RUTGERS

Self-playing Snake Game Based on Pathfinding algorithms

Yang Sui, Jin Xu, Runlin Hou

Snake Game

- Snake Game can be divided into several parts:
  - Map
  - Snake
  - Food

- Implement Snake Game using Graph Theory
  - Map, undrectied graph, each edge has the same weight
  - Snake, body of snake would be considered as unreachable vertex
  - Food, marked as a normal vertice

Principle

- Snake length will be initialized as 3
- New food will be generated on random position after the last food was taken
- The snake can not hit the wall and its own body

Goal

- Get score
- Be alive
- Less movements

Algorithms

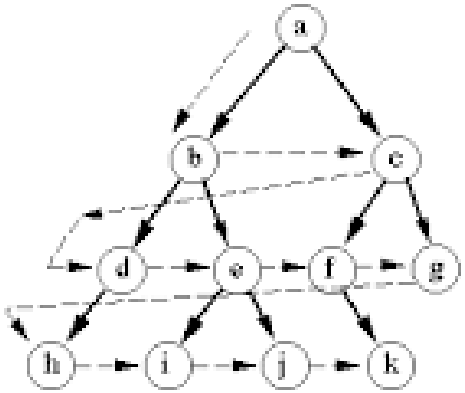
- BFS
- A*
- Hamilton

Breadth-First Search

- BFS will try to traversal all the map to find the target.

- All the vertices that is going to be visit will be added to a FIFO queue

Dijkstra is same with BFS when the weights of edges are the same



Breadth-first search

Breadth-First Search

- Visit the root vertice
- Visit the adjacencies of root vertice
- Visit the adjacencies of adjacencies until there is no un-visited vertices

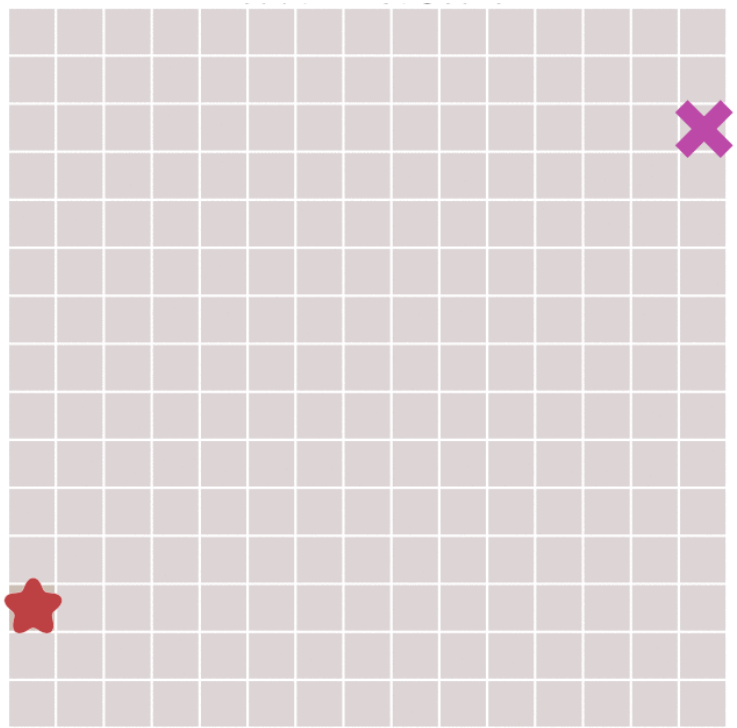
Implementation on Snake Game

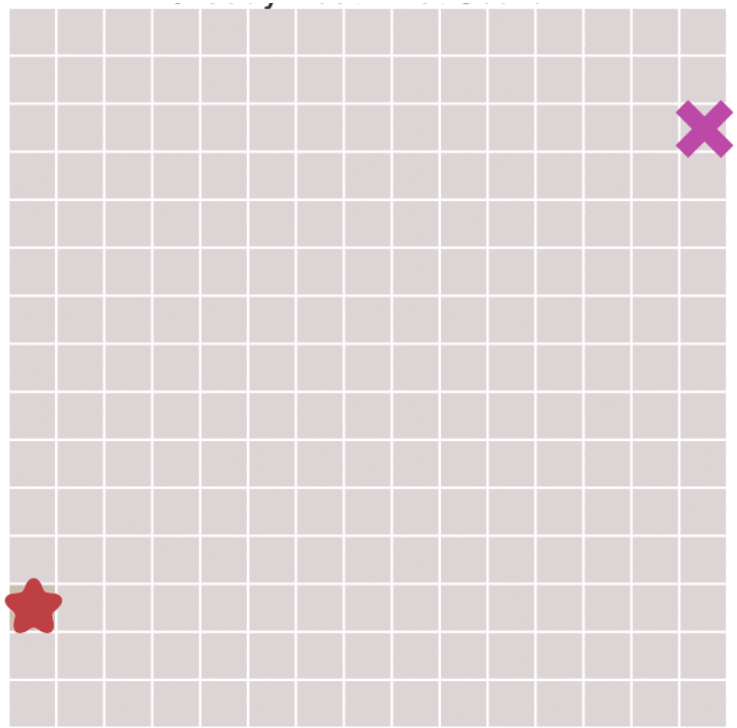
- Connected(ver) will return a list that the vertices ver is connected to
  - It will be avoided to return where the vertices is wall or been occupied by body
- Bfs(a, b) will find the shortest path from a to b using BFS

- Strategy
  - 1st target would be the food
  - If there is no path to the food, trace tail
  - If there is no path to tail, randomly walk

A* Algorithm

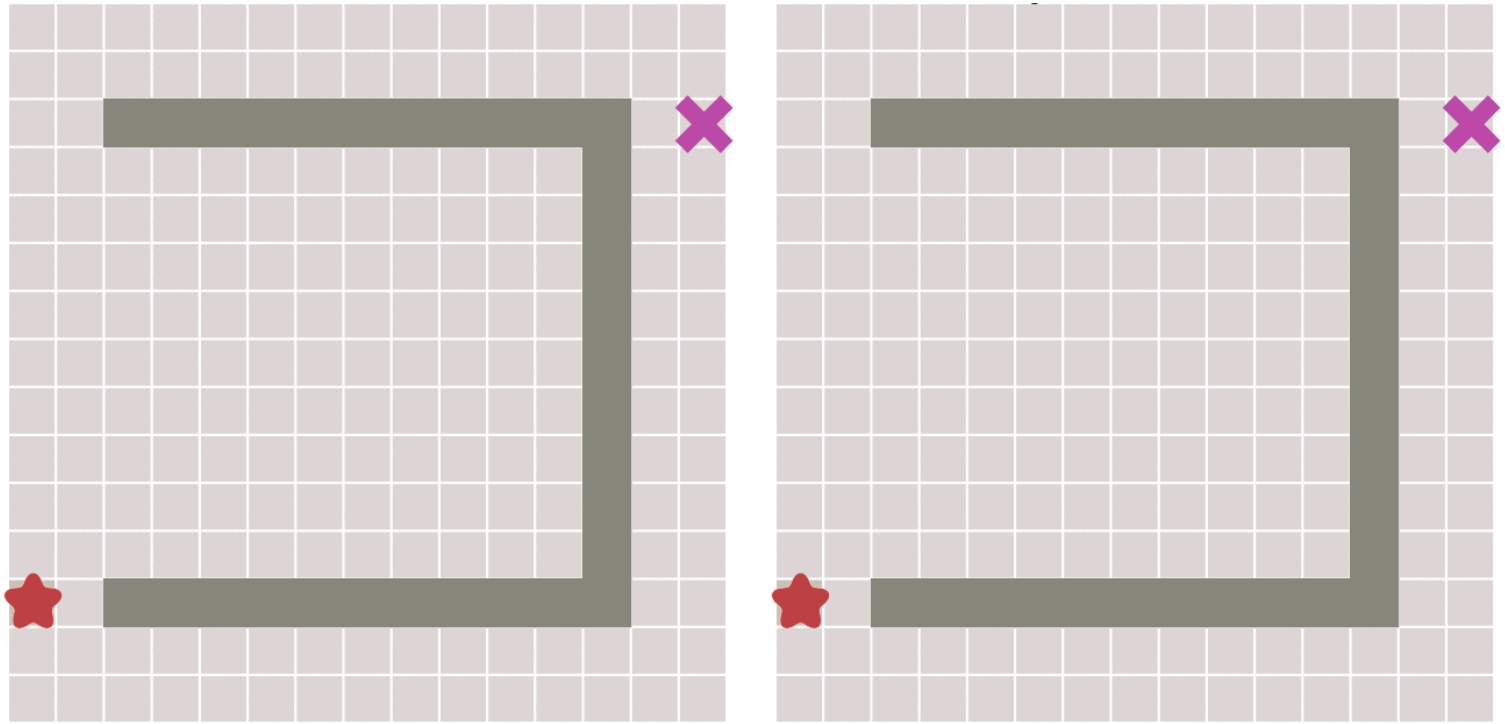
- Dijkstra's Algorithm + Greedy Algorithm





A* Algorithm (cont)

- Dijkstra's Algorithm + Greedy Algorithm



A* Algorithm (cont)

Dijkstra's Algorithm

- All possible directions
- Always shortest
- Slow

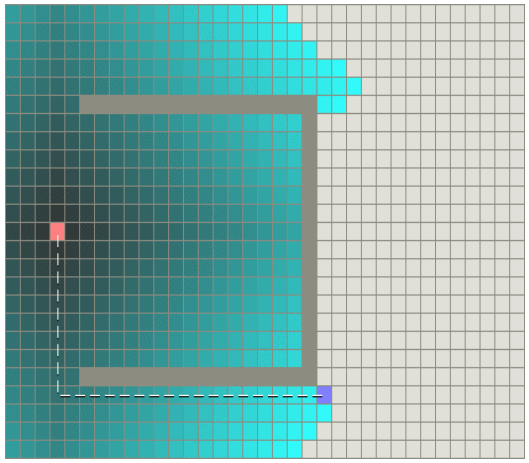
Greedy Algorithm

- The most possible direction
- Not guaranteed shortest
- Fast

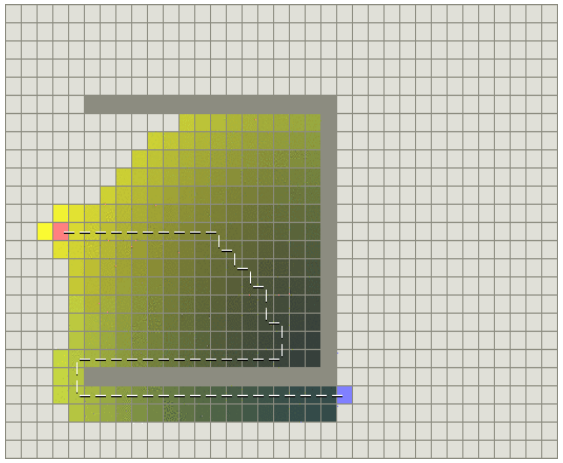
◆Use a heuristic function to guide the Dijkstra's searching path

A* Algorithm (cont)

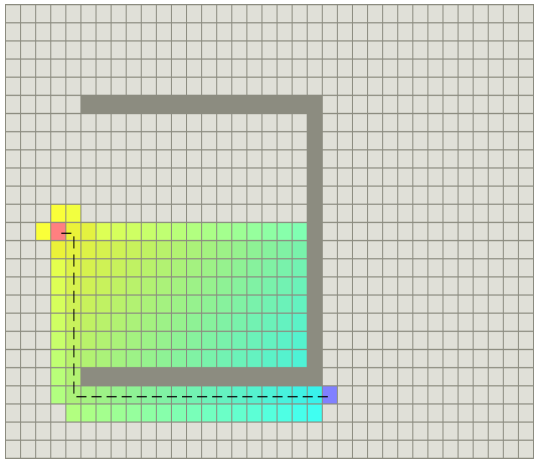
Dijkstra's Algorithm



Greedy Algorithm



A* Algorithm



A* Algorithm (cont)

- Also use a priority queue, but not just adding weights

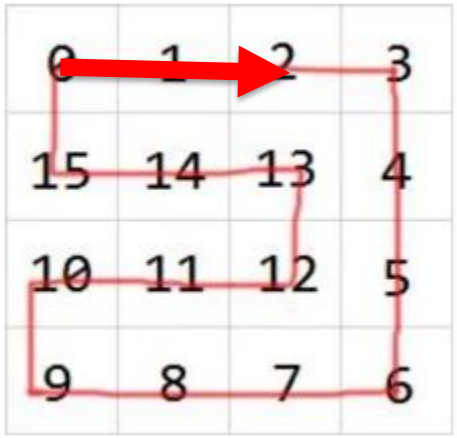
$$f(n) = g(n) + h(n; d)$$

- The cost from starting point to vertex n
- Heuristic estimate the cost from n to destination d
  - Manhattan distance
  - Euclidean distance

Hamilton Algorithm: Alive Longer

- A Hamiltonian cycle, also called a Hamiltonian circuit, through a graph that visits each node exactly once.

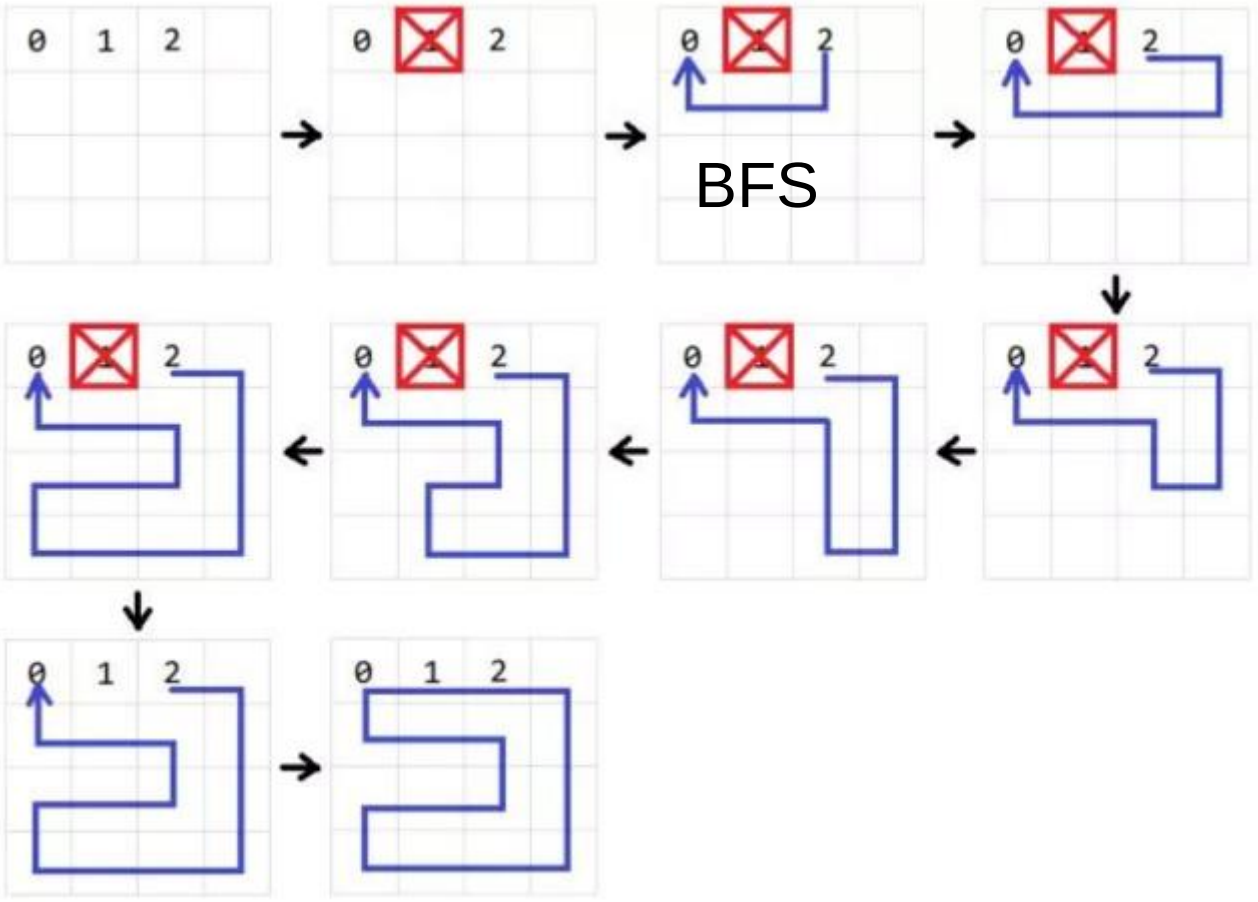
In Snake Game:



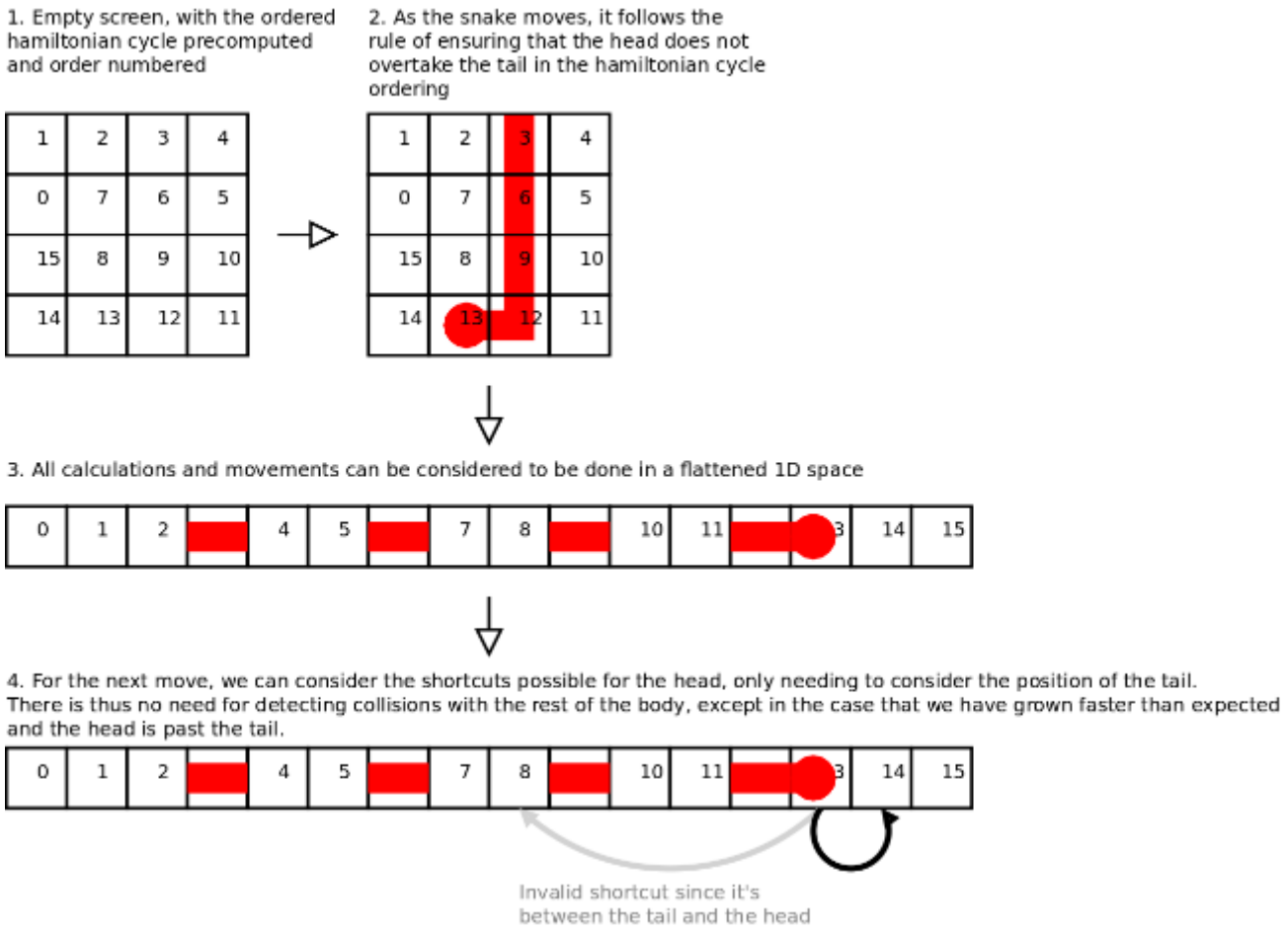
HEAD

INITIAL SNAKE

Build the Hamilton circle.

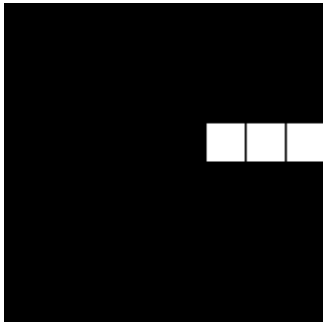


Short Way: Not always Longest Way.

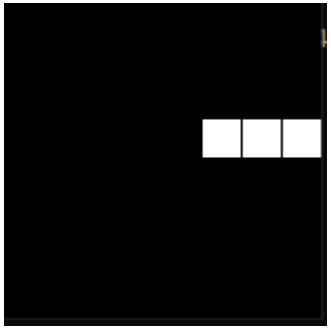


Performance: Alive

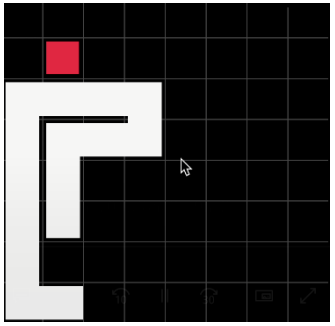
- Hamiton algorithm can finish the map every time
- A*, BFS can only reach half of the map



BFS

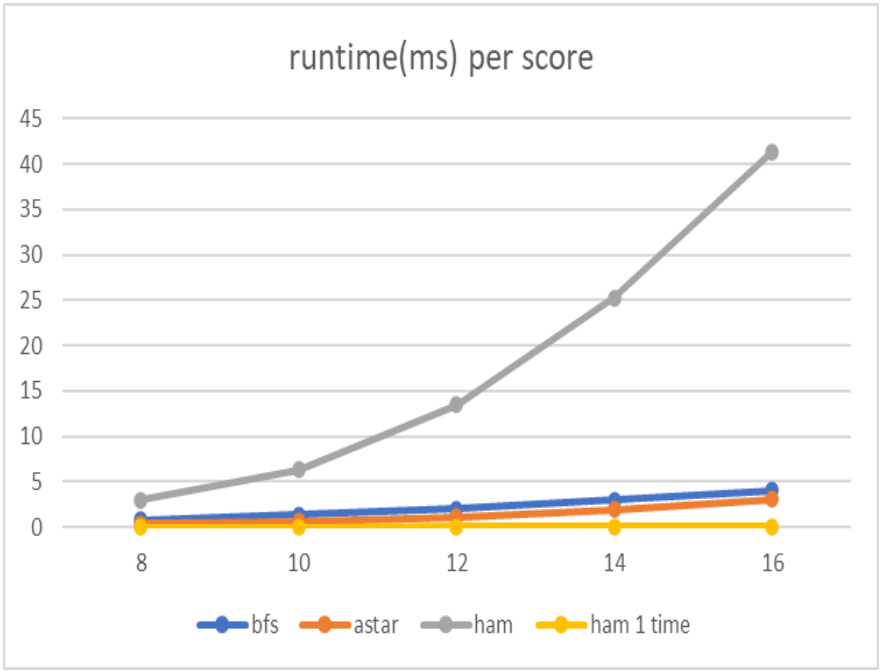


A*



Hamilton

Performance: Move Length & Runtime



Conclusion

- Move Path Length (less is better) :
  - BFS ≈ A* < Hamilton 1time < Hamilton
- Alive(longer is better) :
  - Hamilton 1time = Hamilton > A* > BFS