Getting Started with Neural Networks

Geoffrey Hinton is widely regarded as the *father of deep learning*. His pioneering work on neural networks, backpropagation, and representation learning laid the foundation for modern AI systems used in vision, speech, and language.

> *"Deep learning models function like black boxes, autonomously solving complex problems without human intervention. These systems excel at extracting knowledge from unstructured data, such as images and text, revolutionizing fields like computer vision."*

Learning Resources

The following videos will introduce you to the core ideas behind neural networks. Some mathematical concepts are involved. If you are able to understand them, that's great. If not, do not worry, focus on building an intuition for how neural networks work. For the scope of this project, we will not go deep into mathematical derivations.

Neural Networks
https://www.youtube.com/watch?v=aircAruvnKk

How Neural Networks Learn
https://www.youtube.com/watch?v=IHZwWFHWa-w

Backpropagation
https://www.youtube.com/watch?v=Ilg3gGewQ5U

Convolutional Neural Networks

CNNs are specialized deep learning architectures designed to process grid-like data such as images. They use convolution operations to automatically learn spatial features like edges, patterns, and textures. By stacking multiple layers, CNNs build hierarchical representations from low-level to high-level features. This makes them highly effective for tasks such as image classification, object detection, and medical image analysis.

In healthcare, CNNs are widely used to analyze medical images such as X-rays, MRIs, and CT scans to detect anomalies like tumors, fractures, or lesions. They assist clinicians by improving diagnostic accuracy, enabling early detection, and reducing manual workload.

Alexander Amini is a research scientist at MIT and an excellent educator in deep learning and computer vision. His explanations make complex CNN concepts intuitive and easy to follow.
https://www.youtube.com/watch?v=oGpzWAIP5p0

Tasks

1: Image Processing in Python

Load any two images (can be natural images or medical images such as X-rays) and perform the following steps in a Python notebook.
(You may take help from AI tools while writing the code, but make sure you understand what each step is doing.)

- Grayscale conversion
- Histogram visualization
- Image resizing
- Edge detection
- Noise addition and noise removal (Gaussian filter)

2: Medical Imaging Dataset Exploration

Explore **any two medical imaging datasets** and collect the following information:

- Type of imaging data (X-ray, CT, skin, etc)
- Number of images
- Available classes or labels
- Dataset imbalance
- Any challenges you observe (noise, annotation quality, etc.)

Write a **brief summary** for each dataset.
(*Hint: You may explore datasets from NIH or Kaggle.*)

Submission Instructions

- All work must be submitted on GitHub.
- Join the organization:
  https://github.com/healthcare-ai-vision
- Create a repository named after you.
- Organize submissions in week-wise folders (week1, week2, etc.).
- Push your notebooks, code, and notes to the corresponding folders.

Deadline

19th December, 2025