

From Detection to Interpretation

The Epistemic Function of AI in Scientific Imaging

Research question

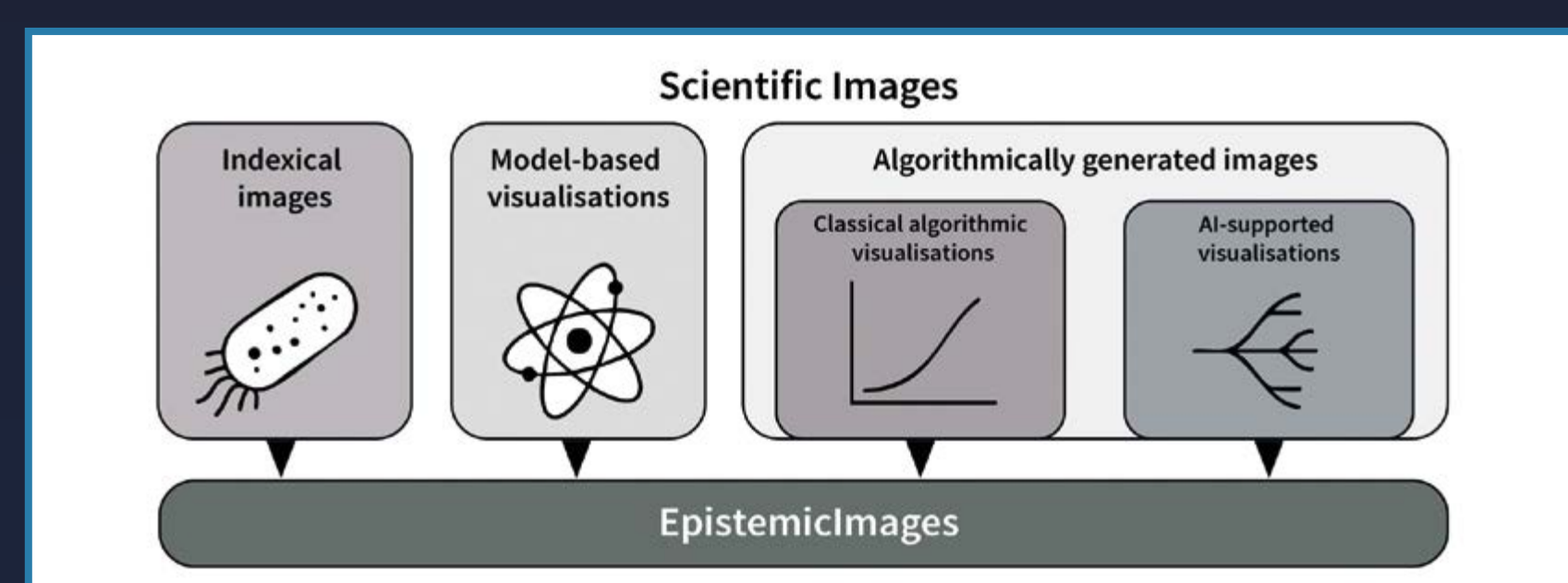
- How does the epistemic function of scientific images change when they are no longer based on a detective coupling to observable phenomena, but appear as machine-generated, epistemically unauthorised artefacts?

Method/Notes

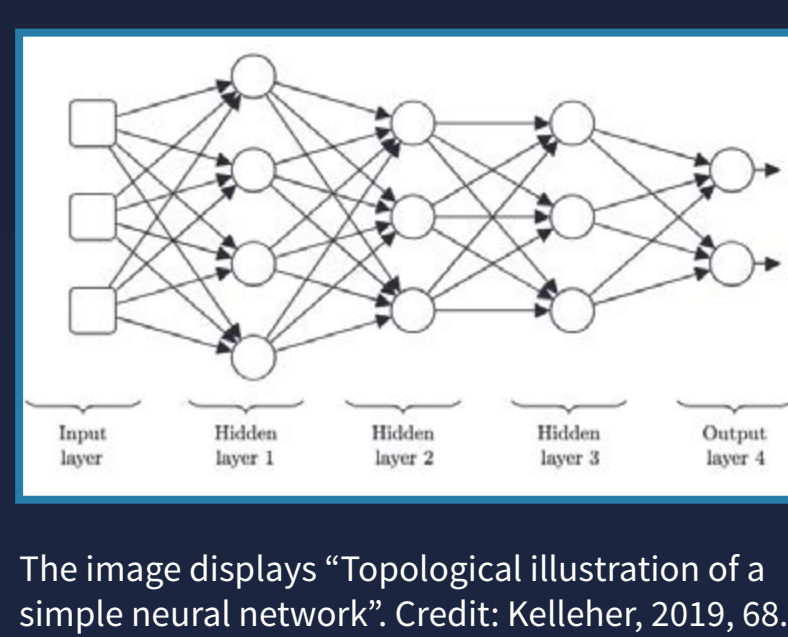
- Systematic analysis of generative methods (CNN, GAN, CASSINI-AUTOMAP) to derive the epistemic consequences for evidence, visibility and validity.
- Focus on the transition from reconstruction to generation and the associated structures of responsibility.

Background

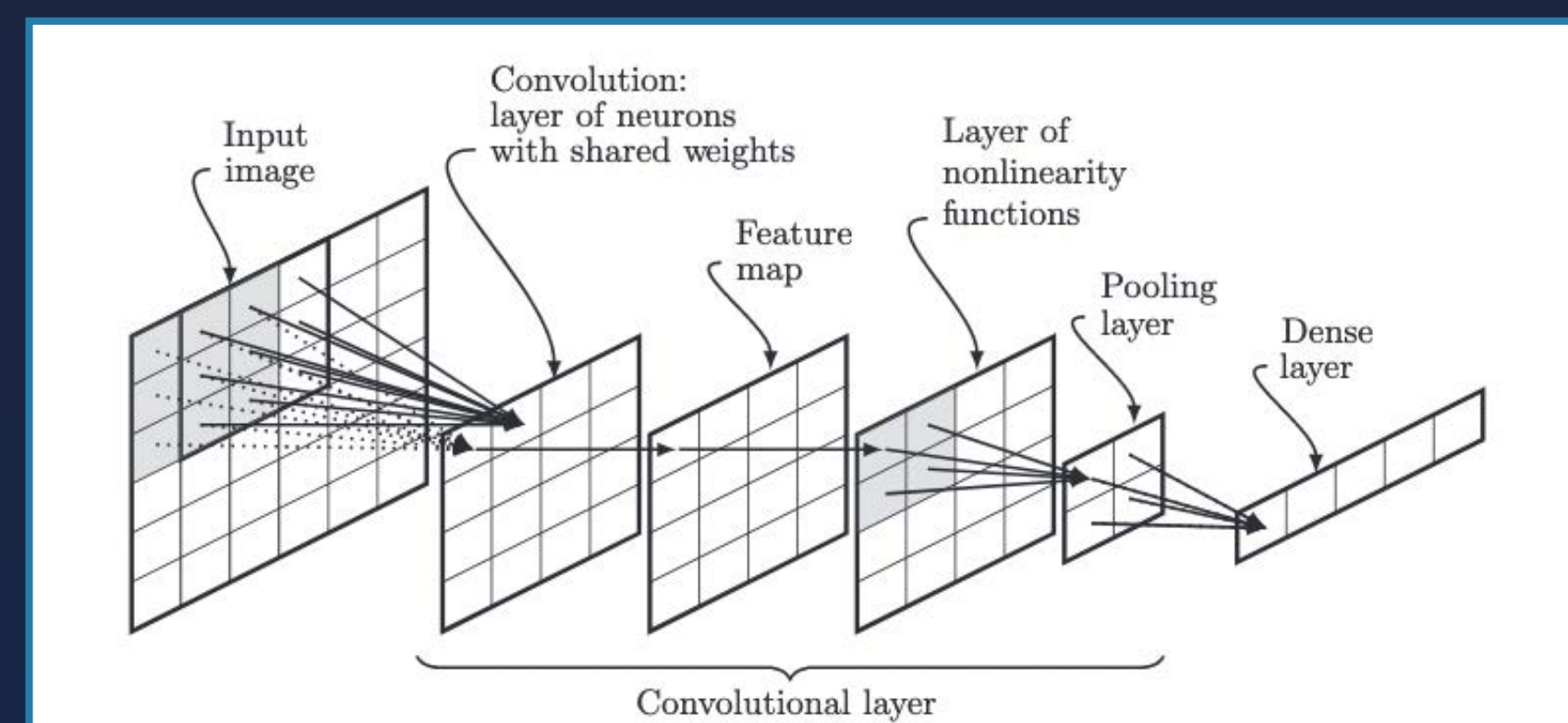
- The epistemic function of scientific images shifts when the detective coupling to empirically detectable phenomena is replaced by algorithmically generated visibility spaces of generative systems.



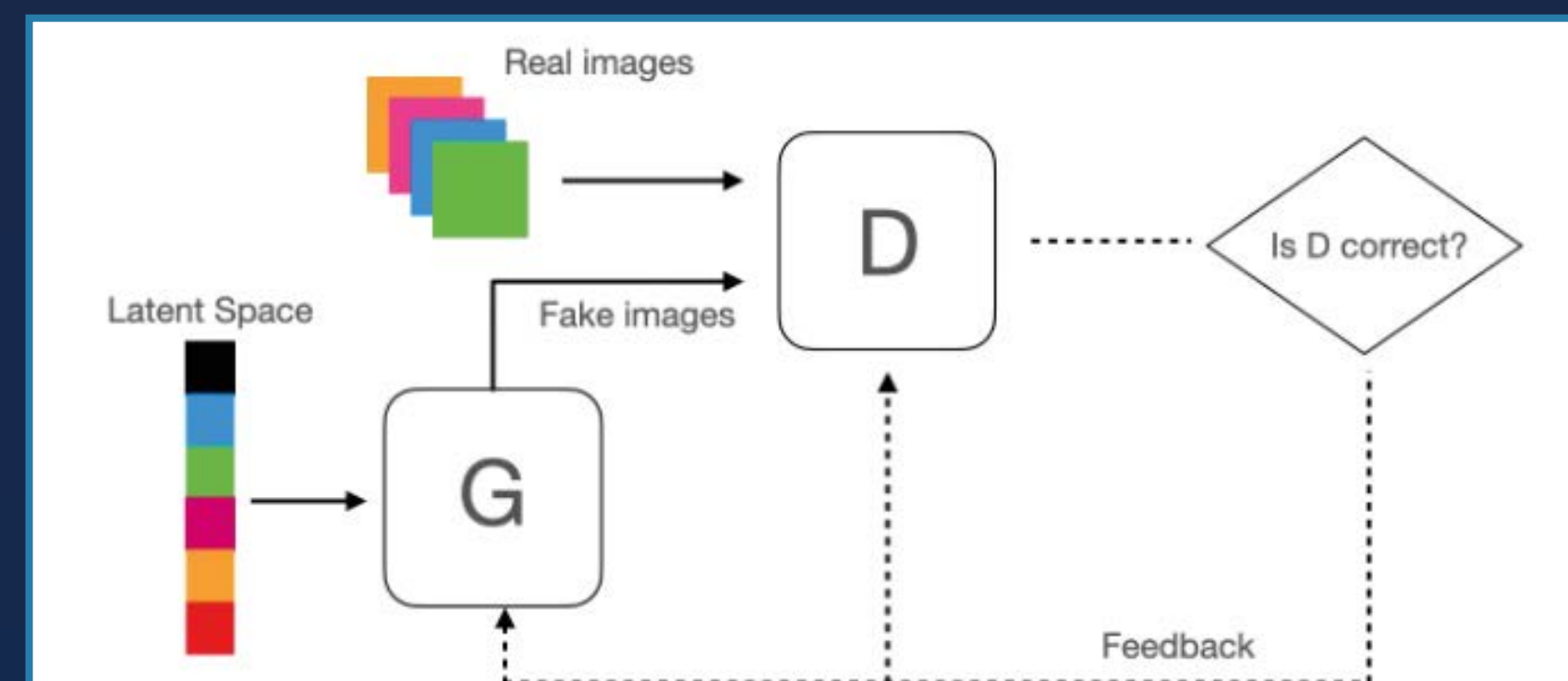
- Technical processes such as CNN, GAN and CASSINI-AUTOMAP are examples of this transition from world reference to probability/latent space.



Convolutional Neuronal Network (CNN)

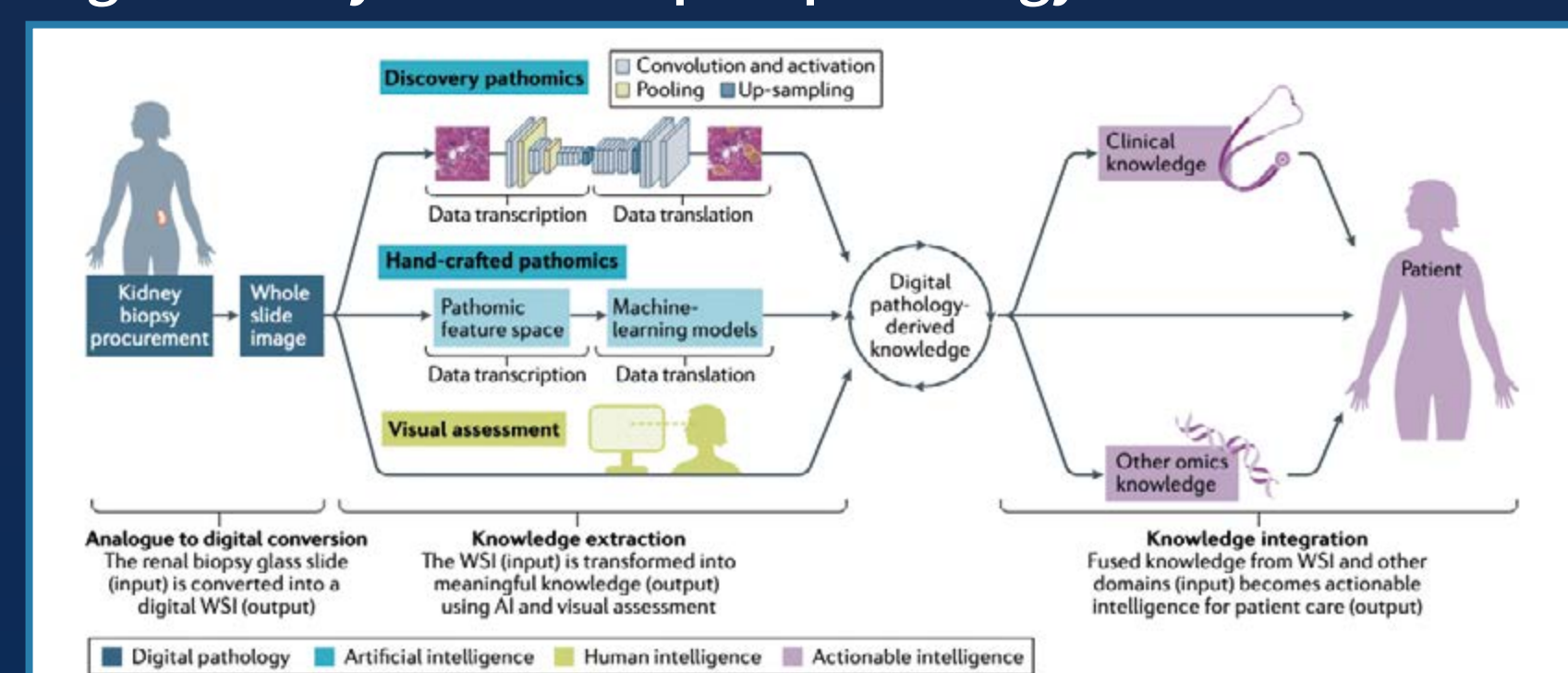


Generative Adversarial Network (GAN)



Schematics of a Generative Adversarial Network (GAN). This type of neural network confronts two nets in a minimax game. The first one is the generator (G) which is going to create new samples of a signal from a compressed dimensional space (i.e., the latent space). The second one is the discriminator (D), which tries to determine whether the input from G is fake in comparison with a sample or real images." Credit: Sanchez-Bermudez et al., 2022, 3.

Digital Ecosystem of Nephropathology



The digital ecosystem of nephropathology comprises three phases: (1) the digitisation of biopsy specimens into whole slide images (WSI), (2) knowledge extraction through human cognition and/or AI (e.g., hand-crafted and discovery pathomics), and (3) the use of the insights gained for clinical decision-making. Each phase transforms input data into structured output data that serves as the basis for the next level of analysis. AI-supported methods supplement the medical evaluation with data-based classifications and prognostic information." Credit: Barisoni et al., 2020, 682.

Transformation of the image function

Historical shift
Index (trace) → model visualisation → generative simulation

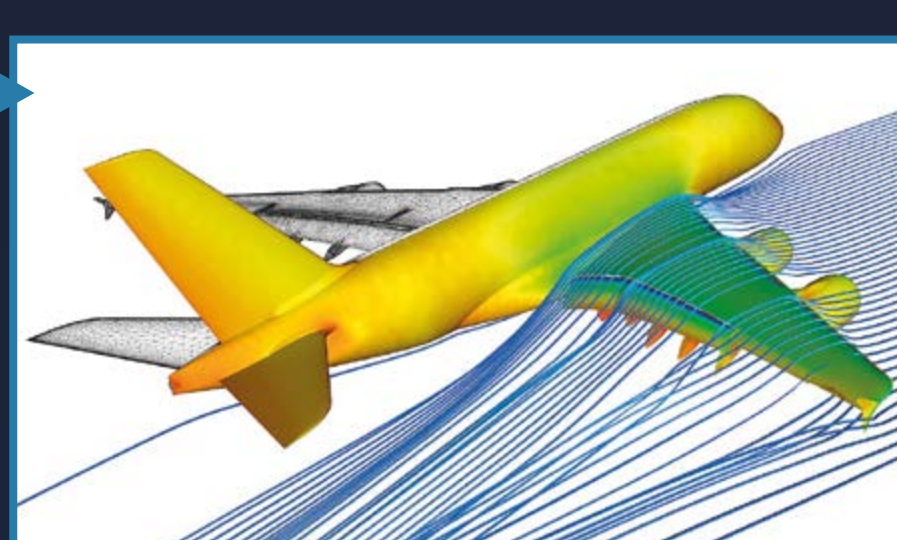
Classical scientific images: Indexical coupling (X-ray, photographic plate)

Not his wife's hand, but one of the first X-rays taken by Wilhelm Conrad Röntgen. Credit: deutschland-funkkultur.de, 2023.



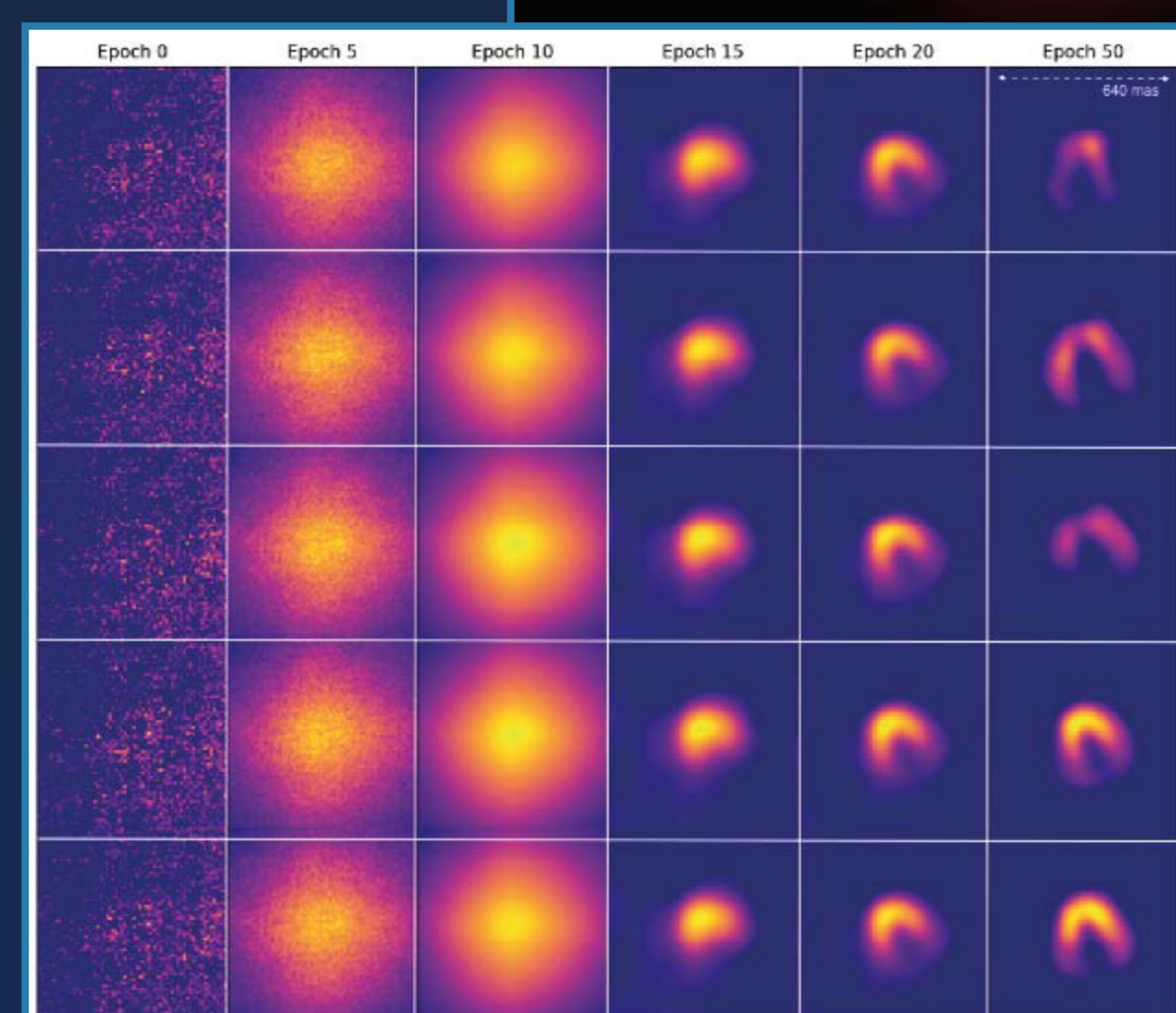
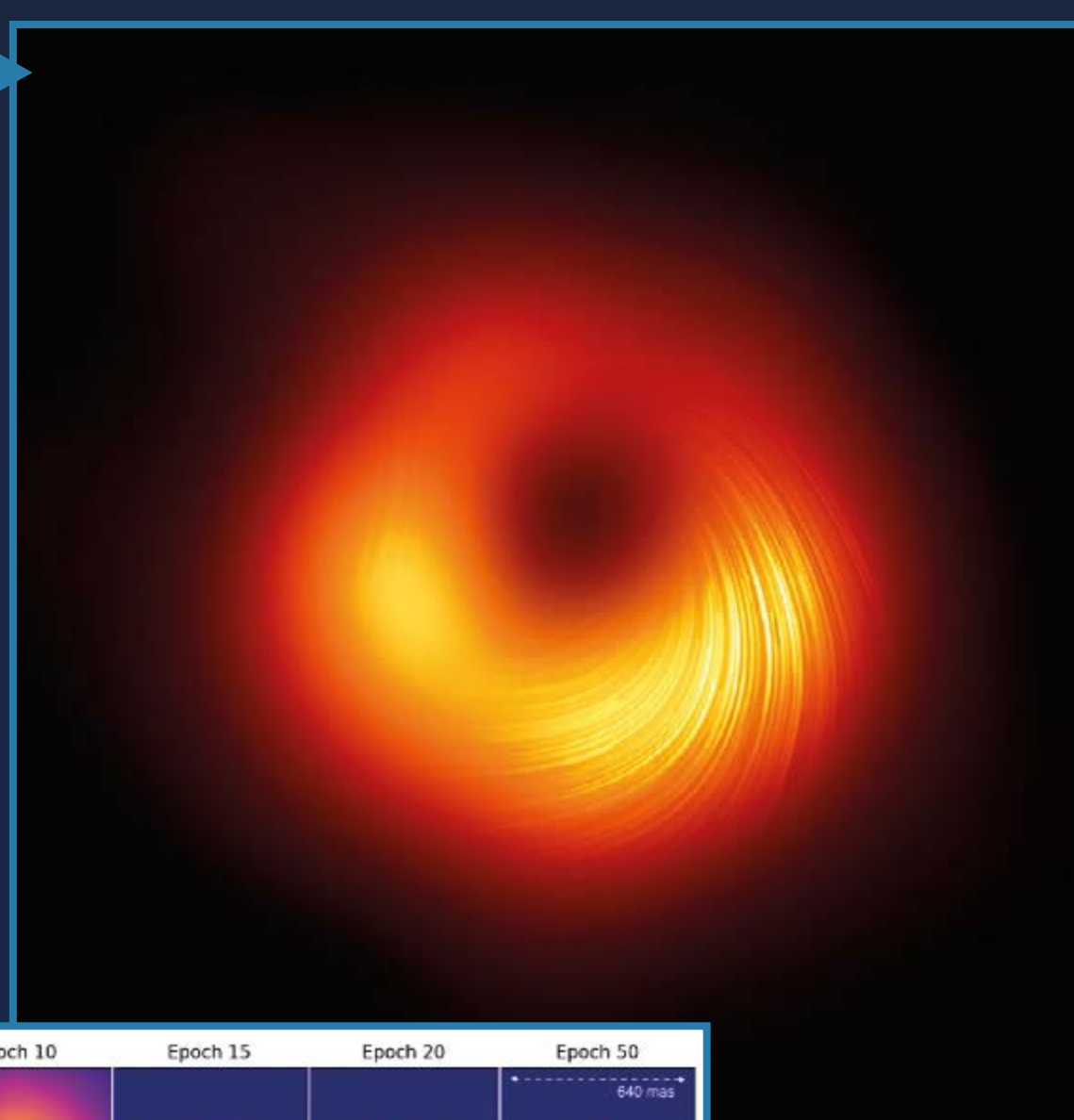
Model-based visualisations: Simulations without direct optical coupling

The image shows the result of a numerical flow simulation on an Airbus A380. Credit: Simulationsmodell 2024.

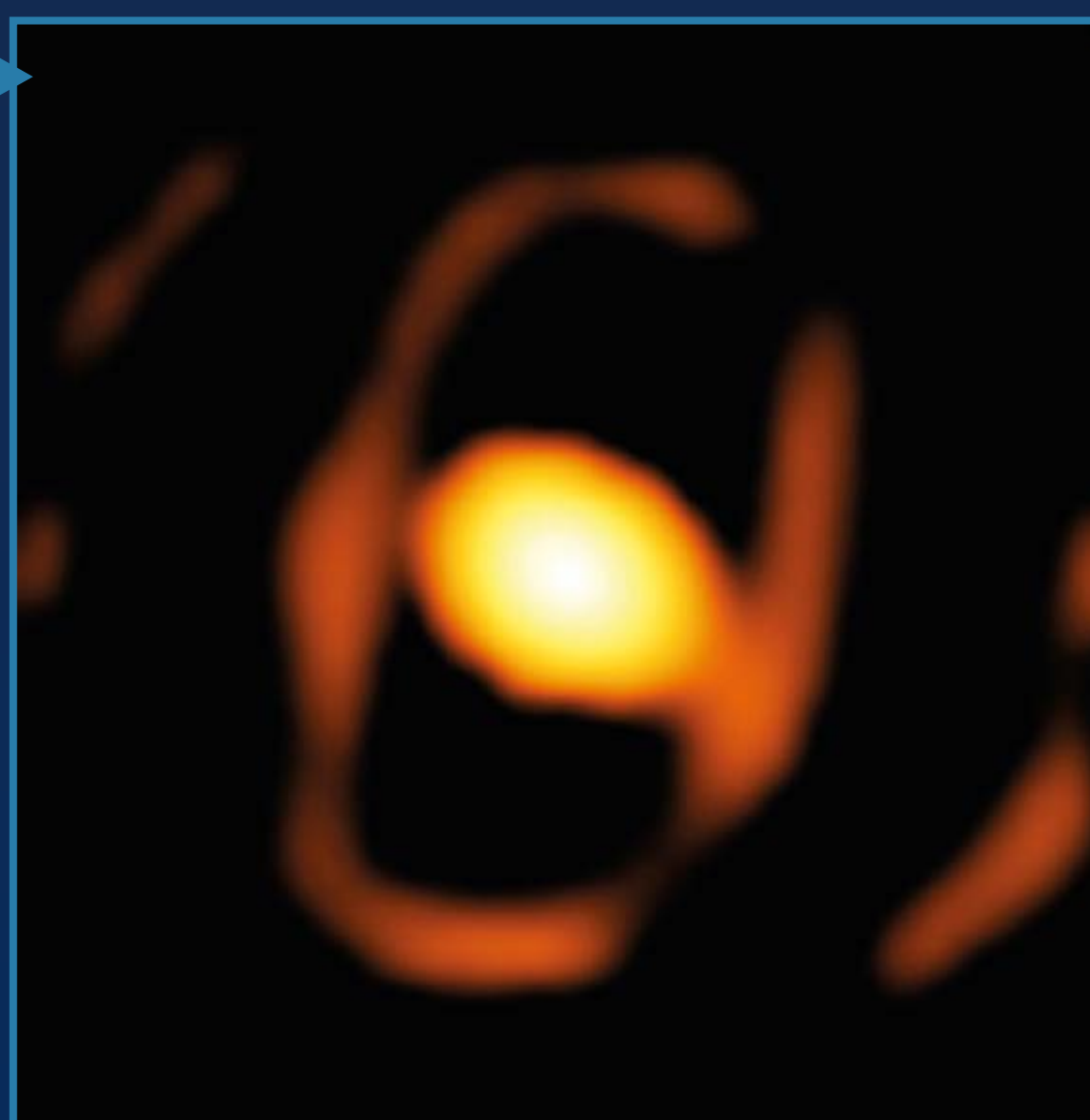


AI-generated images: Visibility from probability and latent spaces without reference to the world

A view of the supermassive black hole in M87 in polarised light. Credit: ESO/EHT Collaboration (2021)



Algorithmically reconstructed image of WOH G64 at 2.2 μm. Credit: ESO/K. Ohnaka et al. (2024).



Main Results

- Visibility without trace:** Generative visualisations create epistemically contingent spaces of possibility rather than referential evidence
- Hybrid authority:** Epistemic authority is hybrid and arises from the responsible appropriation of AI systems
- Validity through practice:** Validity does not arise in the image, but through argumentative embedding, transparency and collective review
- Performative plausibility ≠ validity:** Technical quality measures similarity, not truth
- Under these conditions, knowledge does not arise as a product of machine image production, but through reflexive and responsible validation practices in social contexts.**

Guidelines for responsible practice

- Transparency:** Documentation of data, parameters, training distributions and versioning
- Traceability:** Reproducible pipelines, alternative models, disclosure of uncertainties
- Accountability:** Clear roles for data curation, model supervision and interpretation
- Argumentative embedding:** Images as visible reasons in theoretical references

Risks and incentives

- Epistemic opacity of deep networks hinders traceability
- Delegation of judgement weakens accountability
- Algorithmic decoupling undermines authority without accountability

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