Chapter2

Problems, Problem Spaces and search

(Cont…)

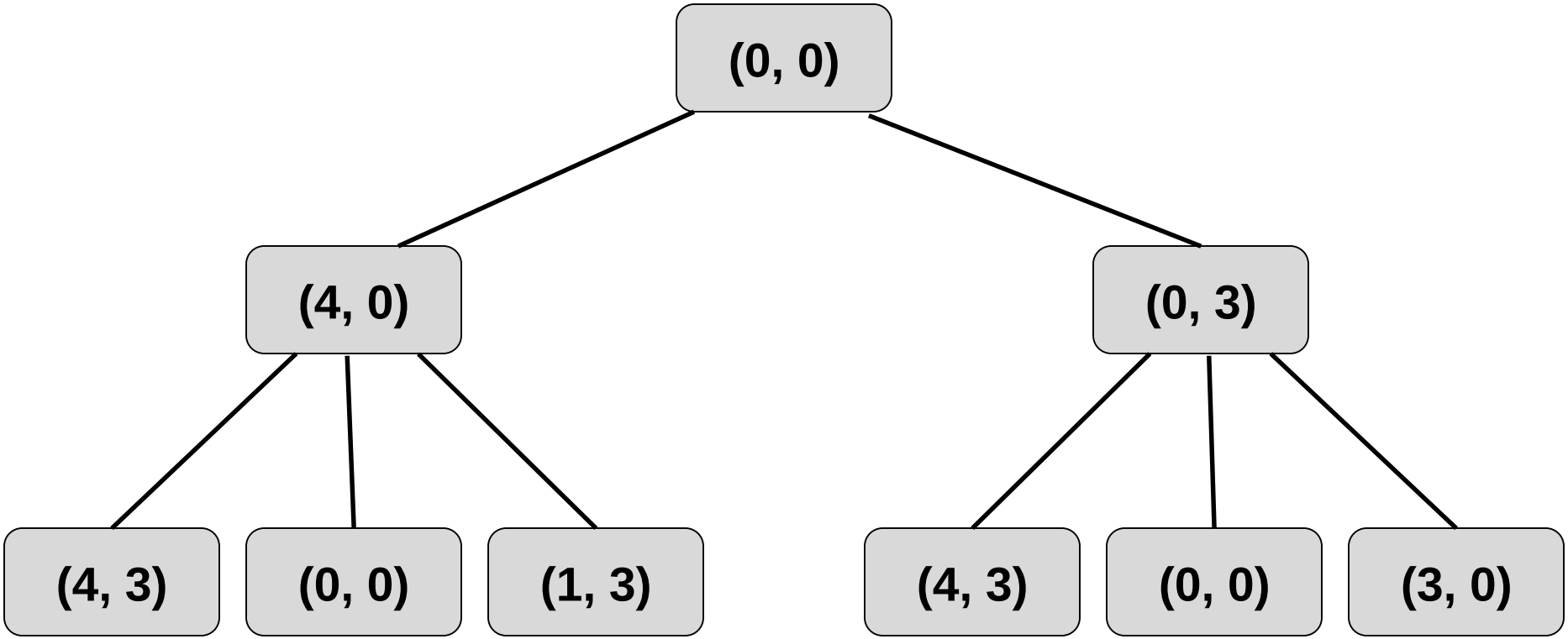
Production Systems

- Search forms the core of many intelligent processes, it is useful to structure AI programs in a way that facilitates describing and performing the search process. Production systems provide such structures
- A production system consists of:
  - A set of rules
  - One or more knowledge/databases
  - A control strategy that specifies the order in which the rules will be compared to the database and a way of resolving conflicts that arise when several rules match at once
  - A rule applier

Control Strategies

- Specifies the order in which the rules will be compared to the database and a way of resolving the conflicts that arise when several rules match at once
- Requirement of good control strategy
  - It causes motion
  - It must be Systematic

Systematic Control Strategy

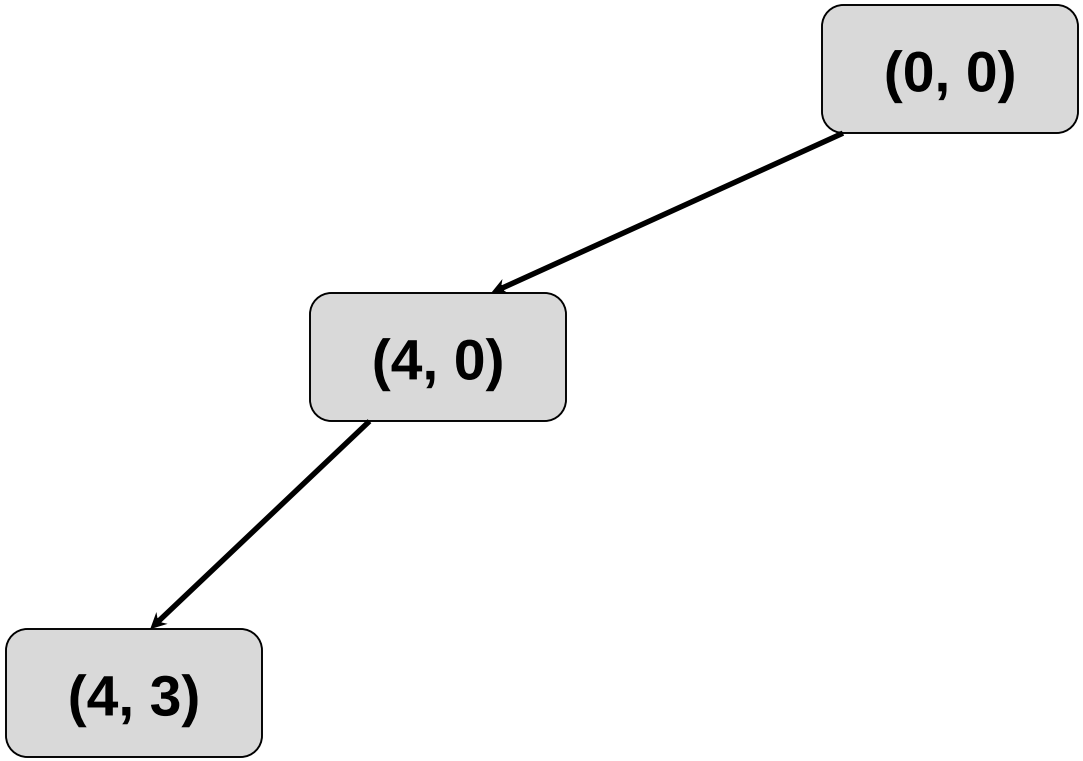


Breadth-First Search

- **Algorithm:**

1. **Create a variable called NODE-LIST and set it to the initial state**
2. **Until a goal state is found or NODE-LIST is empty do:**
   a) **Remove the first element from NODE-LIST and call it E. If NODE-LIST was empty, quit**
   b) **For each way that each rule can match the state described in E do:**
      i. **Apply the rule to generate a new state**
      ii. **If the new state is a goal state, quit and return this state**
      iii. **Otherwise,add the new state to the end of NODE-LIST**

Another Systematic Control Strategy



Depth-First Search

- **Algorithm:**

1. **If the initial state is a goal state, quit and return success**
2. **Otherwise, do the following until success or failure is signalled:**
   a) **Generate a successor, E , of the initial state. If there are no more successors, signal failure**
   b) **Call Depth-first search with E as the initial state**
   c) **If success is returned, signal success. Otherwise continue in this loop**

Chronological backtracking

- The most recently created state from which alternative moves are available will be revisited and a new state will be created. This form of backtracking is called chronological backtracking because the order in which steps are undone depends only on temporal sequence in which steps were originally made.
- Specifically, the most recent step is always the first to be undone

Advantages of DFS

- Requires less memory
- By chance, DFS may find a solution without examining much of search space at all

Advantages of BFS

- Never get trapped exploring blind alley
- If there is a solution then BFS is guaranteed to find it and if multiple solution exists then BFS finds a minimal solution

The Travelling Salesman Problem

- A motion causing and Systematic control structure could in principle solve this problem and return shortest path
- This approach will even work in practice for very short lists of cities but it breaks down quickly as the number of cities grows
- If there are N cities, then the number of different paths among them is 1.2….(N-1),or (N-1)! The time to examine a single path is proportional to N. So, total time required to perform this search is proportional to N!
- Assuming there are only 10 cities, 10! is 3,628,800,which is very large number. The salesman could easily have 25 cities to visit
- To solve this problem would take more time than he would be willing to spend. This phenomenon is called combinatorial explosion

Branch and bound

- Begin generating complete paths, keeping track of shortest path found so far. Give up exploring any path as soon as its partial length becomes grater than the shortest path found so far
- It still requires exponential time and inadequate for solving large problems
- So, in order to solve many hard problems efficiently, It is often necessary to compromise the requirements of mobility and systematically and to construct a control structure that is no longer guaranteed to find the best answer but that will almost always find a very good answer

Heuristics

- Problem Solving method
- Limited time frame
- Quick decision while working with complex data
- Not necessary be optimal
- Nearest neighbour heuristic

1. Arbitrarily select a starting city
2. To select the next city, look at all cities not yet visited, and select the one closest to current city. Go to it next
3. Repeat step 2 until all cities have been visited

Heuristics

- **Consider the task of discovering interesting idea in some specified area following heuristic is often useful**
  - **If there is an interesting function f(x , y) look at what happens if the two arguments are identical**
    - **In domain of mathematics**
    - **Set Theory**
    - **Humanity**

Why should we use Heuristics?

1. **Rarely do we actually need the optimal solution**
2. **Although the approximation produced by heuristics may not be very good in the worst case, worst case rarely arise in the real world**
3. **Trying to understand why heuristic works or why it doesn’t work often leads to a deeper understanding of the problem**

Heuristics

- The purpose of heuristic function is to guide the search process in the most profitable direction by suggesting which path to follow first when more than one is available
- There is a trade-off between the cost of evaluating a heuristic function and the saving in search time that the function provides

Heuristics for 8-puzzle

5		8
4	2	1
7	3	6

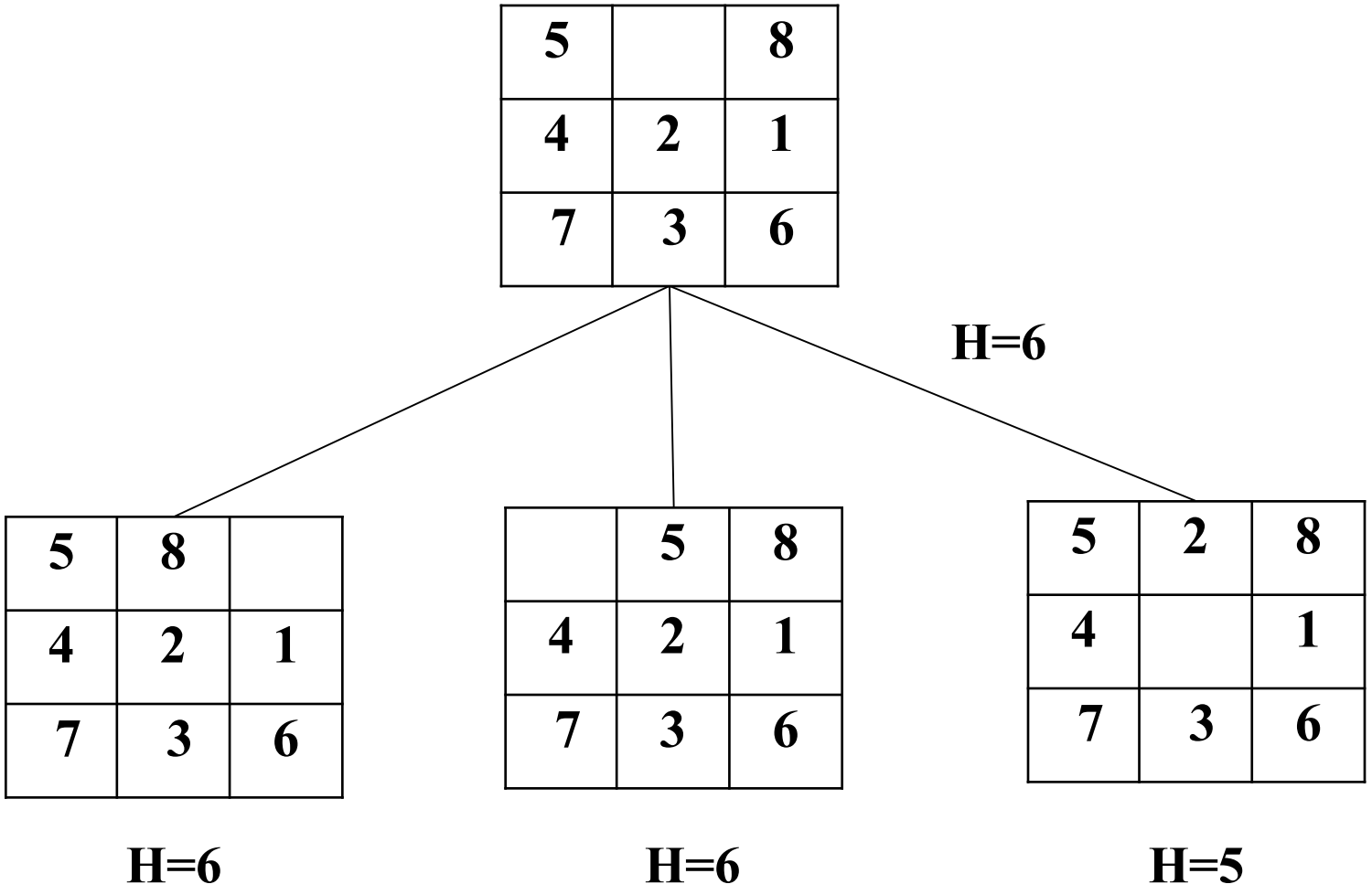
Start

1	2	3
4	5	6
7	8	

Goal

Heuristic1 = number of misplaced numbered tiles

Heuristics for 8-puzzle



Heuristics for 8-puzzle

5		8
4	2	1
7	3	6

Start

1	2	3
4	5	6
7	8	

Goal

Heuristic2 = sum of the (Manhattan) distance of every numbered tile to its goal position

= 2 + 3 + 0 + 1 + 3 + 0 + 3 + 1

=13

Cryptarithmetic Problem

- **Crypt-Arithmetic Problem which is a type of Constraint Satisfactory problem in Artificial Intelligence**
- **The Crypt-Arithmetic problem in Artificial intelligence is a type of encryption problem in which the written message in an alphabetical form which is easily readable and understandable is converted into a numeric form which is neither easily readable nor understandable. In simpler words, the crypt-arithmetic problem deals with the converting of the message from the readable plain text to the non-readable cipher text.**
- **The constraints which this problem follows is as follows:**

1. **A number 0-9 is assigned to a particular alphabet**
2. **Each different alphabet has a unique number**
3. **All the same, alphabets have the same numbers**