

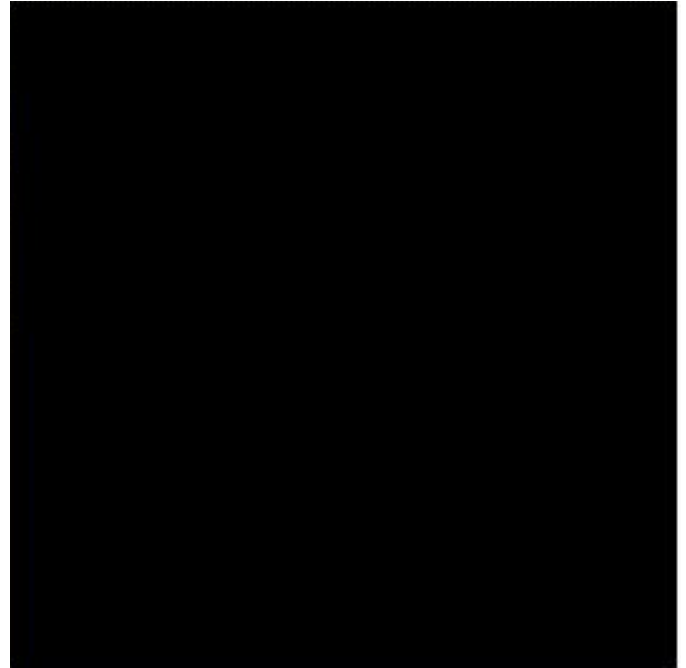
Fourier Neural Operators

Zongyi Li, Nikola Kovachki, Kamyar Azizzadenesheli, Burigede Liu, Kaushik Bhattacharya,
Andrew Stuart, Anima Anandkumar
ICLR 2021

Fourier Transform

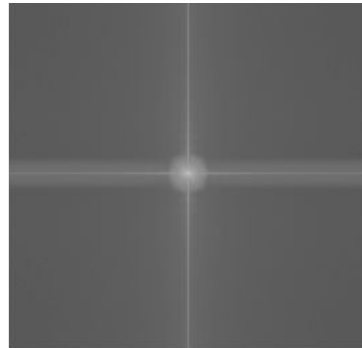
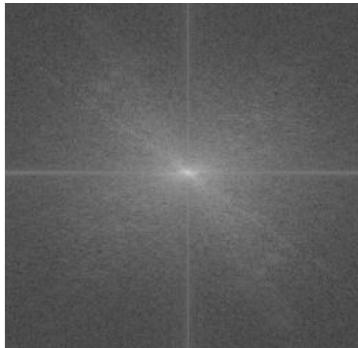
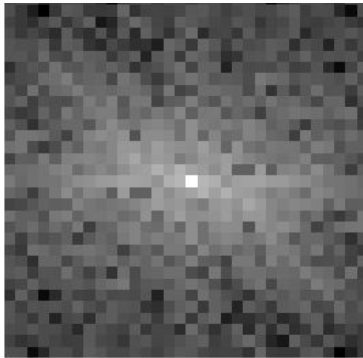
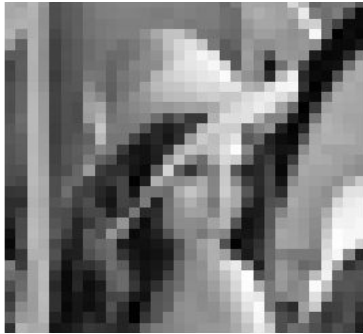
Fourier transform is projecting into a pre-defined basis :

- Of cosines (and sines) waves
- Projection can be inverted
- The higher number of modes, the more precise the reconstruction
- Low frequencies are “preserved” by the resize operation

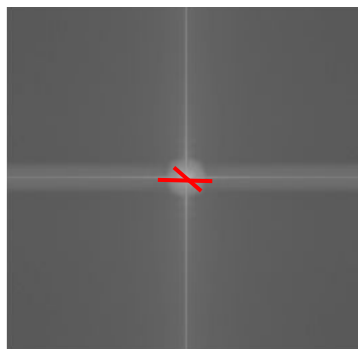
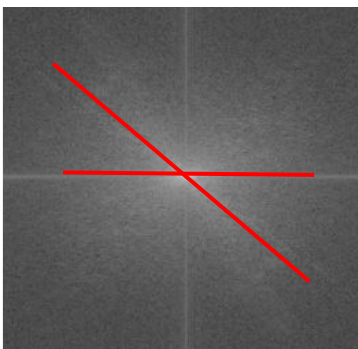
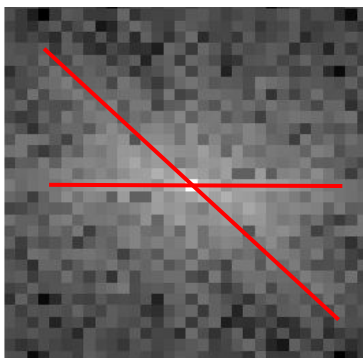
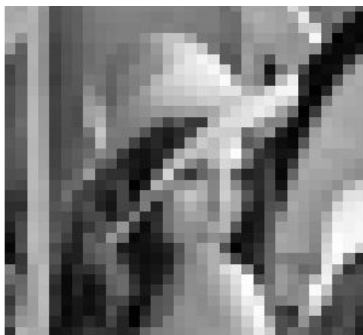


Reconstruction by filtering high frequencies

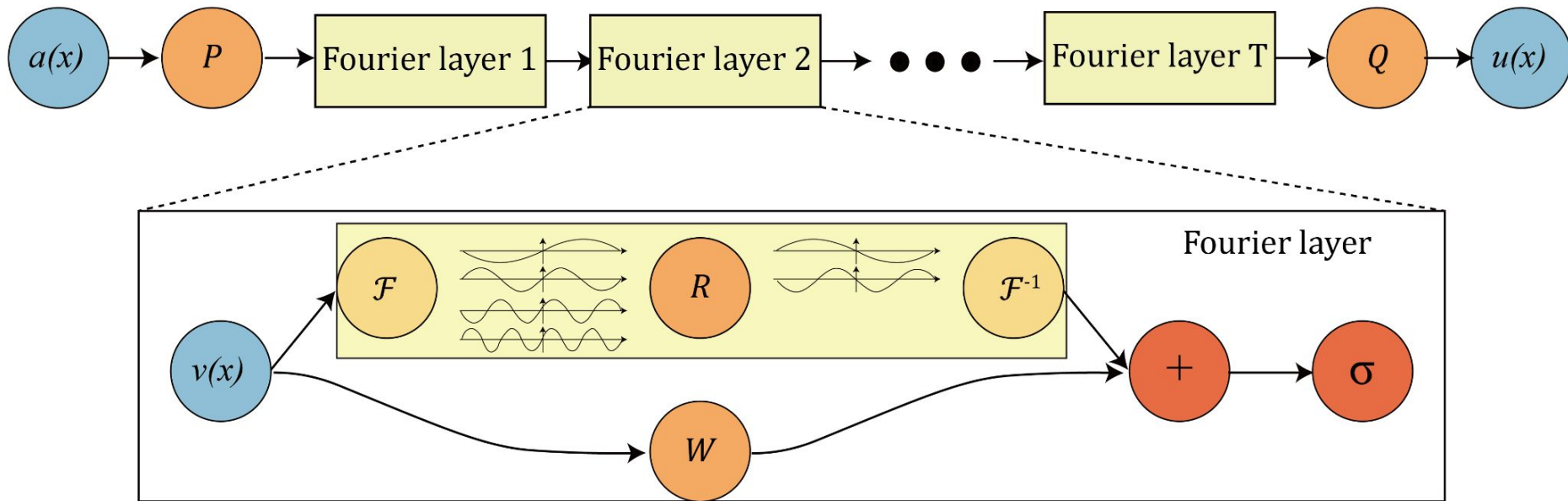
Fourier Transform



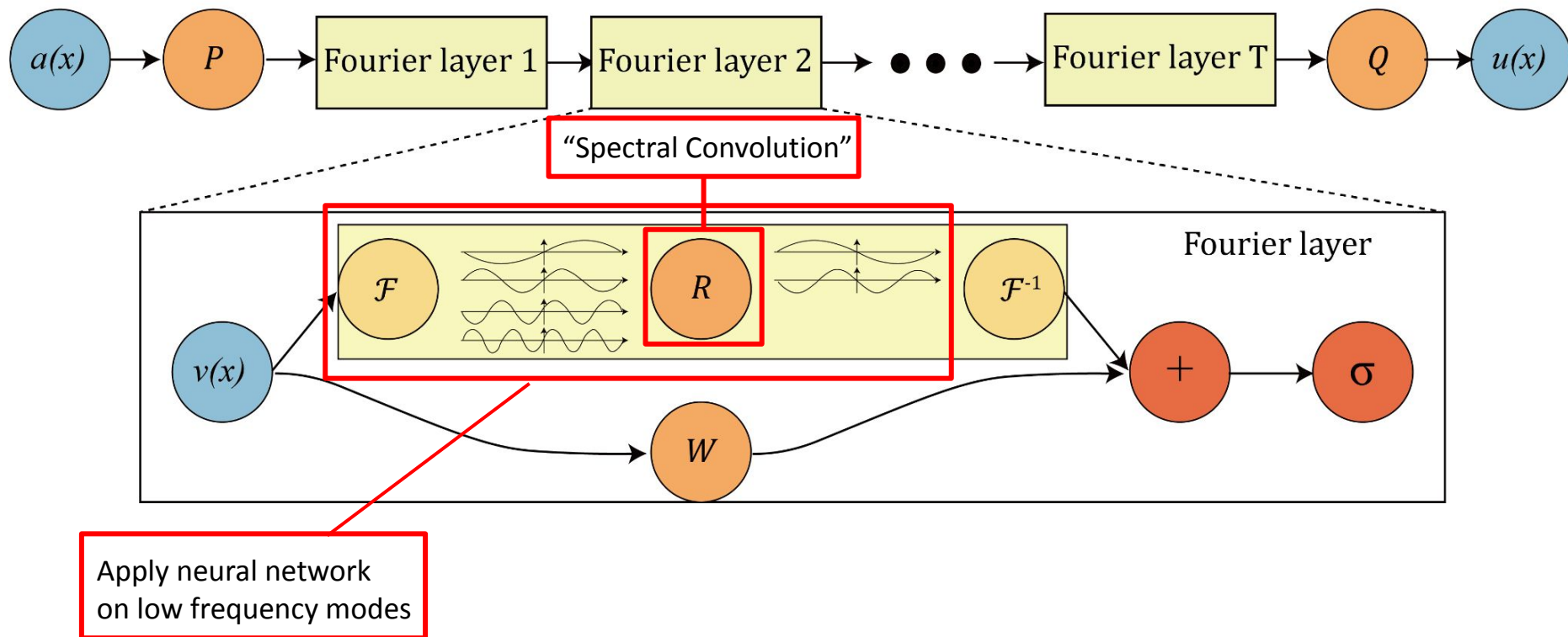
Fourier Transform



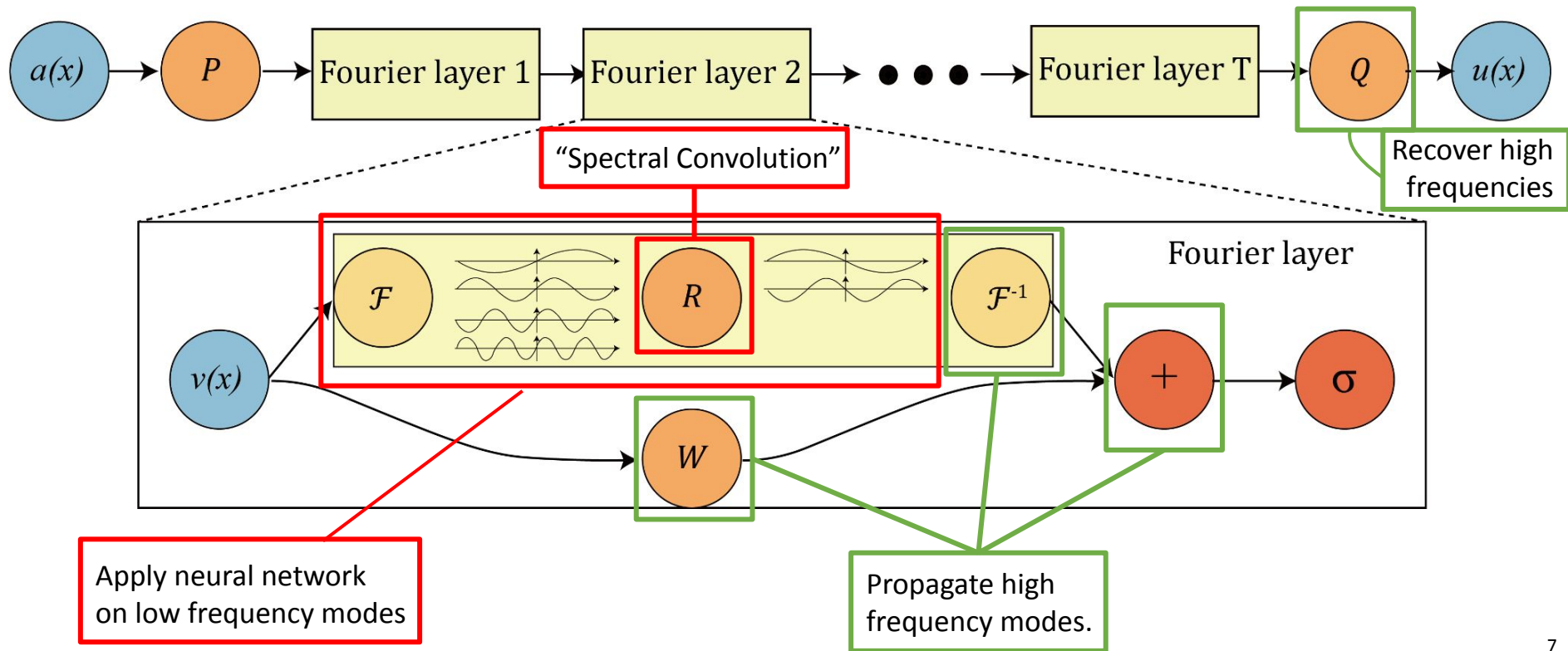
Fourier neural operator



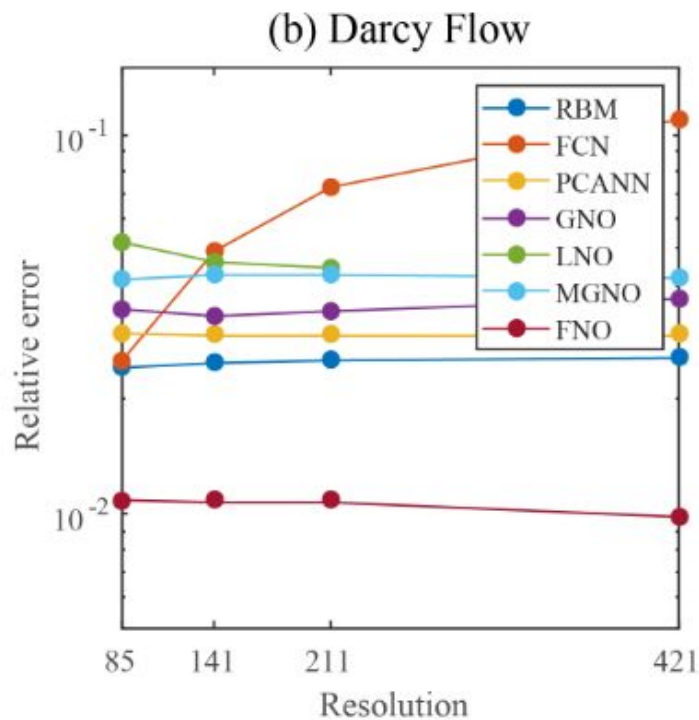
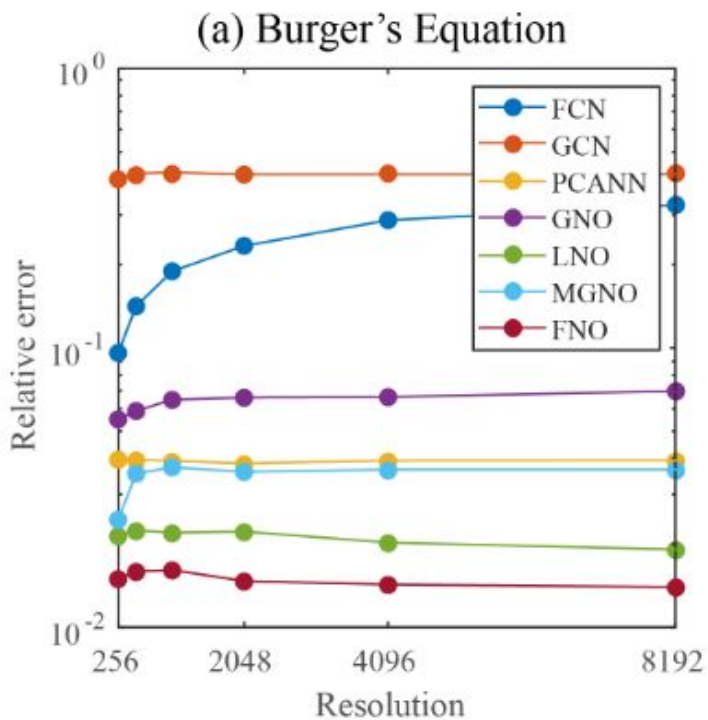
Fourier neural operator



Fourier neural operator

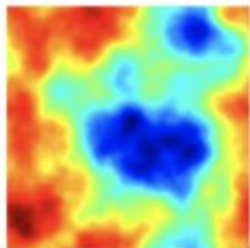


Results - PDE Equations

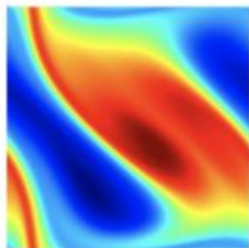


Results - PDE Equations

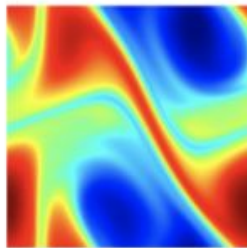
Initial Vorticity



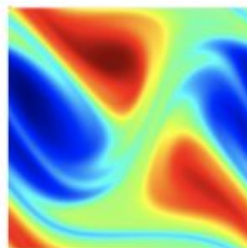
t=15



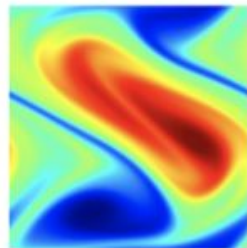
t=20



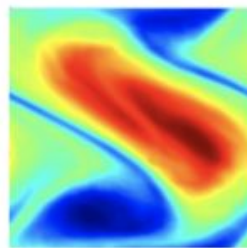
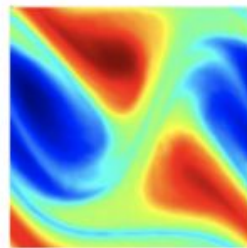
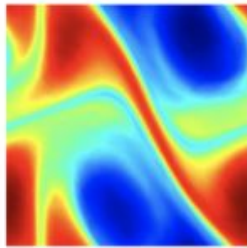
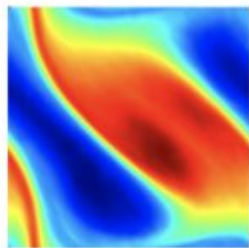
t=25



t=30



Prediction



Zero-shot prediction: trained on $64 \times 64 \times 20$ and evaluated on $256 \times 256 \times 80$

Results - Diffusion models [Hagemann 2023]

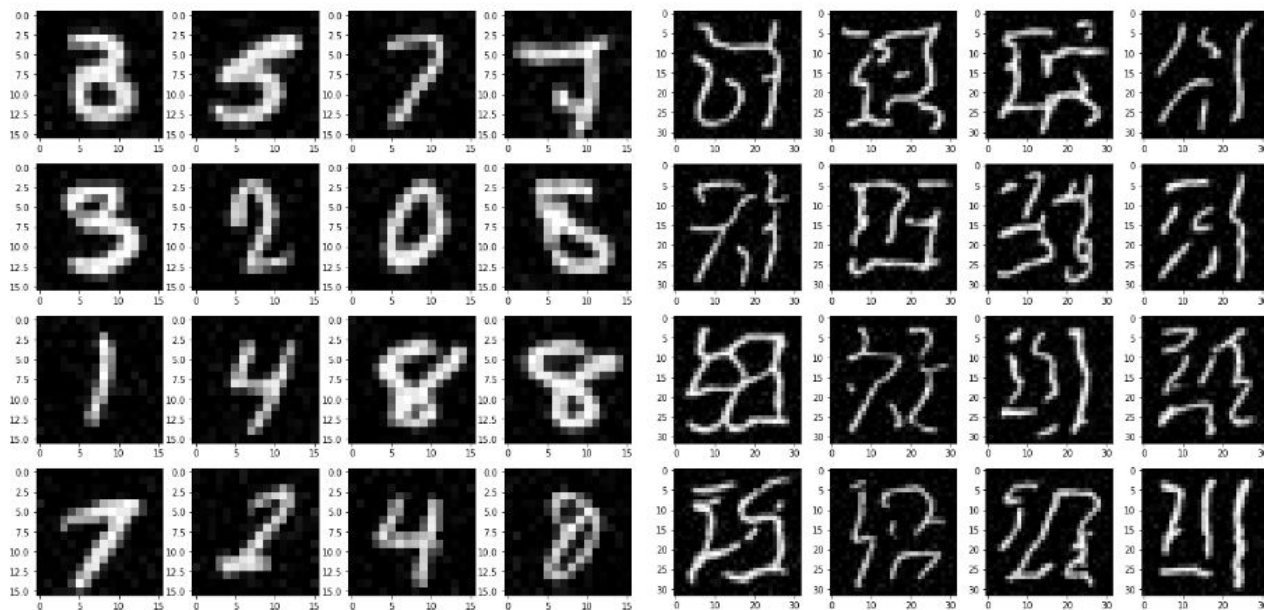
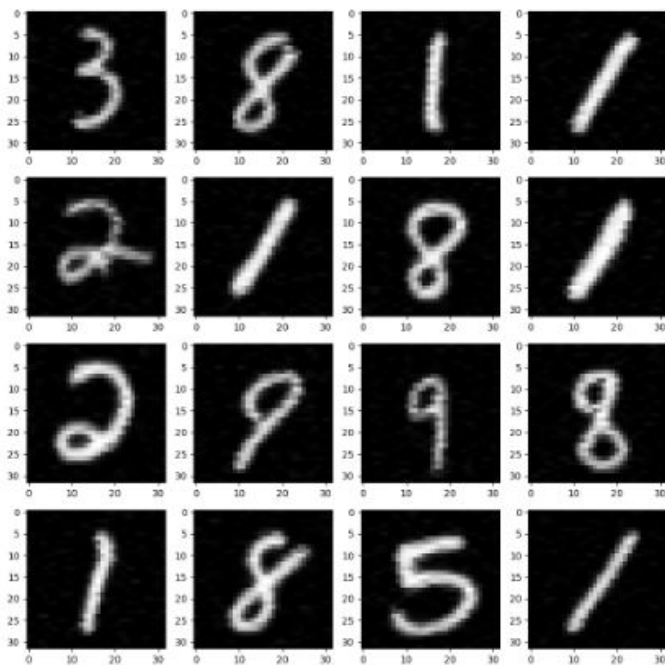
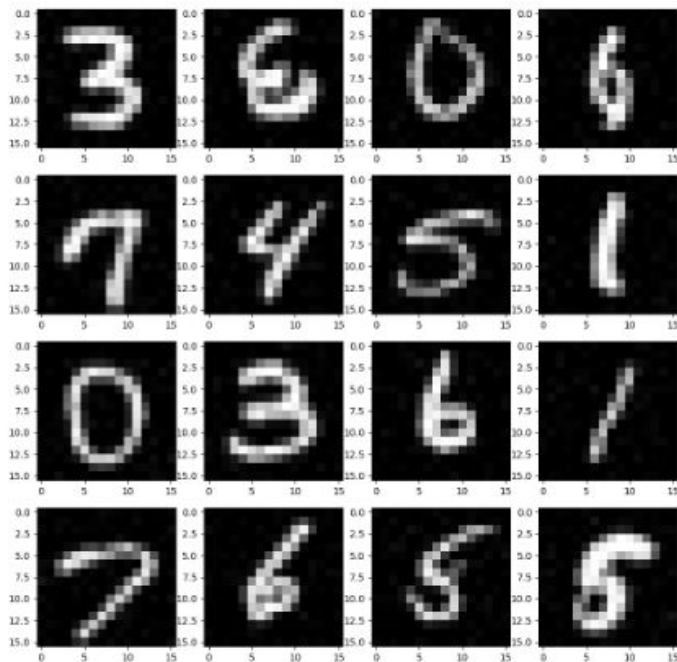
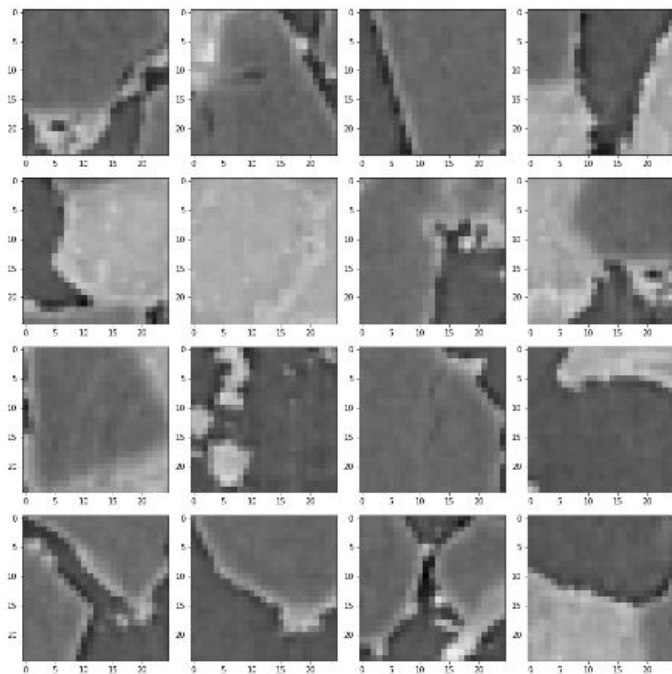


Figure 3: Left: MNIST digits generated by U-net on resolution 16, Right: MNIST digits generated with U-net trained on resolution 16 with resolution 32.

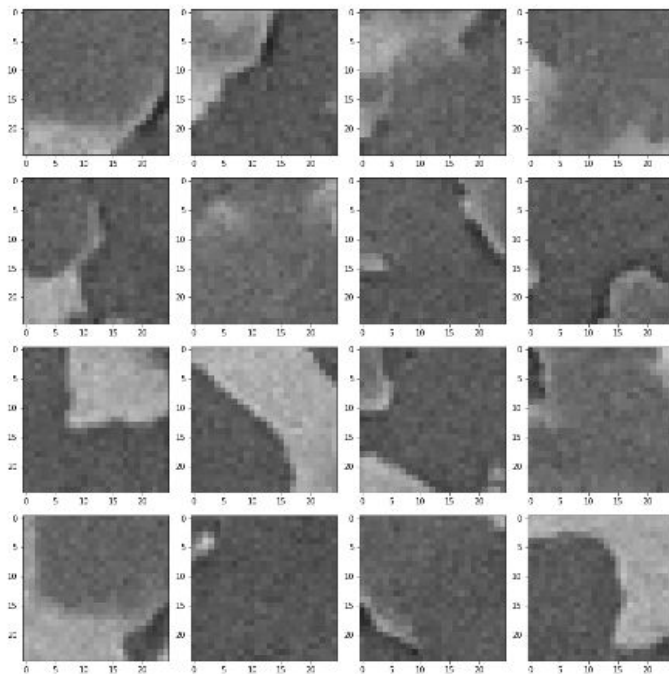
Results - Diffusion models [Hagemann 2023]



Results - Diffusion models [Hagemann 2023]

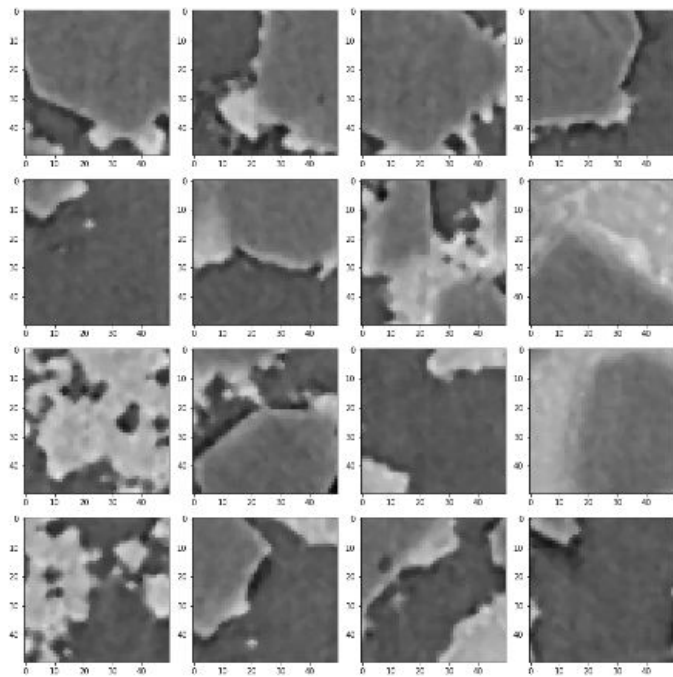


(a) Real material on resolution 25.

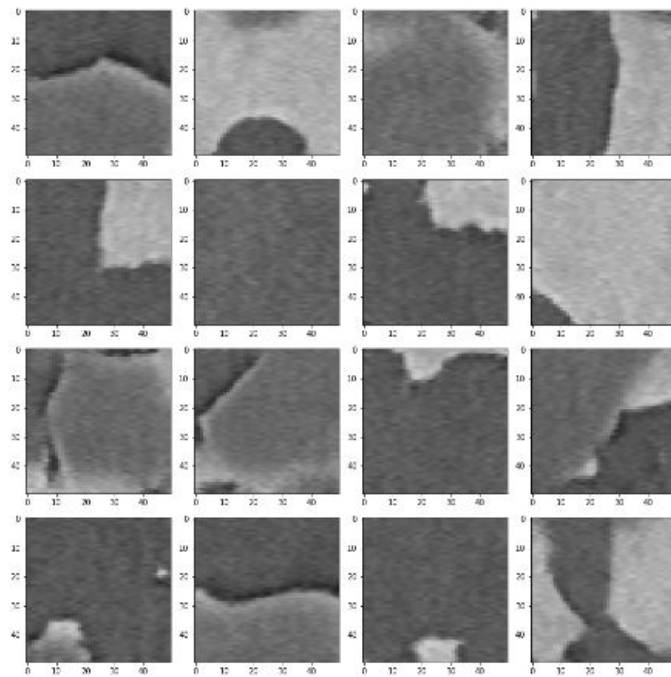


(b) Generated material on resolution 25.

Results - Diffusion models [Hagemann 2023]



(c) Real material on resolution 50.



(d) Generated material on resolution 50.

FIN