无信息搜索

PPT制作及讲解：罗玲

目录

- 理论课回顾
  - 形式化一个搜索问题
    - 问题的定义
    - 问题的解的定义
    - 为什么要搜索算法
  - 问题求解算法的性能
  - 无信息搜索策略
    - 宽度优先搜索(BFS)
    - 一致代价搜索 (UCS)
    - 深度优先搜索(DFS)
    - 深度受限搜索
    - 迭代加深搜索
    - 双向搜索
- 思考题&实验任务

形式化一个搜索问题

1.1 问题的定义 [1]

用5个组件形式化定义一个search problem：

1）initial state 初始状态

2）Actions 行动

3）transition model 转移模型

4）goal test 目标测试

5）path cost 路径耗散

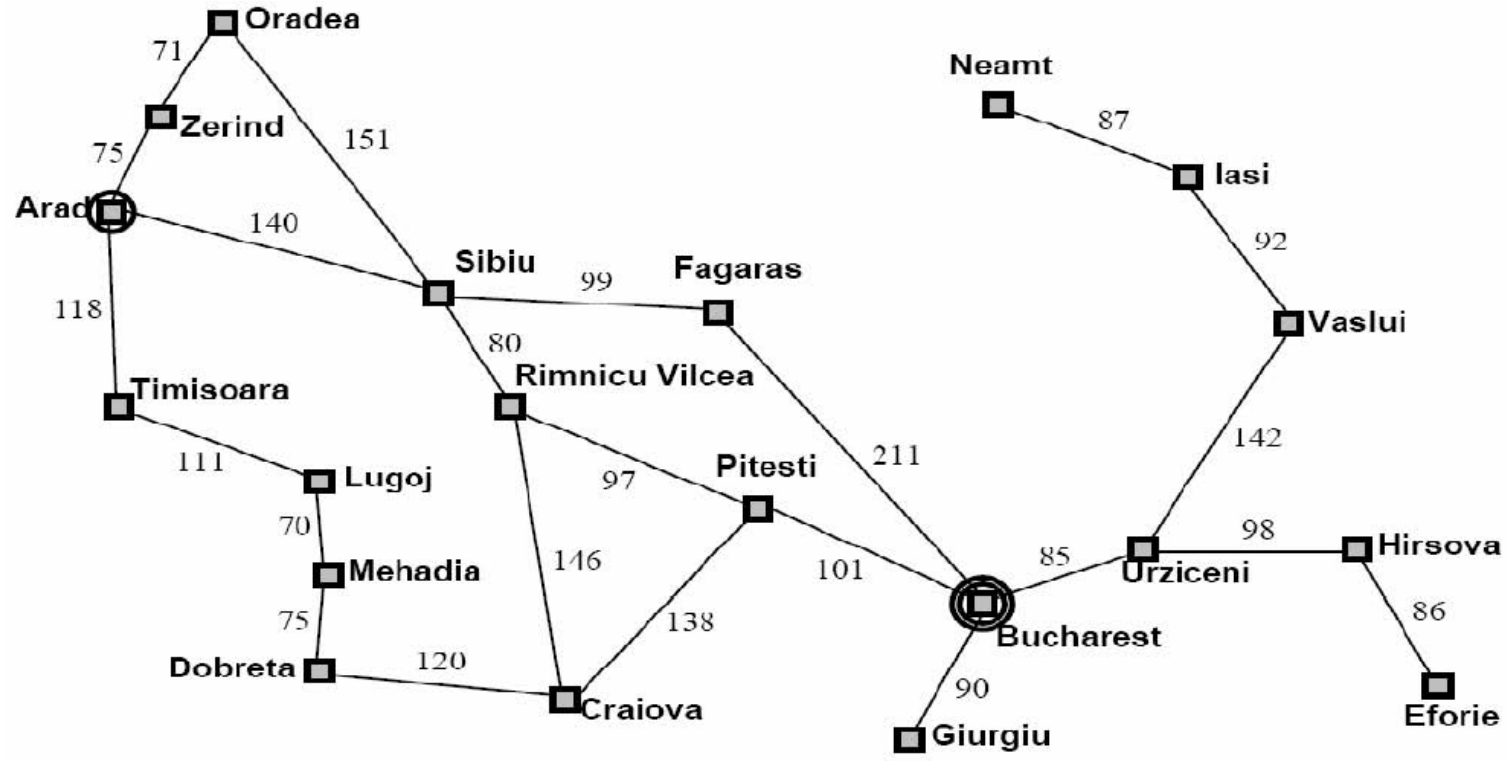
1.2 问题的解（solution）的定义

A solution to a problem is an action sequence that leads from the initial state to a goal state.

即：一个问题的解是：一个**行动**序列

举例

Currently in Arad, need to get to Bucharest



- **States:** the various cities you could be located in.
- **Actions:** drive between neighboring cities.
- **Initial state:** in Arad
- **Goal:** in Bucharest
- **Solution:** the route, the sequence of cities to travel through to get to Bucharest.

通过搜索求解

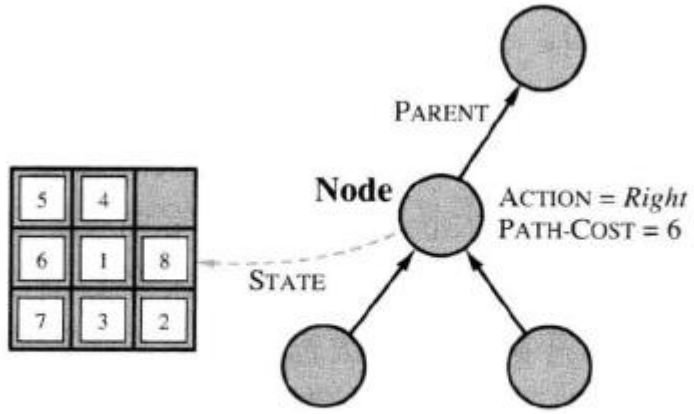
```
function TREE-SEARCH(problem) returns a solution, or failure
    initialize the frontier using the initial state of problem
    loop do
        if the frontier is empty then return failure
        choose a leaf node and remove it from the frontier
        if the node contains a goal state then return the corresponding solution
        expand the chosen node, adding the resulting nodes to the frontier

function GRAPH-SEARCH(problem) returns a solution, or failure
    initialize the frontier using the initial state of problem
    initialize the explored set to be empty
    loop do
        if the frontier is empty then return failure
        choose a leaf node and remove it from the frontier
        if the node contains a goal state then return the corresponding solution
        add the node to the explored set
        expand the chosen node, adding the resulting nodes to the frontier
            only if not in the frontier or explored set
```

图 3.7　一般的树搜索和图搜索算法的非形式化描述。用粗斜体标出的图搜索算法的部分内容是指需要额外处理重复状态

搜索的数据结构

对树中每个结点n，一般定义如下数据结构

- *n*.STATE：对应状态空间中的状态；
- *n*.PARENT：搜索树中产生该结点的结点（即父结点）；
- *n*.ACTION：父结点生成该结点时所采取的行动；
- *n*.PATH-COST：代价，一般用 $g(n)$表示，指从初始状态到达该结点的路径消耗；



结点是数据结构，由搜索树构造。每个结点都有一个父结点、一个状态和其他域。箭头由子结点指向父结点

求解算法的性能

四个方面：

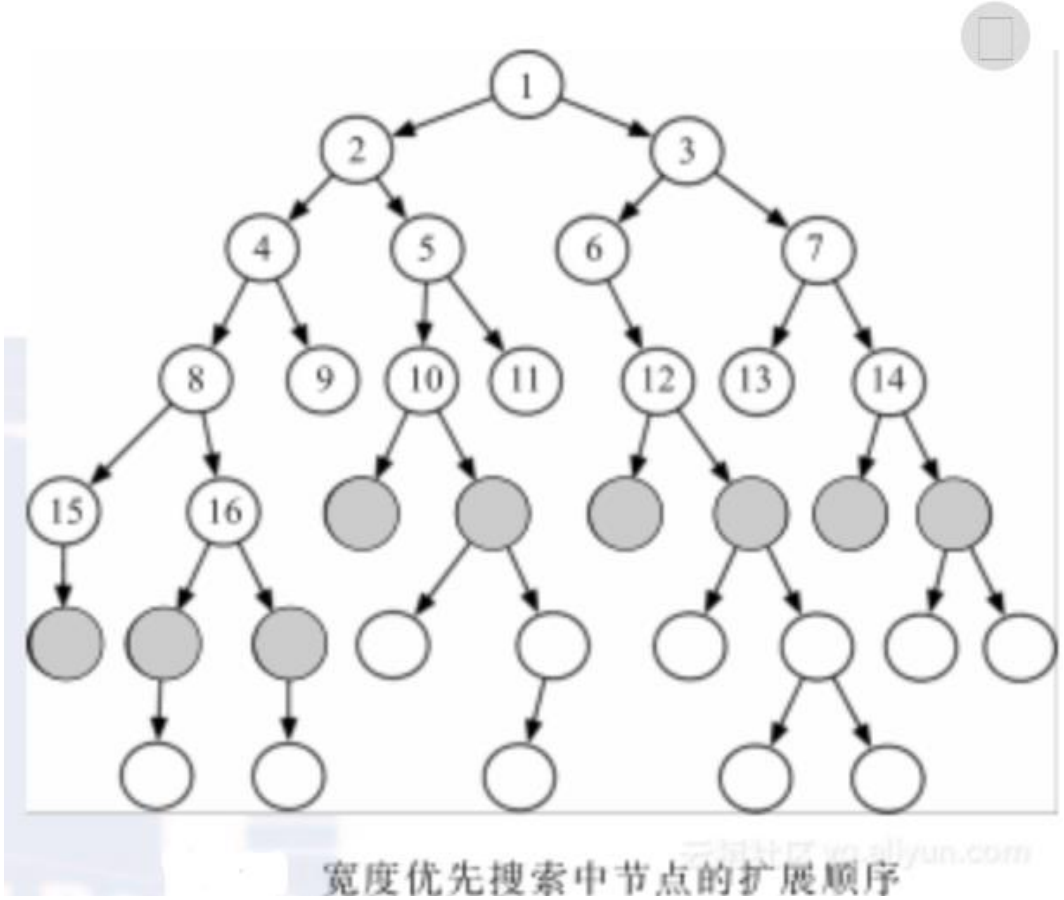
- 完备性（当问题有解时，这个算法能否保证找到解）
- 最优性（搜索策略能否找到最优解）
- 时间复杂度（找到解要花多长时间） 也叫搜索代价
- 空间复杂度（在执行搜索的过程中需要多少内存）

  总代价=搜索代价+内存使用（空间复杂度）

无信息搜索策略

- 宽度优先搜索
- 一致代价搜索
- 深度优先搜索
- 深度受限搜索
- 迭代加深搜索
- 双向搜索

宽度优先搜索(BFS)



宽度优先搜索中节点的扩展顺序

- 完备性;
- 非最优;
- 时间复杂度O(b^d);
- 空间复杂度O(b^d);

- 节点扩展顺序与目标节点的位置无关;
- 边界（frontier）用一个先进先出（FIFO）队列实现;

一致代价搜索Uniform-cost search (UCS)

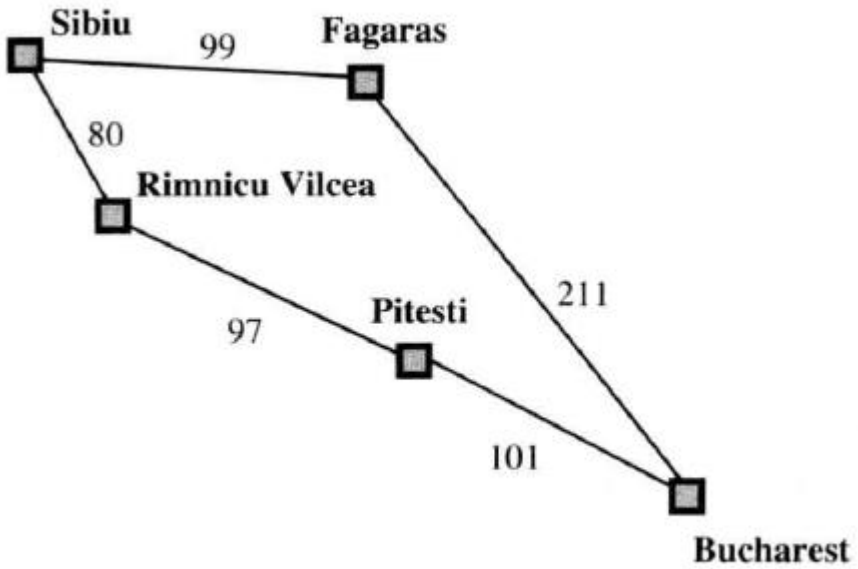


图 3.15　罗马尼亚问题的部分状态空间，用于描述一致代价搜索

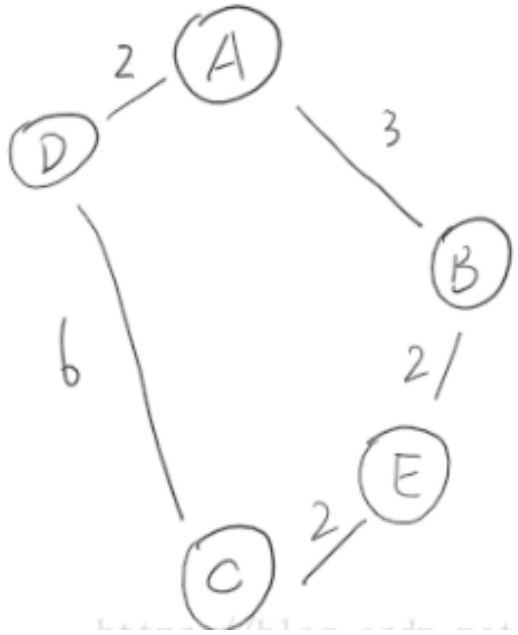
Search Strategy： 扩展最低代价的未扩展节点。

Implementation： 队列，按路径代价排序，最低优先

Complexity： $O(b^{1+\lfloor C^*/e \rfloor})$

一致代价搜索Uniform-cost search (UCS)

```
function UNIFORM-COST-SEARCH(problem) returns a solution, or failure
  node ← a node with STATE = problem.INITIAL-STATE, PATH-COST = 0
  frontier ← a priority queue ordered by PATH-COST, with node as the only element
  explored ← an empty set
  loop do
    if EMPTY?(frontier) then return failure
    node ← POP(frontier)  /* chooses the lowest-cost node in frontier */
    if problem.GOAL-TEST(node.STATE) then return SOLUTION(node)
    add node.STATE to explored
    for each action in problem.ACTIONS(node.STATE) do
      child ← CHILD-NODE(problem, node, action)
      if child.STATE is not in explored or frontier then
        frontier ← INSERT(child, frontier)
      else if child.STATE is in frontier with higher PATH-COST then
        replace that frontier node with child
```



深度优先搜索 (DFS)

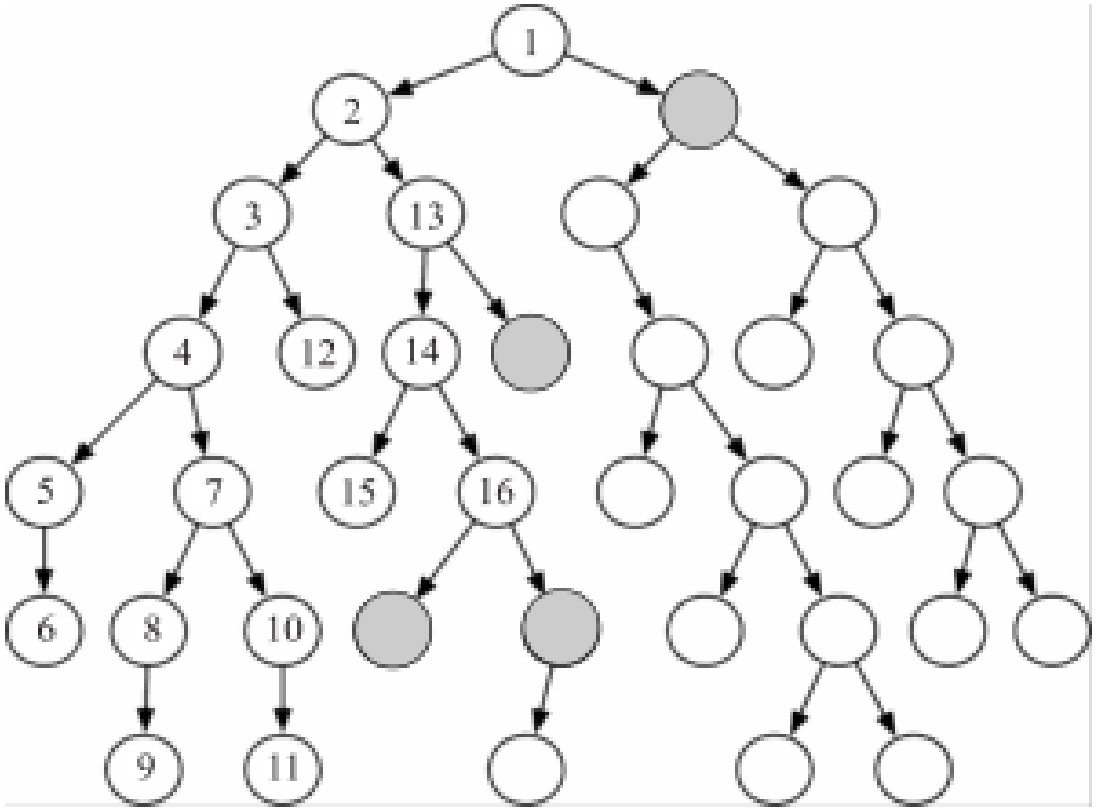


图 3-5　深度优先搜索中节点的扩展顺序

深度受限搜索 (Depth-limited Search)

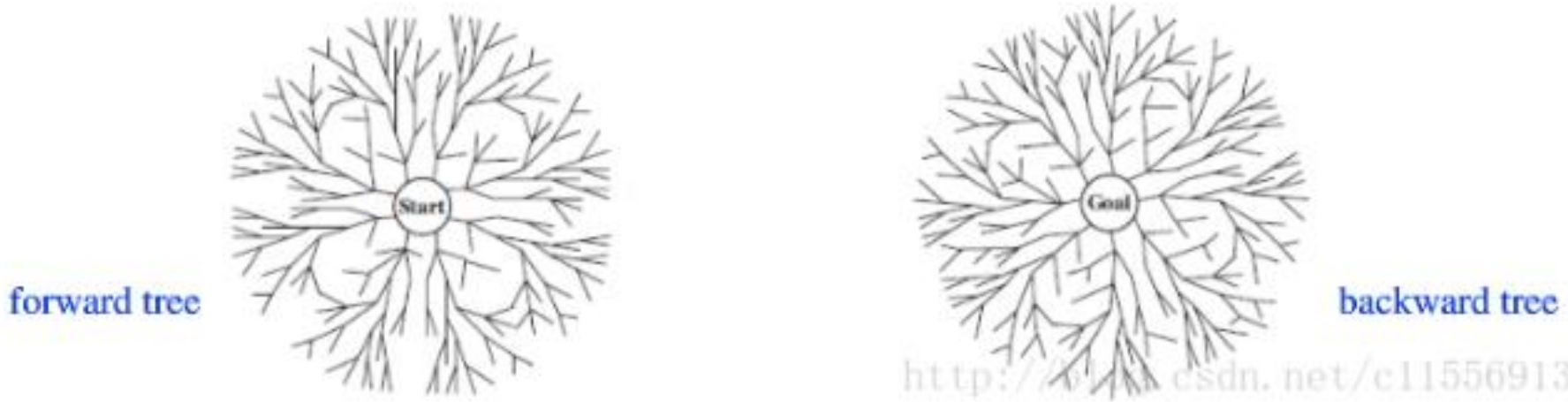
```
function Depth-Limited-Search(problem, limit) returns a solution, or failure/cutoff
    if problem.Goal-Test(node.State) then return Solution(node)
    if limit = 0 then return cutoff     //no solution
    cutoff_occurred? ← false
    for each action in problem.Action(node.State) do
        child ← Child-Node(problem, node, action)
        result ← Recusive-DLS(child, problem, limit - 1)
        if result = cutoff then cutoff_occurred ? ← true
        else if result ≠ failure then return result
    if cutoff_occurred ? then return cutoff    //no solution
    else return failure
```

迭代加深搜索（Iterative Deepening Search）

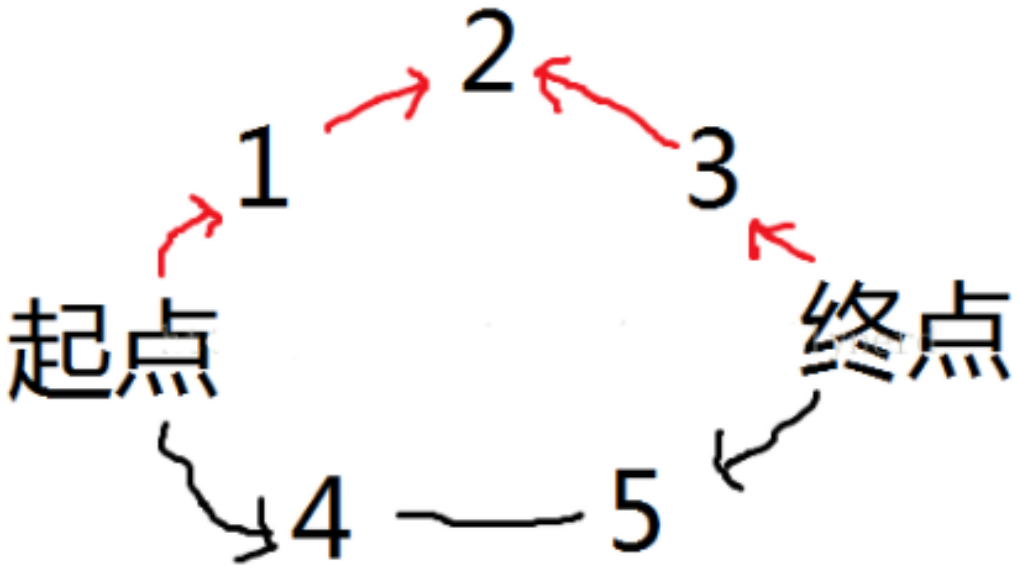
```
1  function Iterative-Deepening-Search(problem, limit) returns a solution, or failure
2      for depth = 0 to ∞ do
3          result ← Depth-Limited-Search(problem,  depth)
4          if result ≠ cutoff then return result
```

双向搜索 （Bidirectional search）

它同时进行两个搜索：一个是从初始状态向前搜索，二另一个则从目标向后搜索。当两者在中间相遇时停止。



双向搜索 （Bidirectional search）



无信息树搜索策略评价

Evaluation of Uninformed Tree-search Strategies

无信息树搜索策略评价

Criterion	Breadth First	Uniform Cost	Depth First	Depth Limited	Iterative Deepening	Bidirectional
Complete	Yes[a]	Yes[a,b]	No	No	Yes[a]	Yes[a,d]
Time	$O(b^d)$	$O(b^{1+\lfloor C^*/\epsilon \rfloor})$	$O(b^m)$	$O(b^\ell)$	$O(b^d)$	$O(b^{d/2})$
Space	$O(b^d)$	$O(b^{1+\lfloor C^*/\epsilon \rfloor})$	$O(bm)$	$O(b\ell)$	$O(bd)$	$O(b^{d/2})$
Optimal	Yes[c]	Yes	No	No	Yes[c]	Yes[c,d]

Where

- b -- maximum branching factor of the tree
- d -- depth of the shallowest solution
- m -- maximum depth of the tree
- l -- the depth limit

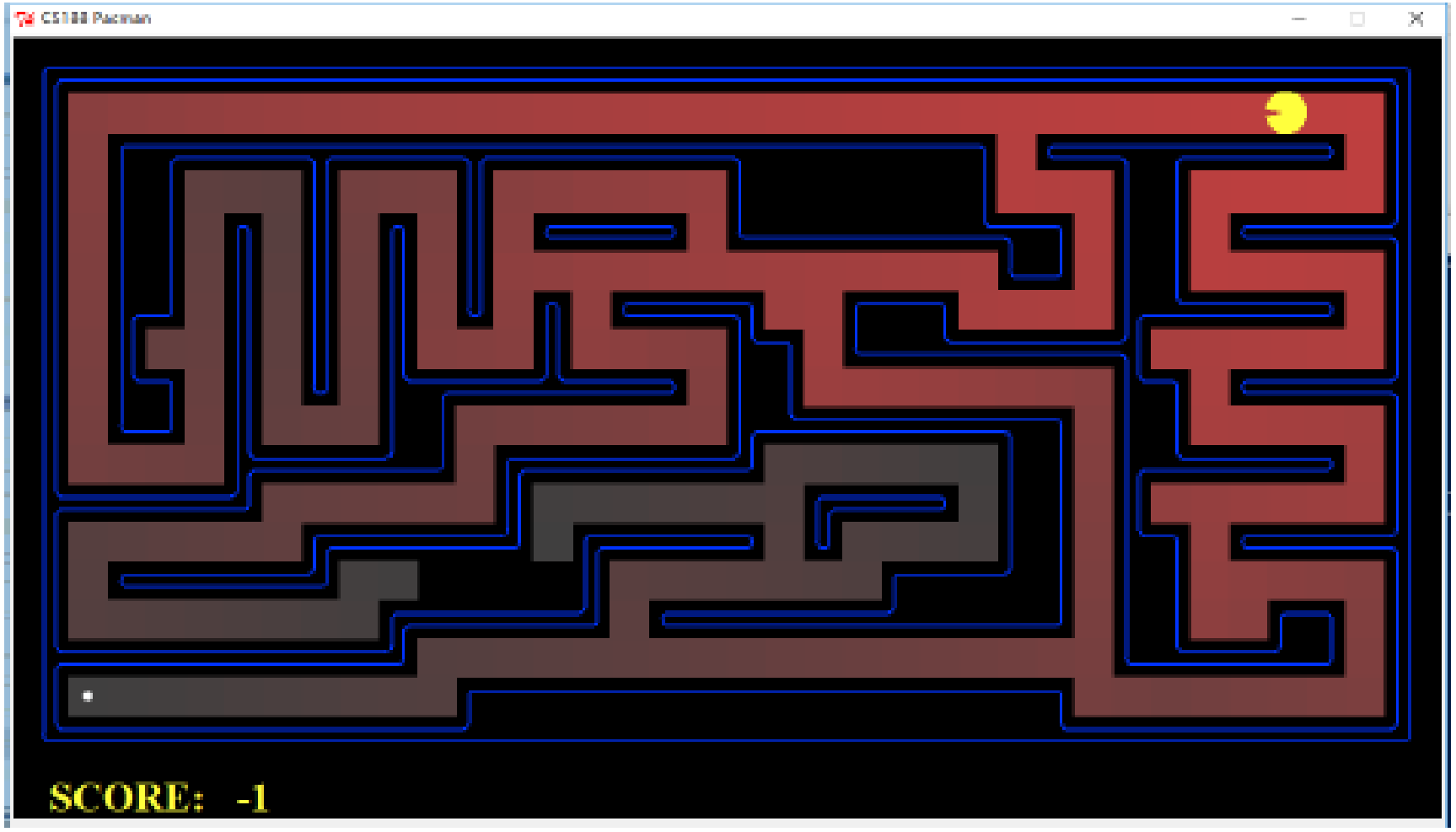
- a -- complete if b is finite
- b -- complete if step costs ϵ for positive
- c -- optimal if step costs are all identical
- d -- if both directions use breadth-first search

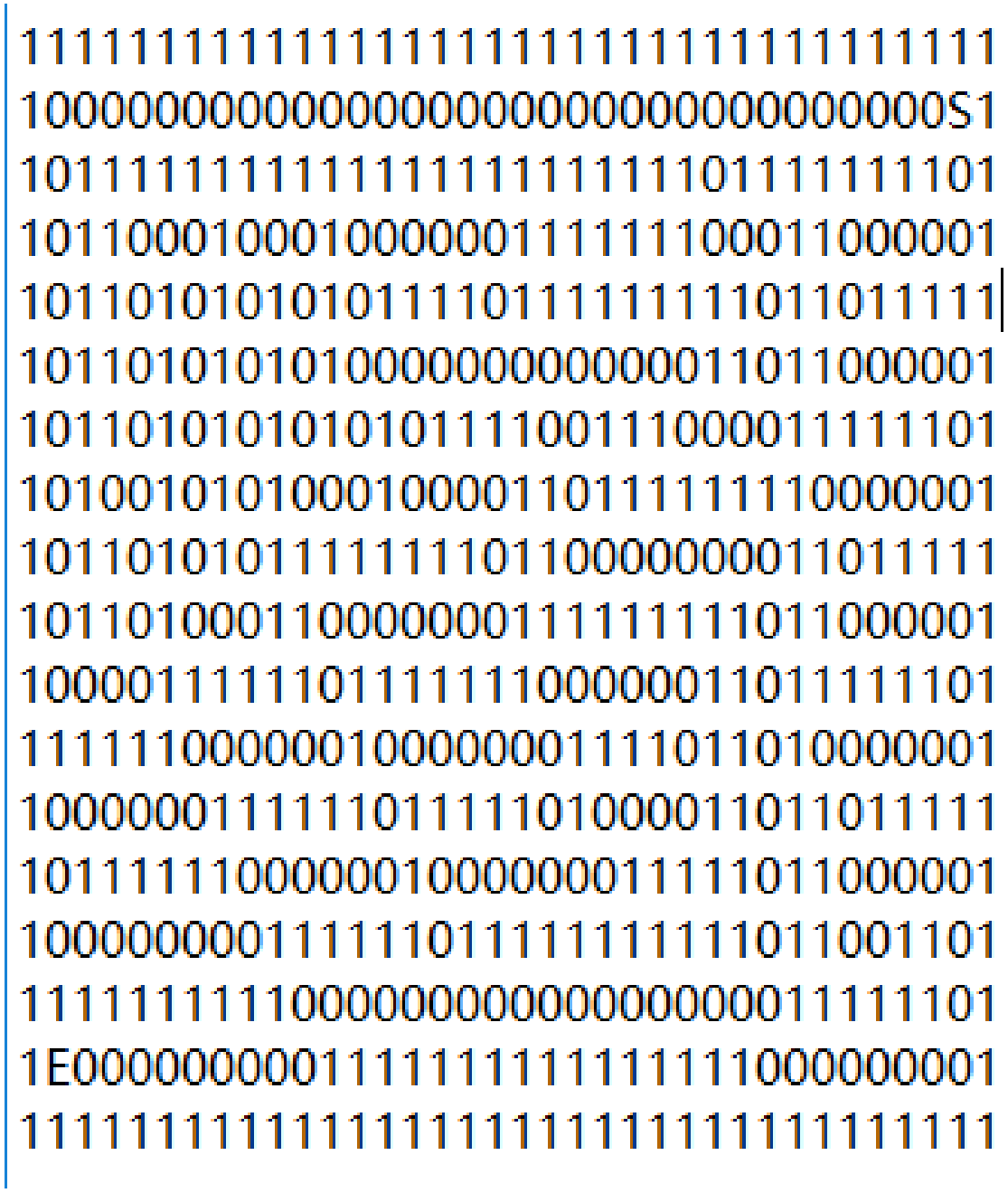
思考题

- 这些策略的优缺点是什么？它们分别适用于怎样的场景？

实验要求

- 从给定类型一和类型二中分别选择一个策略解决迷宫问题。
  类型一：BFS、DFS
  类型二：一致代价、迭代加深、双向搜索
- 代码要求使用python或者C++
- 报告要求：报告中①需要有对实现的策略（两个）的原理解释，②需要两种策略的实验效果（四个方面的算法性能）的对比和分析，③以及自己对不同策略优缺点，适用场景的理解和认识 。
- 提交文件
  - 实验报告：16******_wangxiaoming.pdf。
  - 代码：16******_wangxiaoming.zip。如果代码分成多个文件，最好写份readme。
- DDL: 2018-11-06 23:00:00


CS188 Pacman
SCORE: -1


11111111111111111111111111111111
10000000000000000000000000000S1
10111111111111111111111101111111101
10110001000100000111111100011000001
10110101010101111011111111011011111
10110101010100000000000011011000001
10110101010101011110011100011111101
10100101010001000011011111110000001
10110101011111111011000000011011111
10110100011000000011111111011000001
10000111111011111110000011011111101
11111100000010000000111101101000001
10000001111110111111010000110110111111
10111111000000100000001111101100000l
10000000011111101111111111011001101
11111111110000000000000000011111101
1E000000001111111111111111000000001
11111111111111111111111111111111111