Quantum Computing and Art

Reinterpreting Classical Masterpieces

Arianna Crippa

Trento 05/05/2025

DESY.

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Center for Quantum Technology and Applications (CQTA)

Deutsches Elektronen-Synchrotron DESY
A Research Centre of the Helmholtz Association

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Quantum Home /

DESY. QUANTUM | Center for Quantum Technology and Applications

A DESY-Center for applied quantum research

Quantum computing and quantum sensing are novel and extremely rapidly developing fields which have the potential to change our way of computing, even our way of performing science, and to perform unprecedented accurate measurements.

Quantum

› Helmholtz Quantum Technology Roadmap

Center for Quantum Technology and Applications (CQTA)

- Theoretical models in **condensed matter** and **high energy physics.**
- Optimization/classification:
  - Particle track reconstruction/jet classification,
  - Flight gate assignment,
  - Gene classification.
- Others:
  - cryptography, quantum gravity, ...
- Training.
- Algorithm development.
- Quantum Computer Art:
  - Music, Visual art.

Since 2019: >80 publications, >100 talks
Interviews: Wall Street Journal, Forbes, ...

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SEE KARL JANSEN'S POSTER

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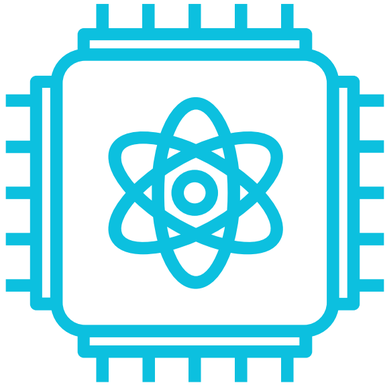


Quantum Computing

HOW TO?

HOW TO?

Art

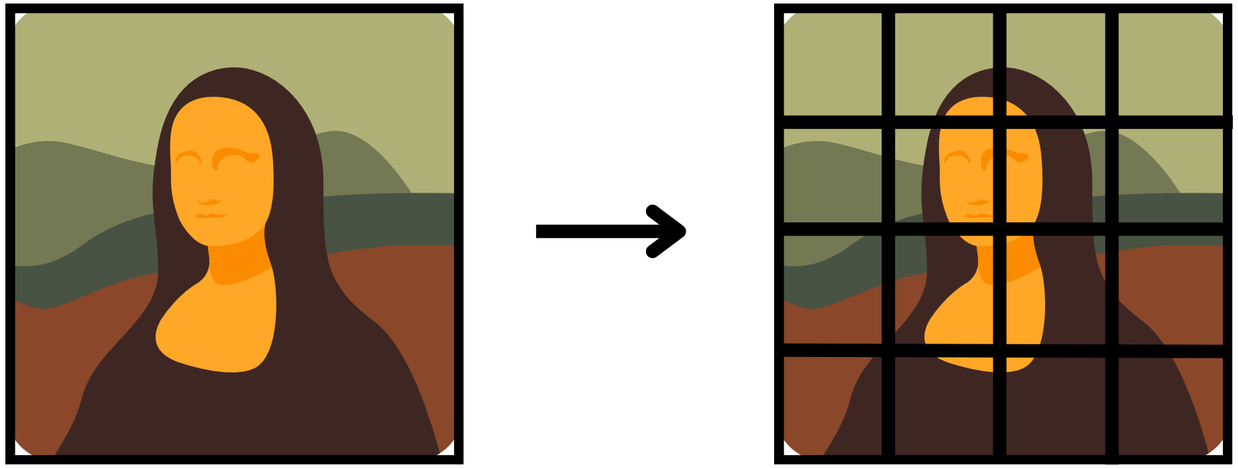
Idea

Idea

Original paintings

Idea

Original paintings analyzed and **divided** into a **lattice.**



Idea

Original paintings analyzed and **divided** into a **lattice.**

Lattice **tiles** of each **column** to **qubits.**

Physical system: Ising Model

$$H = \sum_{n=1}^{N} J_n Z_n Z_{n+1} + \sum_{n=1}^{N} h_{z,n} Z_n + \sum_{n=1}^{N} h_{x,n} X_n$$

Neighbor spin interaction

External magnetic fields

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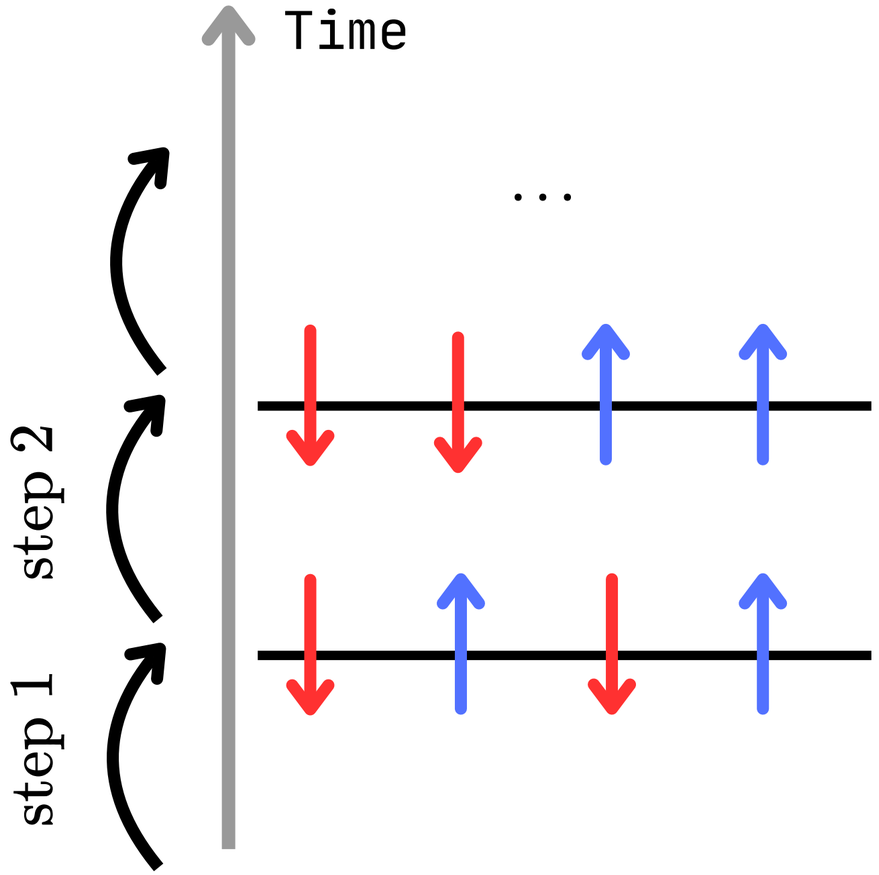
Neighbor spin interaction

External magnetic fields

Time evolution (Trotterization)

$$|\psi(t)\rangle = U(t)|\psi(0)\rangle \equiv e^{-iHt}|\psi(0)\rangle$$

with $$U(t) \approx \prod^{k} \prod_{n=1}^{N} e^{-iH_n t/k}$$



Quantum circuit

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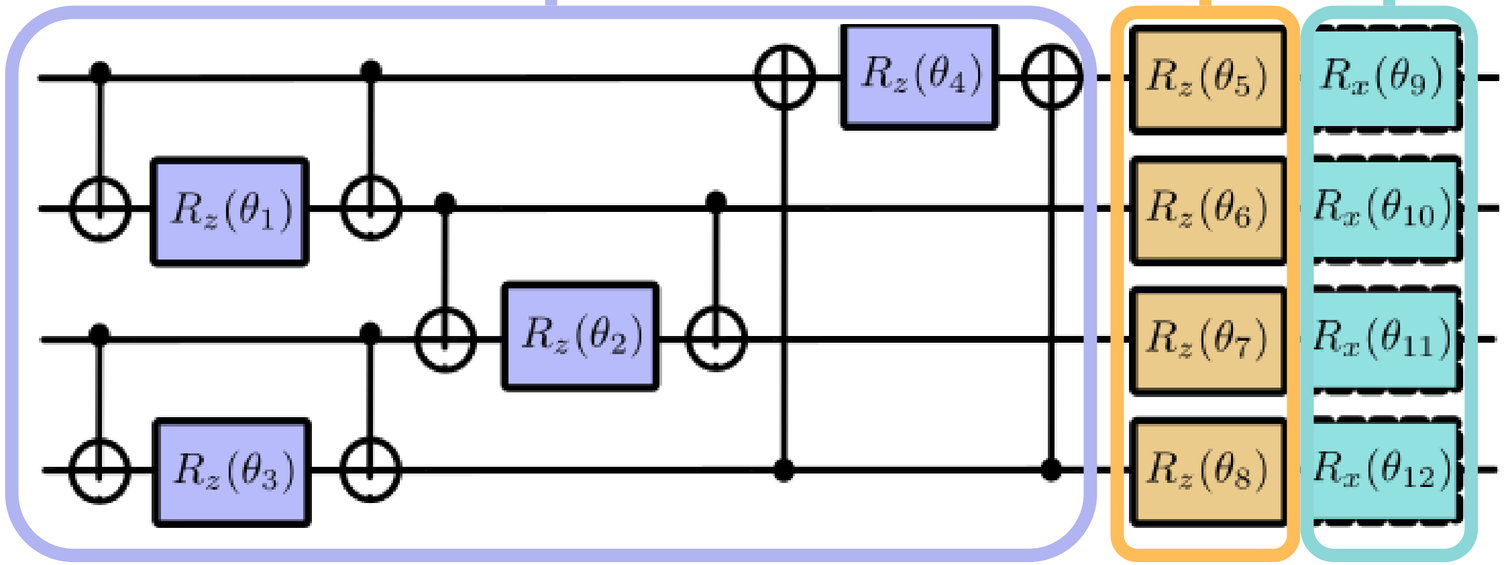
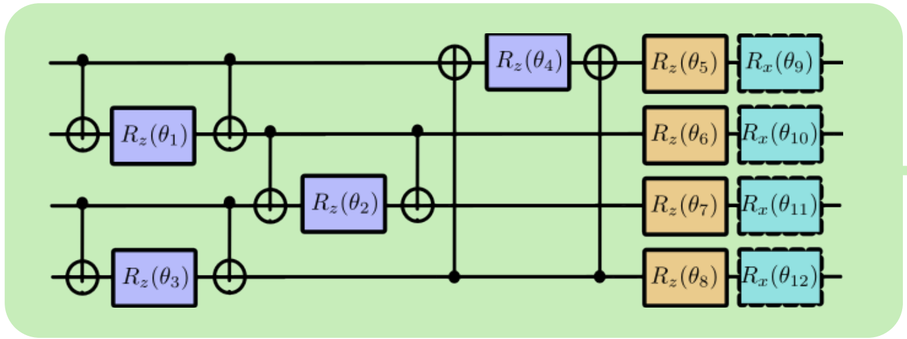
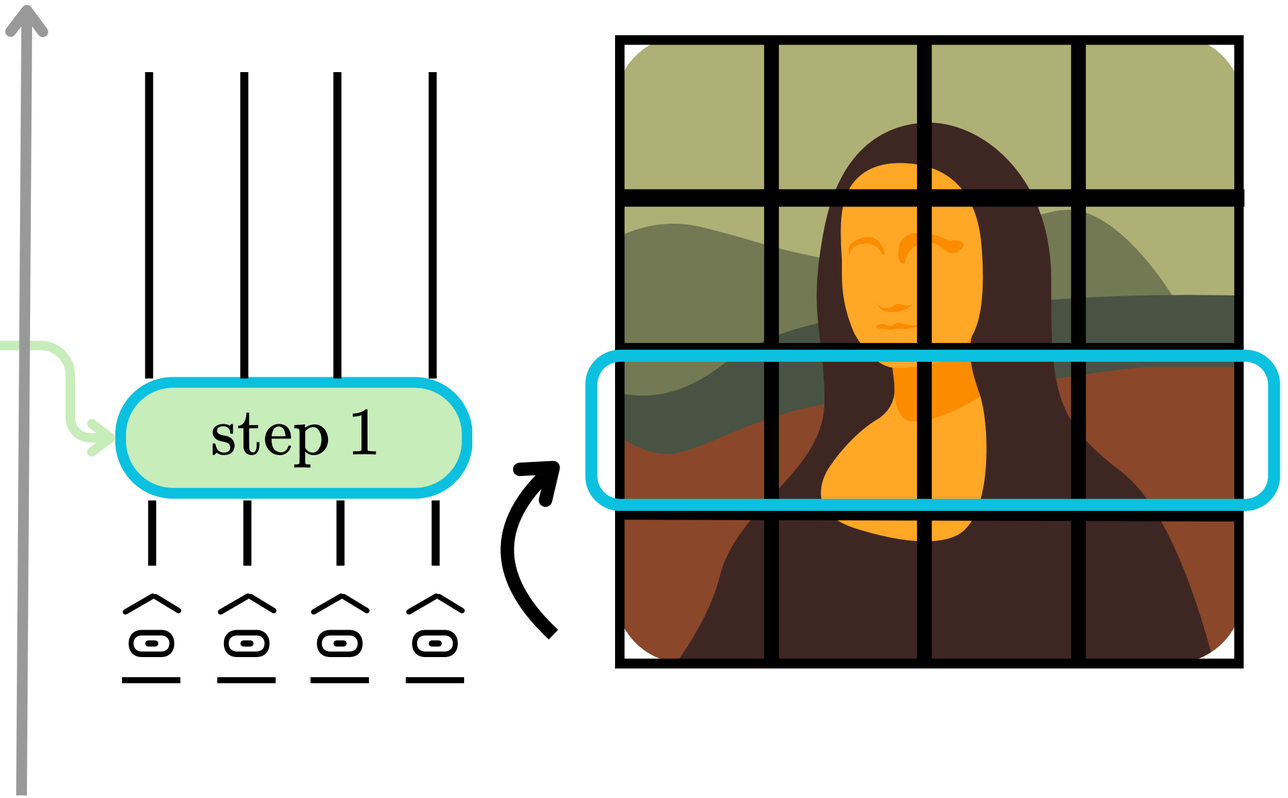


Quantum circuit





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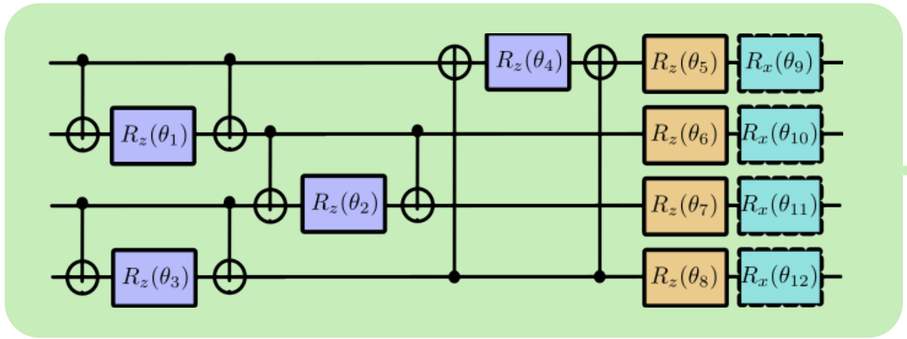

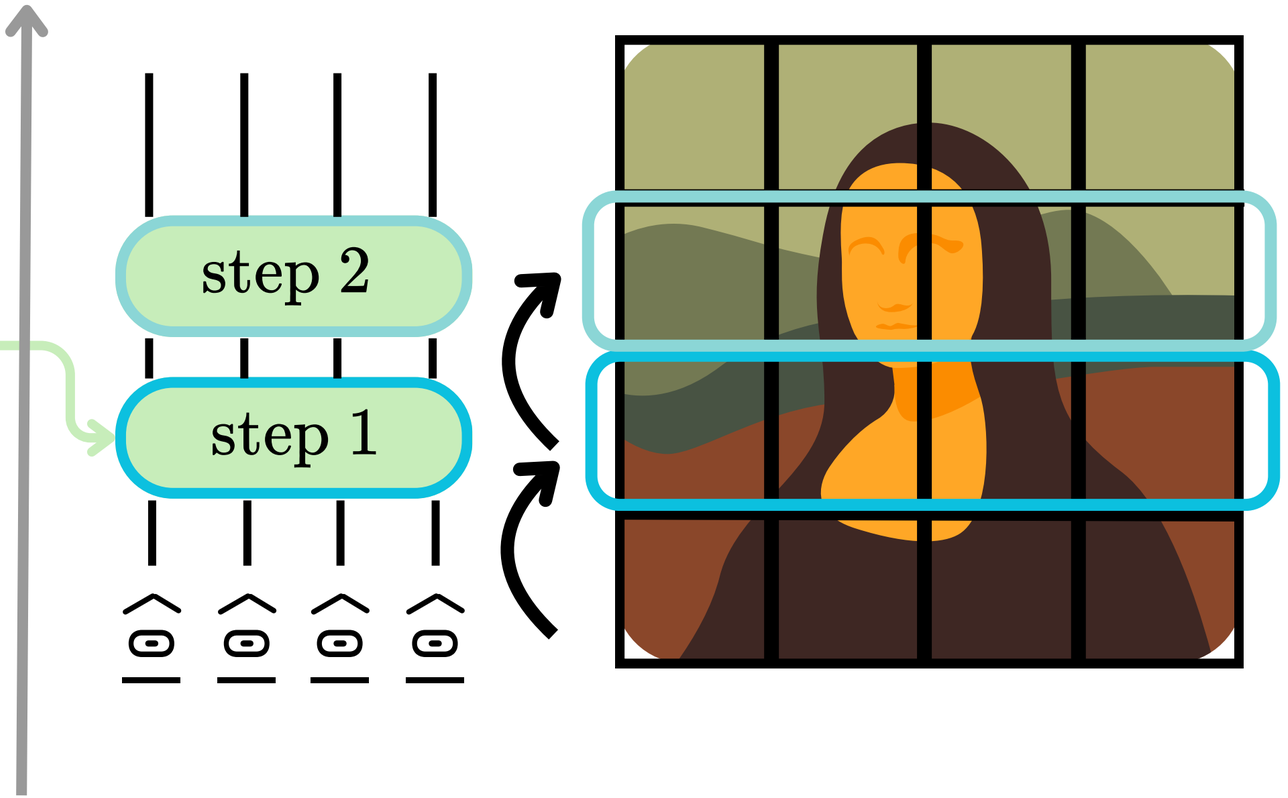

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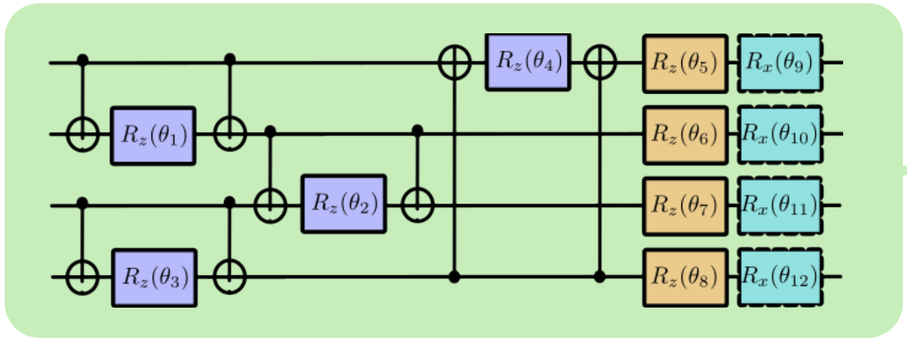

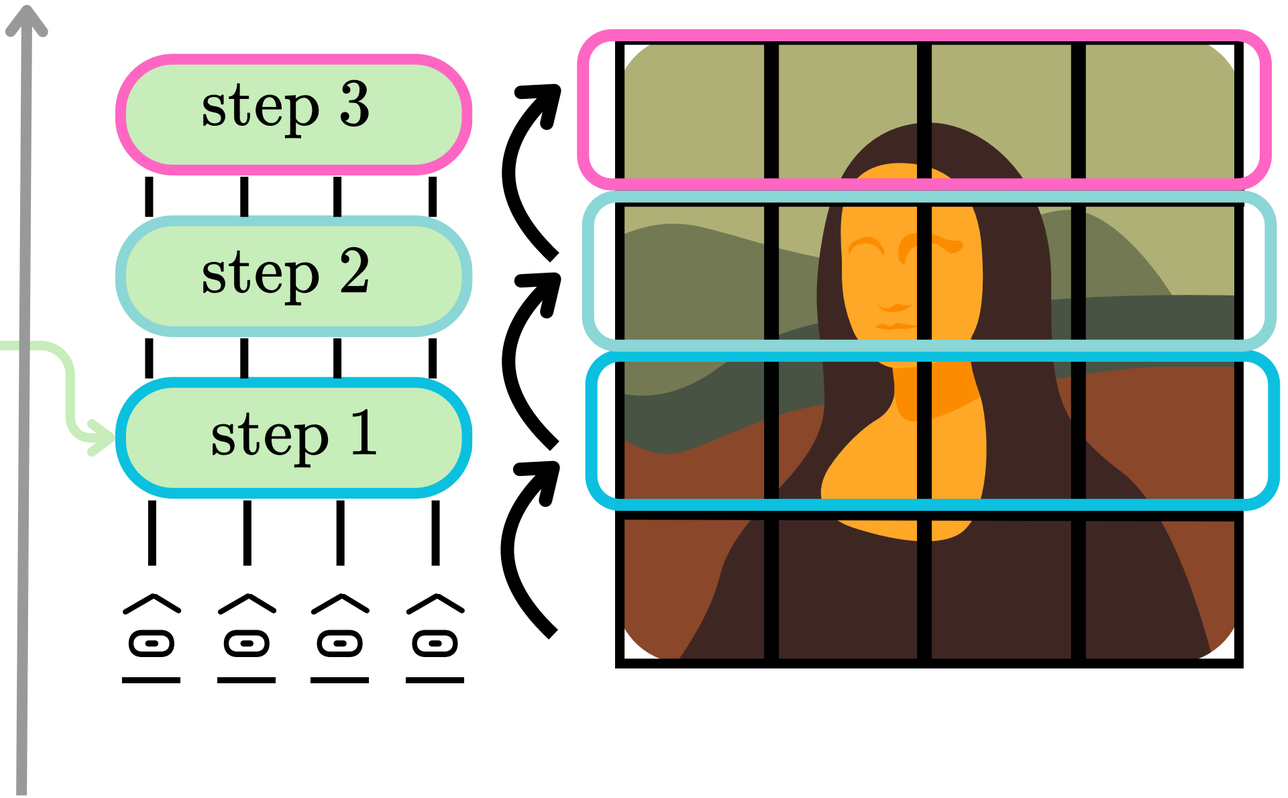

Observables

$$i_n = n + 10 \cdot \langle \psi(t) | \hat{O}_n | \psi(t) \rangle \qquad \text{with} \qquad \hat{O}_n = \frac{(I - Z_n)}{2} \qquad n \in [0, N-1] \begin{cases} \hat{O}_n|0\rangle = 0 \\ \hat{O}_n|1\rangle = |1\rangle \end{cases}$$

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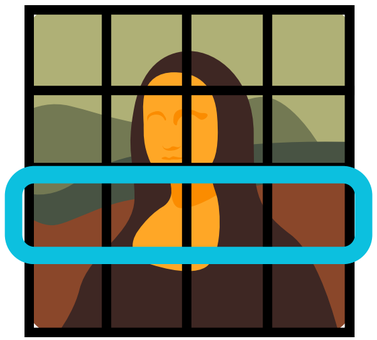

$[i_0, i_1, i_2, i_3]$

$$|\psi(t)\rangle = |0100\rangle$$

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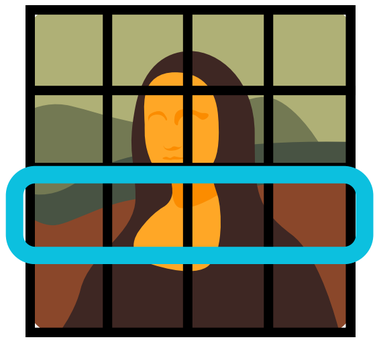

$[i_0, i_1, i_2, i_3]$

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$$i_0 = 0 + 10 \cdot 0 = 0$$

$[i_0, i_1, i_2, i_3]$

$=$

0

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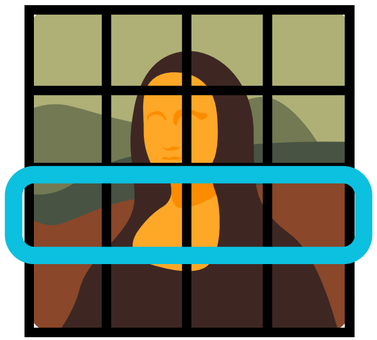

$$[i_0, i_1, i_2, i_3]$$

$$|\psi(t)\rangle = |0100\rangle$$

$$i_0 = 0 + 10 \cdot 0 = 0$$

$$i_1 = 1 + 10 \cdot 0 = 1$$

$$[i_0, i_1, i_2, i_3]$$

$$\begin{matrix} \| & \| \\ 0 & 1 \end{matrix}$$

Observables

$$i_n = n + 10 \cdot \langle \psi(t) | \hat{O}_n | \psi(t) \rangle \qquad \text{with} \qquad \hat{O}_n = \frac{(I - Z_n)}{2} \qquad n \in [0, N-1]$$

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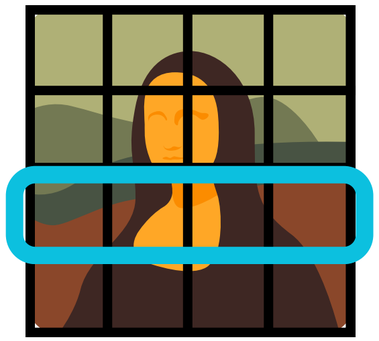

$[i_0, i_1, i_2, i_3]$

$$|\psi(t)\rangle = |0100\rangle$$

$$i_0 = 0 + 10 \cdot 0 = 0$$

$$i_1 = 1 + 10 \cdot 0 = 1$$

$$i_2 = 2 + 10 \cdot 1 = 12$$

$[i_0, i_1, i_2, i_3]$

$0 \quad 1 \quad 12$

Observables

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$$i_0 = 0 + 10 \cdot 0 = 0$$

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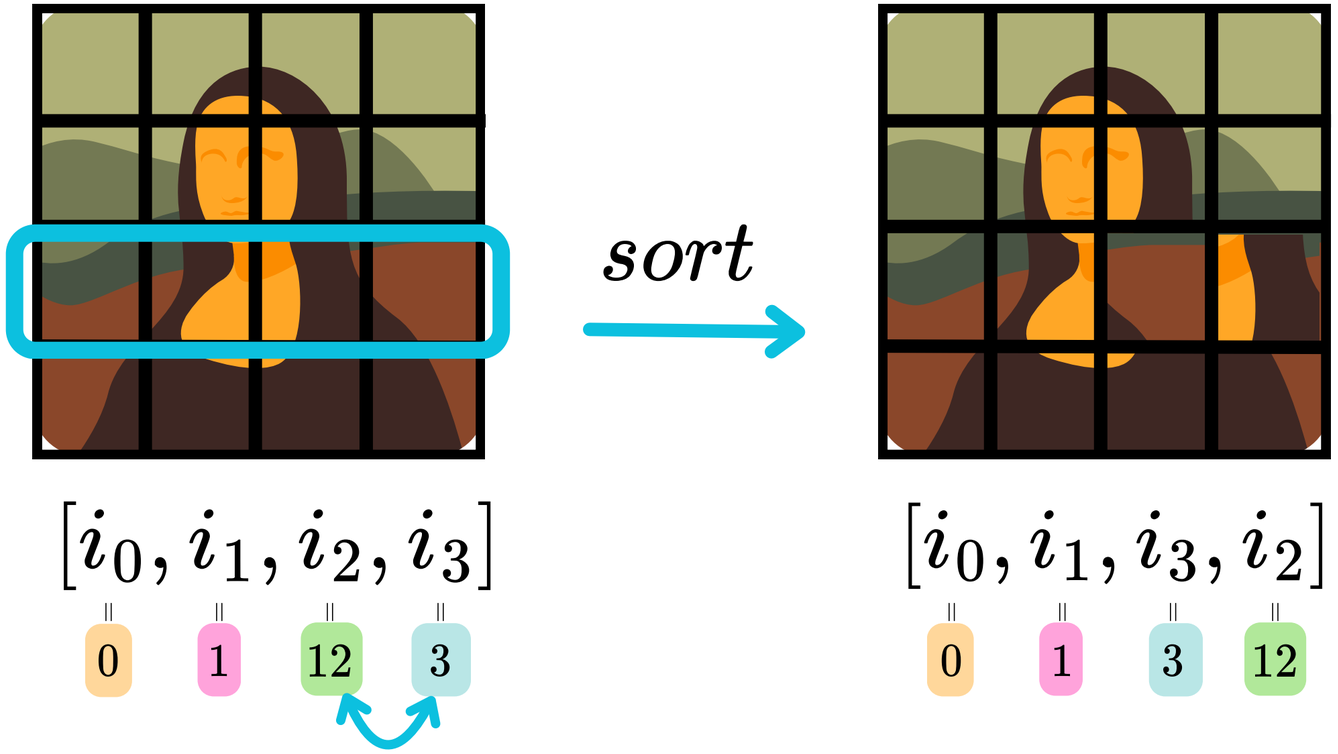
$$i_2 = 2 + 10 \cdot 1 = 12$$

$$i_3 = 3 + 10 \cdot 0 = 3$$

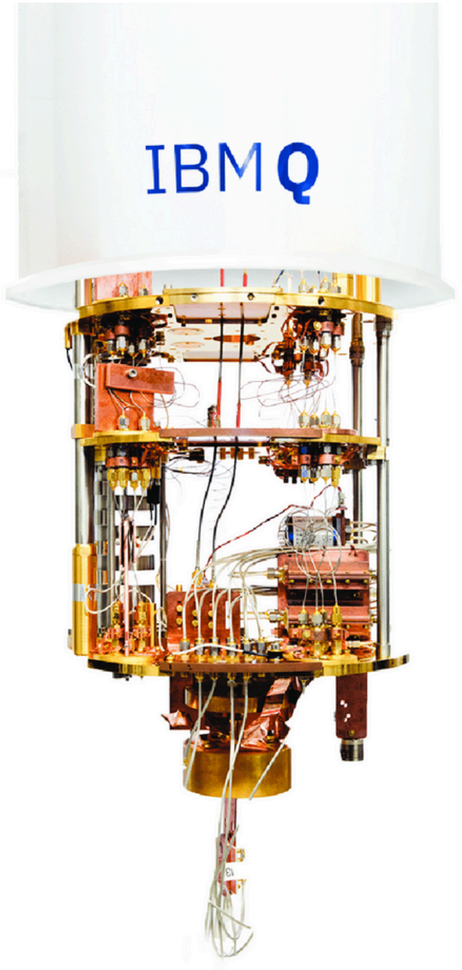
$[i_0, i_1, i_2, i_3]$

$= \quad = \quad = \quad =$

$0 \quad 1 \quad 12 \quad 3$


sort
$[i_0, i_1, i_2, i_3]$
0
1
12
3
$[i_0, i_1, i_3, i_2]$
0
1
3
12

Run on Quantum Hardware



127 qubits Devices:
ibm_kyoto
ibm_sherbrooke
ibm_strasbourg
ibm_nazca

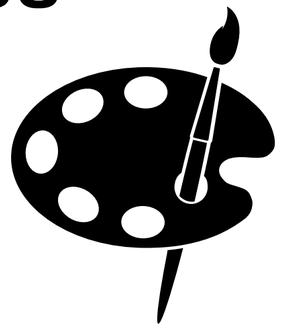
Shots:
4096

Quantum Transformation I-III

FROM REALISM

TO ABSTRACTION

Painting process



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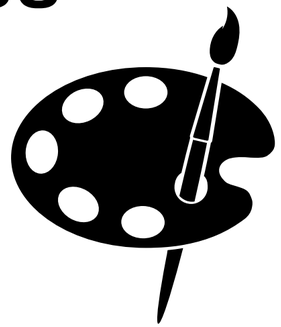

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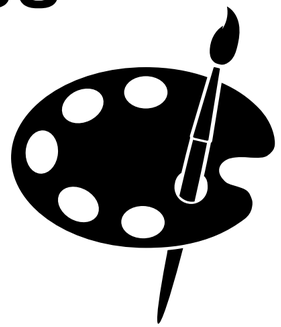

Conclusion and outlook

Bridge Between Quantum Mechanics and Traditional Art:

employ **superposition, entanglement** for real-world **painting** techniques.

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Bring Quantum Computing to the public through Art

Conclusion and outlook

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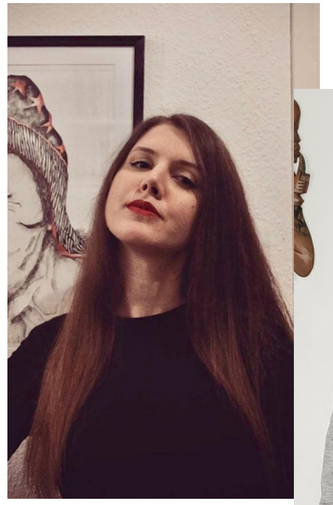
Bring Quantum Computing to the public through Art

Expand Artistic Possibilities with Quantum Computing:

quantum **algorithms** (e.g., VQA, QML) and new **subjects.**

QUANTUM COMPUTING | ARIANNA CRIPPA OMAR COSTA HAMIDO YAHUI CHAI KARL JANSEN PAULO ITABORAI





Music

Visual Art

Literature

About

Join us for an inspiring afternoon exploring the fascinating intersection of quantum computing and the arts. This open and accessible pre-event introduces the core ideas of quantum computing and how they are beginning to influence music, visual arts, and creative thinking. No prior knowledge is needed — just curiosity!

Program

Opening: Quantum Computers & Art	**14:00**
Introduction to Quantum Computing	**14:15**
Quantum Computers in Music	**15:00**
Quantum Computers in Visual Arts	**16:15**
Quantum Art and Society	**17:00**
Discussions	**17:45**

With contributions from:

Chris Kondek (UdK)

Tim Schwägerl (DESY)

Paulo Vito Itaborai (DESY, CyI)

Karl Jansen (DESY, CyI)

Adrian Schmidt (KIT, ITAS)

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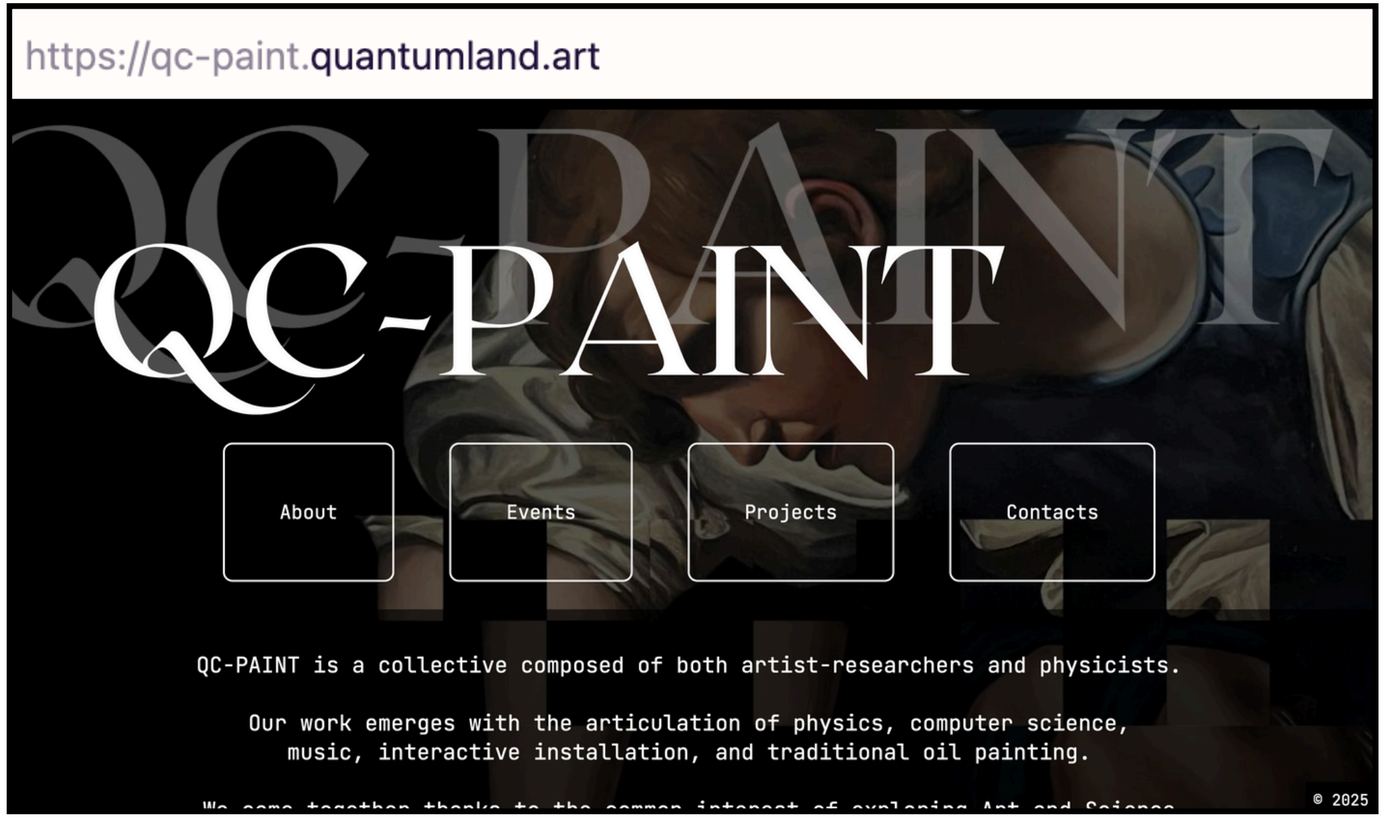
KIT Karlsruher Institut für Technologie

itas Institute for Technology Assessment and Systems Analysis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QC-PAINT is a collective composed of both artist-researchers and physicists.
Our work emerges with the articulation of physics, computer science,
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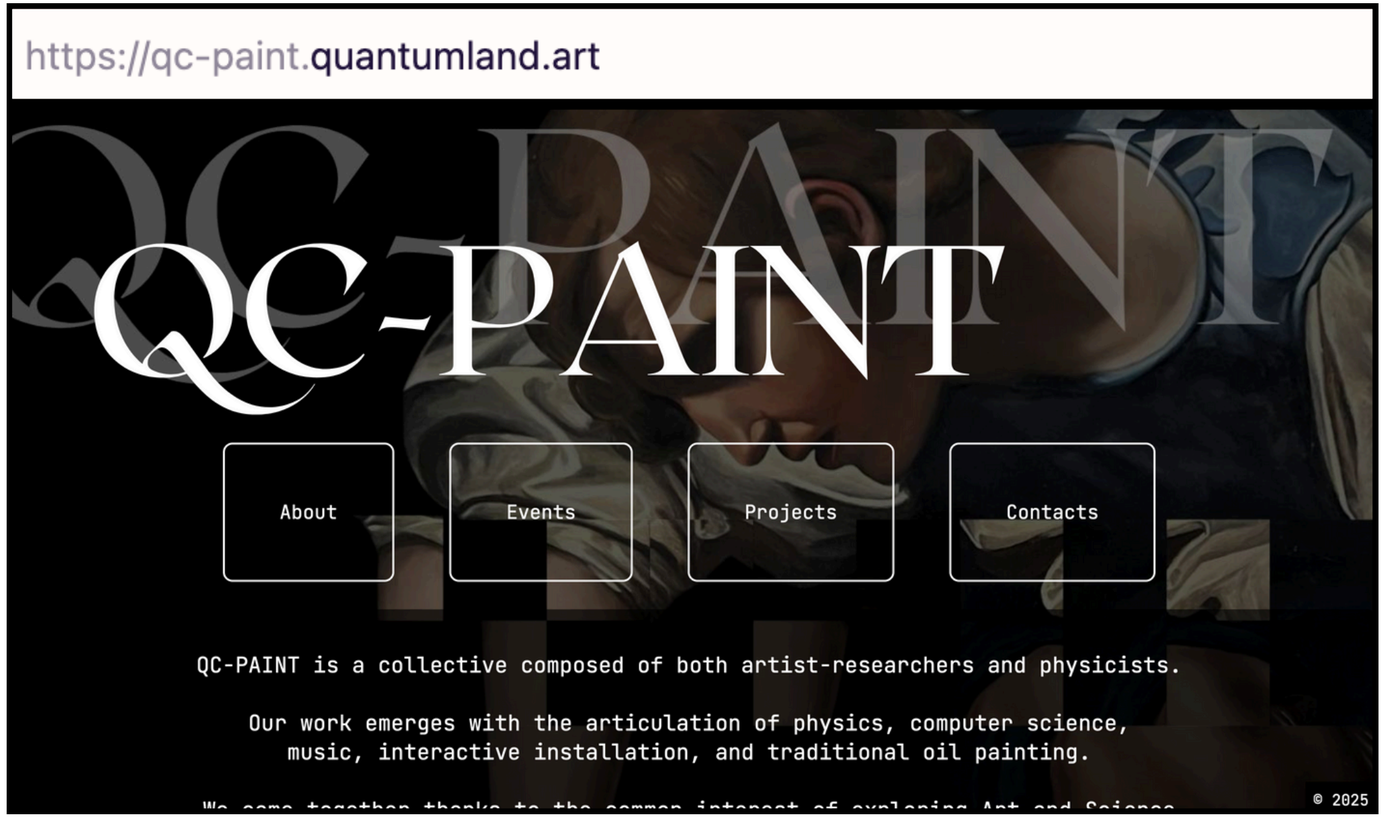
Thank you!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Quantum Transformation I: Caravaggio

Quantum Transformation II: Magritte

Quantum Transformation III: Richter