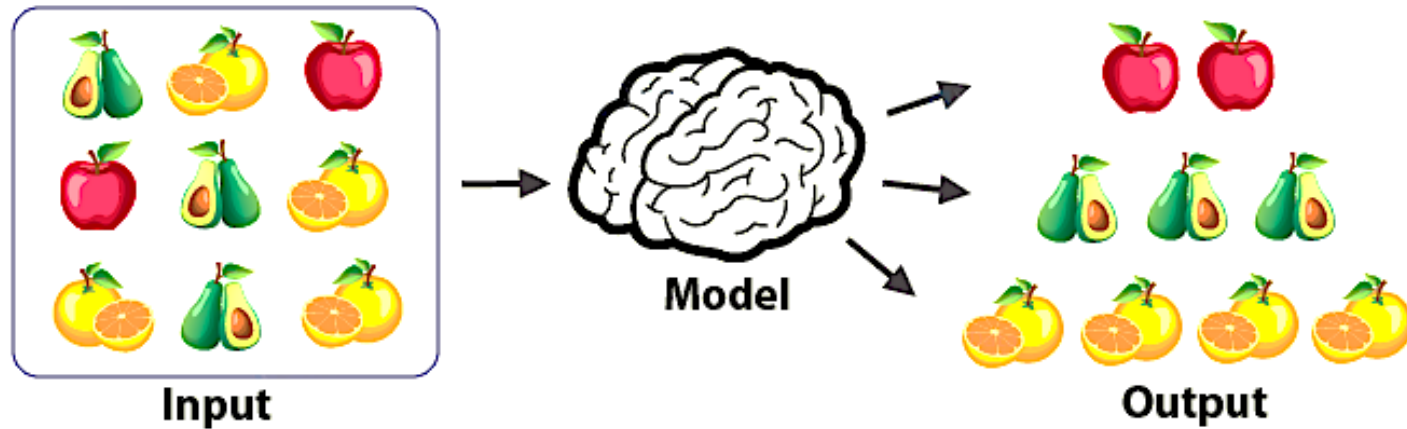# GedankenNet: Self-supervised learning in computational microscopy

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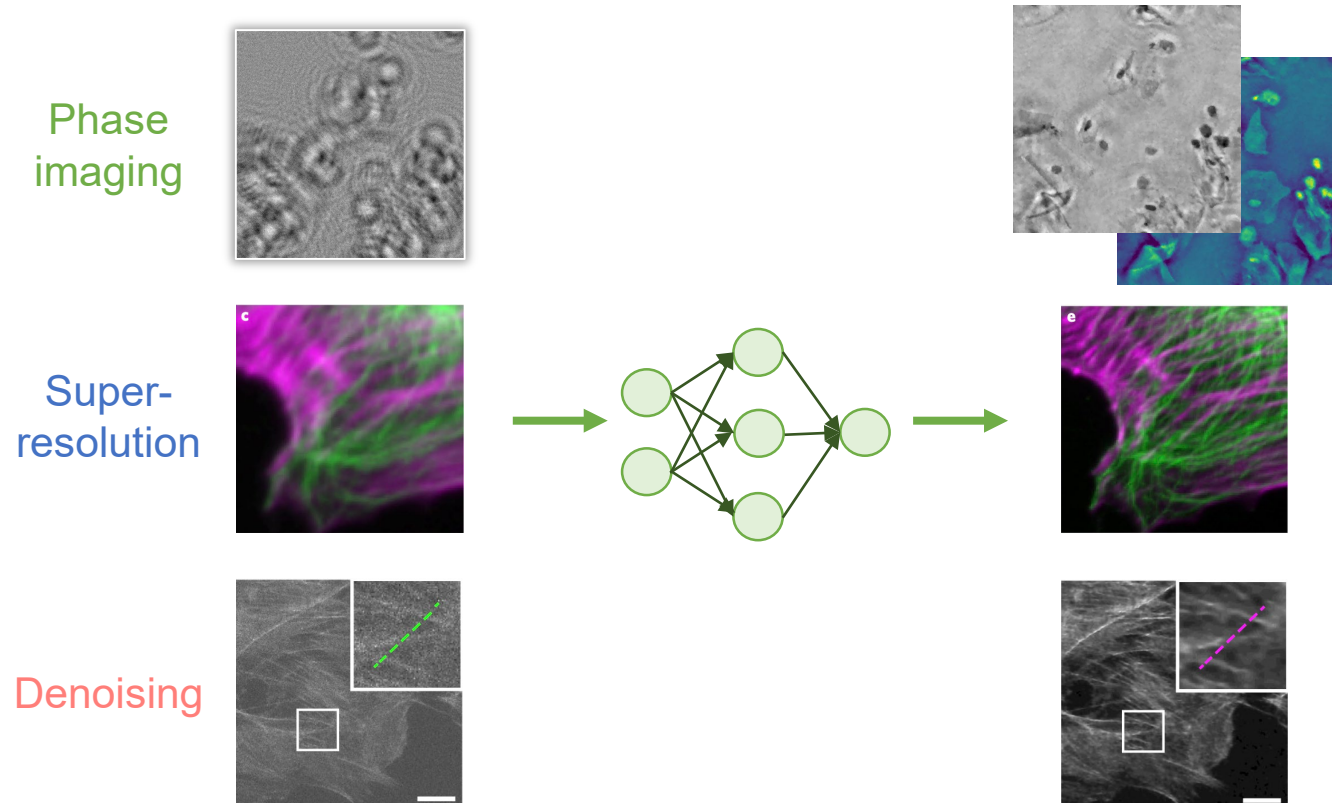
What is self-supervised learning?
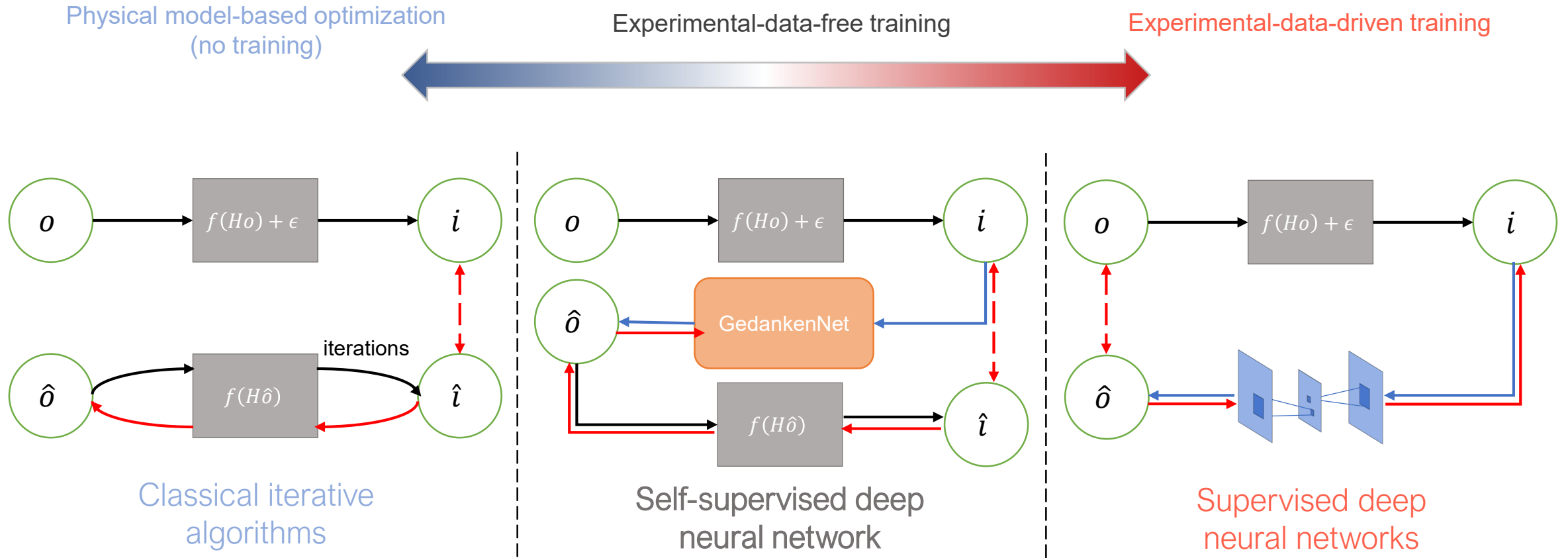

Self-supervised learning

ChatGPT

Why self-supervised learning?

Phase imaging

Super-resolution

Denoising

Computational microscopy enabled by AI

- Generalizability
  - massive labelled dataset
  - transfer learning

- Labelled experimental data
  - labelled data not always accessible
  - incorrect labelling may introduce bias

- Interpretation
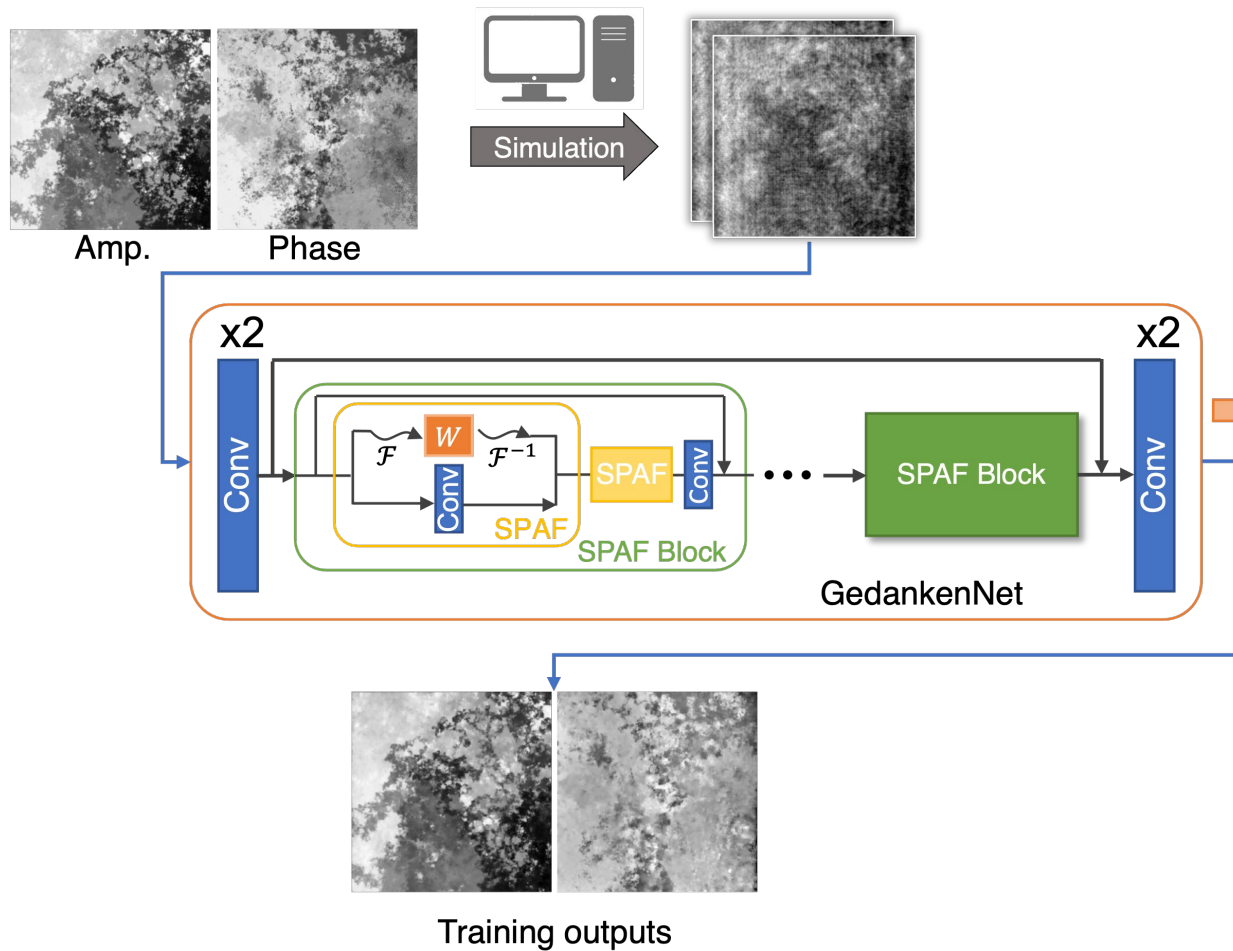 - models that think more similarly to humans

How to apply self-supervised learning?

Huang et al. Self-supervised learning of hologram reconstruction using physics consistency. Nature Machine Intelligence (under revision)

(a) "Gedanken" training

Artificial image dataset

Amp.   Phase

Simulation

$\times 2$

Conv

$\mathcal{F}$ W $\mathcal{F}^{-1}$

Conv

SPAF

SPAF

Conv

SPAF Block

SPAF Block

$\times 2$

Conv

GedankenNet

Training outputs

(b) Testing (external generalization)

Experimental holograms
(Tissues and smears)

Light source

Imaging

Sample

$z \gg z_i$

z_i

CMOS sensor

GedankenNet

Testing outputs
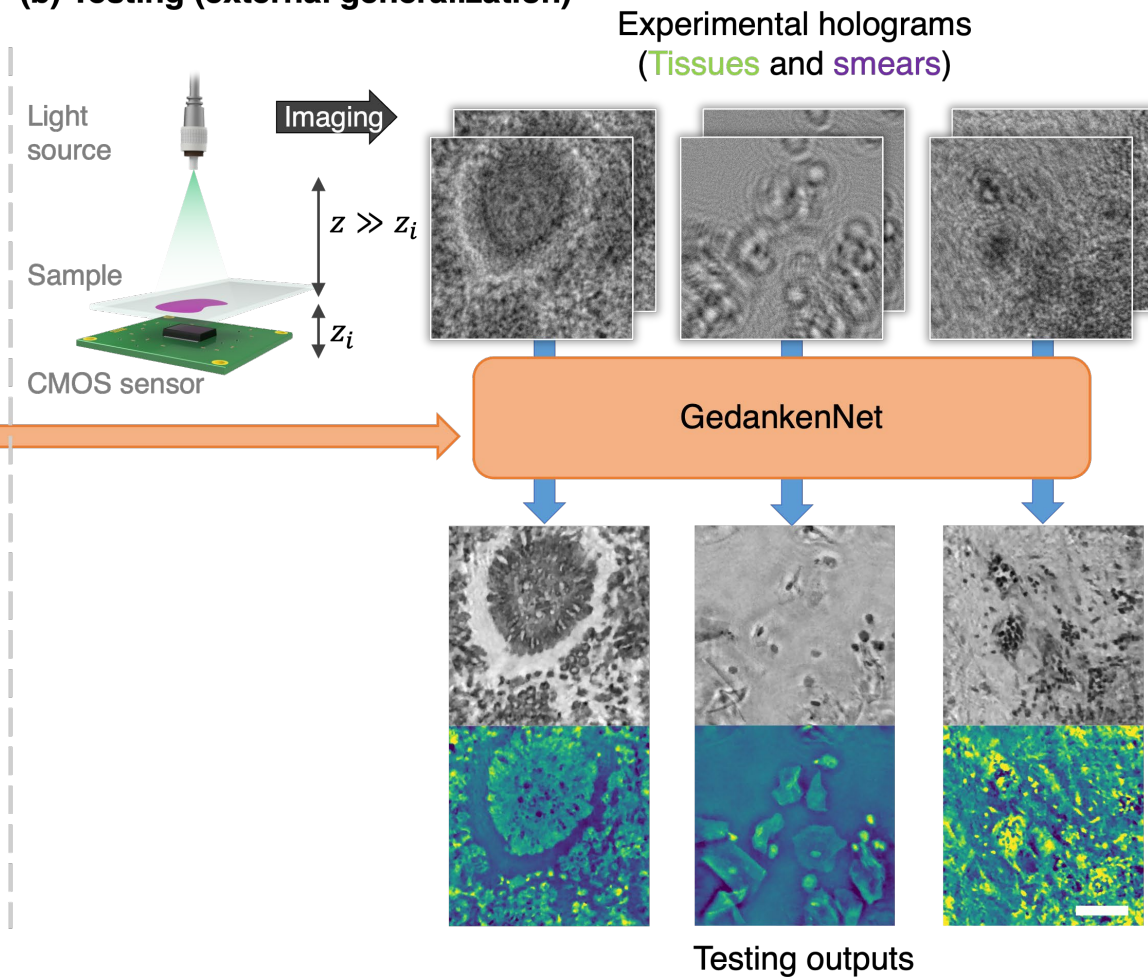
Training and testing pipelines, and the network architecture of GedankenNet.

Noise-free	SNR = 20 dB	SNR = 14 dB	Ground truth

Input holograms $z_1 = 300\ \mu m$ $z_2 = 375\ \mu m$

Amp. Phase

Self-supervised learning (GedankenNet, M=2)

Supervised learning (FIN, M=2)

Training data: **Artificial images**

Supervised learning (FIN, M=2)

Training data: **Lung tissue sections**