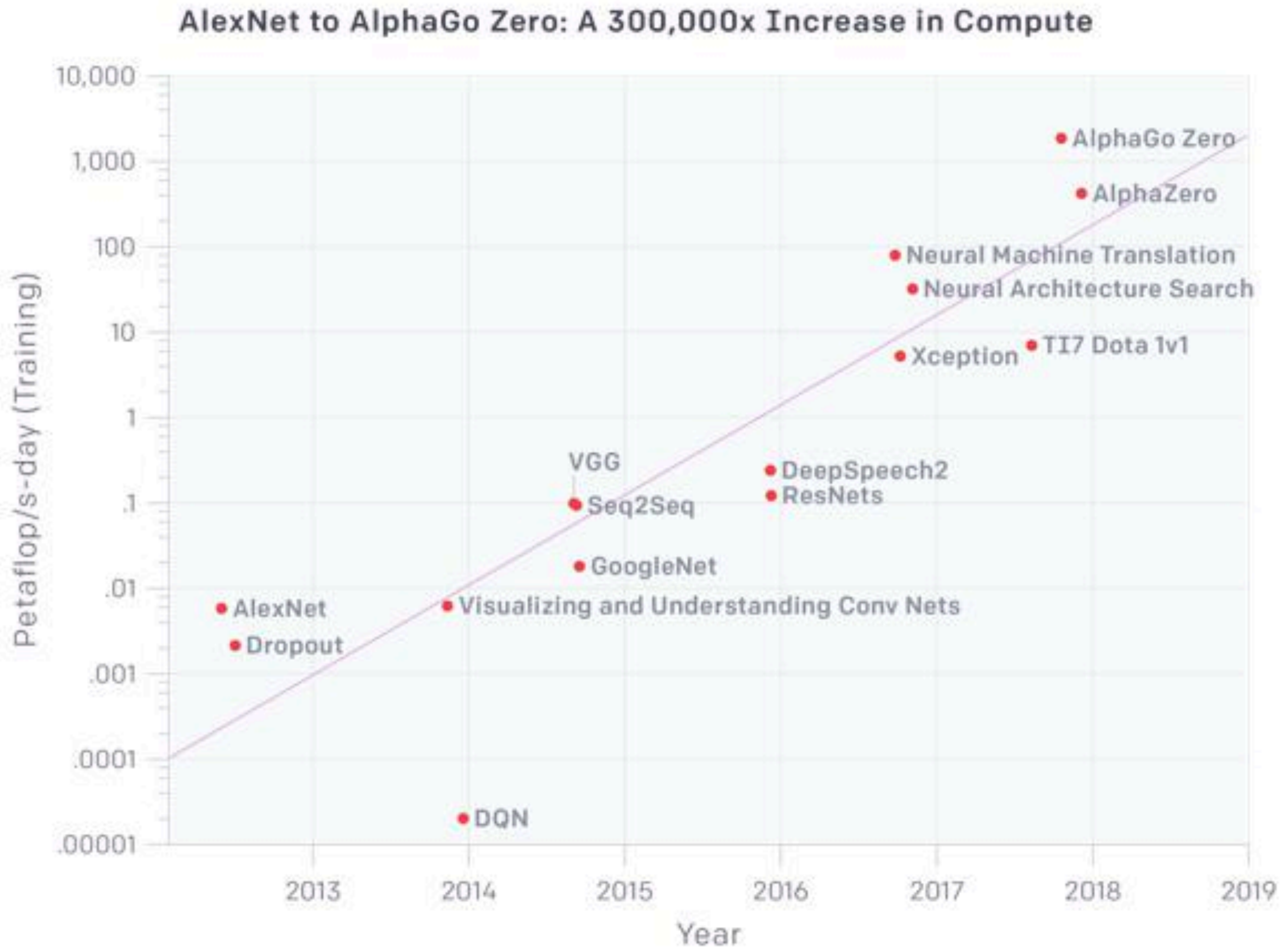
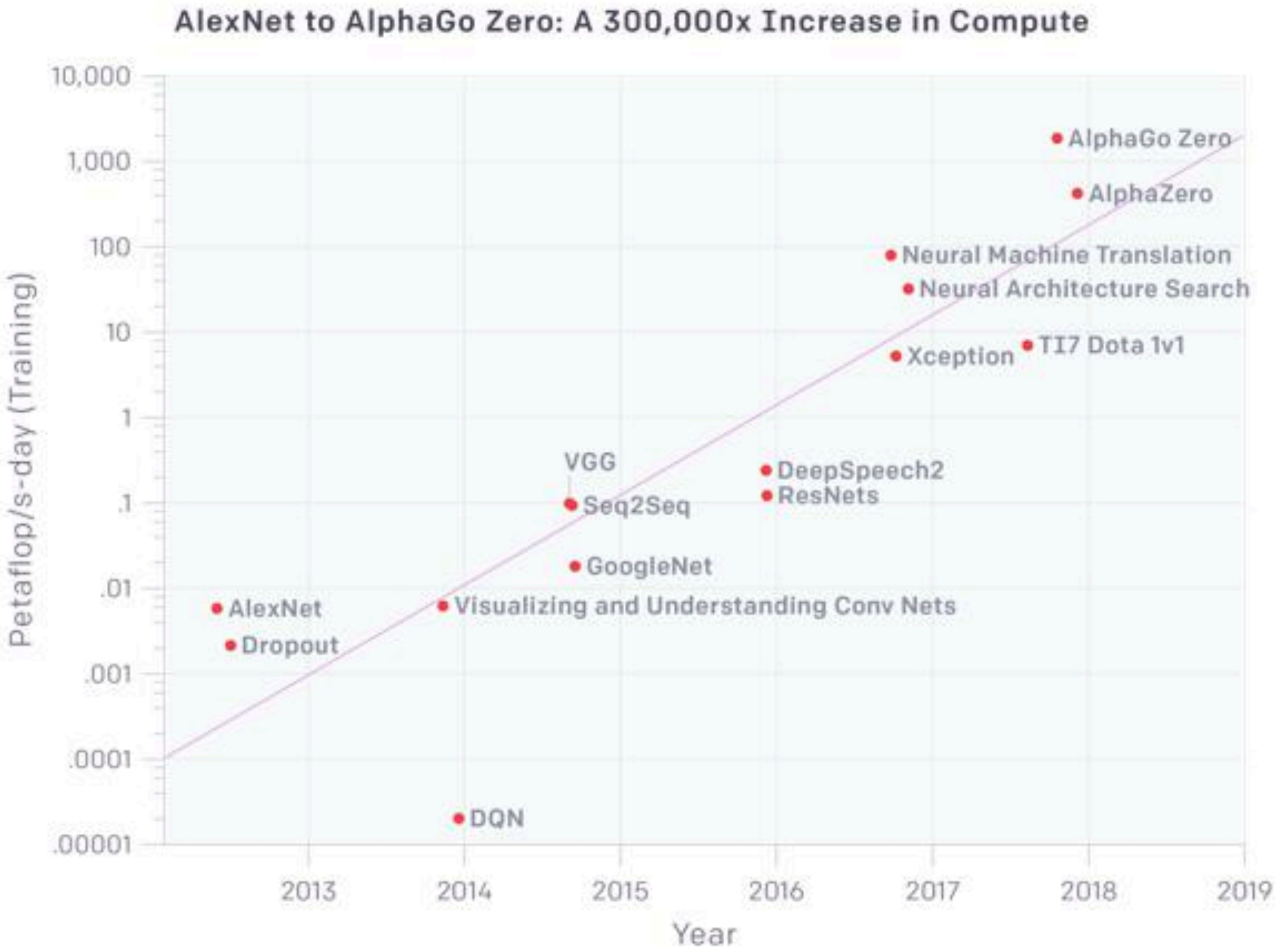
The Power of Compute



Dario Amodei and Danny Hernandez.
AI and Compute.
openai.com/blog/ai-and-compute/

6 The Power of Compute



"Since 2012, the amount of compute used in the largest AI training runs has been increasing exponentially with a **3.5 month doubling time** (by comparison, Moore's Law had an 18 month doubling period)."

Dario Amodei and Danny Hernandez.
AI and Compute.
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Options for the Future of AI

Progress in AI research slows down.

AI research becomes exponentially more expensive.

New AI algorithms using less resources are developed.

New sources of computation power are discovered.

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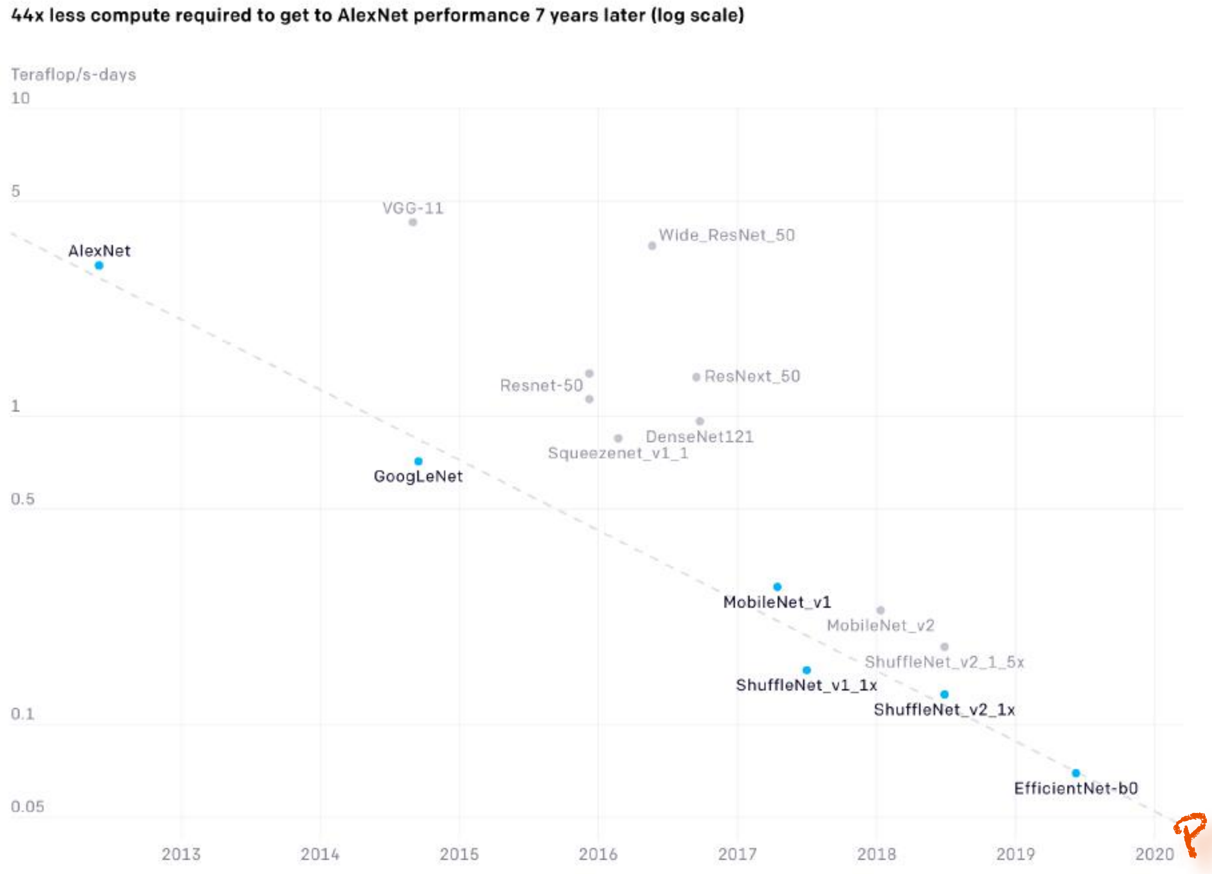
[9] The Power of Efficiency



"Compared to 2012, it now takes 44 times less compute to train a neural network to the level of AlexNet (by contrast, Moore's Law would yield an 11x cost improvement over this period). Our results suggest that for AI tasks with high levels of recent investment, **algorithmic progress** has yielded more gains than classical hardware efficiency."

Published this May!

Danny Hernandez and Tom Brown.
AI and Efficiency.
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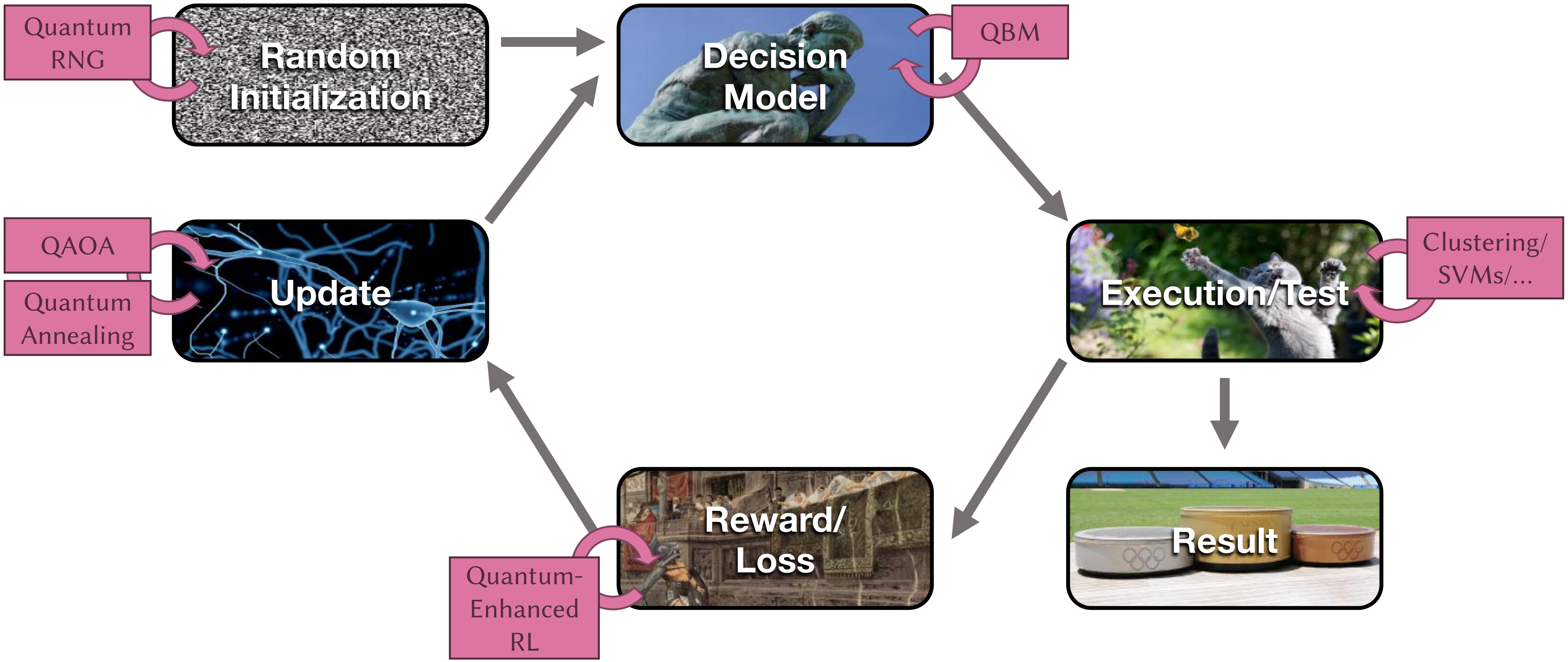
Quantum Computing and AI

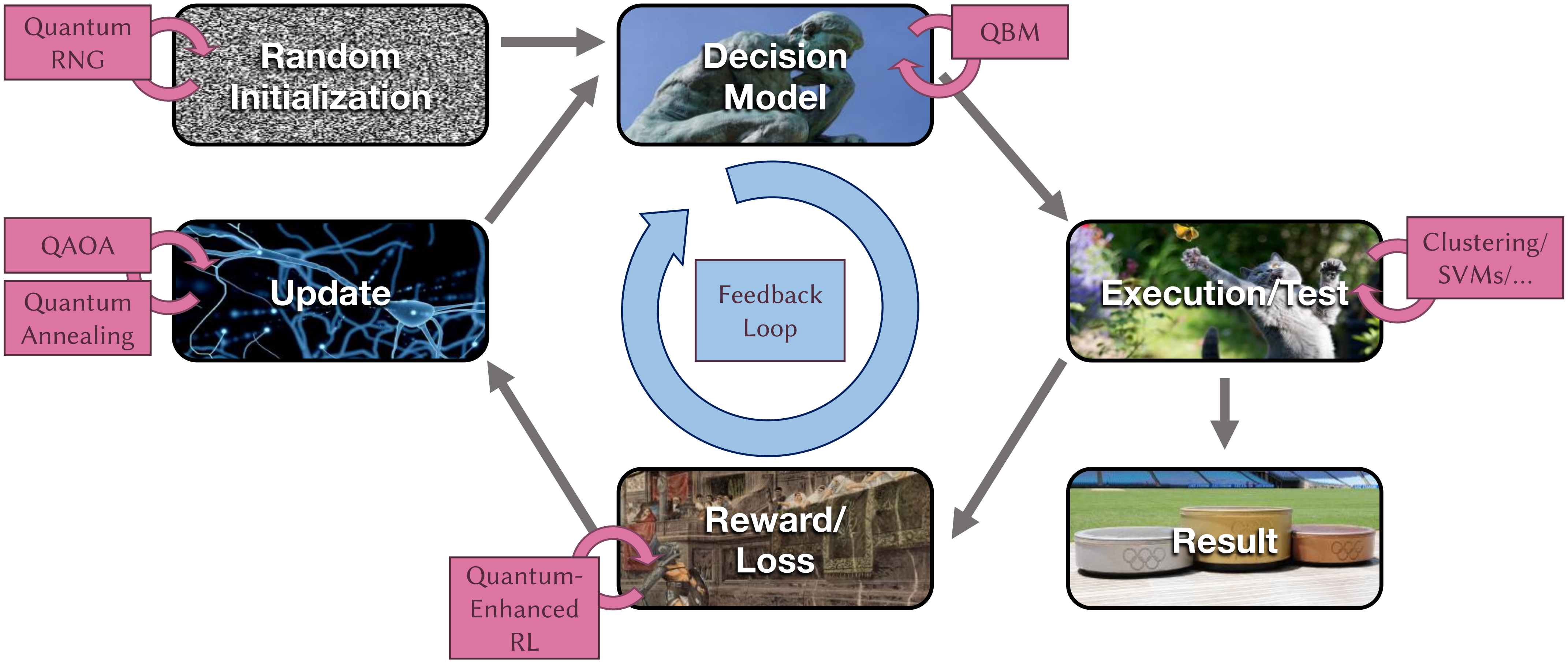
Quantum Computing		Artificial Intelligence
could provide more computing power	→	always needs more computing power
noisy for the foreseeable future	→	needs randomness
can perform stochastic search (quantum annealing or QAOA)	→	uses stochastic search
circuits are hard to construct for new algorithms	←	can invent creative solutions for well-defined goals

operates on a multitude of possibilties to
return a relatively short answer

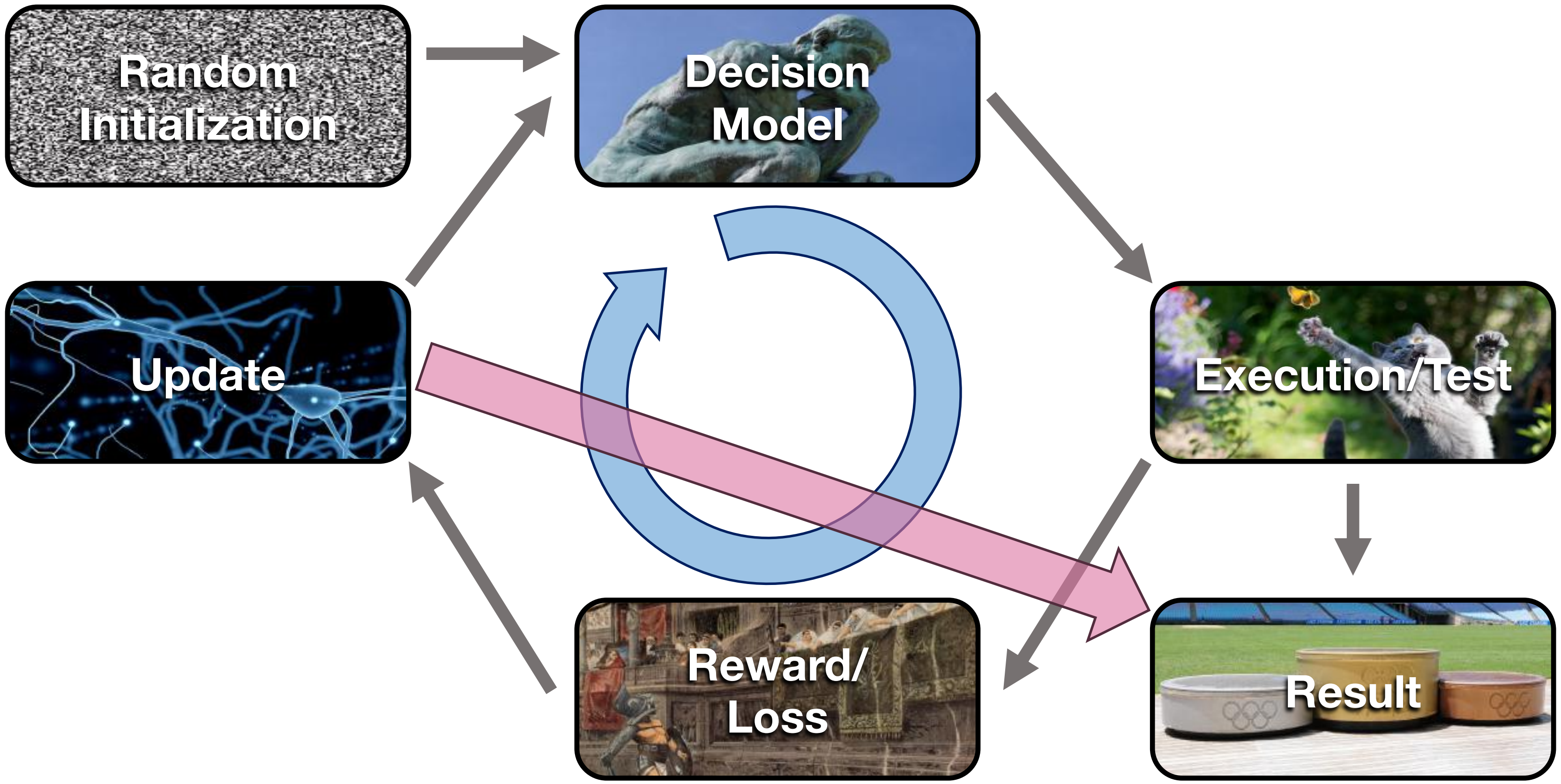
12 Quantum Machine Learning



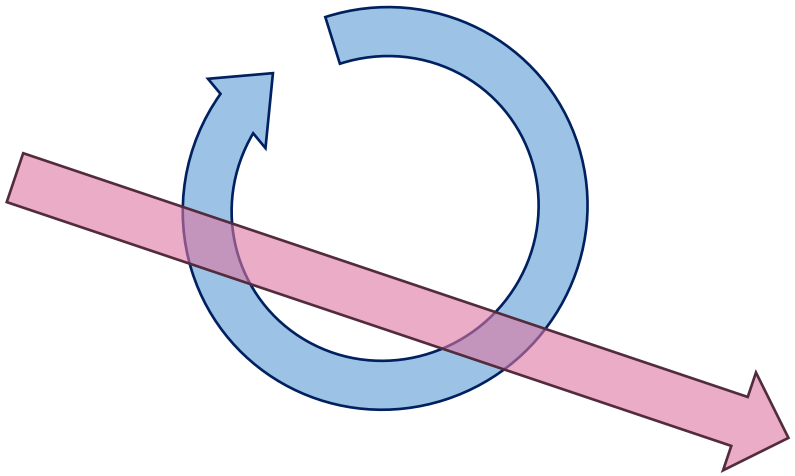
13 Quantum Machine Learning



Quantum Machine Learning



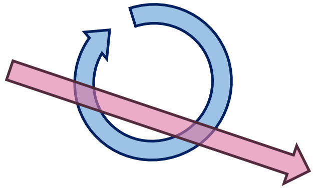
The Holy Grail of Quantum AI



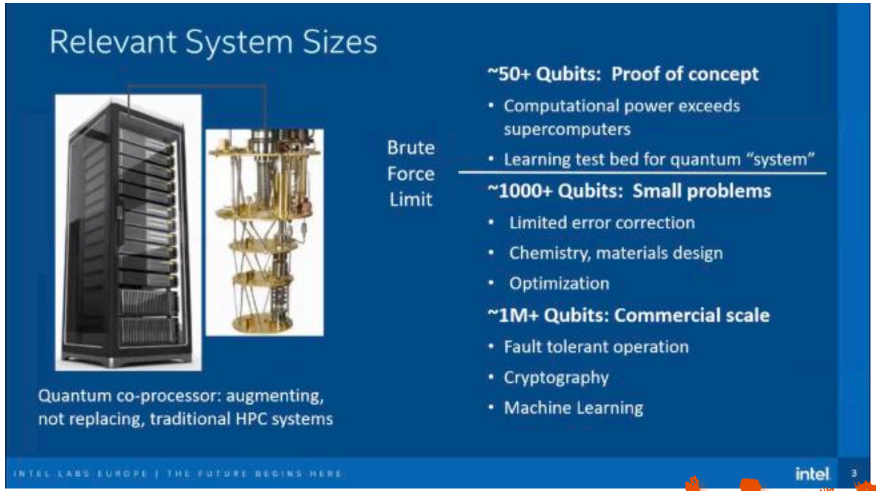
16 Challenges for Quantum AI

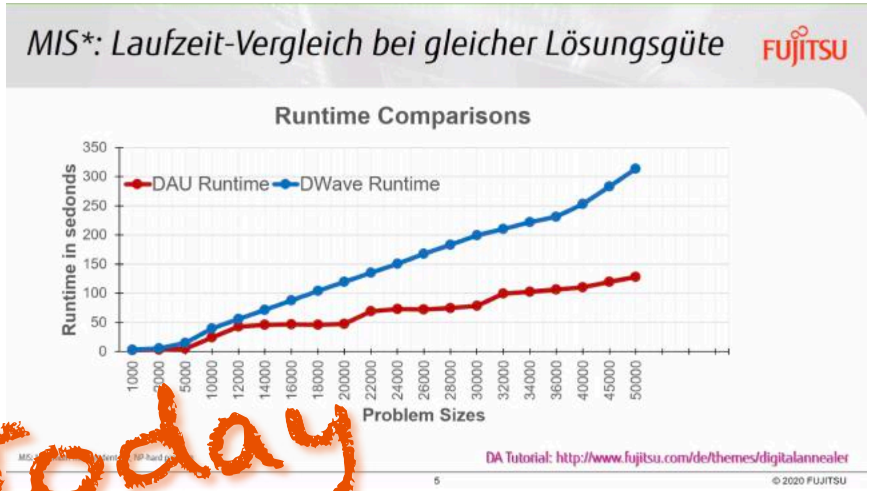
The Feedback Loop

Replace the feedback loop around training entirely with a quantum algorithm.

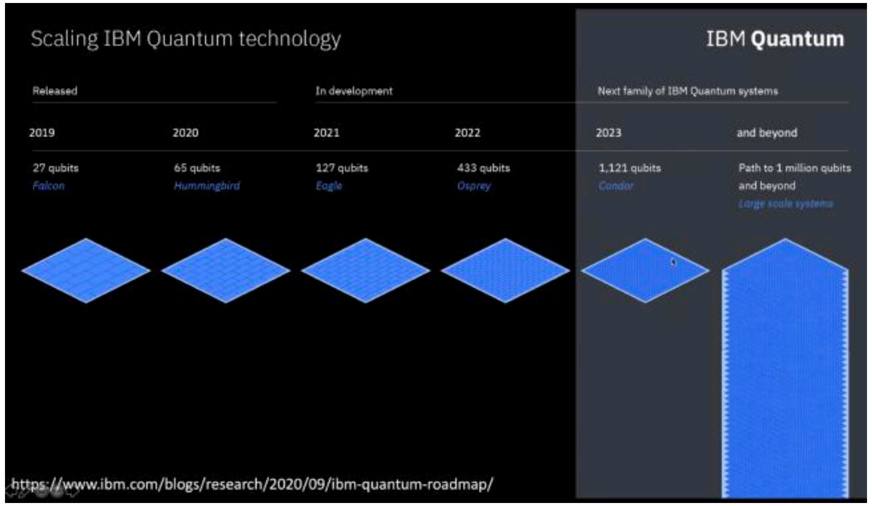


[17] The Amount of Data





Earlier Today



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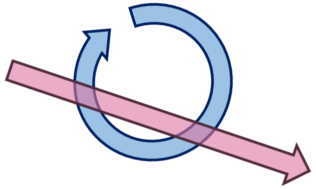
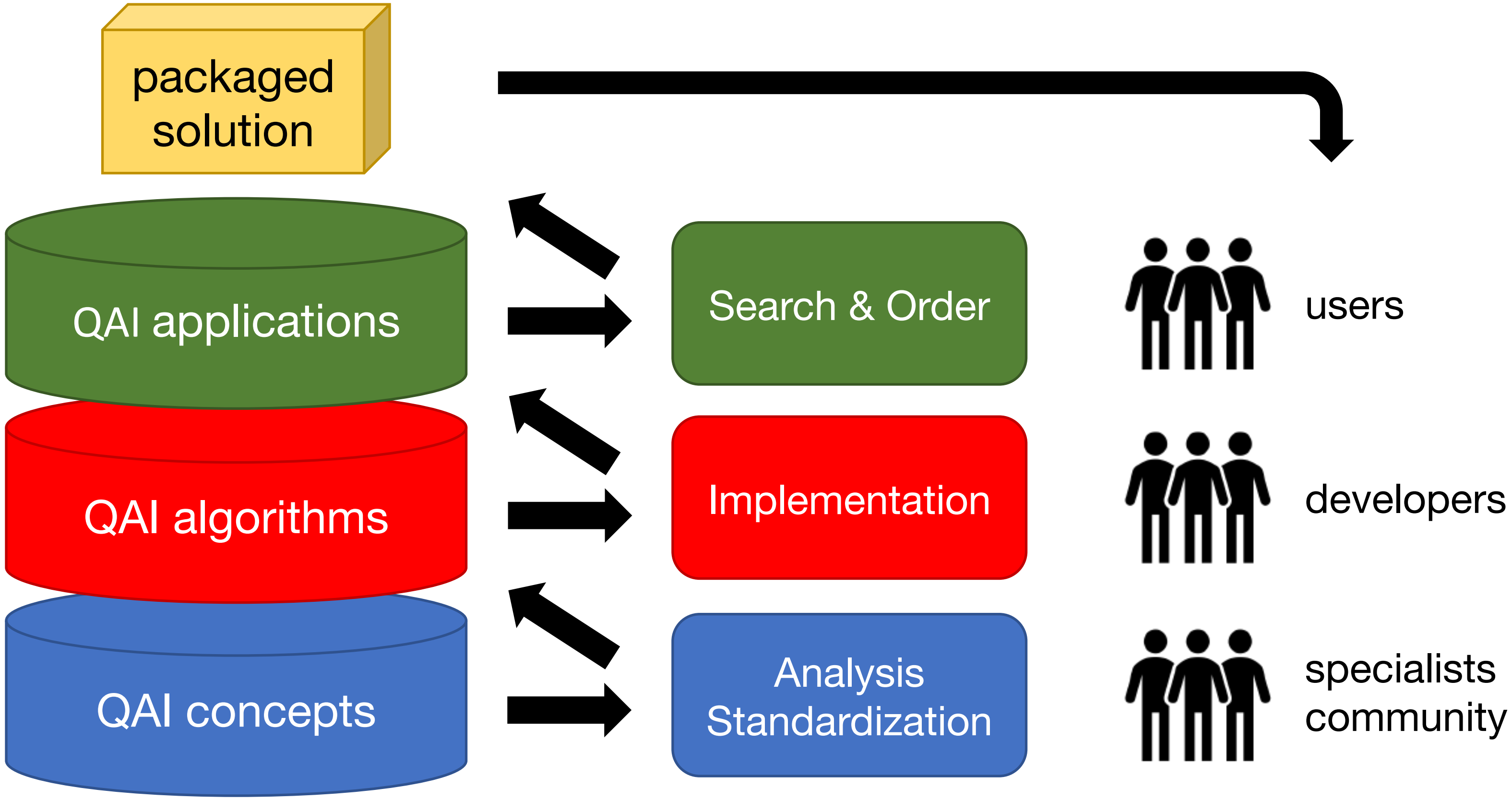


The Training Data

Provide means to process (the essence of) large amounts of data on quantum computers.

A Full Stack of Knowledge

PlanQK
['plaŋk]
www.planqk.de



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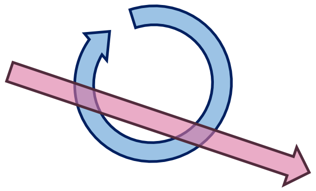

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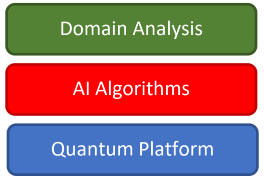
The Interfaces

Provide standardized interfaces that allow for dynamic combination of QAI components and (by extension) for experts of different fields to collaborate on QAI algorithms.



The Best Quantum Algorithm?

1. Employ a dozen algorithmically trained physicists and (physically trained??) programmers.

2. They will find a better algorithm than the one you wrote that one night in total desparation.

3. That algorithm may not actually need to use any quantum hardware.

Prof. Dr. Wolfgang Mauerer
(earlier talk today)

"It's in the journey!"

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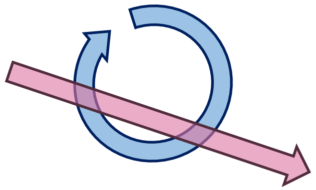

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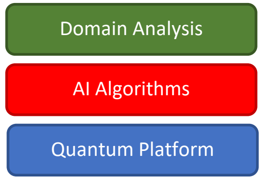
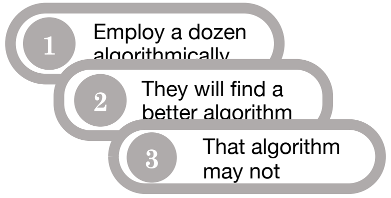


The Real Reason

Keep track of the source of observed improvements and use it wisely.



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Thomas Gabor (QAR-Lab, LMU Munich)

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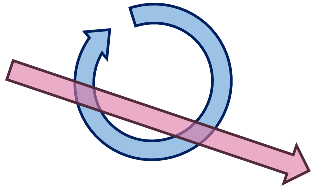

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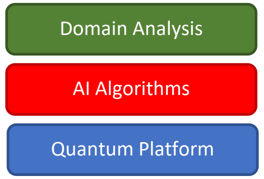

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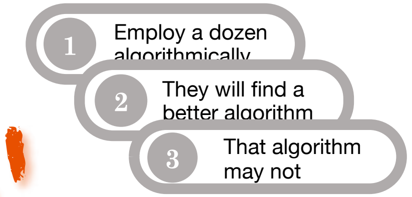

Thank You!

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Paper available!

- https://arxiv.org/pdf/2004.14035.pdf

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Image Sources

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