Neural Network for Hill-Climbable Subgoals

Zeyi Wang

Motivation

- scrubbing
- pre-computation space
- query time

Problem Formulation

- directed graph
  - states and edges
  - each edge has a positive cost of 1 (four-connected)
- an agent has a single current state
  - change by taking an action
- total cost of a path from start to goal is the solution cost
- an algorithm has to be complete

Problem Formulation

- real-time-ness
  - bounded computation
    - move time
    - sub-optimality
    - heuristic (euclidean distance)

Related Work

- A* [Hart, et al. 1968]
- D LRTA* [Bulitko, et al. 2008]
- kNN LRTA* [Bulitko, Björnsson, 2009]
- HCDPS [Lawrence, Ramon, Bulitko, 2010]

Related Work

- static map path finding
- build a "case base" for querying

Related Work

more cases

Related Work

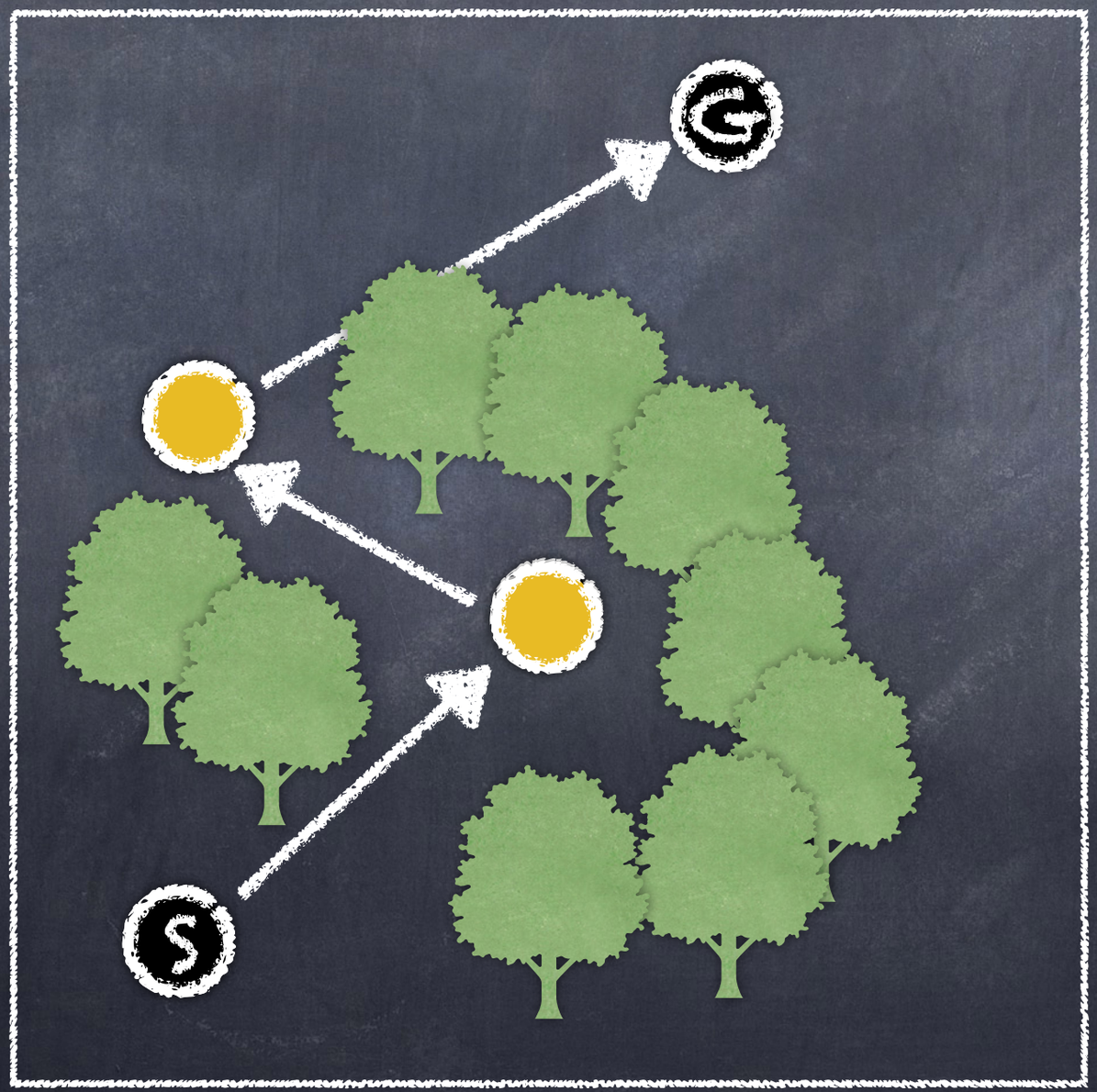
more cases
infinite

less space
constant

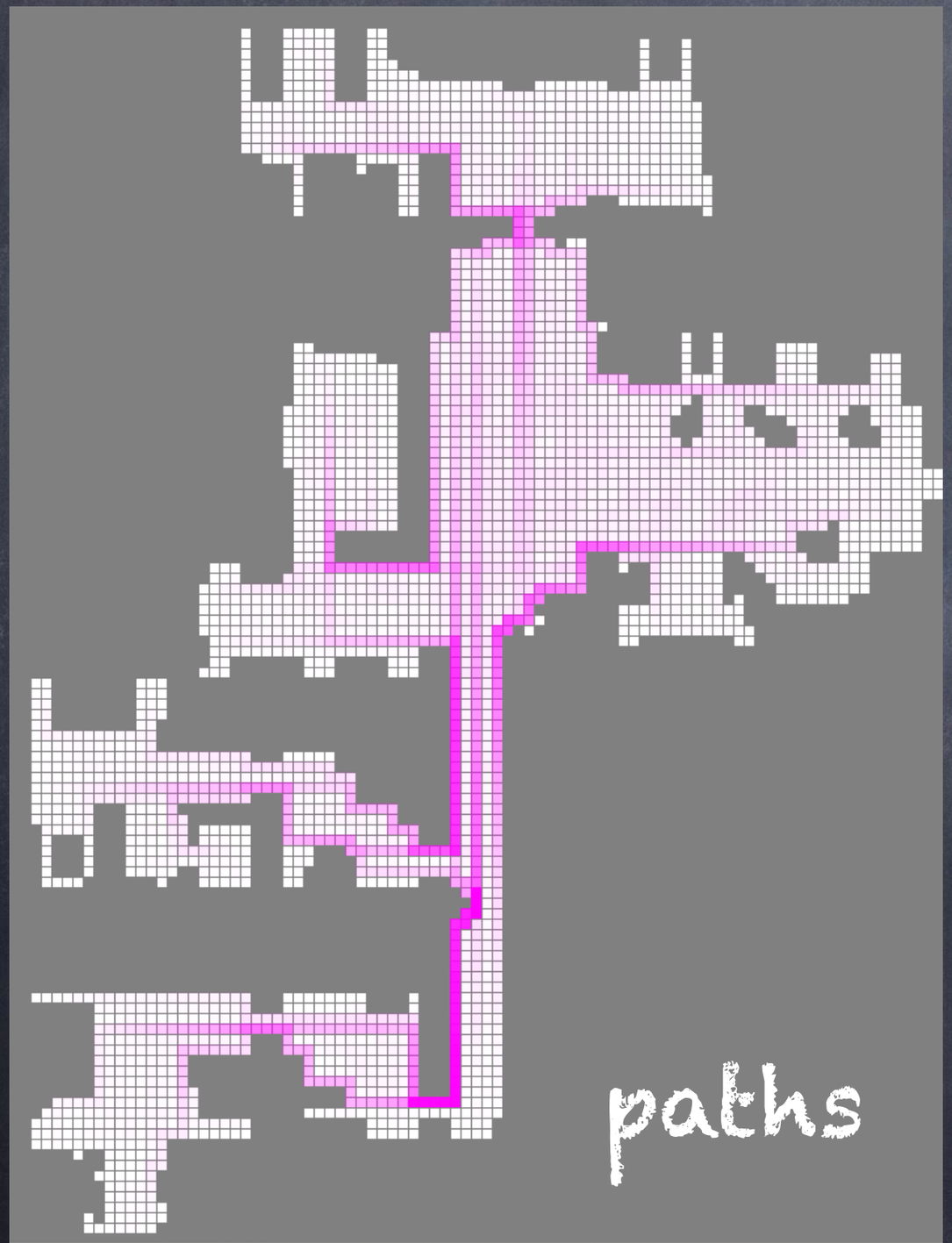
faster query
constant

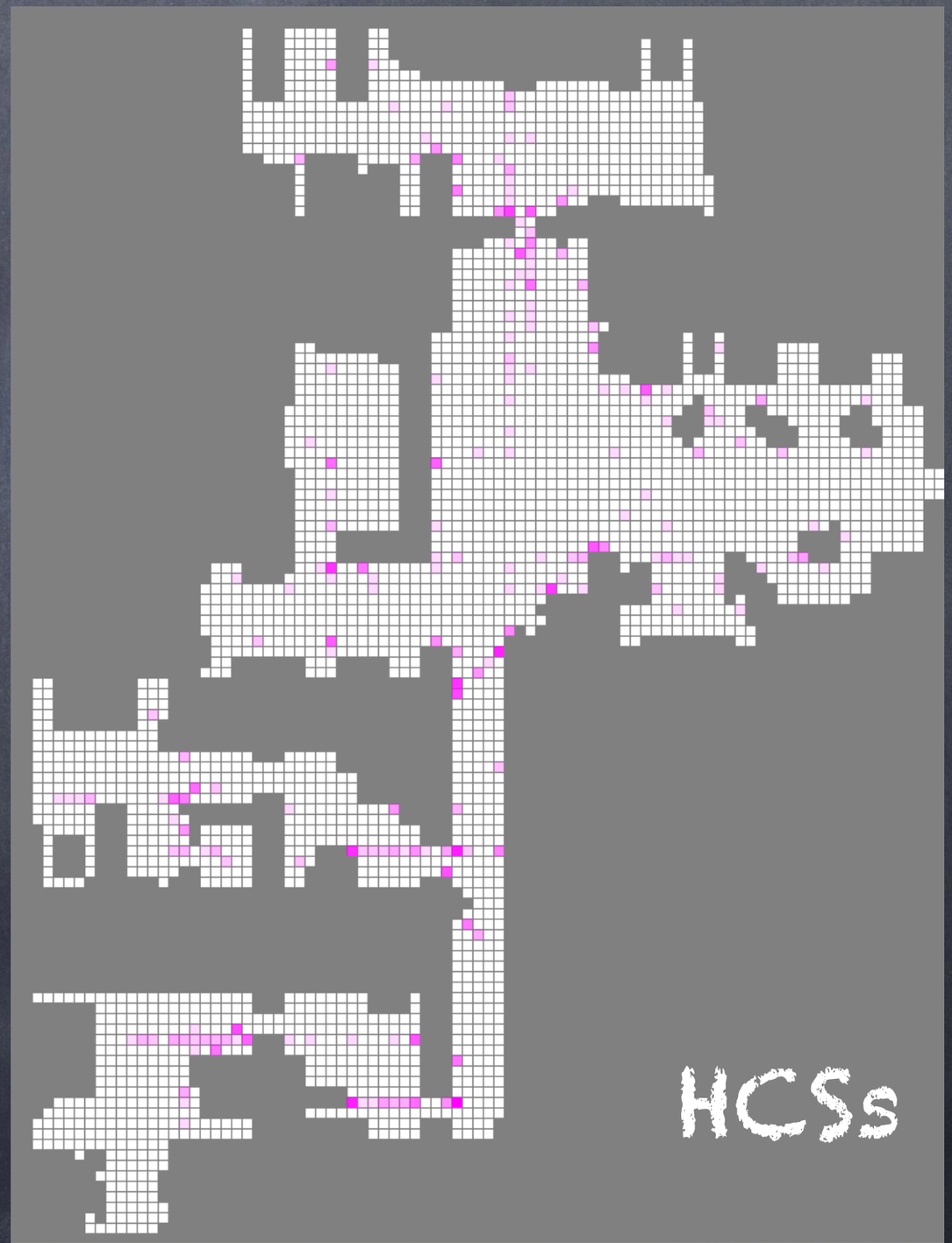
Neural Network for Hill-Climbable Subgoals (NNHCS)

Hill-Climbable Subgoal (HCS)



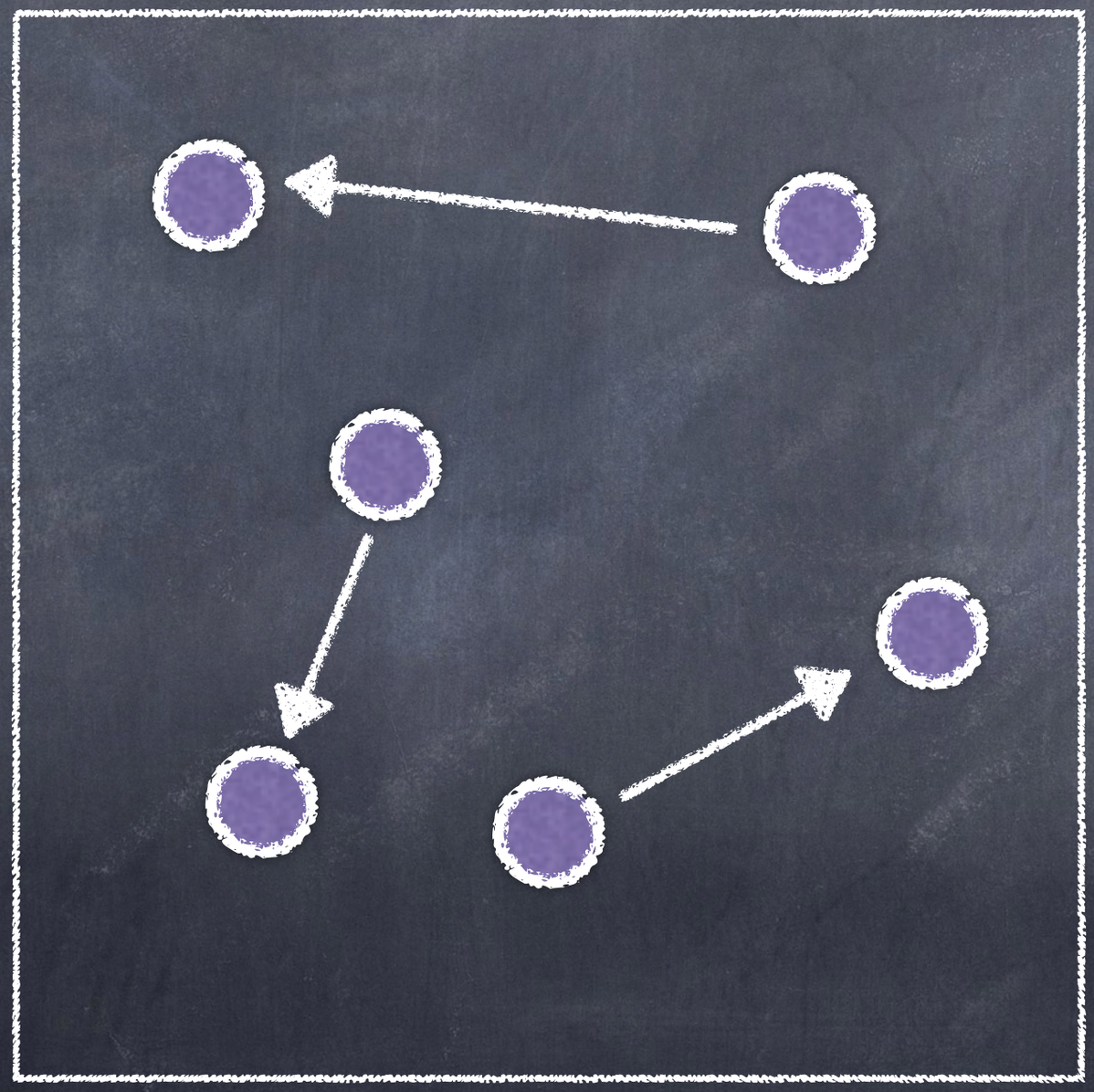
Intuition



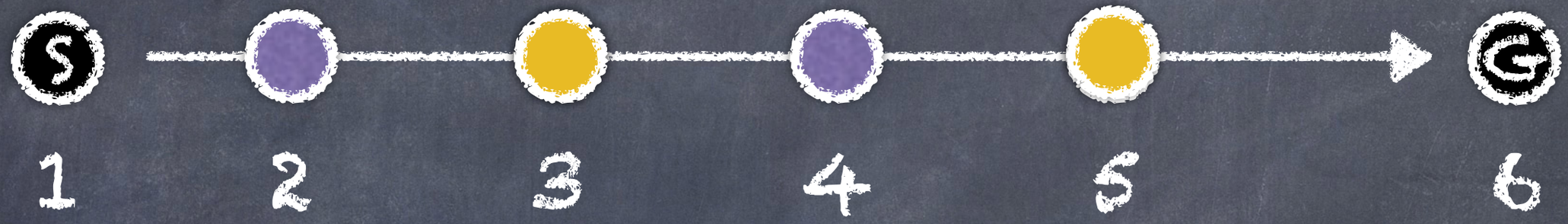


Intuition

Offline



Offline



start	1	2	3	4	5
goal	6	6	6	6	6
HCS	3	3	5	5	6

Offline

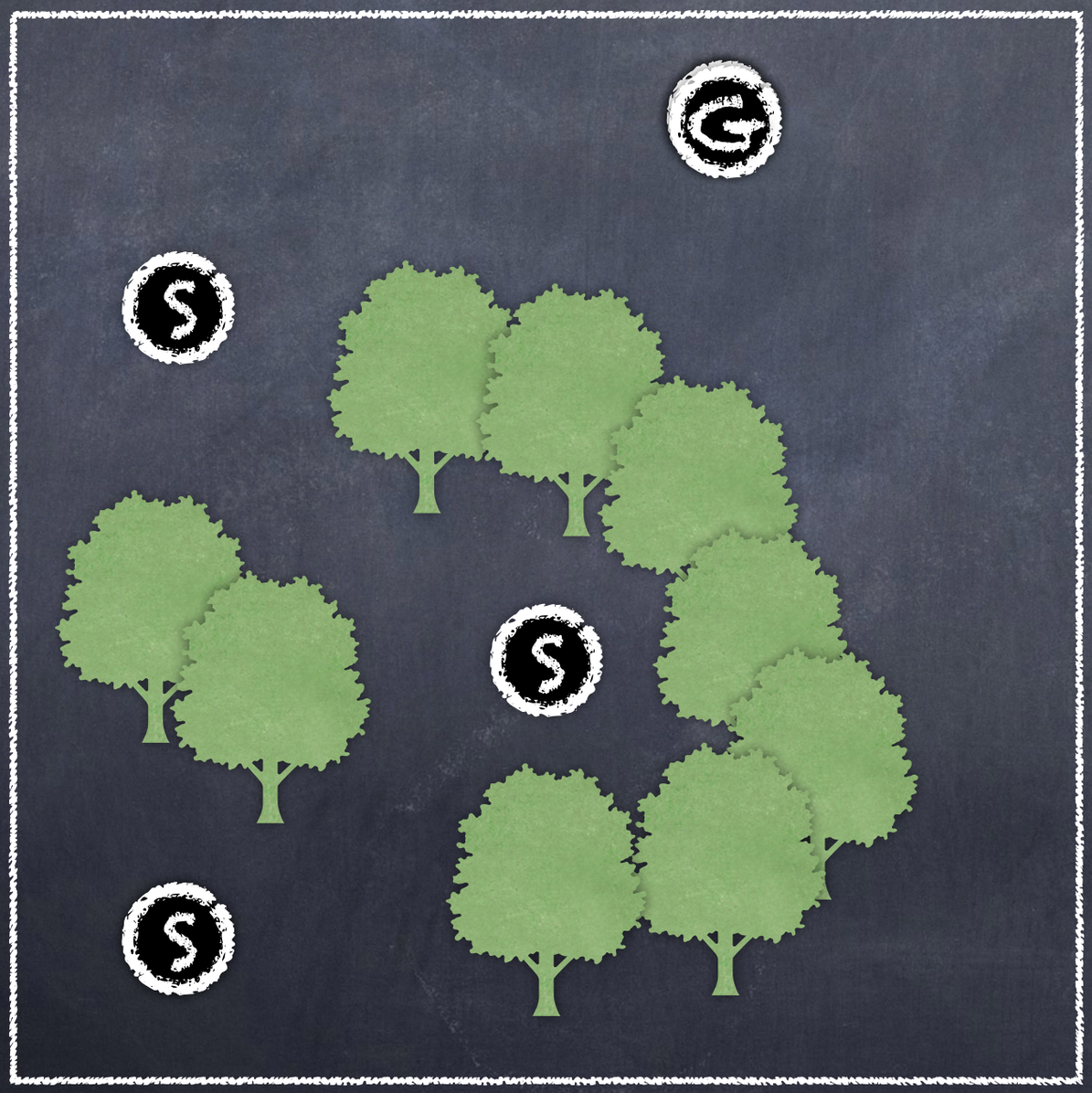
start	1	2	3	4	5	...
goal	6	6	6	6	6	...

HCS	3	3	5	5	6	...

Offline

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
      Embedding-1                [-1, 2, 64]         198,528
         Linear-2                 [-1, 1024]         132,096
        Dropout-3                 [-1, 1024]               0
         Linear-4                 [-1, 3102]       3,179,550
   LargeEmbedModel-5              [-1, 3102]               0
================================================================
Total params: 3,510,174
Trainable params: 3,510,174
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 0.06
Params size (MB): 13.39
Estimated Total Size (MB): 13.45
----------------------------------------------------------------
```

Online

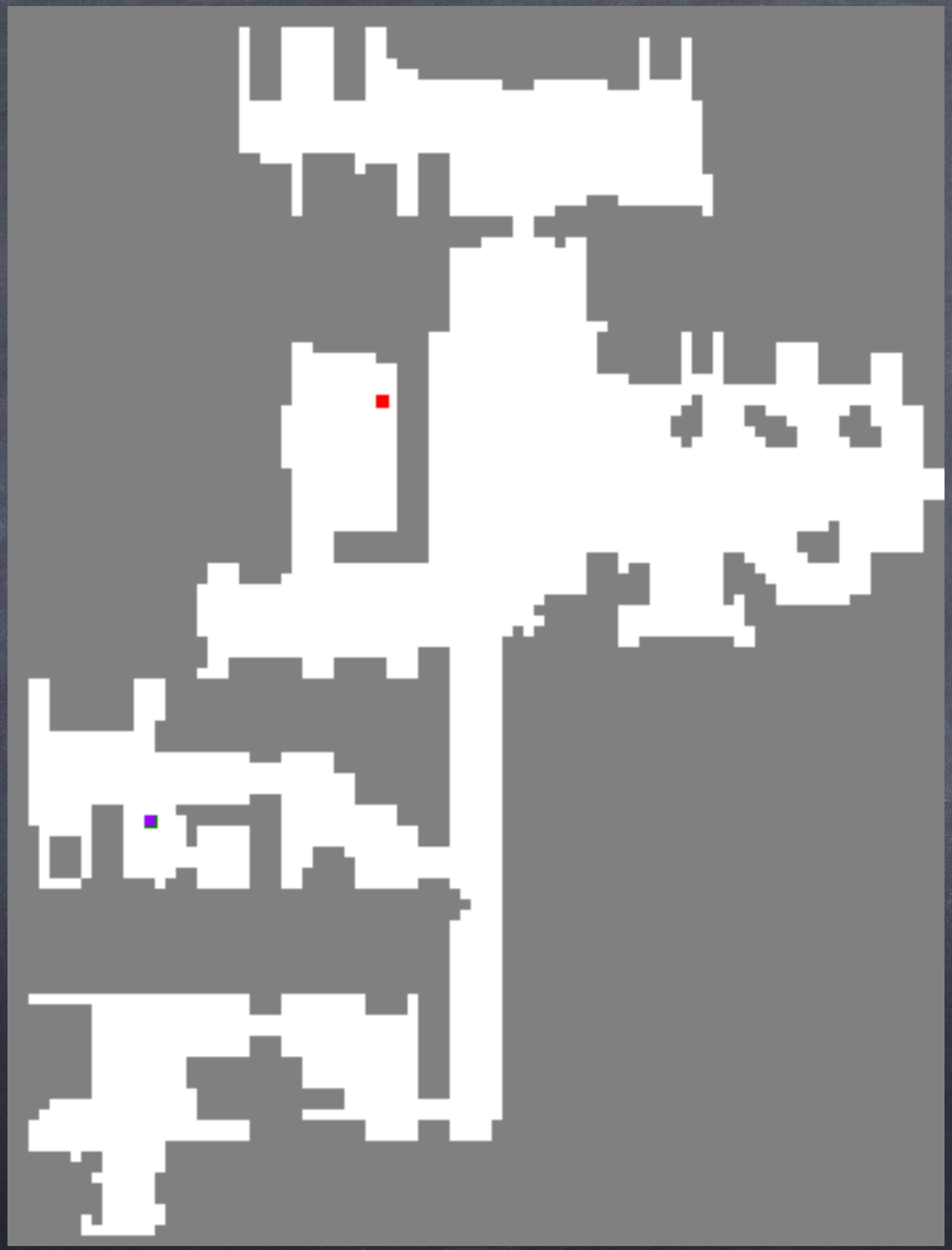


Online

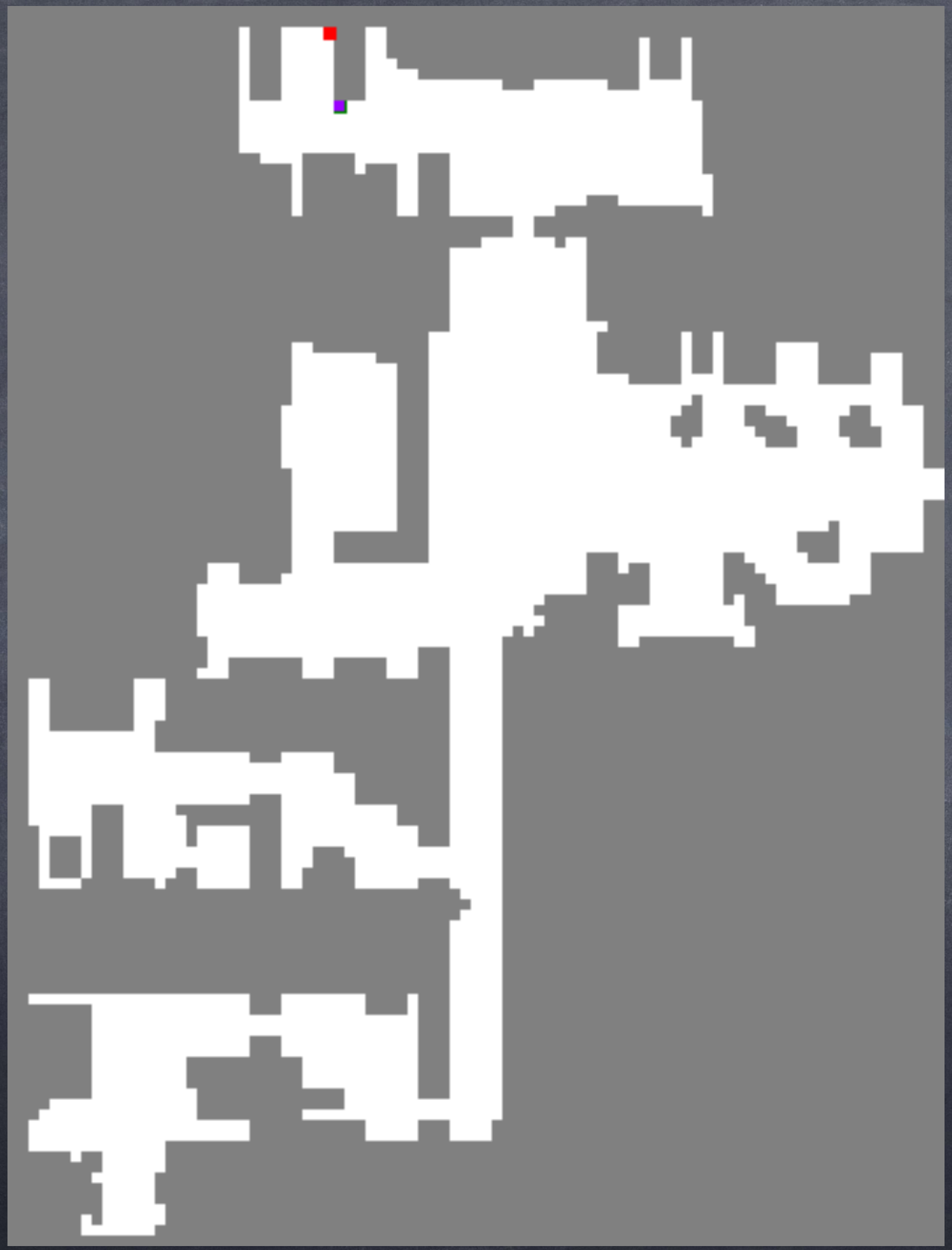
- can't hill-climb? get a new subgoal
- subgoal too far? cutoff steps
- completeness?
  - fallback (oracle) - LRTA* (8)
  - active when visit count > 1

NNHCS in Action

subopt (%)
0



subopt (%)
0



(worst case)

subopt (%)

375

Evaluation

	DB time (s)	DB size (MB)	move time (µs)	overall time (ms)	subopt (%)
NNHCS	1300	13	1127	15.8	3-8
LRTA* (8)	0	0	830	34.3	242.3

- find optimal path 83-85%
- DB time pays off after 71k runs

Weakness (Future Work)

- utilize HCS patterns in map more
  - portable?
- select better HCS/paths
  - 9M vs 14M

Conclusion

- a few HCSs makes a good path
- NN can remember HCSs