Brain MRI processing for enhancing Alzheimer's diagnosis

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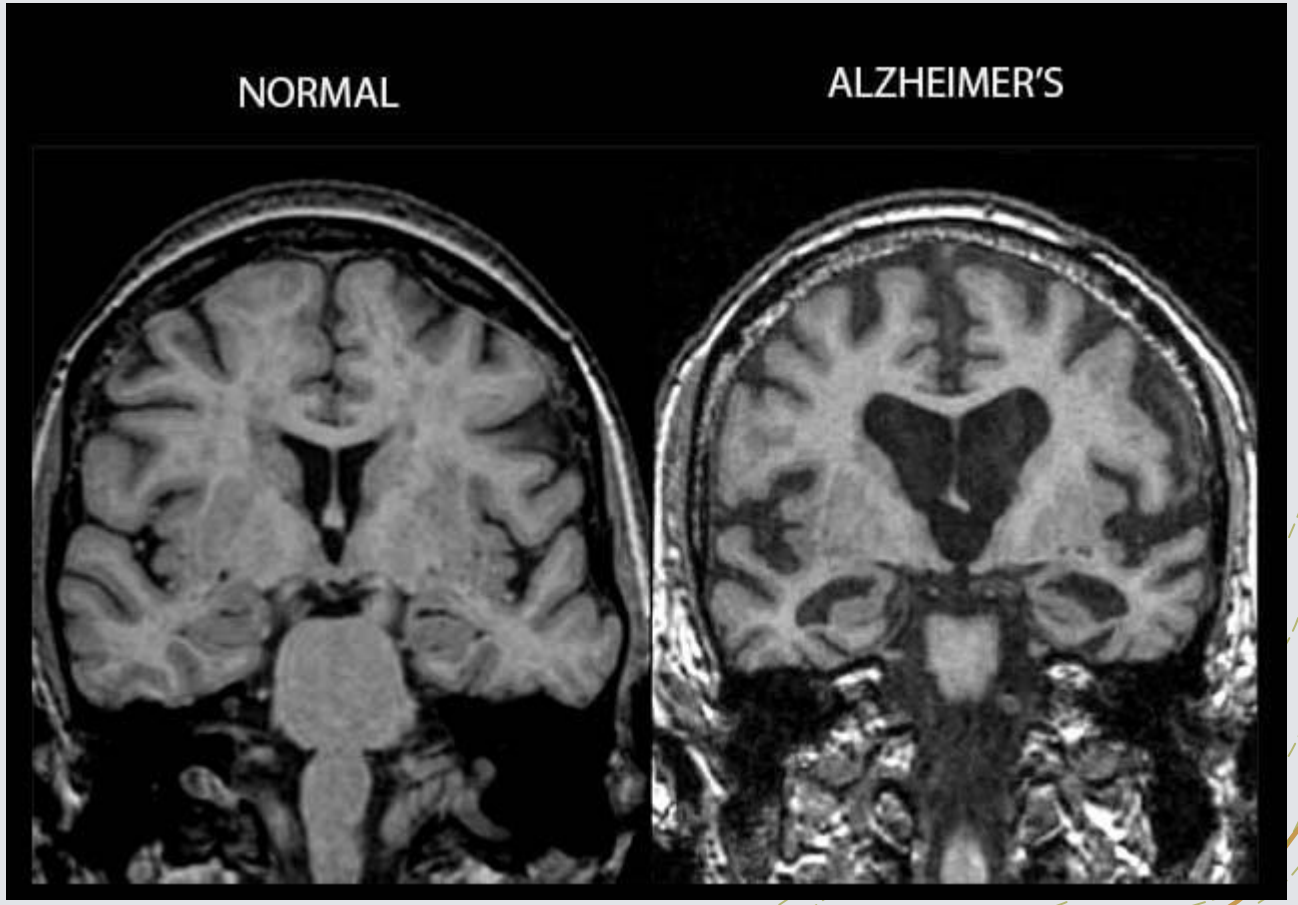
What is Alzheimer Disease (AD)?

- AD is a neurodegenerative disease that gradually affects neural cells, causing a progressive dementia
- It mainly affects the elderly population, even if initial signs of degeneration can be detected even in younger individuals
- The main indicators for the diagnosis of Alzheimer are tissue atrophy, precuneus and hippocampus atrophy



Magnetic resonance imaging (MRI)

- High spatial resolution
- Ability to contrast soft tissue
- Non-invasiveness
- Less health risks than PET or CT

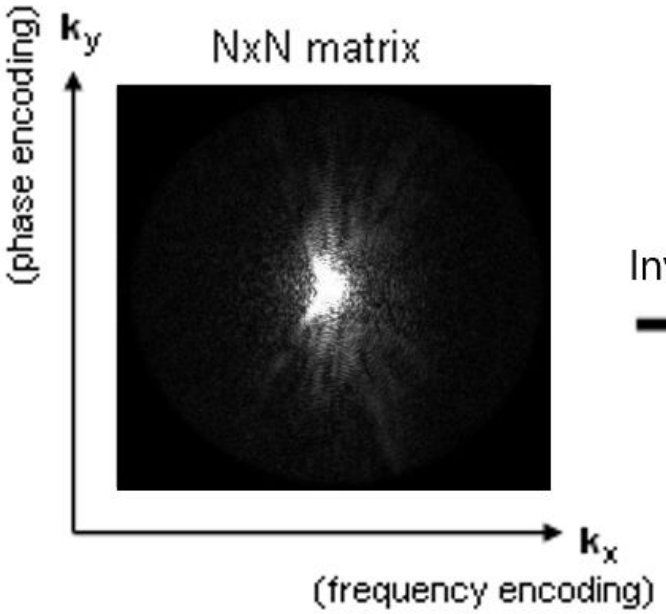
→ Automatic analysis of brain MRI allows to have an **early diagnosis** of Alzheimer

- Artifacts
  - Respiratory and cardiac motion
  - Inappropriate spatial encoding
- Thermal noise
  - Hardware-induced errors
  - Body temperature
- Other noises
- Low SNR in some regions or tissues

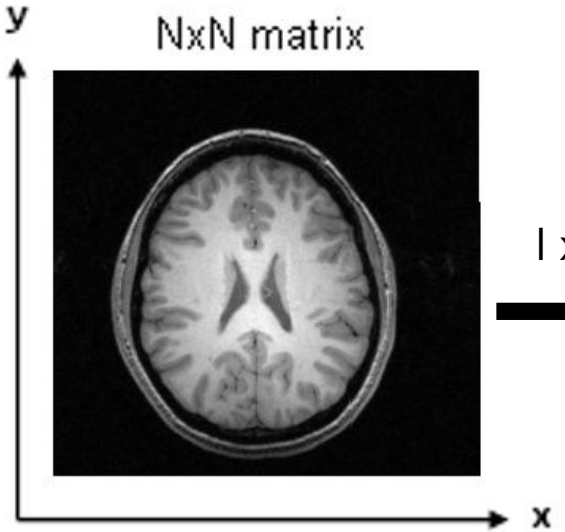
→ **Accuracy limit** in the current state-of-the-art for segmentation and classification methods

IMAGE DENOISING

K-space and noise distributions



Inverse FT



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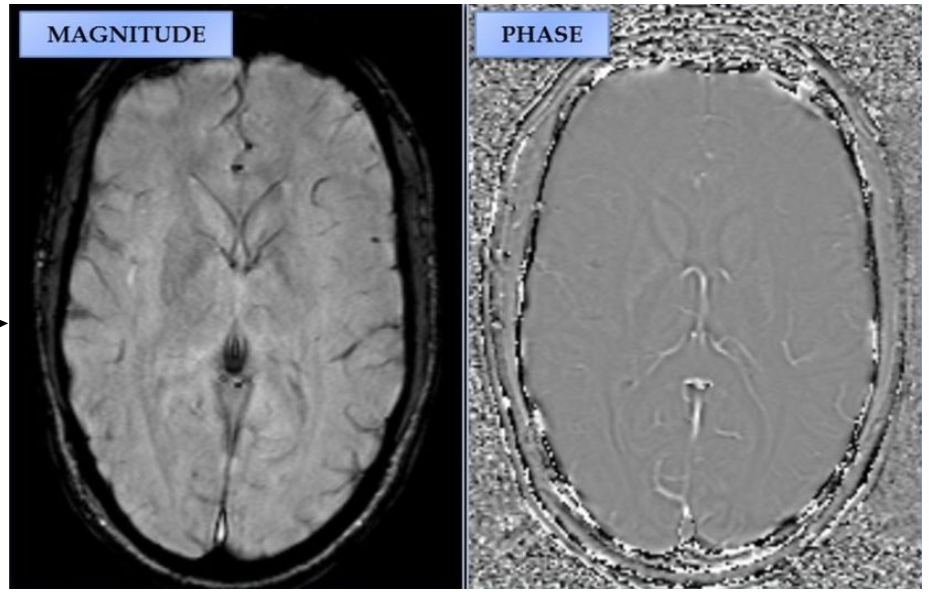
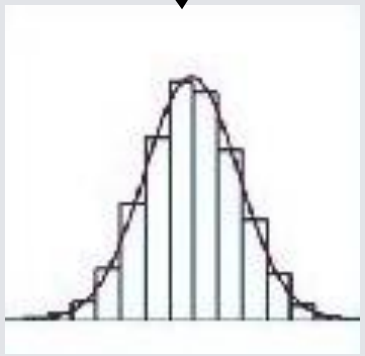
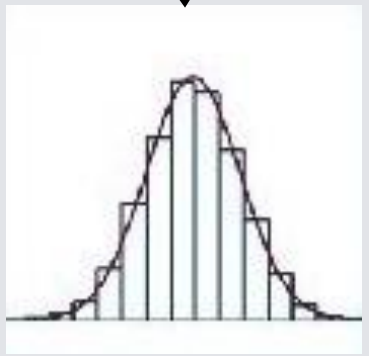
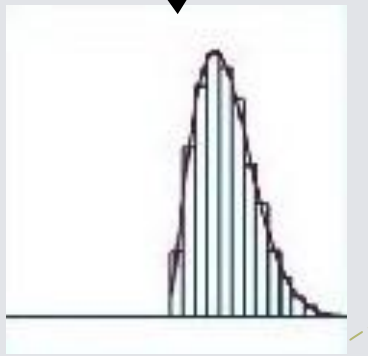




Gaussian distribution



Gaussian distribution

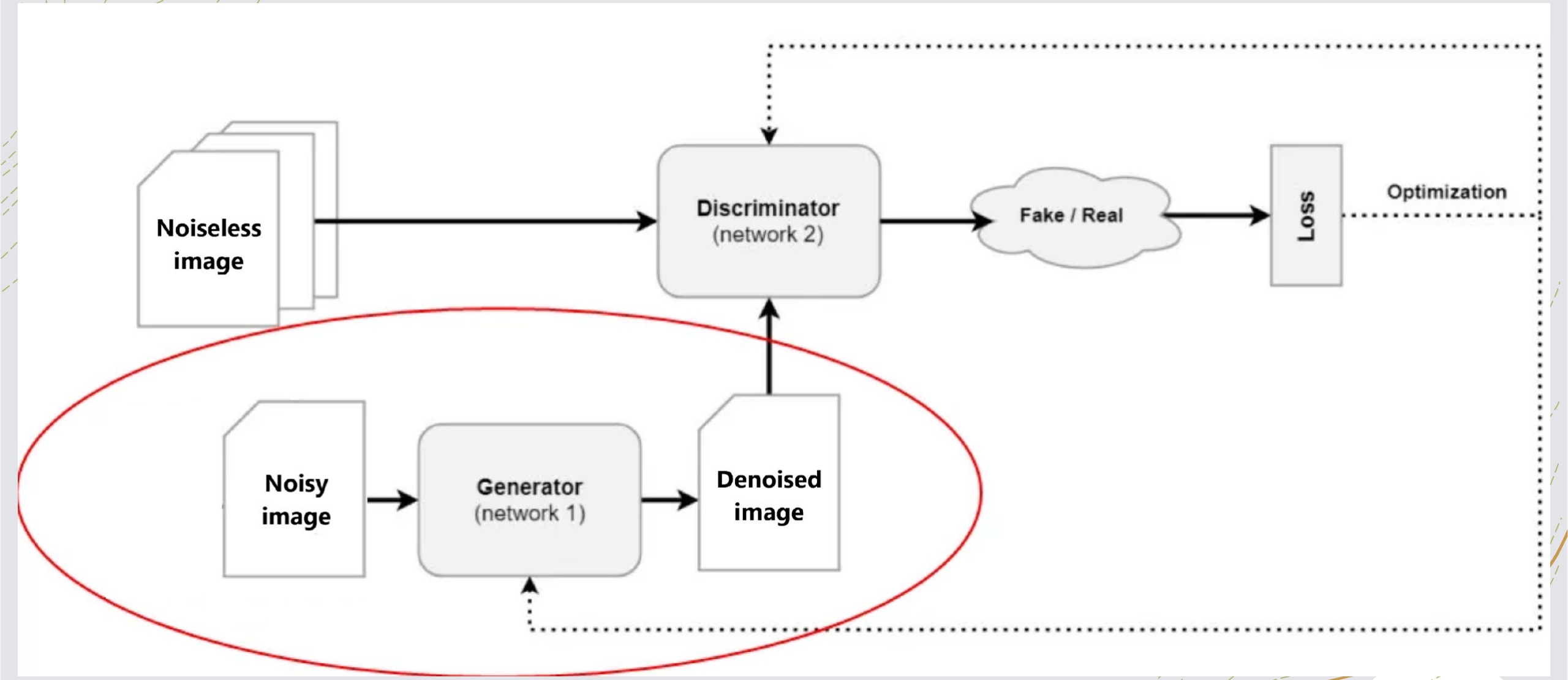


Rician distribution

State-of-the-art in MRI Denoising

- ***Filtering***, ***transformations***, or ***statistical methods*** (bilateral filtering, non-local means and BM3D currently are the most widely-used)
- ***Convolutional NNs***: exploited for their small receptive field (SCNN, DnCNN)
- ***Autoencoders***: may loose important information (as edge or fine structure)
- ***U-net***: large receptive field by utilizing multi-scale features
- ***GANs***: U-net often chosen as generator

Proposed approach



Our Novelty

- Generator
  - Denoising residual network
  - Skip connections
  - Batch normalization
  - No pooling, stride or dilation

- Discriminator
  - Simple CNN
  - It could be changed depending on the performance of the generator

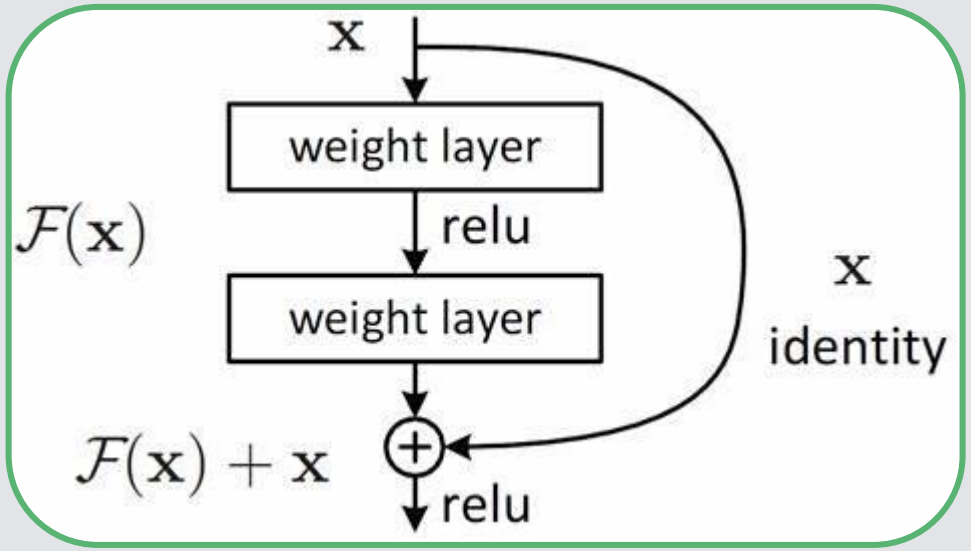


Figure: Residual block

Validation and comparisons

1. Apply our denoising algorithm on different dataset for Alzheimer's classification
2. Use transfer learning in order to achieve a relatively fast but accurate classification
3. Compare the classification results obtained using our denoising algorithm to preprocess the images and those obtained without denoising

Expected results

- Increase in the classification accuracy by around 10% with respect to the classification done on a noisy dataset
- Not excessively long training time

References

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Questions?