

ECS 174: Project Proposal

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Background

Problem

[RSNA 2024 Lumbar Spine Degenerative Classification](#)

Lower back pain is the leading cause of disability in the world—according to the World Health Organization (WHO), it impacts roughly 619 million people. Spondylosis encapsulates a set of degenerative spinal conditions that can be diagnosed via Magnetic Resonance Imaging (MRI). In this dataset, we aim to classify the following subsets of Spondylosis:

- Left Neural Foraminal Narrowing
- Right Neural Foraminal Narrowing
- Left Subarticular Stenosis
- Right Subarticular Stenosis
- Spinal Canal Stenosis

Each imaging study in the dataset also include severity scores (Normal/Mild/Moderate/Severe) and intervertebral disc level information (L1/L2, L2/L3, L3/L4, L4/L5, L5/S1).

Motivation

Prior to the competition being hosted on Kaggle, no research or intense application of machine learning for this specific problem has been developed. Thus, by building a tool that targets a widespread and essential medical condition through computationally-powered early diagnosis, we can ensure that hundreds of millions globally can be treated.

Prior Work

Thus far, prior work has failed to achieve a remarkable performance with the large [majority of models](#) averaging a weighted log loss of around 0.36. We use this measurement as our baseline and hope to improve upon it via a more intelligent model architecture.

Proposed Solution

Dataset

As mentioned previously, we leverage the dataset collected by the Radiological Society of North America (RSNA) in partnership with the American Society of Neuroradiology (ASNR).

Model & Augmentations

Regarding architectures, we're aiming to leverage U-Net (a popular convolutional model in medical imaging tasks), transformer-based models (strong learning representation capabilities), and Kolmogorov-Arnold Networks (KANs; relatively new idea, deviates from the traditional perceptron model in favor of learned spline activation functions). Regarding augmentations, we're hoping to improve the pre-processing pipeline, tune the U-Net architecture, and simply deploy a transformer-based and KAN-based model to experiment with alternative models.

Expected Outcomes

Performance

Our goal here is to build upon the state of the art models (primarily U-Net, transformer based architectures, and Kolmogorov-Arnold Networks (KANs)) for the diagnosis of Spondylosis. The end goal is a non-trivial improvement on top of the baselines in prior work, specifically for any of the specific sub-cases within Spondylosis.

Deliverable

A program to execute the best models we've trained for the specific sub-tasks.

Proposed Timeline

- ☒ ~~{10/24} Brainstorm ideas~~
- ☒ ~~{11/01} Research problem & prior work for proposal~~
- ☒ ~~{11/04} Complete proposal~~
- ☐ [11/11] Setup dataset on local for working with
- ☐ [11/11] Finish pipeline design
- ☐ [11/18] Work on pre-processing strategies for data pipeline
- ☐ [11/18] Work on model architecture
- ☐ [11/25] Initial version of pre-processing pipeline should be finished
- ☐ [11/25] Initial model architecture augmentation should be completed
- ☐ [11/25] Generate initial results

- ☐ [12/1] Iterations upon previous work (pre-processing, pipeline optimization, model architecture changes)
- ☐ [12/1] Submission to Kaggle competition
- ☐ [12/1] Outline final report and divide up sections
- ☐ [12/4] Finish majority of report
- ☐ [12/5] Last-minute revisions + edits to the report
- ☐ [12/5] Report submission