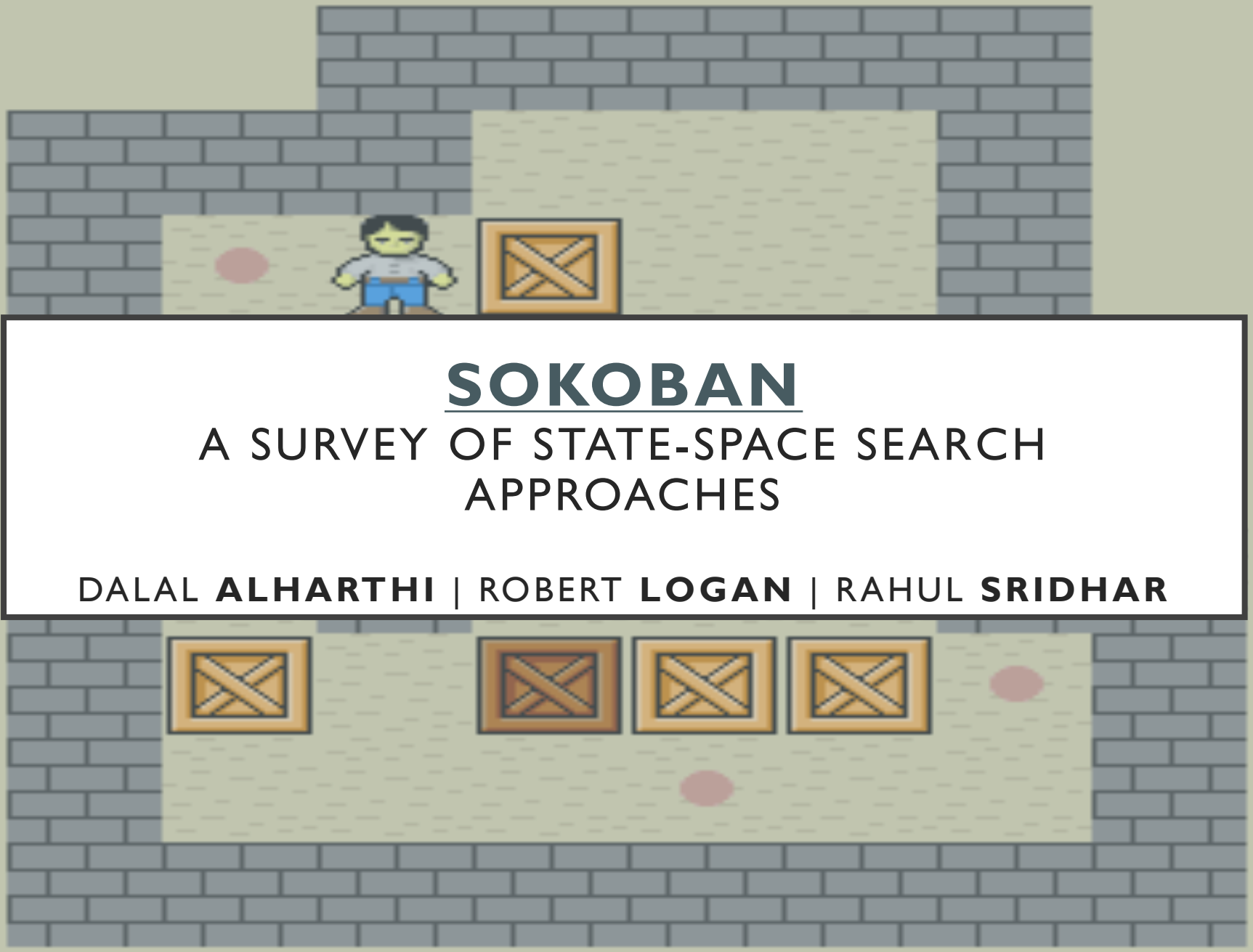


SOKOBAN

A SURVEY OF STATE-SPACE SEARCH APPROACHES

DALAL **ALHARTHI** | ROBERT **LOGAN** | RAHUL **SRIDHAR**

SPECIFICATIONS

SPECIFICATIONS:

- M * N board
- K boxes and K storage locations (initially boxes could be anywhere)
- Any number of walls
- Single player – makes one move at a time
- Player can (only) push a box (onto wall/empty square/storage)

GOAL:

- Player pushes all boxes to their storage locations (ideally in minimum #moves)

COMPLEXITY:

- PSPACE-Complete

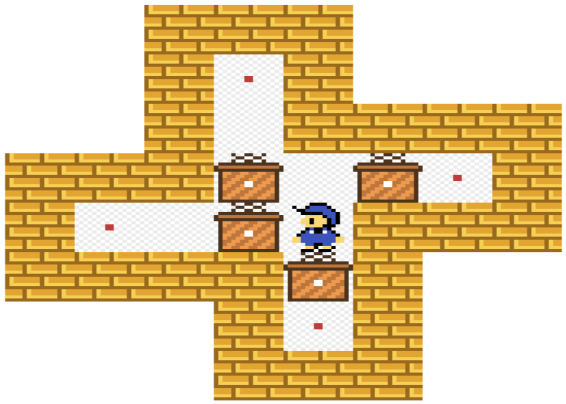
ENVIRONMENT

Type	Yes/No
Fully observable	Yes
Deterministic	Yes
Episodic	No
Static	Yes
Discrete	Yes
Single-Agent	Yes

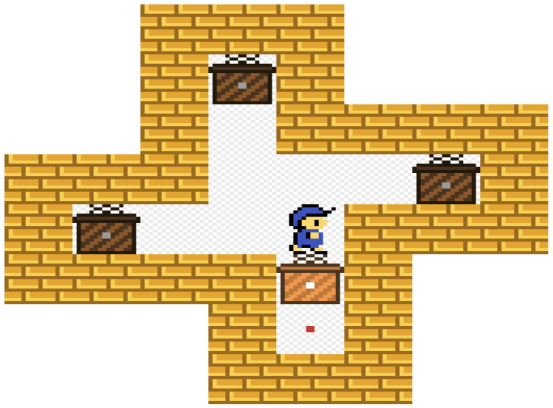
STATE REPRESENTATION

- Our representation of a state consists of:
  - Player coordinates (a structure with (x, y) coordinates of player)
  - An enumerated array of tiles (of size height*width):
    - ✓ Wall locations
    - ✓ Box locations
    - ✓ Storage locations

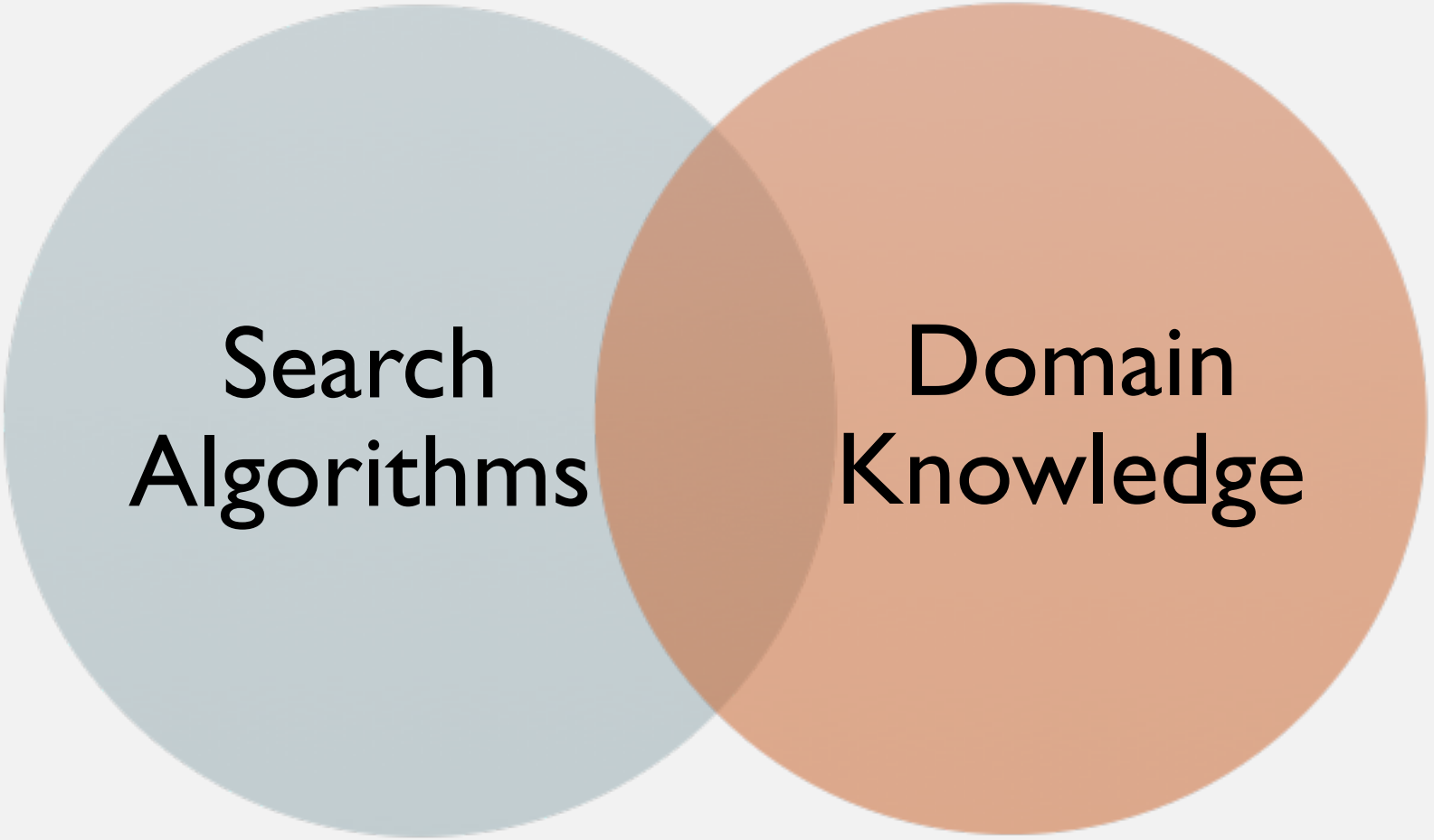
INITIAL STATE



A STATE CLOSE TO THE GOAL



SOLUTION STRATEGIES



SOLUTION STRATEGIES

Search (All optimal)

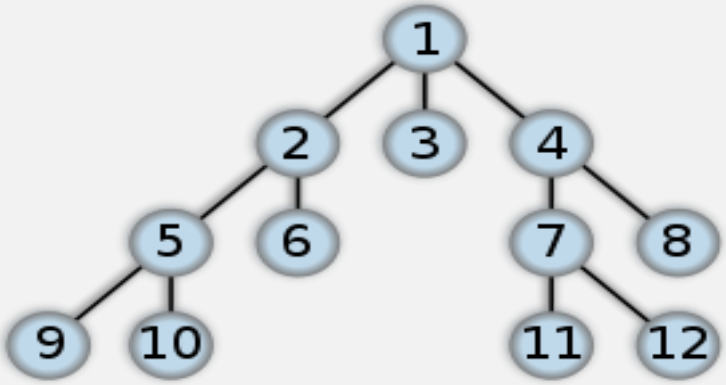
- Uninformed
  - Breadth First Search
- Informed
  - A* Search
  - IDA* Search

+

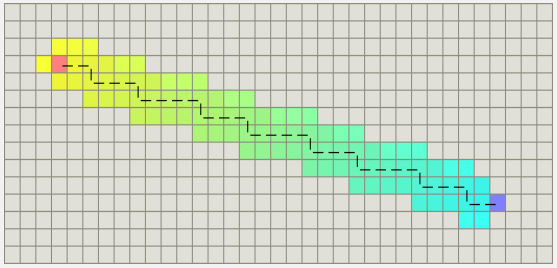
Domain Knowledge

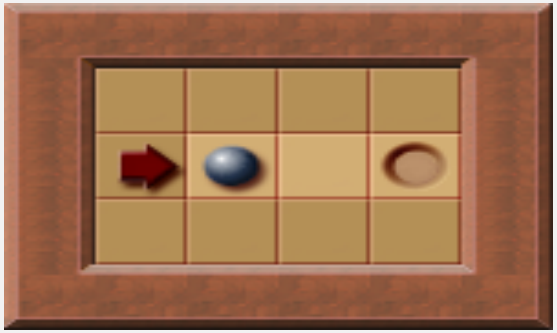
- Distance-based Heuristics
  - H_1 = Minimum Manhattan distance (consistent)
  - H_2 = Minimum Cost Matching (consistent)
- Deadlock-based Heuristics
  - Simple
  - Freeze

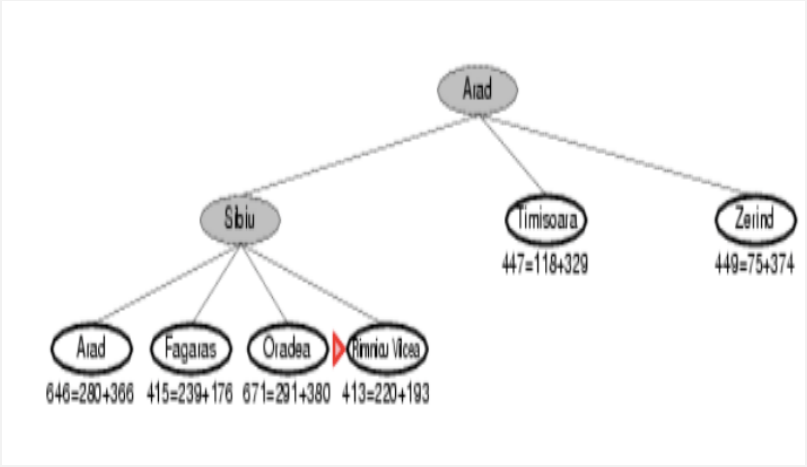
SOLUTION STRATEGIES

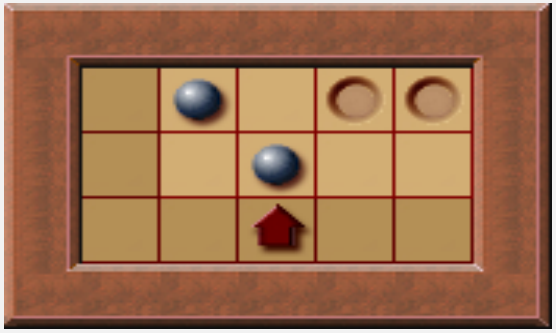


+









TEST SUITE + BENCHMARKS

- MICROBAN
  - ✓ Test suite with 99 puzzles with varying levels of difficulty

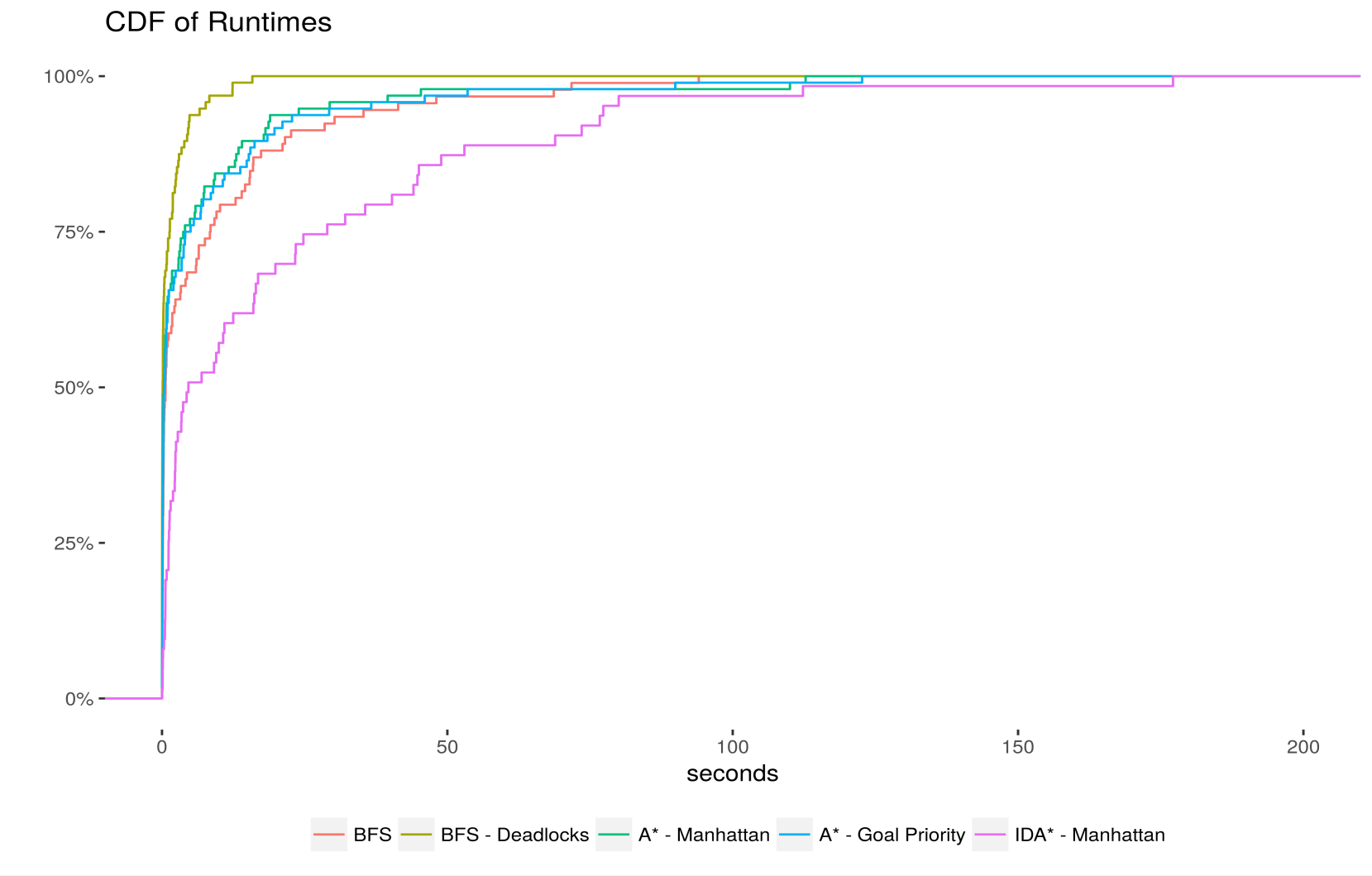
- STATISTICS & BENCHMARKS
  - ✓ Completeness (*finds solution*)
  - ✓ Optimality (*#moves*)
  - ✓ Running time
    - ➢ Imposed a 3 minute time limit
  - ✓ Number of states visited
  - ✓ Incremental comparison (comparing various search strategies with deadlocks + heuristics)

EXPERIMENTAL RESULTS - COMPLETENESS

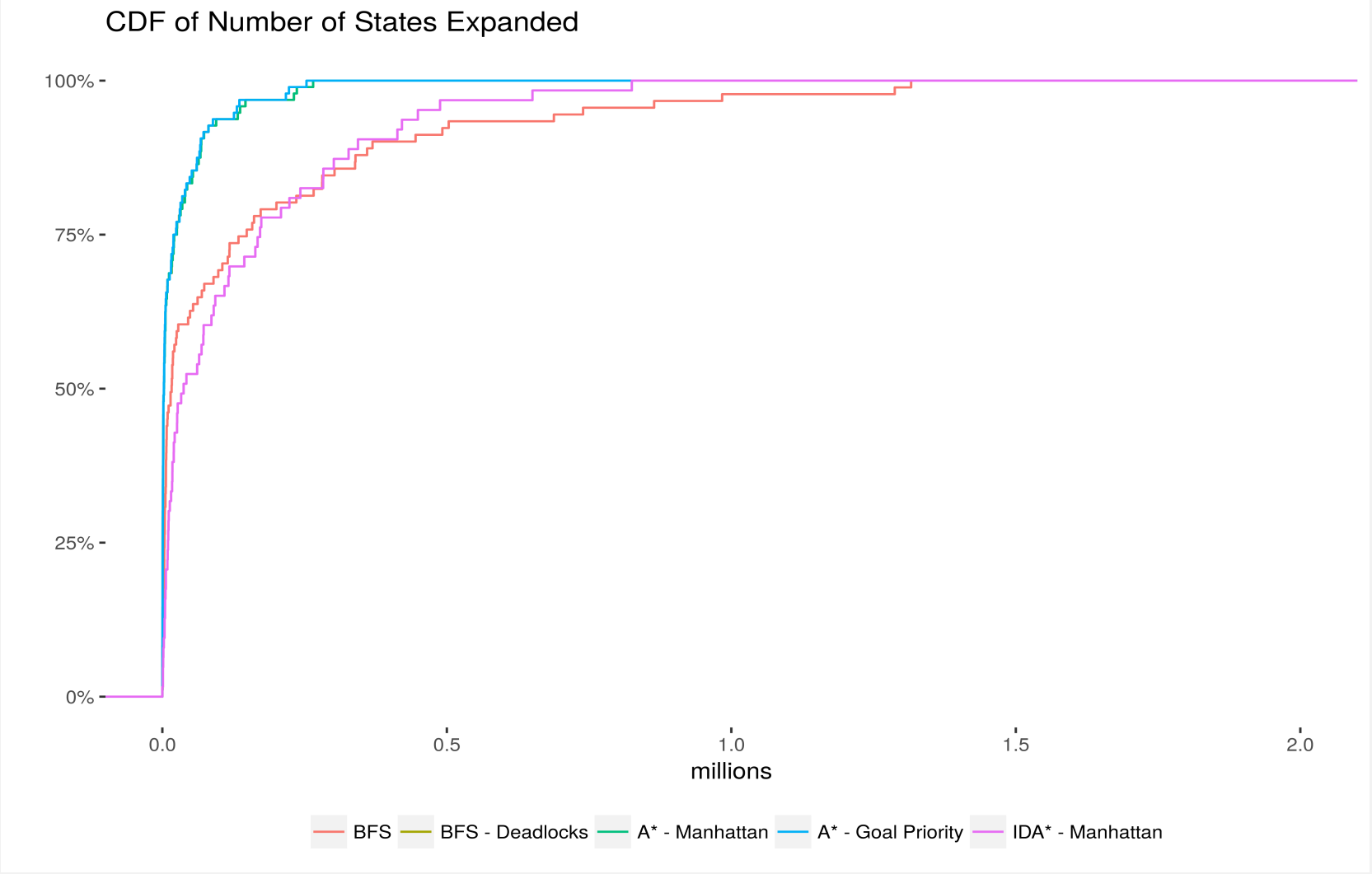
Algorithm	# Solved*	Average runtime (in secs)
BFS	92	7.8
BFS with deadlock	96	1.3
A* with H1	96	6.2
A* with H2	96	6.8
IDA* with H1	63	20.9

* *Out of 99 puzzles in <=3 minutes*

EXPERIMENTAL RESULTS - RUNNING TIME



EXPERIMENTAL RESULTS - #STATES EXPANDED



FURTHER ENHANCEMENTS

- Tunnel macros
- Corral deadlocks
- Better heuristics
- And much more…