



# Rush Hour

Team Carter

Eindpresentatie



# Team Carter

Minor Artificial Intelligence

Algoritmen en Heuristieken



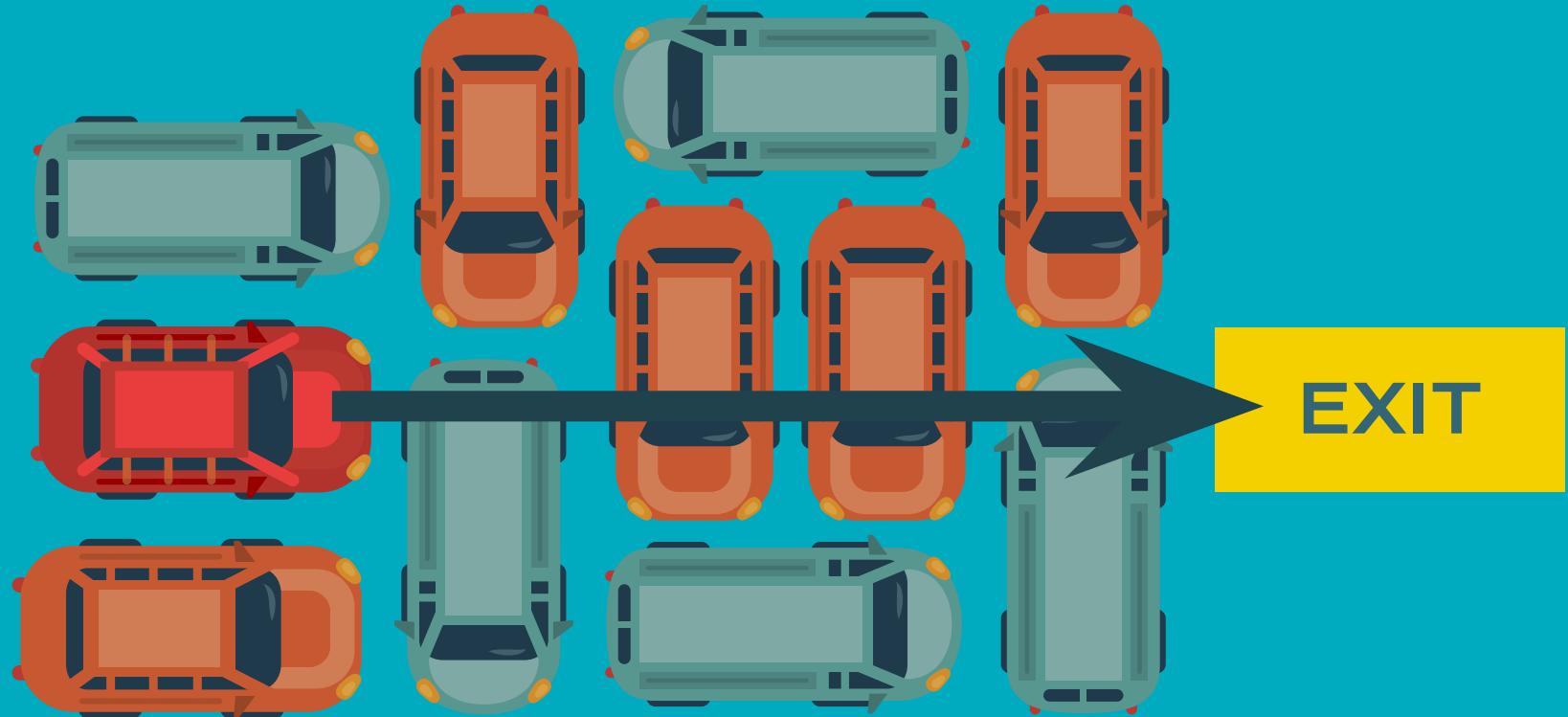
# Rush Hour



Files zijn erg vervelend!

Iedereen wil eruit,  
maar hoe?

Nagebootst in  
Rush Hour





# Case

Welke zetten?

Met de hand? Beter met de computer

Spelbord met voertuigen in Python  
geïmplementeerd

Algoritmen  
Heuristieken





# Terminologie

**Voertuigen**

**Auto** met lengte 2  
**Vrachtwagen** met lengte 3

**Zet**

Combinatie van voertuig  
en stap(pen)

**Oplossing**

Carter op de plek voor  
de uitgang

**Carter**

Rode auto

# Beperkingen

- Beweeg voertuigen *één voor één*
- Voertuigen *alleen voor- en achteruit* in hun *oriëntatie*
- Voertuigen kunnen *niet van rij of kolom wisselen*
- Voertuigen kunnen *niet door of over andere voertuigen* heen 'springen'



# Probleem en uitdaging

Accuraatheid

vs.

Snelheid

Oplossing in min mogelijk aantal zetten

*Net zoals in een file niet telkens voor- en achteruit*

Zo snel mogelijk een oplossing

*Net zoals in een file er zo snel mogelijk uit*



# State space

Product van alle mogelijke configuraties per rij / kolom

**6x6**

3 spelborden

800,000

-

10,800,000

**9x9**

3 spelborden

5.930e12

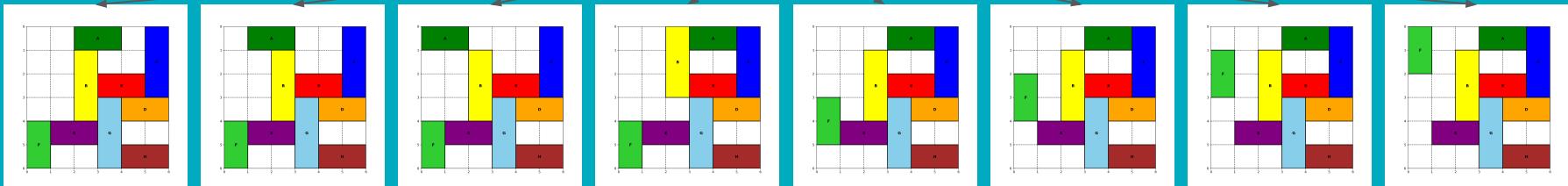
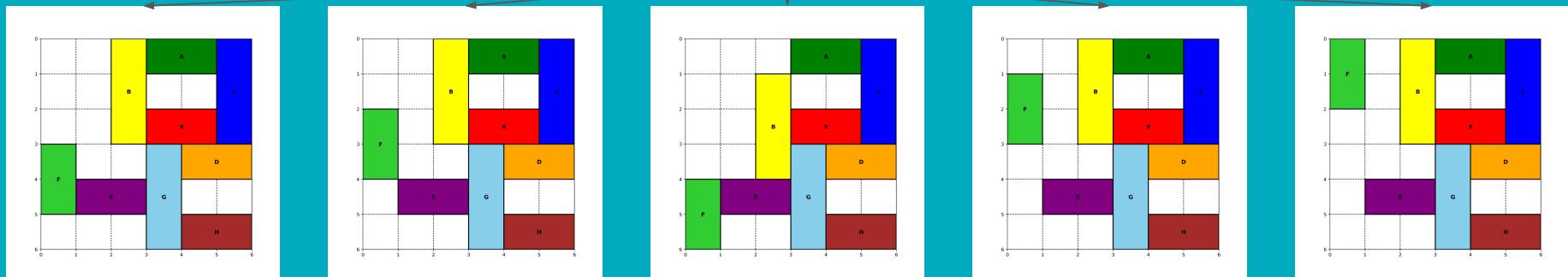
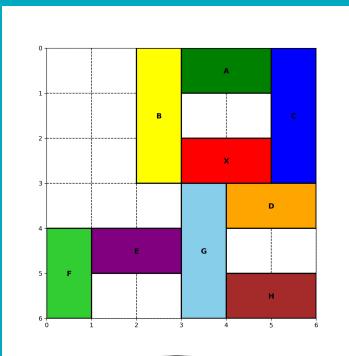
-

4.519e17

**12x12**

1 spelbord

1.088e30





# Methode

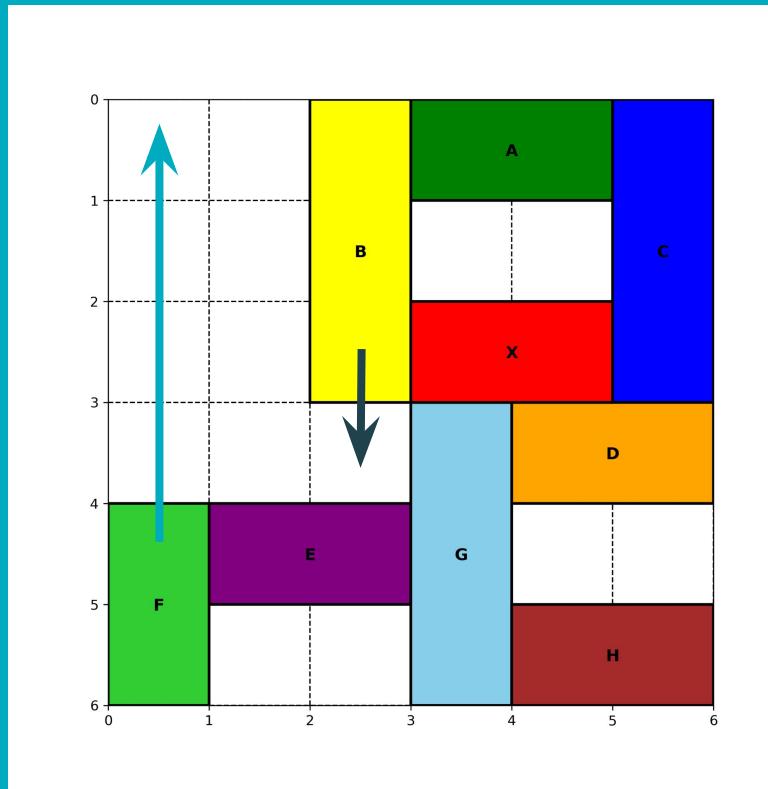
## Algoritmen

1. Breadth First
2. Random
3. A\*
4. StepRefiner

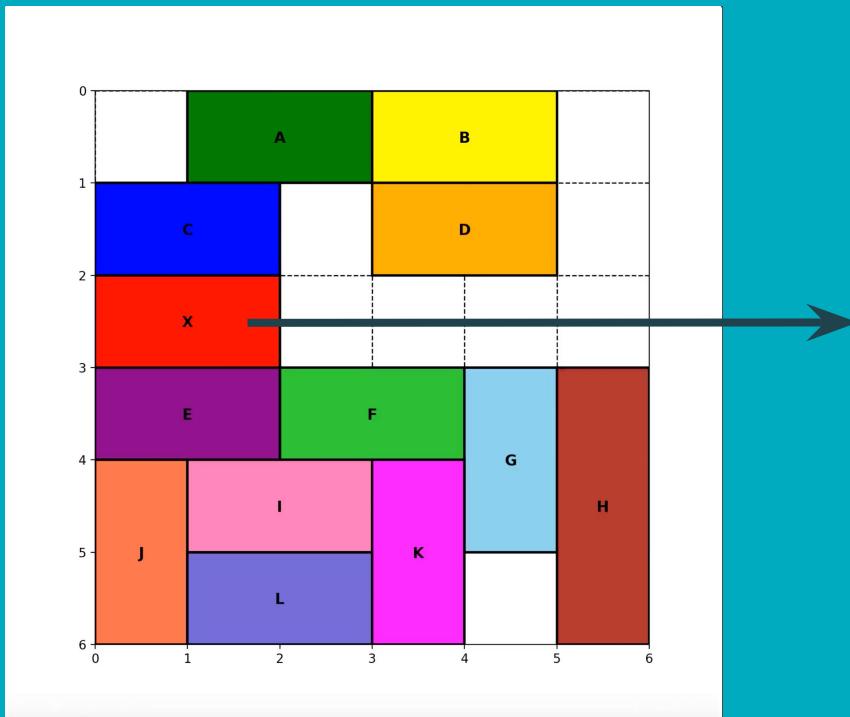
## Heuristieken

- **Max Move:** alleen max aantal stappen
- **Free Carter:** Carter vrije doorgang naar de uitgang heeft

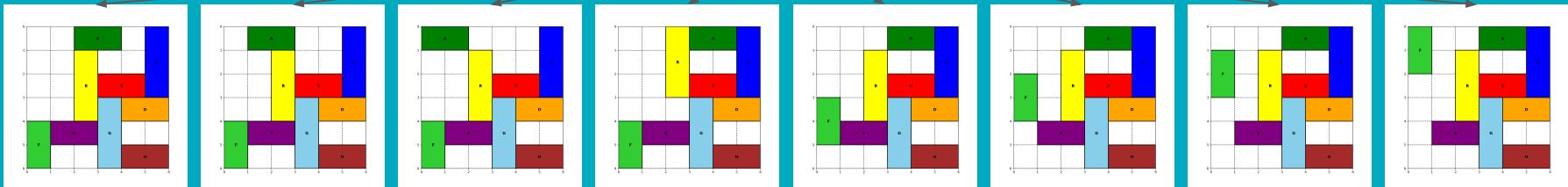
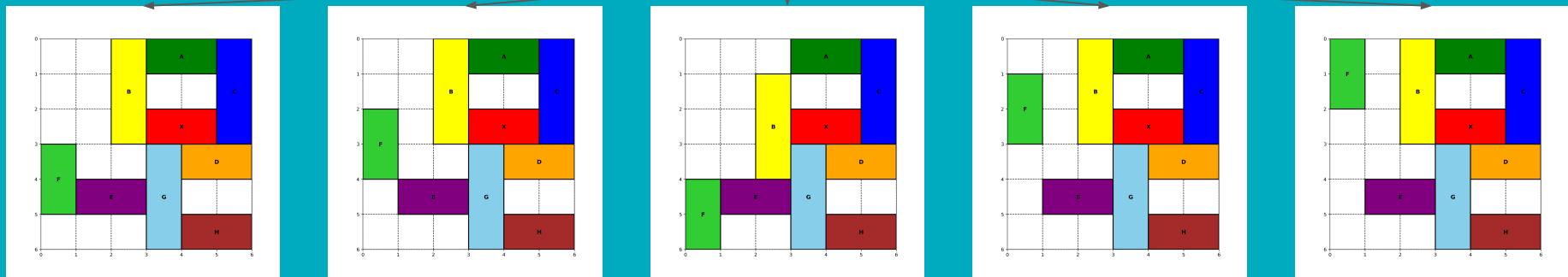
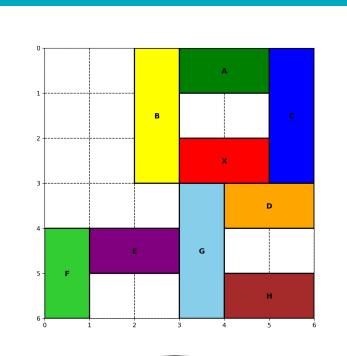
# Max Move



# Free Carter



EXIT

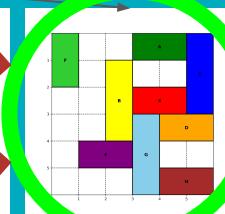
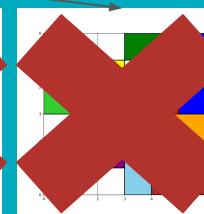
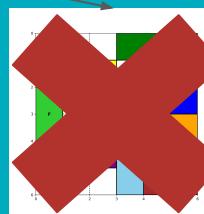
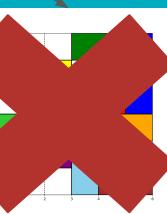
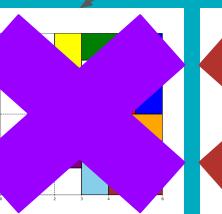
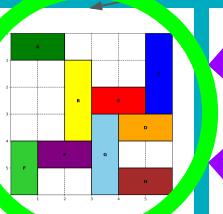
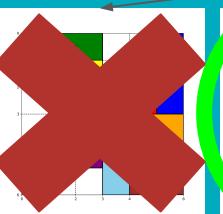
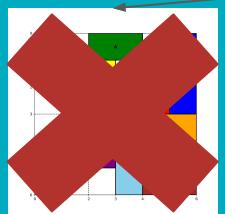
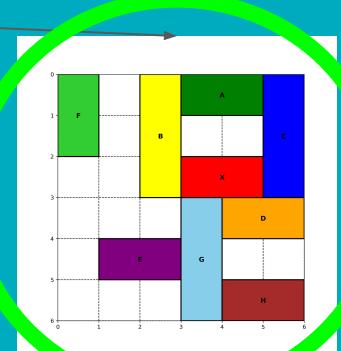
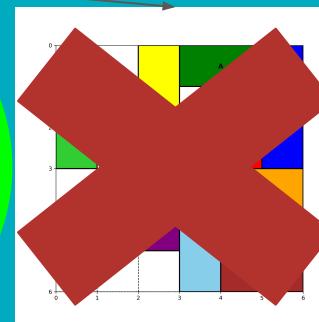
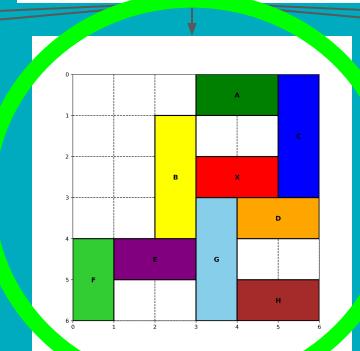
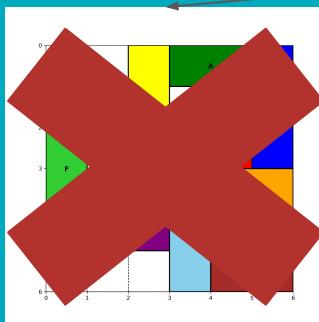
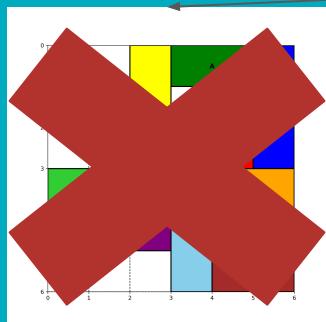
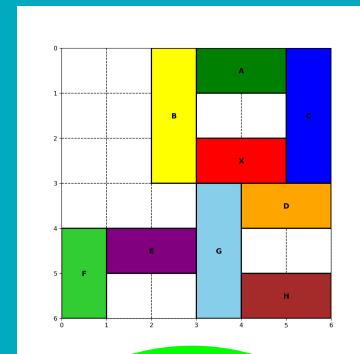




Max Move



Archief

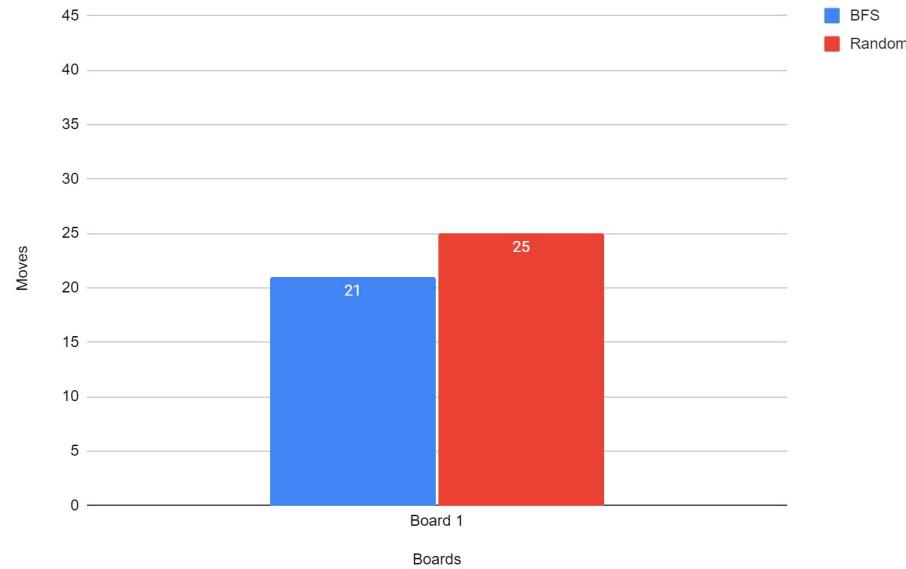




# Resultaten

## BFS vs Random

Moves to finish board



Average time to finish board

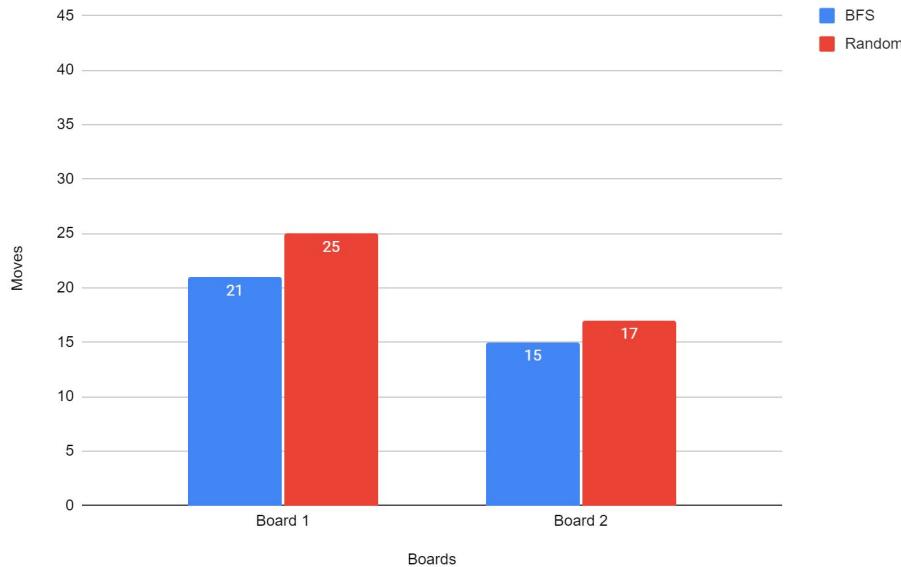




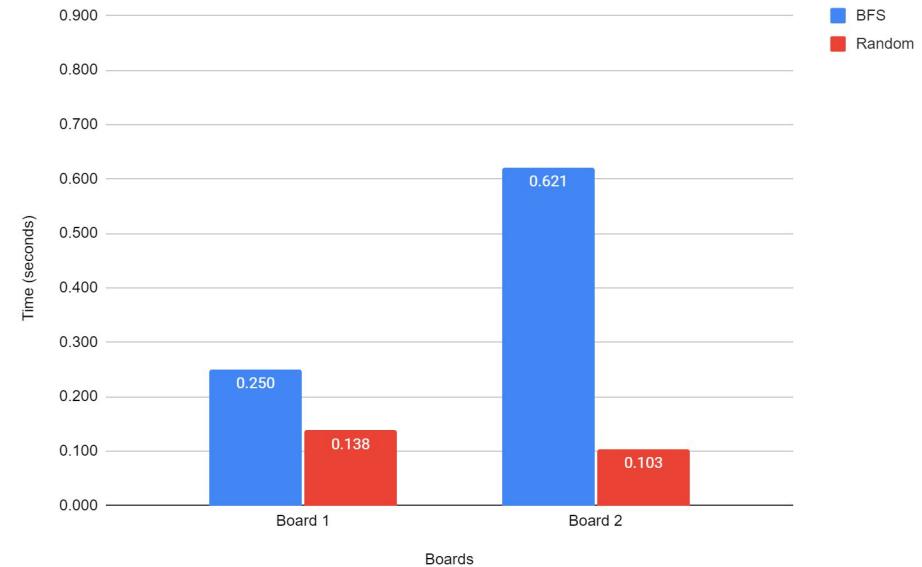
# Resultaten

## BFS vs Random

Moves to finish board



Average time to finish board

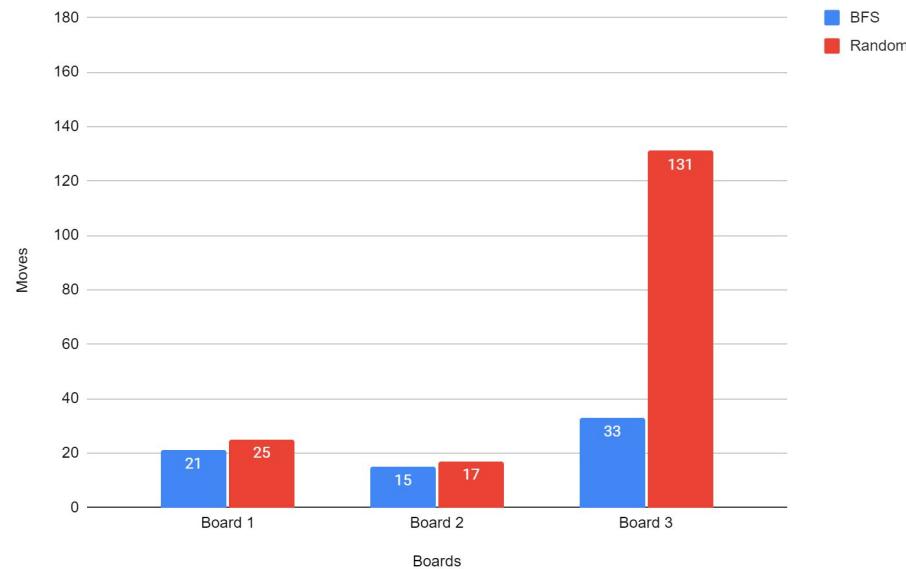




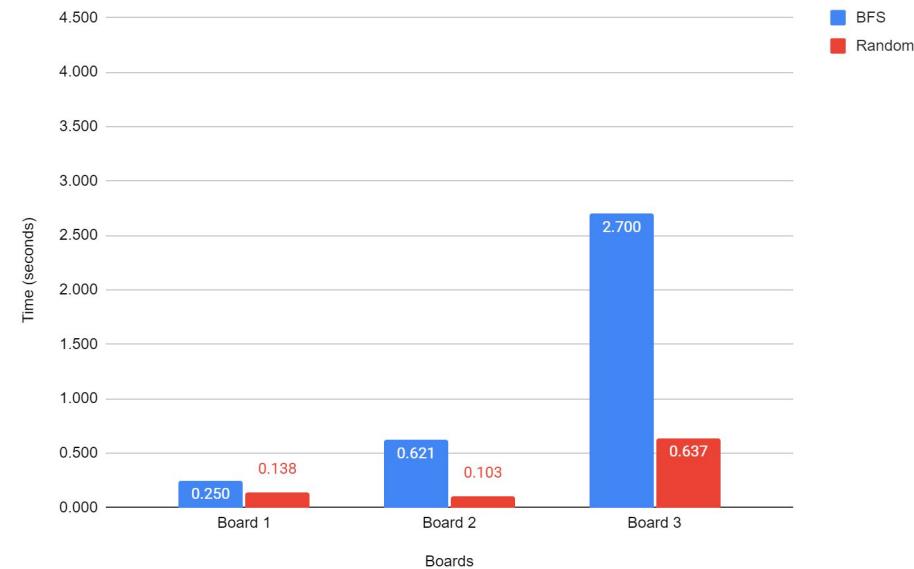
# Resultaten

## BFS vs Random

Moves to finish board



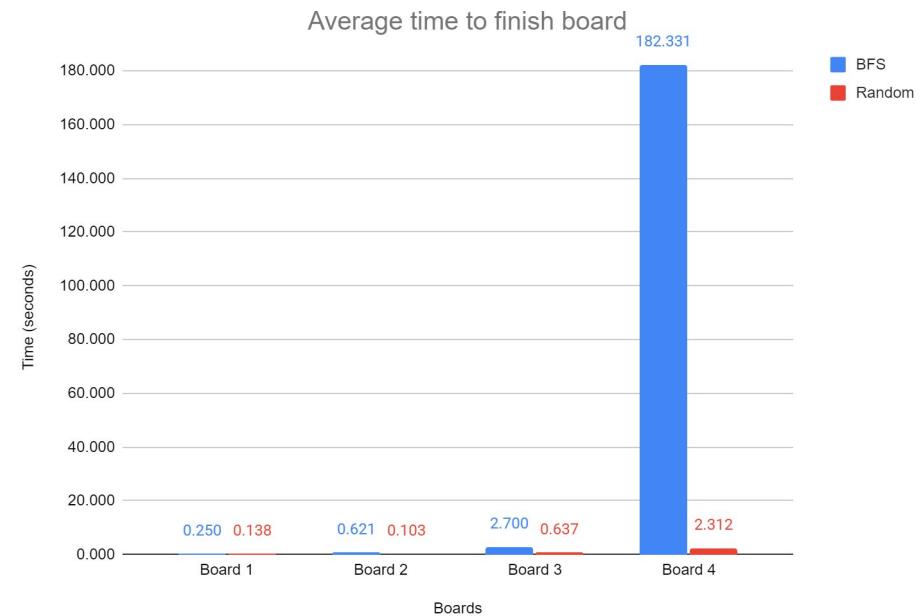
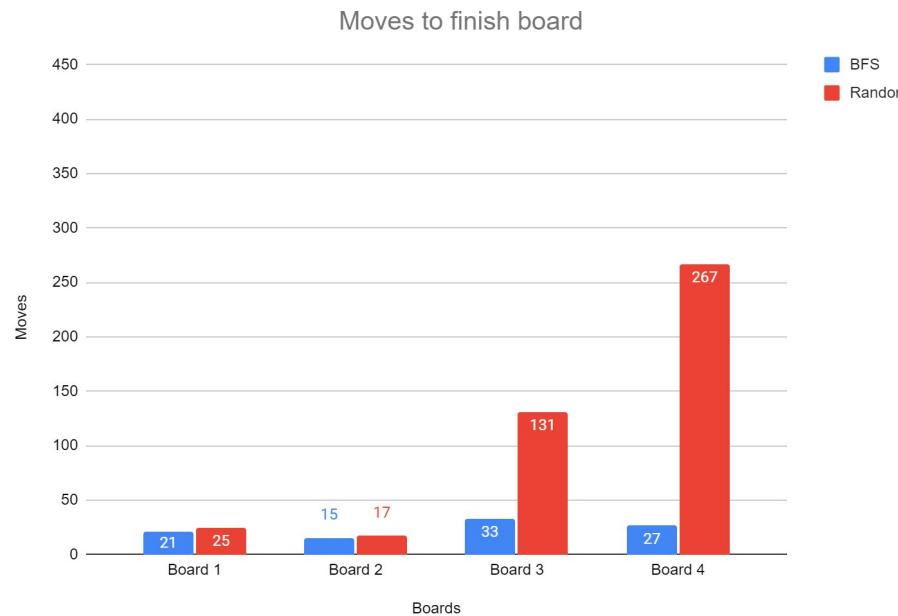
Average time to finish board





# Resultaten

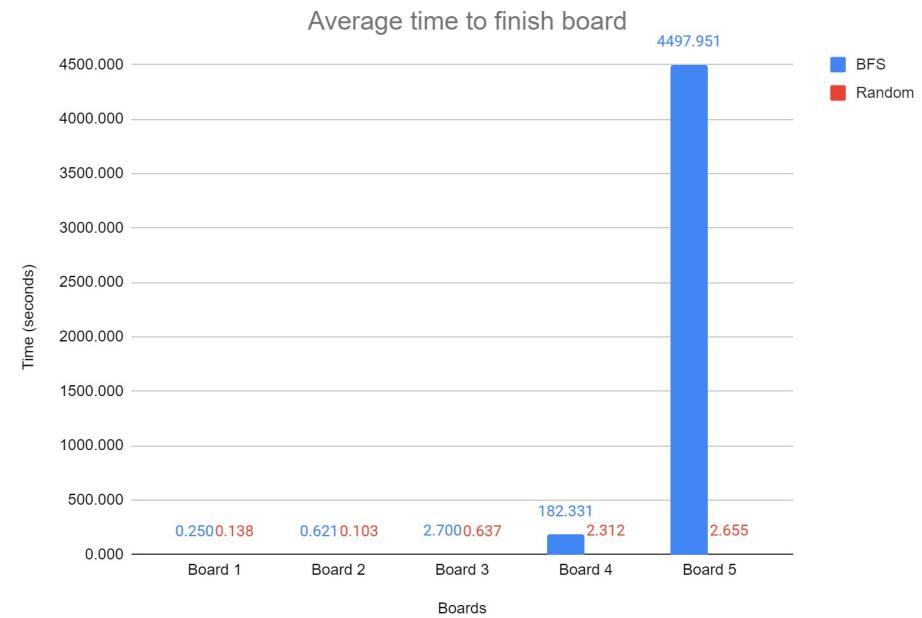
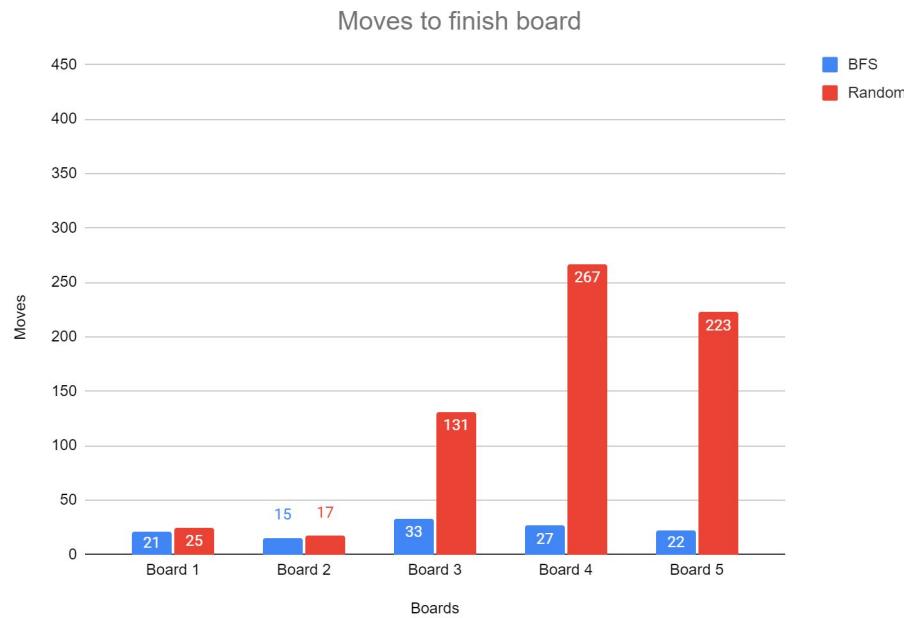
## BFS vs Random





# Resultaten

## BFS vs Random

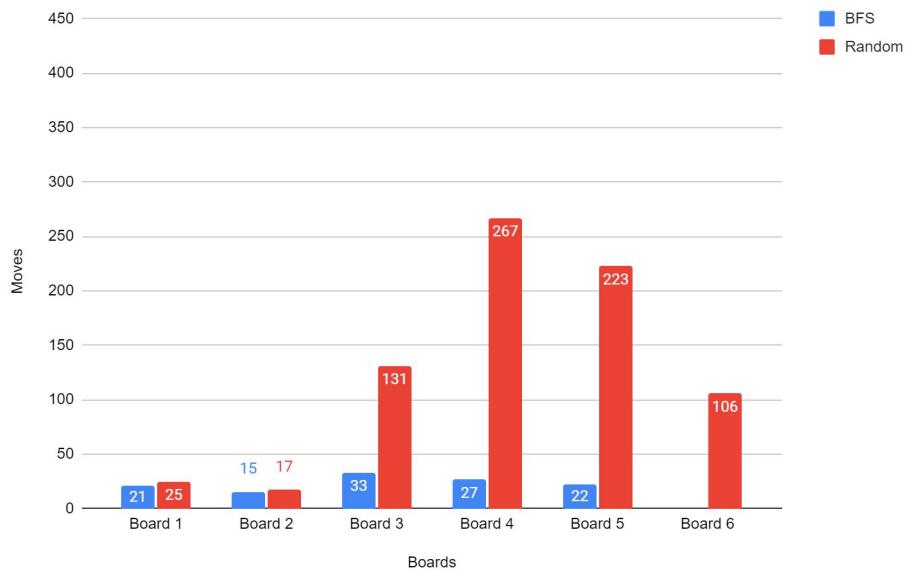




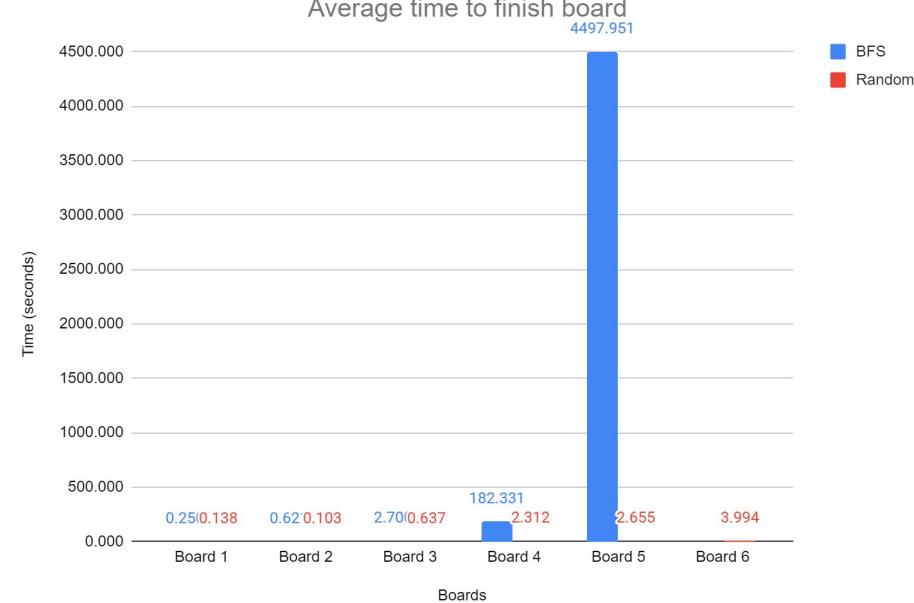
# Resultaten

## BFS vs Random

Moves to finish board



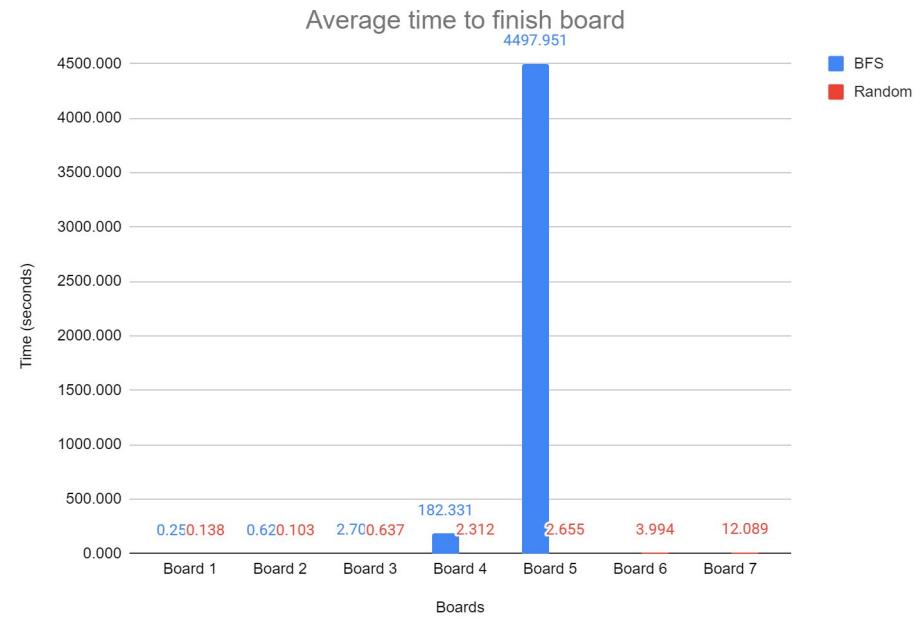
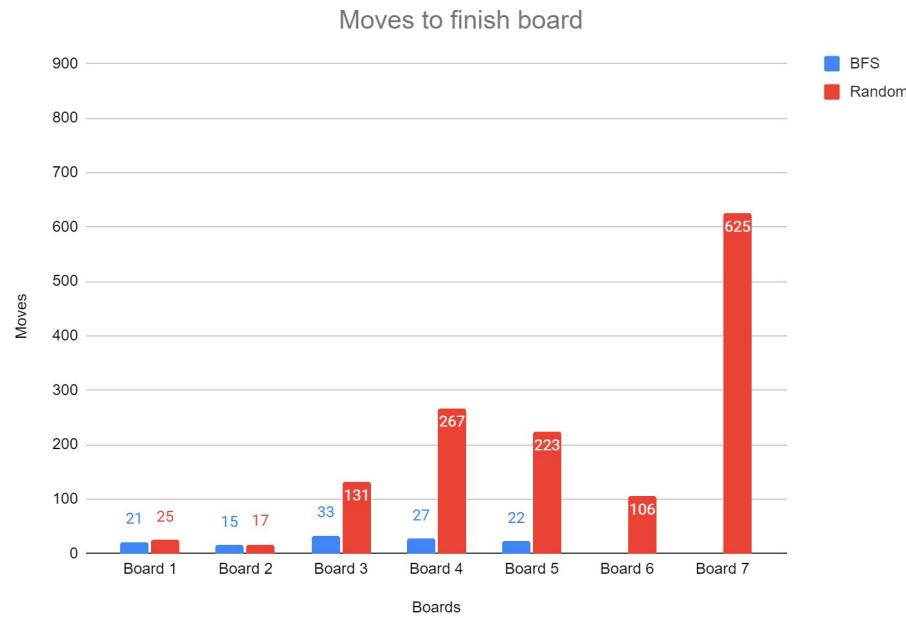
Average time to finish board





# Resultaten

## BFS vs Random



```
Number of seen states: 4100000, Number of moves made: 16
Number of seen states: 4150000, Number of moves made: 16
Number of seen states: 4200000, Number of moves made: 16
Number of seen states: 4250000, Number of moves made: 16
Number of seen states: 4300000, Number of moves made: 16
Number of seen states: 4350000, Number of moves made: 16
Number of seen states: 4400000, Number of moves made: 16
Number of seen states: 4450000, Number of moves made: 16
Number of seen states: 4500000, Number of moves made: 16
Number of seen states: 4550000, Number of moves made: 16
Number of seen states: 4600000, Number of moves made: 16
Number of seen states: 4650000, Number of moves made: 16
Number of seen states: 4700000, Number of moves made: 16
Number of seen states: 4750000, Number of moves made: 16
Number of seen states: 4800000, Number of moves made: 16
Number of seen states: 4850000, Number of moves made: 16
Number of seen states: 4900000, Number of moves made: 16
Number of seen states: 4950000, Number of moves made: 16
Number of seen states: 5000000, Number of moves made: 16
Number of seen states: 5050000, Number of moves made: 16
Number of seen states: 5100000, Number of moves made: 16
Number of seen states: 5150000, Number of moves made: 16
zsh: killed    python -m scripts.breadth_first_script 'RushHour9x9_6.csv'
```



Is er een middenweg tussen...

Accuraatheid

vs.

Snelheid



# Zoektocht naar middenweg

A\* werd geboren...!

...en zijn broertje **Step Refiner**



# A\*

- Min heap
- Max move
- Free Carter

**Score:** diepte + aantal voertuigen voor Carter



# StepRefiner

Bord setup:  
zet 0



zet 3



zet 13



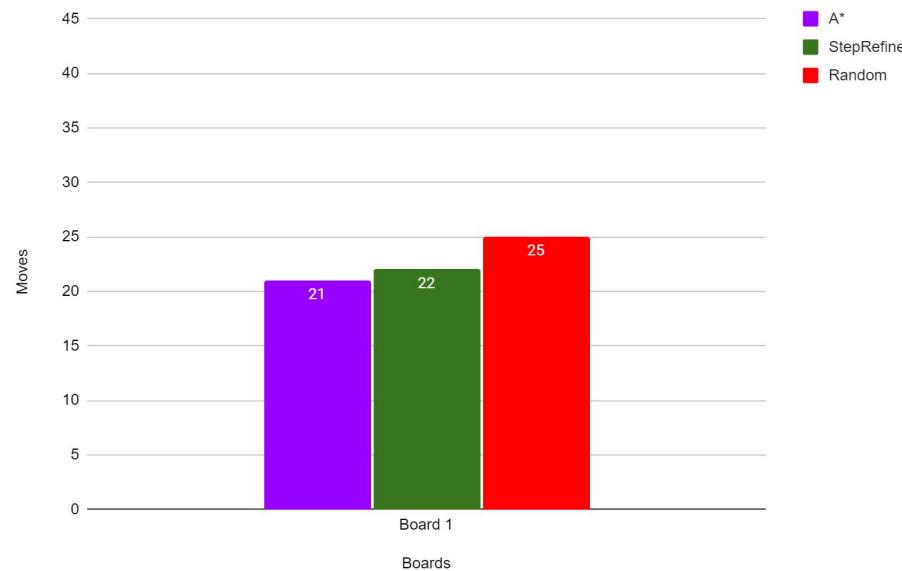
Oplossing:  
zet 23



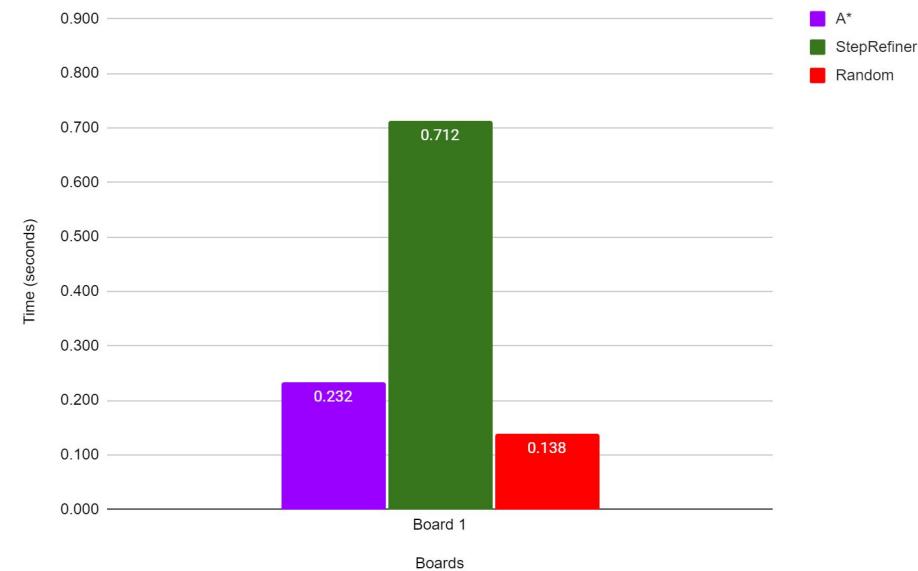
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

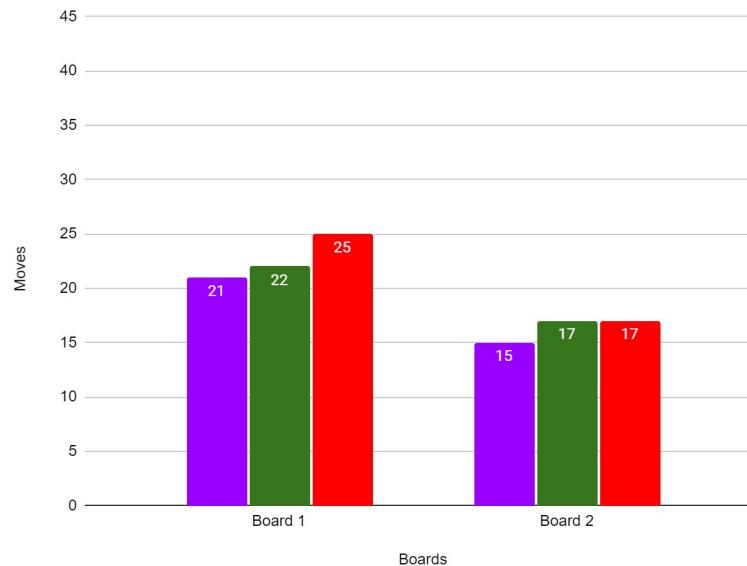




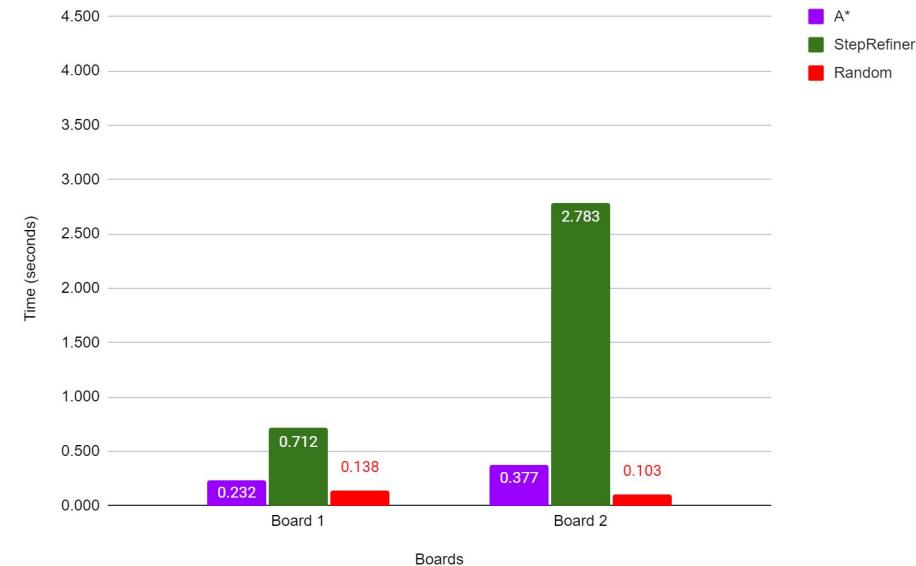
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

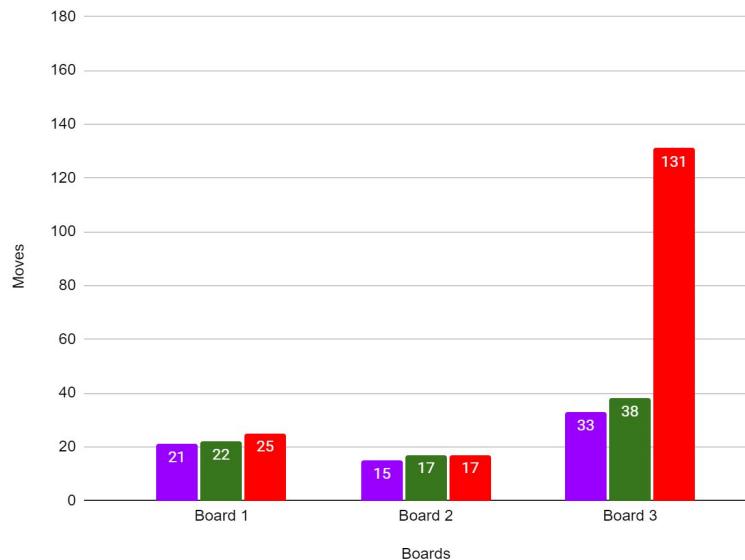




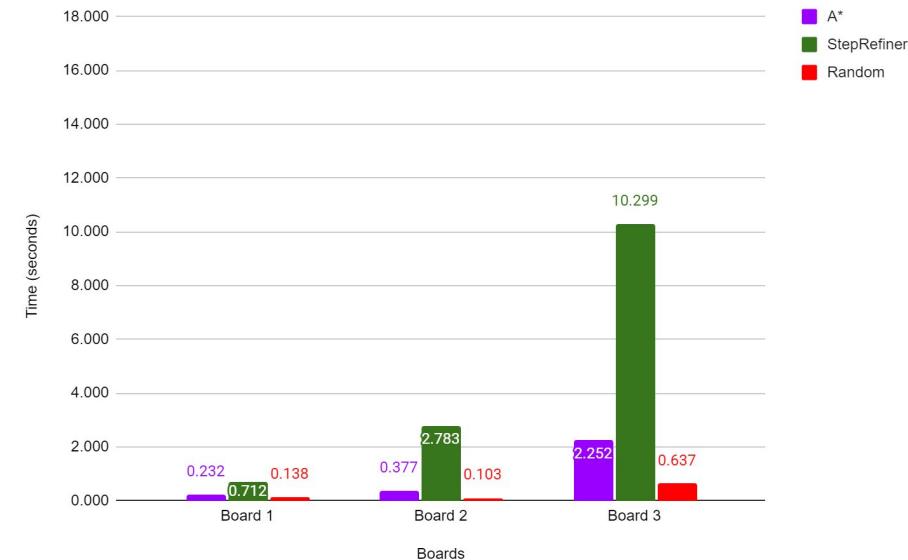
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

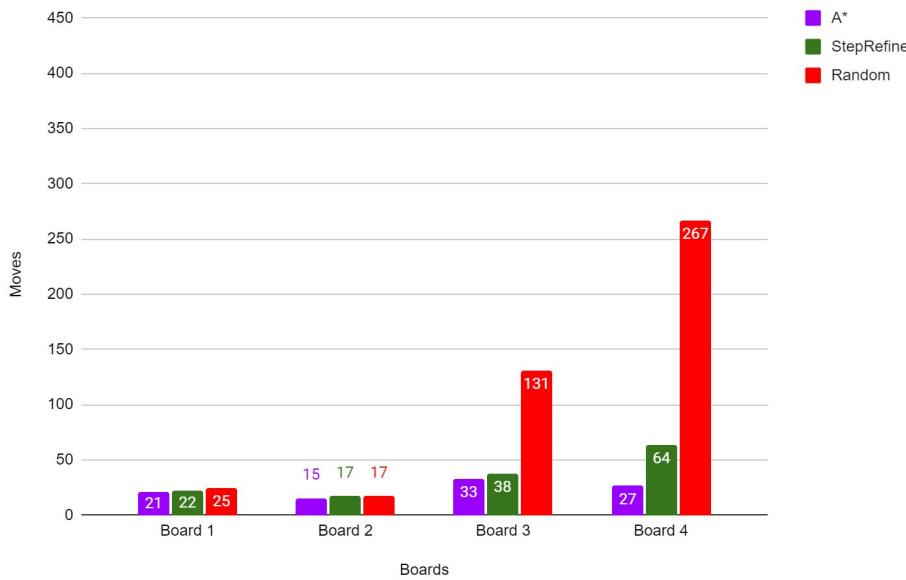




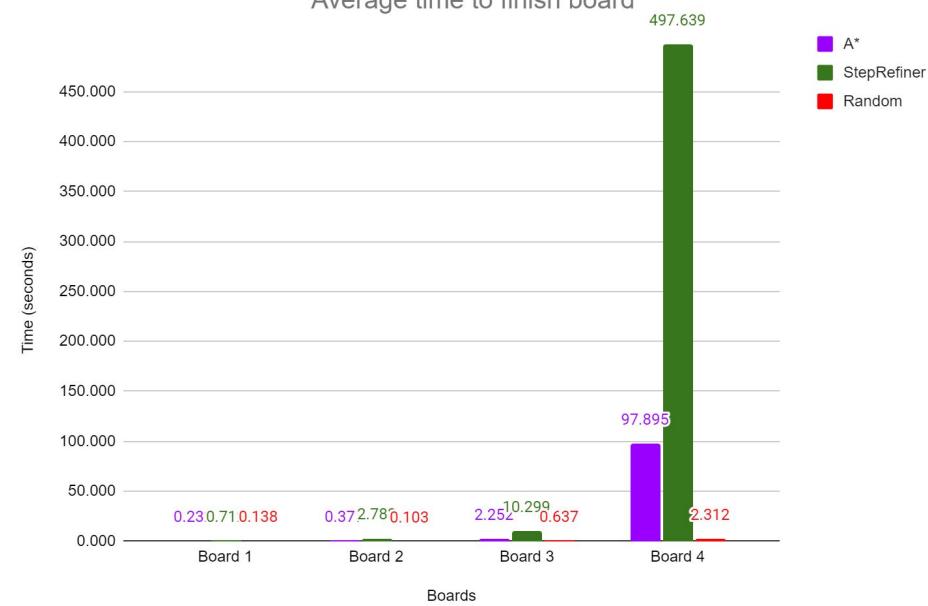
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

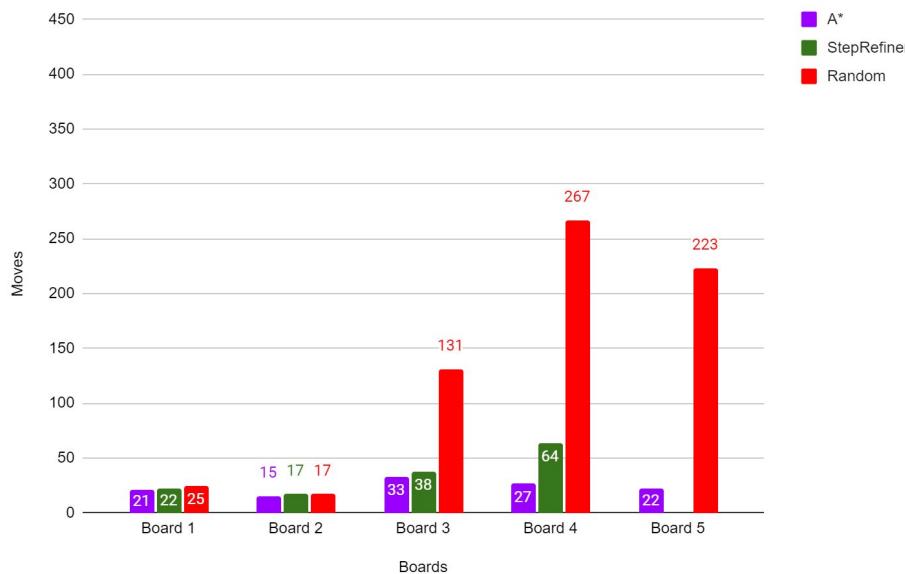




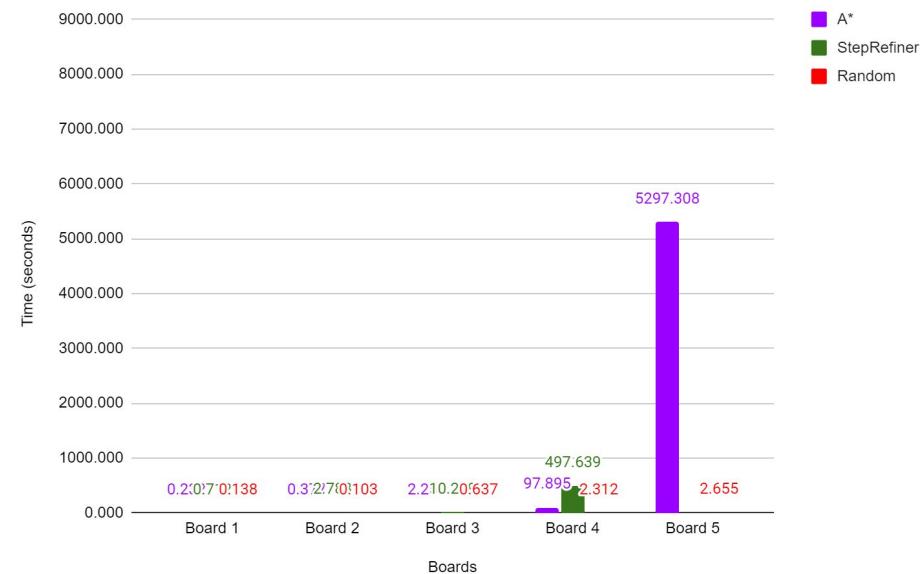
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

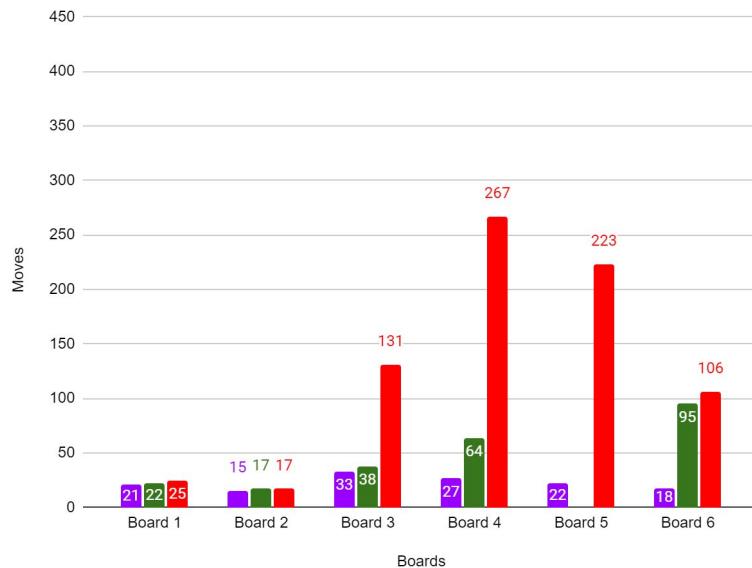




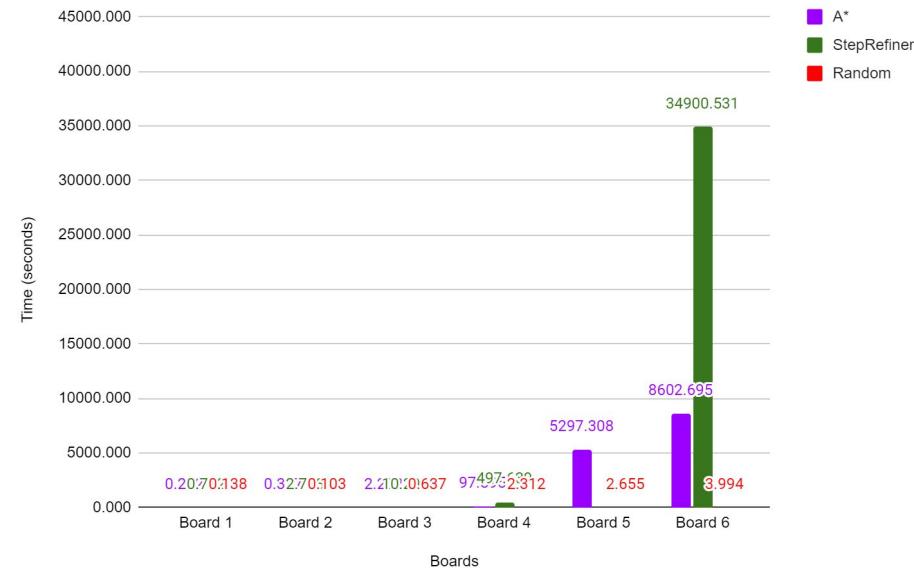
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board

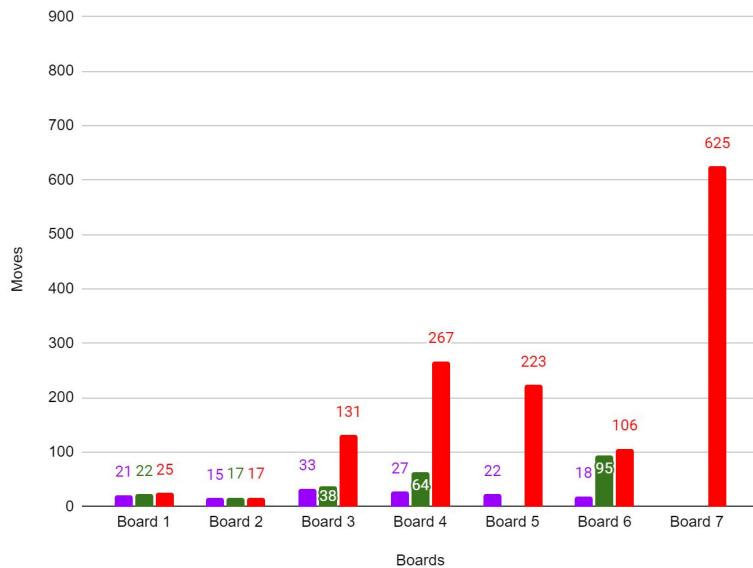




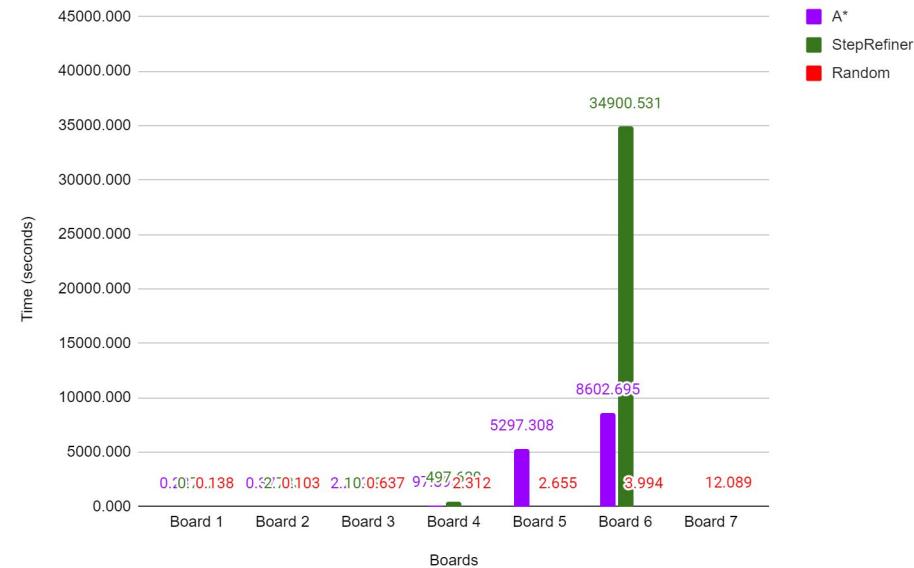
# Resultaten

## Random vs A\* vs StepRefiner

Moves to finish board



Average time to finish board





# Conclusie

- **Random** is altijd het snelst
- Op 6x6 bord zijn **BFS** en **A\*** acceptabel snel en accuraat
- **A\*** werkt met onze heuristieken beter dan BFS
- **StepRefiner** leuke poging geen prijs



# Future work

- Slimmere heuristieken
  - Slimmere score **A\***
- Algoritmes efficiënter maken
- Tussentijdse oplossingen opslaan
- Parallel door de boom lopen bij **A\*** en **BFS**



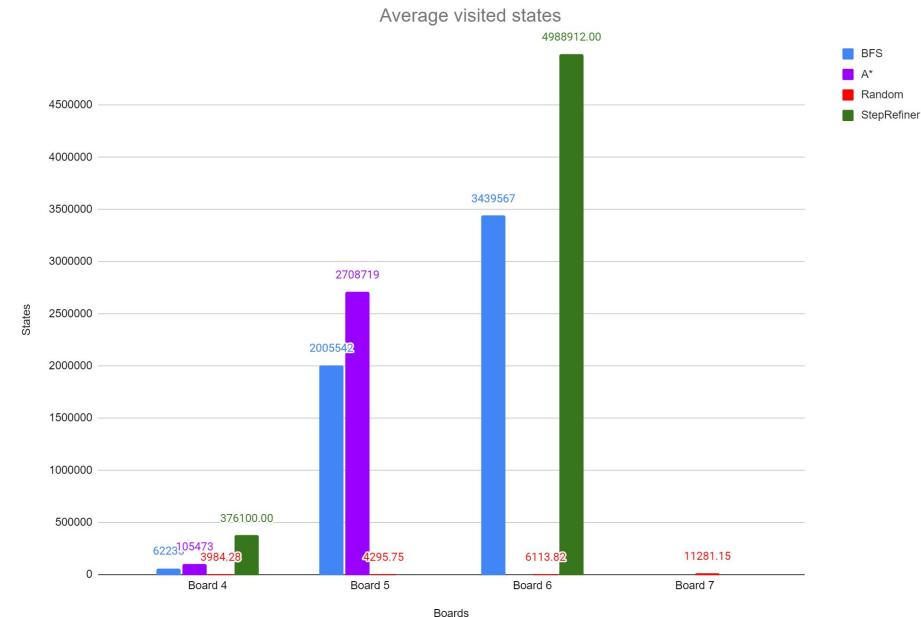
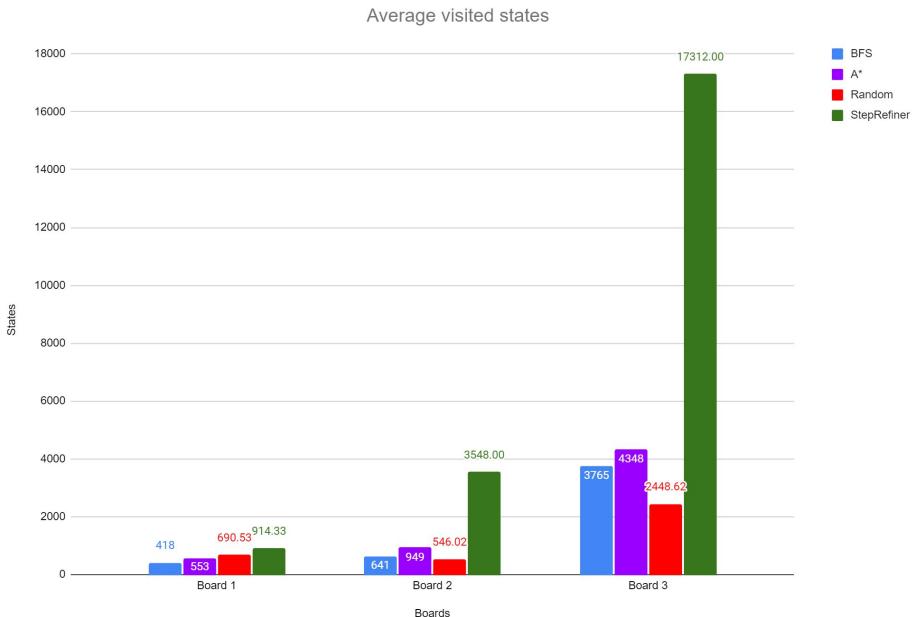
# Rush Hour

Team Carter

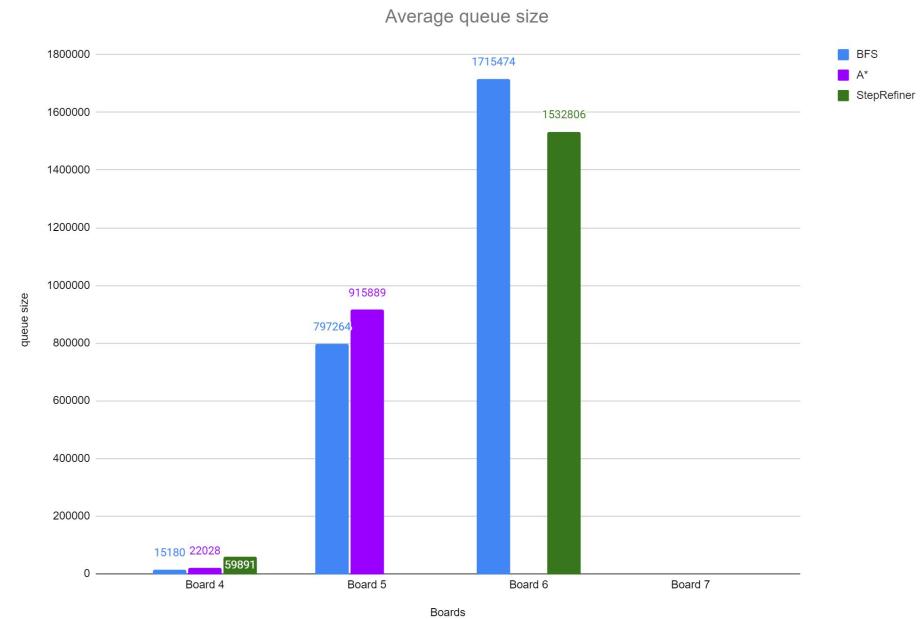
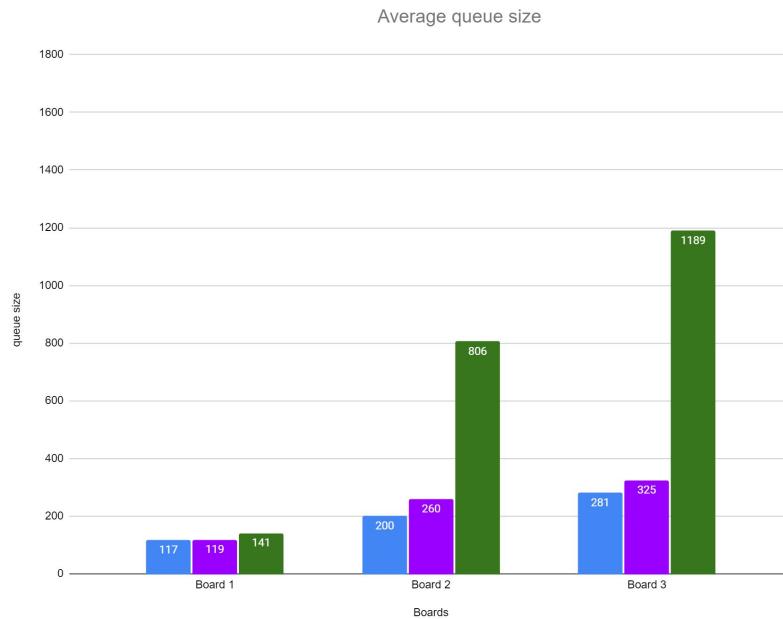
Eindpresentatie



# Average visited states



# Average max queue size

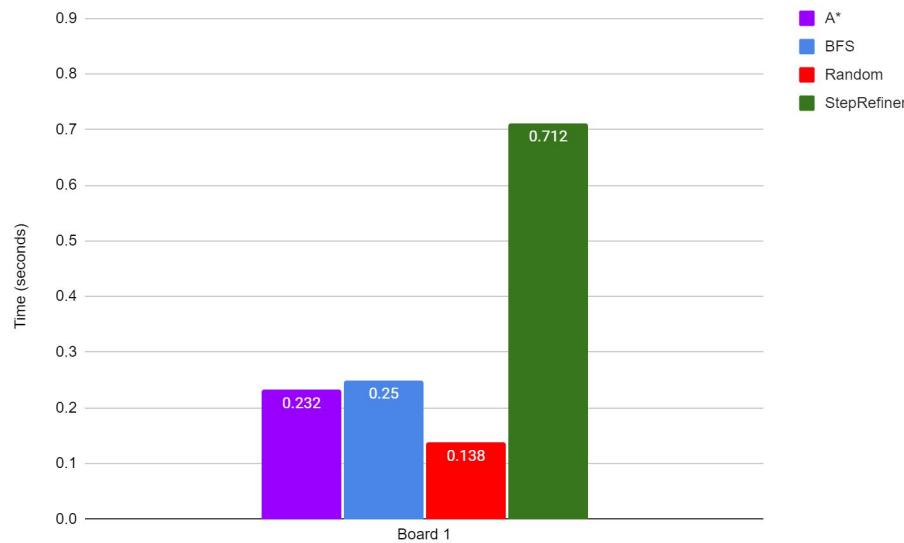




# Board 1

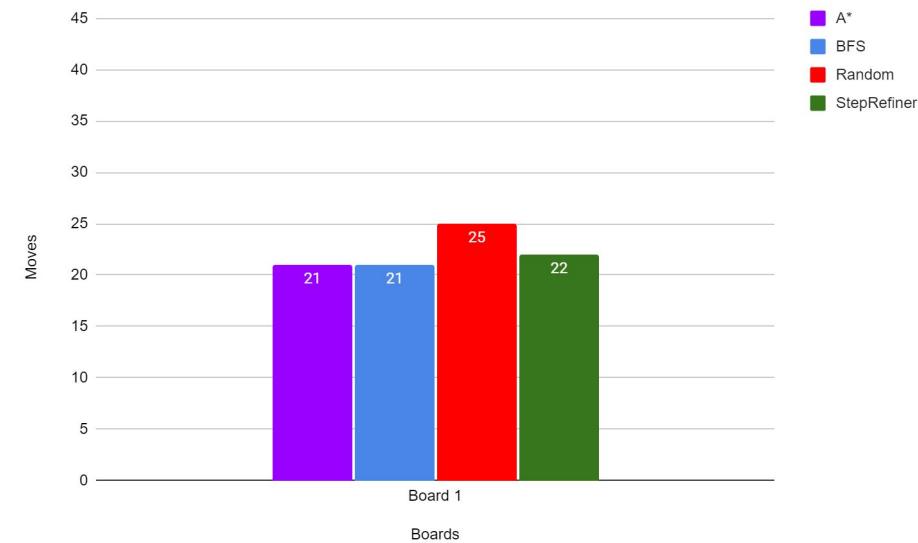
Average time to finish board

Board 1



Moves to finish board

Board 1

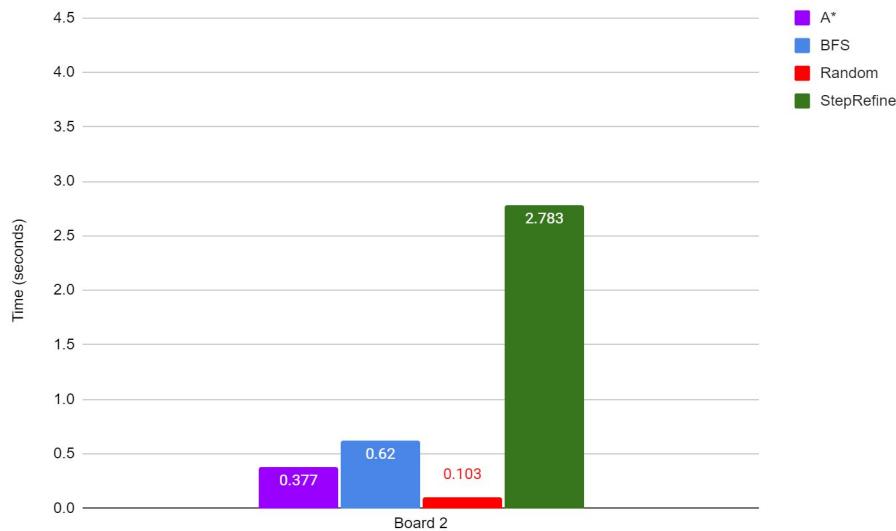




# Board 2

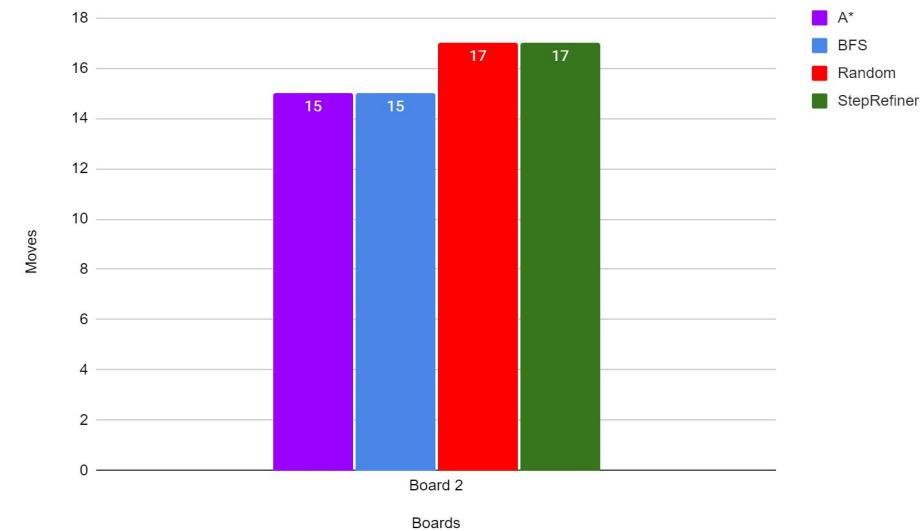
Average time to finish board

Board 2



Moves to finish board

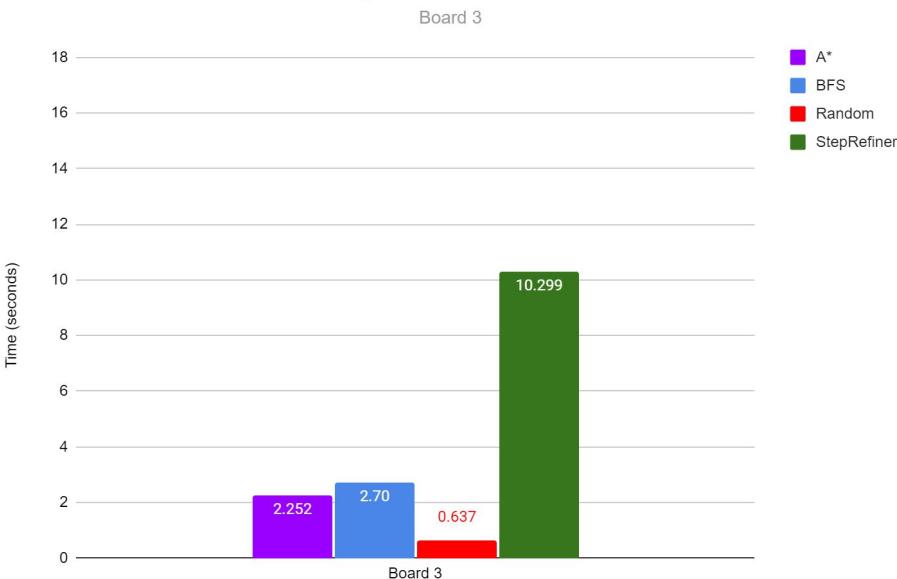
Board 2



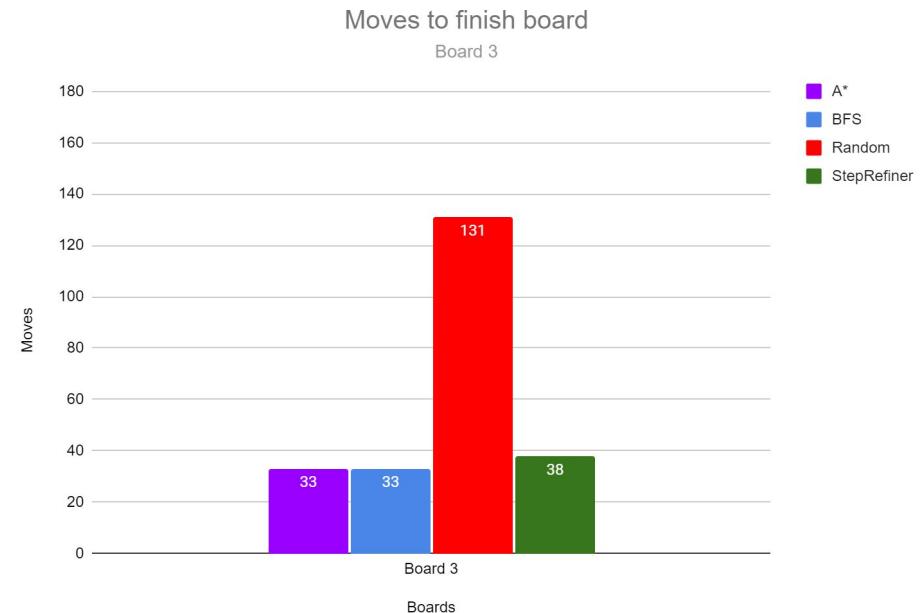


# Board 3

Average time to finish board



Moves to finish board

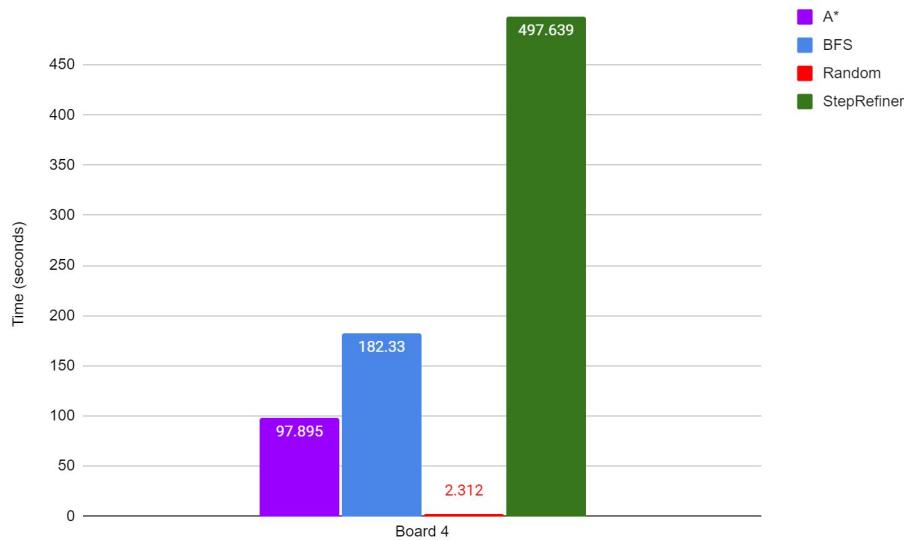




# Board 4

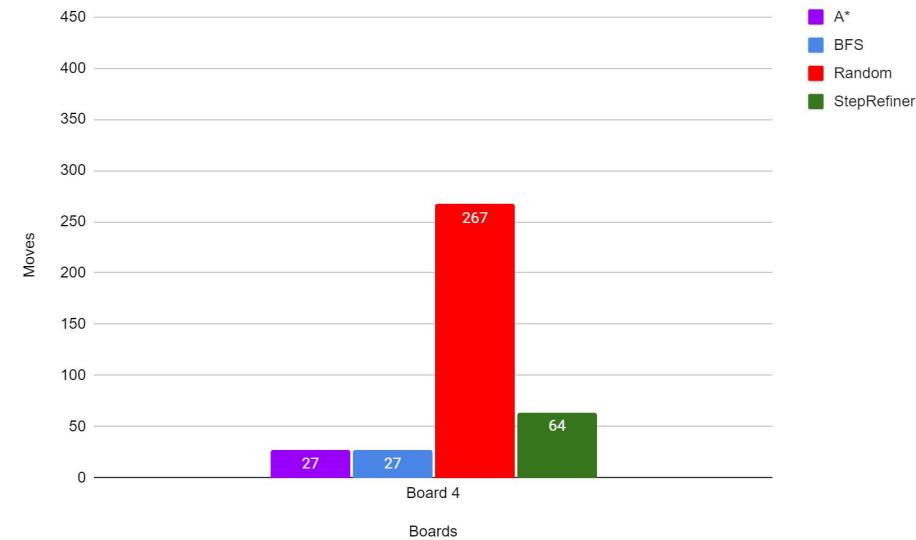
Average time to finish board

Board 4



Moves to finish board

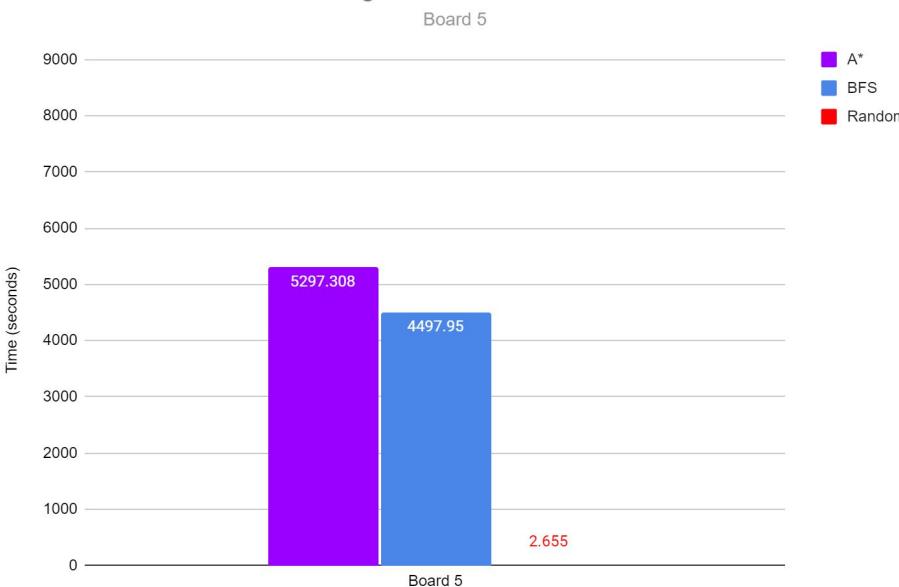
Board 4



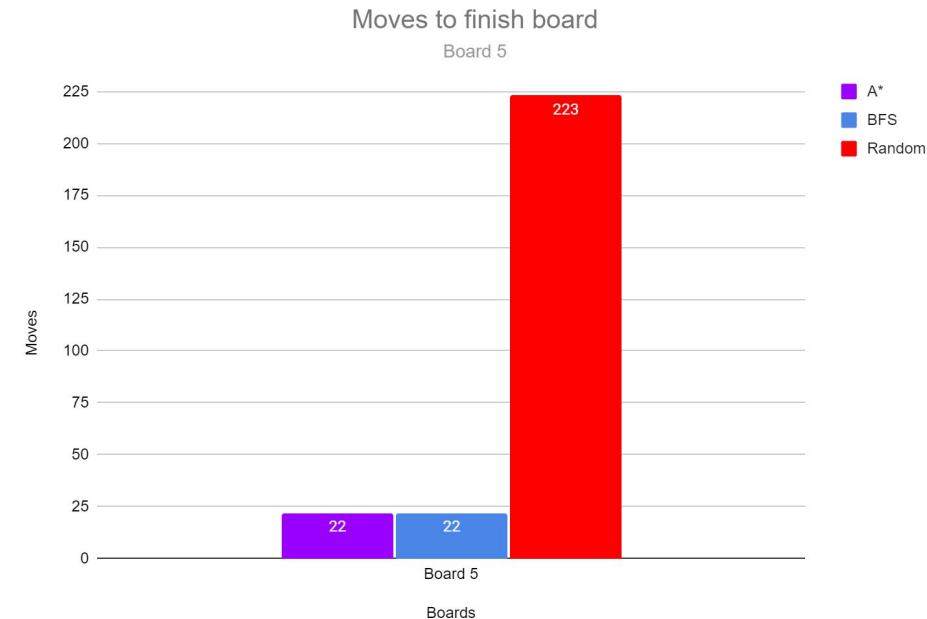


# Board 5

Average time to finish board



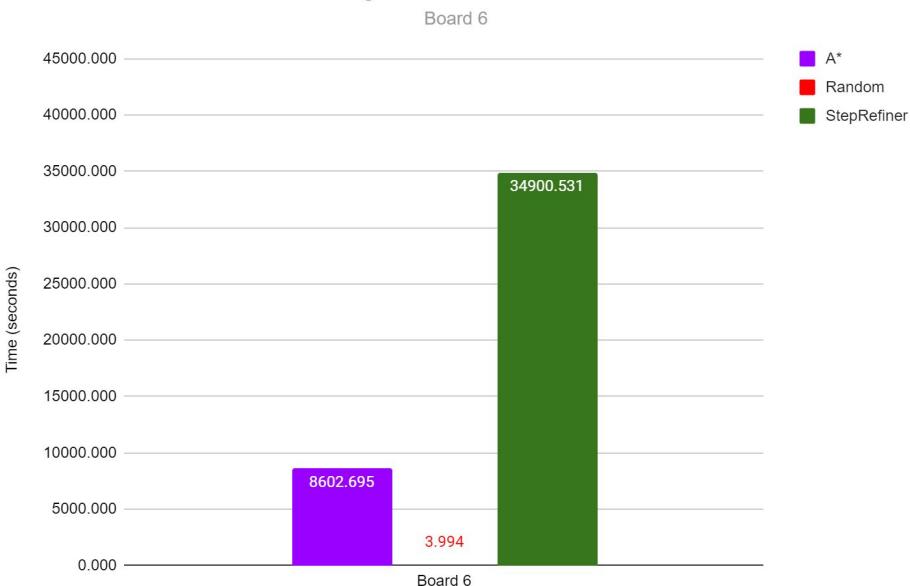
Moves to finish board



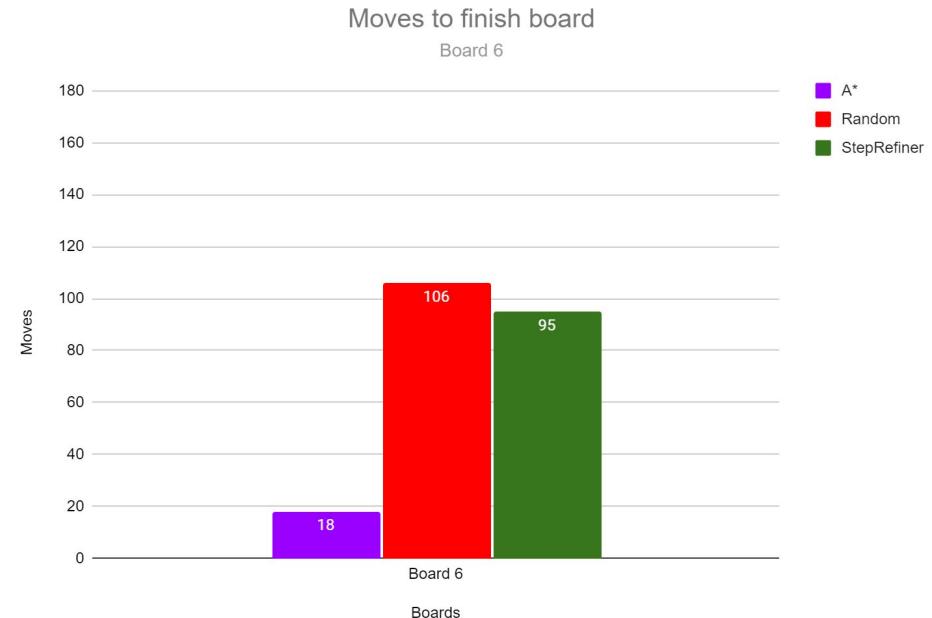


# Board 6

Average time to finish board



Moves to finish board





# Board 7

