Detecting strategic moves in HearthStone matches

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HearthStone basics

Online collectible card game from Blizzard. Turn based game.

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Online collectible card game from Blizzard. Turn based game.

Opponent's deck

My deck

HearthStone basics

Online collectible card game from Blizzard. Turn based game.

Opponent's hand

Opponent's deck

My deck

My hand

HearthStone basics

Online collectible card game from Blizzard. Turn based game.

Opponent's hand

Opponent's hero

Opponent's deck

My deck

My hero

My hand

HearthStone basics

Online collectible card game from Blizzard. Turn based game.

Opponent's hand

Opponent's hero

Opponent's deck

Opponent's creature

My creature

My deck

attack   health

My hero

My hand

Beginner challenge

Complex game for beginners

- **1053 cards**, and counting
- Some cards have a **large impact** on the game
- **Many synergies** between cards

Our solution

Identify **key actions** from **strategic events** of **experienced** players matches

Dataset

2066 matches from three good players

Available at https://bitbucket.org/Valnora/hsdataset

Each match i is a pair (x_i, y_i)
- y_i: game result
- $x_i = [x_i^1, \dots, x_i^n]$: feature vector list

- x_i^k: feature vector for turn k
  - Cards played during the turn
  - Number of cards in hand
  - Board state
  - Players health

```
{
    "turn": 12,
    "cards_played": ["Thing from below"],
    "current_player": "me",
    "my_health": 30,
    "opponent_health": 19,
    "my_armor": 0,
    "opponent_armor": 0,
    "my_hand": 3,
    "opponent_hand": 6,
    "my_board": [{
        "card_name": "Thing from below",
        "card_health": 5,
        "card_attack": 5
    },
    {
        "card_name": "Tuskarr totemic",
        "card_health": 2,
        "card_attack": 3
    },
    {
        "card_name": "Stoneclaw totem",
        "card_health": 1,
        "card_attack": 0
    },
    {
        "card_name": "Stoneclaw totem",
        "card_health": 2,
        "card_attack": 0
    }],
    "opponent_board": [{
        "card_name": "Mounted raptor",
        "card_health": 4,
        "card_attack": 5
    }]
}
```

Strategic events

What is a strategic event ?

> **Intuitive definition**
>
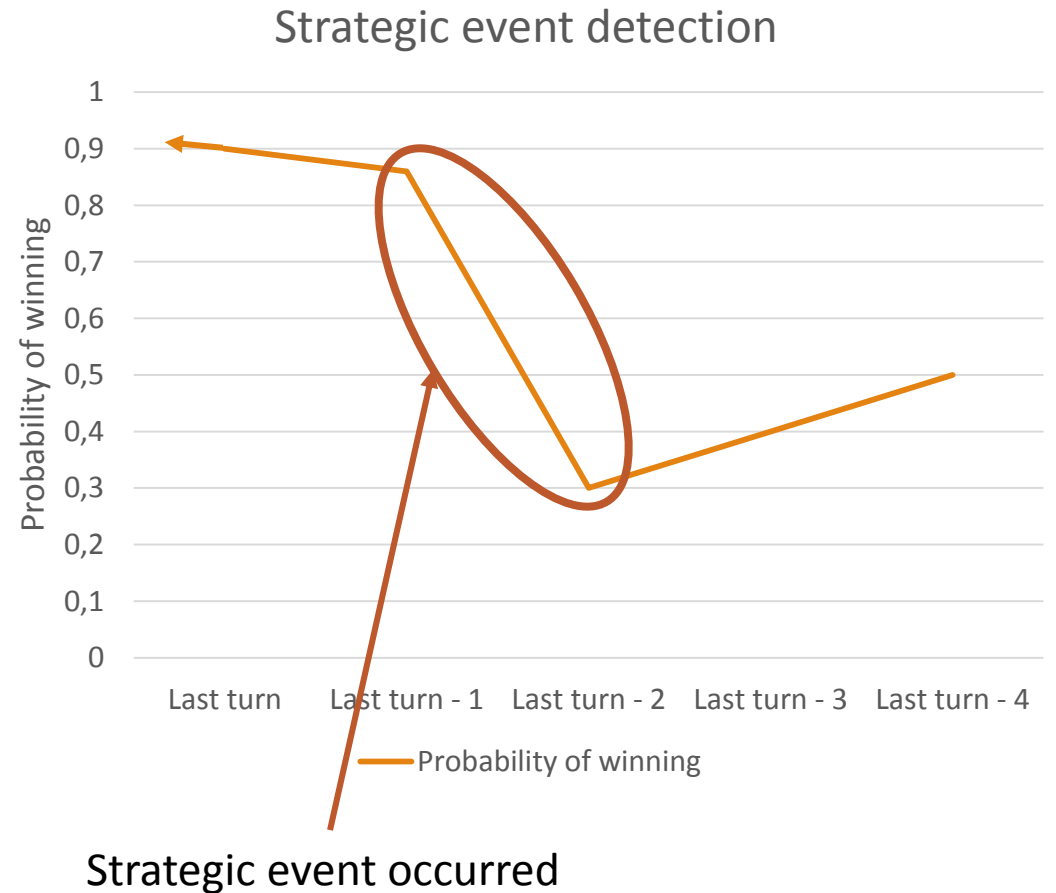> A strategic event is an event that impacts the predicted outcome of the game

- Predefined by experts (goal, free-kick in soccer) [CHG02]
  - We want to automatically identify these events
- Induce crowd reaction [WYHG14]
  - Not available
- Visual effects (kills in MOBA) [CC15]
  - Does not bring more information than the card itself

Strategic event detection

A strategic event is an event that impacts the predicted outcome of the game

Strategic event detection process

1. Predict game outcome at the end of each turn

2. Identify consecutive turns were the outcome prediction changes

Strategic event detection

Probability of winning

Last turn   Last turn - 1   Last turn - 2   Last turn - 3   Last turn - 4

—— Probability of winning

Strategic event occurred

Predicting game outcome

Step 1: Achieve a **reliable prediction** of game outcome at the **end of each turn**

⚠️ End goal: find **key actions**, **not** the **best** game outcome **prediction**

Classifiers features
◦ Players health and armor
◦ Creatures total health and attack
◦ Players number of cards
◦ Number of creatures with taunt

Predicting game outcome

Goal: Achieve a **reliable prediction** of game outcome at the **end of each turn**

First idea: One classifier for each turn, in **increasing** turn order
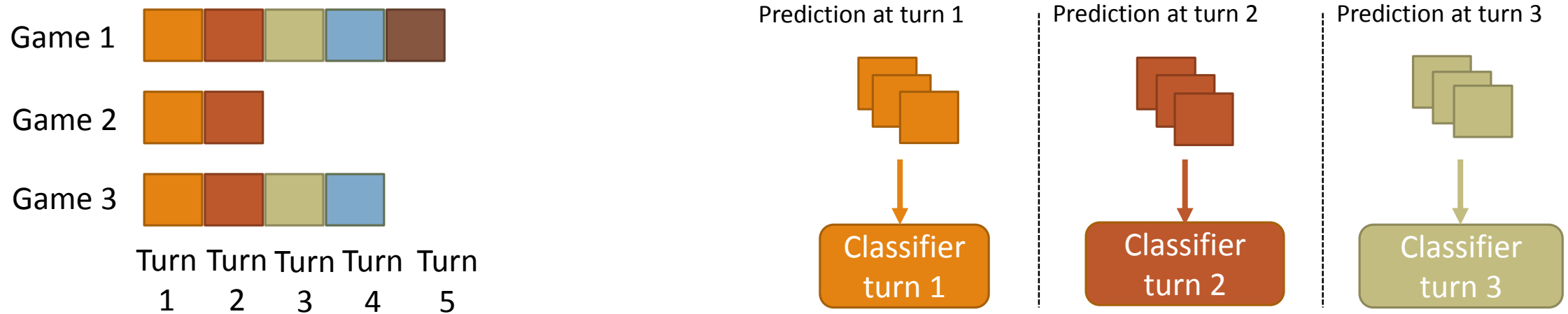
Result: **Unreliable** outcome prediction

Main issue: Turns that have the same number represent different game stages

Predicting game outcome

Goal: Achieve a **reliable prediction** of game outcome at the **end of each turn**

Second idea: One classifier for each turn, in **decreasing** turn order (end alignment)
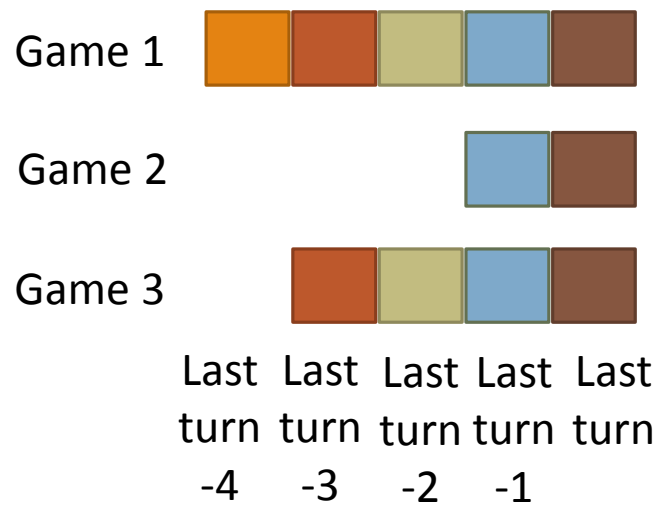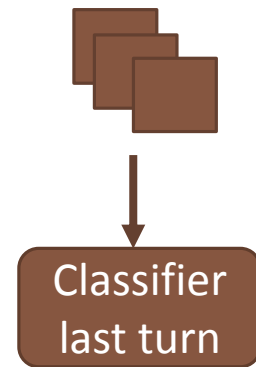
Game outcome prediction results
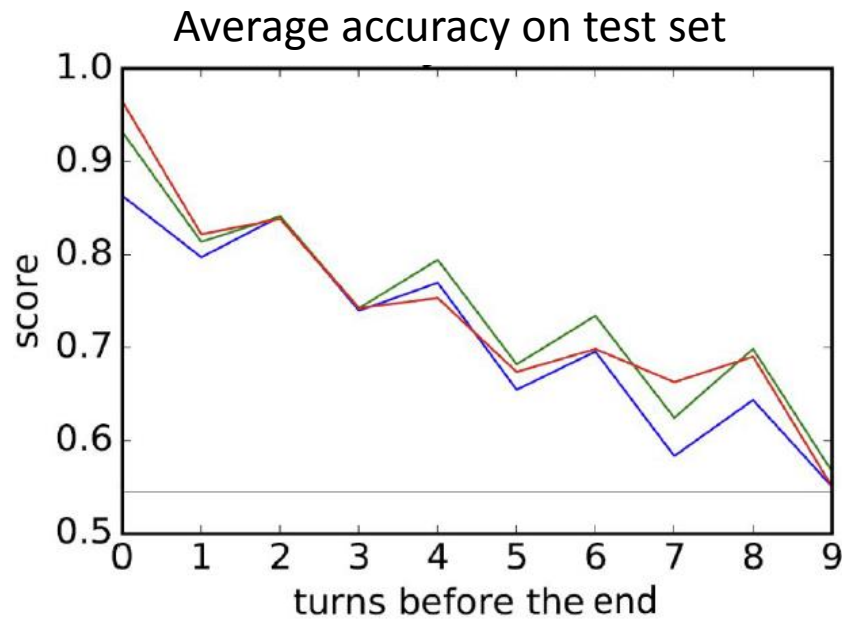
Average accuracy on test set
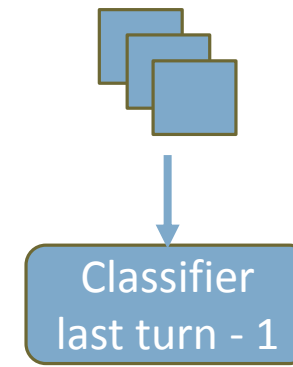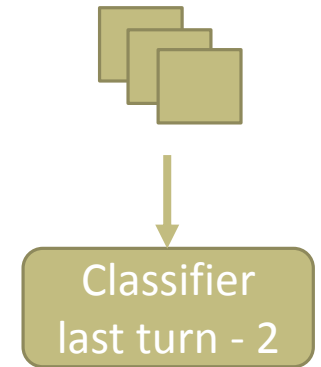
Unstable results

— Logistic regression
— Random forest
— Naive Bayes

Game outcome prediction results
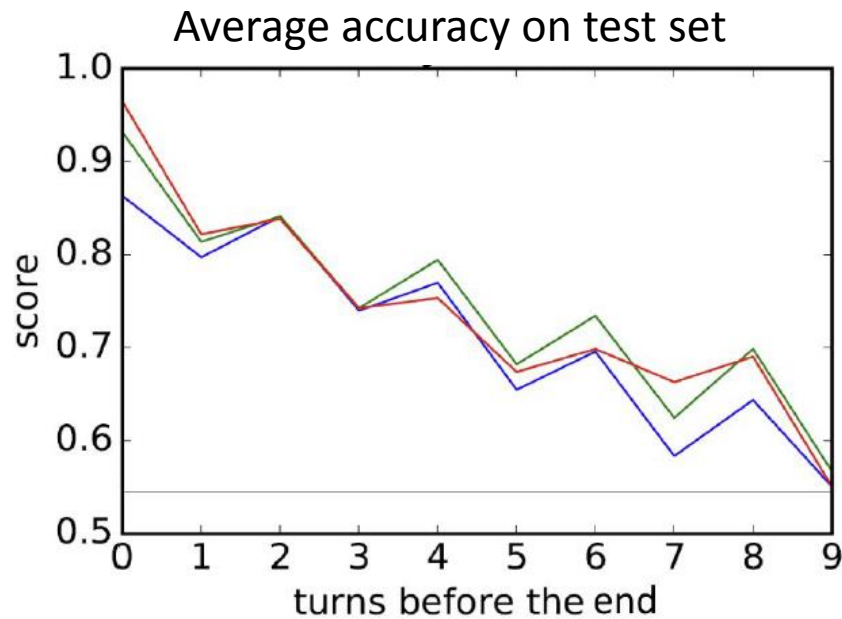
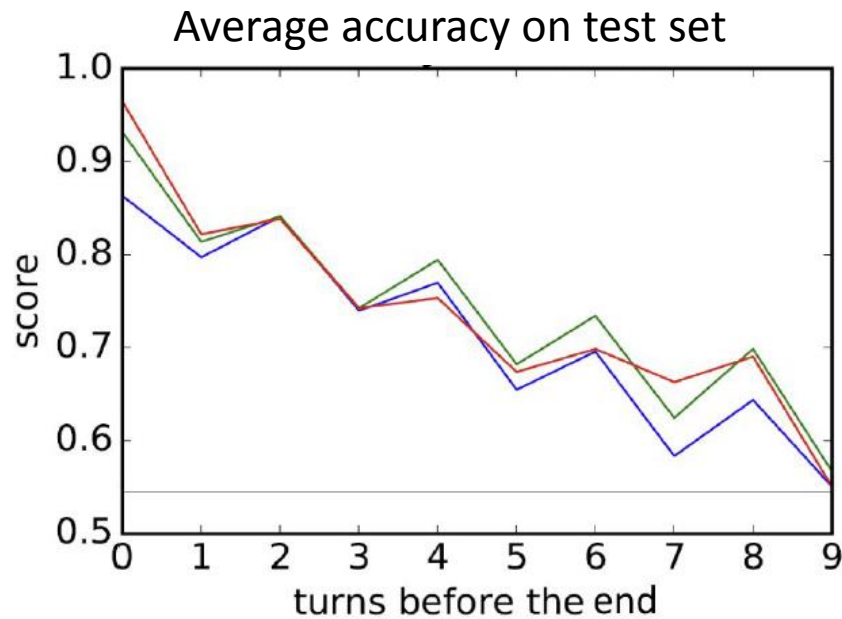Average accuracy on test set

— Logistic regression
— Random forest
— Naive Bayes

Unstable results

⇩

Every odd turn, the first player has an edge

Game outcome prediction results

Average accuracy on test set

Logistic regression
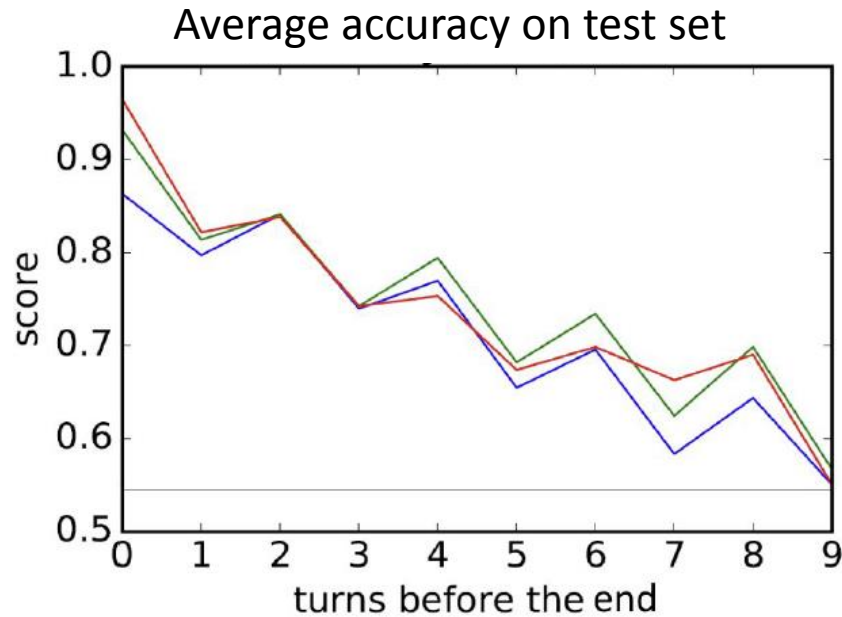Random forest
Naive Bayes

Unstable results

⇩

Every odd turn, the first player has an edge

⇩

Make a **prediction** at the end of every **even turn**

Game outcome prediction results

Average accuracy on test set
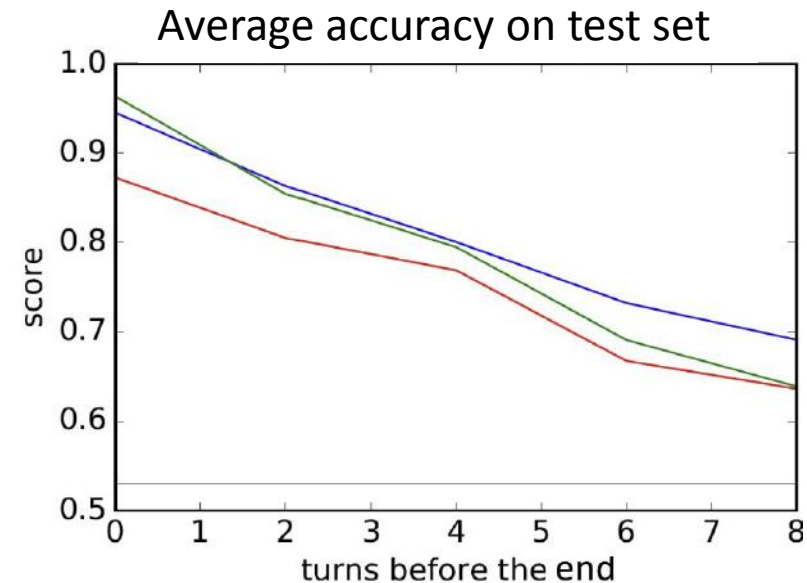
- Logistic regression
- Random forest
- Naive Bayes

Unstable results

⬇

Every odd turn, the first player has an edge

⬇

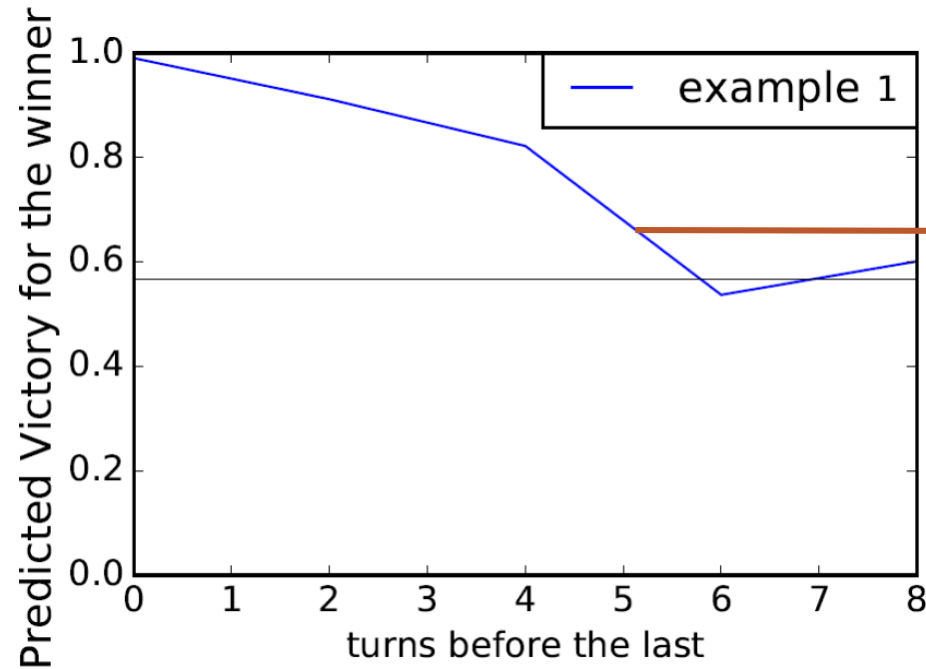Make a **prediction** at the end of every **even turn**

⬇

Average accuracy on test set
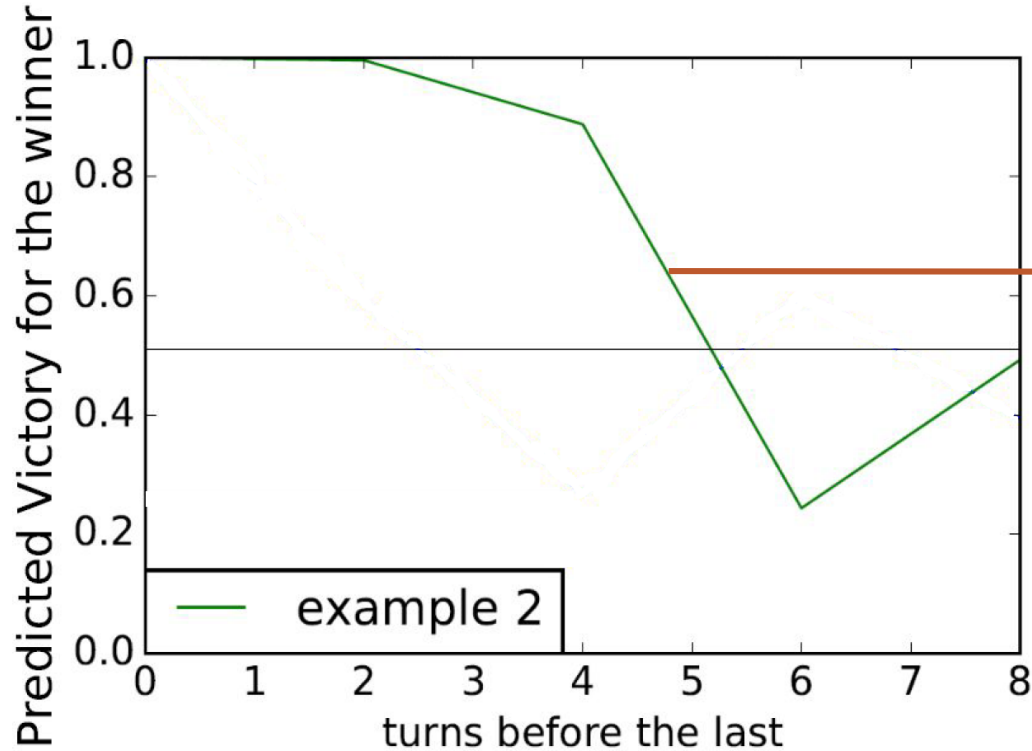
Strategic events analysis

Step 2: Strategic events are correlated with changes in classifier predictions

Strongest card of the Hunter class

Strategic events analysis

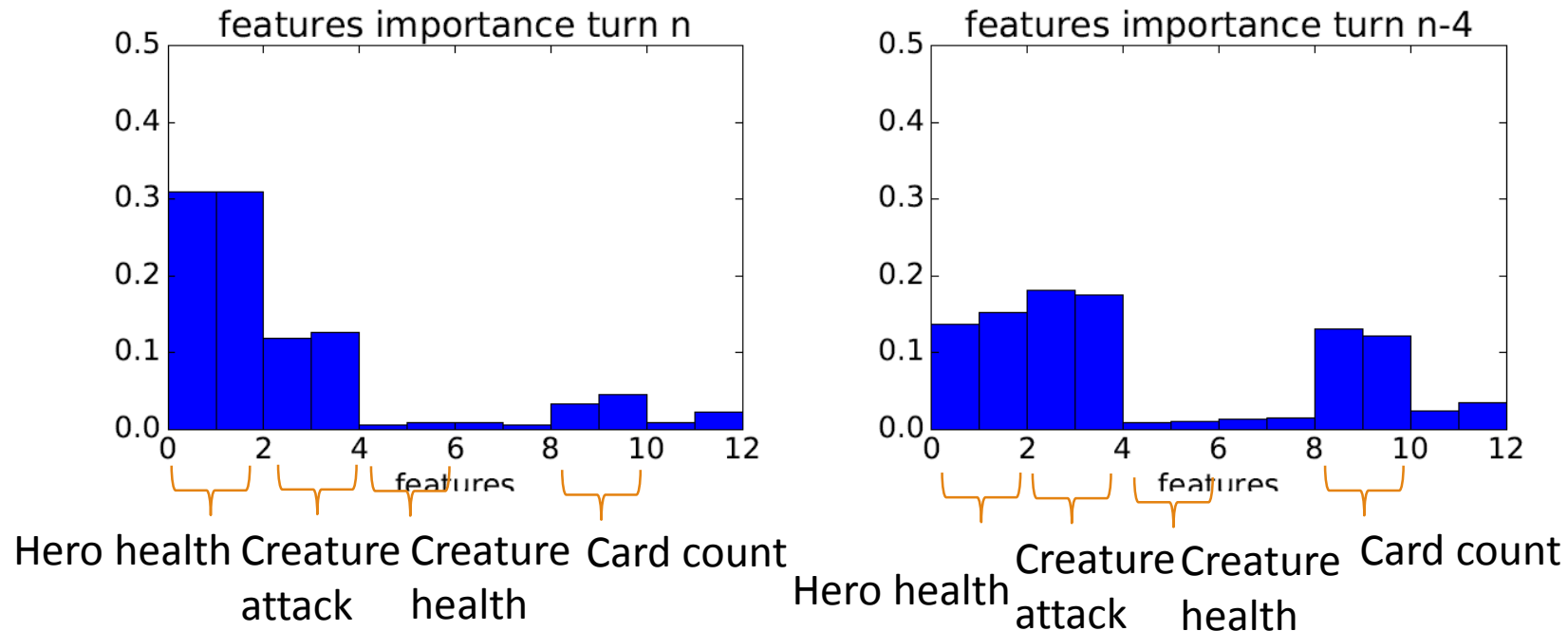Step 2: Strategic events are correlated with changes in classifier predictions

Powerful synergy that deals damage while putting creatures on the board

Strategical insights

Identify common game strategies

Feature importance analysis from classifier (from logistic regression)

Can help beginners to focus on specific resources (creature attack or number of cards) depending on the game moment

Conclusion

Simple method to identify strategic events in a game

Analysis of these key events enables beginner to identify key actions

Analysis of classifiers gives strategical insights

Perspectives

Get more data
- ◦ Matchup analysis
- ◦ Common game plan (aggressive, control, combo…) modeling with LDA

Automatically extract set of strong cards
- ◦ Pattern mining on cards played during key events: promising results

Applicability to other sports: strategic plays in sport points
- ◦ Common settings with turn based sports (tennis, volley-ball, badminton…)

Questions ?

References

Wei-Ta Chu and Yung-Chieh Chou, *Event detection and highlight detection of broadcasted game videos*, Workshop on Computational Models of Social Interactions, 2015.

Peng Chang, Mei Han, and Yihong Gong, *Extract highlights from baseball game video with hidden markov models*, Int. conf. on Image Processing, 2002.

Zengkai Wang, Junqing Yu, Yunfeng He, and Tao Guan, *Affection arousal based highlight extraction for soccer video*, Multimedia Tools and Applications **73** (2014), no. 1, 519–546.