



Dota2 Matches --Prediction Model



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What is Dota2:

- Dota2 is a multiplayer online battle arena video game which is played in matches between two teams (called Radiant and Dire). Each team consists of five players, with both teams occupying their own separate base on the map.



Recommended
2,823.2 hrs on record

- Each of the powerful characters have unique abilities
Posted: December 16, 2013
Causes anxiety problems, low self esteem, Tourette's syndrome, mood swings, Bipolar disorder, breakdown of relationships, raging erections, racism. Would definitely recommend.

Motivation:

- Personal-wise: For normal players, matching mechanism greatly determine how many fun they might get from playing. Ideally, the system wishes to maintain a 50% winning chance for normal match, and a fair combat for ranking match. Current matching methodology doesn't perform satisfactorily.



- Public-wise: Dota2 as a popular MOBA (multi-player online battle arena) video game needs improvement in matching mechanism as posted on Kaggle. It's a chance to apply knowledge and **HELP** a large group of people.

Bad Experience!



Bad Experience!

	Ancient Apparition	482133999 All Pick	Lost
	Necrophos	481817668 All Pick	Won
	Templar Assassin	481706913 All Pick	Lost
	Shadow Fiend	481664120 All Pick	Lost
	Lone Druid	481568847 All Pick	Lost
	Broodmother	481539182 All Pick	Lost
	Gyrocopter	480789489 All Pick	Lost
	Pudge	480717265 All Pick	Lost
	Alchemist	480421474 All Pick	Lost
	Io	480377363 All Pick	Lost
	Earthshaker	480267275 All Pick	Lost
	Pugna	480245772 All Pick	Lost

WHEN YOU LOST MATCH IN DOTA2



O T A 2

AFTER 60 MINUTES

8/26/14	10:35		Phantom Assassin	Win	37:19	Unranked
8/26/14	09:38		Necrophos	Loss	46:50	Unranked
8/26/14	09:01		Tiny	Loss	29:57	Unranked
8/26/14	04:18		Zeus	Loss	33:41	Unranked
8/26/14	03:34		Doom	Loss	38:04	Unranked
8/24/14	04:46		Sand King	Win	49:57	Unranked
8/24/14	04:08		Abaddon	Loss	30:12	Unranked
8/24/14	03:27		Tidehunter	Loss	35:24	Unranked

Input Dataset:

Test

match_id	account_id	hero_id	player_slot
50000	117784	96	0

match_id	account_id	hero_id	kills	deaths	assists	denies	last_hits
0	0	8	50000	158361	84	1	30
0	1	5	50000	158362	46	2	109
0	0	8	50000	137970	85	3	58
0	2	1	50000	1090	39	4	271
0	3	6	50000	2391	9	4	245
0	4	15	50000	2391	128	5	162
0	0	102	317	10355	303	369	107
0	5	46	2390	13395	452	517	208
0	0	7	475	5035	189	223	27
0	6	73	60	17550	496	456	147

Methodology:

Matching system is essentially a prediction model that takes inputs as demonstrated in last page and generates prediction of win or lose. In order to offer better prediction, we created a model to assign score to every player to represent their combat ability. Idea of Stochastic Gradient Descent was applied to train dataset (including 50,000 matches).



Our Model includes three important aspects:

1. Categorize each hero and item
2. Estimate player's performance on different heros
3. Calculate compatibility of each team

1. Categorize heroes and items:

As a game that highlights strategy elements, Dota2 fulfills this feature by item design.

Like an example in next page, a hero can play different roles based on how the player choose items. Players don't have to stick with one role.

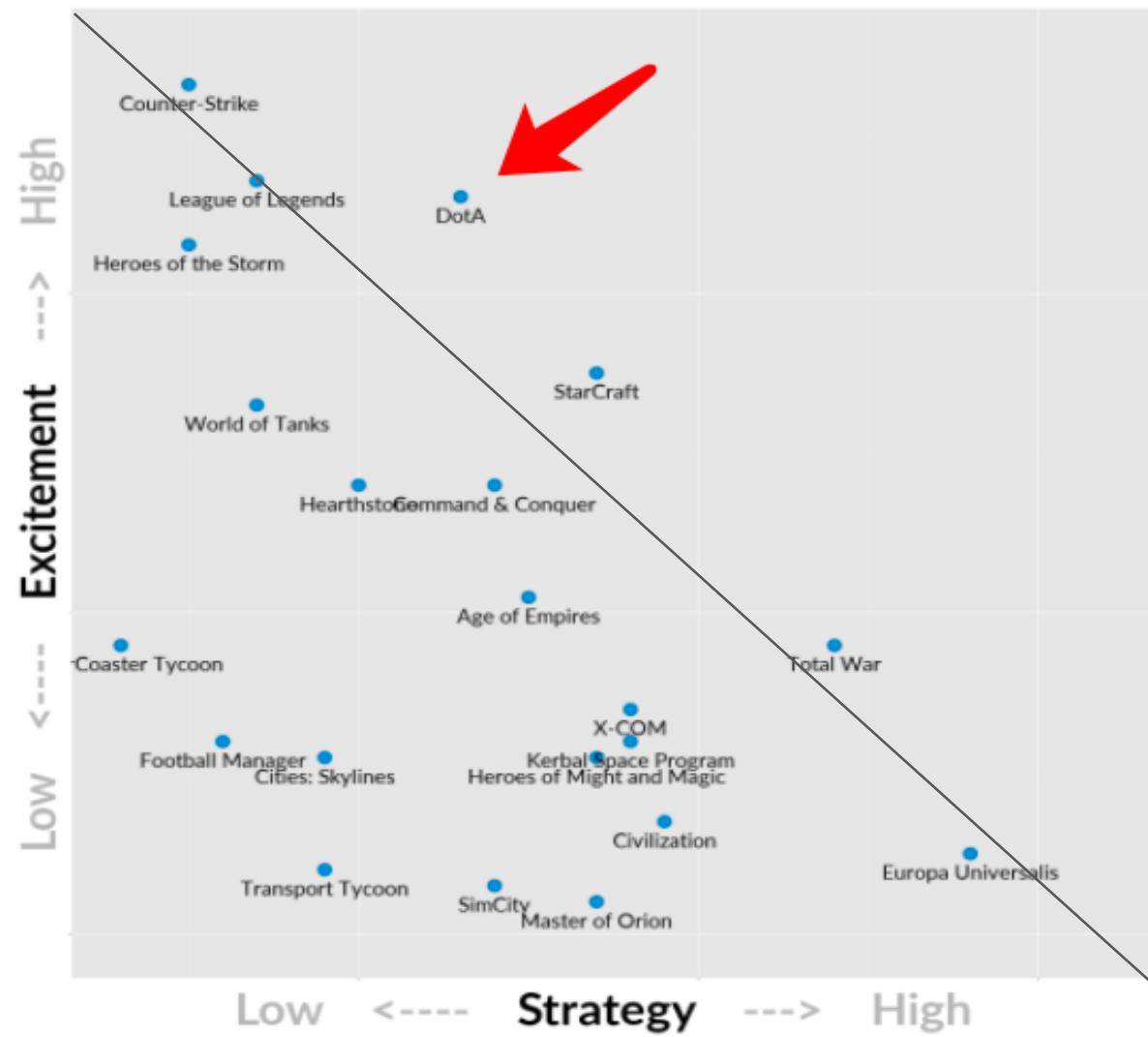


Figure source-- Game Genre Map: The Cognitive Threshold in Strategy Games

1. Categorize heroes and items:

- Heroes were categorized into five types: Carry, Tank/Durable, Pusher, Ganker, and Support (based on library data on Dota2.com)



- For example, the hero Abaddon is classified as Carry, Durable, or Support. Thus the hero vector of Abaddon is $v = [1, 1, 0, 0, 1]$
- Items were assigned vectors with same dimension and the actual values were found and adjusted by training process. By this we get the item value of each player (as one element of X_i .)

2. Player's performance

- A player's performance is represented by a vector with 25 attributes obtained from the game: gold, gold_spent, gold_per_min, xp_per_min, minute, kills, deaths, assists, denies, last_hits.
- W_j is the weight vector that weights the features for each hero. (e.g. for carry, gold/gold_spent, gold_per_min, assists and hero healing will have higher weights)

match_id	account_id	hero_id	gold	gold_spent	gold_per_min	xp_per_min	kills	deaths	assists	denies	last_hits
0	0	86	3261	10960	347	362	9	3	18	1	30
0	1	51	2954	17760	494	659	13	3	18	9	109
0	0	83	110	12195	350	385	0	4	15	1	58
0	2	11	1179	22505	599	605	8	4	19	6	271
0	3	67	3307	23825	613	762	20	3	17	13	245
0	4	106	476	12285	397	524	5	6	8	5	162
0	0	102	317	10355	303	369	4	13	5	2	107
0	5	46	2390	13395	452	517	4	8	6	31	208
0	0	7	475	5035	189	223	1	14	8	0	27
0	6	73	60	17550	496	456	1	11	6	0	147

$$Loss = C \cdot \max(0, -y \cdot (\sum_{i=1}^5 (X_i w_j + u_score_i + h_score_j) - \sum_{i=6}^{10} (X_i w_j + u_score_i + h_score_j) + F(\{w\}_{j=1}^5) - F(\{w\}_{j=6}^{10})))$$

$w \in R^{h \times d}$: weight matrix, h is the number of heroes

$X \in R^{n \times d}$: training data, n: number of samples, d: number of features

$y \in R^n$: labels

$C \in R$: penalty weight. depending on the number of remaining towels of each side

$u_score \in R^u$: user score, u: number of users

$h_score \in R^h$: hero score, h: number of heroes

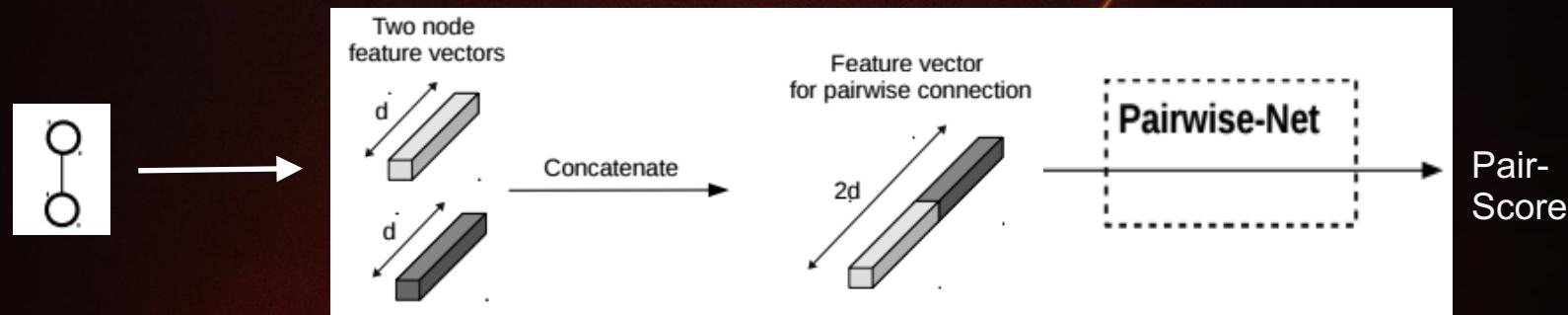
F : a set of fully connected layers.

3. Model compatibility between heroes

- Fully connected graph(Model compatibility of every hero)
- 5-layer fully connected network



- Compatibility has been proved crucial to success by a lot of official games and high rank matches.



Training:

- 50k matches (158360 players) in training set, 100k (many new players) matches in testing set (Downloaded from kaggle)
- Stochastic gradient descent for optimization



```
loss = ratio_node * tf.maximum(0.0, -train_labels_node * (ret[0] - ret[1] + ret[2] - ret[3]))\n    + reg_hinge + 5e-4 * reg_nn\n\nbatch = tf.Variable(0)\nlearning_rate = tf.train.exponential_decay(\n    0.01, # Base learning rate.\n    batch * BATCH_SIZE, # Current index into the dataset.\n    TRAIN_SIZE / 20, # Decay step.\n    0.995, # Decay rate.\n    staircase=True)\n\noptimizer = tf.train.GradientDescentOptimizer(learning_rate).minimize(loss, global_step=batch)
```

Preliminary Results:

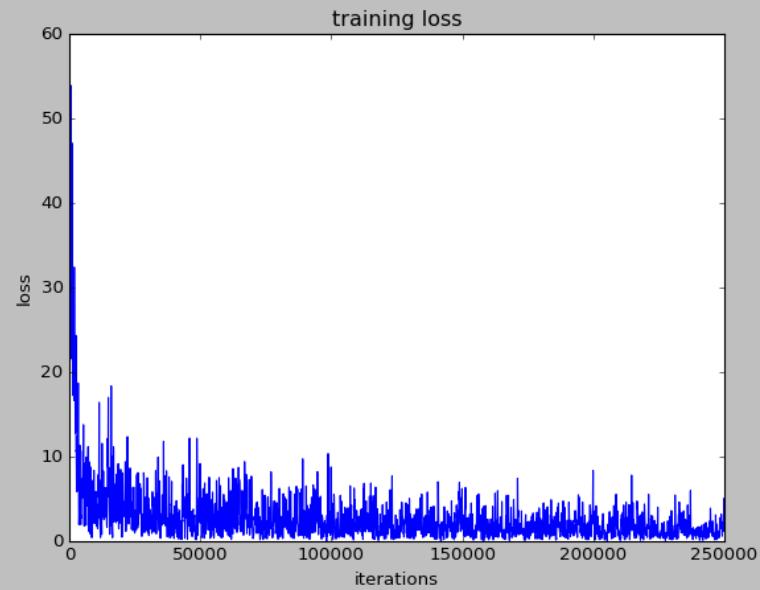
Training accuracy: 97%

DOTA 2

Testing accuracy: 57.97% (hero score)

Testing accuracy: 56.22% (hero score + compatibility)

Testing accuracy: 53% (player score + hero score + compatibility)



Problems of the Result:

Dataset is pretty limited:

- Only 50k matches

- Average per players only have 3.5 matches

- Lots of players in testing dataset are not in training dataset set

- Large part of players only appear once in our dataset



Compatibility does not work

Compatibility is essential in team fight, which should be important, but in our dataset players just choose the hero they want to play without considering the compatibility of the team.

Questions
D O & A 2 
Answers

Why Items important?

With more than 148 different items to choose from, each player could carry no more than 6 items.

Different combinations of item choice granted this game a huge degree of freedom and diversity.

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