

# Neural Network-Based Chess Motif Detection

# Project Description

- Modern chess engines excel at calculating optimal moves but often fail to explain *why* those moves are strong in terms that humans understand. This project aims to bridge that gap by building a neural network capable of detecting tactical and positional motifs in chess positions.

- Using a large dataset of annotated chess puzzles, the system will analyze board states and output the motifs present in each position as a multi-label classification problem.
- The tool is designed primarily as a research project, focusing on neural network design, dataset engineering, and motif detection accuracy rather than production deployment.

- The end goal is to create a fast, interpretable system that enhances chess learning by identifying patterns such as forks, pins, and discovered attacks.

# Features and Requirements

## Core Features

# Motif Detection

## Requirements:

- Detect well-established chess motifs (e.g., pins, forks, discovered attacks, weak squares, open files).
- Accept any valid FEN position as input.
- Achieve performance significantly better than random classification.
- Support expansion as additional motifs are introduced.

## Multi-label Output

### Requirements:

- Allow multiple motifs per position.
- Represent outputs as a binary vector (~130 motifs).
- Use sigmoid activation for independent motif probabilities.
- Evaluate using multi-label metrics such as F1 score, precision, and recall.



## Engine Analysis Integration (Optional)

### Requirements:

- Provide engine evaluations for positions.
- Optionally display best moves alongside detected motifs.
- Use engine output as a validation mechanism for predictions.

## Readable UI

### Requirements:

- Display chess boards in ASCII/terminal format.
- Output detected motifs in a clear list.
- Maintain fast response time for near real-time analysis.

# Schedule

# Sprint 1

- Week 1: Finish research and architecture design
- Week 2: Data Processing
- Week 3: Construct Initial Neural Network
- Week 4: Basic UI and Testing

## Spring 2

- Week 5: Network Tuning & Training
- Week 6: Advanced Features and Engine Integration
- Week 7: UI improvements and Evaluation
- Week 8: Finish Research Paper and Documentation and Flex

# Dataset

- Source: Lichess puzzle dataset (via Kaggle).
- File size: ~460MB CSV containing hundreds of thousands of puzzles, with millions available.
- Sprint 1 subset: **10,000 puzzles** for proof-of-concept.

## Key Fields Used:

- FEN (board state)
- Themes (motif labels)
- Moves (optional auxiliary data)
- Rating / Popularity (optional filtering for data quality)

## **Design Goal:**

Start small for rapid experimentation, then scale dataset and model complexity in Sprint 2.



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# Neural Network Architecture

## Why I want to learn it

- They are a core part of modern AI and machine learning
- Have lots of potential applications

## How I will learn with AI

- Discovery of new terms
- Summarizing for subtopics
- Providing examples

# Types of Neural Networks

- Perceptrons
- Feed Forward Networks (FNNs)
- And more

# Activation Functions

- Decide how much signal the node sends
- Without them neural networks are basically just  $ax + b = y$
- They introduce non-linearity by modifying the results of the linear transformation of each node
- This allows neural networks to approximate any complex function

# Data Visualization

## Why I want to learn it

- I want to be able to evaluate my neural network



## How will I learn with AI

- Explain new concepts
- Generate guides
- Suggest libraries and tools to use