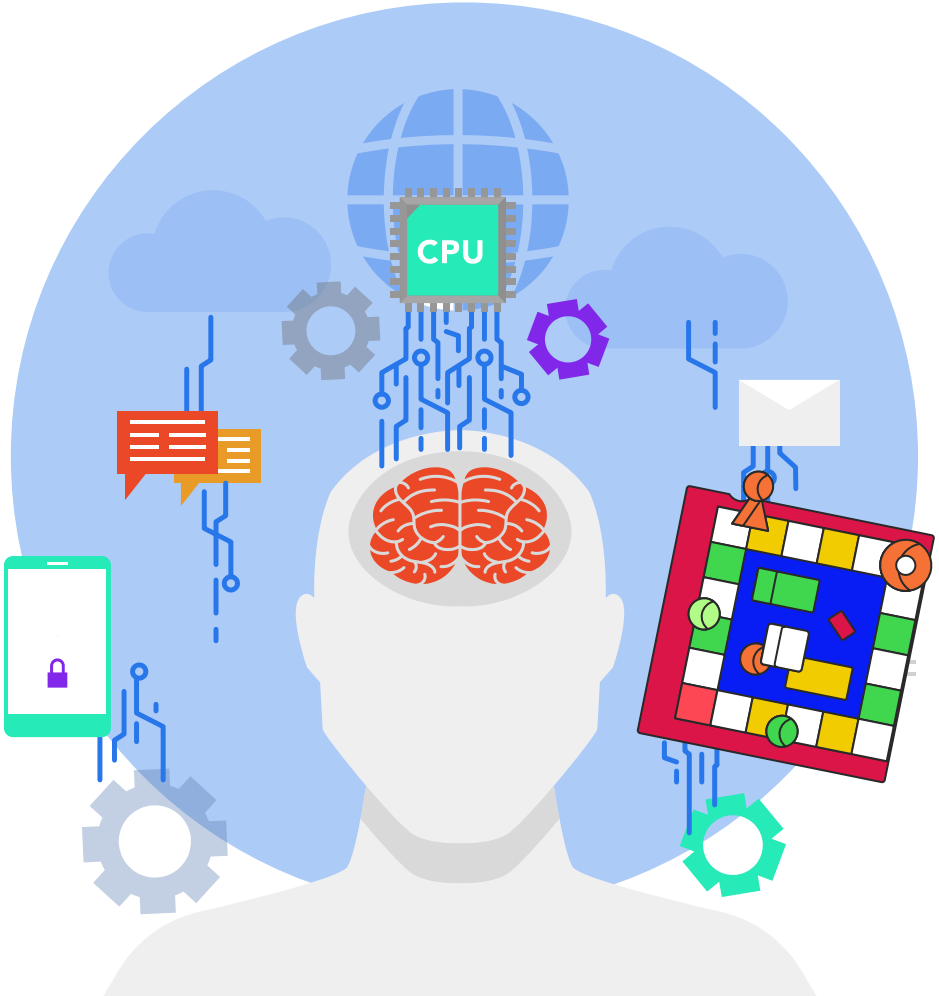


Connect 4 Outcome Predictions

Gaurang Ruparelia, Remi Vaughan
Prof. Linda M. Sellie
CS-UY 4563
Apr 27, 2023

Introduction

What is Connect-4?

- 6 by 7 grid
- Win by connecting 4 pieces horizontally, vertically, or diagonally
- On each turn, 7 moves can be played

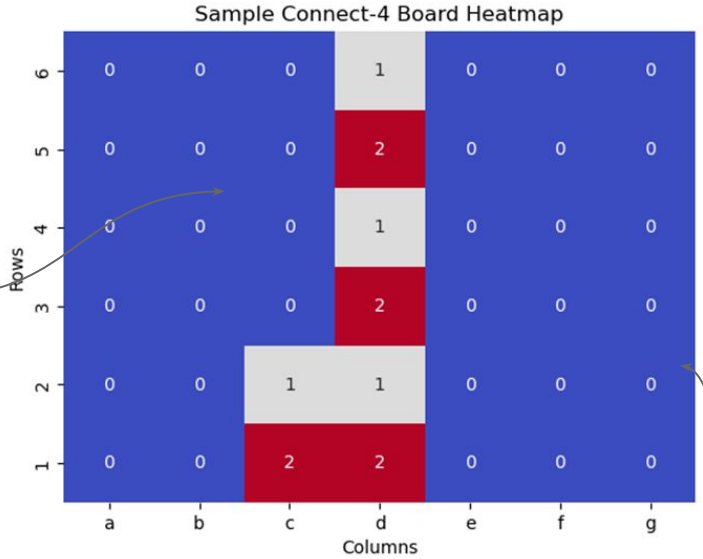
Connect-4 Dataset

- Found on OpenML.org
- 43 features
- 67,557 samples
- 8-ply positions
- Game theoretical value

Unsupervised analysis

Inputs

- 42 features
- 0 - blank
- 1 - Player 1
- 2 - Player 2



Outputs

- 2 - win
- 1 - loss
- 0 - draw

Preprocessing

Normalization

Data already normalized

01

Outcome class bias

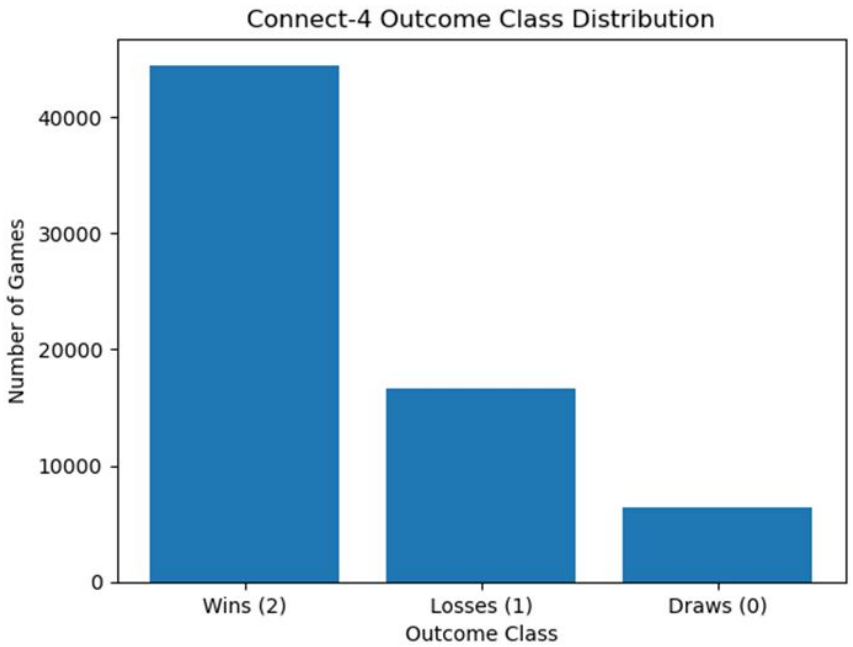
Bias towards class 2

02

One Hot encoding

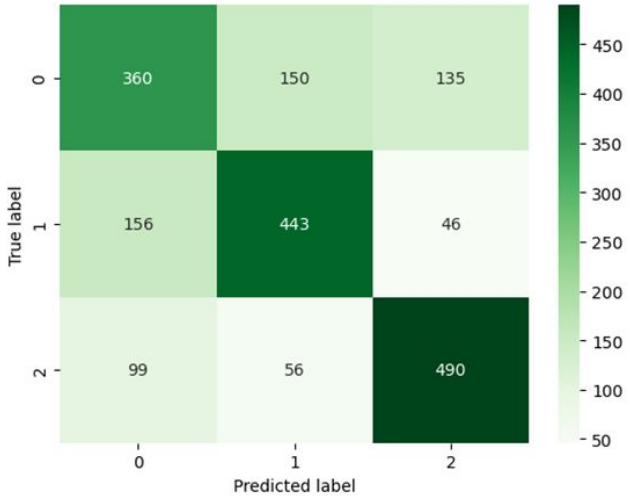
3 binary classifiers

03



Logistic Regression

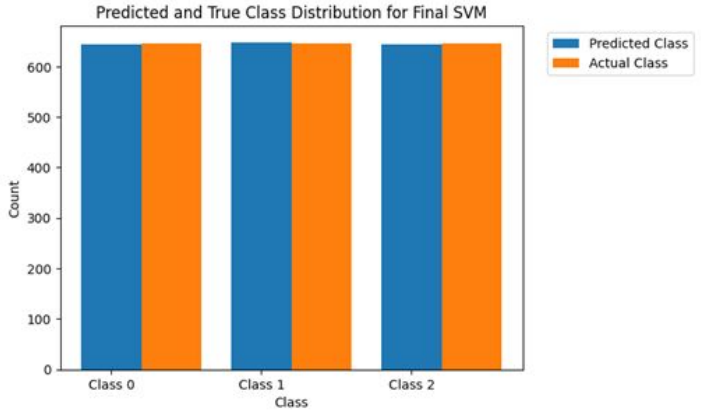
- Hyperparameters tested
  - L1 and L2 regularizations
  - C = 0.001 to 1000
  - feature transformations [X, X^2, X^3]
- Best hyperparameters
  - L2 regularization
  - C = 1000
  - feature transformations X^3
- Test set performance
  - Overfitting
  - Poor performance on class 0
- Best test set accuracy: 67%



	precision	recall	f1-score	support
0.0	0.59	0.56	0.57	645
1.0	0.68	0.69	0.68	645
2.0	0.73	0.76	0.74	645
accuracy			0.67	1935
macro avg	0.67	0.67	0.67	1935
weighted avg	0.67	0.67	0.67	1935

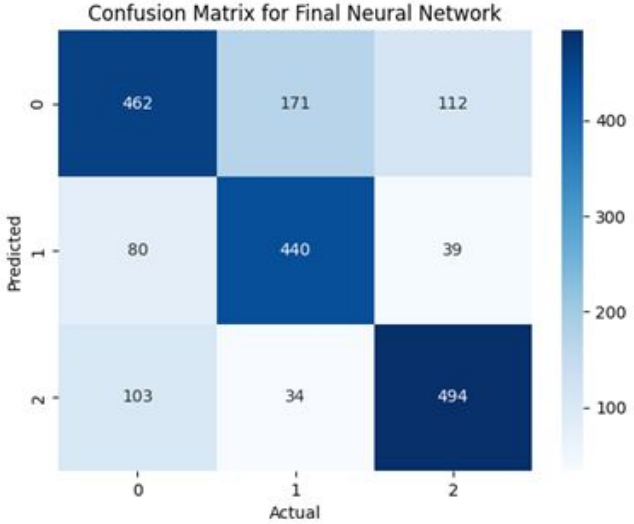
Support Vector Machines

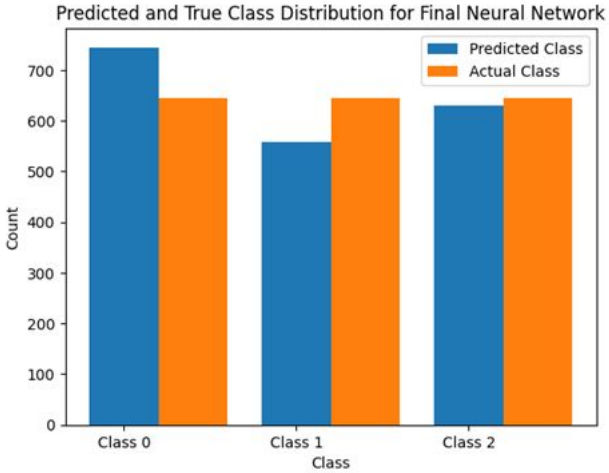
- Hyperparameters tested
  - L2 regularization, lambdas [0, 0.001, … 10000]
  - Multiple thresholds [0.1, 0.25, 0.5, 0.75, 0.9]
  - Linear and quadratic kernels
- Best hyperparameters
  - Lambda = 0.001
  - Threshold = irrelevant (0.5 used)
  - Quadratic kernel
- Test set performance
  - Guessed classes in equal proportion
  - Only correct ⅔ of the time
- Best test set accuracy: 65.8%



Neural Networks

- Hyperparameters tested
  - L2 regularization, lambdas [0, 0.001, … 10000]
  - ReLU, Sigmoid, and Tanh activations used
- Architectures used
  - [30, 15, 15]
  - [30, 15, 15, 15]
  - [30, 15, 15, 15, 15]
- Best hyperparameters
  - Lambda = 10
  - Tanh activation
  - [30, 15, 15] Architecture
- Best test set accuracy: 72.14%





Results and Limitations

Best Model

Neural Network

5 layer, Tanh, L2 regularization

72.14% accuracy!

1970s

Very specific

Dataset is very specific positions, model is useless outside of these

Improvements

Dataset Improvement

01

Use a larger dataset of games with more varied positions

Neural Network Improvement

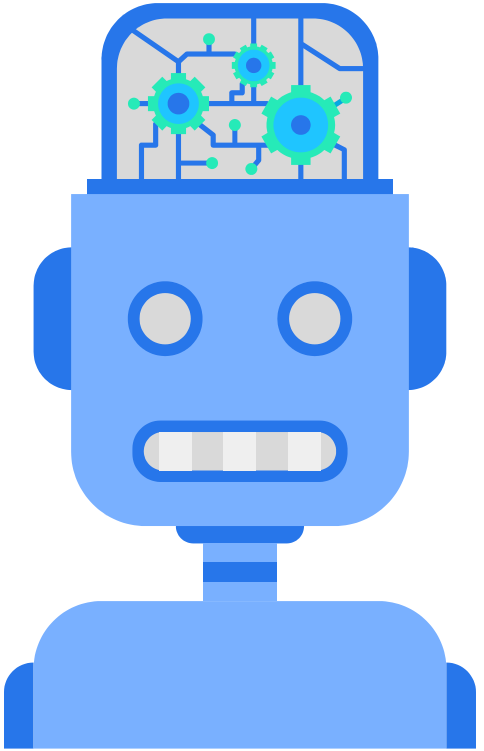
02

Experiment with different architectures, lambdas, and activations

Strategy Improvement

03

Try other strategies, such as evolutionary models



Thank you :)

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