

Item Prediction in *Dota 2*

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Background

Dota 2 is a popular online five-on-five video game with a rich competitive scene. In every game of *Dota 2*, players steadily accumulate gold over time from a number of sources. Gold can then be spent on items that make their characters stronger as the game progresses. My neural network predicts which items each player is most likely to purchase given the current state of the game at a given point in time.

Data

I used information about 49,867 public matches taken from Kaggle^[1], a machine learning competition website. I used information about eight random times in each game. I used a 90/5/5 train/dev/test split.

Input

I wanted the network to be able to predict which items the opponents would buy with only information a player would normally have in-game, so the algorithm gets the following input:

- Current player items
- Current elapsed game time
- Which character each player has chosen to play out of the 115 available options
- The skill rating of each player

Output

There are five players on each team, and 95 possible items they could buy. The network returns the probability of each player buying each item, for a total of 950 predictions. Example outputs for two characters are shown below. Upper case item names are ones that were bought.

```
Hero: Undying
Game Time: 14:16
Current Items: ['Arcane Boots']
Future Items: ['Mekansm', 'Vladmir's Offering', 'Guardian Greaves']
Predicted Future Items: Probabilities:
1 GUARDIAN GREAVES [████████████████████████████████████████] ]
2 MEKANSM [██████████████████████████████████████] ]
3 VLADMIR'S OFFERING [██████████████████████████████████] ]
4 aghanim's scepter [██████████████████████████████] ]
5 vanguard [██████████████████████████] ]
6 pipe of insight [██████████████████████████] ]
7 platemail [██████████████████████████] ]
8 blade mail [██████████████████████████] ]
9 perseverance [██████████████████████████] ]
10 crimson guard [██████████████████████████] ]
```

```
Hero: Keeper of the Light
Game Time: 14:16
Current Items: []
Future Items: ['Force Staff']
Predicted Future Items: Probabilities:
1 FORCE STAFF [████████████████████████████████████████] ]
2 mekansm [██████████████████████████████████] ]
3 aghanim's scepter [██████████████████████████████] ]
4 arcane boots [██████████████████████████] ]
5 eul's scepter of divinity [██████████████████████████] ]
6 glimmer cape [██████████████████████████] ]
7 guardian greaves [██████████████████████████] ]
8 boots of travel [██████████████████████████] ]
9 necronomicon [██████████████████████████] ]
10 shadow amulet [██████████████████████████] ]
```

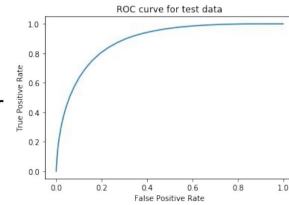
Model

I used a vanilla fully-connected neural network with two hidden layers. In addition, I used L1 regularization, batch norm, and dropout for regularization. For the loss function I used binary cross-entropy, since the prediction for each item for each hero is an independent binary prediction.

Results

| | Train | Dev | Test |
|------|--------|--------|--------|
| Loss | 0.1089 | 0.1186 | 0.1185 |
| AUC | 0.9037 | 0.8854 | 0.8859 |

True positive rate and false positive rate for various cutoff probabilities.



Discussion

These results were actually much better than I had expected. Players may make sub-optimal purchases, and there may be many viable item choices for a given situation, so the model's performance is quite good. It takes years for players to develop an intuition for which items the opponents will buy, so this network would actually be fairly useful for newer players.

Future

If I had more time, I would definitely use a bigger dataset, and perhaps use more features about the current game state. I could also extend the functionality to predicting other player choices.

References

[1] <https://www.kaggle.com/devinanzelmo/dota-2-matches/data>