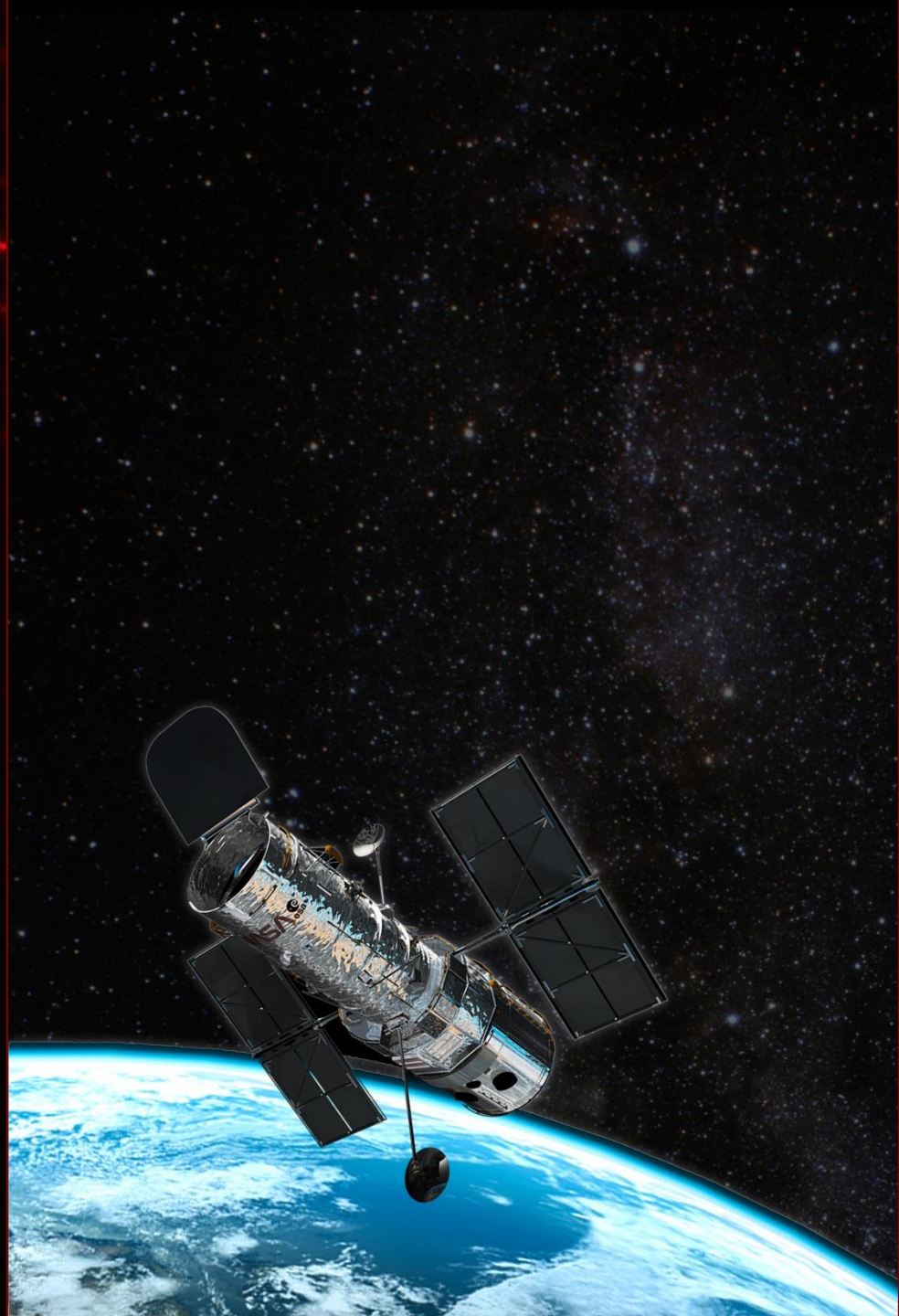
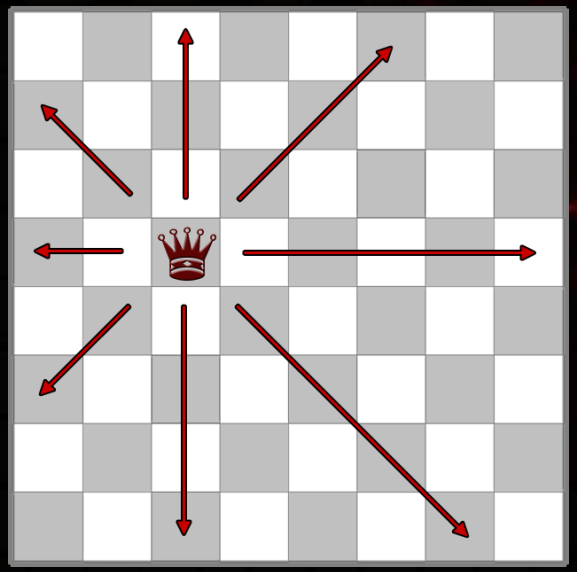
heuristische Constructieve Algoritmes

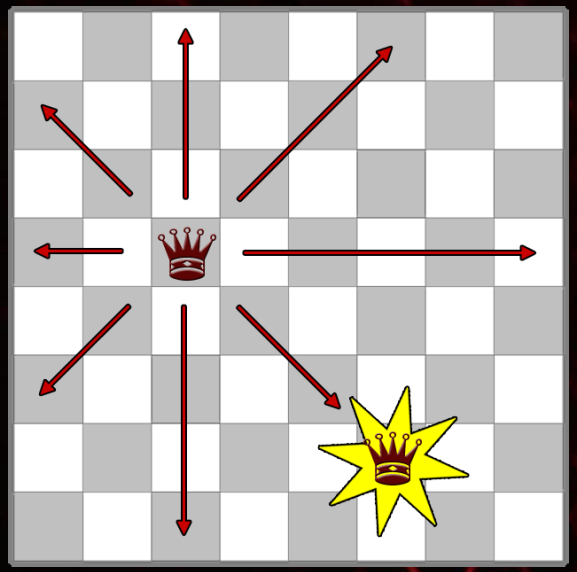
“Looking ahead in state-space”

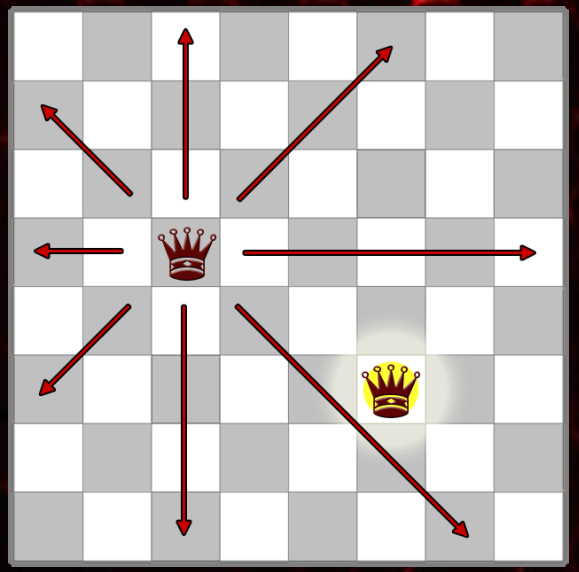


Daan van den Berg
Editie 0.99c, November 2015, MinProg, UvA

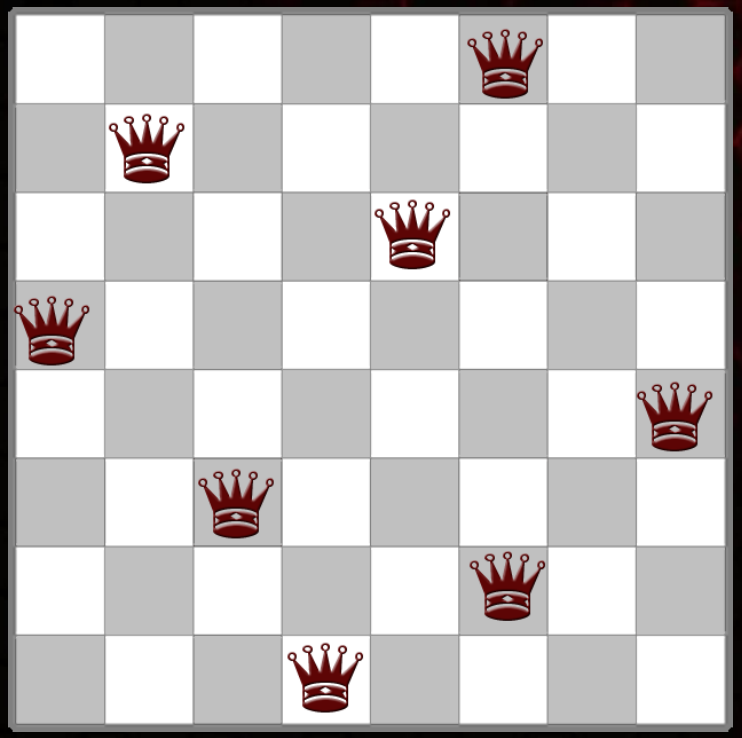
heuristische Depth-first search

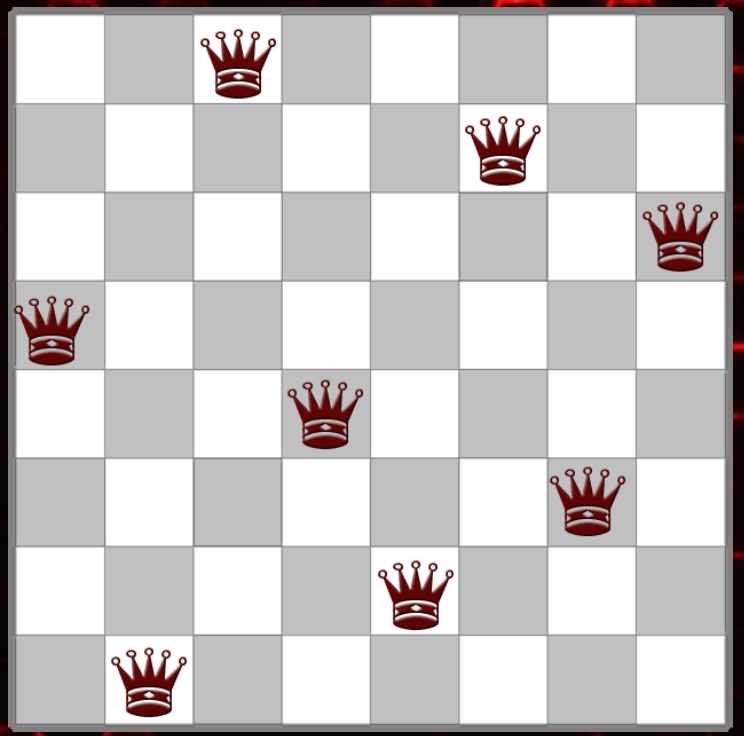






heuristische Depth-first search

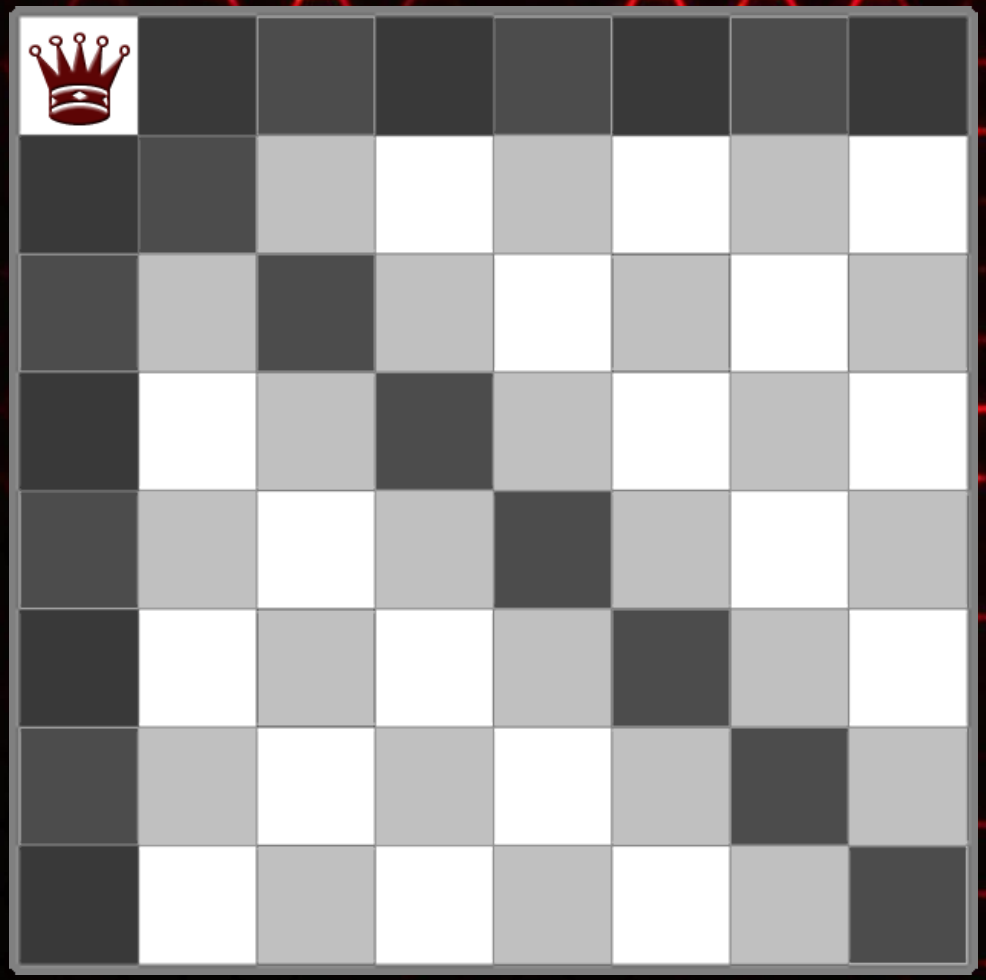




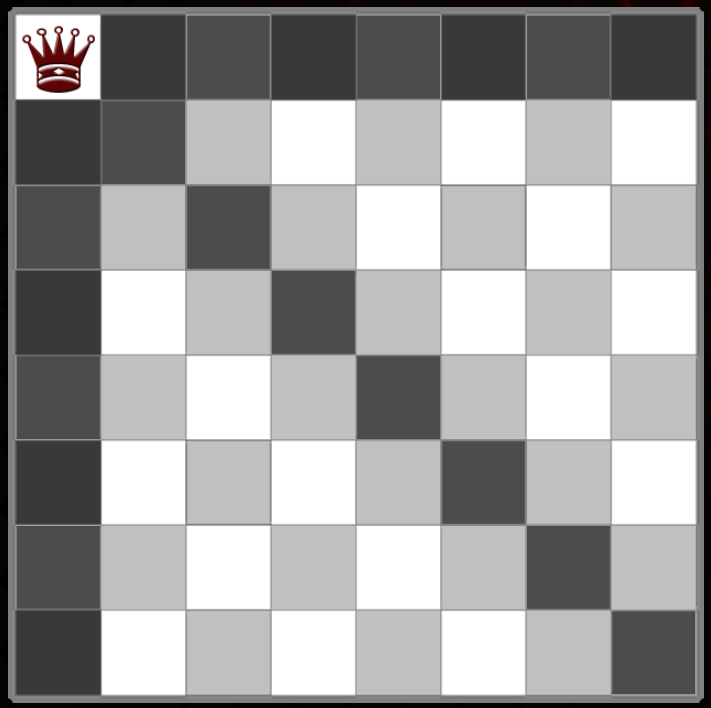
- 2 van de 12 *fundamentele* oplossingen (92 totaal)

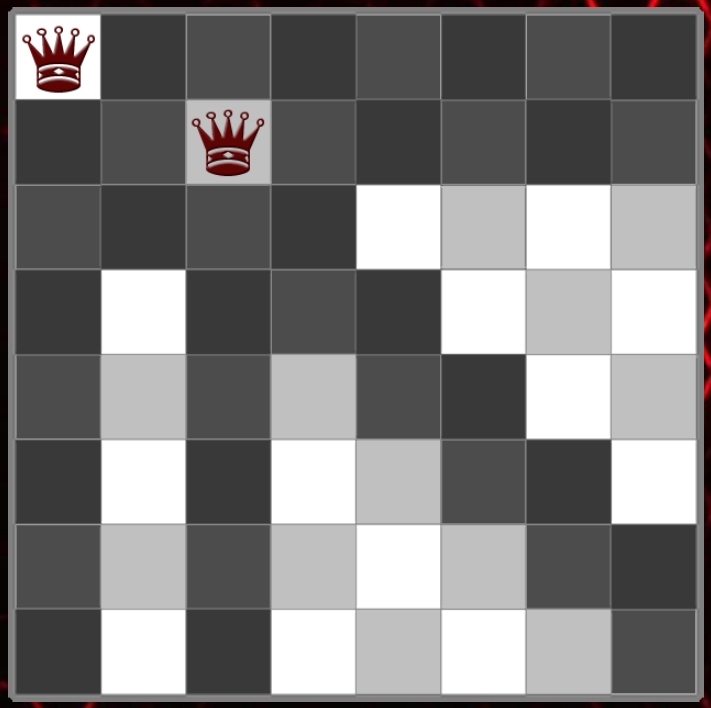
heuristische Depth-first search

- Open velden
- Afgedekte velden



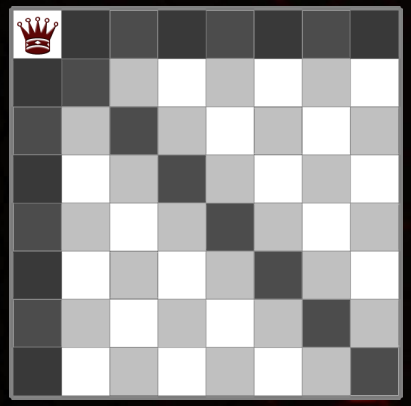
heuristische Depth-first search

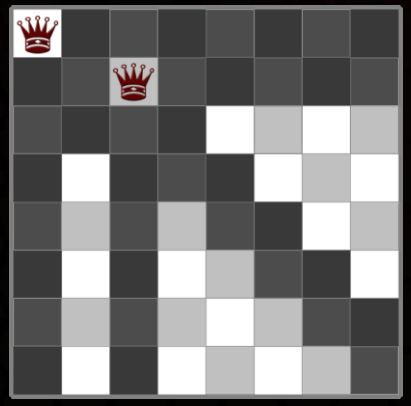


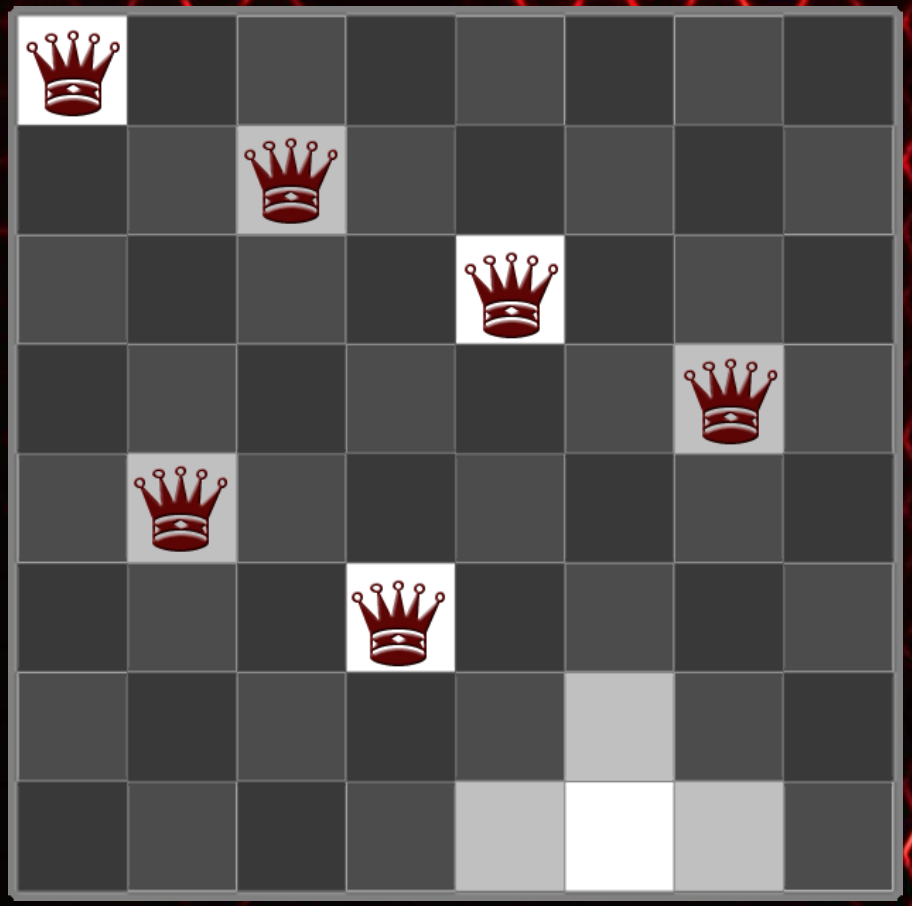


Normale depth-first search

heuristische Depth-first search





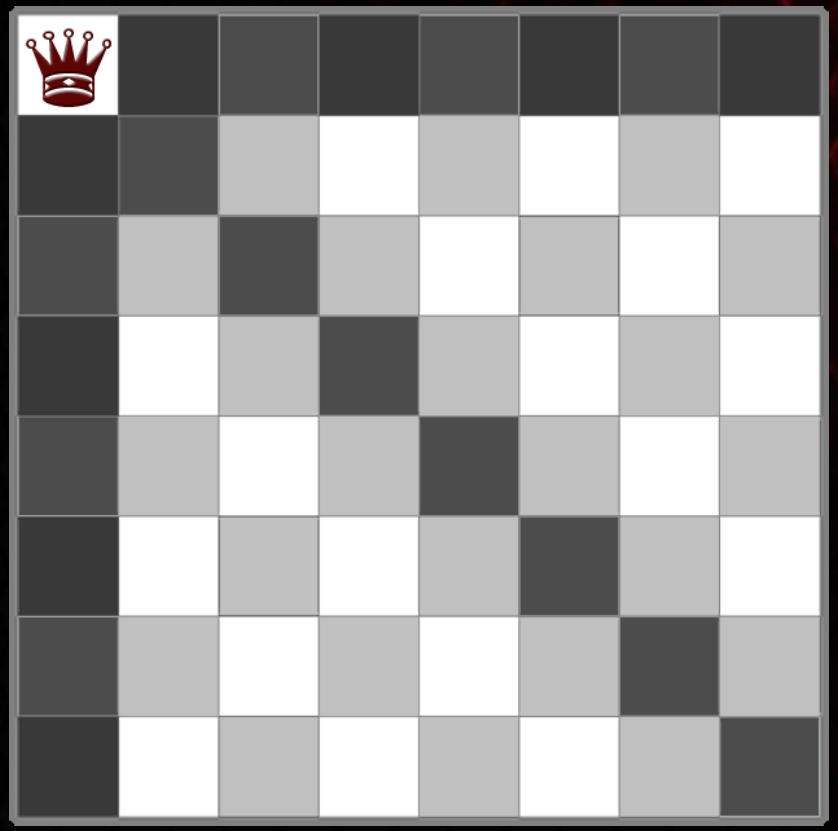


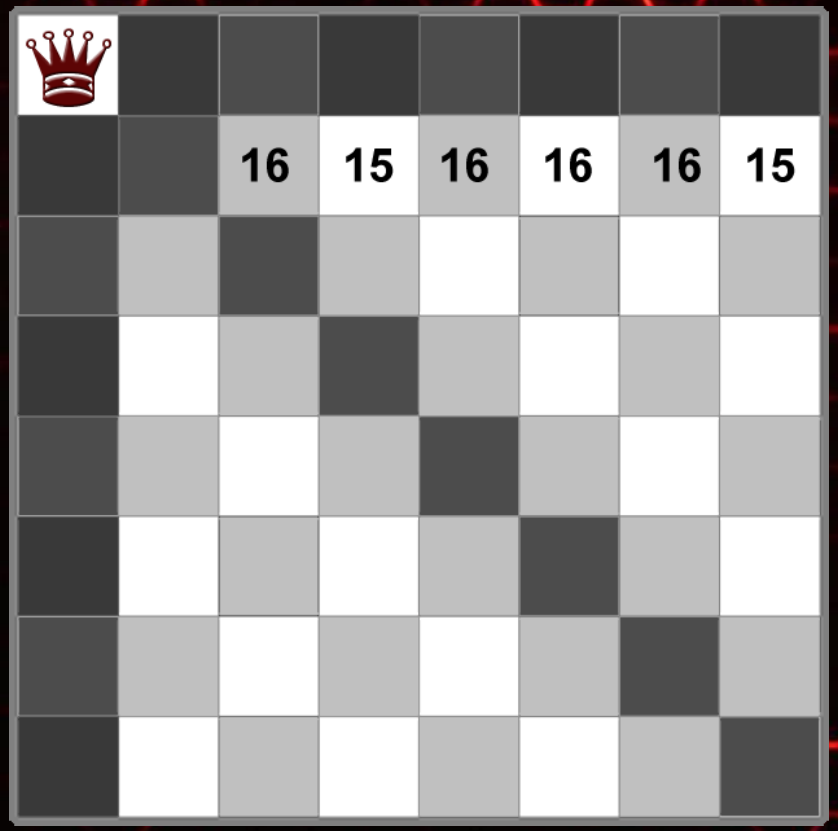
Normale depth-first search

heuristische Depth-first search

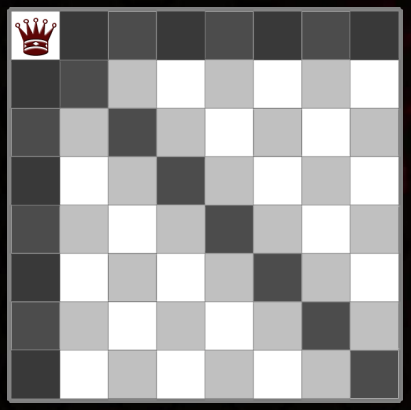
- Heuristiek: plaats nieuwe koningin zo in de rij, dat er zo min mogelijk open velden afgedekt worden.
- Verwachting: eerder een oplossing.
- quasilogica, gokken, wadlopen, voodoo.
- Kosteloos?

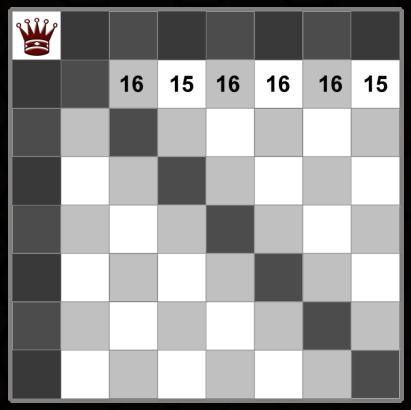
heuristische Depth-first search

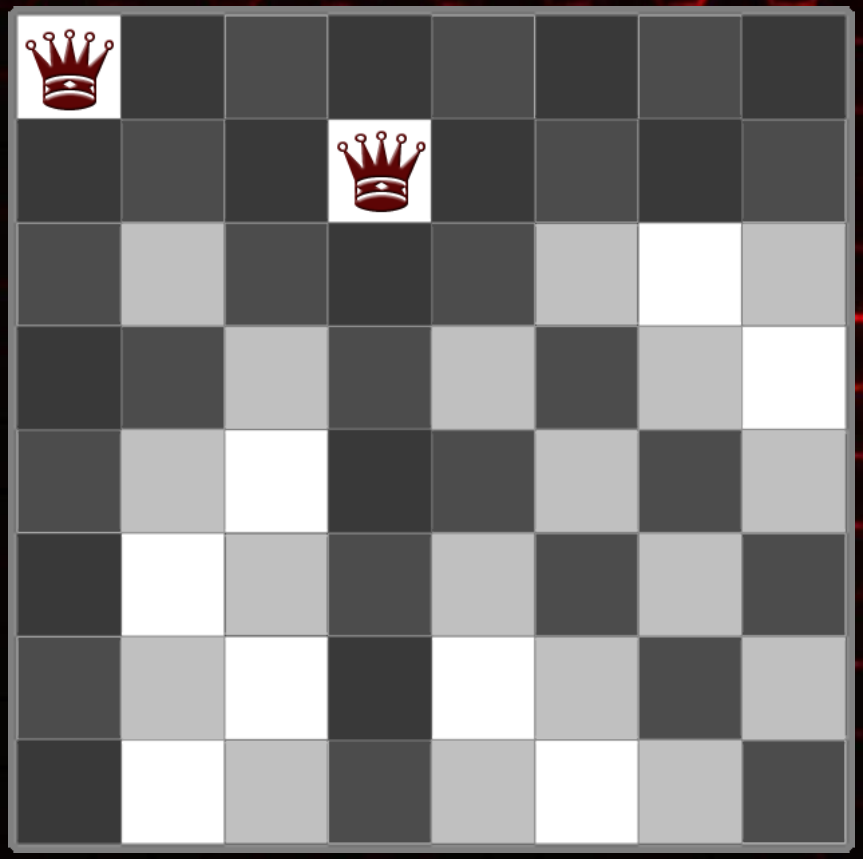




heuristische Depth-first search

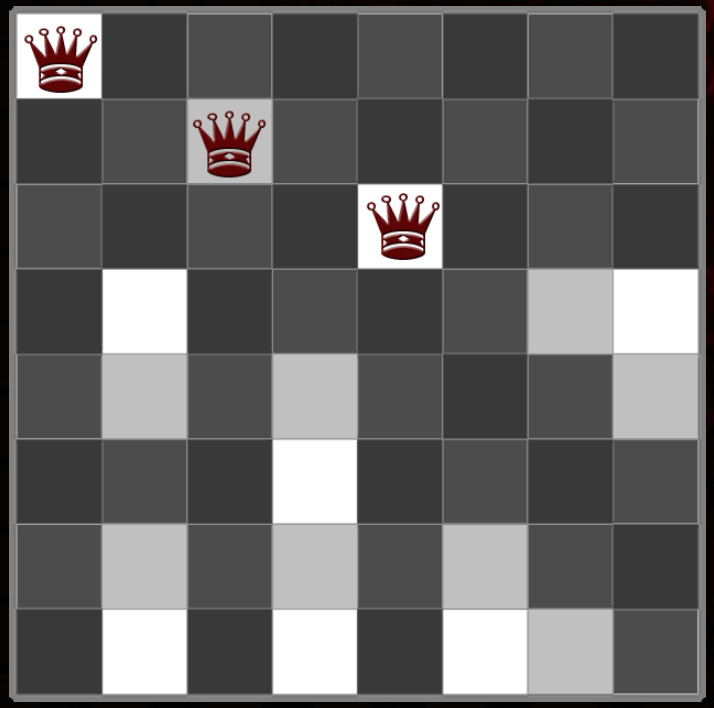






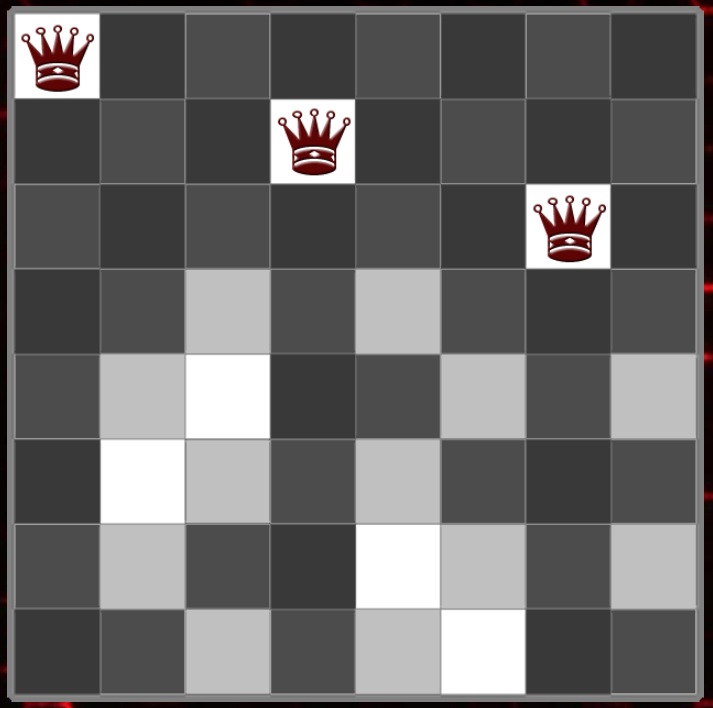
heuristische Depth-first search

Level 3 zonder heuristiek



14 uit 64 open

Level 3 met heuristiek



16 uit 64 open

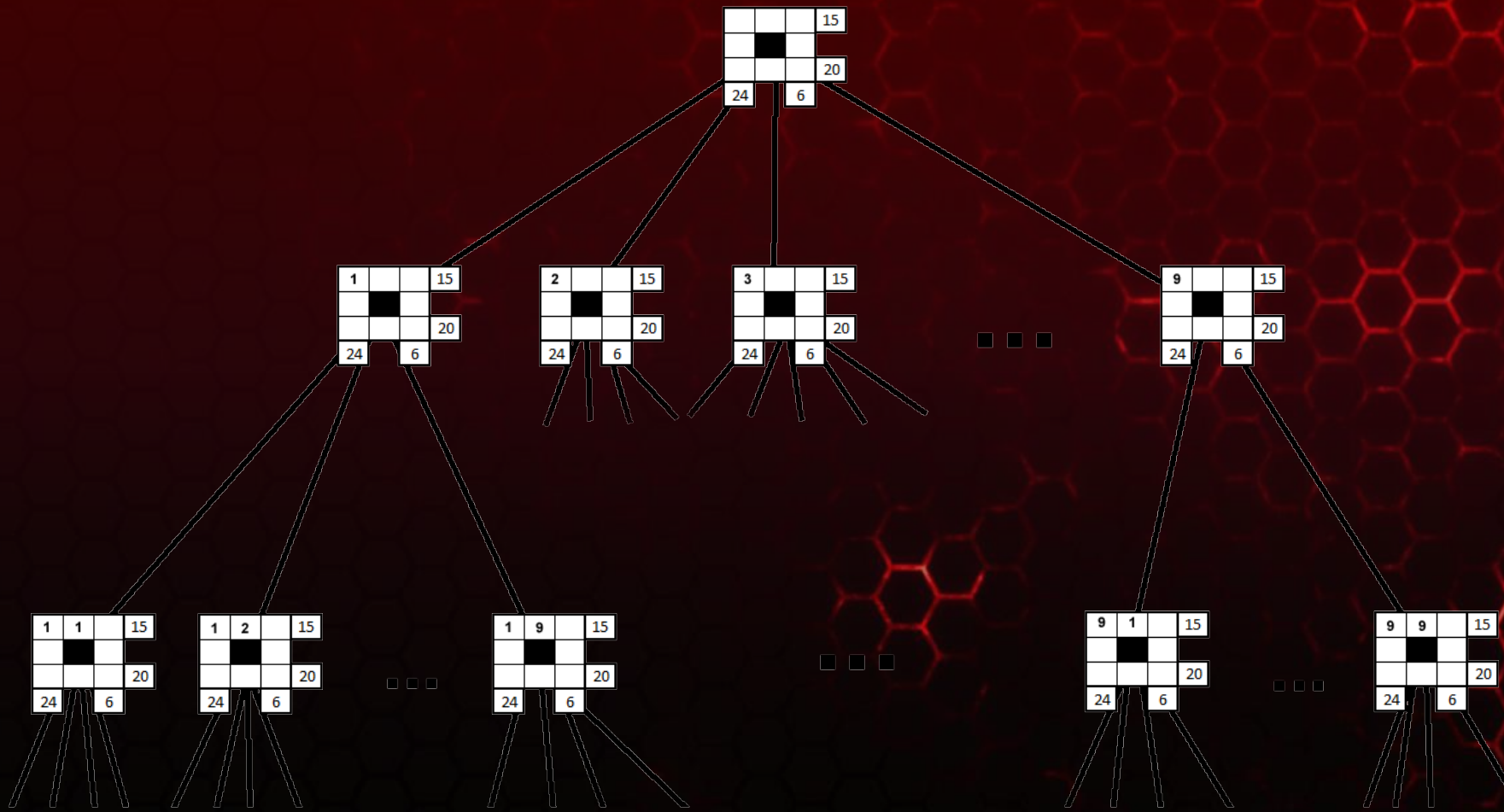
heuristische Depth-first search

- Constructief, depth-first, stack, (of recursief), backtracking ...
- maar: geeft voorkeur aan bepaalde volgorde
- Heuristieke functie
- Kosteloos?

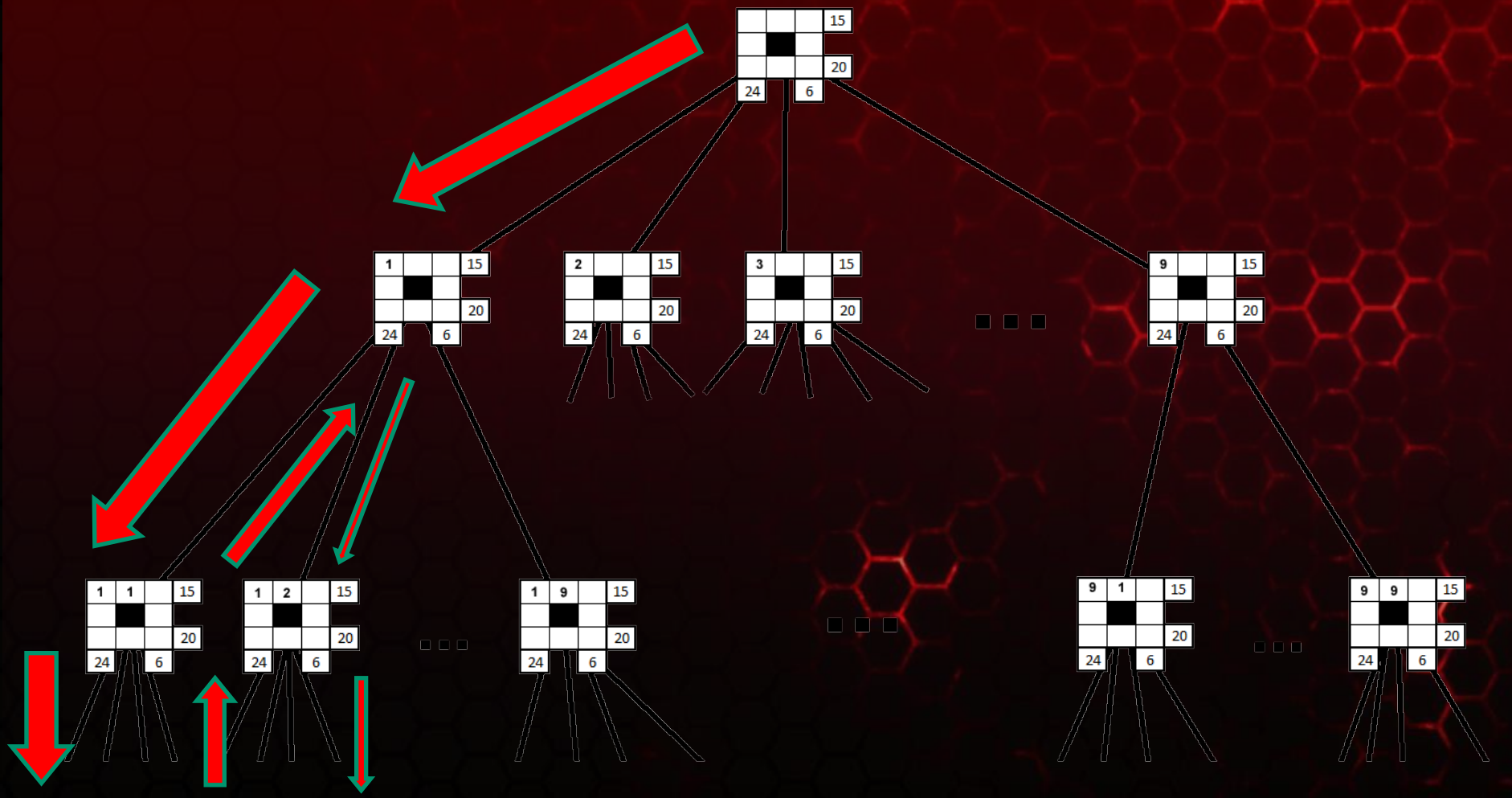
heuristische Depth-first search

- Depth-first
- Voorkeur bepaalde volgorde?
- Heuristieke functie?
- Kosten ?
- Resultaat?

heuristische Depth-first search

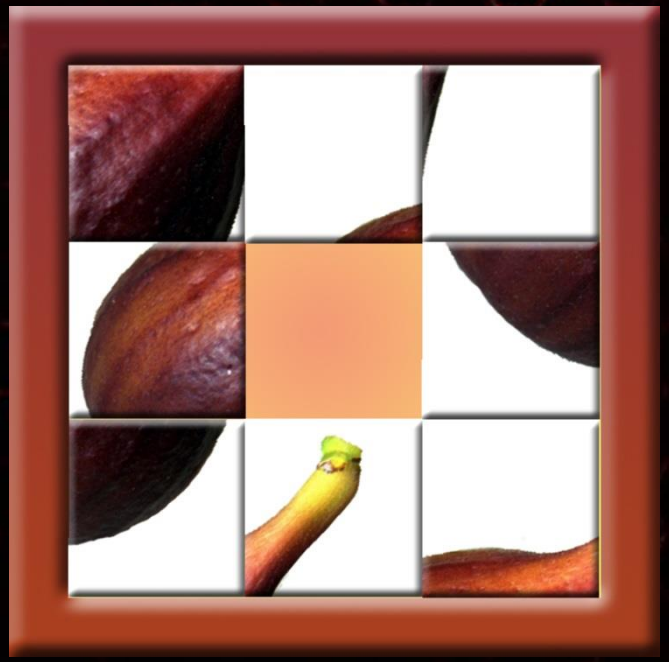


heuristische Depth-first search



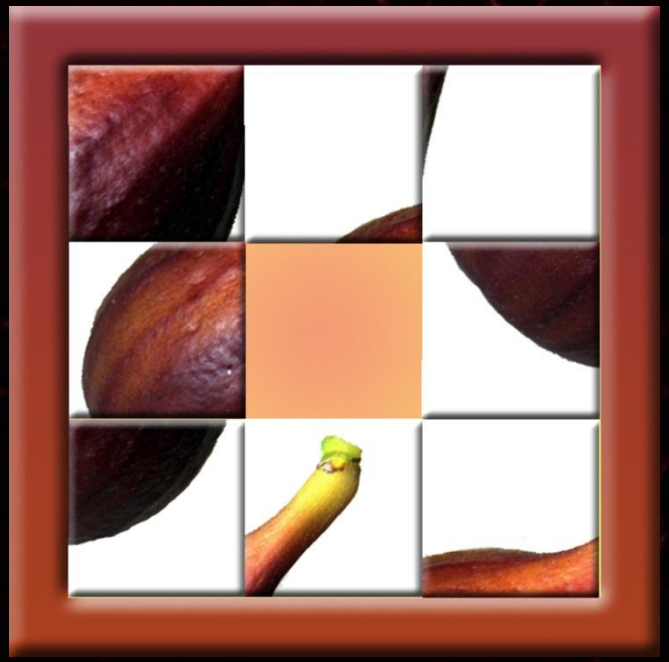
heuristische Depth-first search

- Depth-first
- Voorkeur bepaalde volgorde?
- Heuristieke functie?
- Kosten ?



heuristische Breadth-first search

- Breadth-first
- Voorkeur bepaalde volgorde?
- Heuristieke functie?
- Kosten ?



heuristische Breadth-first search

- Voorrangsregels opstellen

heuristische Breadth-first search

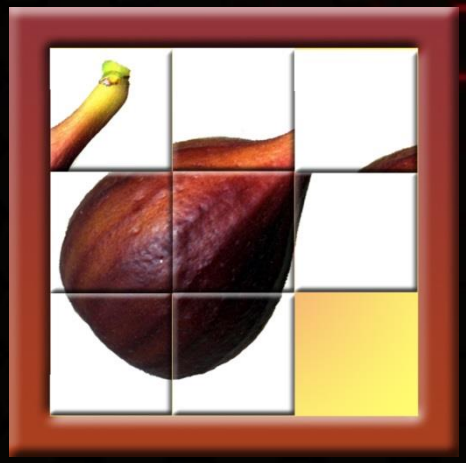
```
class Puzzelnode
{
        int score;
        int[] puzzel;
        String sequentie;
        boolean isduplicaat;

        //methodes ...
        bepaalscore ( );
}
```

Een priority queue van puzzelnodes
in plaats van een gewone queue

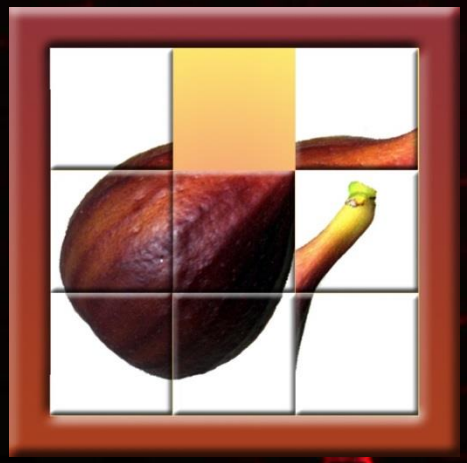
Scorefunctie
Evaluatiefunctie
Heuristiek

heuristische Breadth-first search

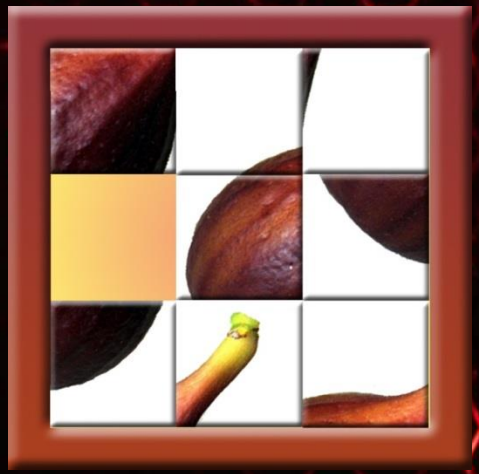
- Heuristiek: “Misplaced Tiles”
- Het aantal tegels op de verkeerde plaats



Misplaced= 2



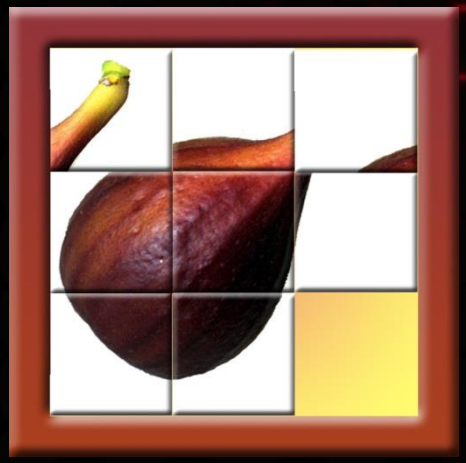
Misplaced = 3



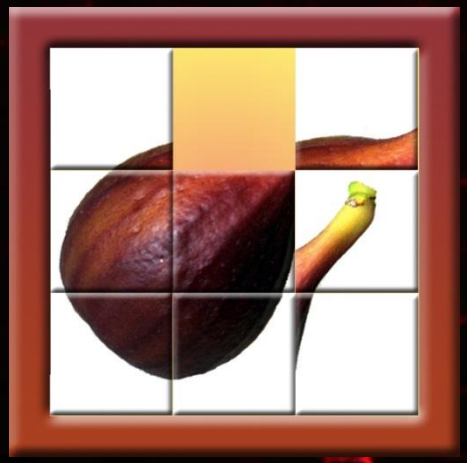
Misplaced= 8

heuristische Breadth-first search

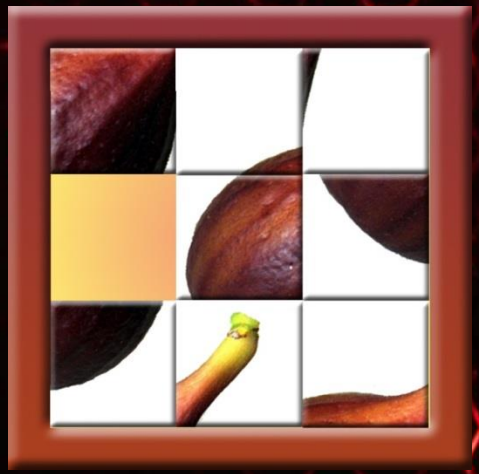
- Heuristiek: “Summed Manhattan Distance”
- Opgeteld aantal benodigde ‘correctiestapjes’ per tegel



Misplaced= 2
Manhattan = 6



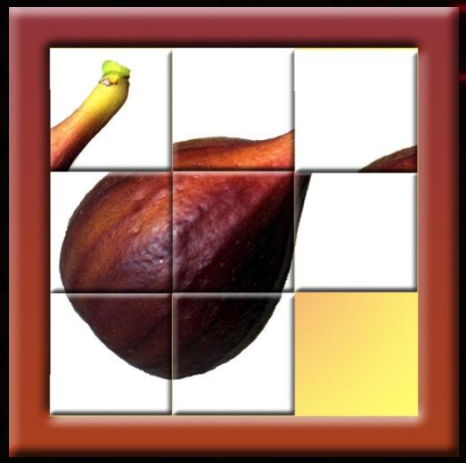
Misplaced = 3
Manhattan = 3



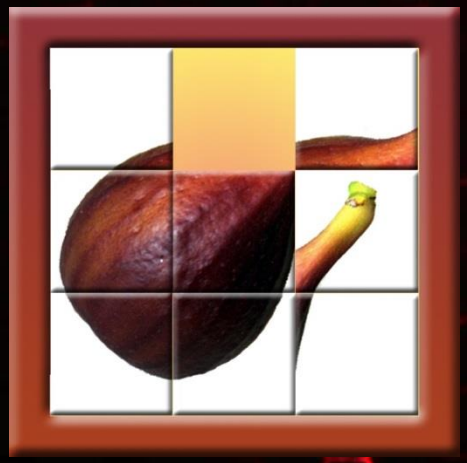
Misplaced= 8
Manhattan = 16

heuristische Breadth-first search

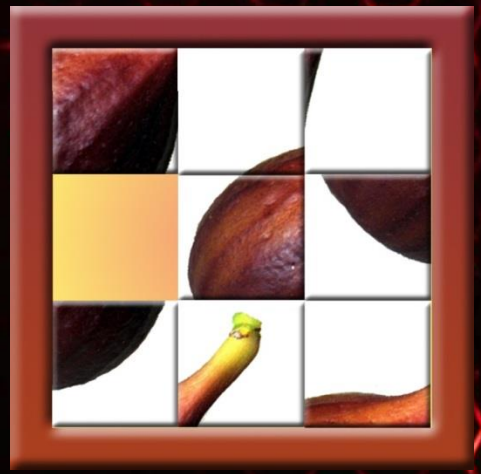
- **Heuristiek: “Linear Conflict”**
- **Manhattan Distance PLUS twee extra penalty voor een benodigde swap in de rij**



Misplaced= 2
Manhattan = 6
LinearCn = 8



Misplaced = 3
Manhattan = 3
LinearCn = 3



Misplaced= 8
Manhattan = 16
LinearCn = 16

heuristische Breadth-first search

- Misplaced Tiles
- Manhattan Distance
- Linear Conflict
- Tiles out of row/column

- N-MaxSwap (Gaschnig's heuristic)
- X-Y
- Nilsson's Sequence Score
- Pattern Database
  (Sebastian Wandelt, Humboldt U. Berlin)

heuristische Breadth-first search

- Misplaced Tiles
- Manhattan Distance
- Linear Conflict
- Tiles out of row/column

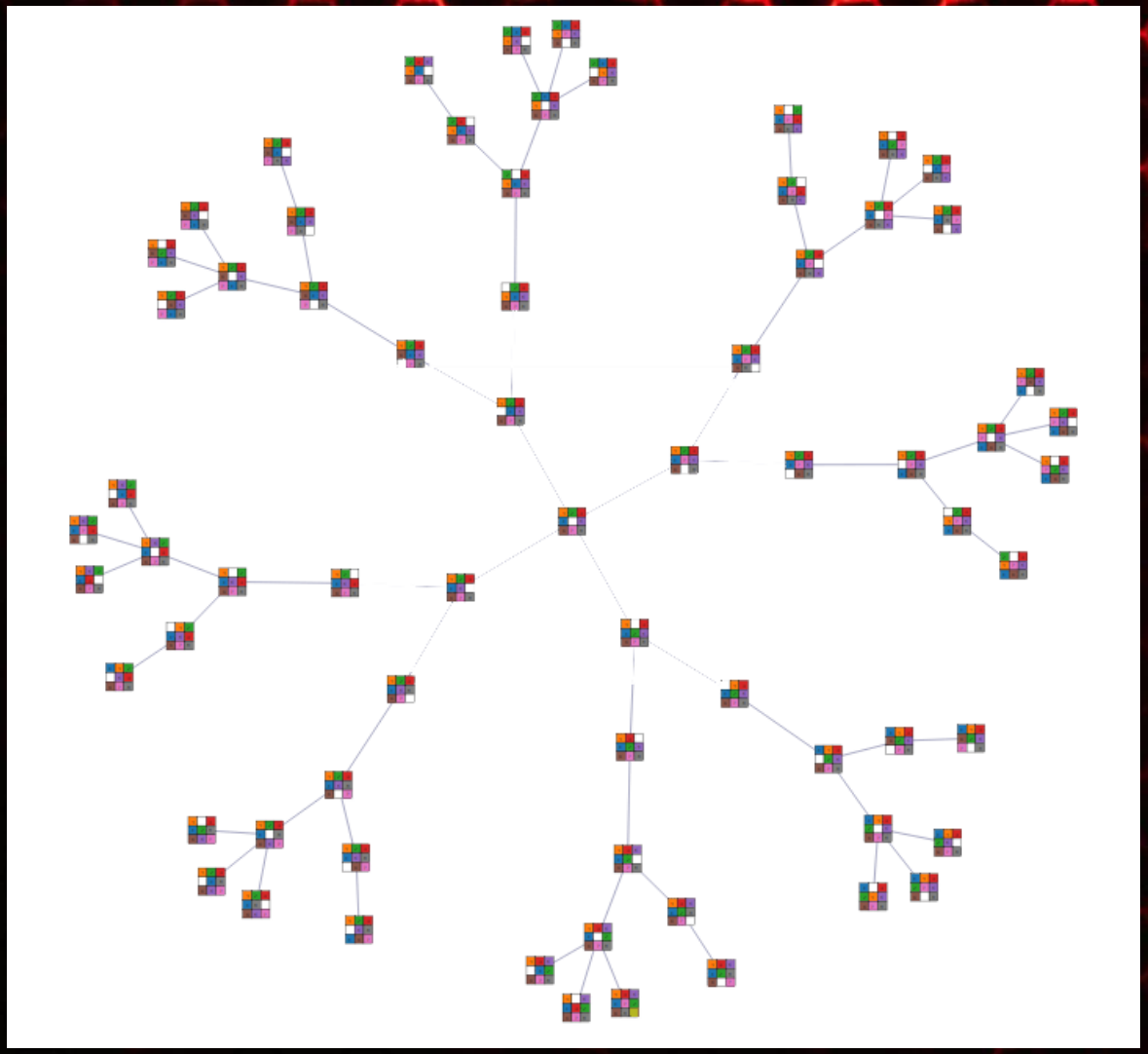
- N-MaxSwap (Gaschnig's heuristic)
- X-Y
- Nilsson's Sequence Score
- Pattern Database

(Sebastian Wandelt, Humboldt U. Berlin)

- **Admissible (= onderschatten!)**
- **Precisie**
- **Kosten (rekentijd)**

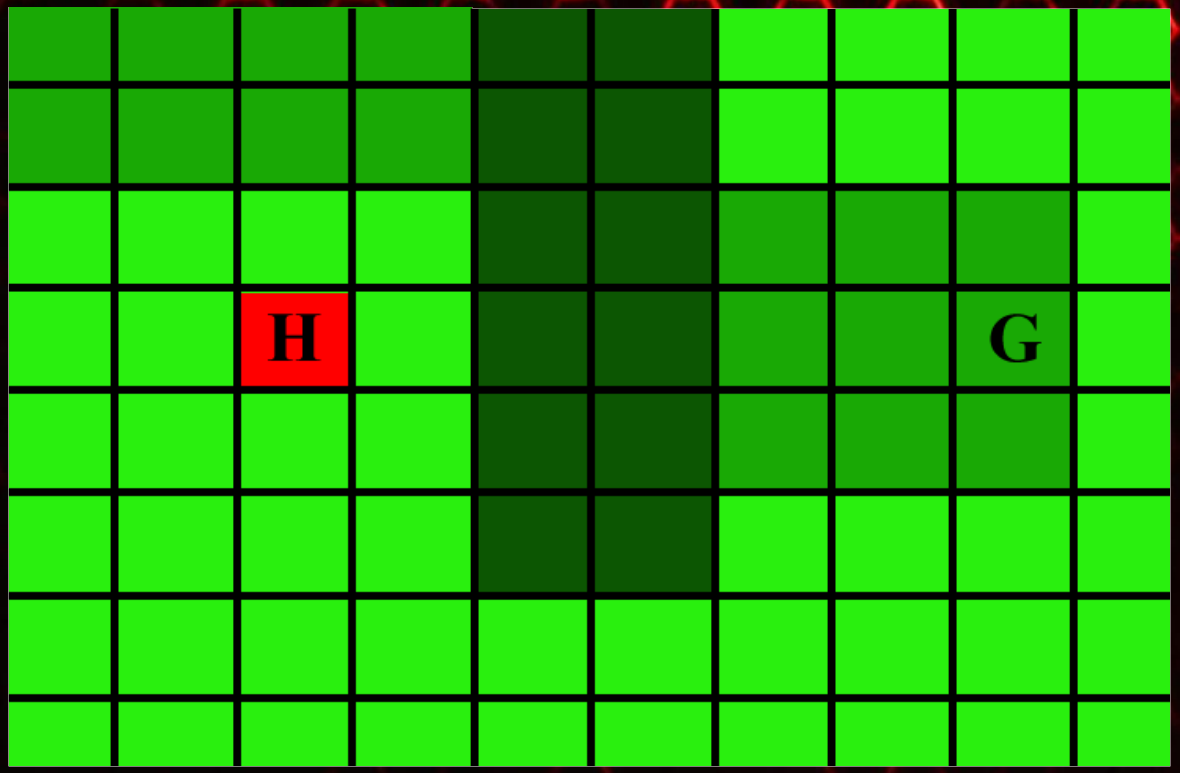
heuristische Breadth-first search

- Best-first search



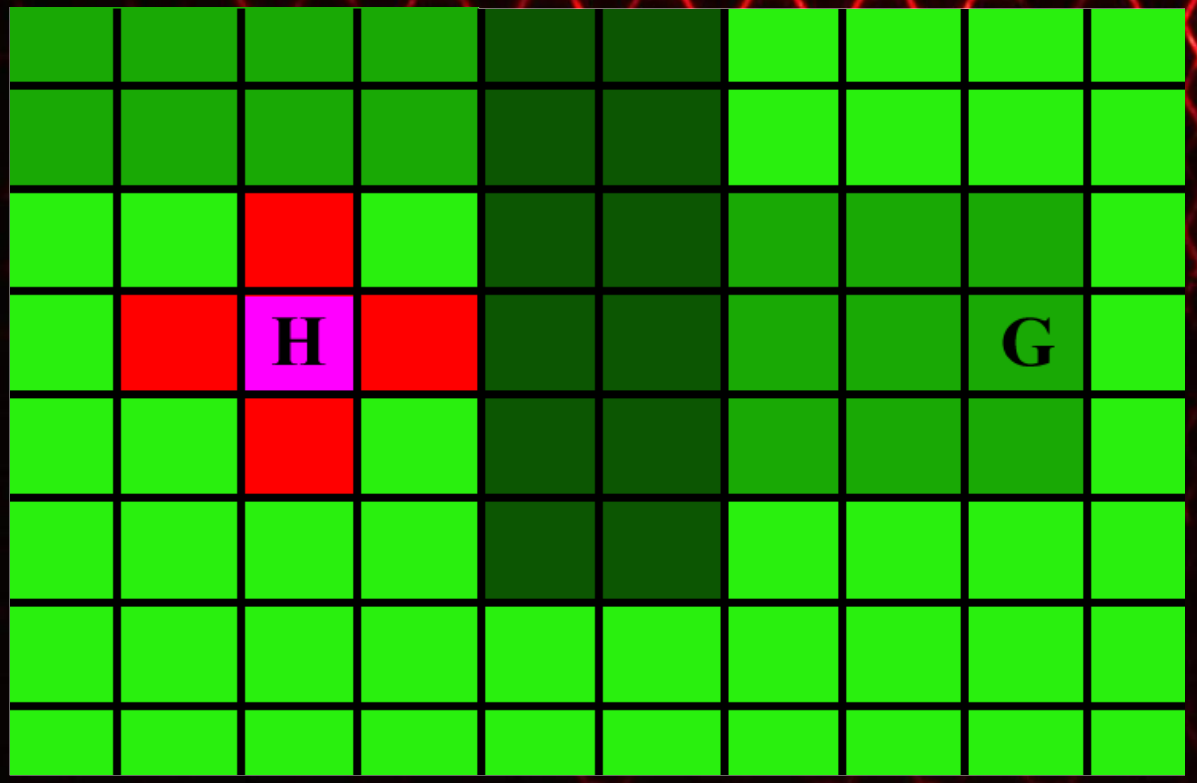
Uniform-Cost Search

Uniform-Cost Search

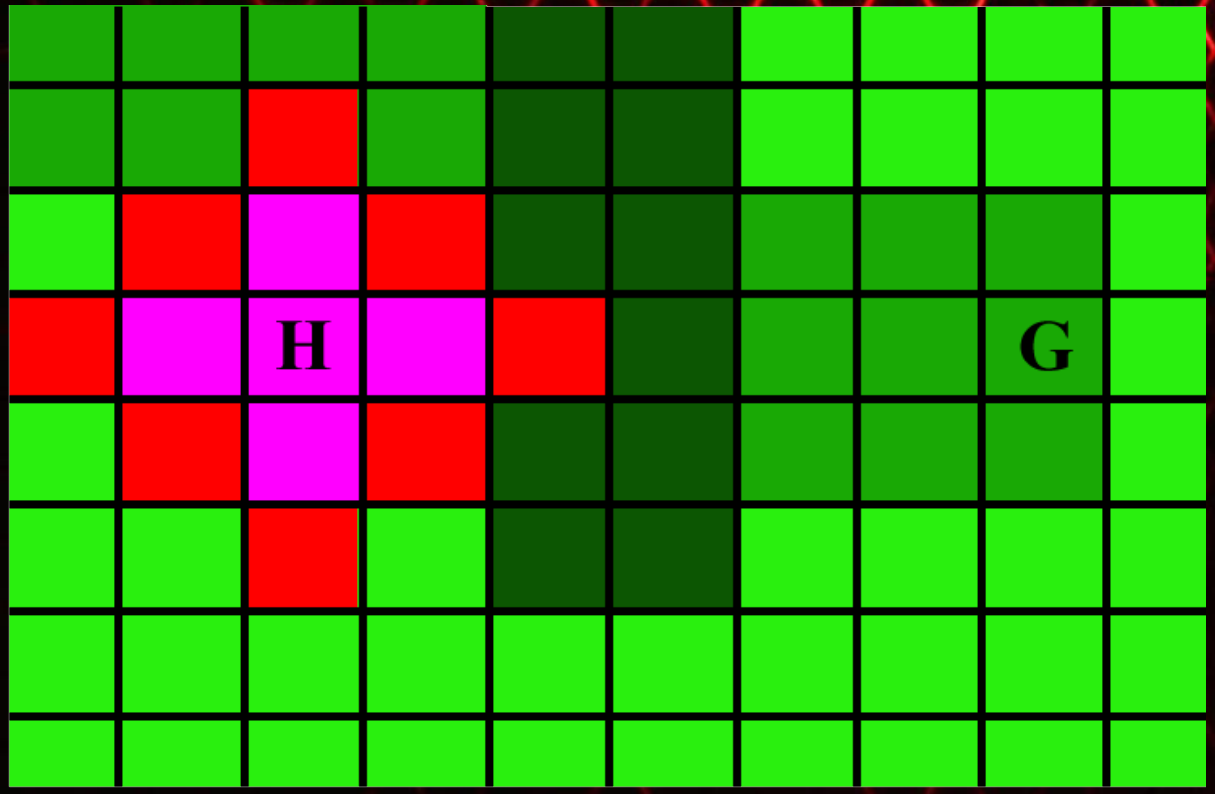


C: 0
189

Uniform-Cost Search



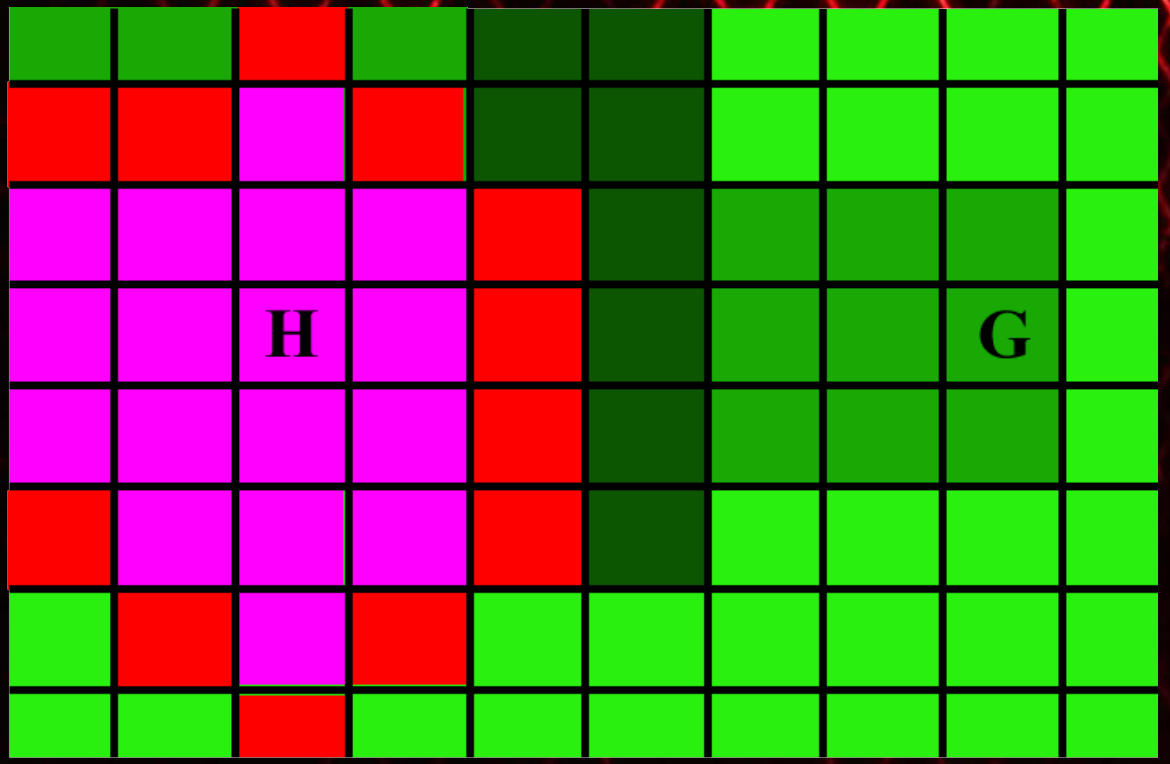
Uniform-Cost Search



C: 2	C: 2	C: 2		C: 3	C: 4				
138	140	187	...	89	191				

C: 1	C: 1	C: 0	C: 1	C: 1					
139	188	189	190	238					

Uniform-Cost Search



C: 4	C: 4	C: 4		C: 5	C: 6				
88	90	287	...	87	291				

C: 3	C: 3	C: 2	C: 1		C: 1				
89	137	138	139	...	238				

A-STAR

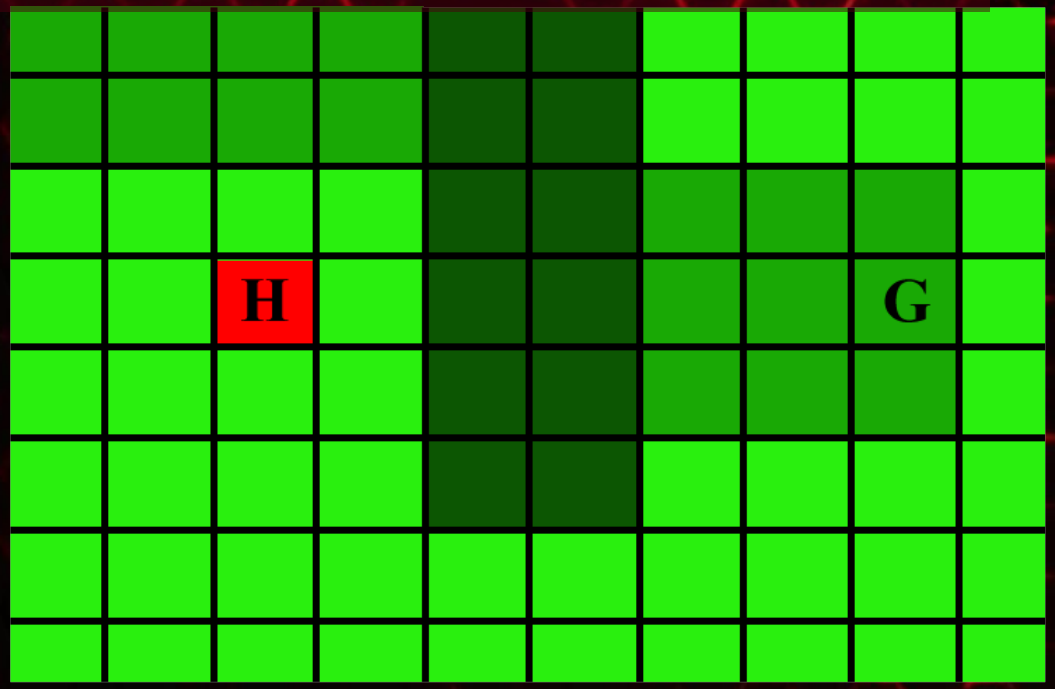
After a full week of *absence*, uniform-cost *returns* to state-space.

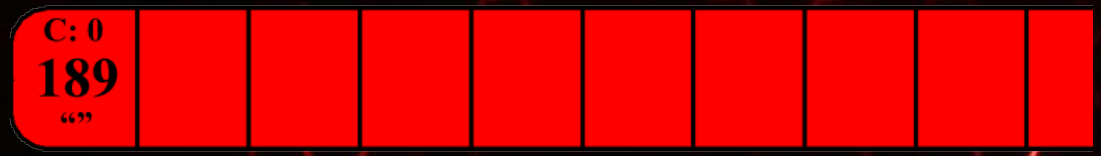
This time, he brought a new *and* powerful weapon: an *admissible heuristic*

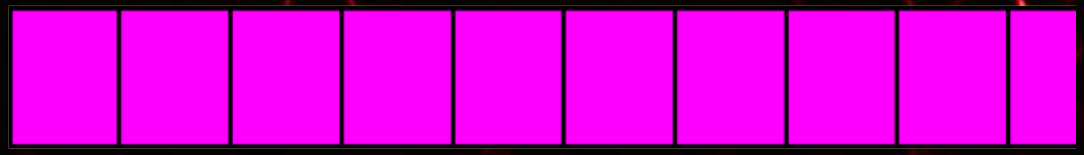
"That miserable *exponential* complexity won't stand a chance. A-star is born! "

A-star

UFC-search met admissible heuristic

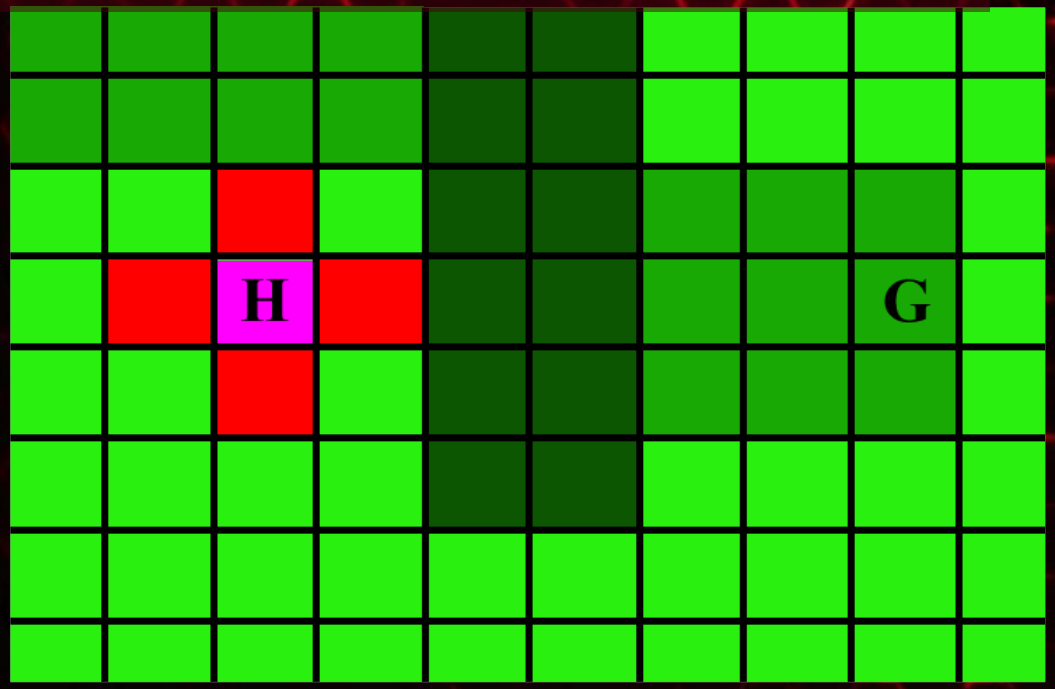






A-star

UFC-search met admissible heuristic

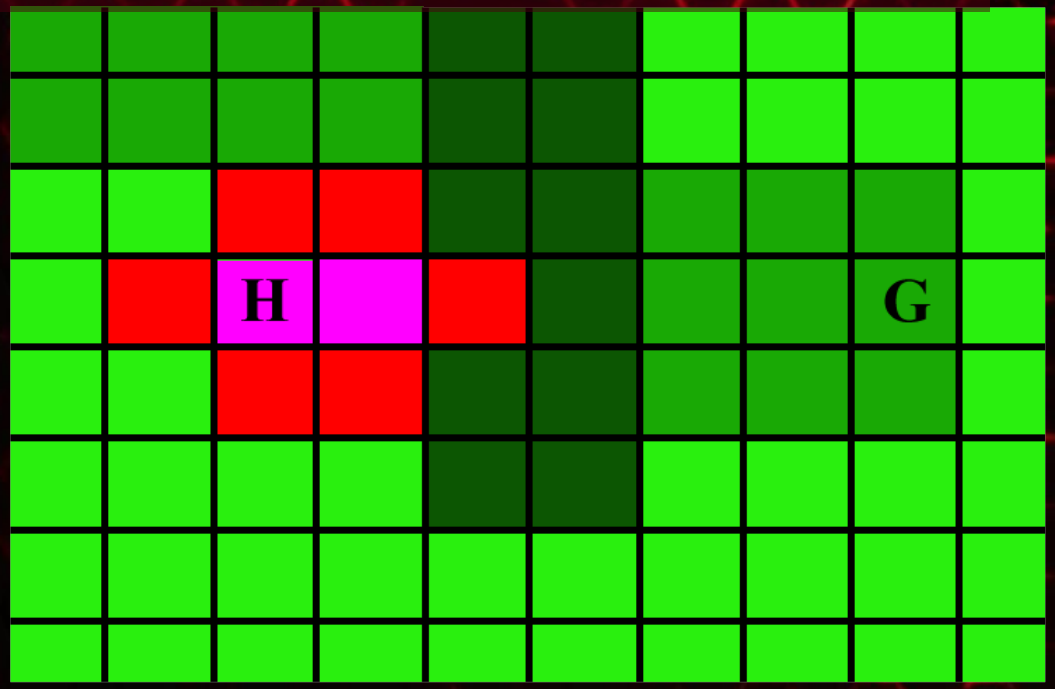


C: 1+5	C: 1+7	C: 1+7	C: 1+7						
190	139	188	239						
“R”	“U”	“L”	“D”						

C: 0									
189									
“”									

A-star

UFC-search met admissible heuristic

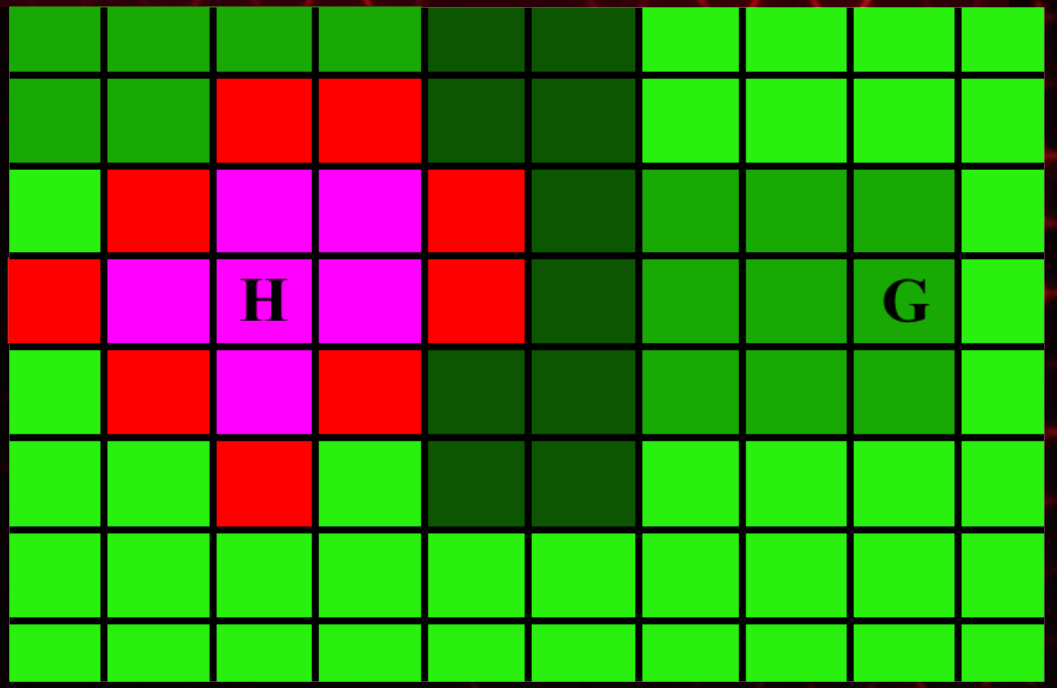


C: 1+7	C: 1+7	C: 1+7	C: 2+6	C: 4+4	C: 2+6				
139	188	239	140	191	240				
"U"	"L"	"D"	"RU"	"RR"	"RD"				

C: 0	C: 1								
189	190								
""	"R"								

A-star

UFC-search met admissible heuristic

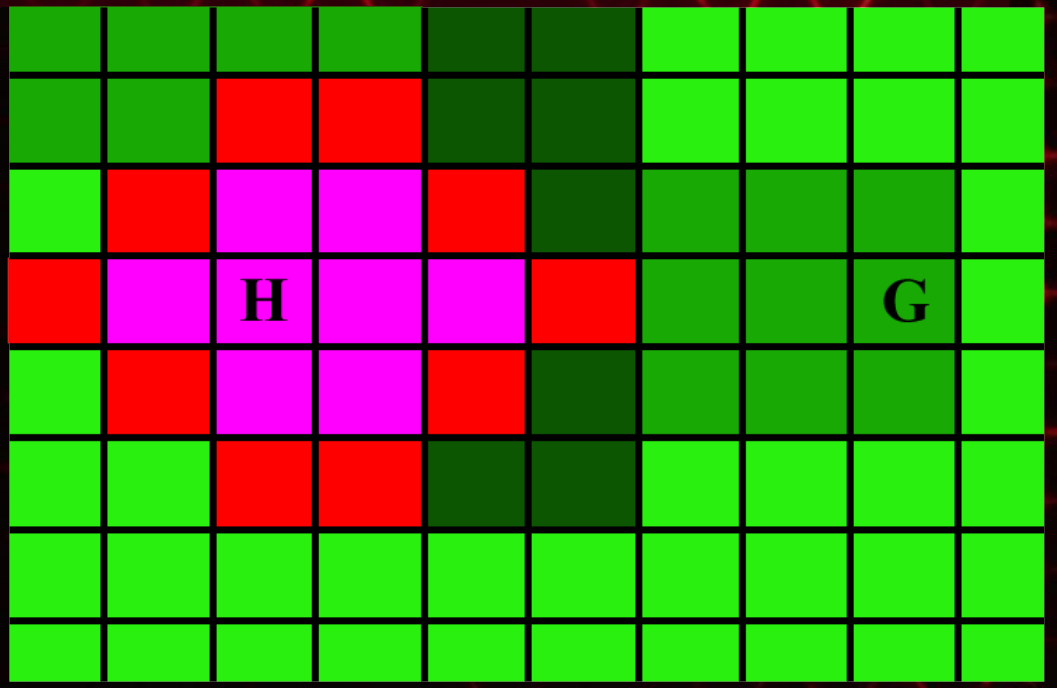


C: 4+4	C: 2+6	C: 2+8	C: 2+8	C: 2+8	C: 2+8	C: 2+8	C:5+5	C:4+7		
191	240	89	138	238	187	289	141	90		
“RR”	“RD”	“UU”	“UL”	“LD”	“LL”	“DD”	“RUR”	“RUU”		

C: 0	C: 1	C: 1	C: 1	C: 1	C: 2				
189	190	139	188	239	140				
“”	“R”	“U”	“L”	“D”	“RU”				

A-star

UFC-search met admissible heuristic



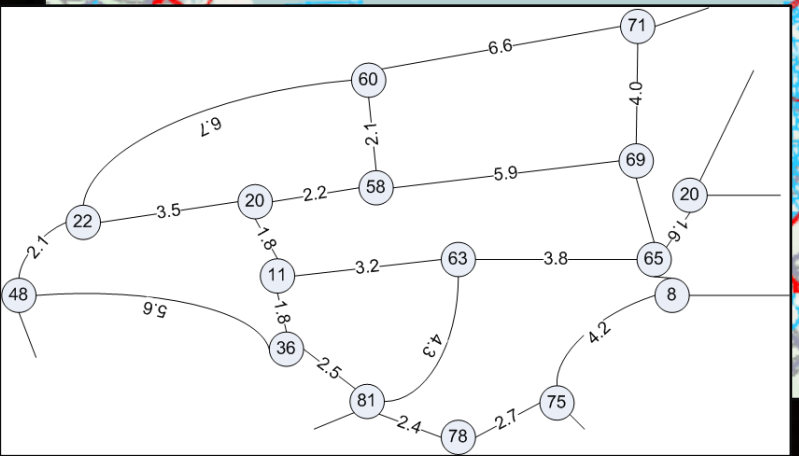
C: 2+8	C: 2+8	C: 2+8	C: 2+8	C: 2+8	C:5+5	C:4+7	C:7+3	C:3+7	C:7+5
89	138	238	187	289	141	90	192	290	241
"UU"	"UL"	"LD"	"LL"	"DD"	"RUR"	"RUU"	"RRR"	"RDD"	"RRD"

C: 0	C: 1	C: 1	C: 1	C: 1	C: 2	C: 4	C: 2		
189	190	139	188	239	140	191	240		
""	"R"	"U"	"L"	"D"	"RU"	"RR"	"RD"		


Sint-Annaparochie
Sint-Anne
N393
N398
N357
LEEUWARDEN


Norwich
Cambridge
Chelmsford


Leeuwarden
Groningen
Oldenburg
Assen
Emmen
Zwolle
Amsterdam
Netherlands
Enschede
Leiden
Rotterdam
Münster
Nijmegen
Tilburg
Middelburg
Eindhoven
Essen
Dortmund
Antwerpen
Düsseldorf
Gent
Ghent
Köln
Cologne
Maastricht
Aachen
Belgium
Koblenz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Sint-Annaparochie
Sint-Anne
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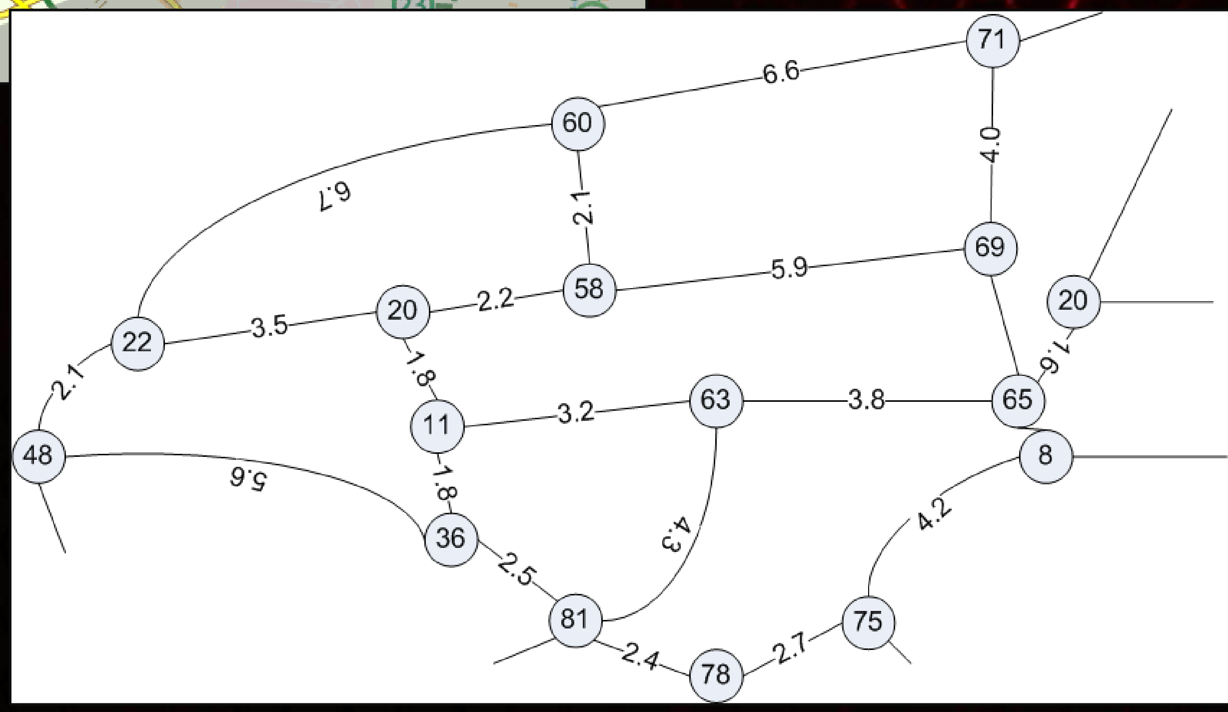
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2.7

Zoeken in een gewogen graaf