

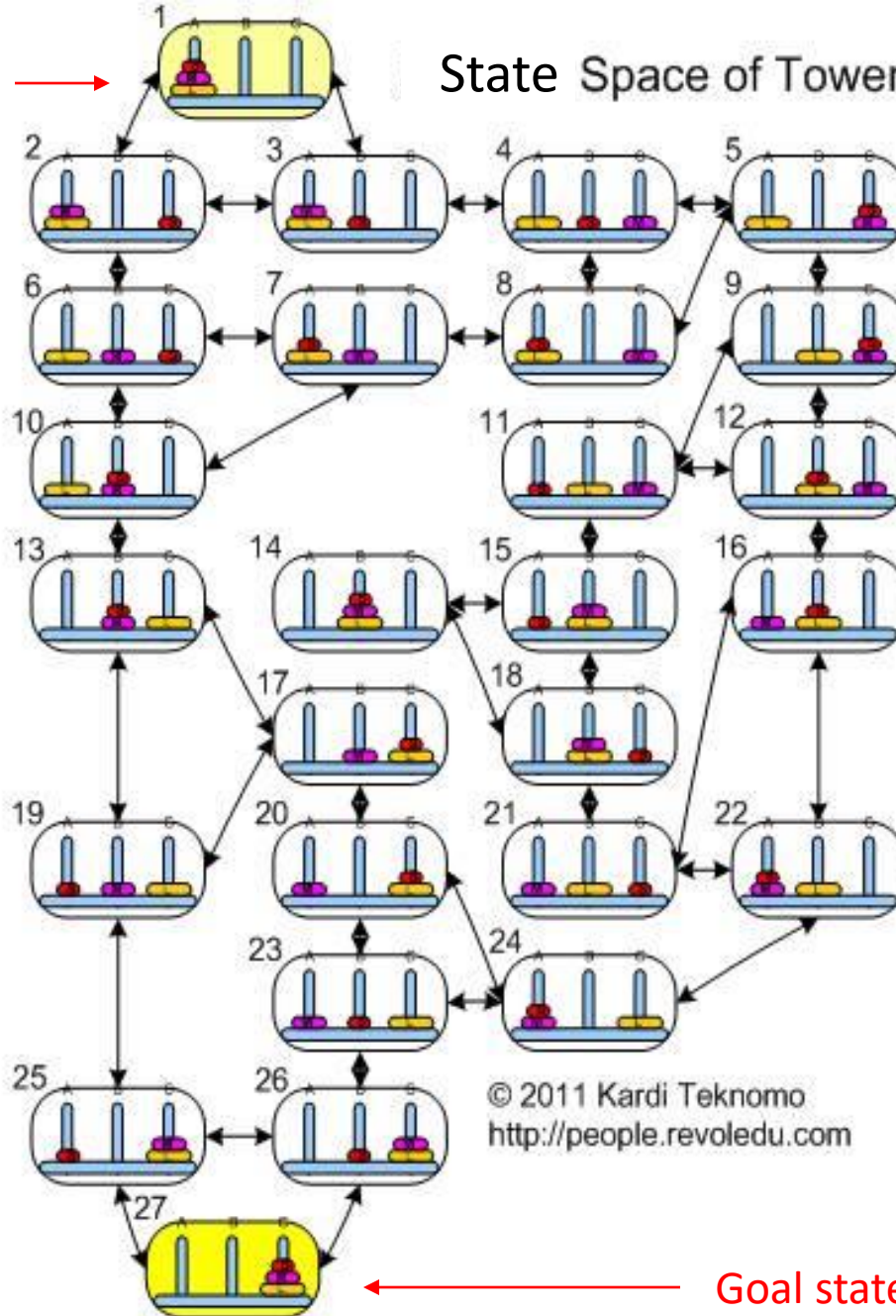
State Space & Breadth-First Search

CSX3009 Algorithm Design

Initial state



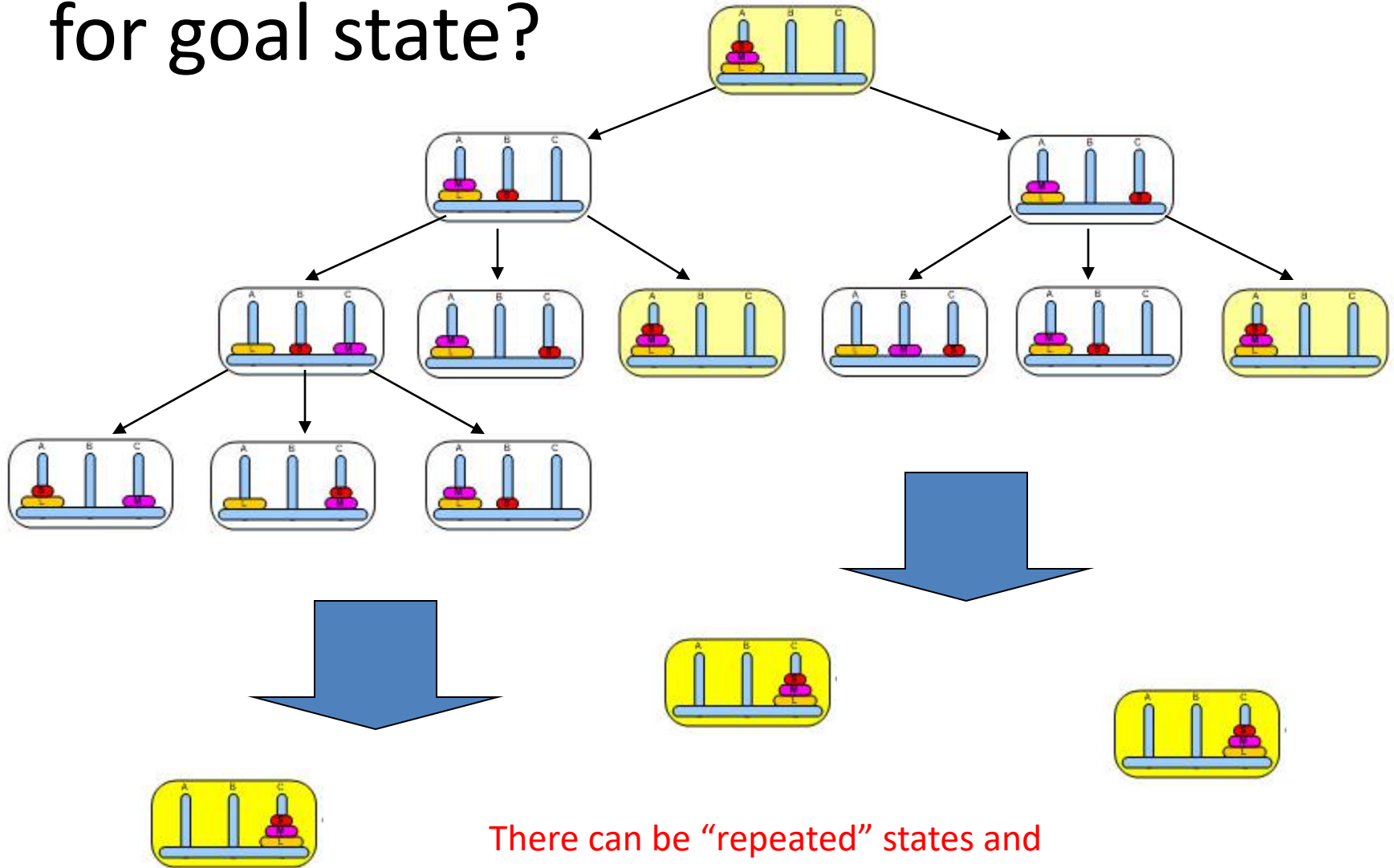
State Space of Tower of Hanoi (3 disks)



Goal state

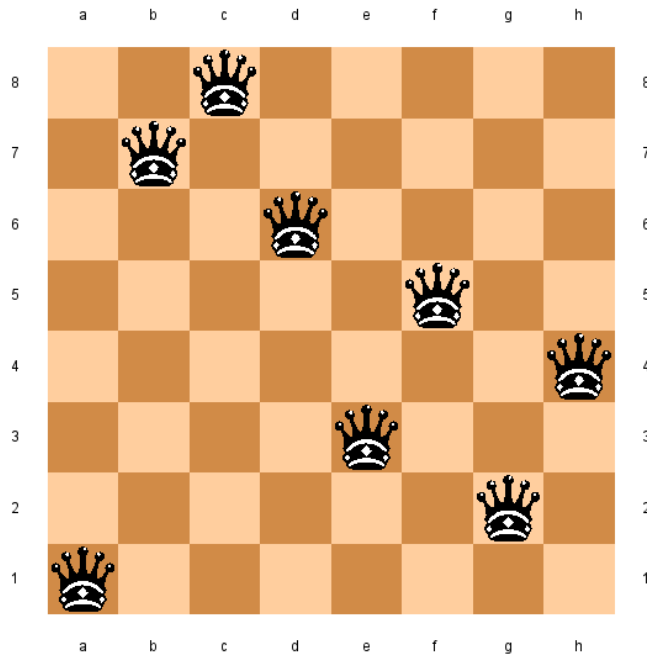
If you've never known about Tower of Hanoi problem, learn about it briefly [here](#).

How to search for goal state?



Modeling a problem

- N queens



Complete-State Formation:

- **States:** any arrangement of 8 queens on the board
- **Actions:** move a queen to any square
- **Goal test:** 8 queens on the board, none attacked

Each queen can take any of the 64 positions
→ 64^8 states with 8 queens (2.81×10^{14})

Incremental Formulation I

- **States:** Any arrangement of 0 to 8 queens on the board
- **Initial state:** No queens
- **Actions:** Add queen in empty square

First queen: 64 choices of position

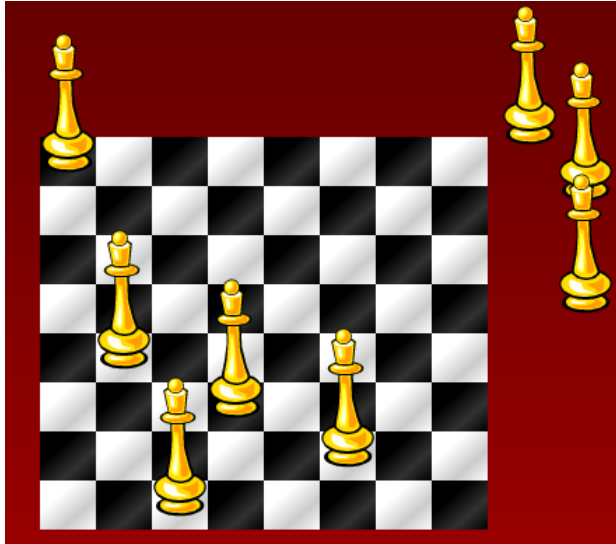
Second queen: 63 choices of position

...

Total number of possible states : $64 \times 63 \times 62 \times 61 \times 60 \times 59 \times 58 \times 57$

1.785 x 10¹⁴ states

Incremental Formulation II



States: Any arrangement of 0 to 8 queens on the board

Initial state: No queens

Actions: Add queen in *leftmost empty column* such that is not attacking other queens

First queen : 8 choices of rows

Second queen : 5 or 6 choices of rows
(must not be the same row as the first,
must not be in diagonal with the first)

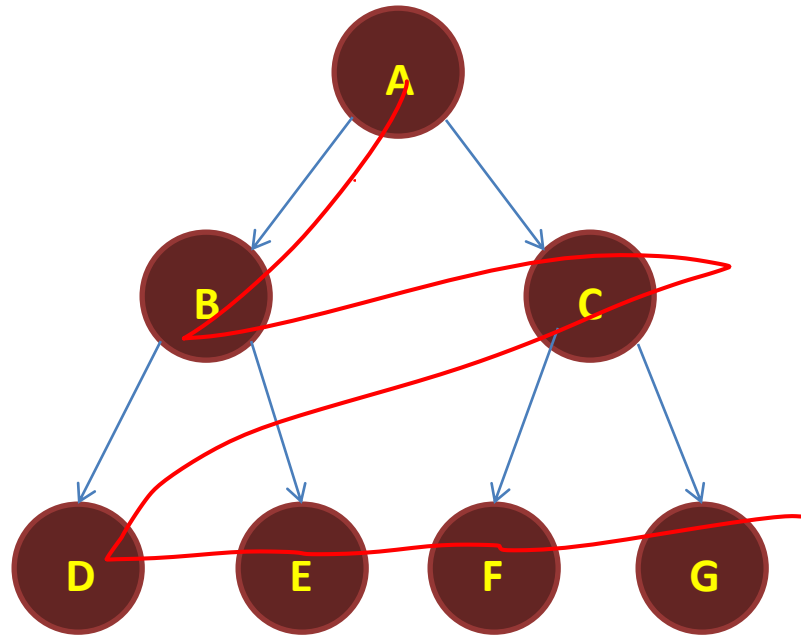
...

A lot fewer choices for the rest of the queens

2057 states

Breadth First Search

Analogous to the diagram in page 3
(searching for goal state of Tower of Hanoi)



**Click through animation to see
sequence of states being searched**

Algorithm structure of BFS

`s = initial_state`

while not Goal(s)

for each successor_state x of s

 enqueue(x)

 s = dequeue()

4-Queens

