

Sokoban: Search in a complex domain

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What is Sokoban?

Sokoban is a puzzle game first published in 1982

- You play a warehouse keeper
- The goal is to push boxes onto goal locations in a map
- Movements in cardinal directions
- Boxes can only be pushed into empty spaces
- Only one box can move at a time

Why is it interesting?

- Application of AI to games can lead to investigation of new techniques
- High branching factor of maximum

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Board Representation

- Two-level representation with static and dynamic objects
-

Heuristics

Player Space Search



Board Space Search



Bi-directional Search



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Method Comparison

Search Method	Time limit		
	5 sec	11 sec	15 sec
A*	12	15	16
Best First	56	60	64
Bi-directional Best First	76	81	82
Bi-directional A*	39	41	43

- No significant difference in number of maps solved with different limits
- Is the search going in the right direction?

Map Performance

- Can be solved within 15 sec, but not 11
- Requires a box to be positioned (at x) and not moved until the end.
- Problem is caused by heuristic preferring boxes on goals

Map 54

```

#####
#   . . .   #
#   . . . .  #
##### x  #
#   $ $   #
#           # #
###$####   #
#@ $     #$ #
### $    $  #
      ##     #
      #####
  
```

Map Performance

- Solved very quickly
- All but one box require only a single move
- Heuristic gives accurate estimate to the goal

Map 66

```
#####
##.$@ ###
###.# ###
###$#  #
#.$ #.# #
##.$ $# #
#.$ # # #
## #.$ #
#.$ #.###
##.$ $###
#.$ # ###
## $# ###
## .# ###
##    ###
#####
```

Map Performance

- Unsolved within 15 sec
- Intermediate goal area causes issues with heuristic
- Requires making specific move sequences to get boxes on goals

Map 93

```

#####
####      @##  #  #
###      $ ##      #
##      $ ##      ## ###
#      $ ##      ## # #
# $ ##      ## $ #
# $ ##      ## # # #
# ##      ## ## # #
#      ## ### # #
#####* ##      ## # #
      ***##      #
#####. . *.#####
      ##. . #
      #####
  
```

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