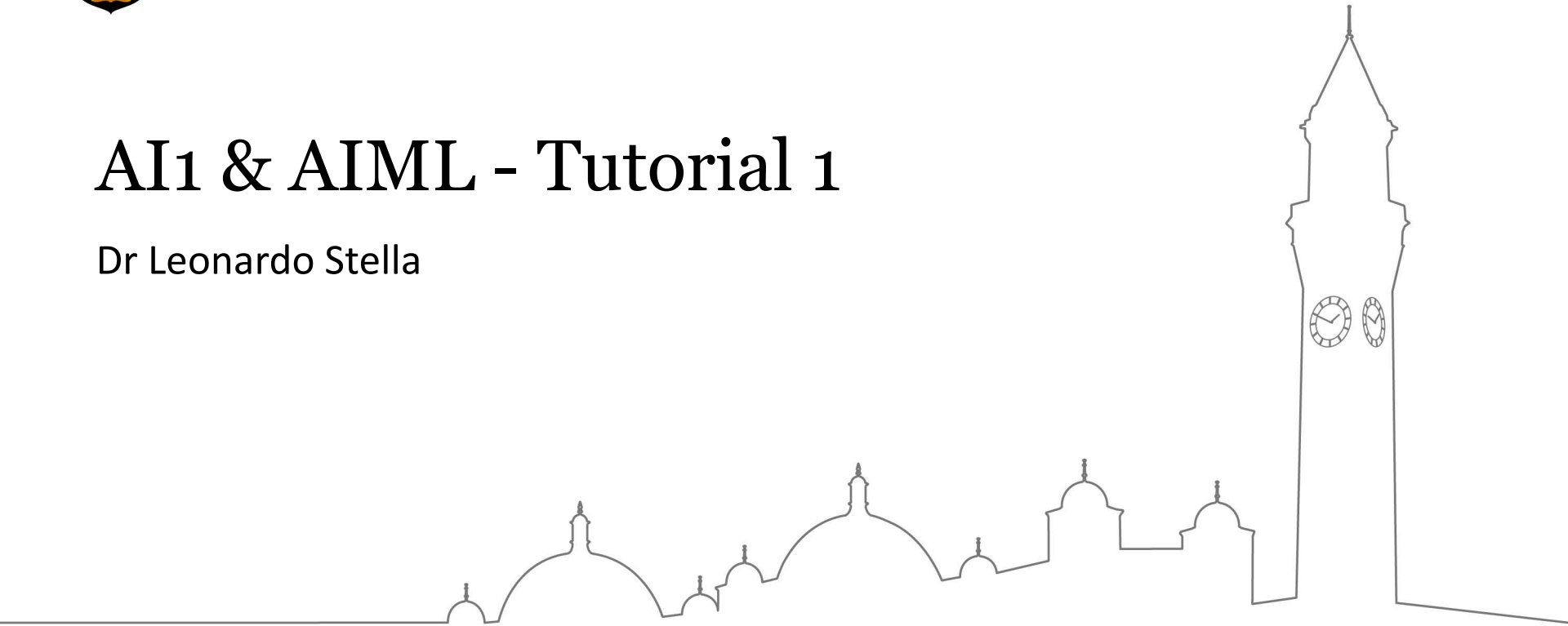
UNIVERSITY OF BIRMINGHAM

AI1 & AIML - Tutorial 1

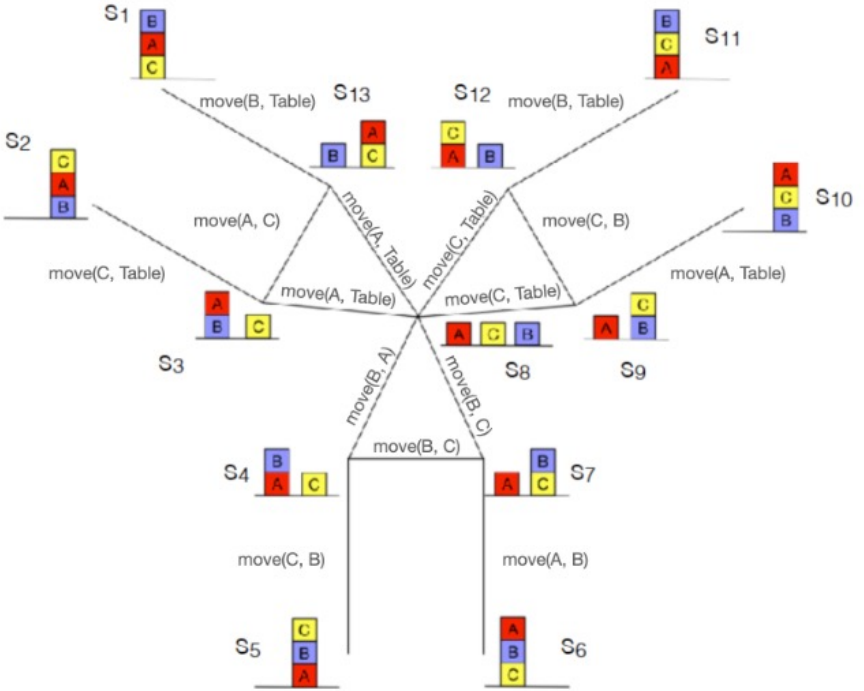
Dr Leonardo Stella



Exercise 1

Activity. In pairs or small groups, consider the following state space graph for the three-block world [10’]:

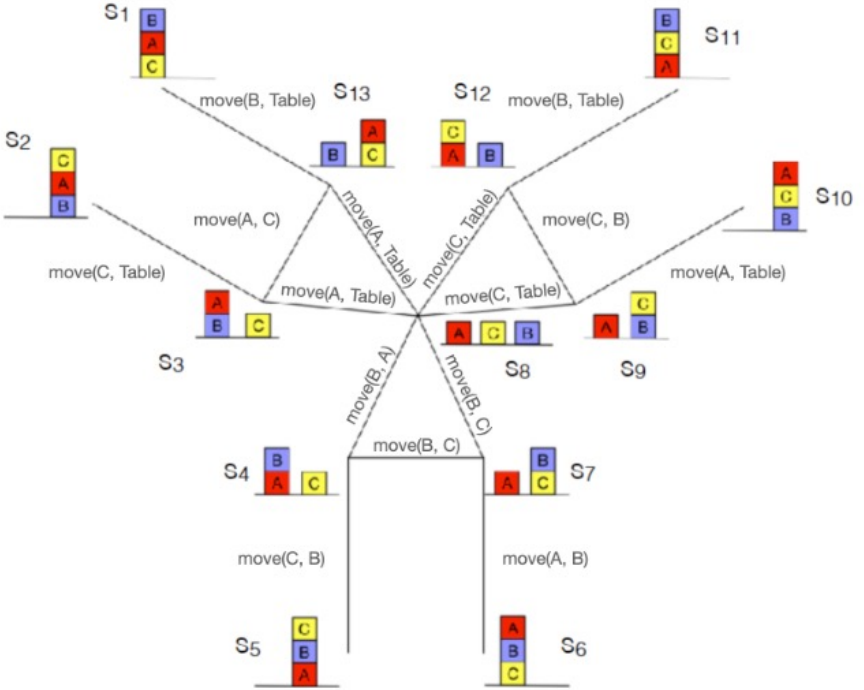
- In this problem, there are 3 blocks, labelled A, B and C and the goal is to go from one configuration, e.g., B on top of A on top of C (state s1), to another
- To do so, blocks can be placed on the table and then moved into different configurations



Exercise 1

Activity. Provide a search problem formulation for the three-block world

- **Initial state**: ?
- **Actions**: ?
- **Transition model**: ?
- **Goal test**: ?
- **Path cost**: ?

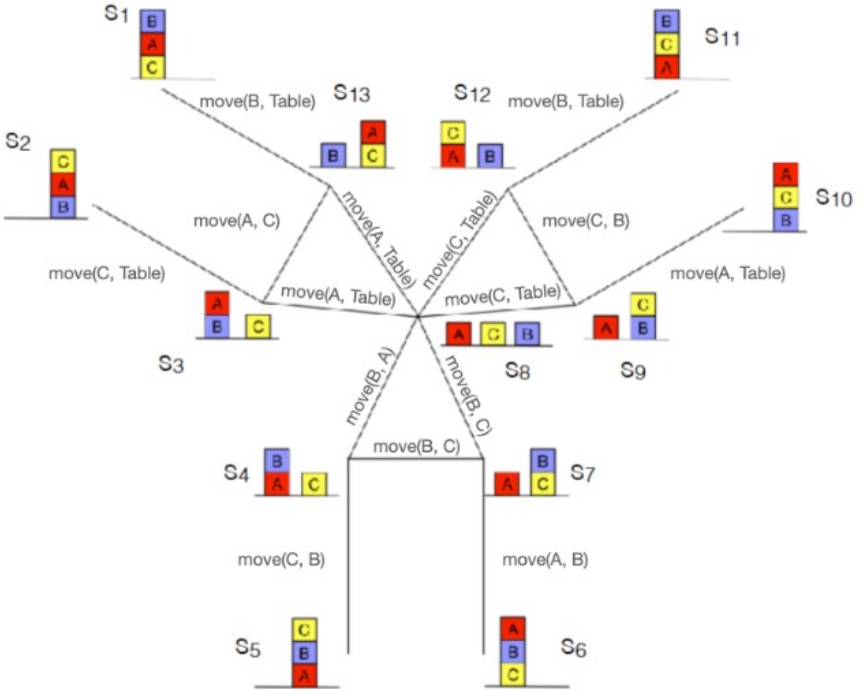


Exercise 1

Activity. Provide a search problem formulation for the three-block world

Solution: (one possible solution)

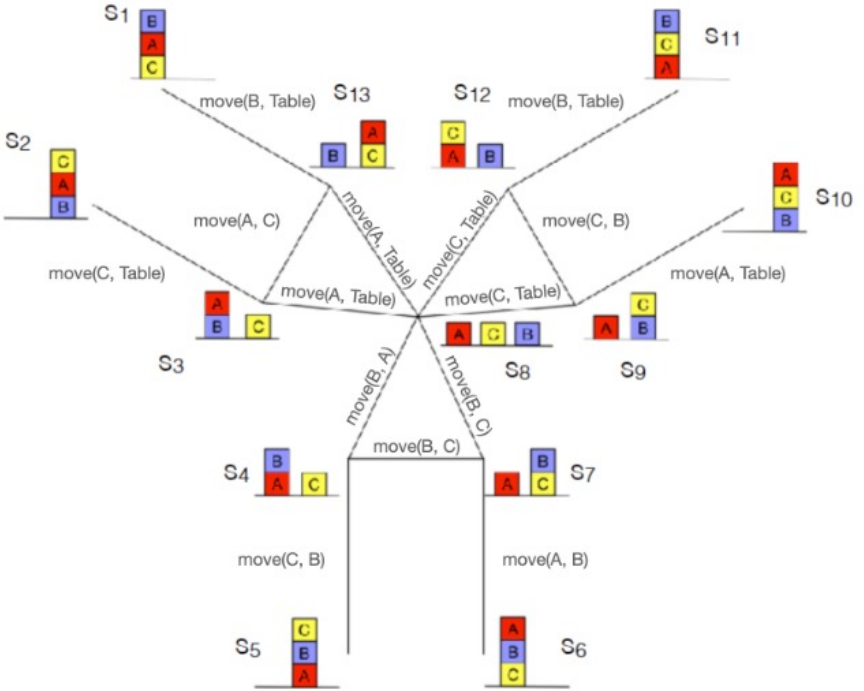
- **Initial state**: any of the 13 states
- **Actions**: move(X, Y), where X and Y can be A, B, C, Table with X ≠ Y
- **Transition model**: see image, e.g., from s3 -> s13 via move(A, C)
- **Goal test**: check if state is a goal (any)
- **Path cost**: each step costs 1



Exercise 2

Activity. In pairs or small groups, consider the following state space graph for the three-block world [15’]:

Assume that the initial state is node s_{13} and the goal state is node s_5. The possible moves are represented by the functions move(X,Y) in the graph, which means to move X from where it is to sit on top of Y. Assume that the cost of each move is 1

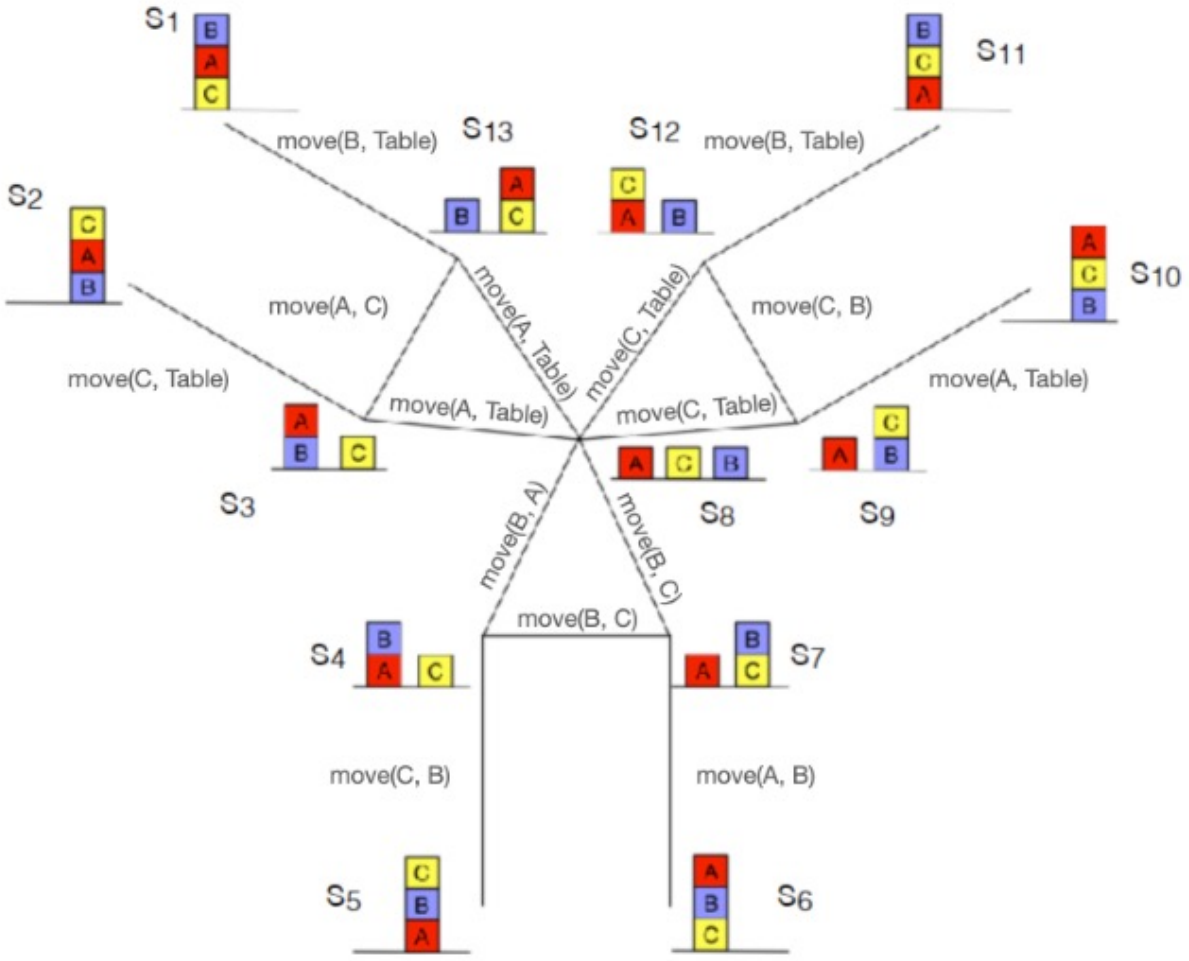


Exercise 2

Activity. Generate the BFS tree until the goal state is found and write down the sequence of nodes in the order they are visited by BFS

1. When two frontier nodes are at the same depth of the tree, consider that the one with the smaller identifier is expanded first
2. For the sequence of visited nodes, use lowercase letters and commas to separate the node identifiers without any space, e.g., s1,s2,s3,s4,s5,s6

Exercise 2

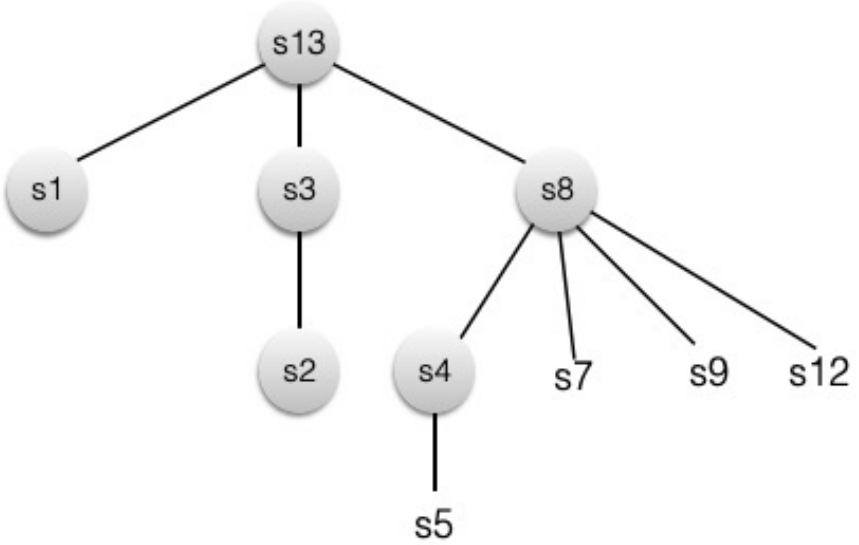

S1
S11
move(B, Table)
S13
S12
move(B, Table)
S2
move(A, C)
move(A, Table)
move(C, Table)
move(C, B)
S10
move(C, Table)
move(A, Table)
move(A, Table)
move(C, Table)
S3
S8
S9
move(B, A)
move(B, C)
move(B, C)
S4
S7
move(C, B)
move(A, B)
S5
S6

Exercise 2

Solution: the order of expansion is: s13,s1,s3,s8,s2,s4

The visited nodes are shown within a circle, whereas the nodes not in a circle represent the frontier

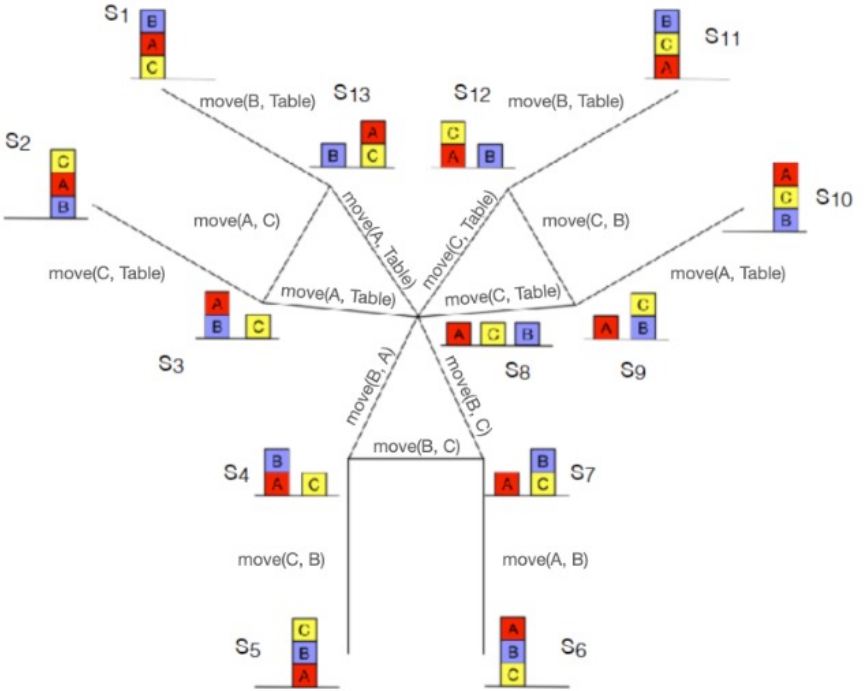
The nodes are visited in the following order: s13,s1,s3,s8,s2,s4. Note that s7, s9 and s12 do not need to be visited, because the search process stops when s5 is placed in the frontier



Exercise 3

Activity. In pairs or small groups, consider again the state space graph for the three-block world [5’]:

Assume that the initial state is node s_{13} and the goal state is node s_5. The possible moves are represented by the functions move(X,Y) in the graph, which means to move X from where it is to sit on top of Y. Assume that the cost of each move is 1



Exercise 3

- Activity. Write down the cost of the solution corresponding to the BFS algorithm. What is the cost of this solution?

Exercise 3

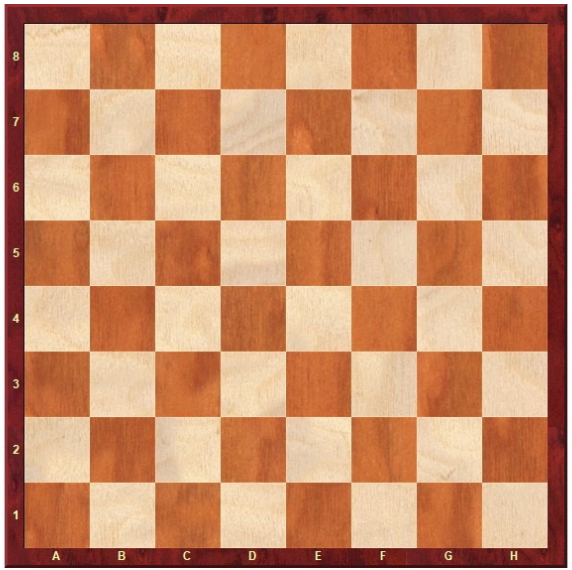
Activity. Write down the cost of the solution corresponding to the BFS algorithm. What is the cost of this solution?

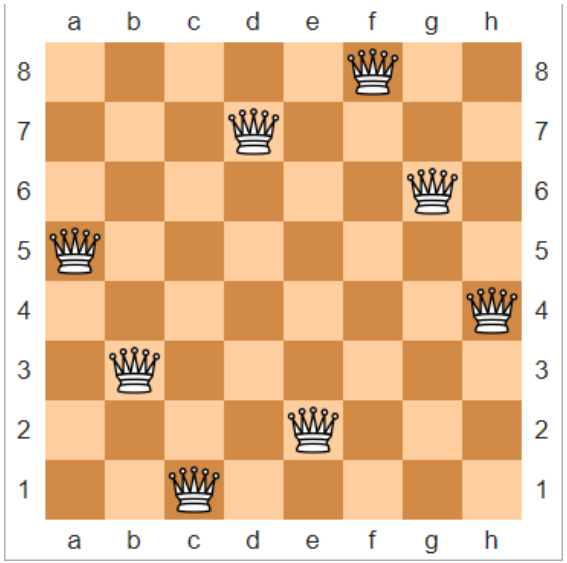
Solution: the solution is the sequence of actions, namely, move(A, Table), move(B, A), move(C,B)

Since each action has cost 1, the cost of the above solution is 3

Exercise 4

ACTIVITY. In pairs or small groups, consider the 8-queen puzzle (initial state and goal state shown below). Provide a formulation of the corresponding search problem [15’]:

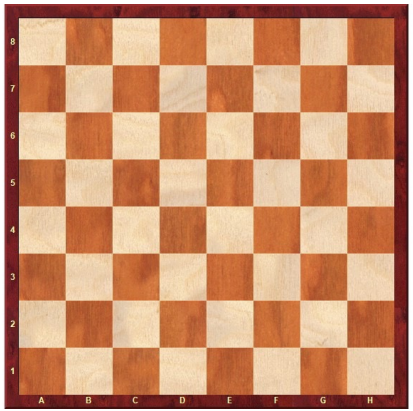


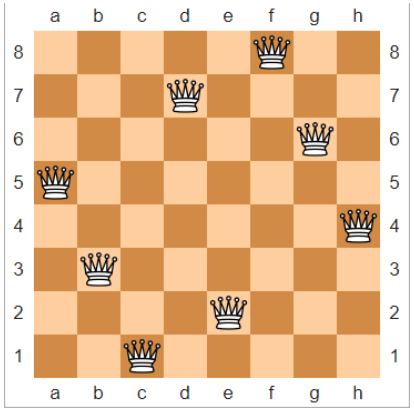


Exercise 4

Solution: (one possible solution)

- **Initial state**: ?
- **Actions**: ?
- **Transition model**: ?
- **Goal test**: ?
- **Path cost**: ?

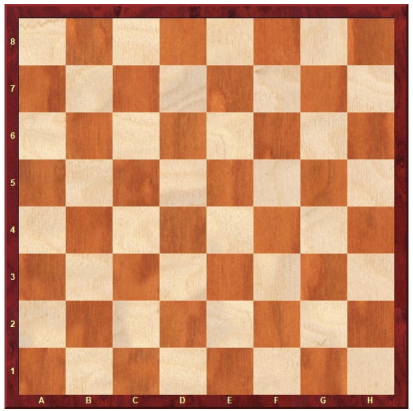


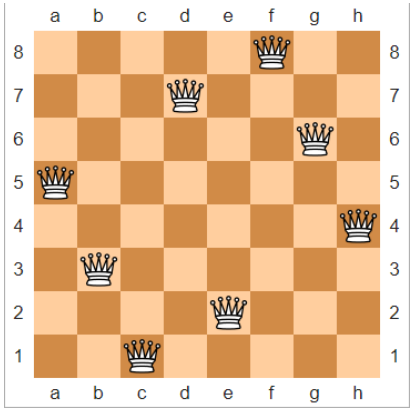


Exercise 4

Solution: (one possible solution)

- **Initial state**: empty board
- **Actions**: ?
- **Transition model**: ?
- **Goal test**: ?
- **Path cost**: ?

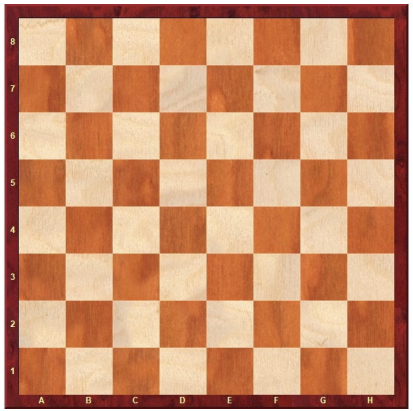


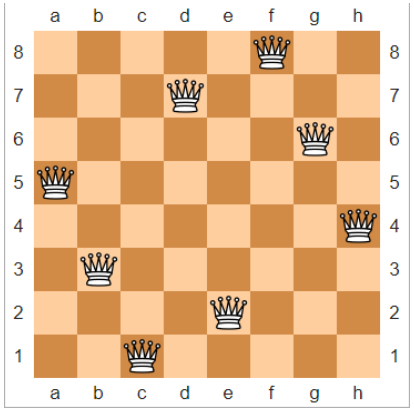


Exercise 4

Solution: (one possible solution)

- **Initial state**: empty board
- **Actions**: place a queen on an empty square
- **Transition model**: ?
- **Goal test**: ?
- **Path cost**: ?

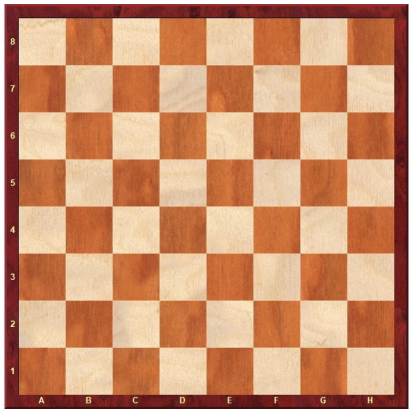


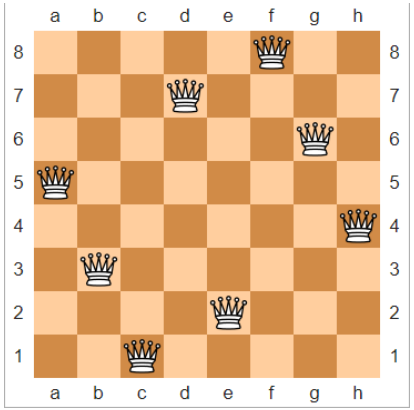


Exercise 4

Solution: (one possible solution)

- **Initial state**: empty board
- **Actions**: place a queen on an empty square
- **Transition model**: the corresponding board after taking the action
- **Goal test**: ?
- **Path cost**: ?

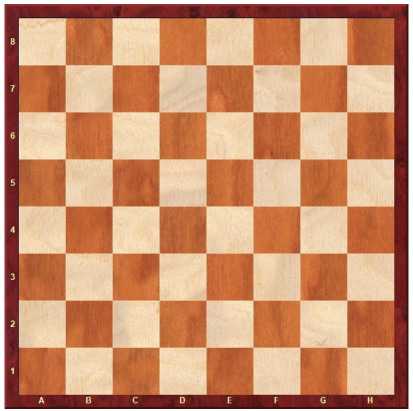


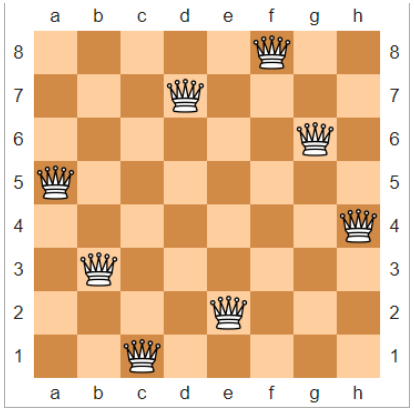


Exercise 4

Solution: (one possible solution)

- **Initial state**: empty board
- **Actions**: place a queen on an empty square
- **Transition model**: the corresponding board after taking the action
- **Goal test**: all 8 queens placed on the board; no conflicts
- **Path cost**: ?

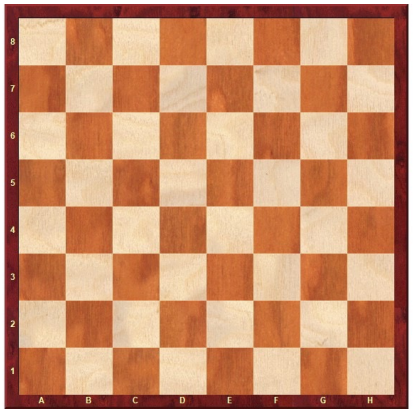


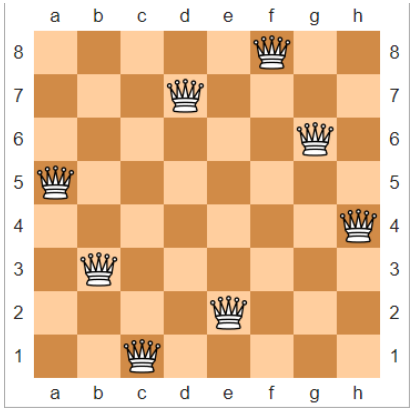


Exercise 4

Solution: (one possible solution)

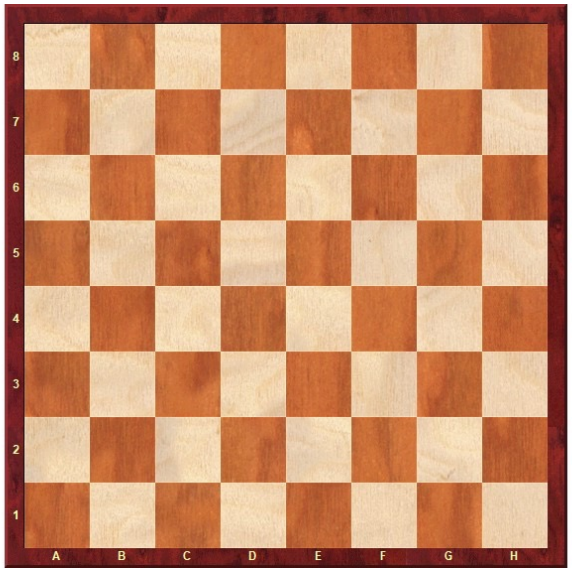
- **Initial state**: empty board
- **Actions**: place a queen on an empty square
- **Transition model**: the corresponding board after taking the action
- **Goal test**: all 8 queens placed on the board; no conflicts
- **Path cost**: each step costs 1

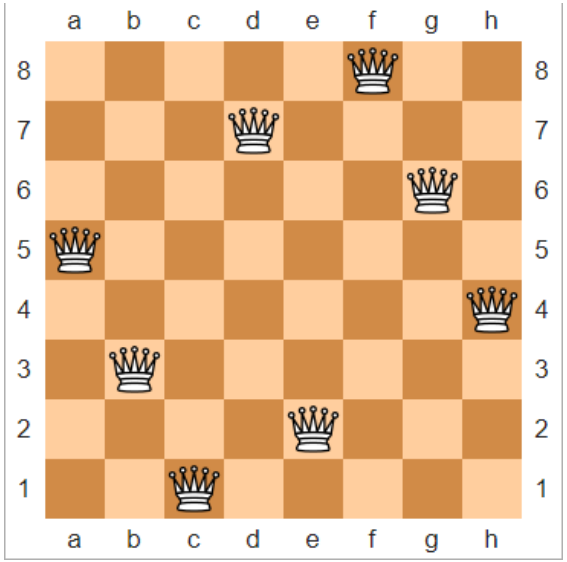




Exercise 5

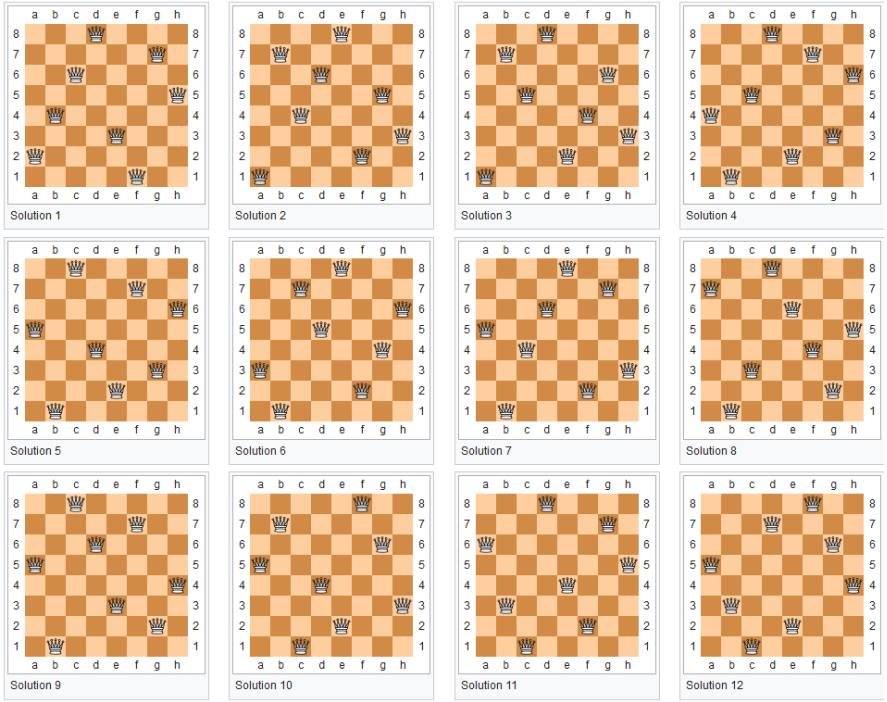
ACTIVITY. In pairs or small groups, consider again the 8-queen puzzle. Discuss how to apply BFS to find one solution [15’]:

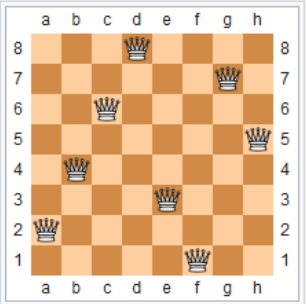




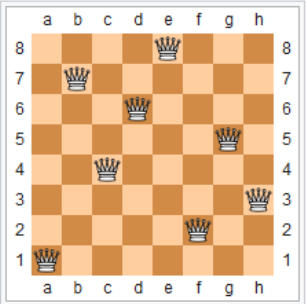
Exercise 5

Solution: The 12 fundamental solutions to the 8-queen problem are:

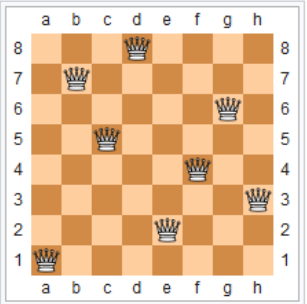




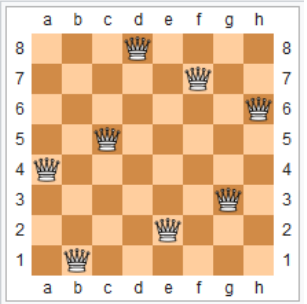
Solution 1



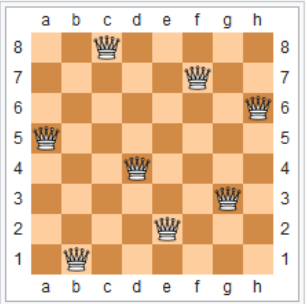
Solution 2



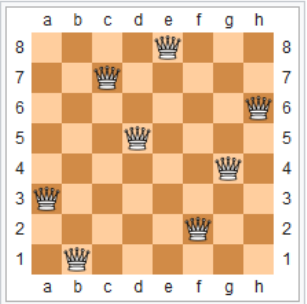
Solution 3



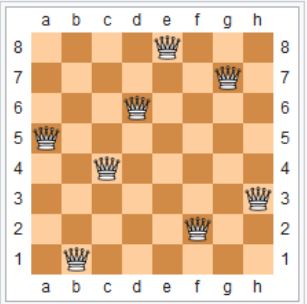
Solution 4



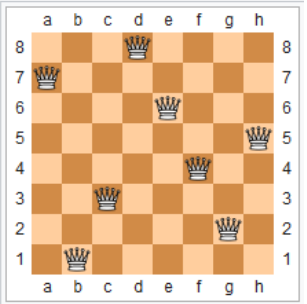
Solution 5



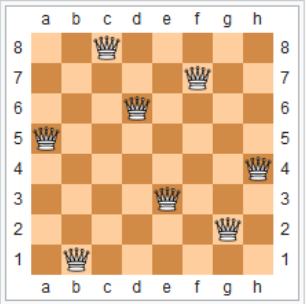
Solution 6



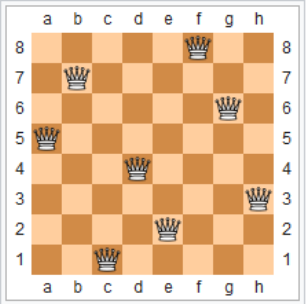
Solution 7



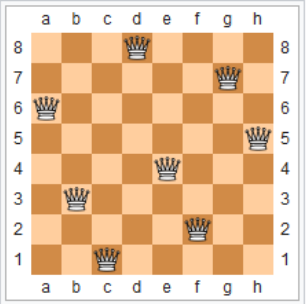
Solution 8



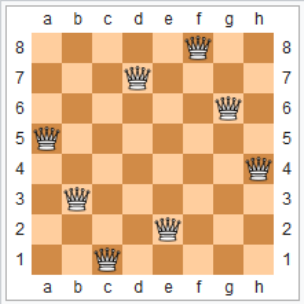
Solution 9



Solution 10



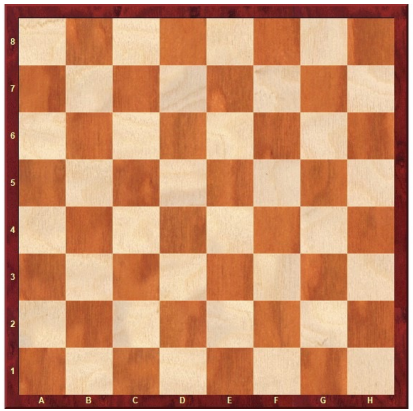
Solution 11

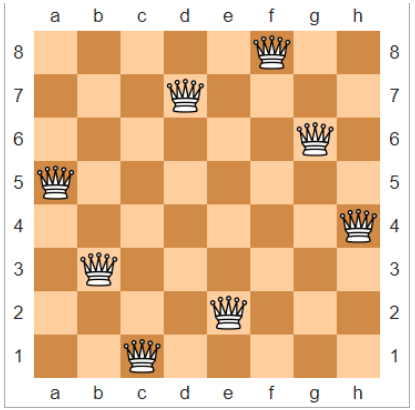


Solution 12

Exercise 6

ACTIVITY. In pairs or small groups, consider again the 8-queen puzzle and the problem formulation given in Exercise 4. What is the branching factor b for the corresponding tree search [5']?





Exercise 6

ACTIVITY. In pairs or small groups, consider again the 8-queen puzzle and the problem formulation given in Exercise 4. What is the branching factor b for the corresponding tree search [5']?

Solution: the root node is the empty board, therefore the first queen can be placed on any one of the 64 possible squares (b = 64)