1. **INTRODUCTION**
   1. Implicit representation – what is it?
   2. Where are they used?
   3. Advantages and limitations?
   4. Well stated objective of the project
2. **STATE OF THE ART**
   1. Timeline of methods of first methods used in reconstruction and denoising task, until the current ones (SIREN, NERF, TITAN, etc…)
      1. Here we have to also introduce CT and PET.
3. **FIRST APPROACH (The report)**
   1. 3 Experiments on the Shepp-Logan data (very briefly).
4. **FINAL METHOD**
   1. Experiments on the synthetic data created.
5. **Results and Analysis**
6. **Conclusions**

**Merge “first approach” and “final method”**

**TIMELINE sketch idea :**

* **1960s - 1970s:**

Early techniques like linear filtering and simple interpolation methods are used for image reconstruction and denoising.

**CT and PET**

* **Computed Tomography (CT):**
  + **Origin:** Invented in the early 1970s, with the first clinical scanner installed in 1971 by Sir Godfrey Hounsfield and Dr. Allan Cormack.
  + **Purpose:** Mainly used for non-invasive imaging of internal structures in the body, providing detailed cross-sectional images (slices) for diagnostic purposes, such as detecting tumors, injuries, or abnormalities.
  + **How it works:** CT scanners use X-rays to obtain multiple cross-sectional images of the body from different angles. These images are processed by a computer to create detailed two-dimensional slices or three-dimensional images. The density of tissues influences the amount of X-ray attenuation, allowing differentiation between structures like bones, organs, and tumors.
* **Positron Emission Tomography (PET):**
  + **Origin:** Developed in the 1950s, with the first PET scanner built in 1952 by Gordon Brownell and his colleagues.
  + **Purpose:** Primarily used to detect and visualize biochemical processes in the body, especially in oncology, neurology, and cardiology. PET scans are valuable for assessing metabolic activity and molecular interactions, aiding in the diagnosis and monitoring of diseases like cancer and neurological disorders.
  + **How it works:** PET scanners detect positron-emitting radiotracers injected into the body. As the radiotracers decay, they emit positrons that collide with electrons, producing gamma rays. Detectors in the PET scanner capture these gamma rays and create images that reflect the distribution of the radiotracer in the body. PET provides functional information about metabolic processes, such as glucose metabolism or receptor binding, aiding in the diagnosis and monitoring of various diseases.
* **1980s - 1990s:**

**Wavelet transforms** emerge as a powerful tool for image denoising and compression.

Total variation (TV) regularization is introduced, providing better results for image reconstruction and denoising by promoting sparsity in the gradient of the image.

* **1990s - Early 2000s:**

Non-local means (NLM) algorithm is proposed, leveraging similarities between image patches for denoising.

Variational methods gain popularity for image reconstruction and denoising, offering a framework for incorporating prior knowledge about images.

* **2000s - 2010s:**

Sparse representation-based methods, such as dictionary learning and sparse coding, become prevalent for image denoising and reconstruction.

Compressed sensing theory revolutionizes image reconstruction by exploiting sparsity to recover images from fewer samples.

Deep learning methods start gaining traction, initially through shallow architectures like stacked denoising autoencoders.

**Late 2010s - Present:**

**Convolutional neural networks** (CNNs) dominate the field, surpassing traditional methods in performance for image reconstruction and denoising.

**Generative adversarial networks** (GANs) and variational autoencoders (VAEs) are employed for image reconstruction and denoising tasks, offering more realistic and high-fidelity results.

**Attention mechanisms** are integrated into neural network architectures to focus on relevant image regions, improving reconstruction and denoising performance.

**Implicit representations**, particularly implicit neural representations (INRs), emerge as a promising approach for image reconstruction and denoising. INRs represent images implicitly as the output of a neural network without explicitly storing pixel values, allowing for compact and efficient representations. Techniques like NeRF (Neural Radiance Fields) and its variants are developed for scene reconstruction from images, enabling high-quality reconstructions with detailed geometry and appearance. Other INR-based methods, such as implicit surface representations, are explored for tasks like image completion, inpainting, and denoising.

* SIREN
* NERF
* TITAN