# Isolation Heuristic Analysis

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**Abstract**

The goal of this analysis is to compare performance of different heuristics for Isolation game. In this analysis the following three different heuristics were explored: a) an amount of moves of the player; b) an amount of moves of the player minus an amount of moves of the opponent; c) an amount of moves of the player minus an amount of moves of the opponent multiplaied by 5. Based on T-test, heuristic B has the best winrate compared to other heuristics.

## Introduction

In this analysis we will explore different heuristics for an adversarial search agent to play the game "Isolation".

Isolation is a deterministic, two-player game of perfect information in which the players alternate turns moving a single piece from one cell to another on a board. Whenever either player occupies a cell, that cell becomes blocked for the remainder of the game. The first player with no remaining legal moves loses, and the opponent is declared the winner.

To test our heuristics we will use Student's t-test[1] on pairs of heuristics. The null hypotesis will be that both heuristics have the same winrate.

## Heuristics

In this analysis the following three different heuristics were explored:

- an amount of moves of the player (A).
- an amount of moves of the player minus an amount of moves of the opponent (B).
- an amount of moves of the player minus an amount of moves of the opponent multiplaied by 5 (C).

Despite Heurisirc B is the same heuristic as from the lecture and used as a baseline in `tournament.py`, we will include it into the analysis to show an example of t-test when we failed to reject the null hypotesis.

## Data

To collect data for this analysis we will use following command for all three heuristics, specifying the file where to store the result, `tournament.txt`.

```
for i in {1..100}; do
python tournament.py | grep % | sed -e's/[^0-9.]//g' | paste -sd " " - >> tournament.txt;
done
```

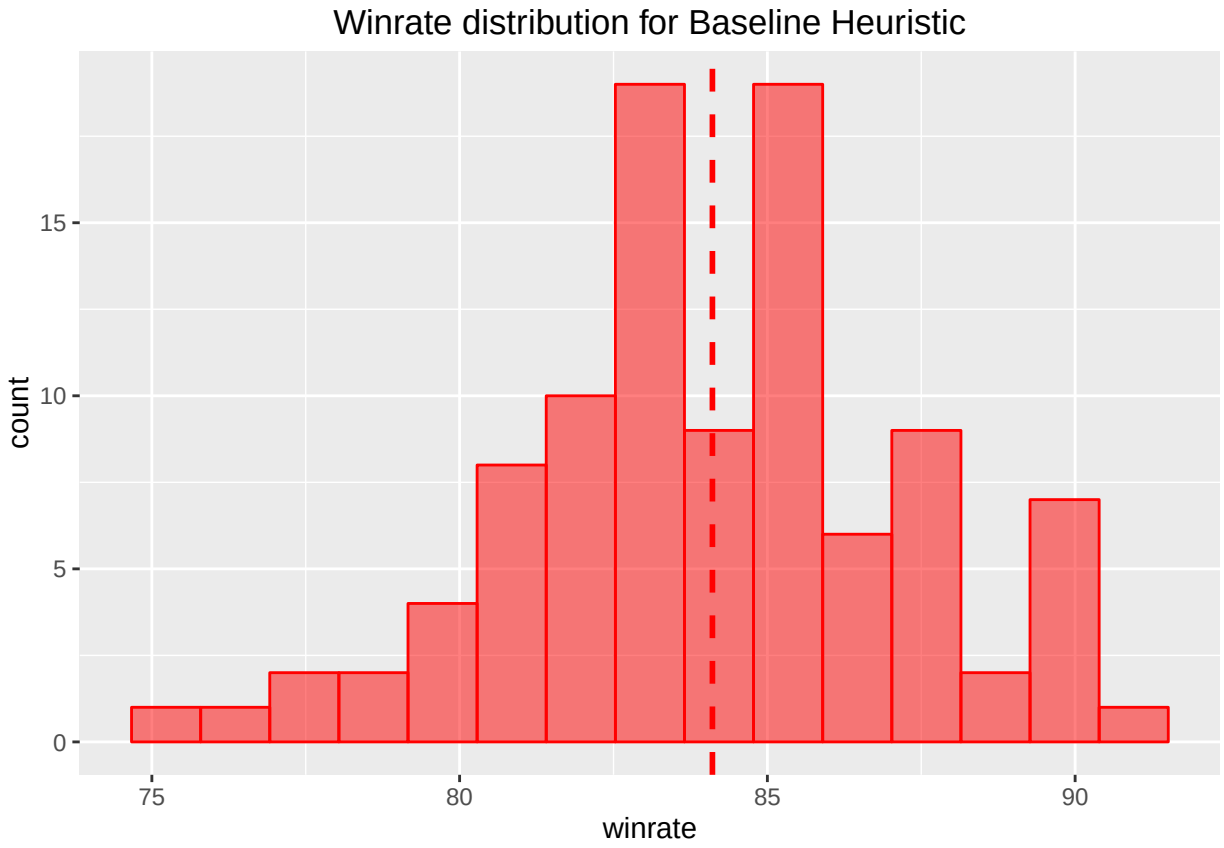
```
# Heuristic A: moves(player)
cnames = c('Winrate.Baseline', 'Winrate.HeuristicA')
tournament1 <- read.table('./tournament1.txt', header = F, col.names = cnames)

# Heuristic B: moves(player) - moves(another_plauer)
```

[1] Student's t-test

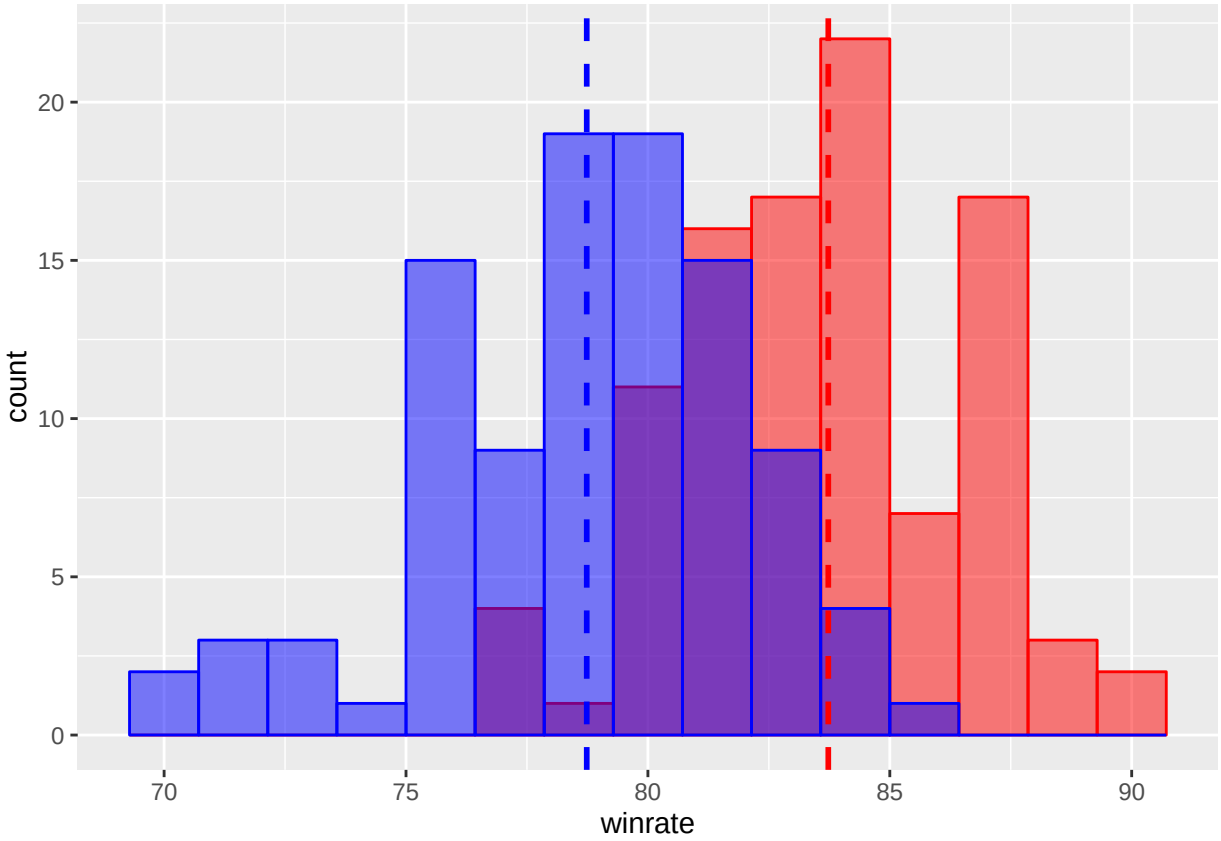
```
cnames = c('Winrate.Baseline', 'Winrate.HeuristicB')
tournament  <- read.table('./tournament.txt',  header = F, col.names = cnames)

# Heuristic C: moves(player) - 5 * moves(another_plauer)
cnames = c('Winrate.Baseline', 'Winrate.HeuristicC')
tournament2 <- read.table('./tournament2.txt', header = F, col.names = cnames)
```



# Hypothesis test

## Baseline vs Heuristic A



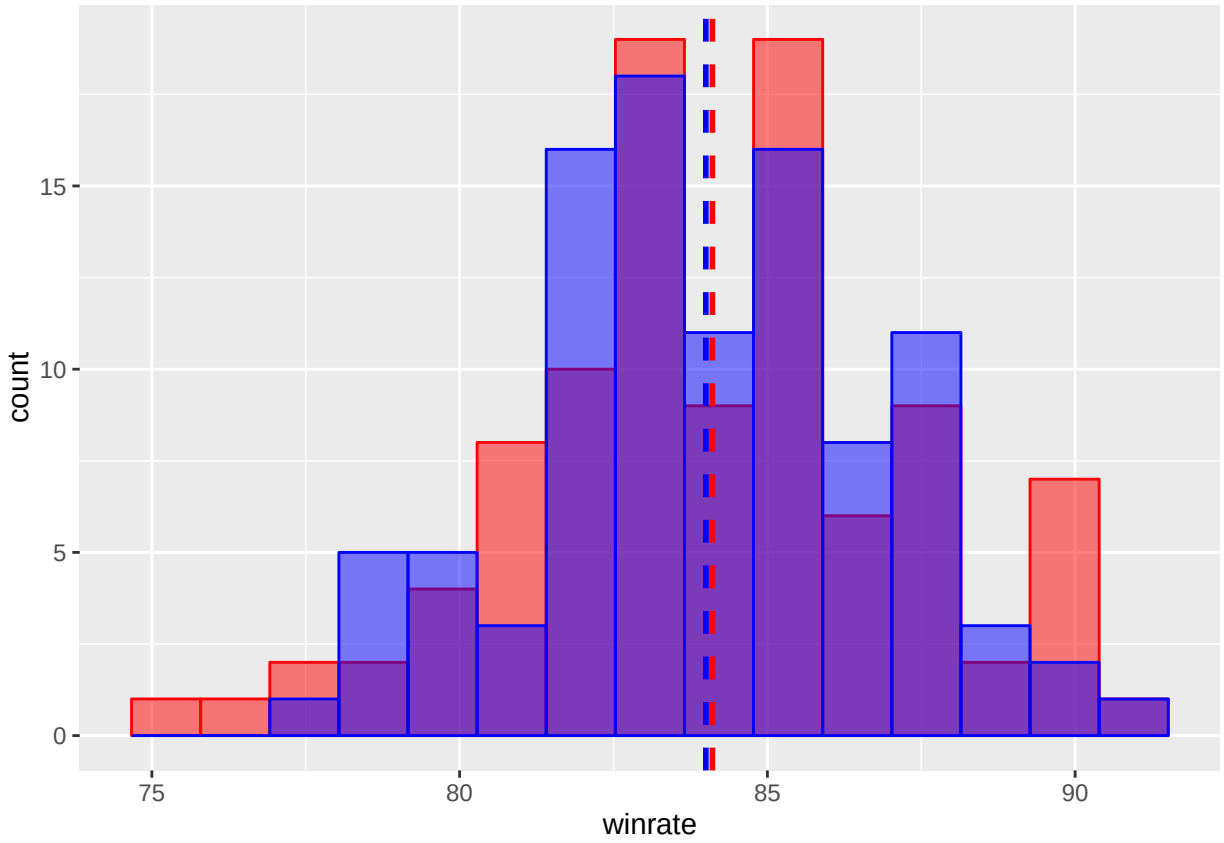

mu0 - Heuristics have the same winrate

```
t <- t.test(tournament1$Winrate.Baseline, tournament1$Winrate.HeuristicA)
t$conf.int
t$p.value
```

```
## [1] 4.131056 5.854544
## attr(,"conf.level")
## [1] 0.95
## [1] 2.281335e-23
```

`Confidence interval` doesn't contain zero and `p-value` is very small, so we can reject the null hypotesis and conclude that heuristic A has worse winrate than baseline heuristic.

### Baseline vs Heuristic B



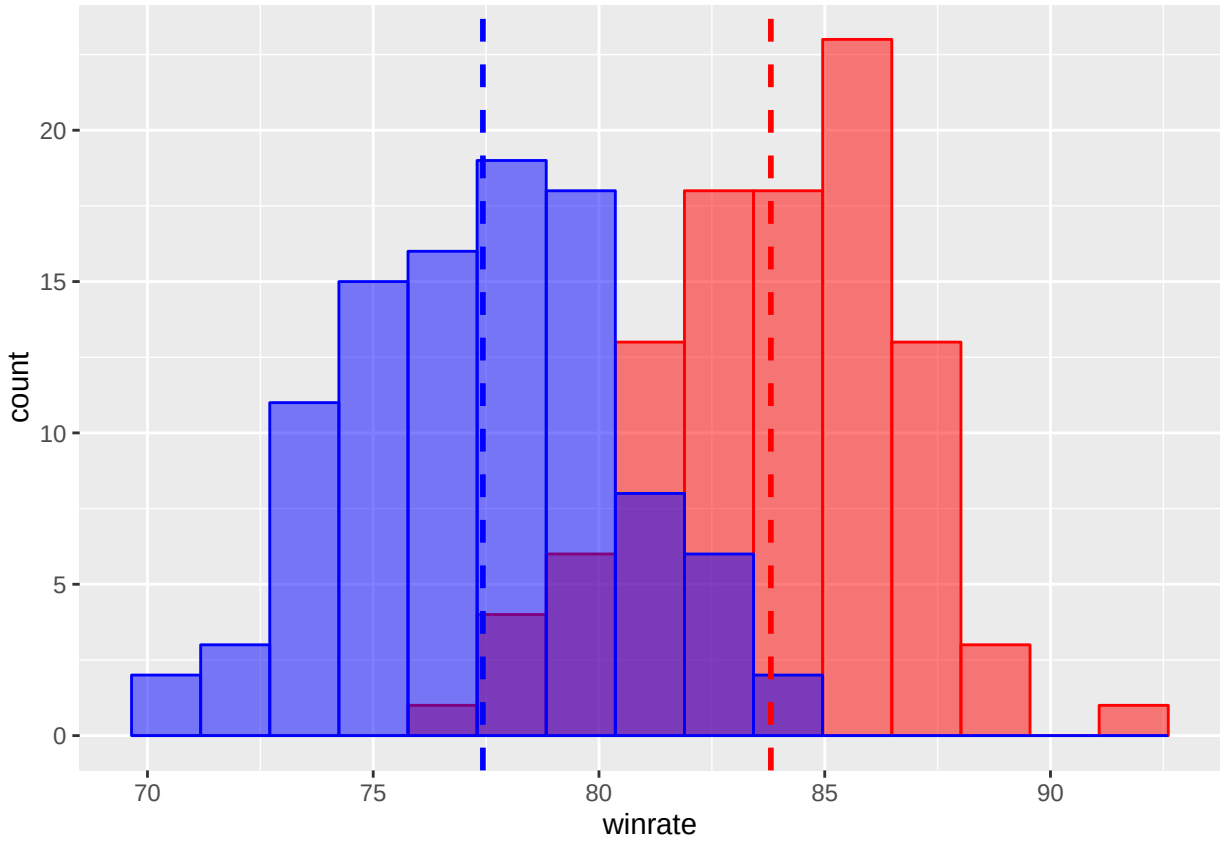

mu0 - Heuristics have the same winrate

```
t <- t.test(tournament$Winrate.Baseline, tournament$Winrate.HeuristicB)
t$conf.int
t$p.value
```

```
## [1] -0.7294664  0.9432664
## attr(,"conf.level")
## [1] 0.95
## [1] 0.8012476
```

`Confidence interval` contains zero and `p-value` is about `80%`, so we failed to reject the null hypotesis. It means that difference in winrates for heuristic B and baseline is insignificant, as expected, since it's the same heuristic.

### Baseline vs Heuristic C




mu0 - Heuristics have the same winrate

```
t <- t.test(tournament2$Winrate.Baseline, tournament2$Winrate.HeuristicC)
t$conf.int
t$p.value
```

```
## [1] 5.549277 7.206523
## attr(,"conf.level")
## [1] 0.95
## [1] 5.948996e-35
```

`Confidence interval` doesn't contain zero and `p-value` is very small, so we can reject the null hypotesis, once again, and conclude that heuristic C has worse winrate than baseline heuristic.

## Conclusion

Compared this three heuristics we can conclude that baseline heuristics has better winrate than both alternative heuristics.