

Chessboard Square Classification and Board- State Reconstruction (Real Data)

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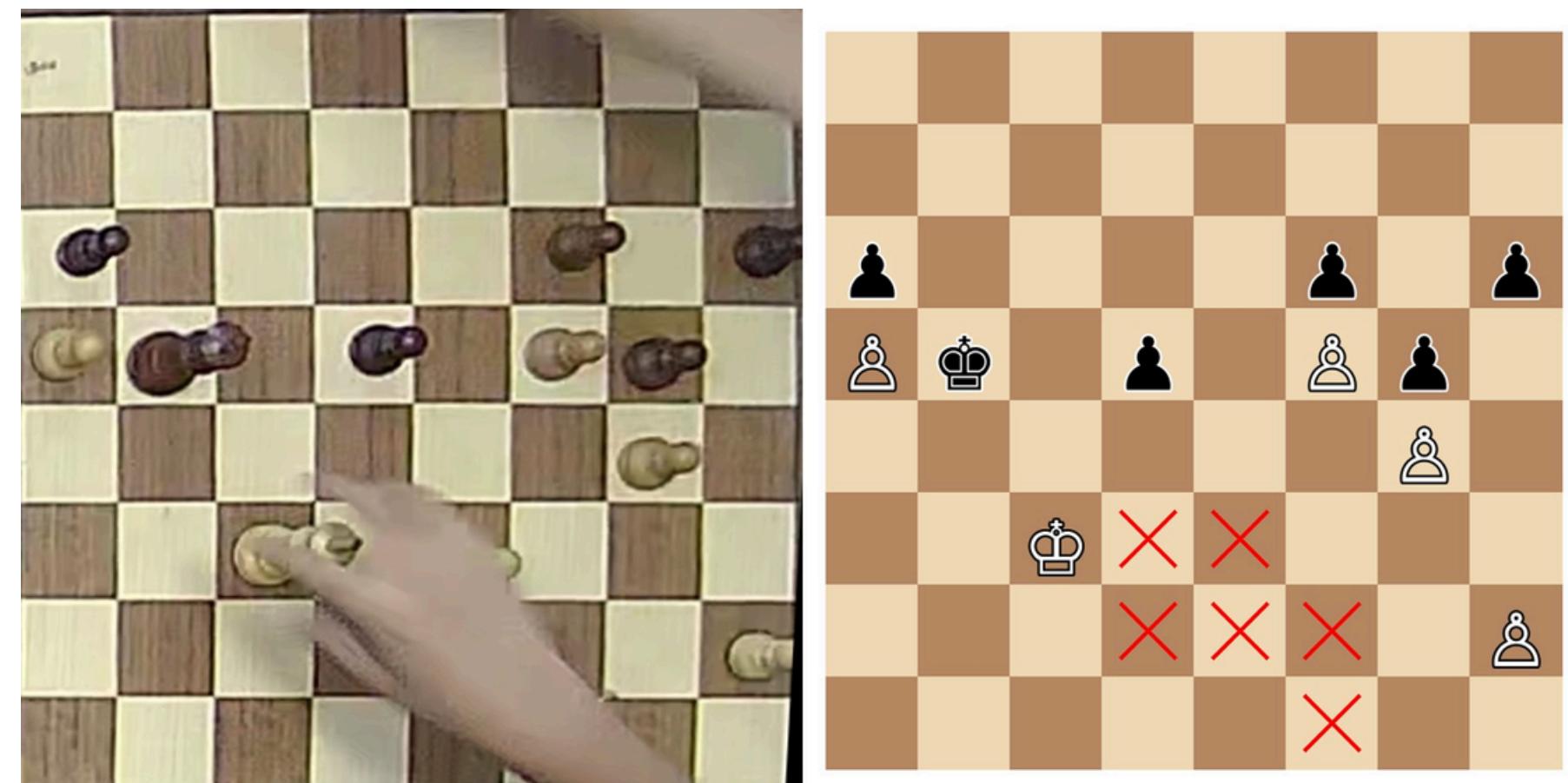


The Problem Statement

The Goal: Image → Digital Representation (FEN)

The Challenge:

- Lighting conditions: Shadows and glare.
- Image Quality: Low resolution, and motion blur reducing fine details.
- Occlusion: Hands blocking the board and the pieces.



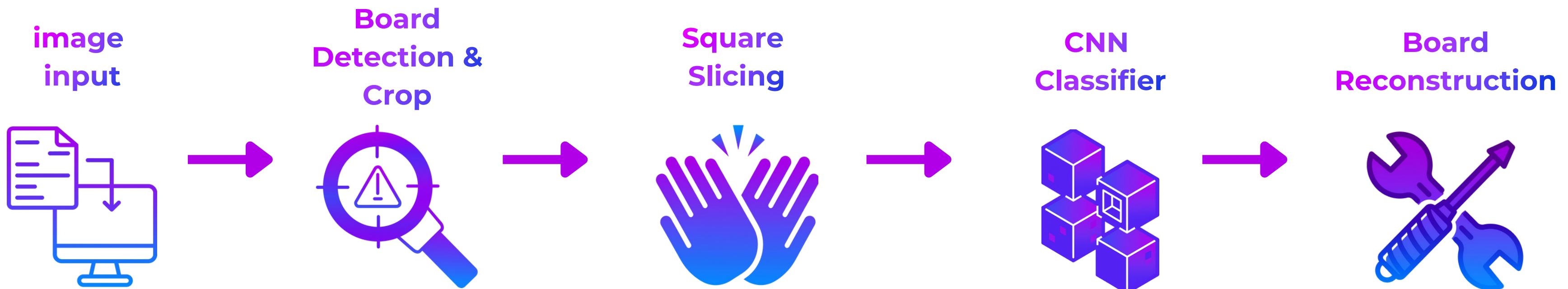
Method & Solution

Pre-processing:

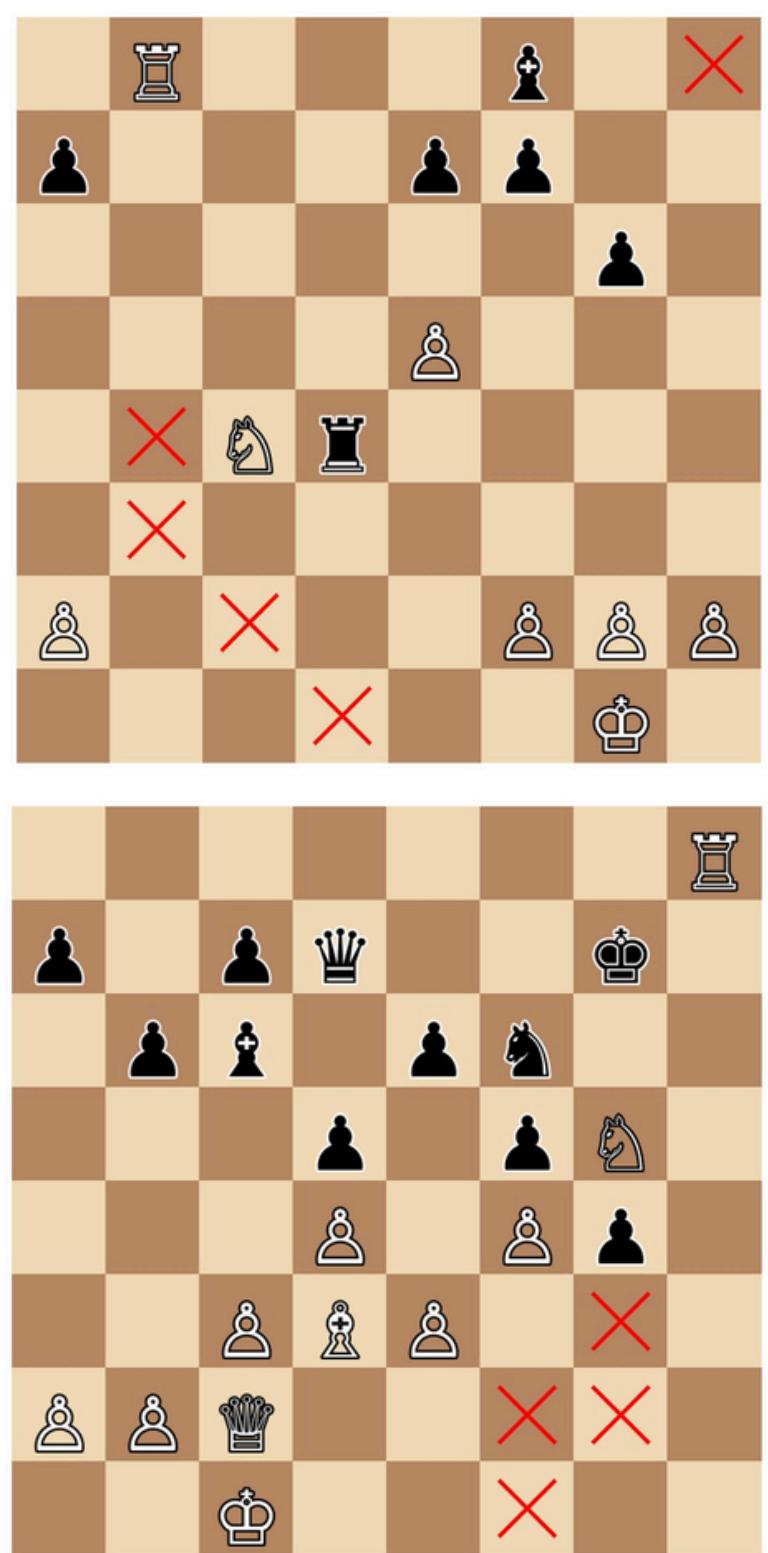
- Hybrid input labeling
- Slice into 64 sub-images (with overlap).
- Center each sub-image on the corresponding board square

Inference:

- Classify each square independently.



Model Architecture & Uniqueness



The Model:

- Architecture: ResNet18 (Transfer Learning).
- Data: >40,500 (training), 5,000 (validation, test).

Our Unique Approach:

- Automated Data Filtering: Implemented a geometric radius-based algorithm to filter unlabeled PGN data, ensuring the model trained only on clean samples.
- Geometric Heuristics: Handling occlusions by analyzing square corner visibility (missing corners → potential occlusion).
- Robust Data Augmentation: Applied heavy geometric and lighting transforms to ensure performance under varying real-world conditions.

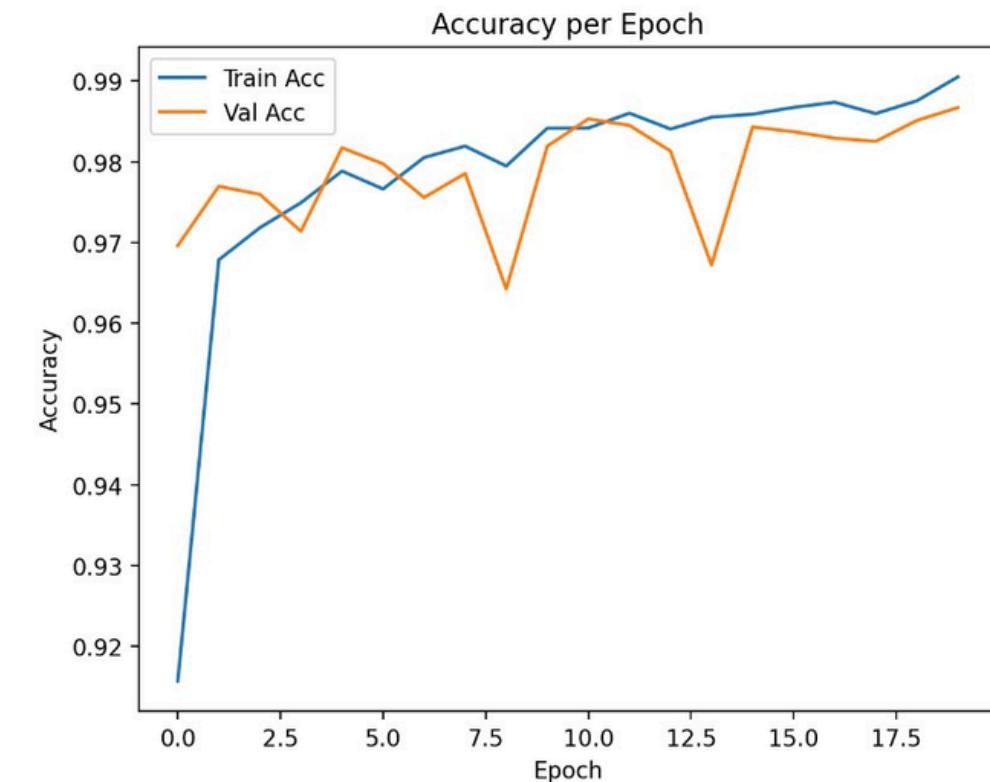
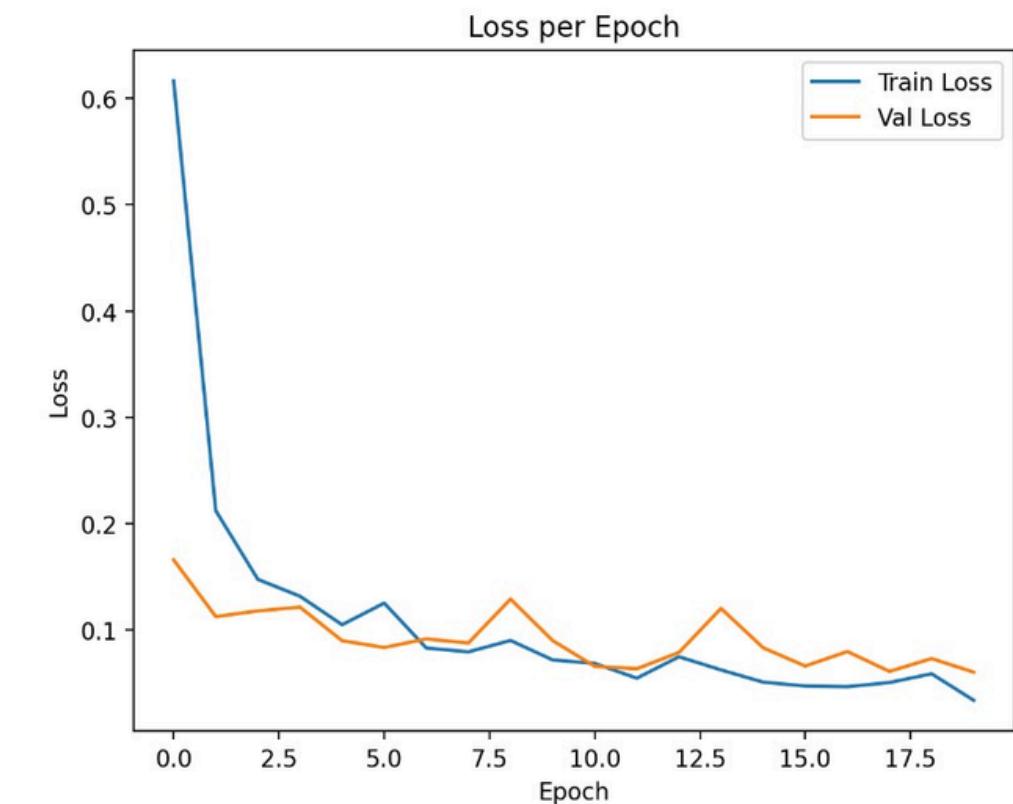
Results & Evaluation

Performance:

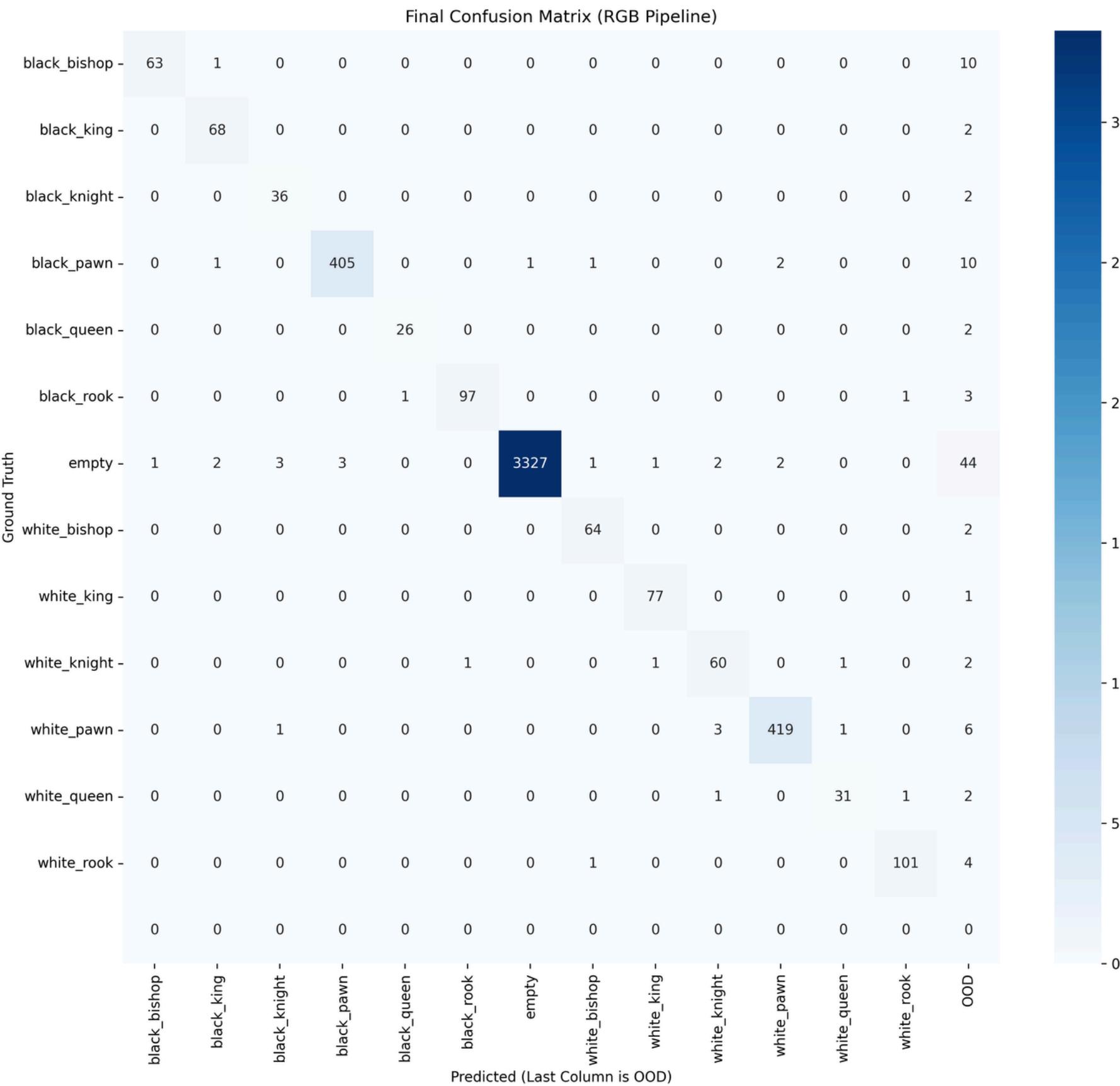
- Test Accuracy: 95.5% (Square Classification).
- Board Reconstruction: High success rate on full boards.

Analysis:

- High accuracy, minor confusion between visually similar pieces.
- The curves demonstrate fast convergence and strong generalization, with the validation loss.

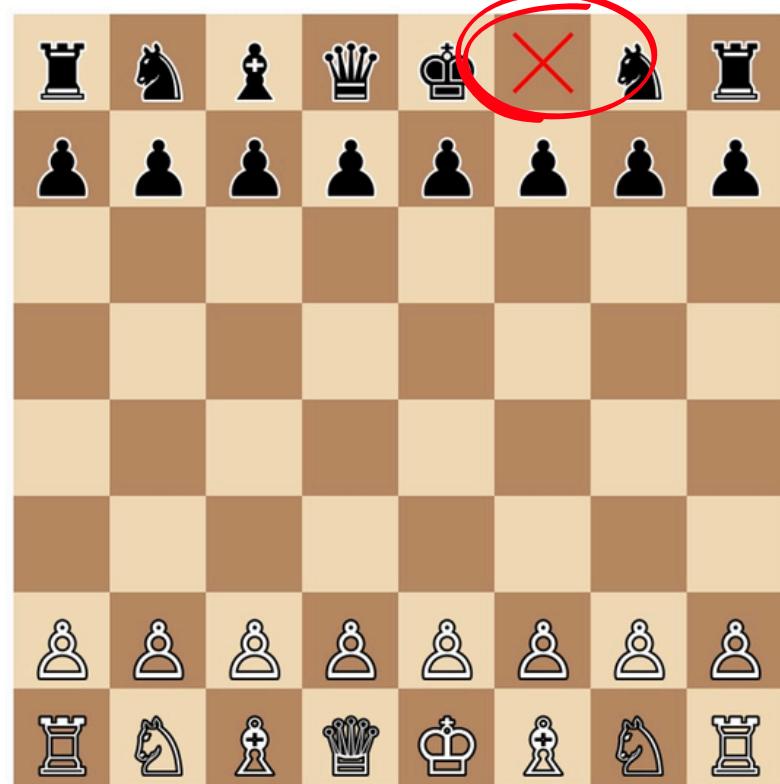


Results & Evaluation



The strong diagonal confirms **high accuracy** across all classes. Minor misclassifications occur only between geometrically similar pieces

Failure Cases



Common Errors:

1. Geometric Ambiguity ("Top-Down"):

- In 2D projection, distinct 3D features (height, cuts) are lost.
- **Result:** High confusion rate between White Pawn and White Bishop due to identical circular bases.

2. Extreme Occlusions:

- **Static:** Tall pieces (Queen/King) blocking the square behind them.
- **Dynamic:** Player's hand moving across the board creates "unknown" artifacts.

Insights

- **Preprocessing Bottleneck:**

Model accuracy is strictly bounded by the board cropping quality.

- **Detection vs. Classification**

Determining presence is robust. The real challenge is distinction between similar classes (King vs. Queen).

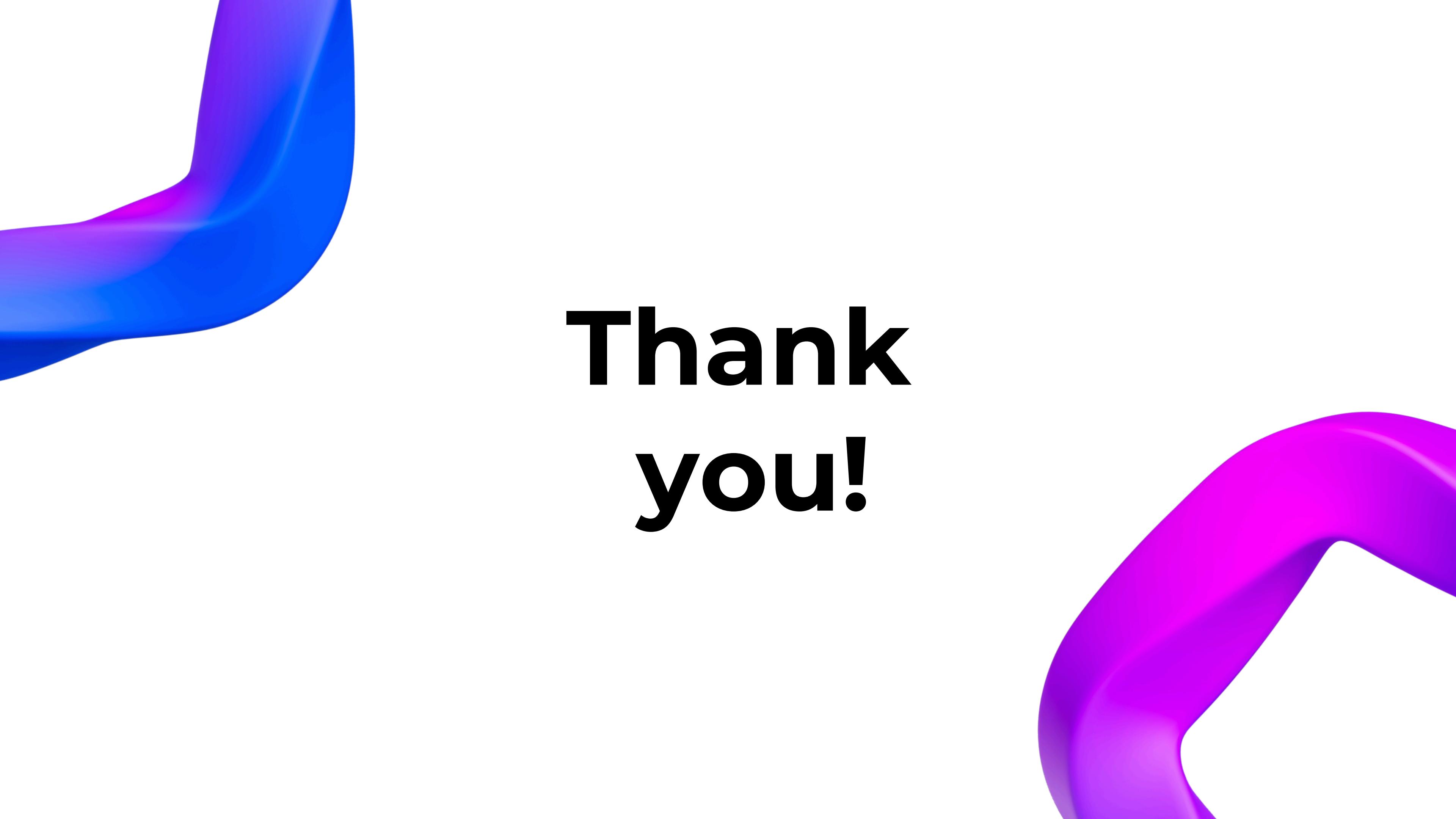
- **Detail Loss in Downscaling:**

Resizing square crops to standard CNN inputs destroys fine-grained features. Small details often vanish, making distinct pieces look identical to the network.



Summary & Links

- Developed a complete pipeline from raw image to digital FEN.
- Successfully handled real-world challenges like shadows and occlusions.
- [Link to our website](#)



**Thank
you!**