ME 620: Fundamentals of Artificial Intelligence

Lecture 3: Problem Solving as State Space Search - I

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Production Systems

- What is an AI Technique?
- Production Systems
  - Components of a Production System
  - Basic Procedure
  - Control and Control Strategies
    - Irrevocable
    - Backtracking
    - Graph Search
  - Problem Representation
- Specialized Production Systems
  - Commutative Production Systems
  - Decomposable Production Systems

What is an AI Technique?

- Artificial intelligence problems span a very broad spectrum. They appear to have very little in common except that they are hard.

- Are there any techniques that are appropriate for the solution of a variety of these problems?

What is an AI Technique?

One of the few hard and fast results to come out of the first three decades of AI research is the realization that

Intelligence requires Knowledge

What is an AI Technique?

AI Technique is a method that exploits knowledge and should be represented in such a way that:

- knowledge captures generalizations
- understood by people who provide it
- easily be modified
- used to help overcome its own sheer bulk.

What is an AI Technique?

To build a system to solve a particular problem, we need to do four things:

1. Define the problem precisely.
2. Analyze the problem.
3. Isolate and represent task knowledge.
4. Choose the best problem-solving techniques.

What is an AI Technique?

Traditional Programming	**Programming With AI**
Program can **answer** ONLY the **specific questions** it is meant to solve.	Program with AI can **answer generic questions** it is designed to solve.
Modification in the program leads to **change in its structure**.	**Modifications** in program **do not change** the **structure**; independent pieces of information.
Modification **may lead to affecting** the **program adversely.**	**Quick and Easy** program modification.

Problem as a State Space Search

- Problem-solving tasks can be formulated as a search in a state space.
  - A state space consists of all the states of the domain and a set of operators that change one state into another.
  - The states can best be thought of as nodes in a connected graph and the operators as edges.
  - Certain nodes are designated as goal nodes, and a problem is said to be solved when a path from an initial state to a goal state has been found.

Problem as a State Space Search

The set of all possible configurations of the relevant objects is the space of problem states or the problem space. This is also called the state space.

For Example – 8-Puzzle

Each tile configuration is a problem state

8-puzzle have a relatively small space

362,880 i.e., 9! different configurations.

Problem as a State Space Search

For Example – Play Chess

Initial State as an 8 X 8 array

Legal moves as set of rules; each rule consisting of two part

A left side that serves as pattern to be matched

A right side that describes the change to reflect the move

Goal State as any board position where opponent does not have a legal move.

Problem as a State Space Search

Play chess by starting at an initial state, using a set of rules to move from one state to another, and attempting (search) to end up in one of a set of final states.

This state space representation seems natural for chess, because the set of states corresponding to set of board positions.

This kind of representation is also useful for less structured problems with use of more complex structures than a matrix.

Formal Description of a Problem

State Space	Define a state space that contains all the possible configurations of the relevant objects.
Initial States	Specify one or more states within that space as possible situations from which the problem-solving can start.
Goal States	Specify one or more states that would be acceptable as solutions to the problem
Operators	Specify a set of rules that describes the actions (operators) available; information on what must be true, for the action can take place.

Playing 8-Puzzle

Problem Solving as State Space Search

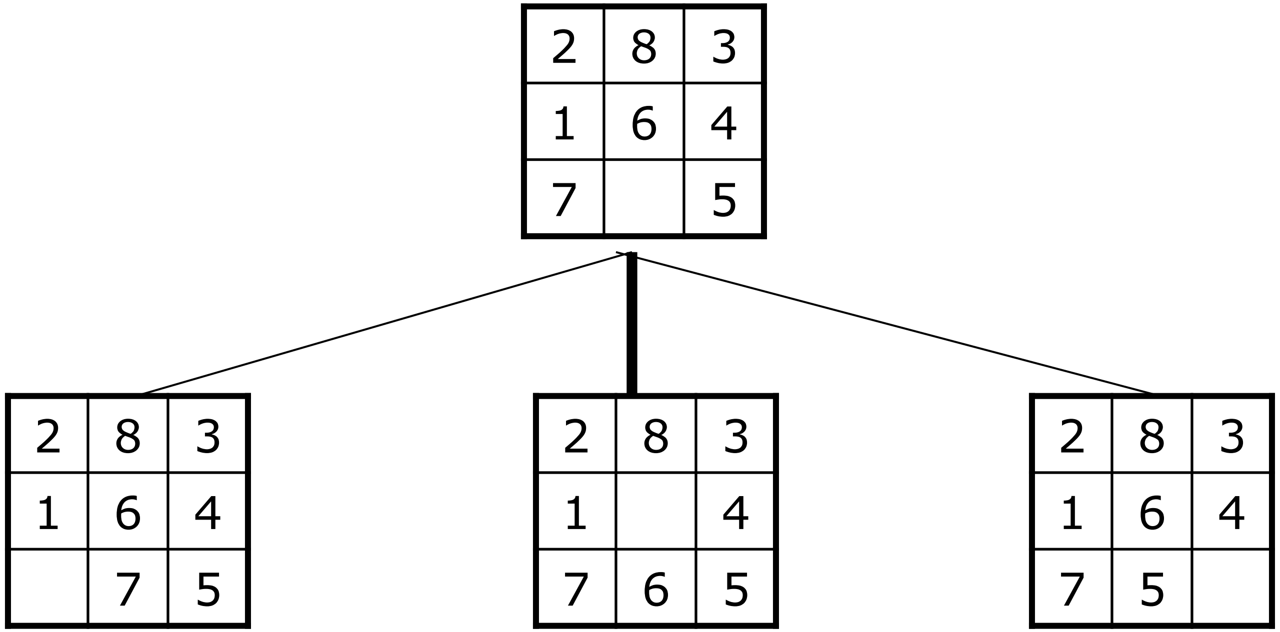
s ; Start Node

2	8	3
1	6	4
7		5

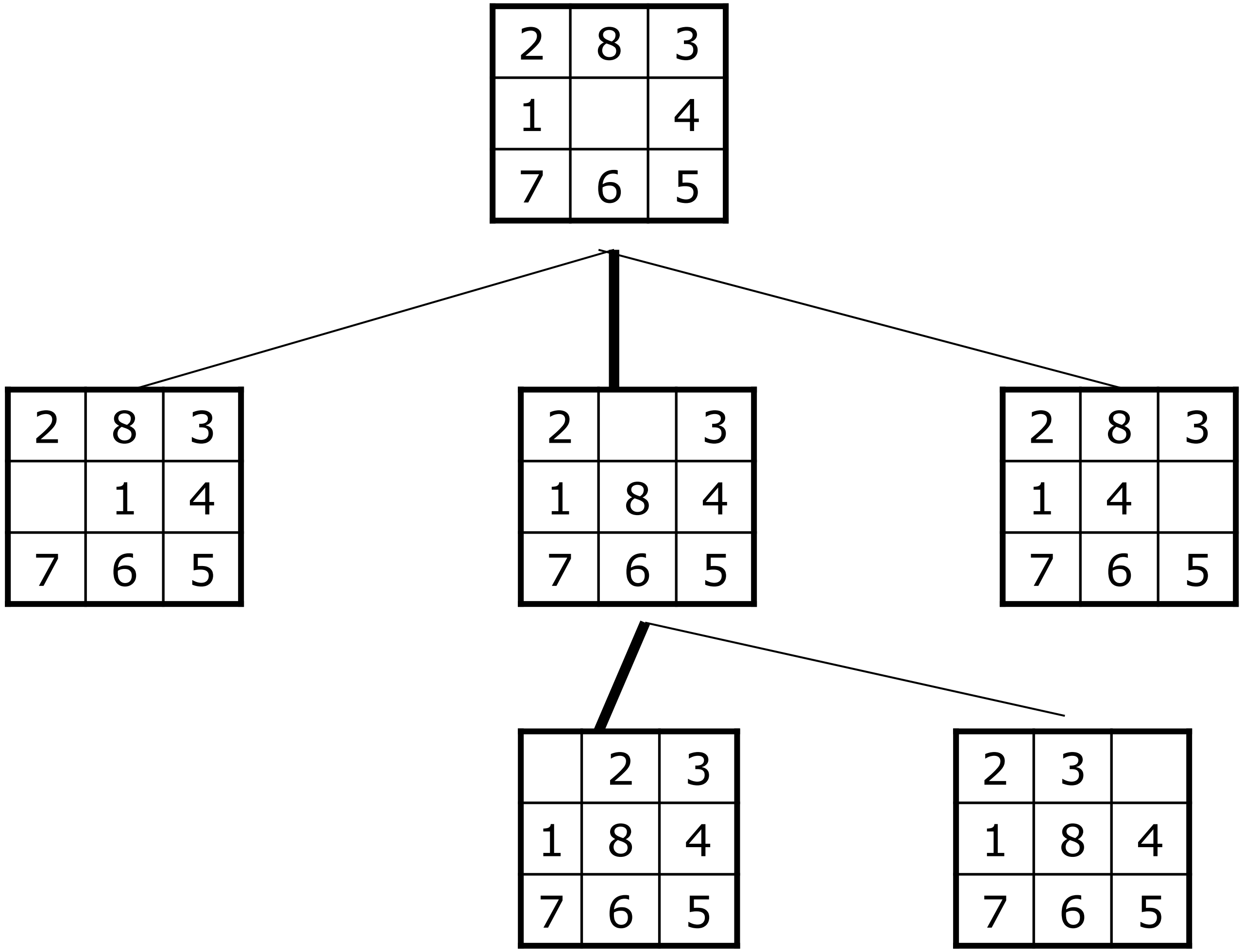
g ; Goal Node

1	2	3
8		4
7	6	5

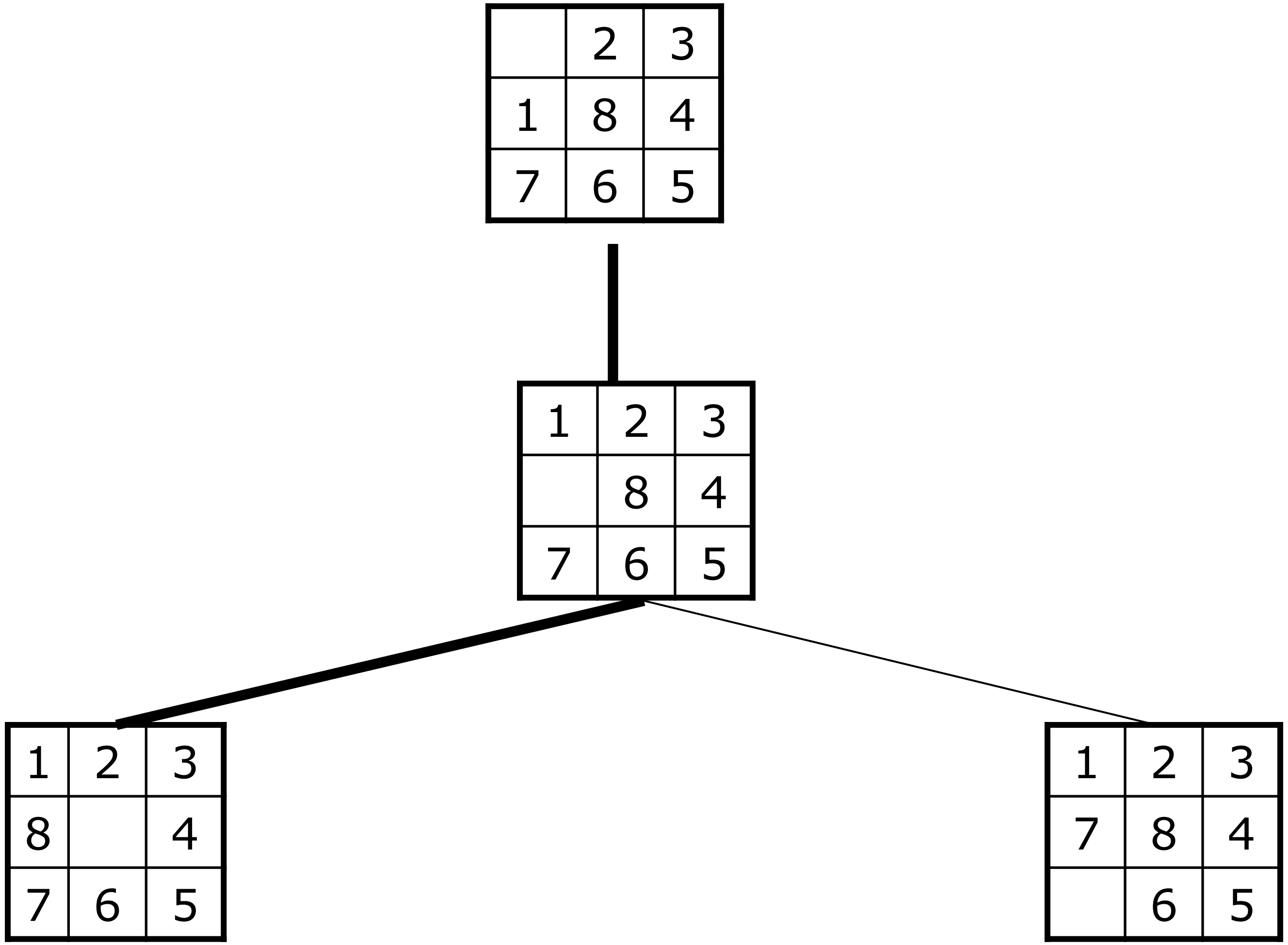
Playing 8-Puzzle



Playing 8-Puzzle



Playing 8-Puzzle



Productions Systems and AI

A system consisting of a separate

database,

operations and

control components

represents an appropriate metaphorical building block for constructing lucid descriptions of AI systems.

Production Systems

AI systems display a more or less rigid separation between computational components of data, operations and control.

Various generalizations of the computational formalism known as a production system involves a clean separation of these computational components and thus seem to capture the essence of operation of many AI systems.

Production Systems

Selecting rules and keeping track of those sequences of rules already tried constitute what we call the control strategy for production systems.

The operation of AI production systems can thus be characterized as a search process in which rules are tried until some sequence of them is found that produces a database satisfying the termination condition.