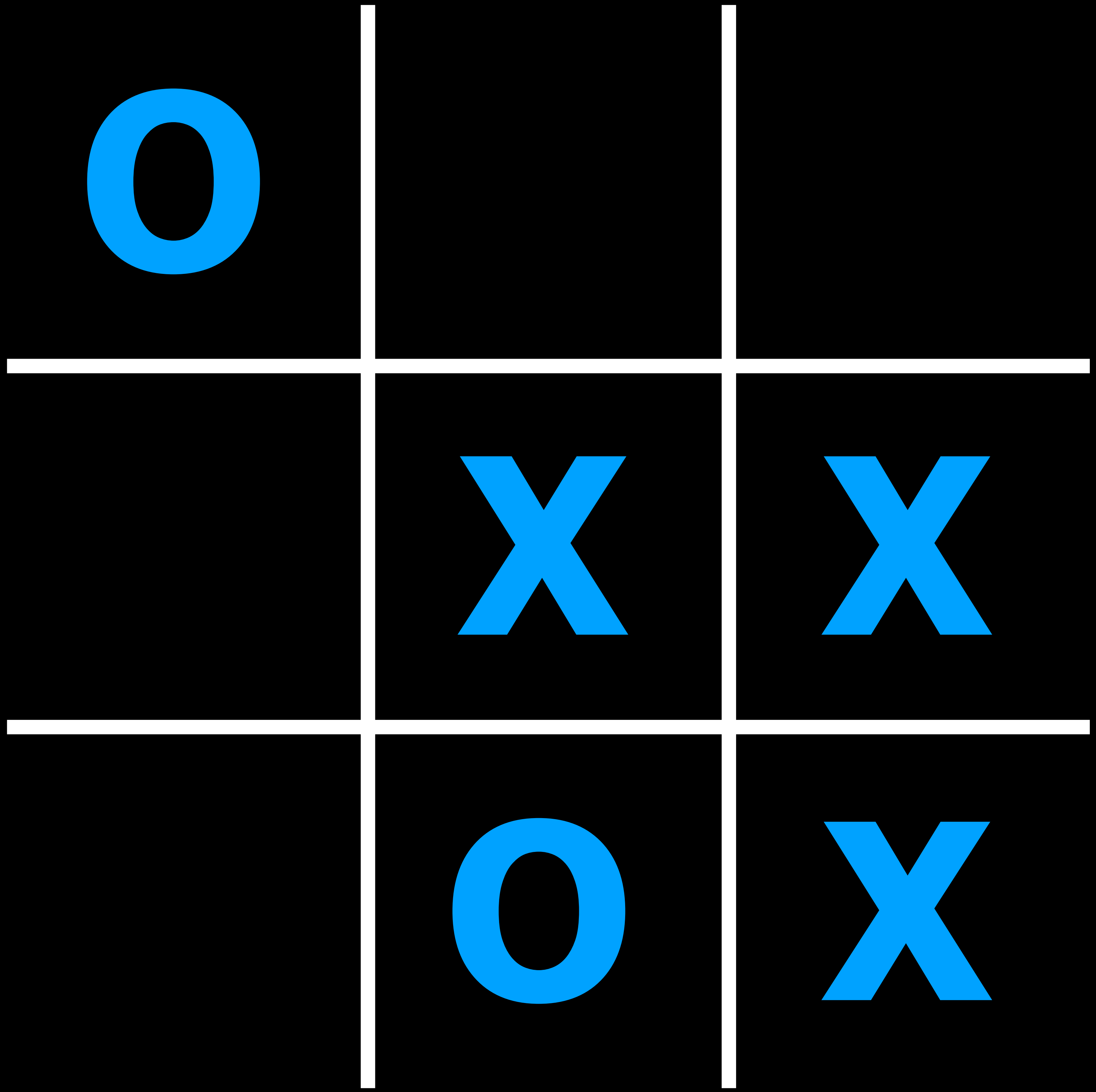
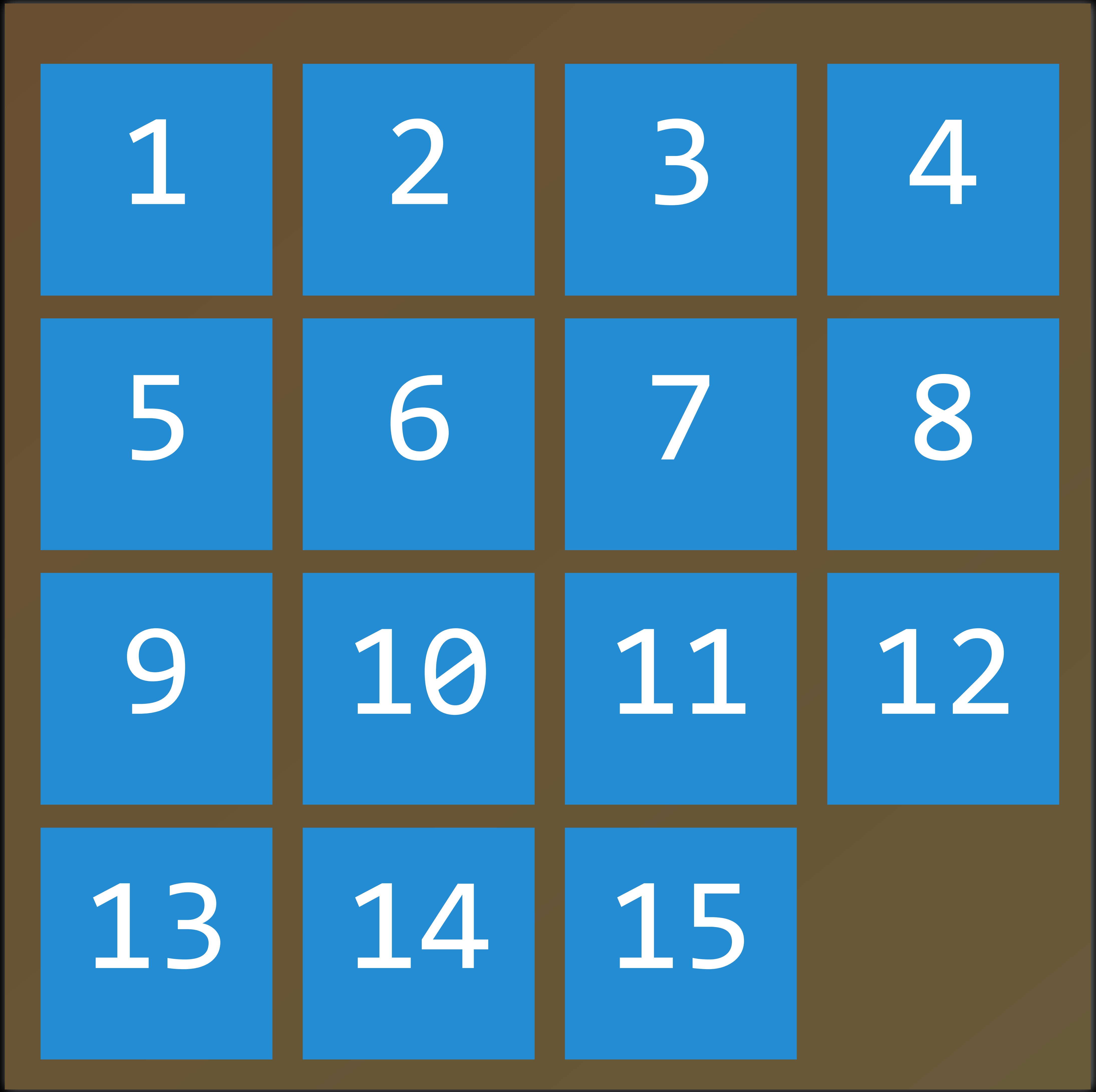
Introduction to Artificial Intelligence

Dr.Bayan O. Mohammed
2024-2025

Search

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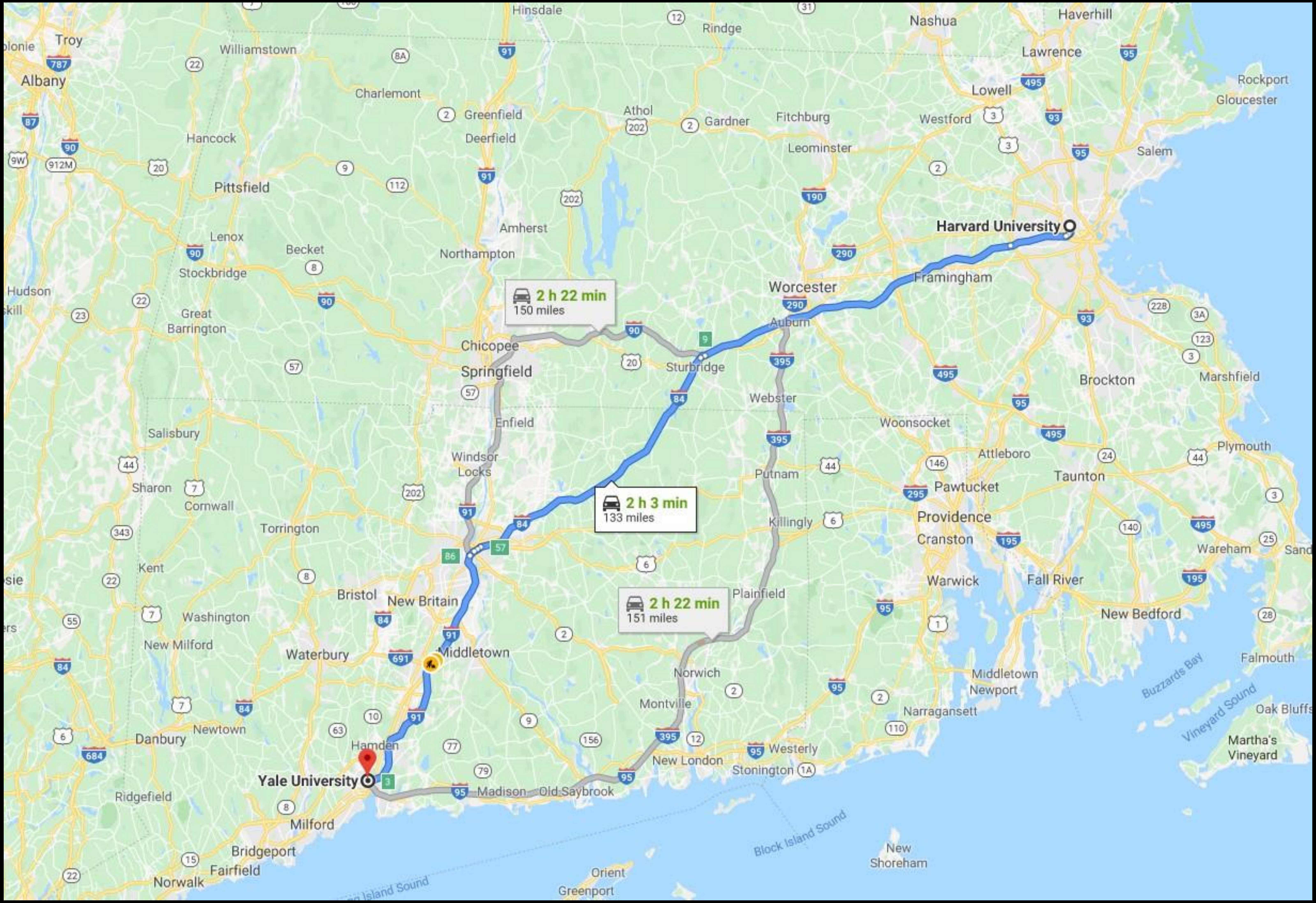
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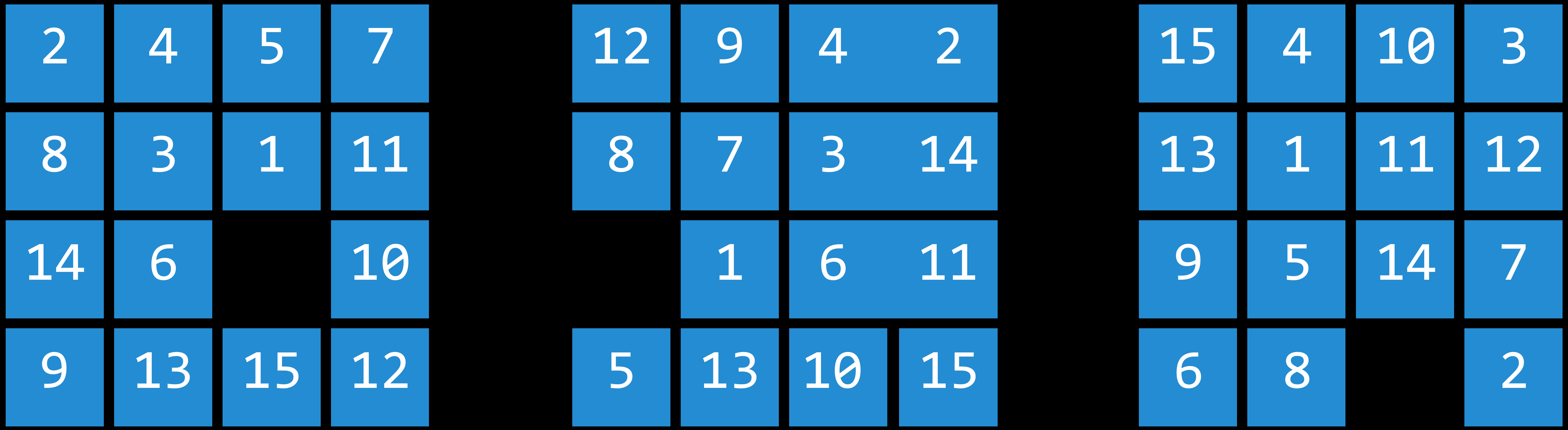
Search Problems

agent

entity that perceives its environment
and acts upon that environment

state

a configuration of the agent and its environment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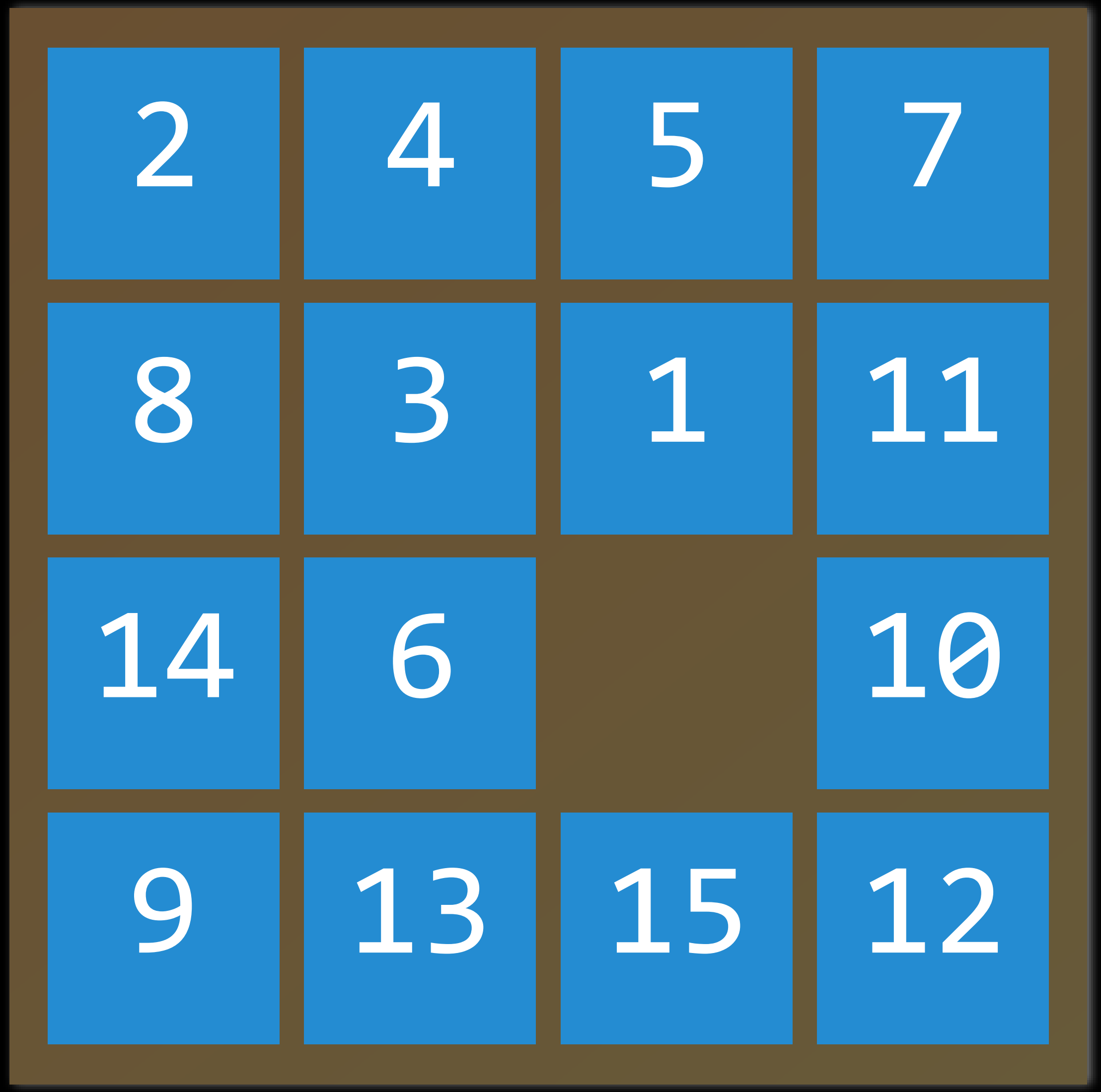
initial state

the state in which the agent begins

initial state



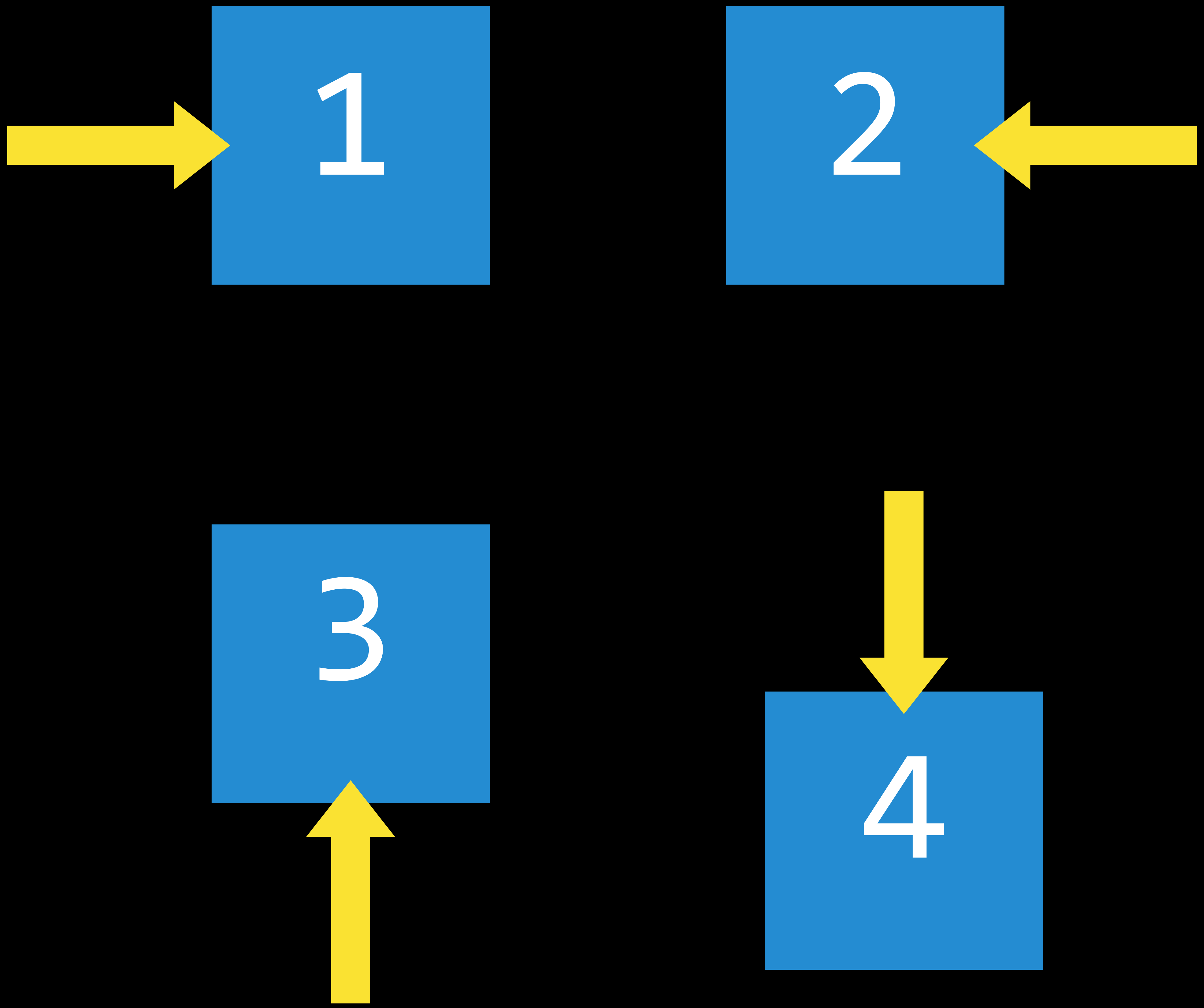
actions

choices that can be made in a state

actions

ACTIONS(s) returns the set of actions that can be executed in state s

actions



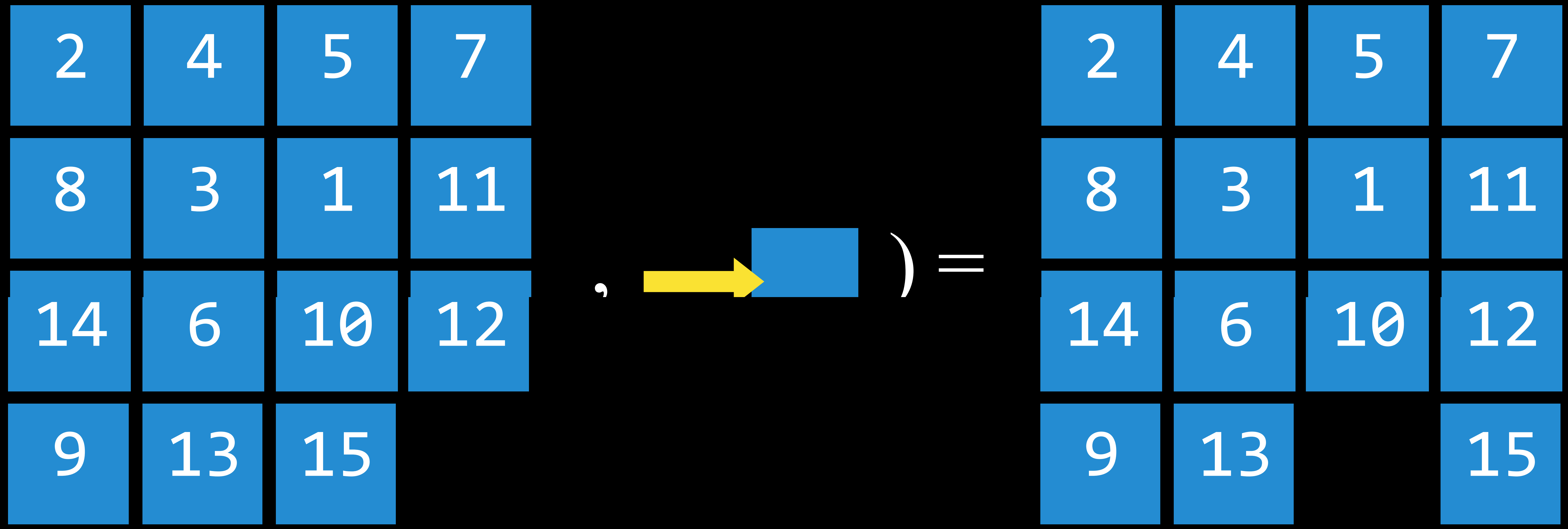
transition model

a description of what state results from performing any applicable action in any state

transition model

$\textsc{Result}(s, a)$ returns the state resulting from performing action a in state s

RESULT(



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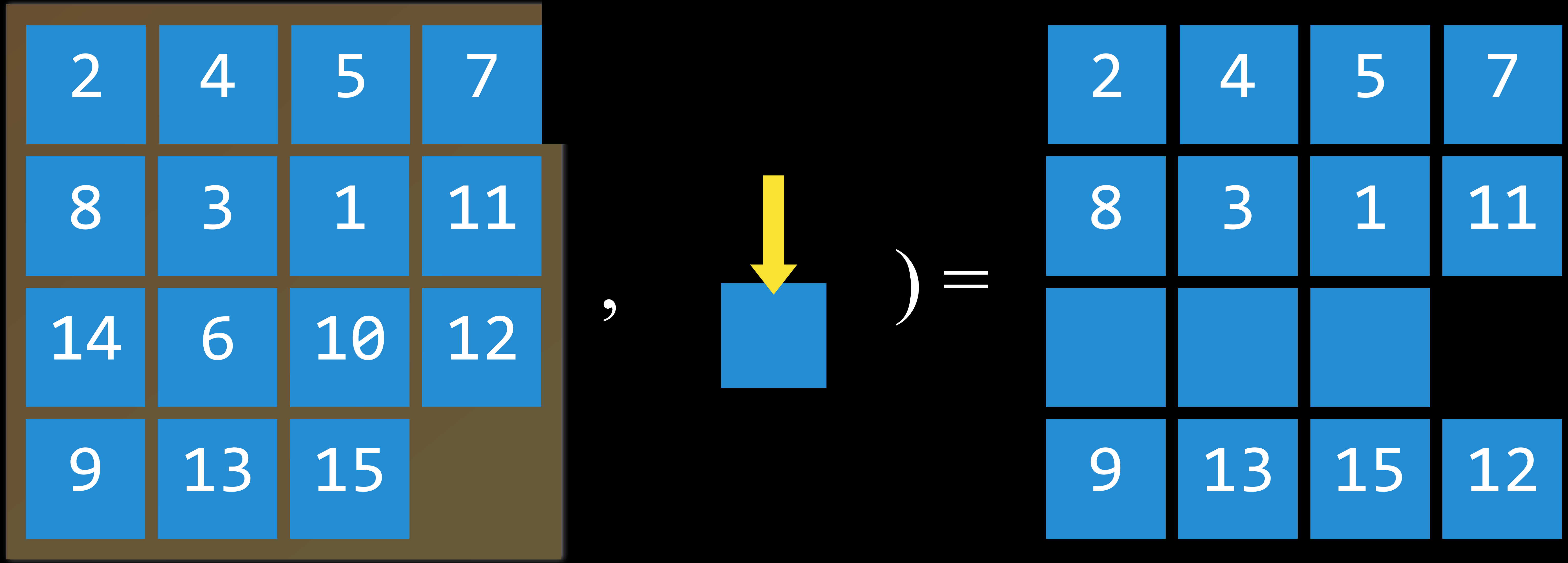
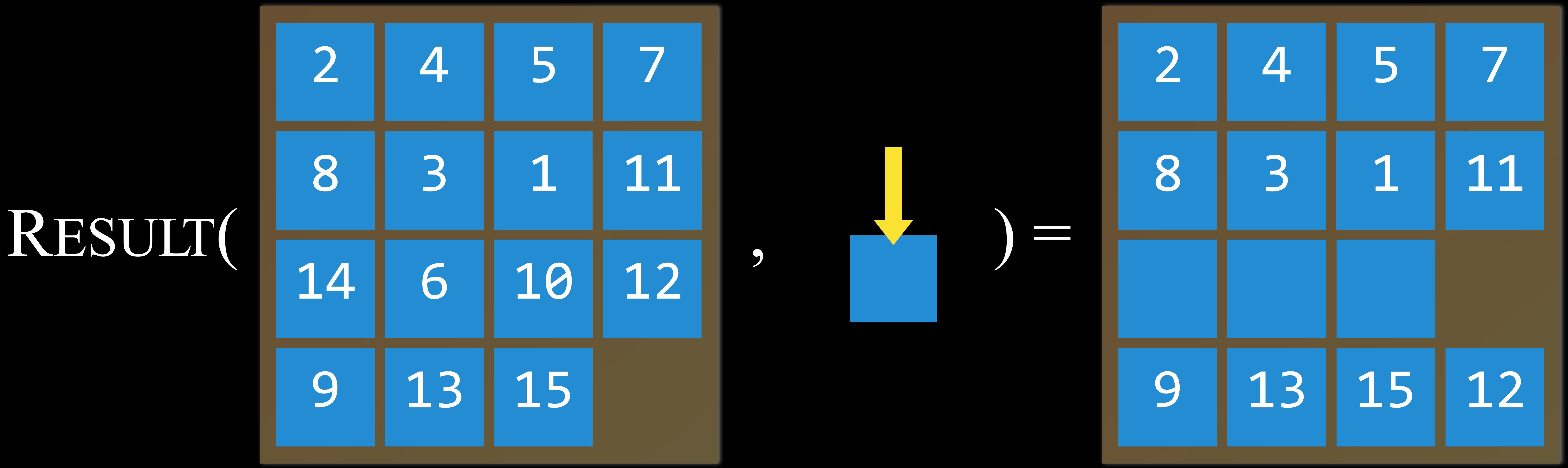
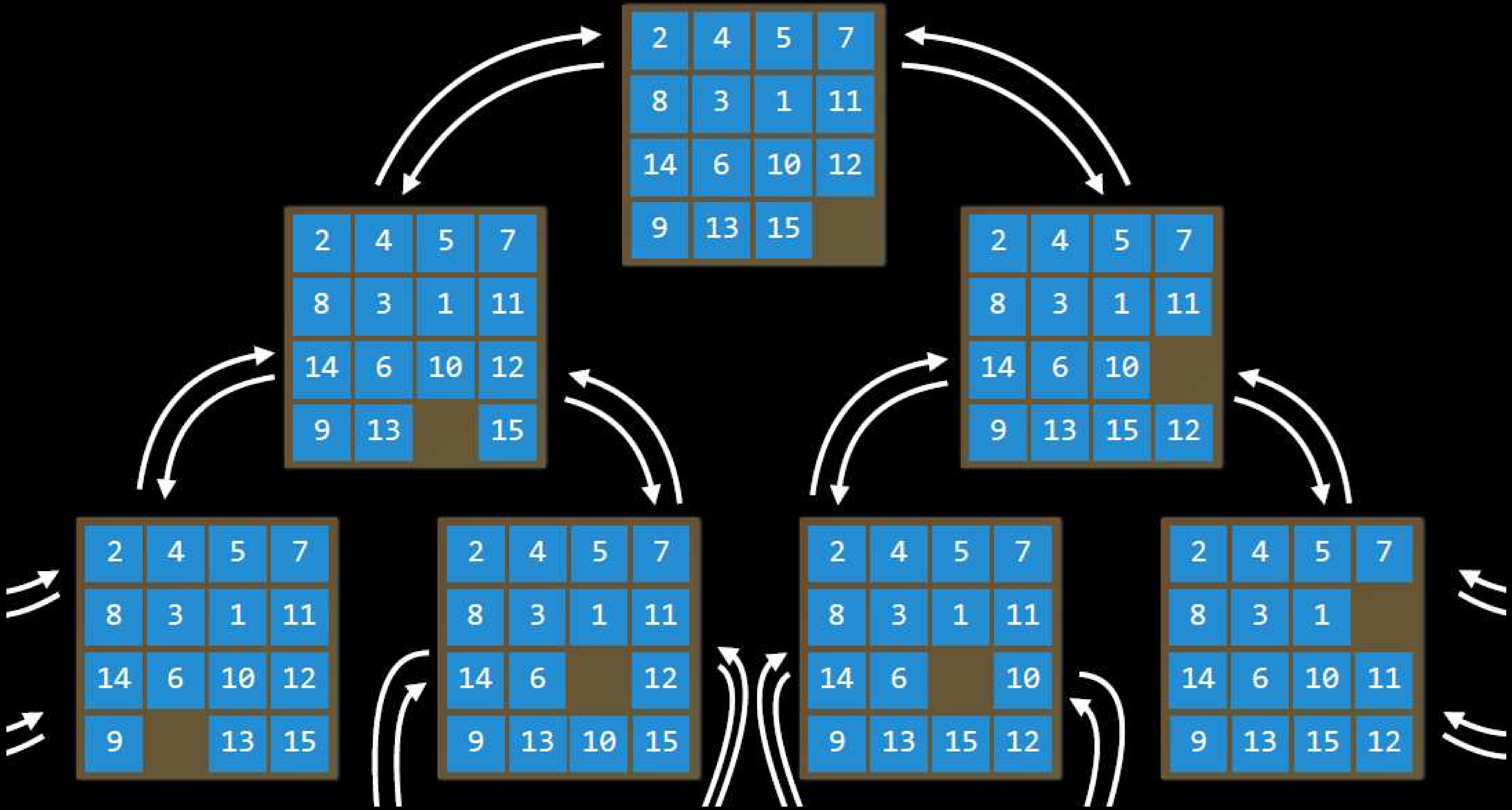


transition model



state space

the set of all states reachable from the initial state by any sequence of actions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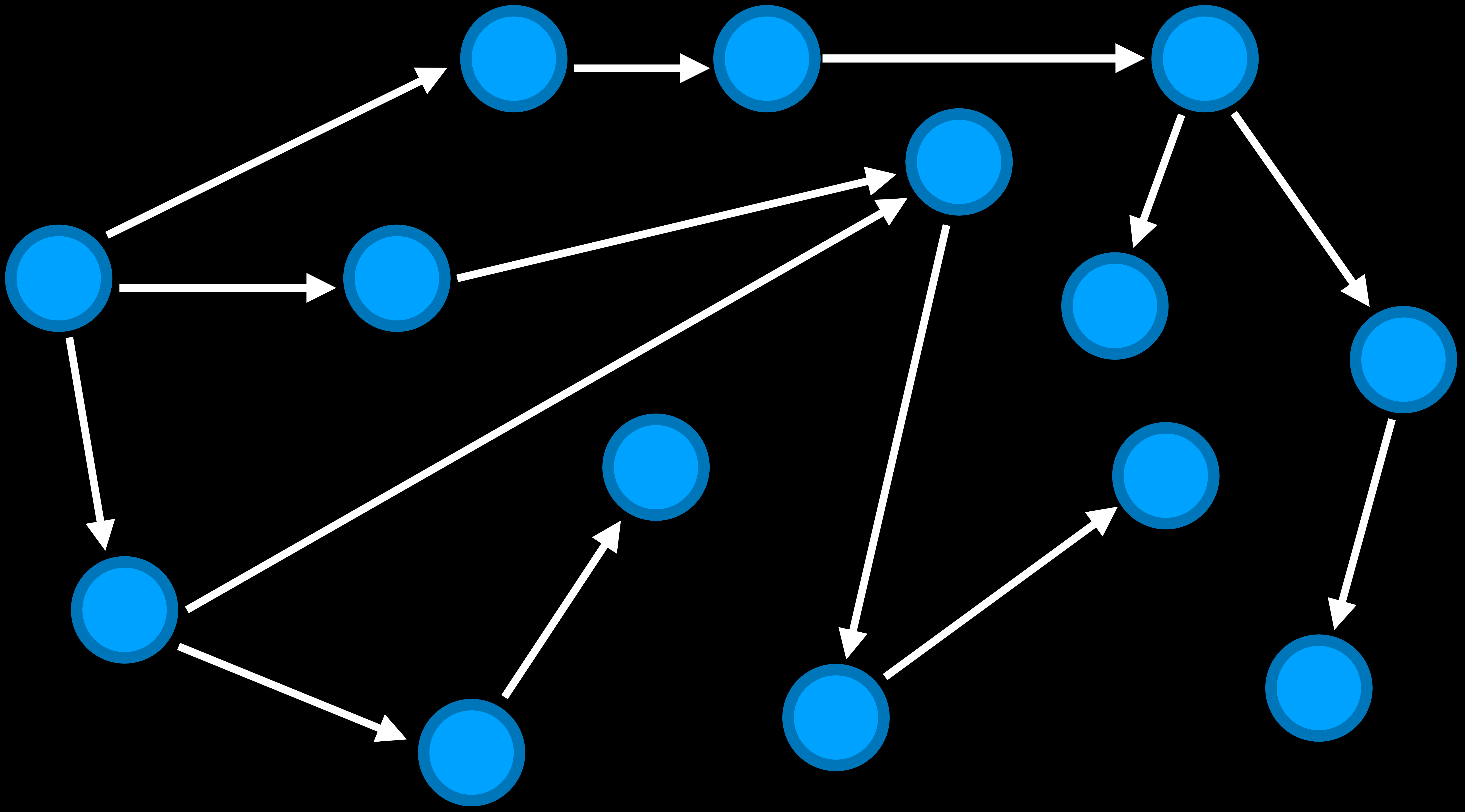
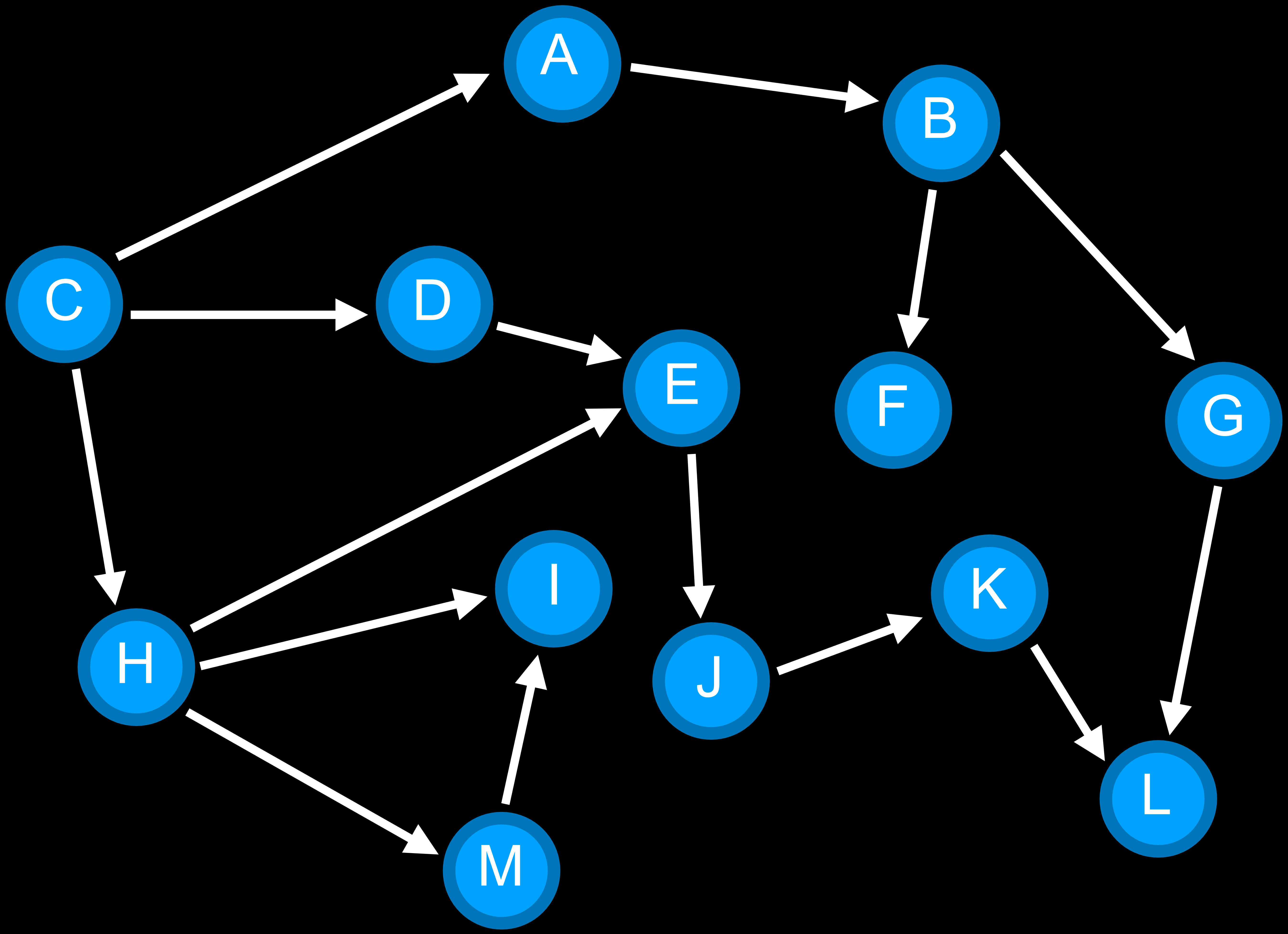


goal test

way to determine whether a given state is a goal state

path cost

numerical cost associated with a given path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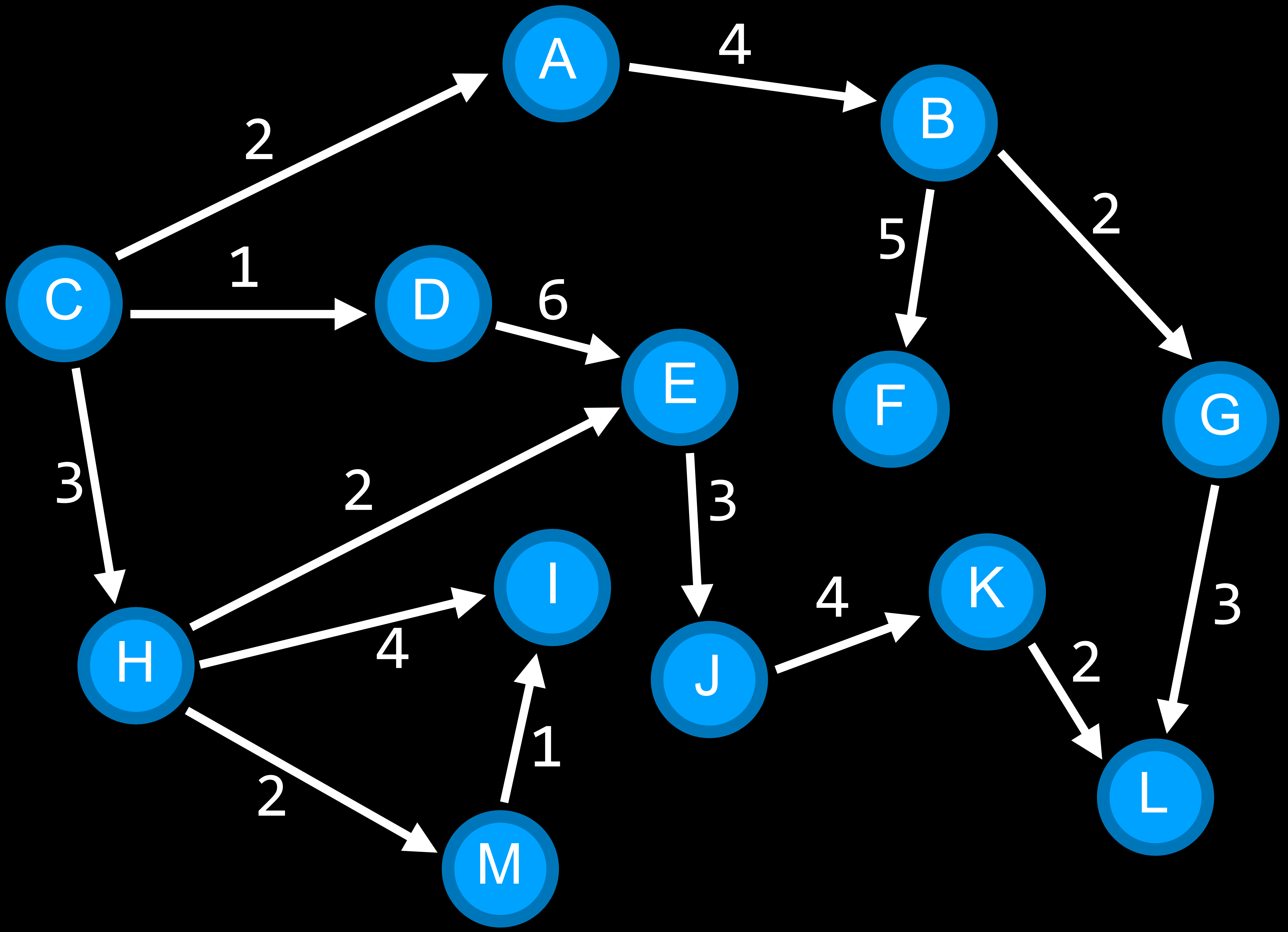
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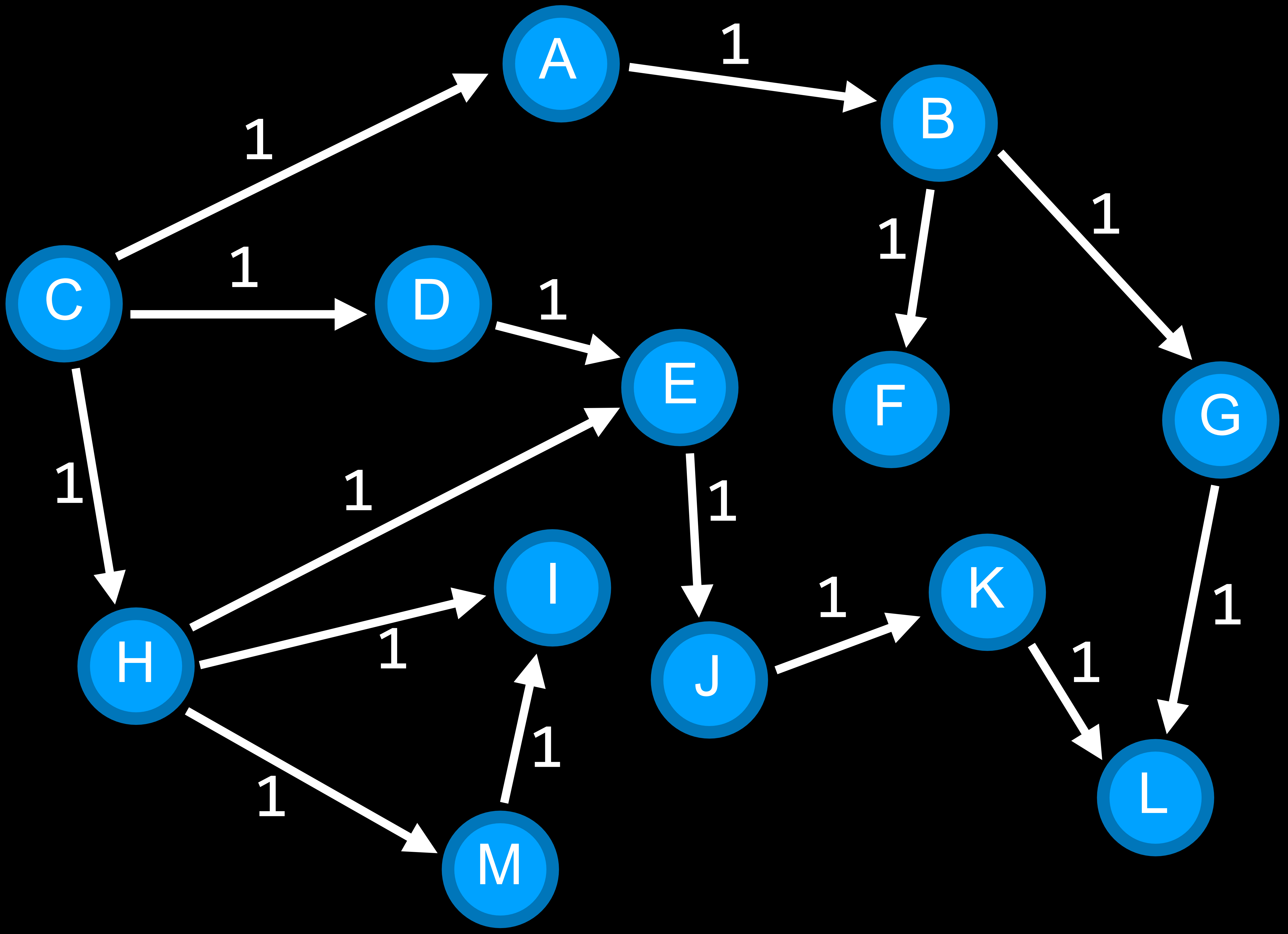
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Search Problems

- initial state
- actions
- transition model
- goal test
- path cost function

solution

a sequence of actions that leads from the initial state to a goal state

optimal solution

a solution that has the lowest path cost among all solutions

node

a data structure that keeps track of

- a **state**
- a **parent** (node that generated this node)
- an **action** (action applied to parent to get node)
- a **path cost** (from initial state to node)

Approach

- Start with a **frontier** that contains the initial state.
- Repeat:
    - If the frontier is empty, then no solution.
    - Remove a node from the frontier.
    - If node contains goal state, return the solution.
    - **Expand** node, add resulting nodes to the frontier.

Find a path from A to E.

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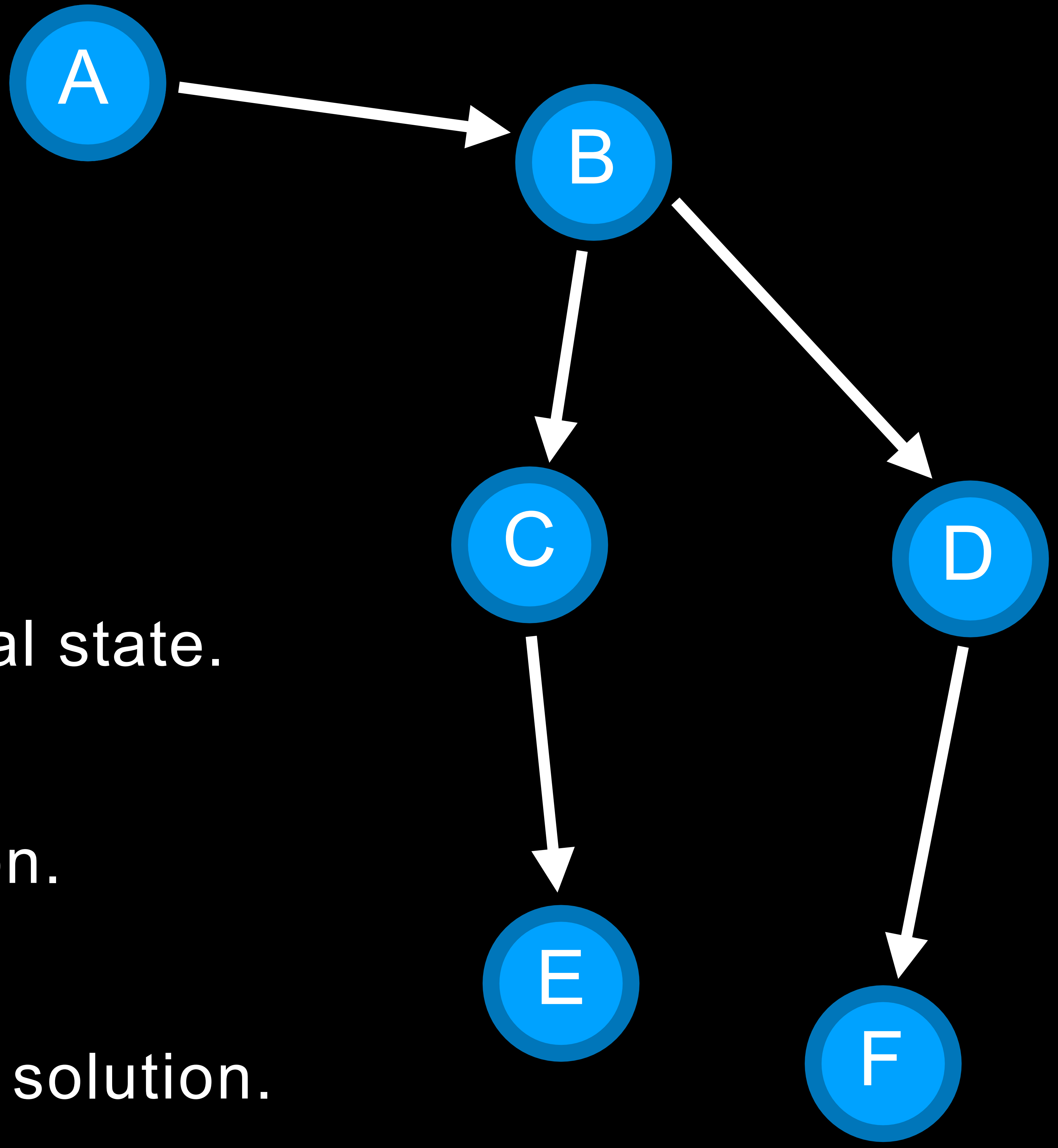
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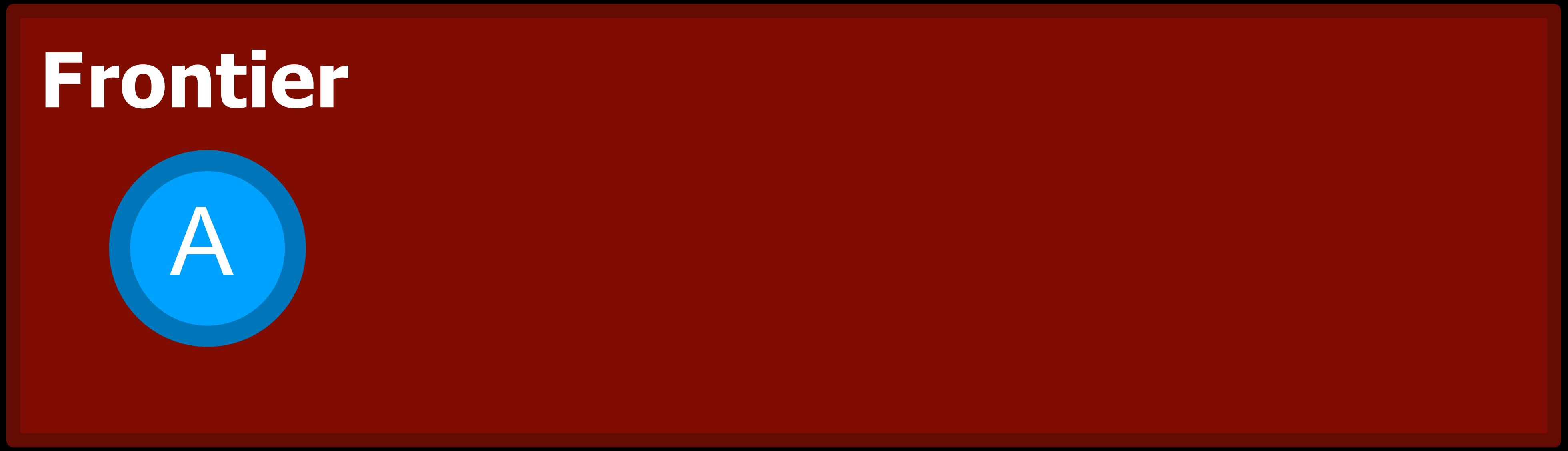

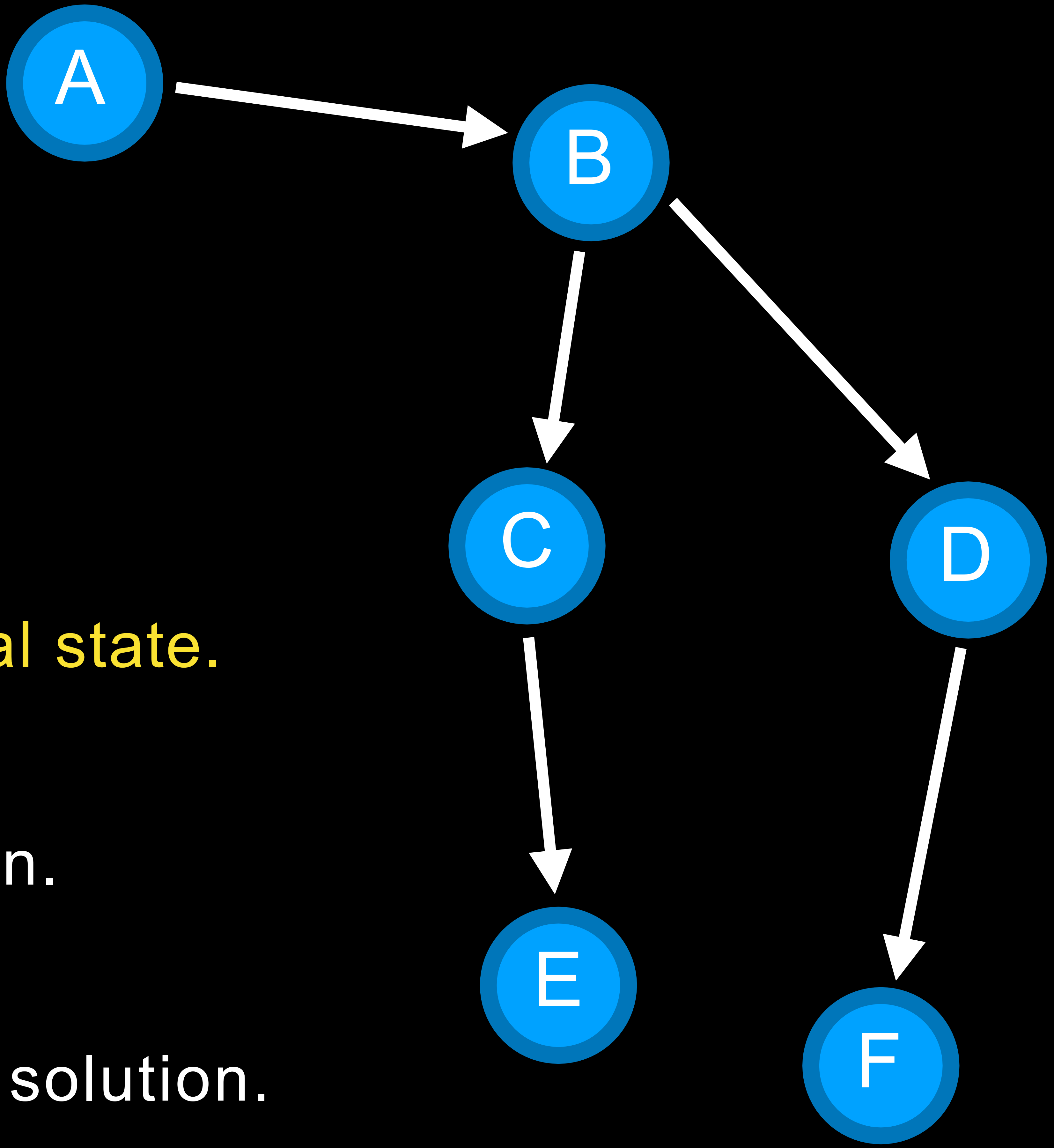

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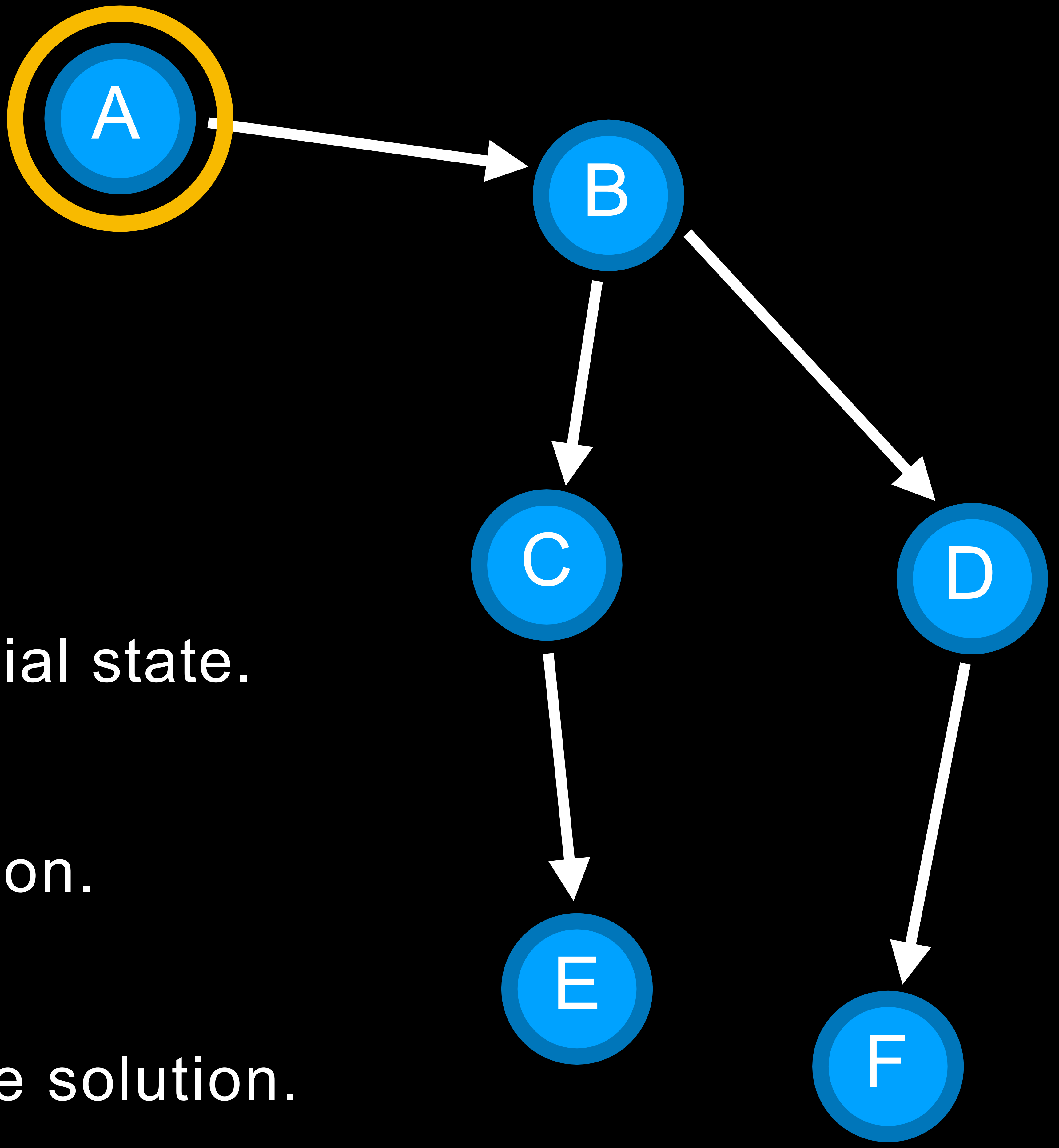

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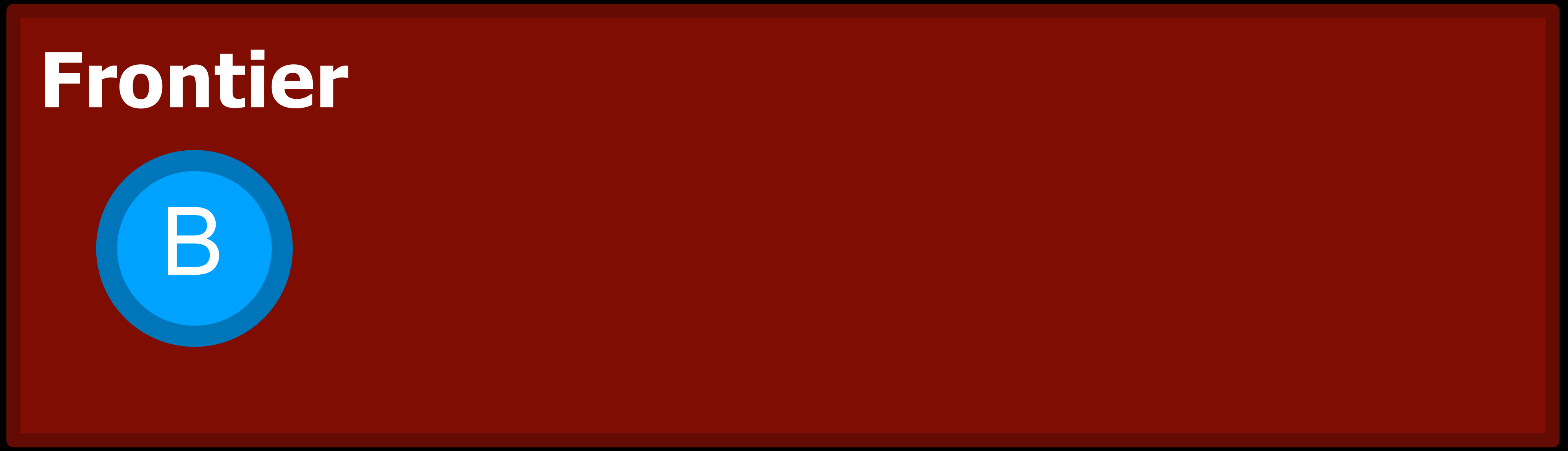

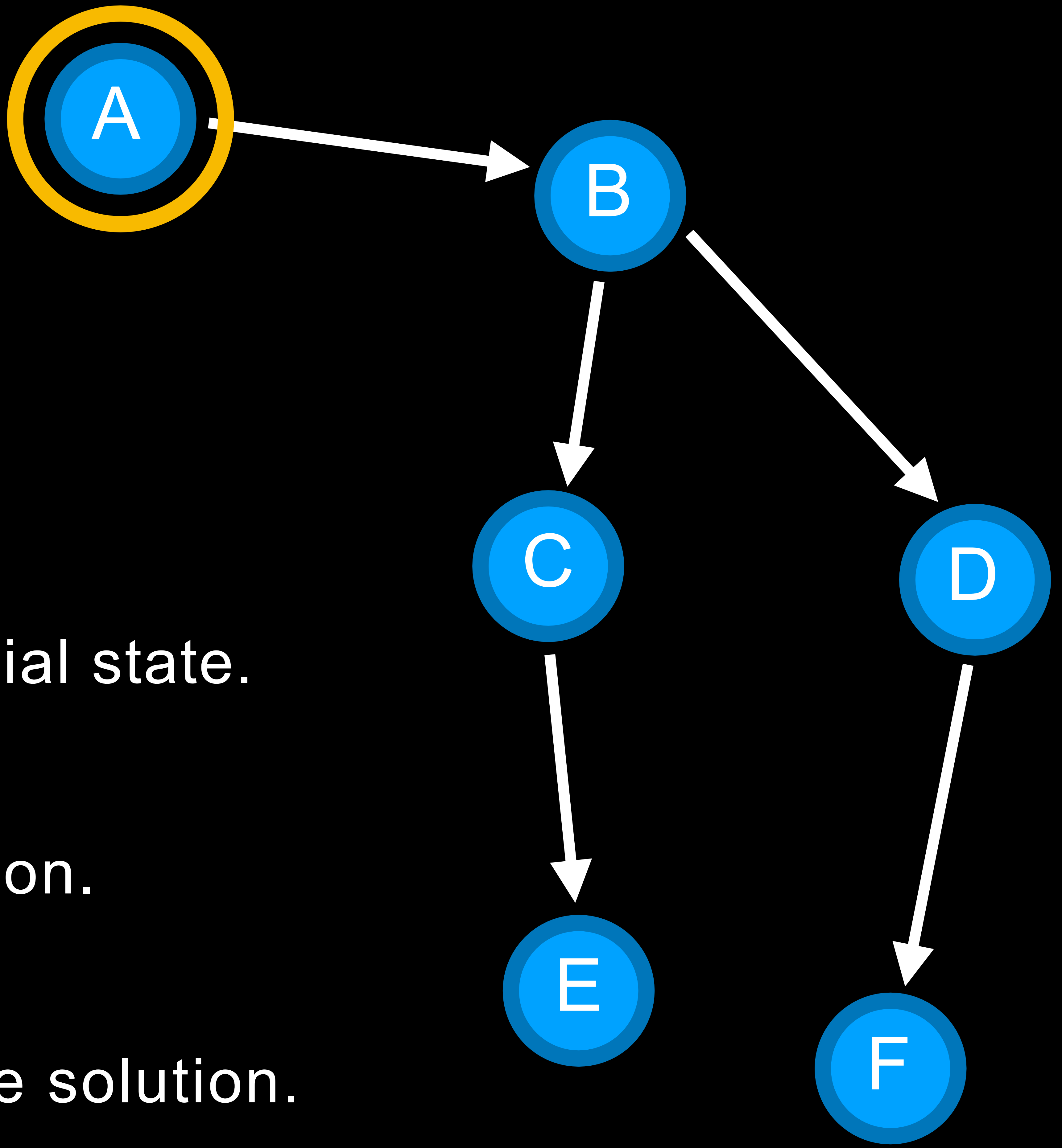

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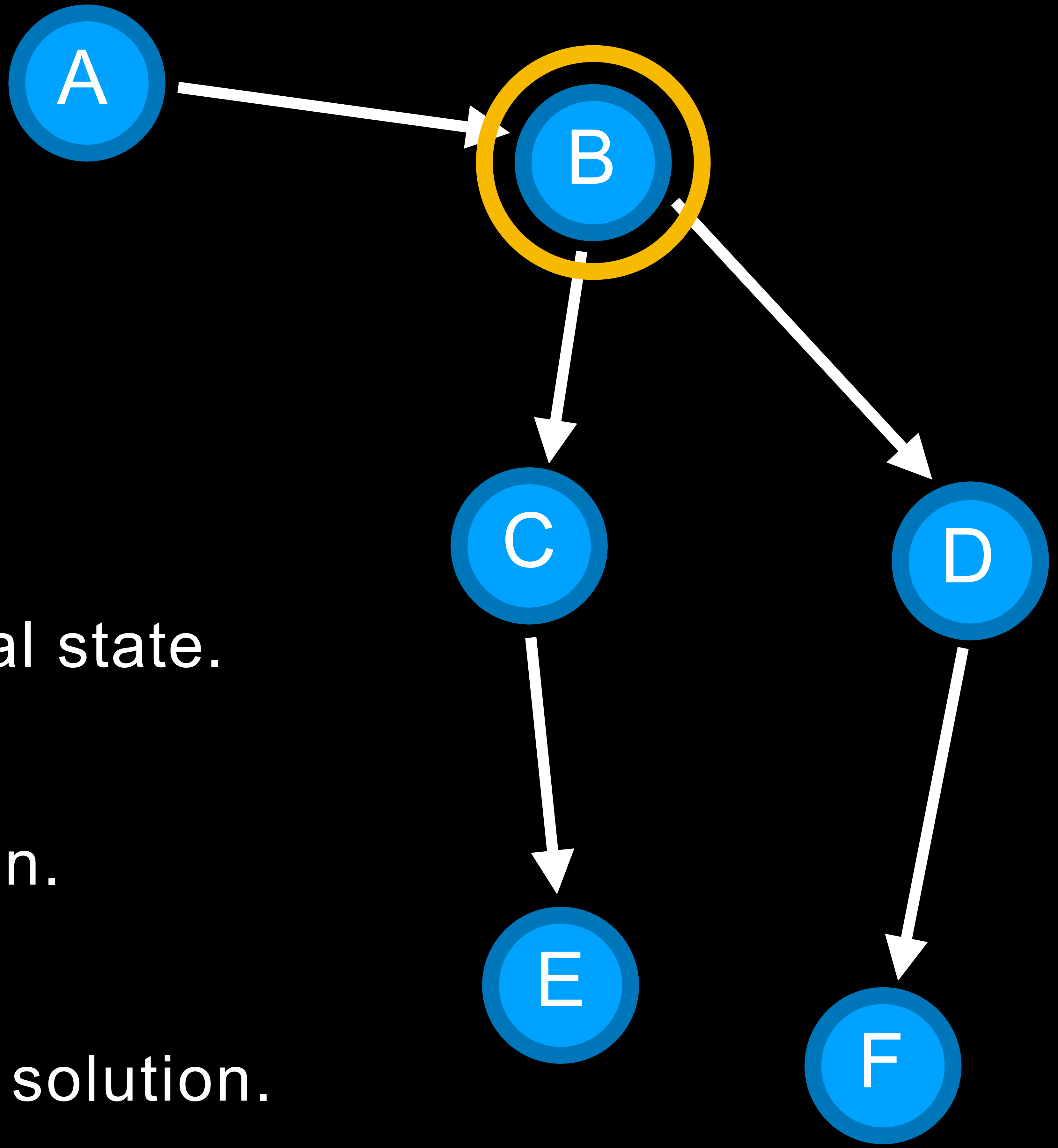

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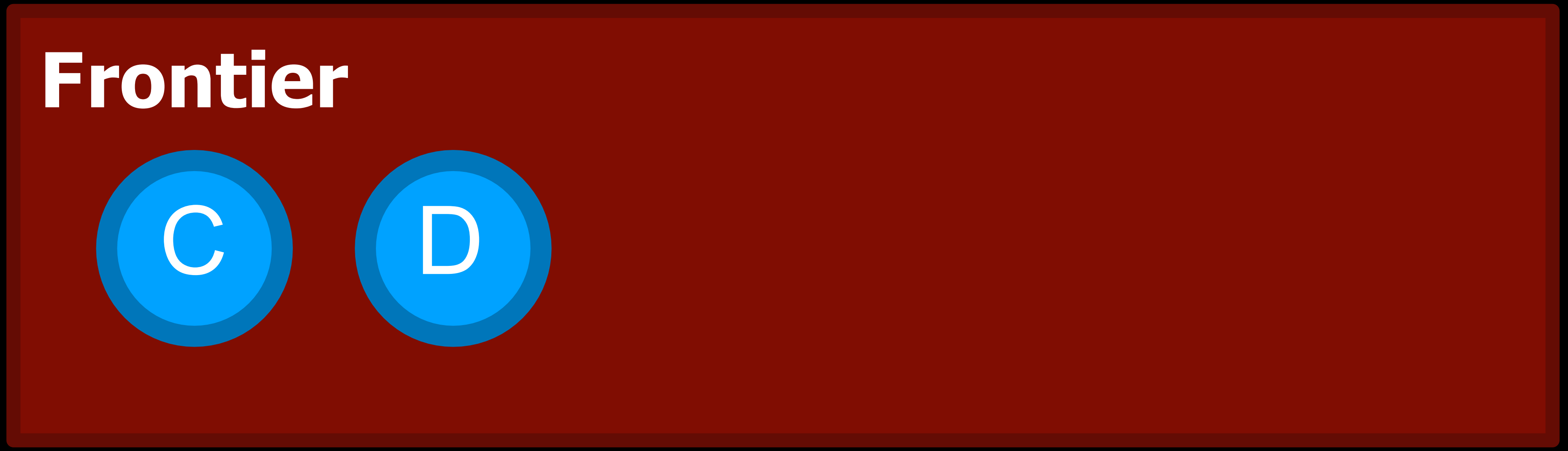

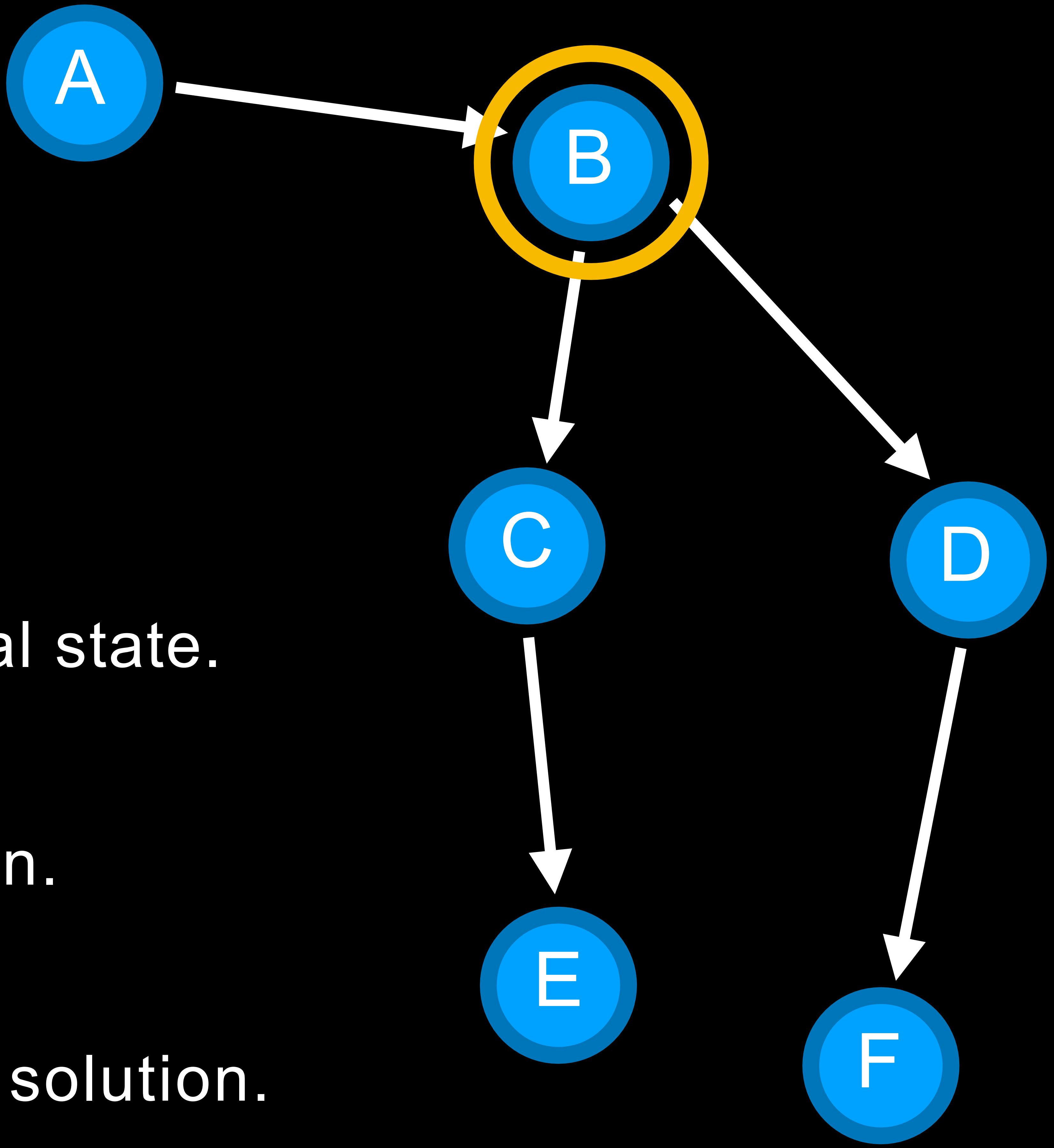

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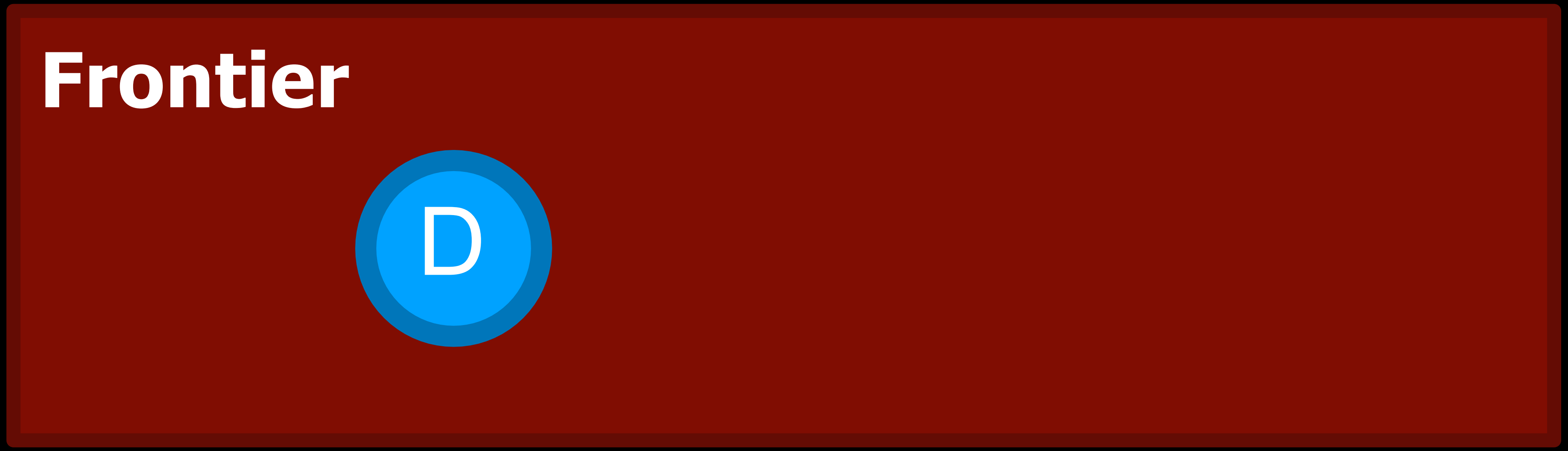

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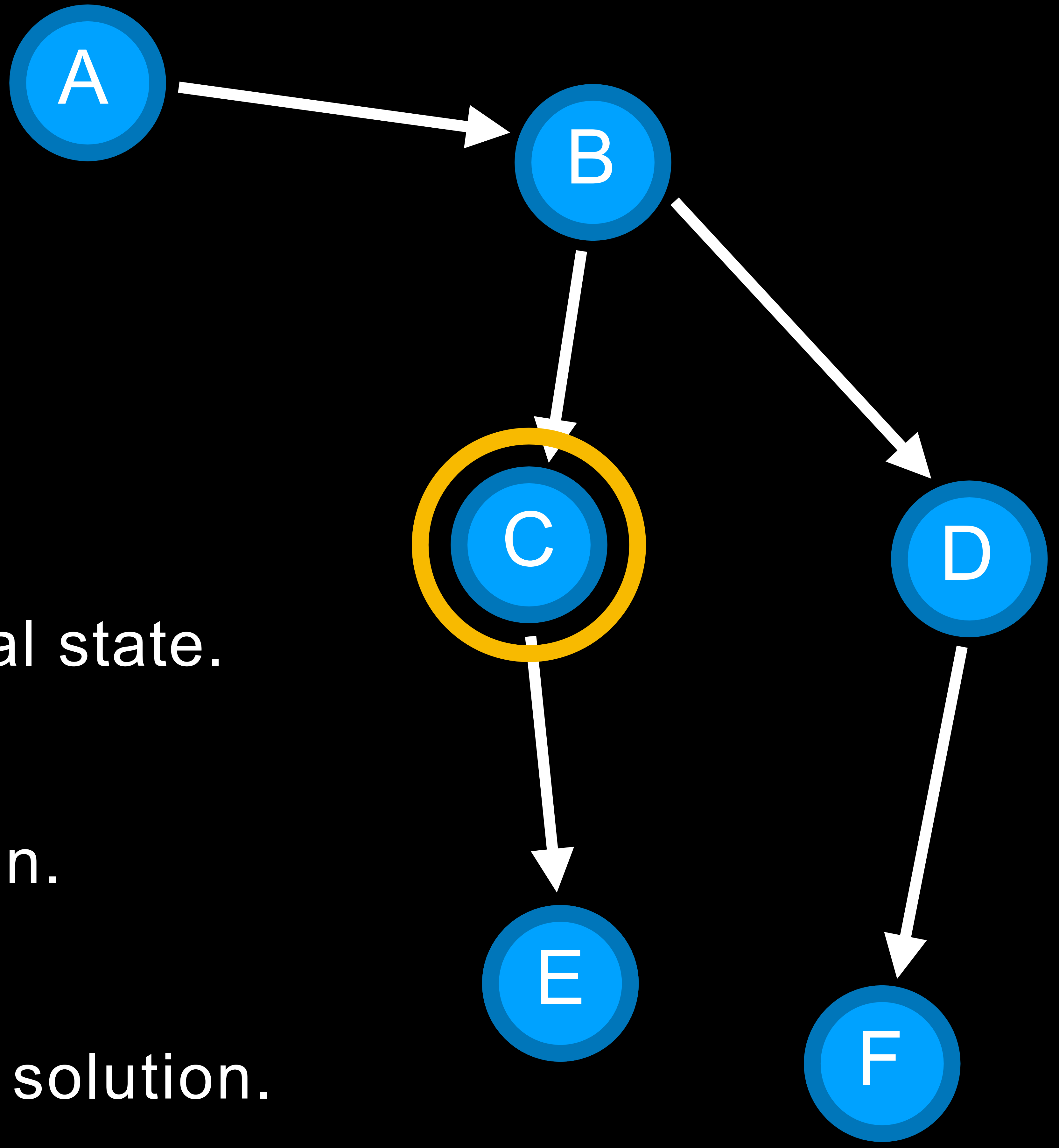

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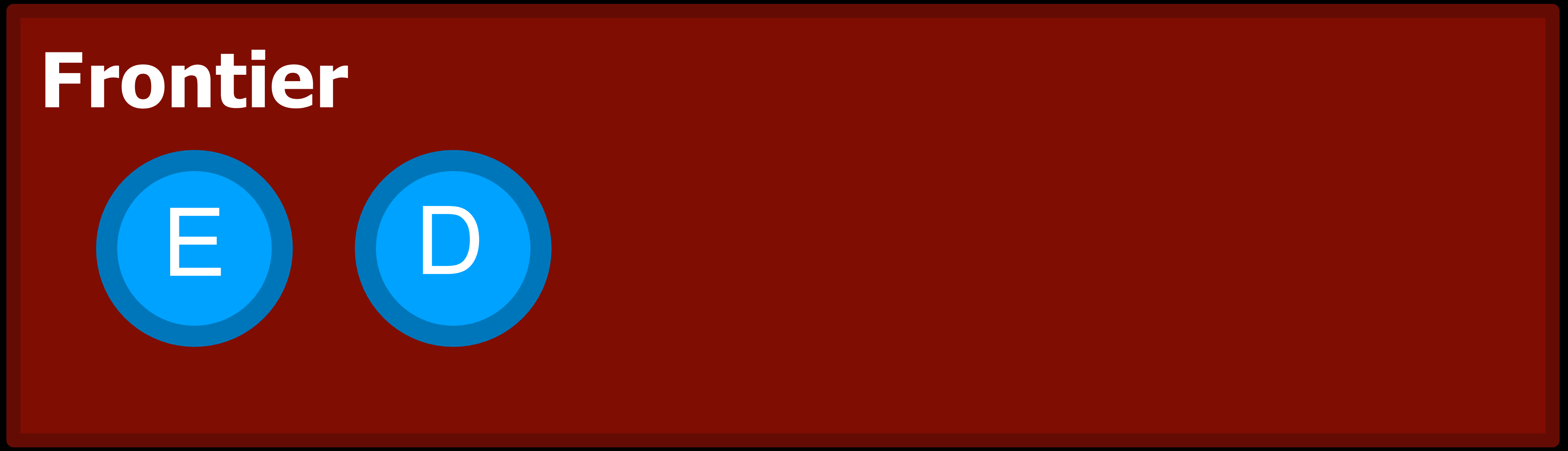

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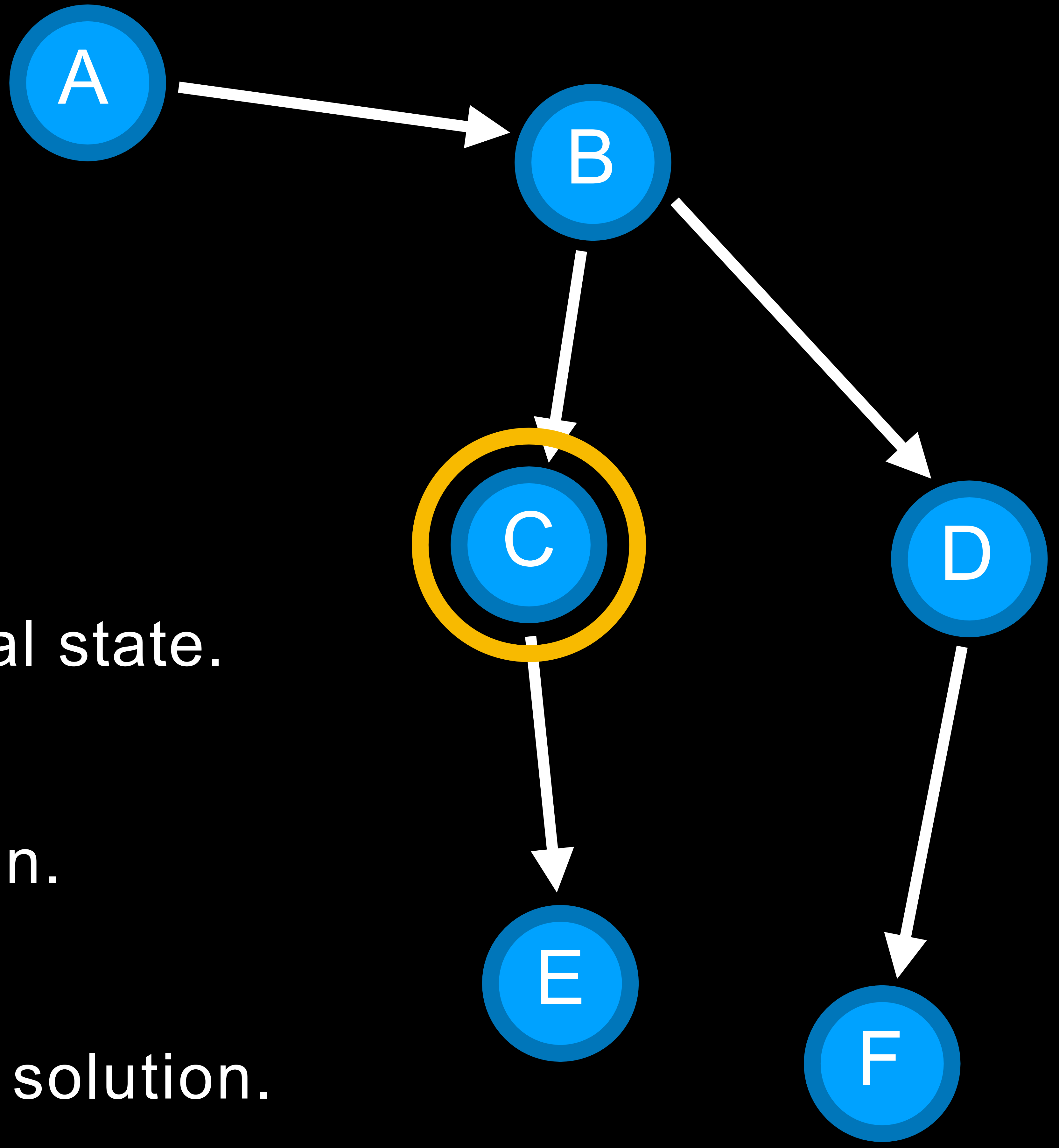

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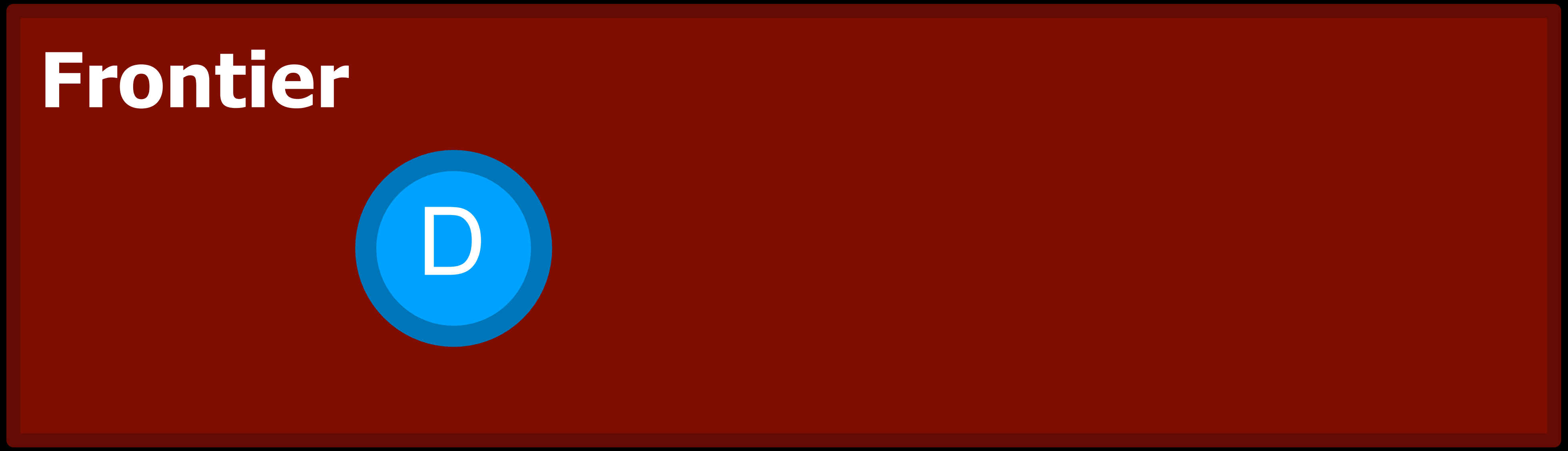

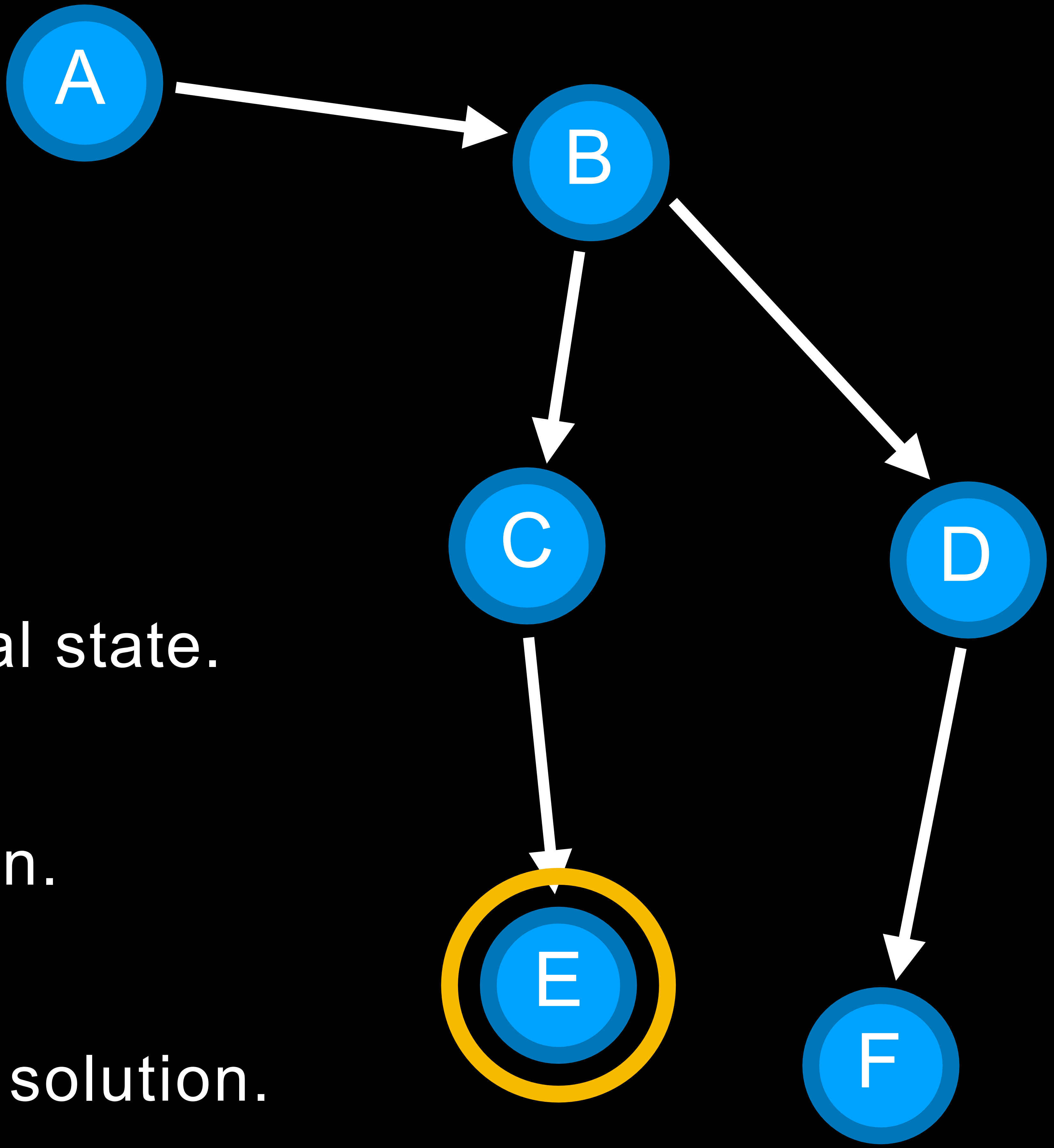

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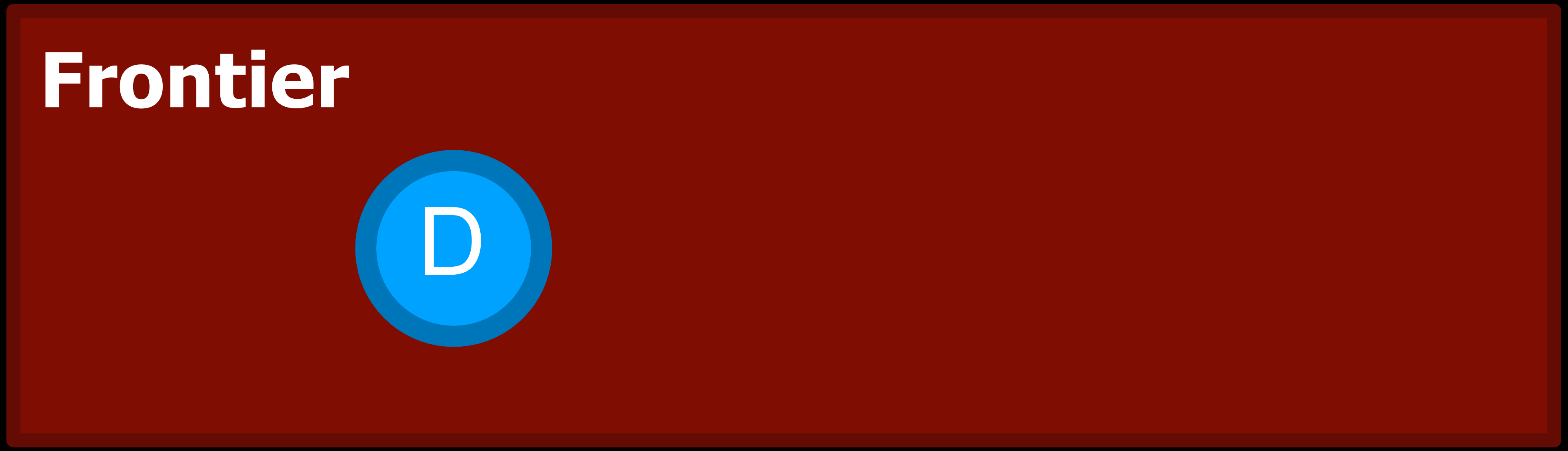

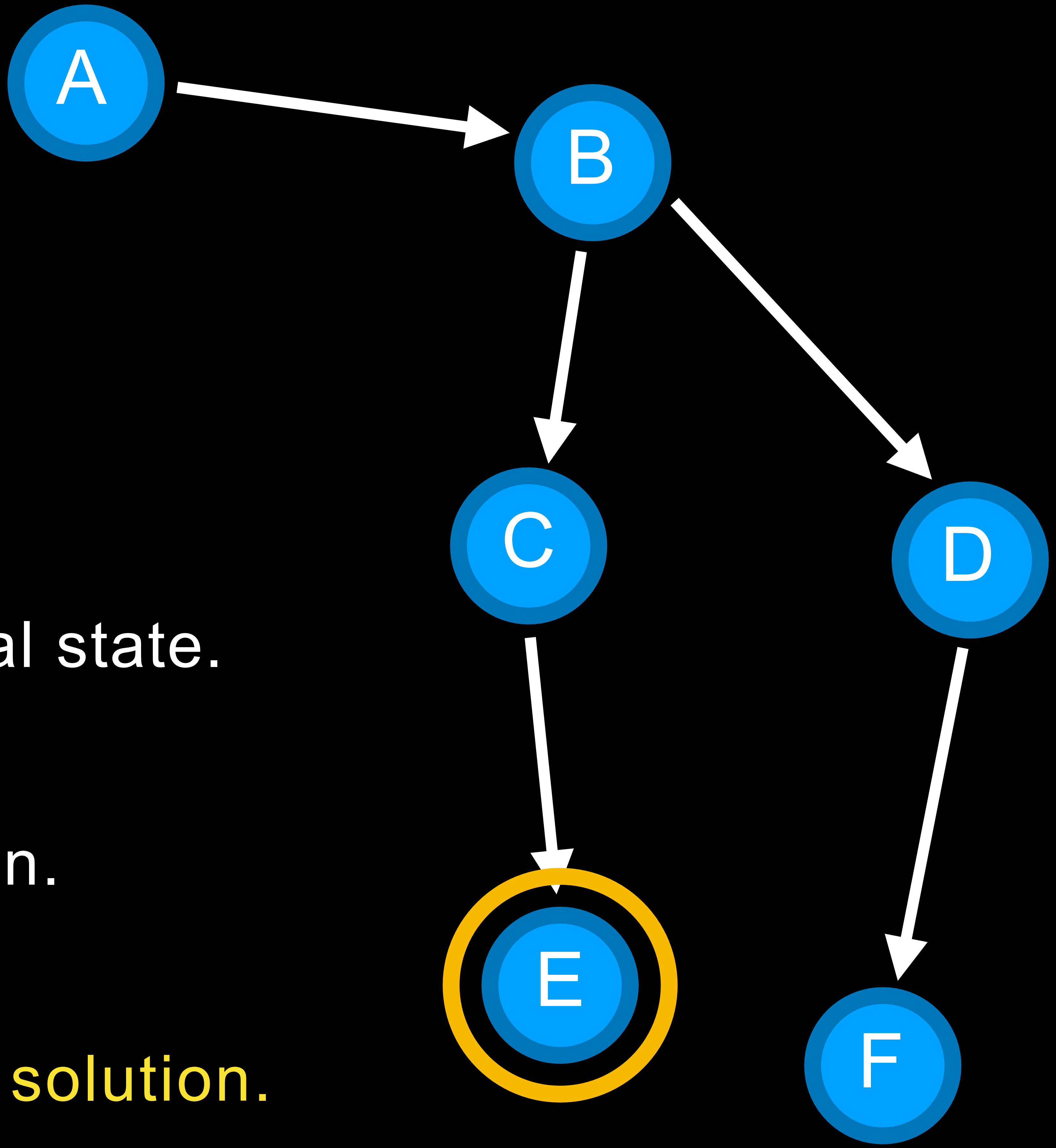

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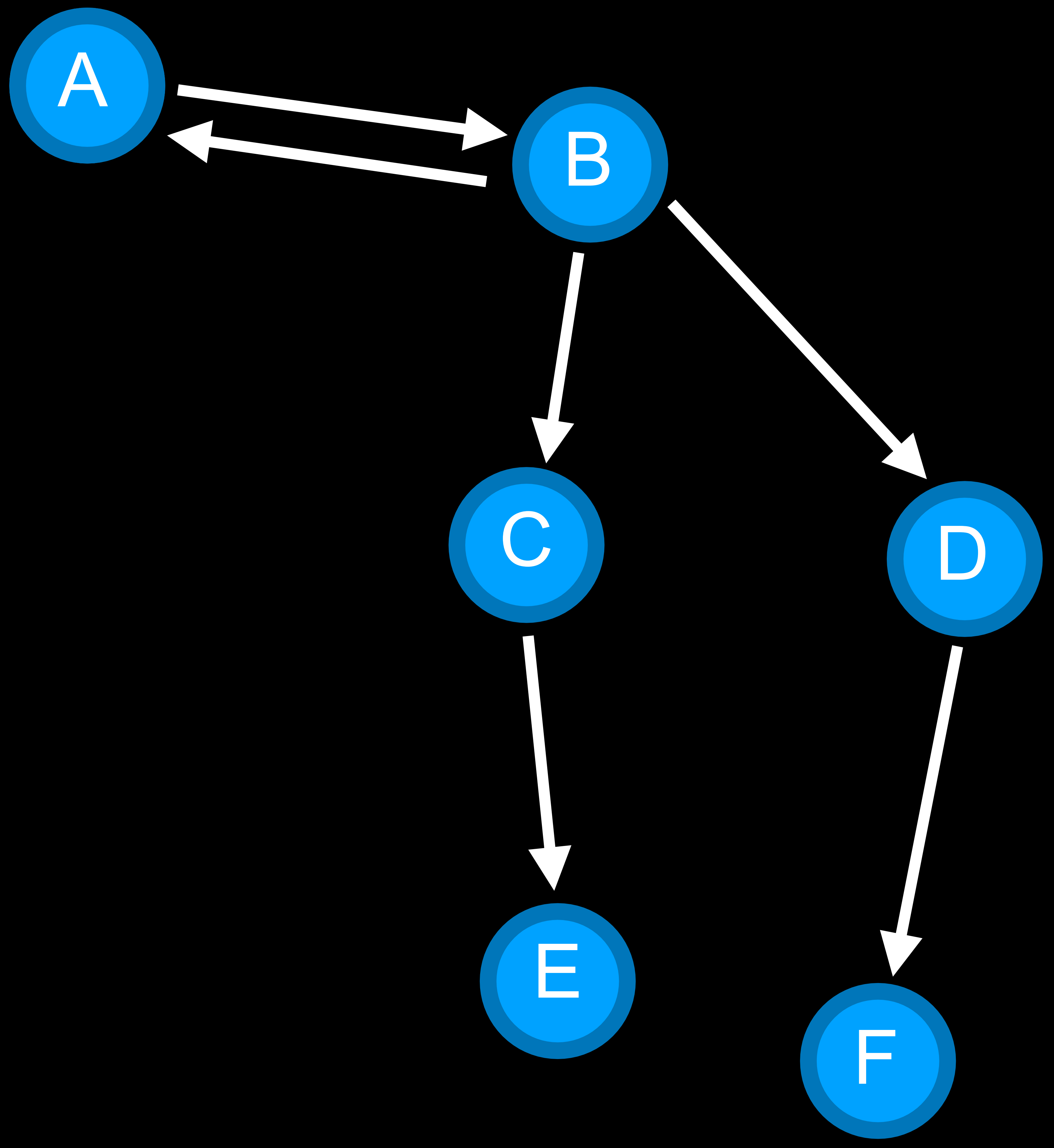
What could go wrong?

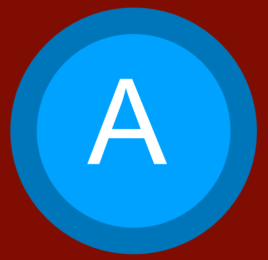
Find a path from A to E.

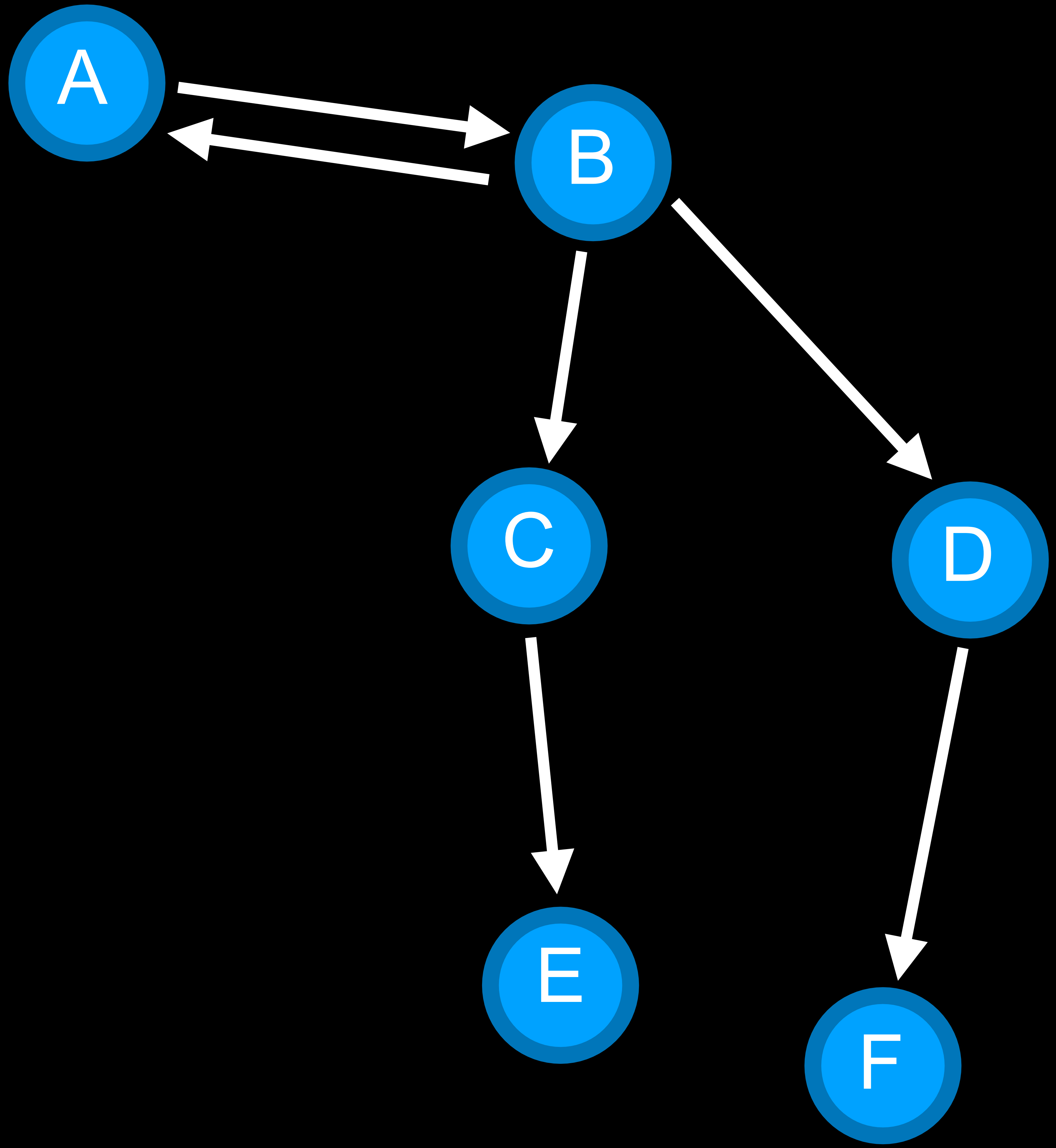
Frontier



Find a path from A to E.

Frontier

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 & C \arrow[d] & D \arrow[d] \\
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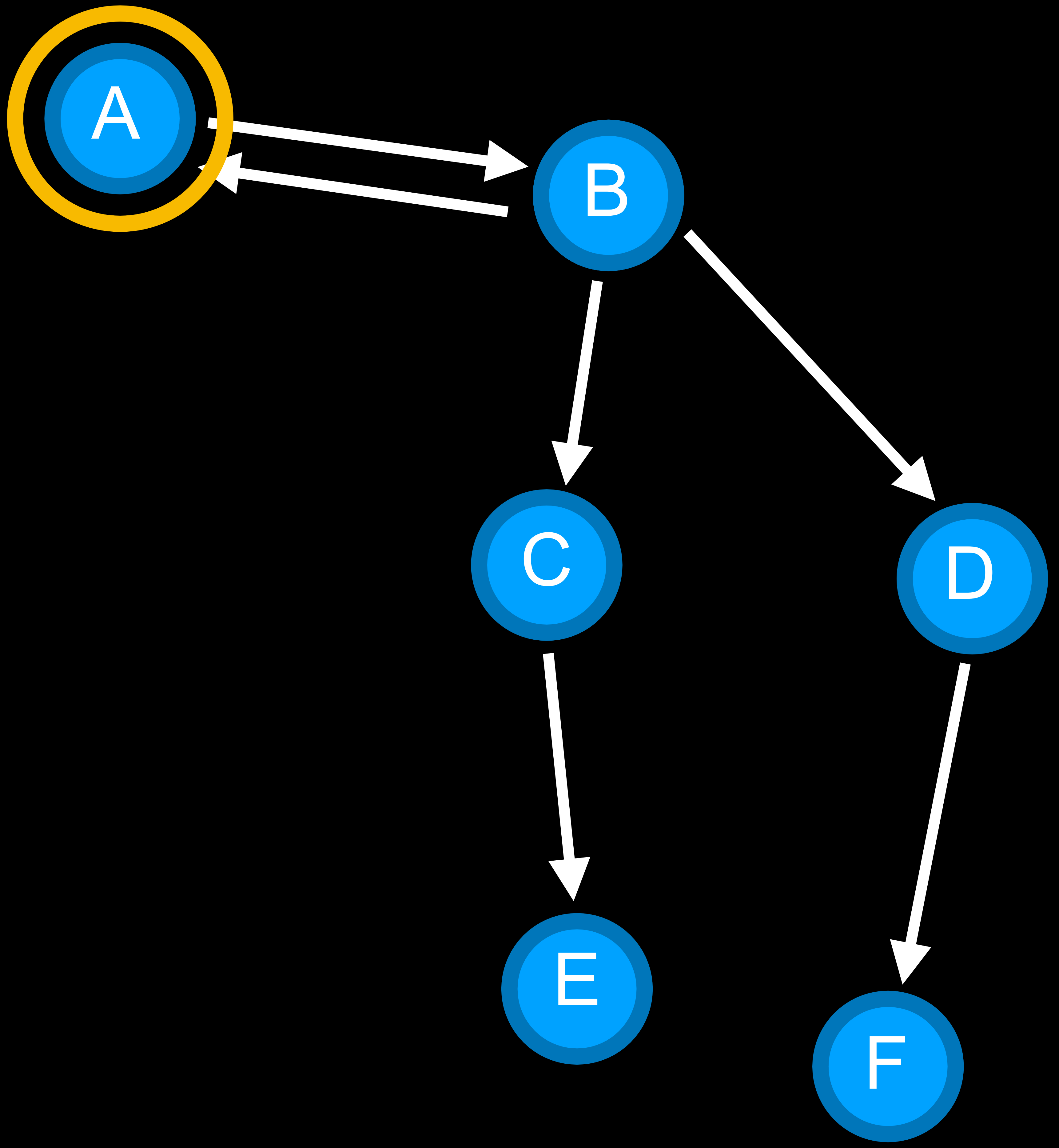
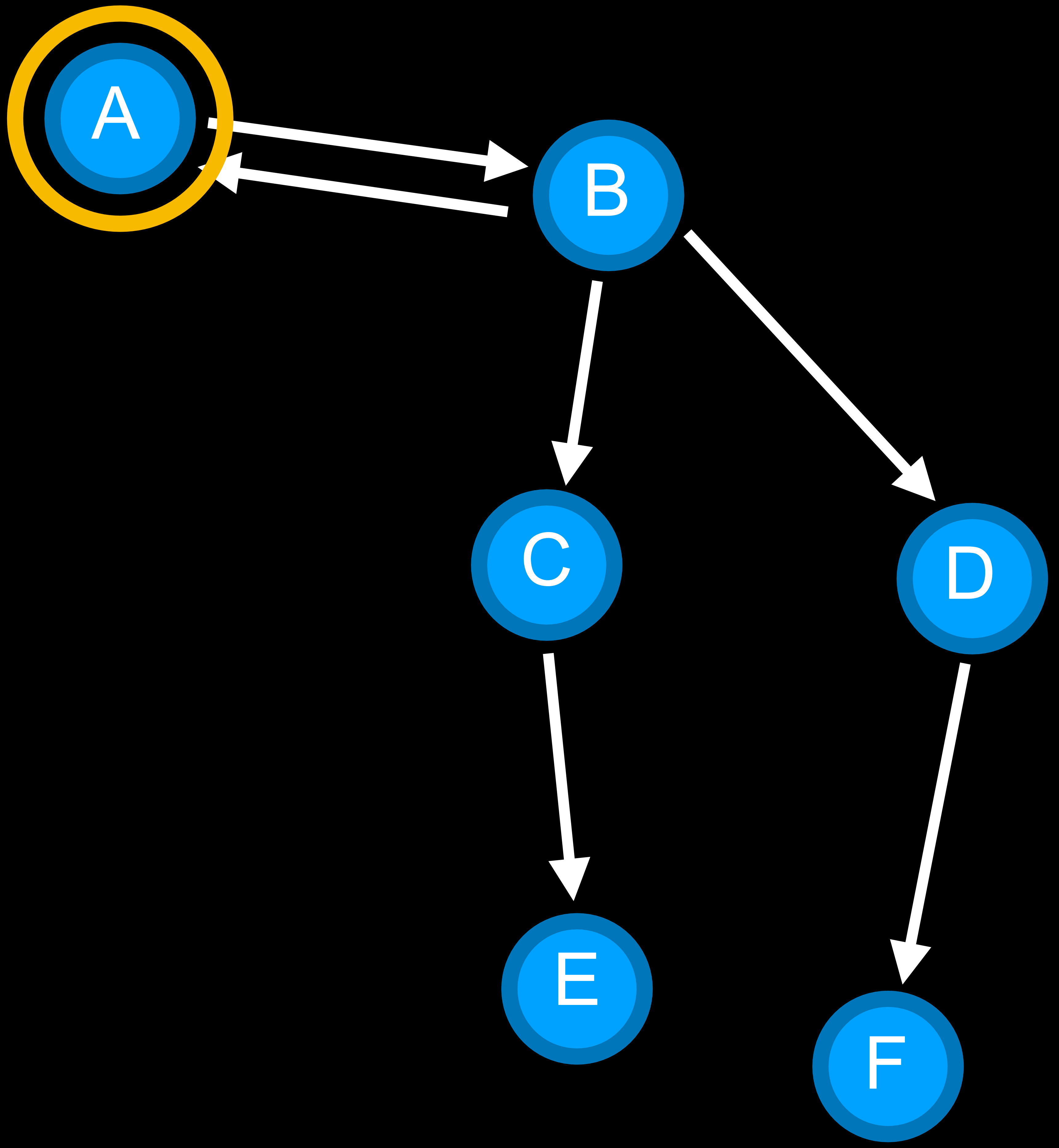
Frontier



Find a path from A to E.

Frontier

B



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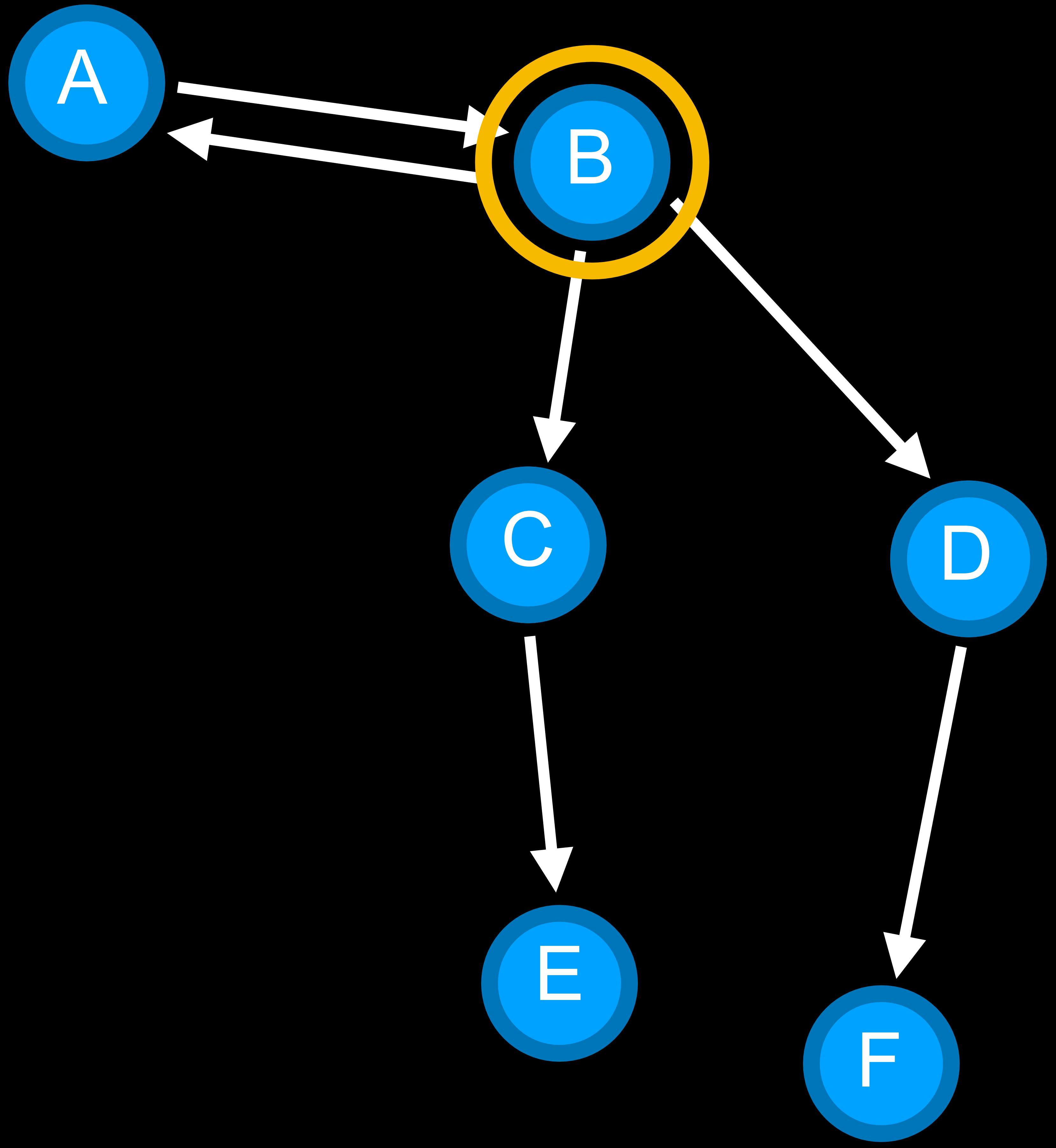
Frontier



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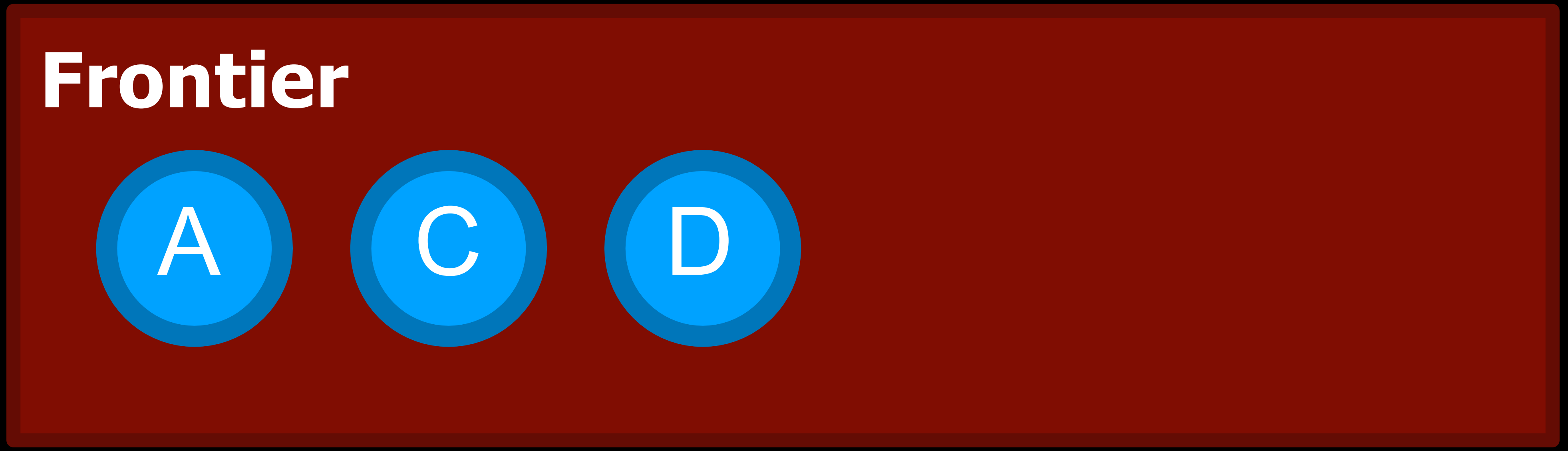

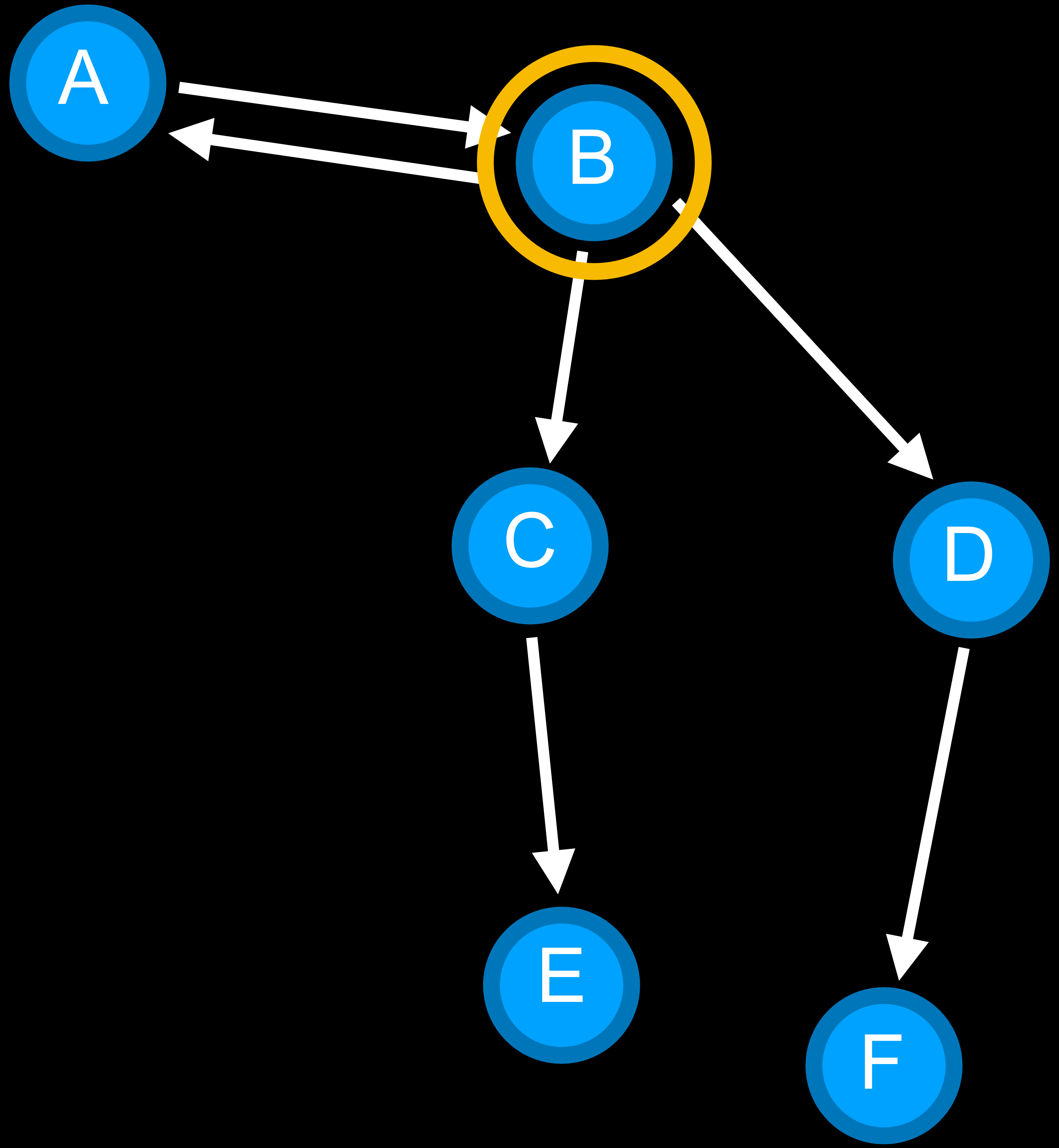

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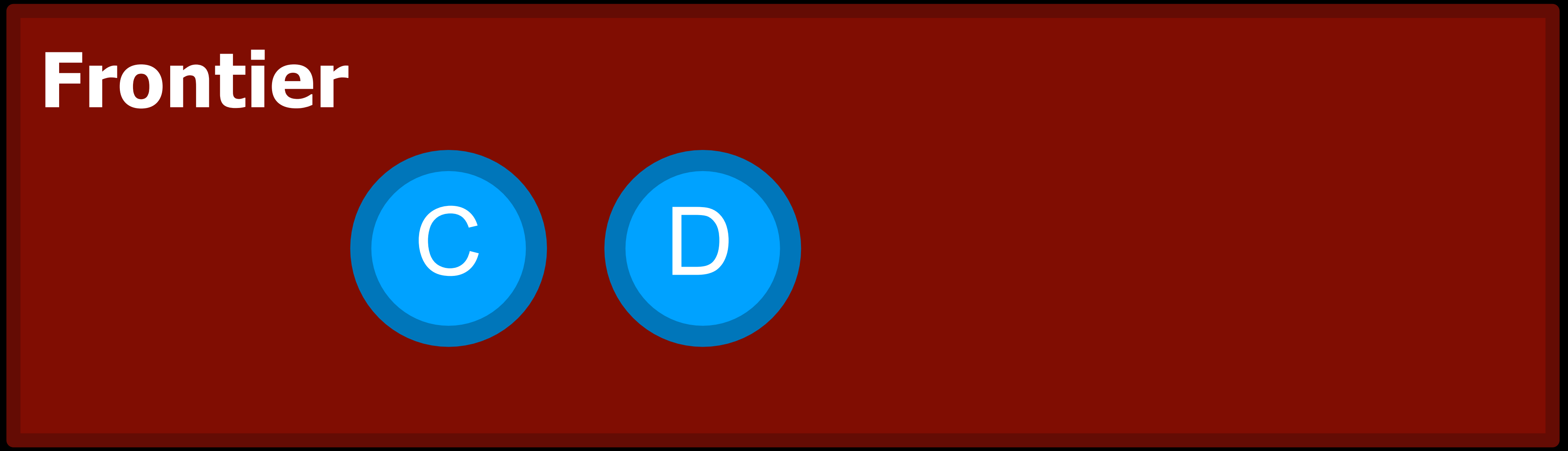

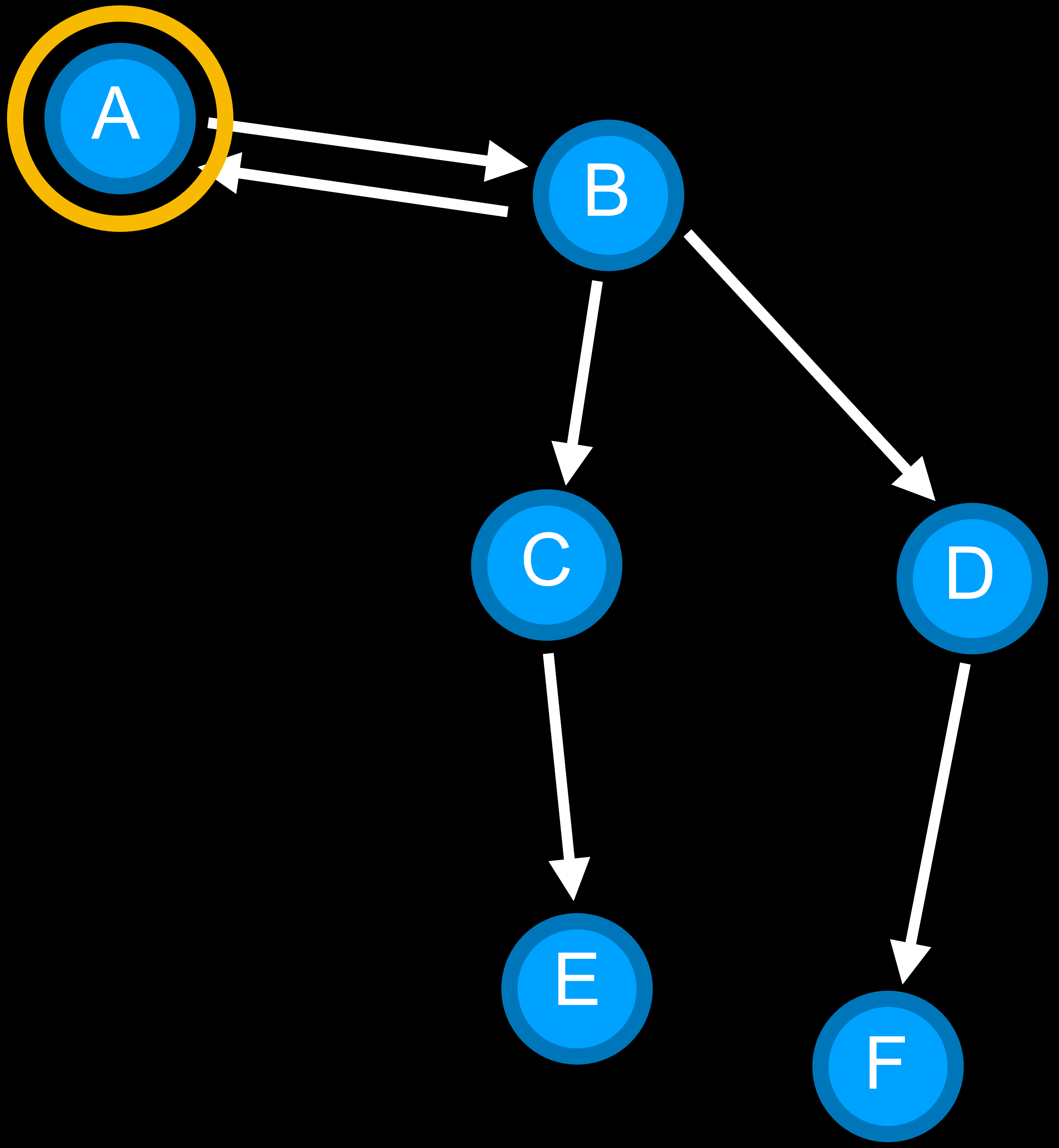

Revised Approach

- Start with a **frontier** that contains the initial state.
- Start with an empty **explored set**.
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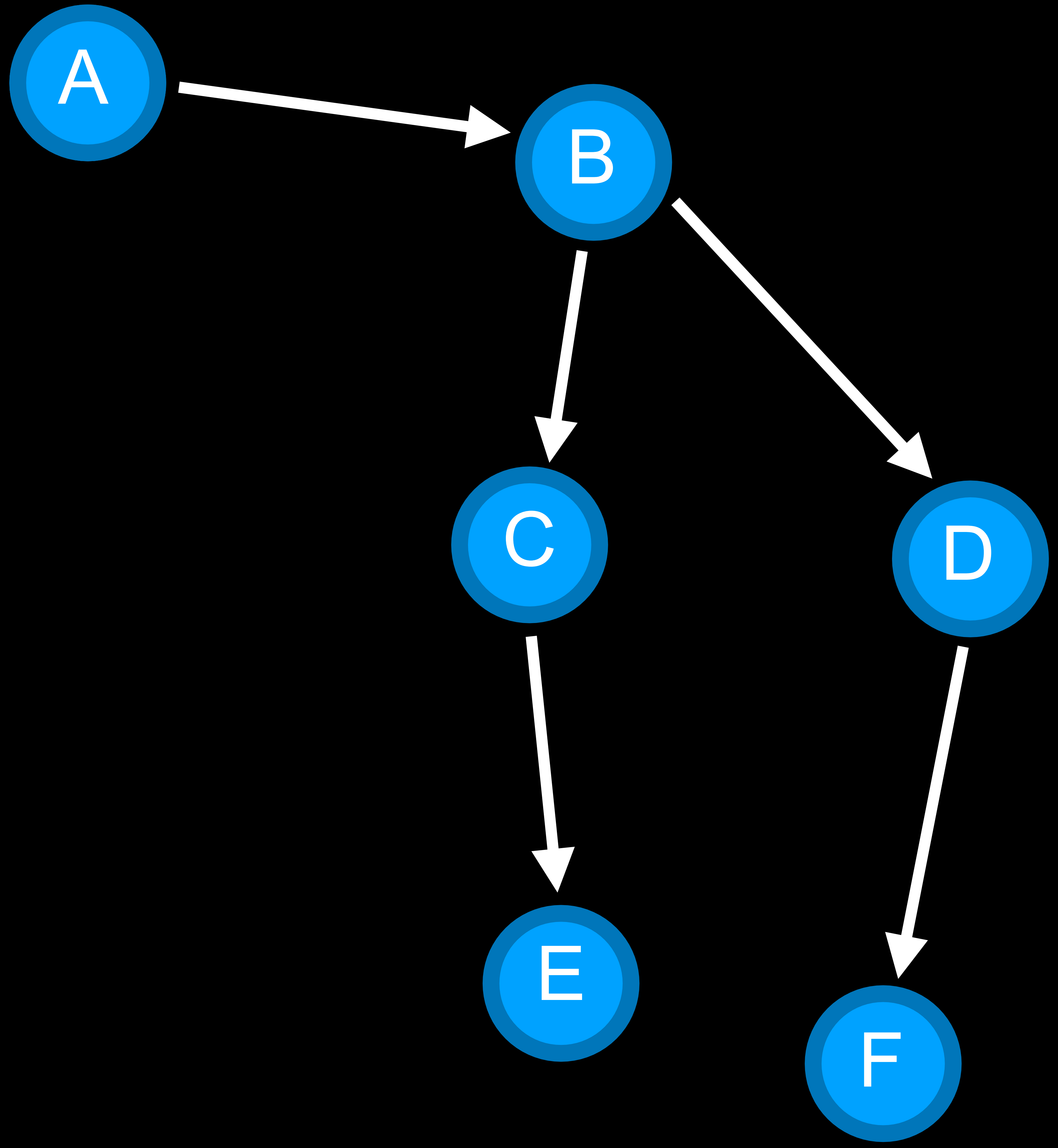
stack

last-in first-out data type

Find a path from A to E.

Frontier

Explored Set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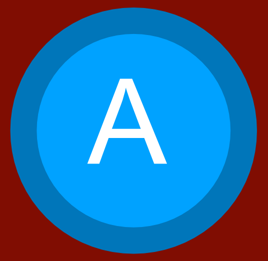
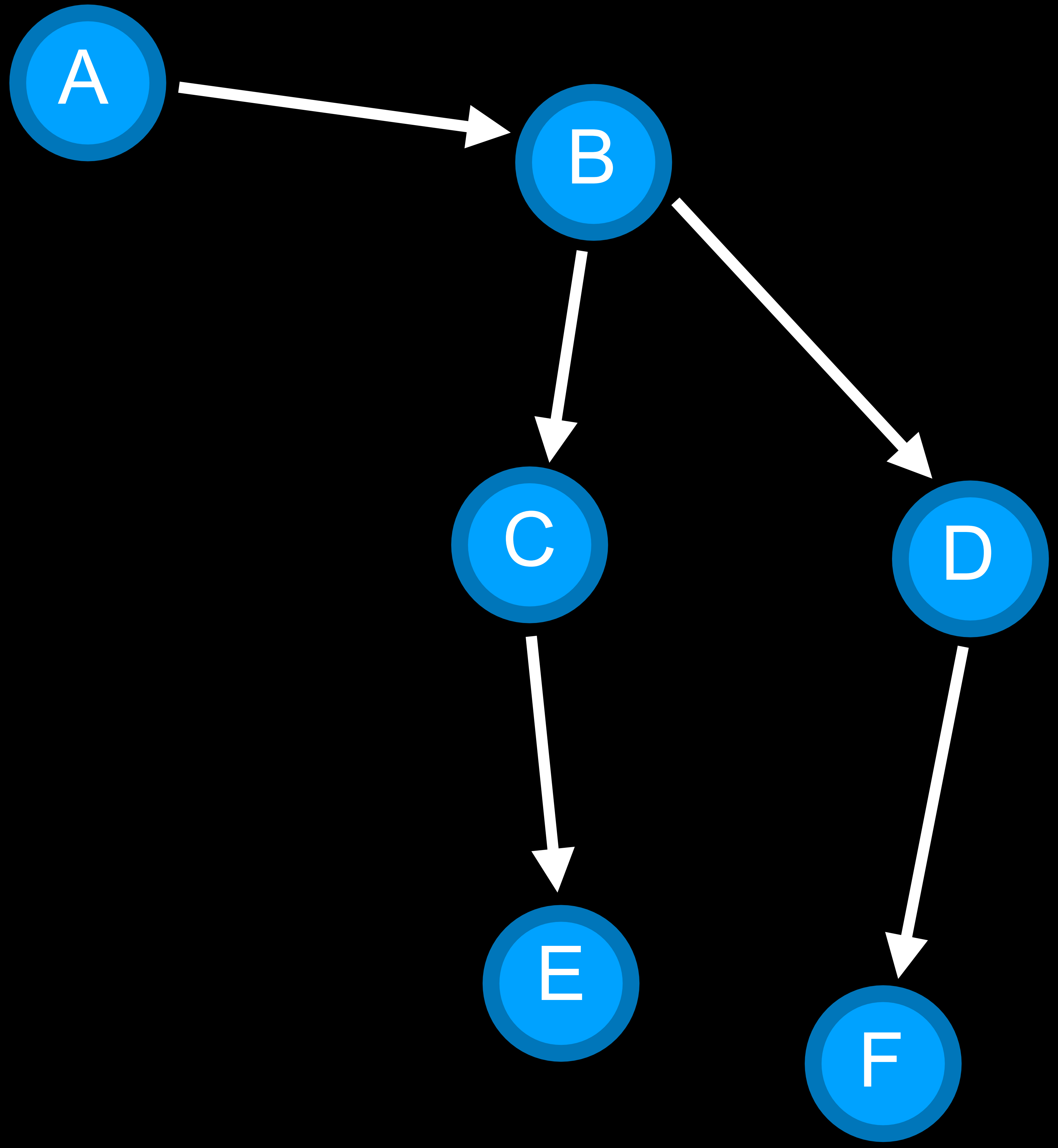
Find a path from A to E.

Frontier



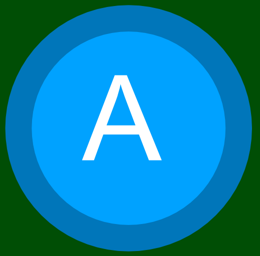
Explored Set

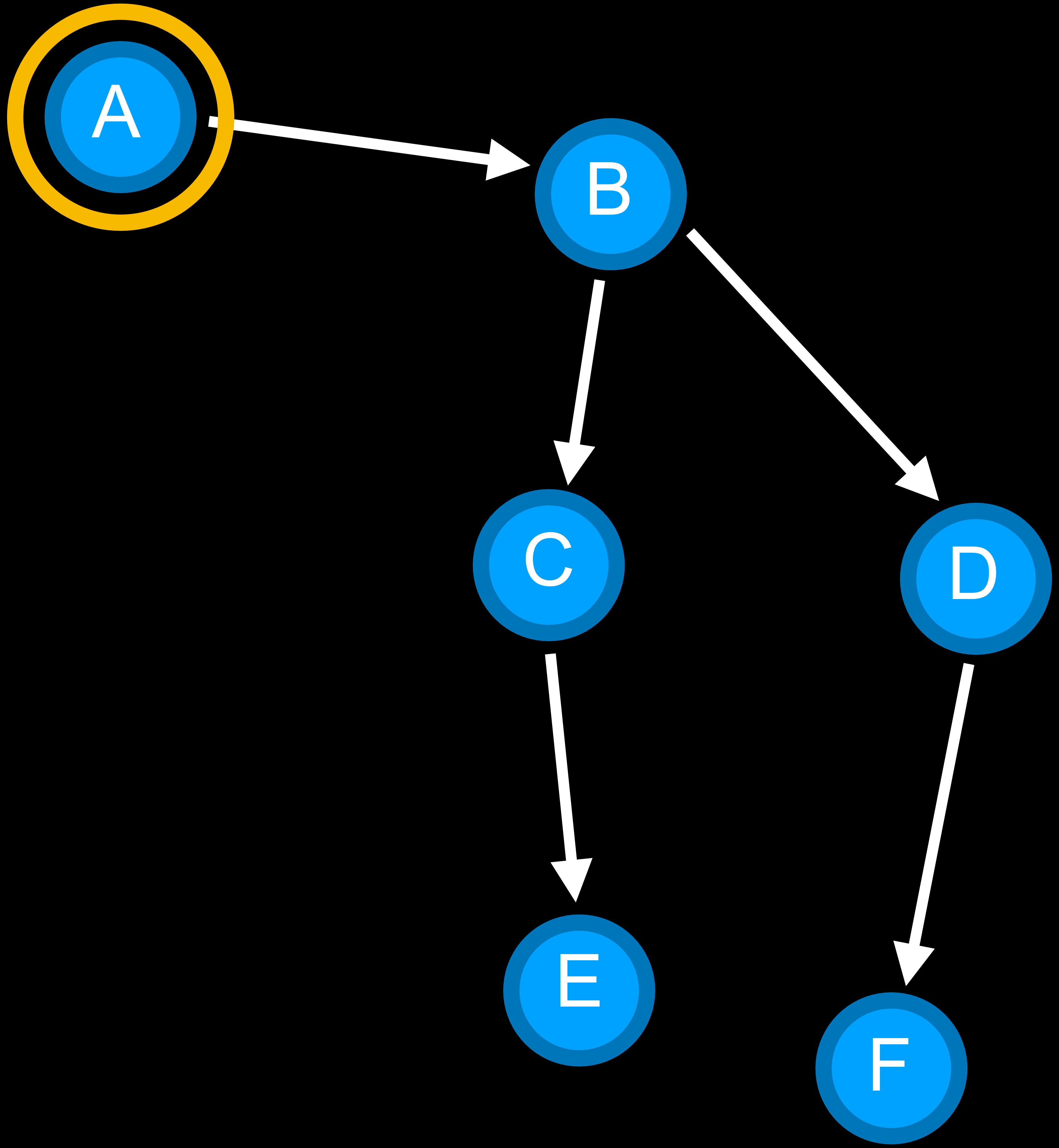


Find a path from A to E.

Frontier

Explored Set





Find a path from A to E.

Frontier

B

Explored Set

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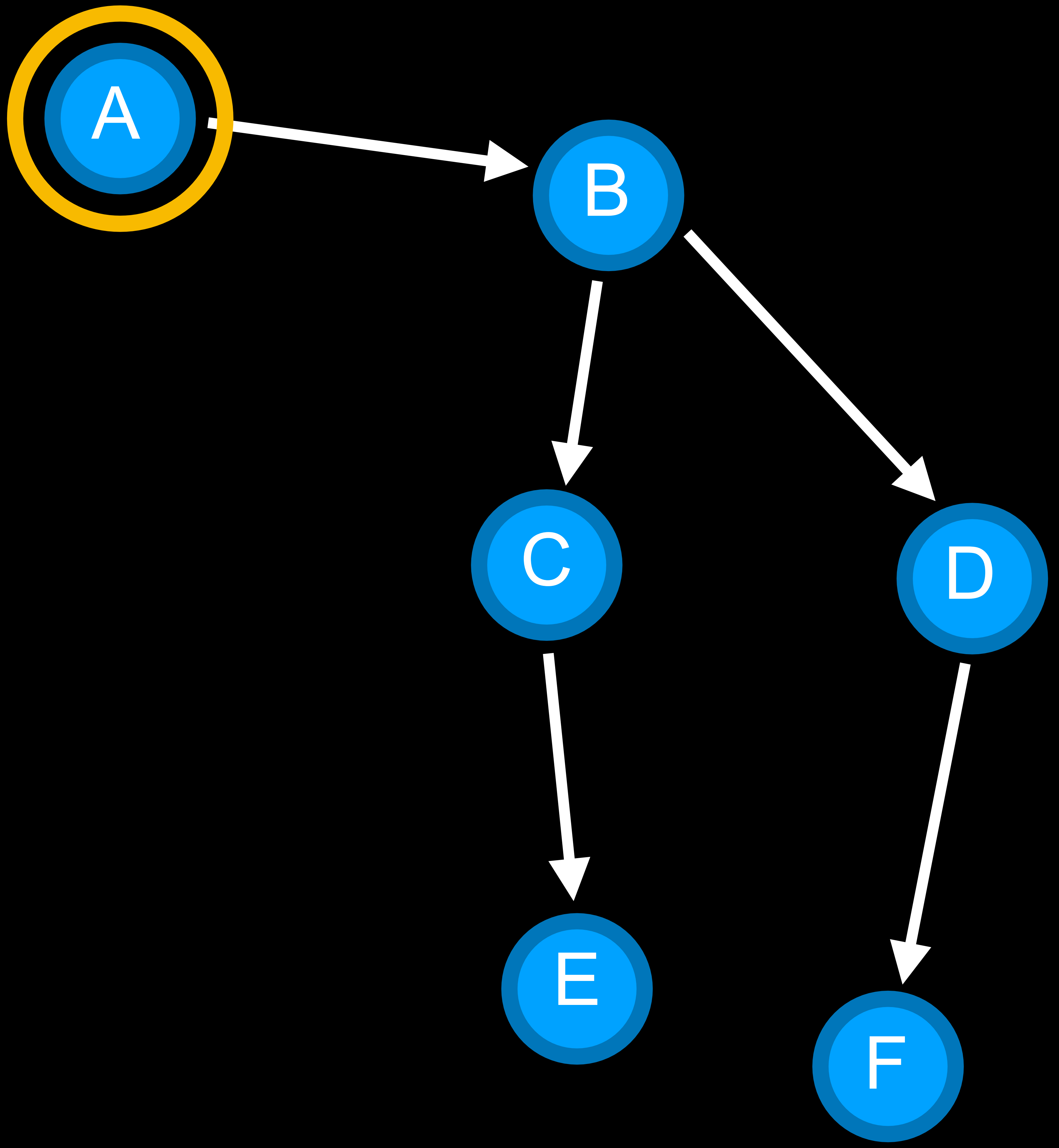

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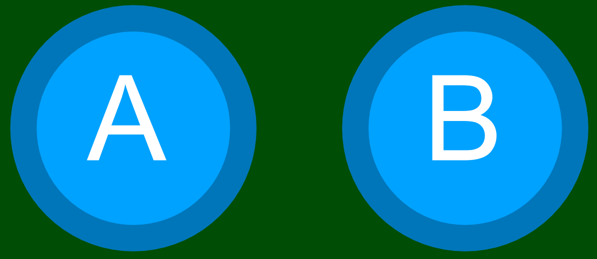
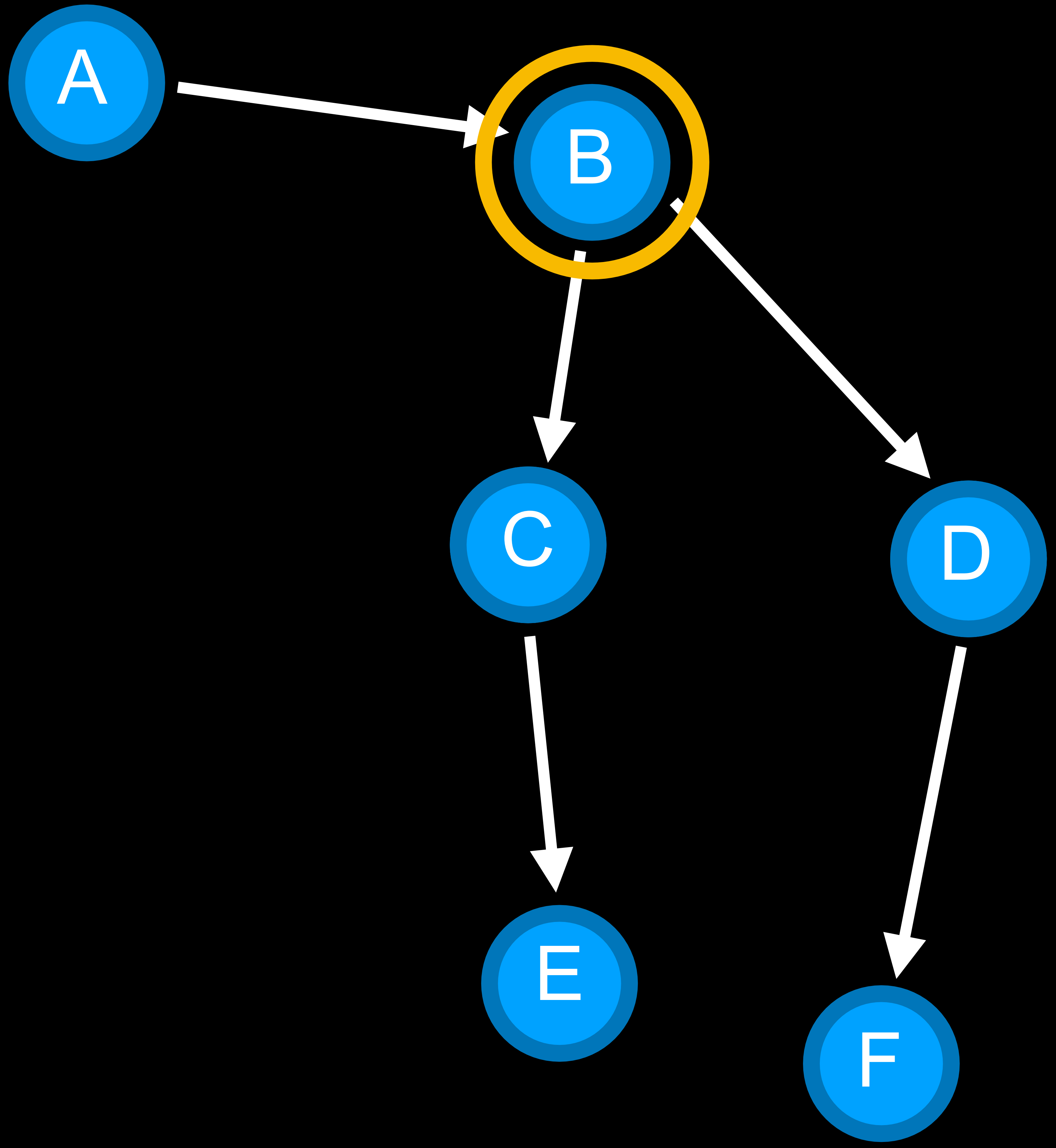
Frontier

Explored Set





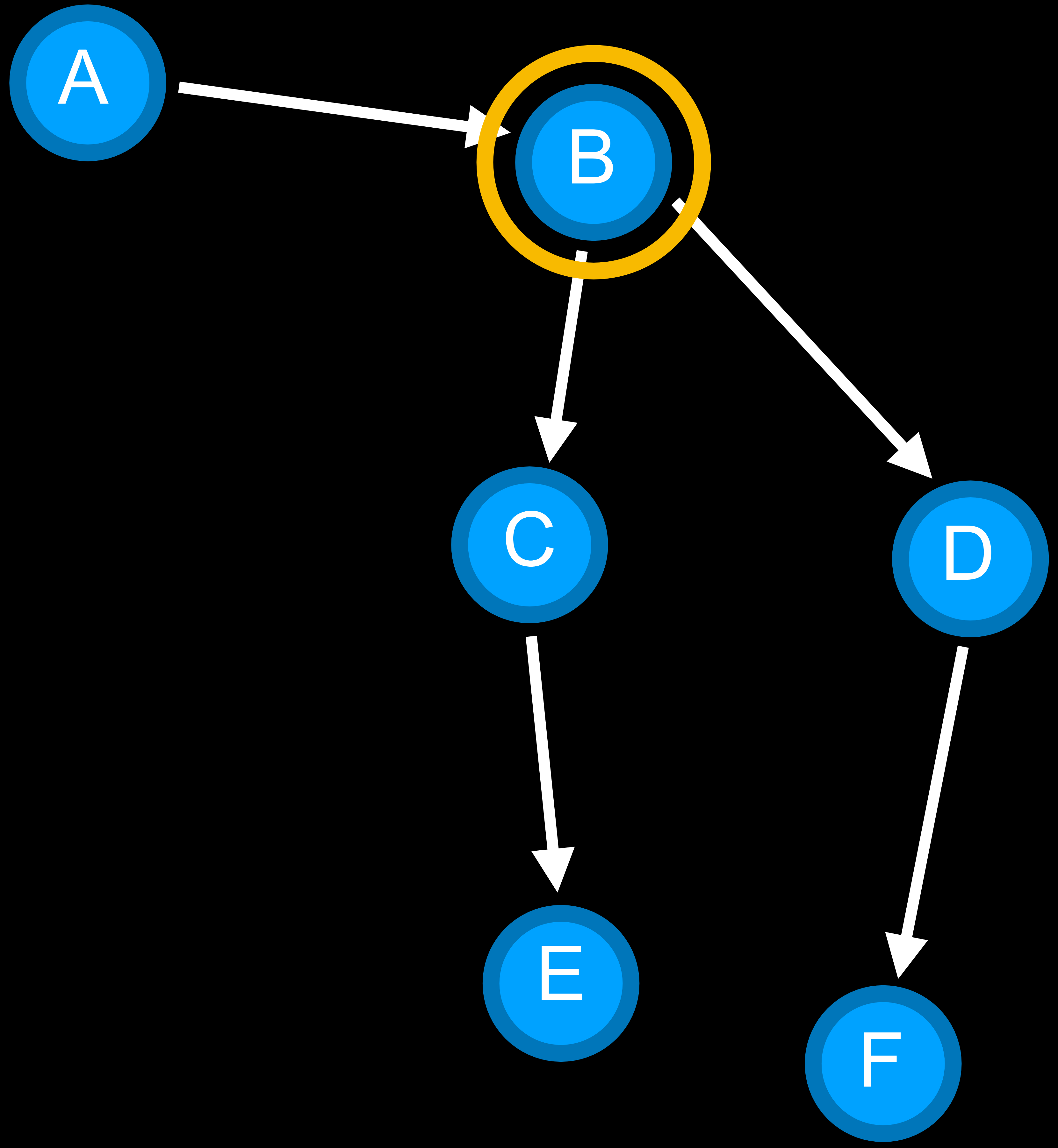
Find a path from A to E.

Frontier

C D

Explored Set

A B



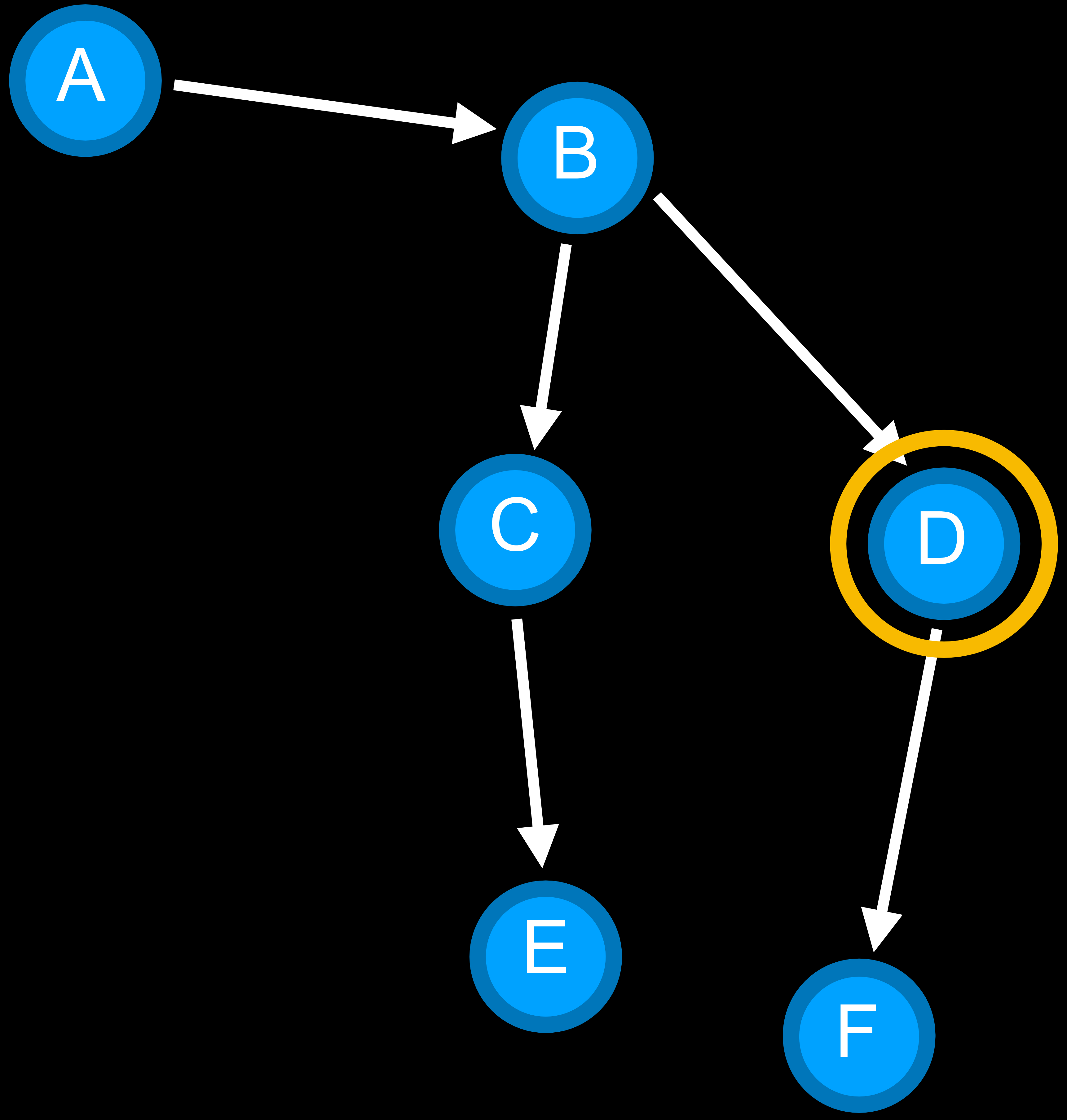
Find a path from A to E.

Frontier

C

Explored Set

A B D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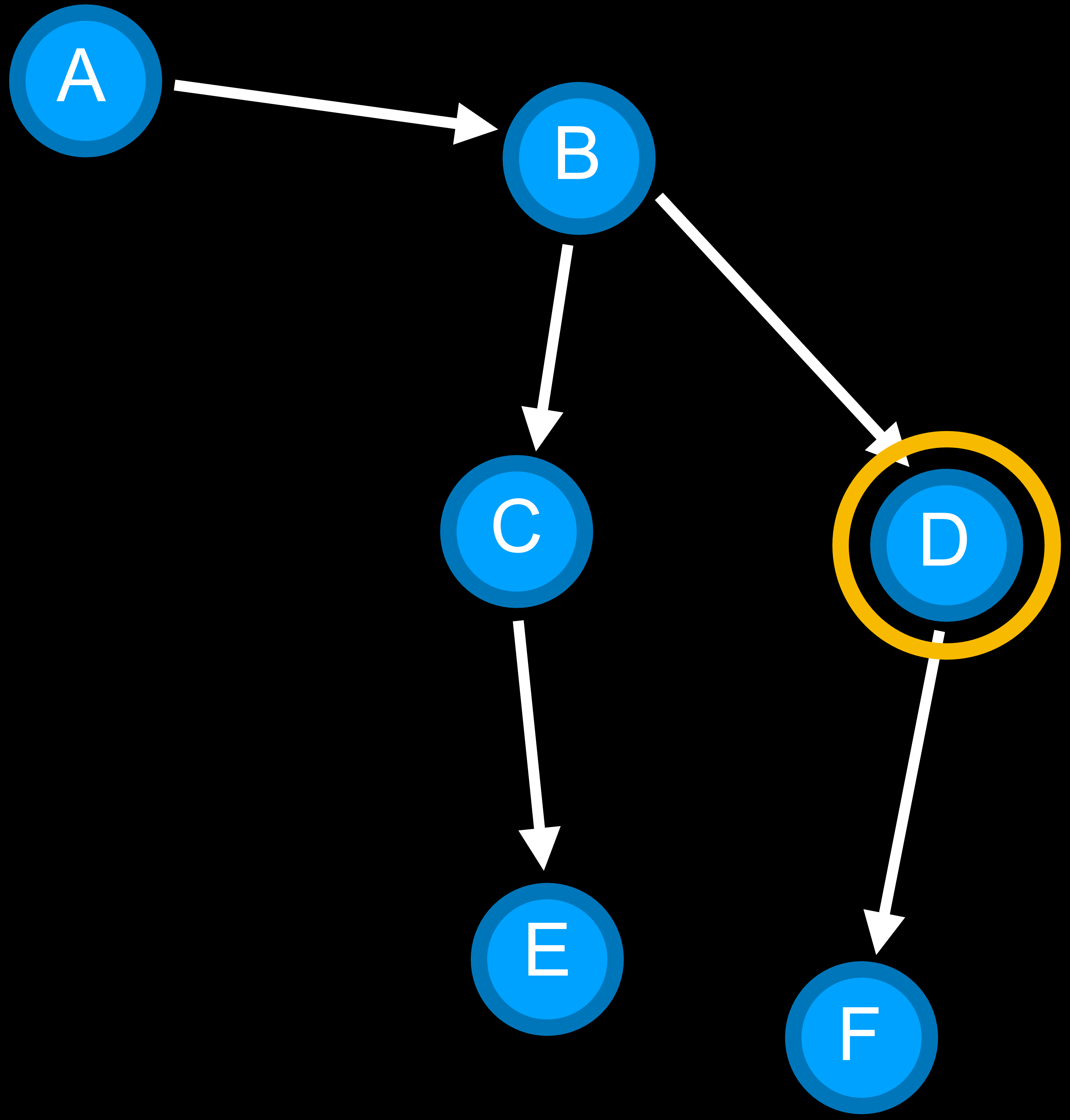
Frontier

C F

Explored Set

A B D



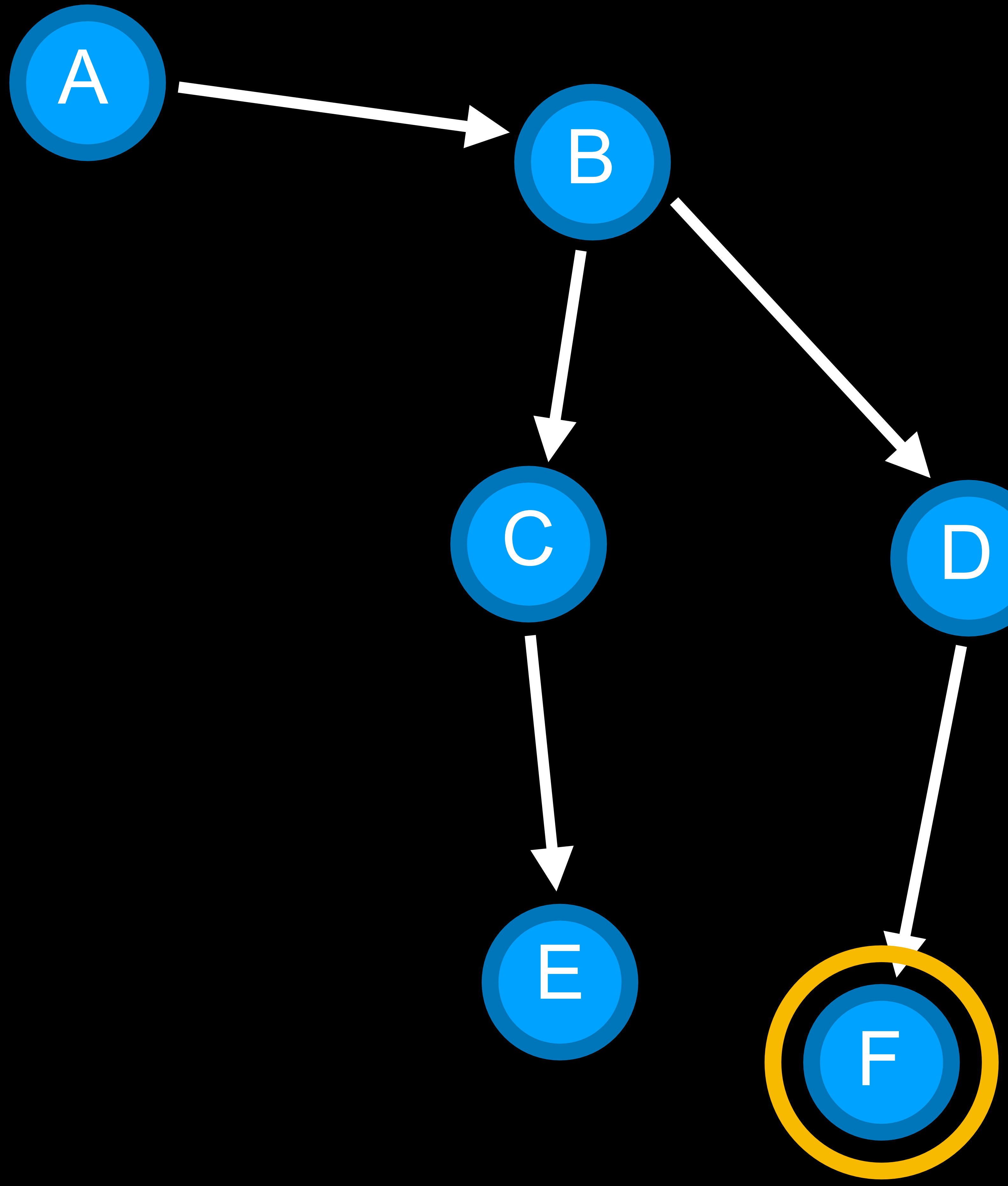
Find a path from A to E.

Frontier

C

Explored Set

A B D F

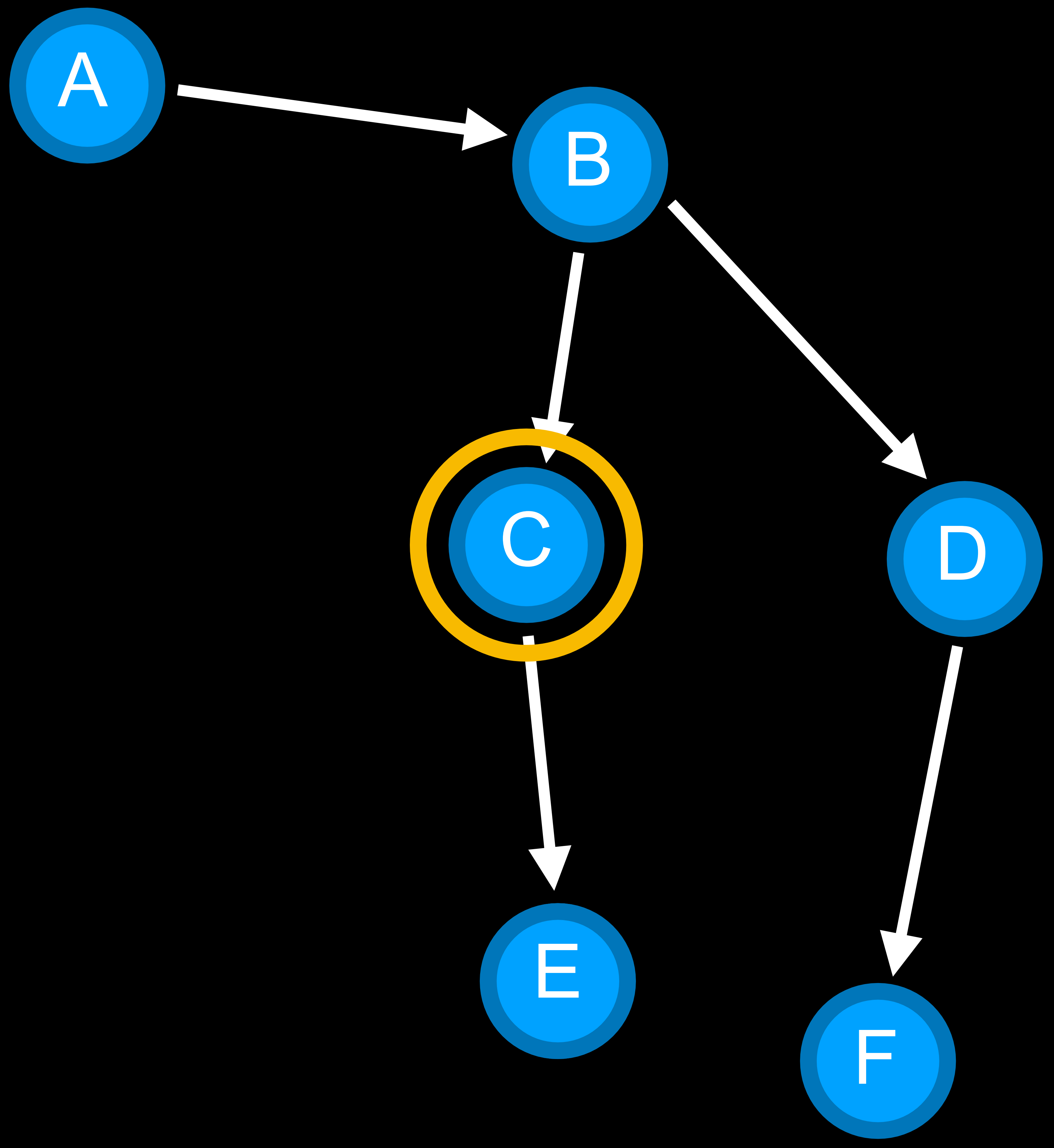


Find a path from A to E.

Frontier

Explored Set

A B D F C



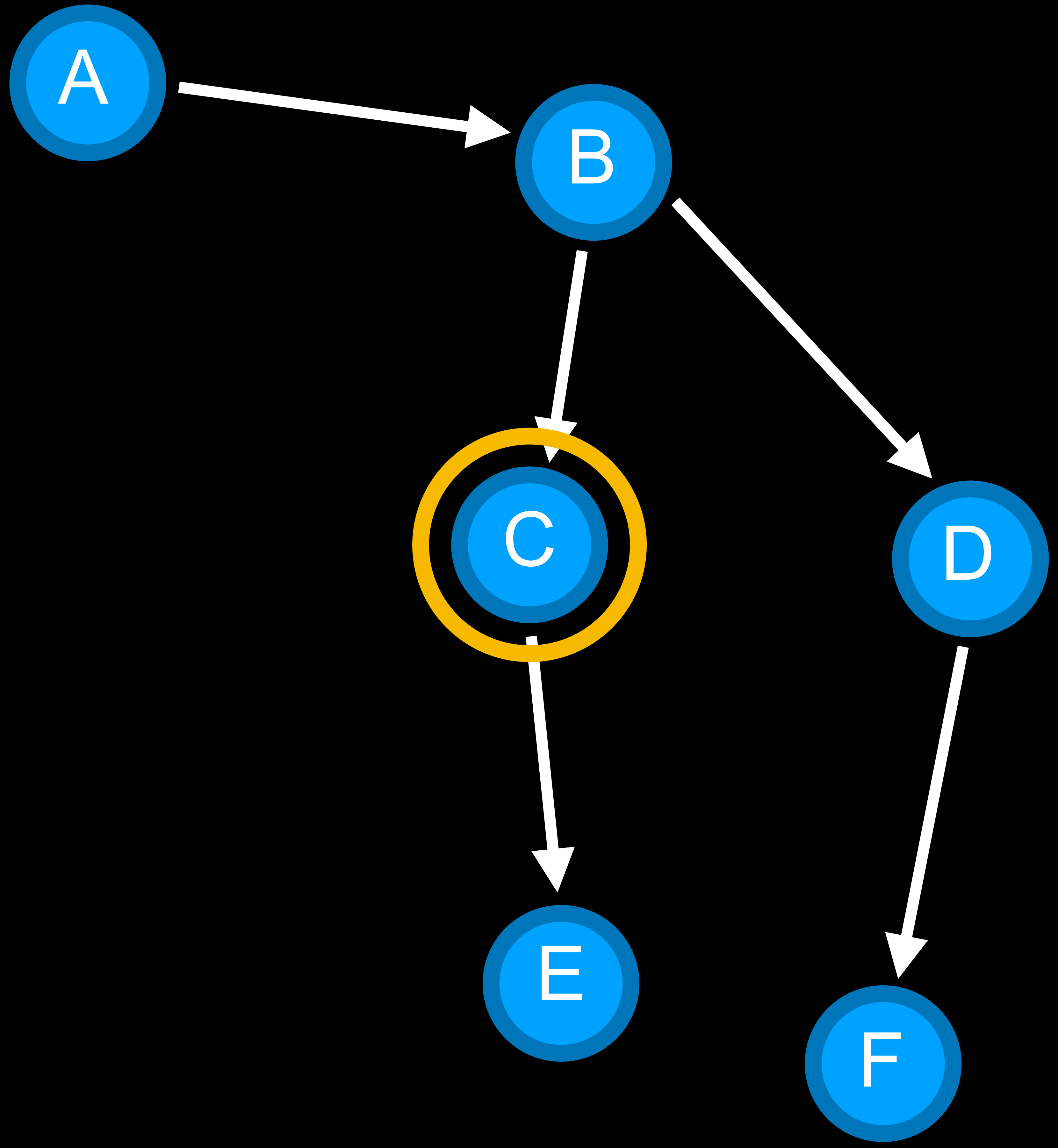
Find a path from A to E.

Frontier

E

Explored Set

A B D F C

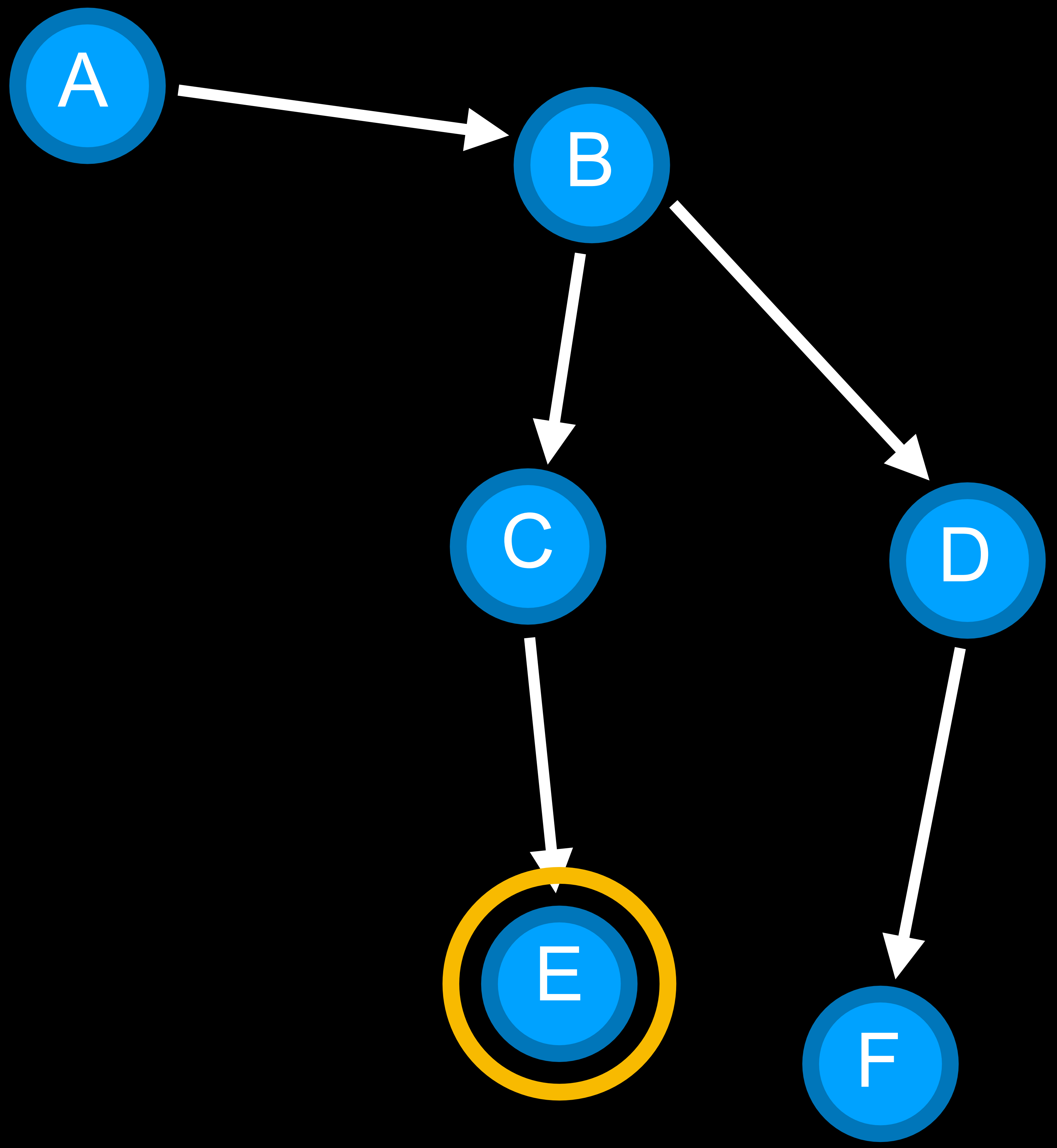


Find a path from A to E.

Frontier

Explored Set

A B D F C



Depth-First Search

depth-first search

search algorithm that always expands the deepest node in the frontier using stack data structure.

Breadth-First Search

breadth-first search

search algorithm that always expands the shallowest node in the frontier using Queue data structure.

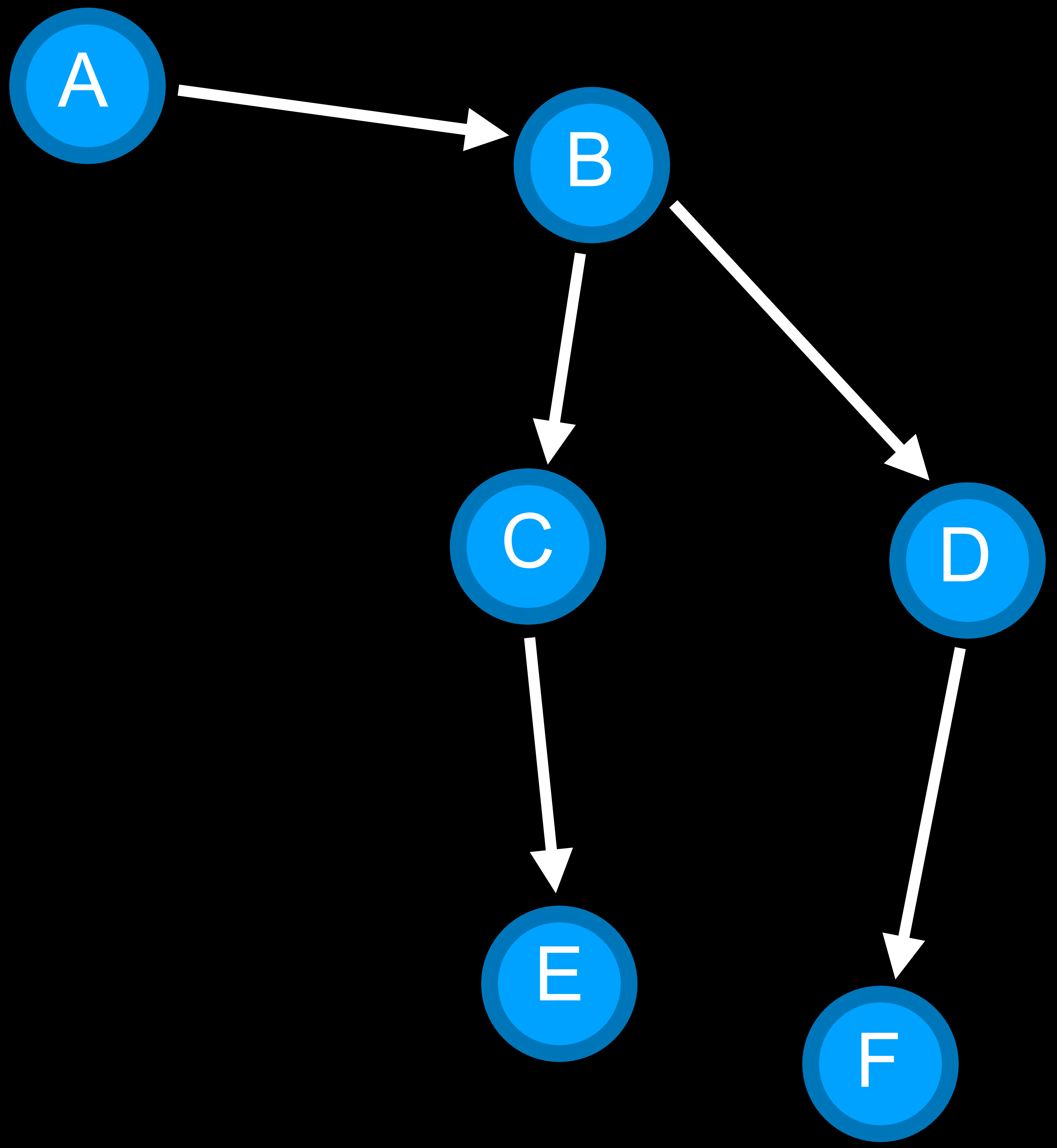
queue

first-in first-out data type

Find a path from A to E.

Frontier

Explored Set

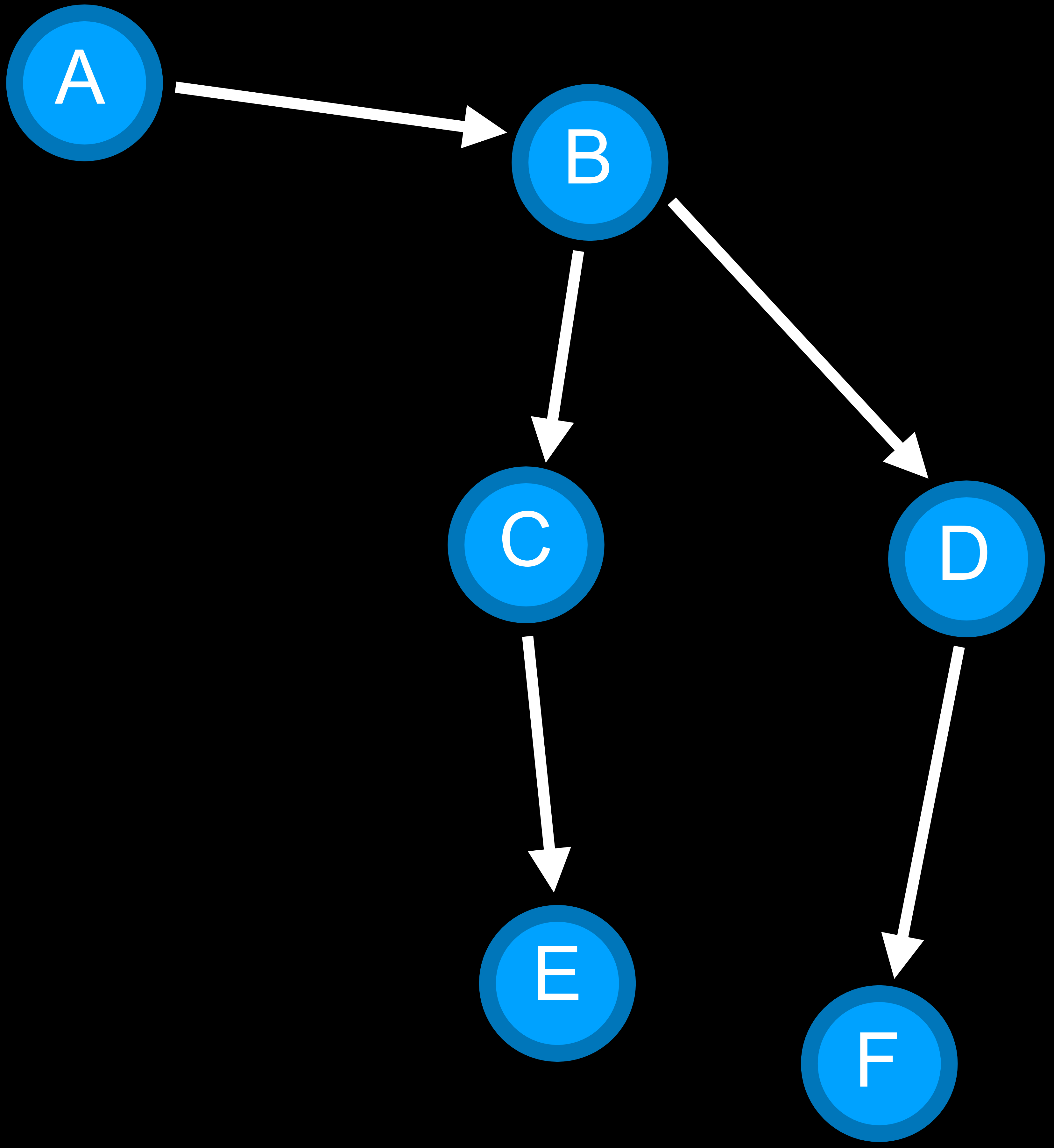


Find a path from A to E.

Frontier

A

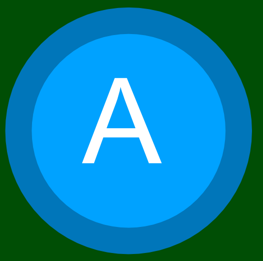
Explored Set

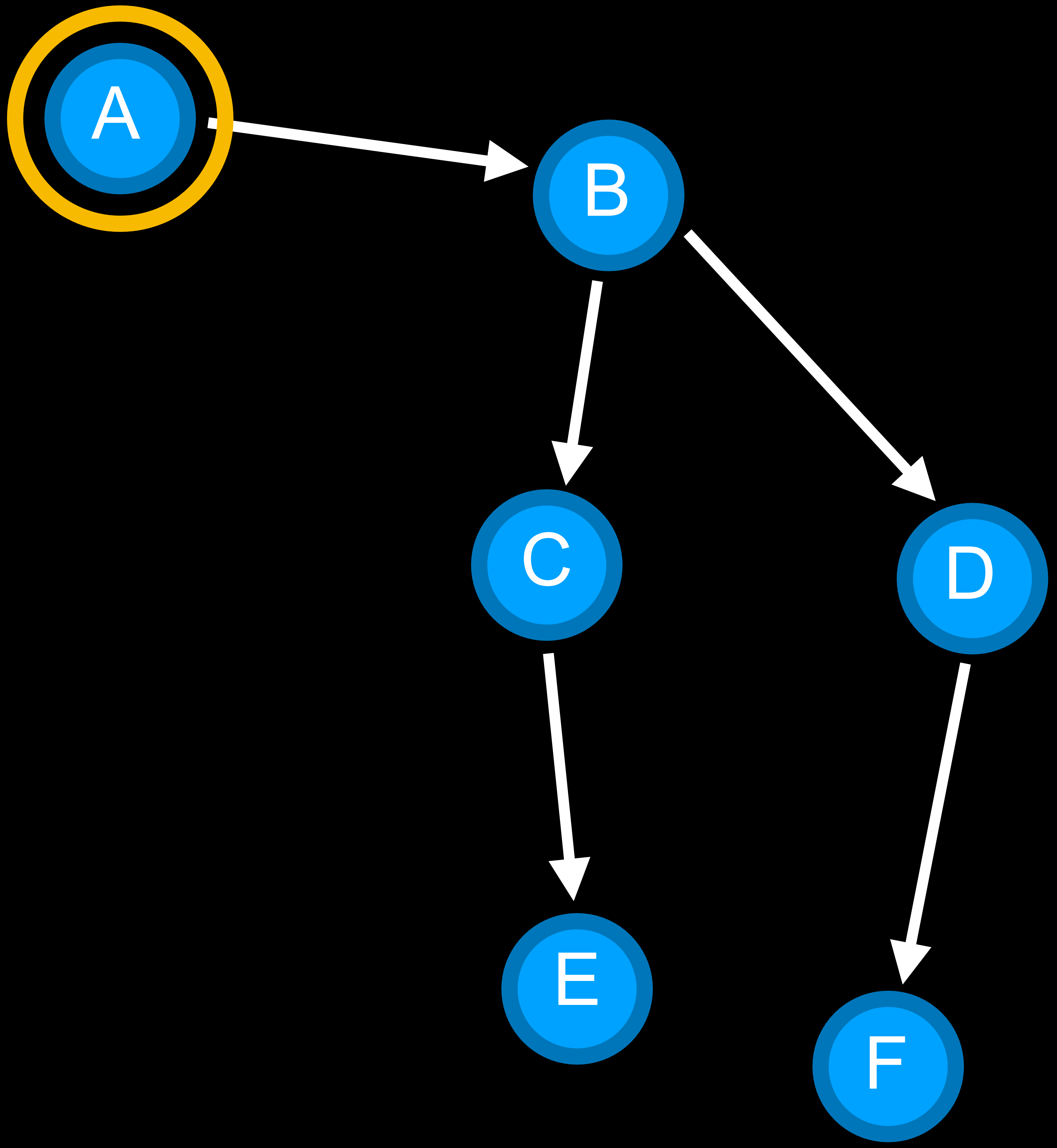

$$\begin{tikzcd}
A \arrow[r] & B \arrow[d] \arrow[dr] & \\
& C \arrow[d] & D \arrow[d] \\
& E & F
\end{tikzcd}$$

Find a path from A to E.

Frontier

Explored Set





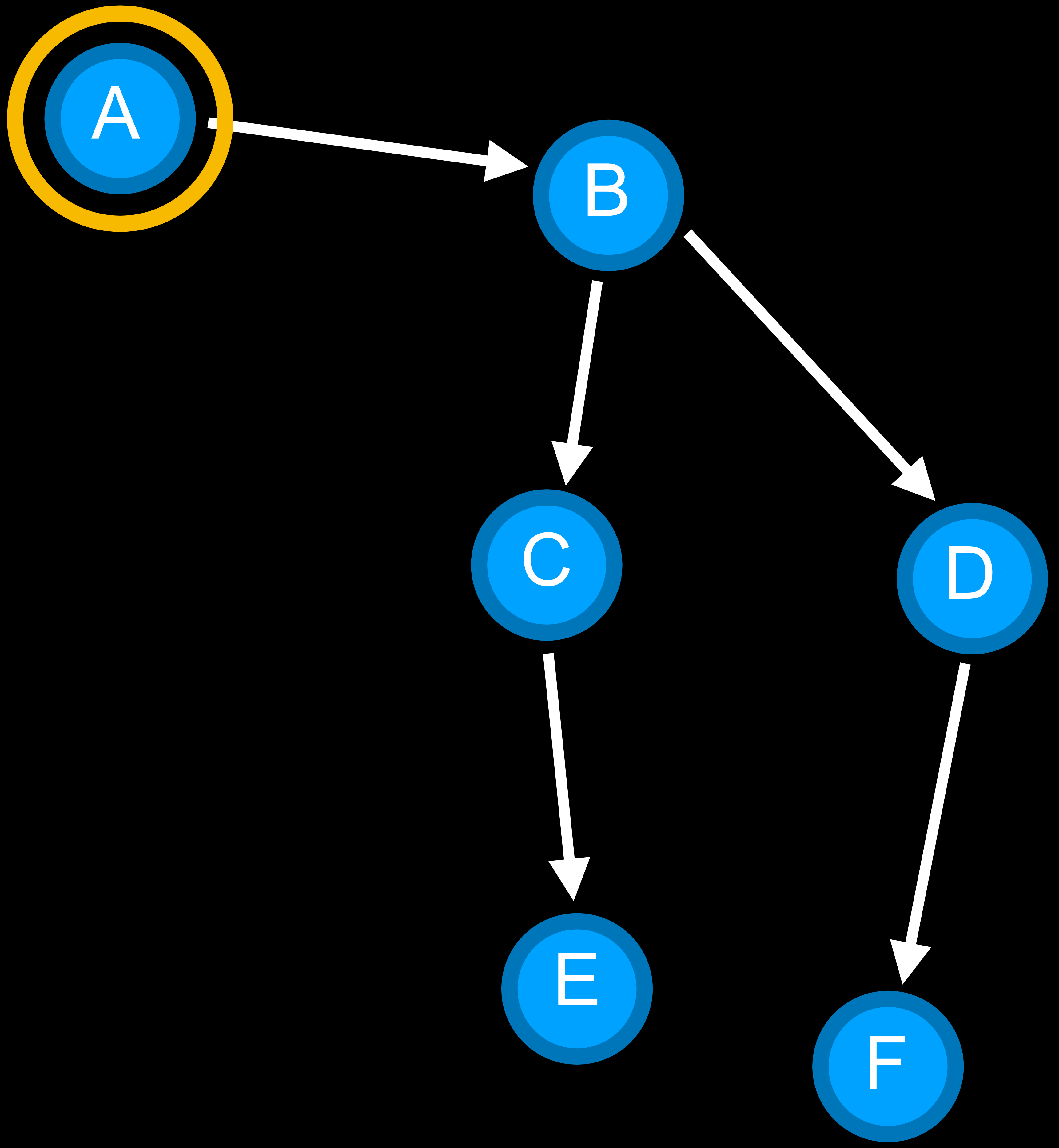
Find a path from A to E.

Frontier

B

Explored Set

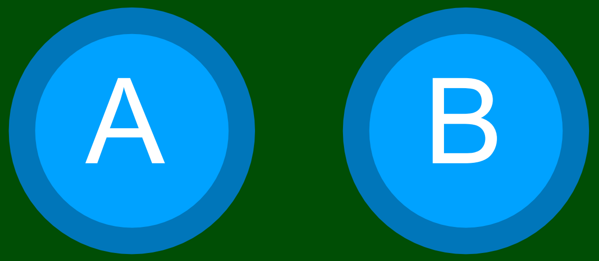
A

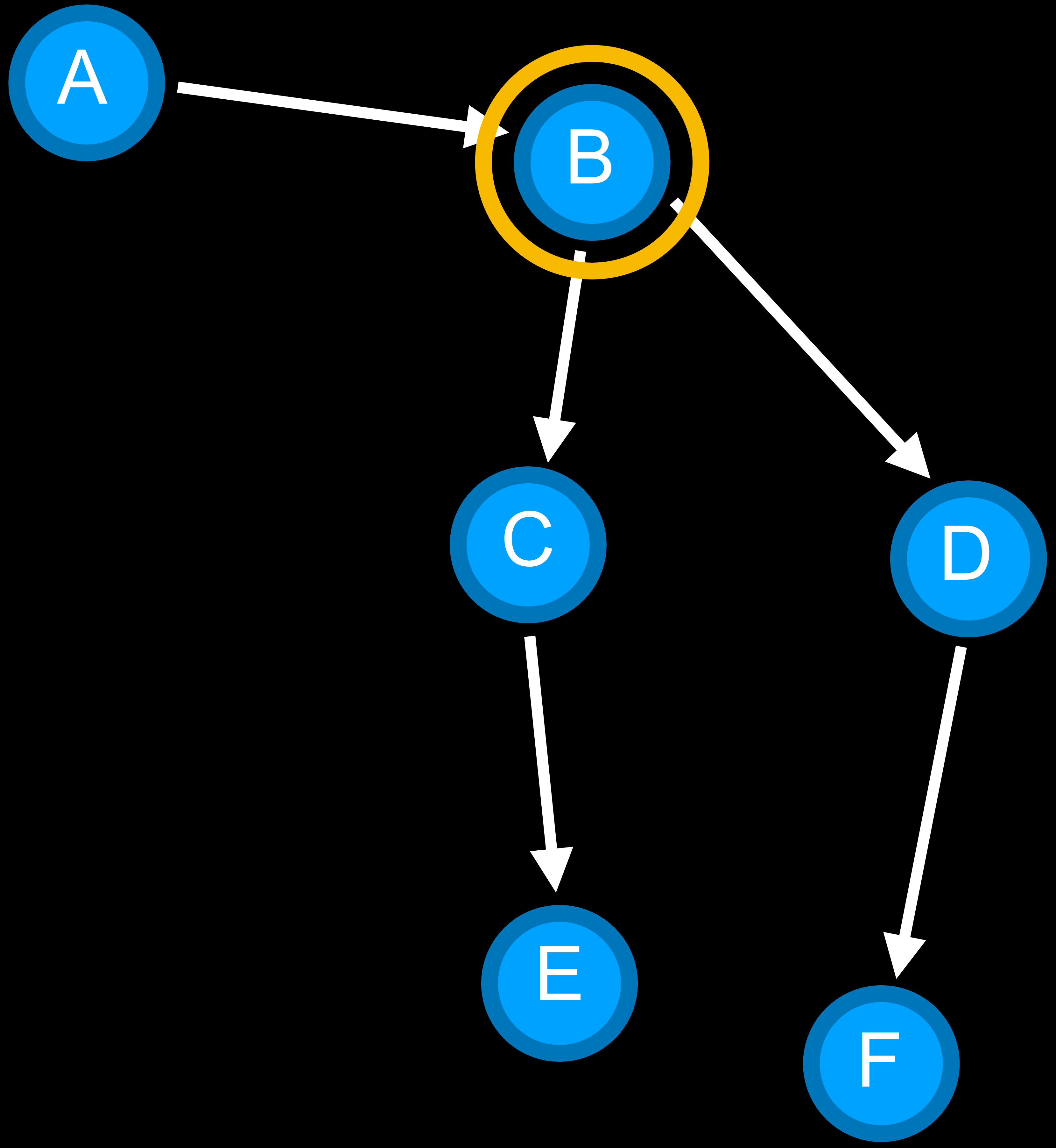


Find a path from A to E.

Frontier

Explored Set





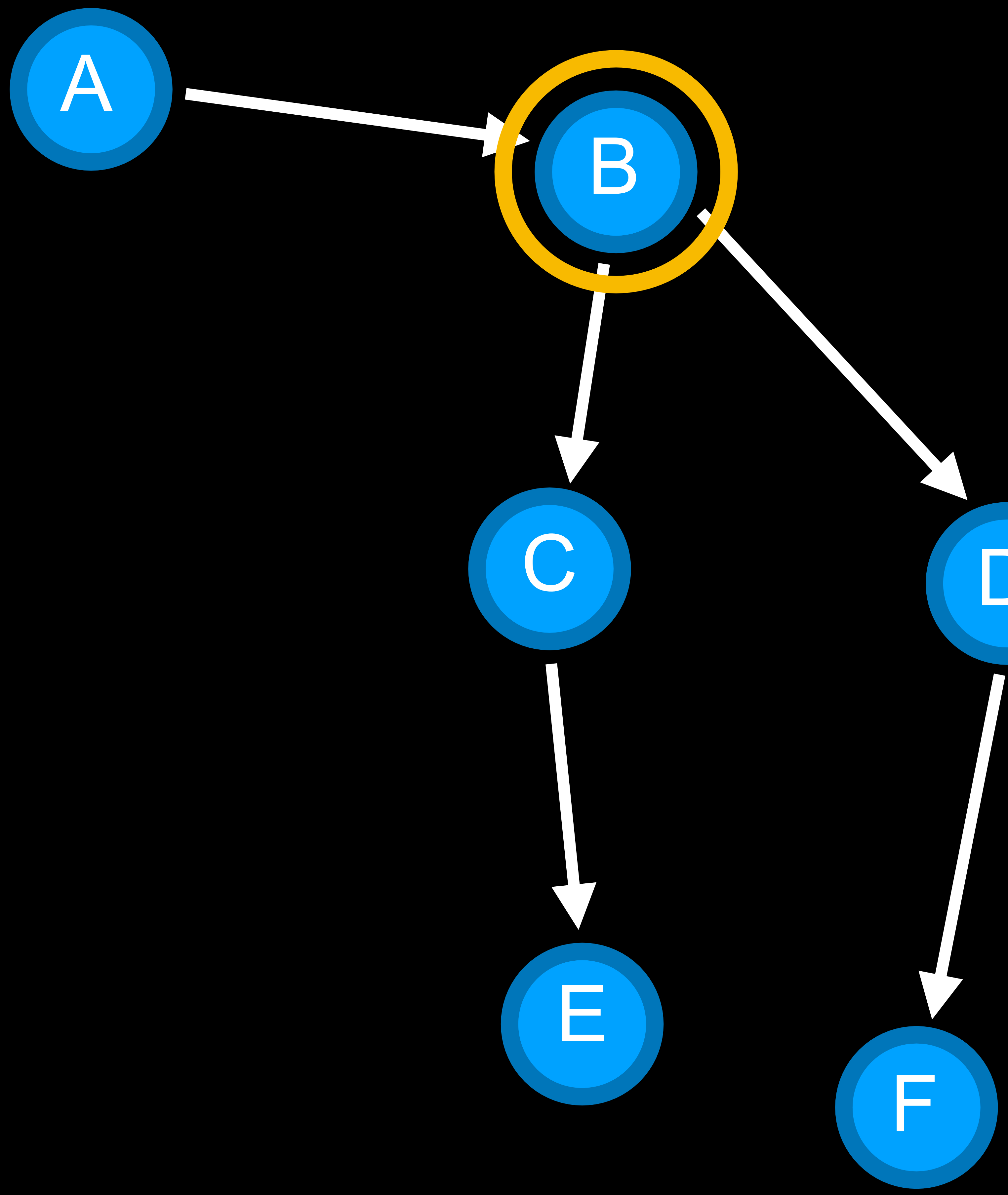
Find a path from A to E.

Frontier

C D

Explored Set

A B



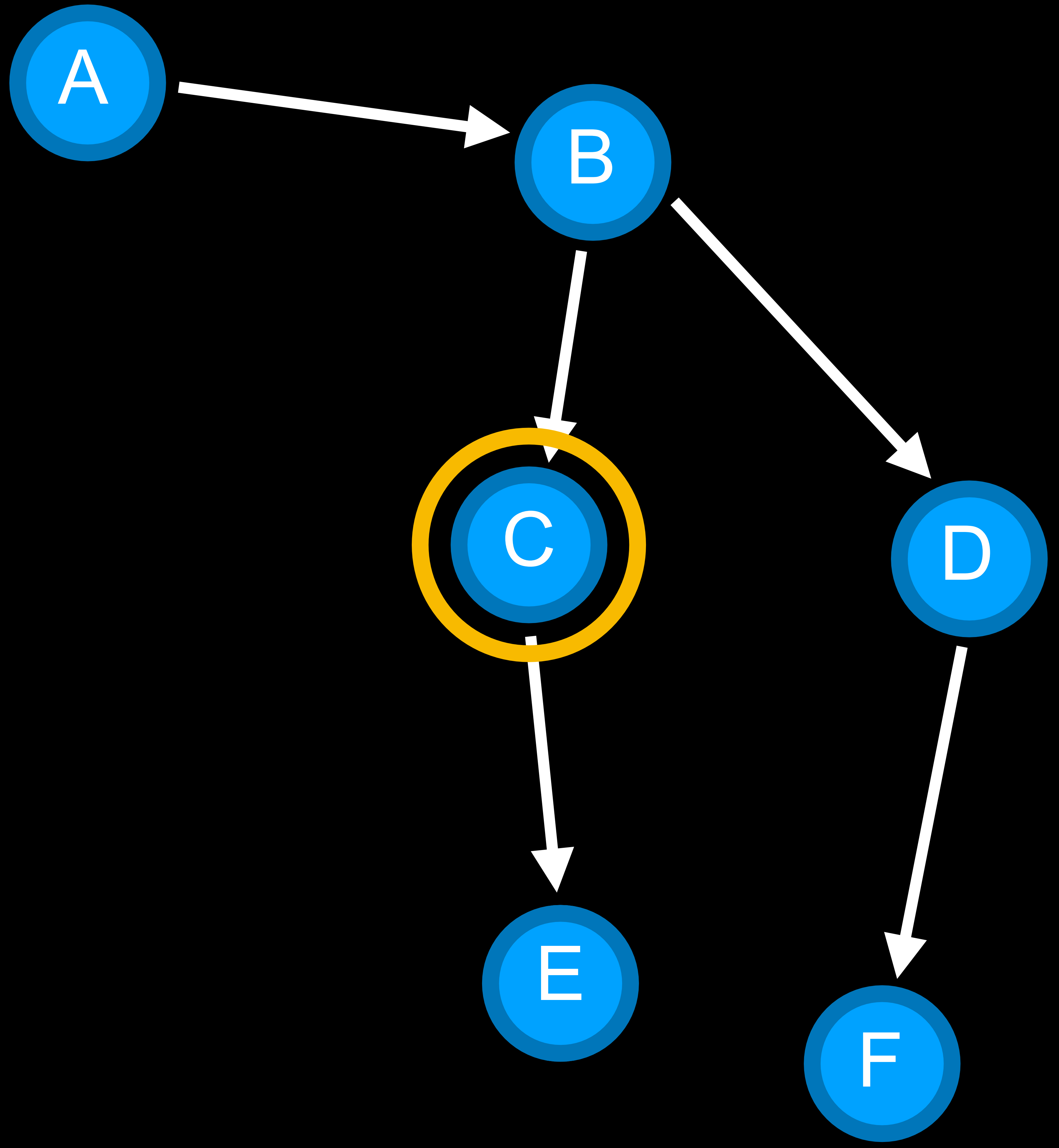
Find a path from A to E.

Frontier

D

Explored Set

A B C



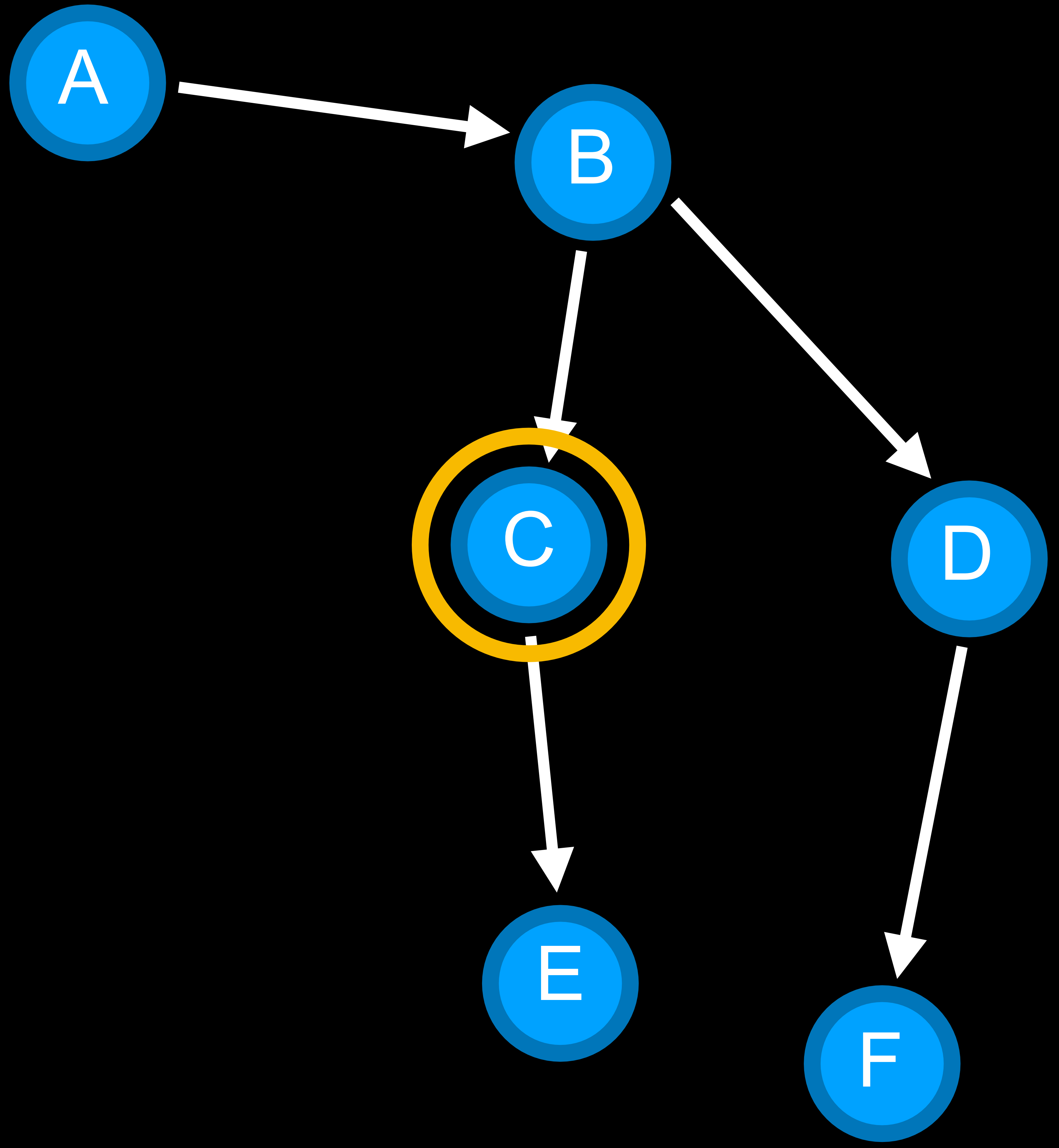
Find a path from A to E.

Frontier

D E

Explored Set

A B C


$$\begin{tikzcd} A \arrow[r] & B \arrow[d] \arrow[dr] & \\ & \boxed{C} \arrow[d] & D \arrow[d] \\ & E & F \end{tikzcd}$$

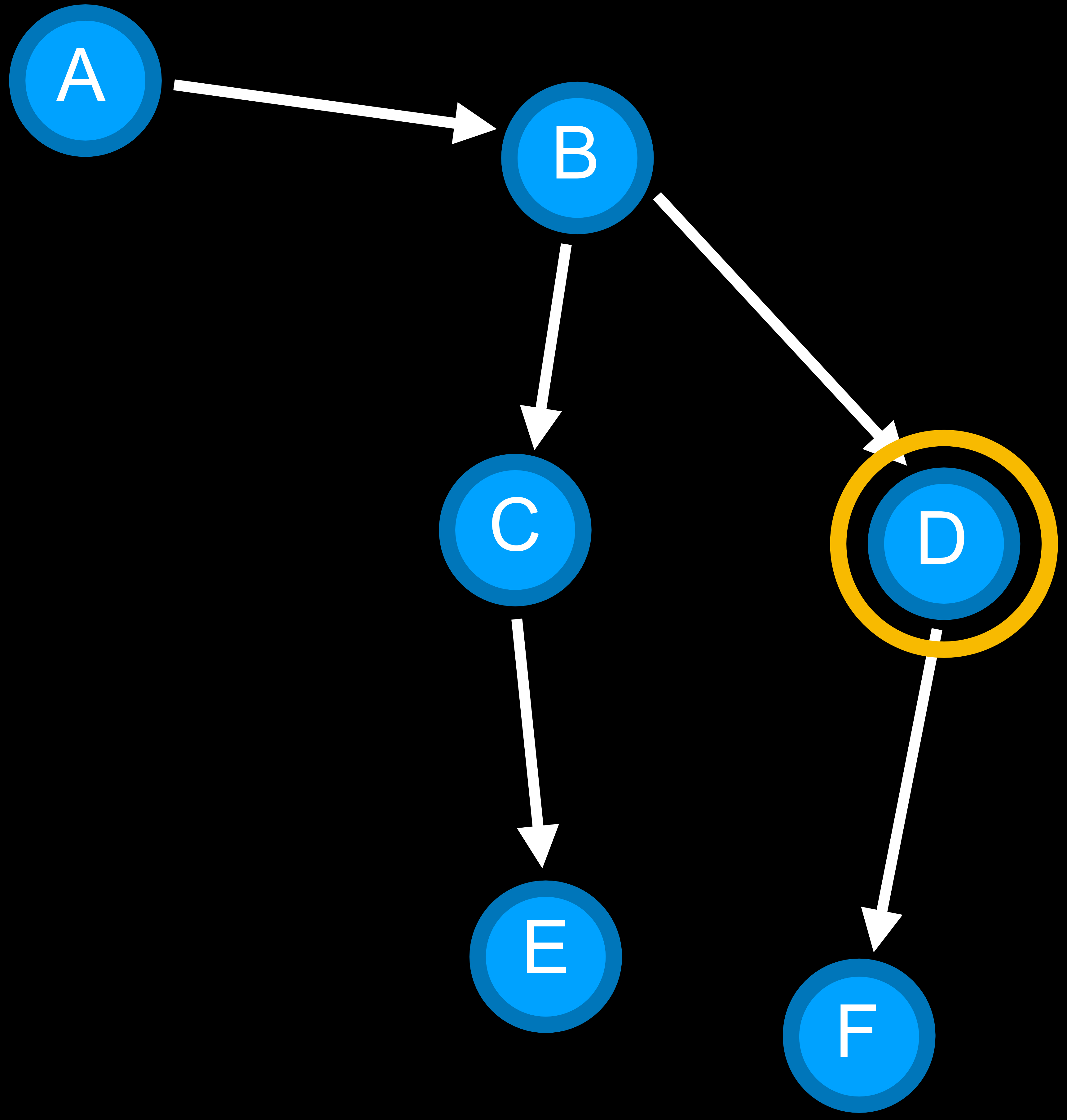
Find a path from A to E.

Frontier

E

Explored Set

A B C D



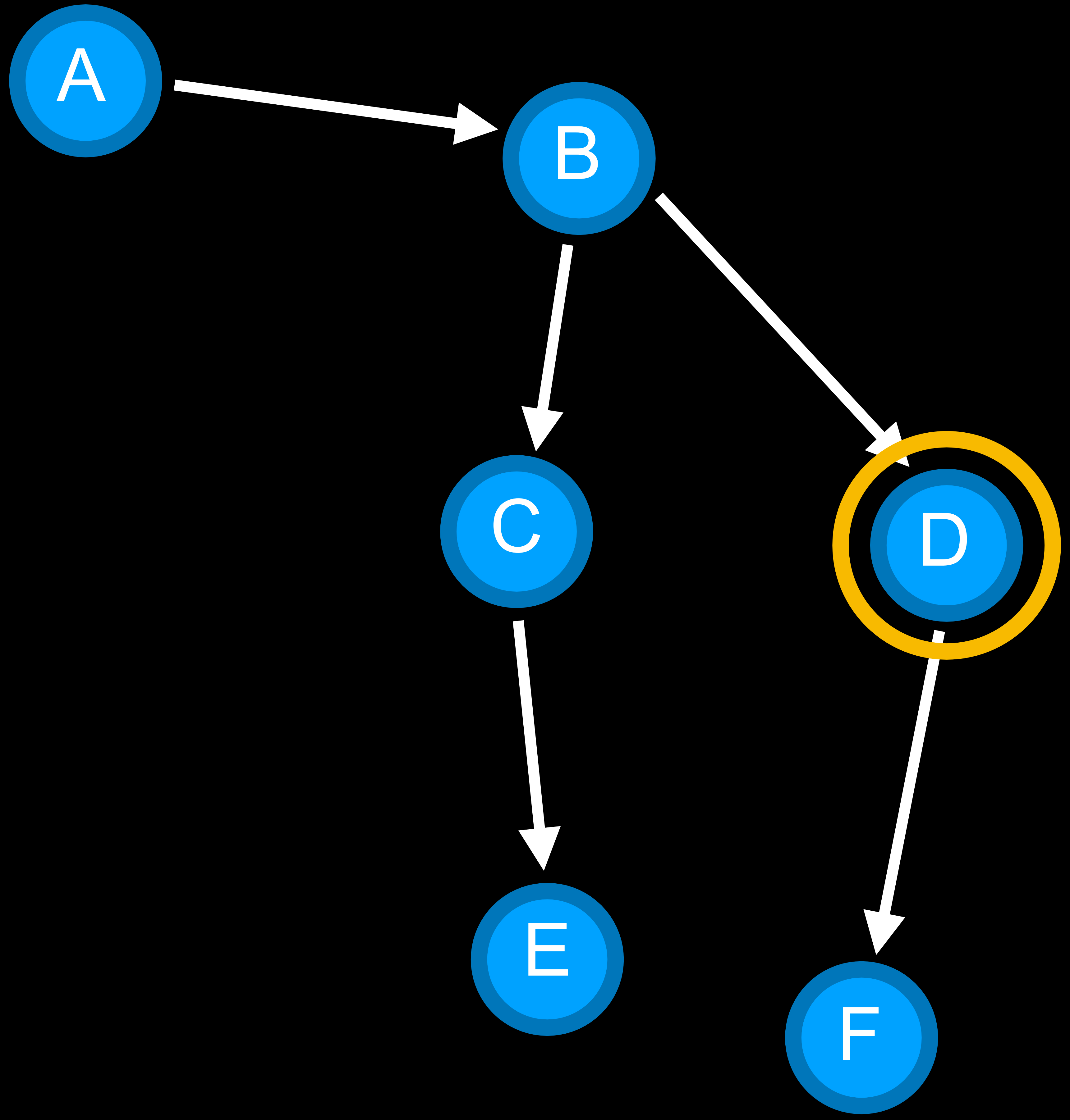
Find a path from A to E.

Frontier

E F

Explored Set

A B C D



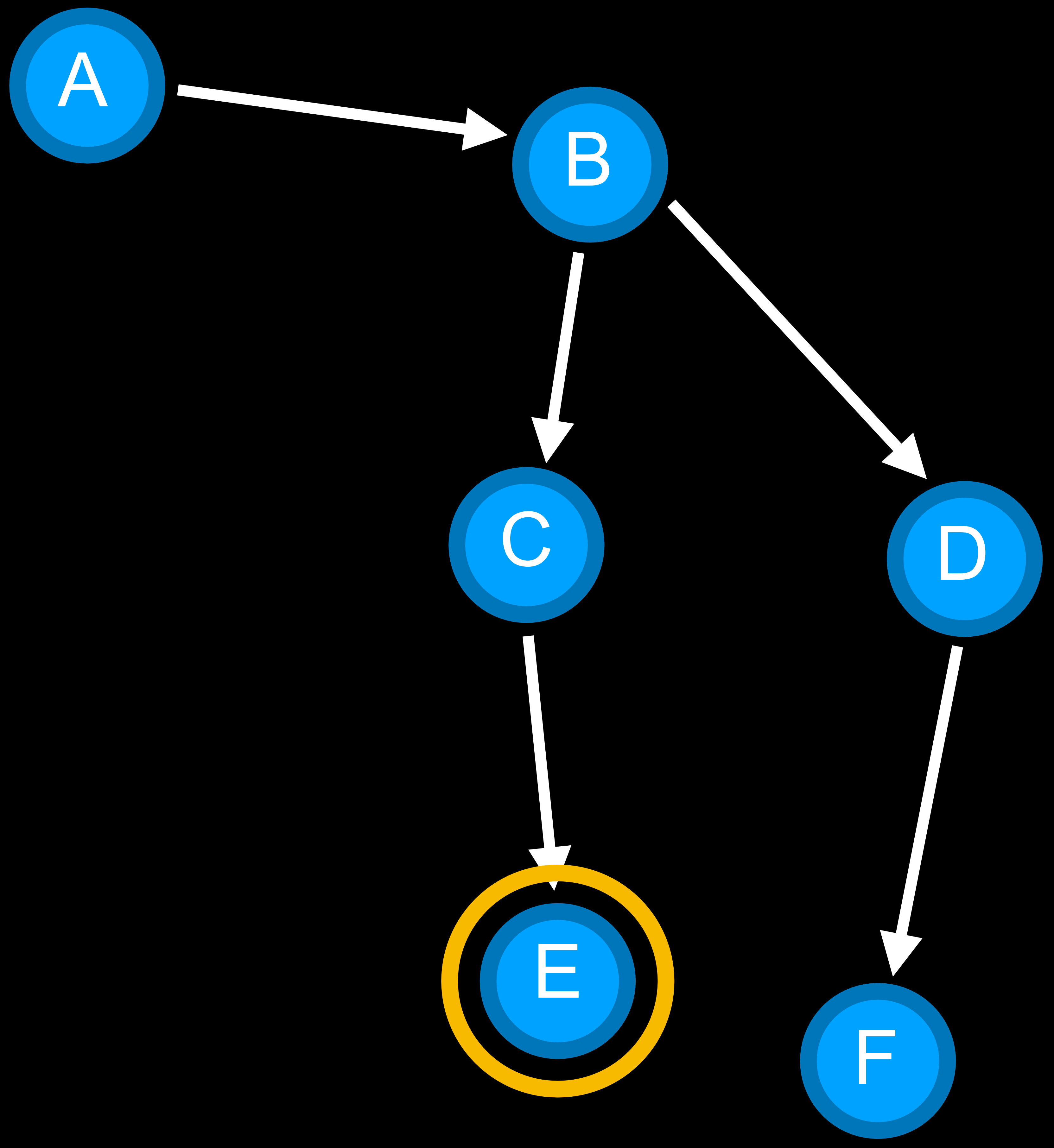
Find a path from A to E.

Frontier

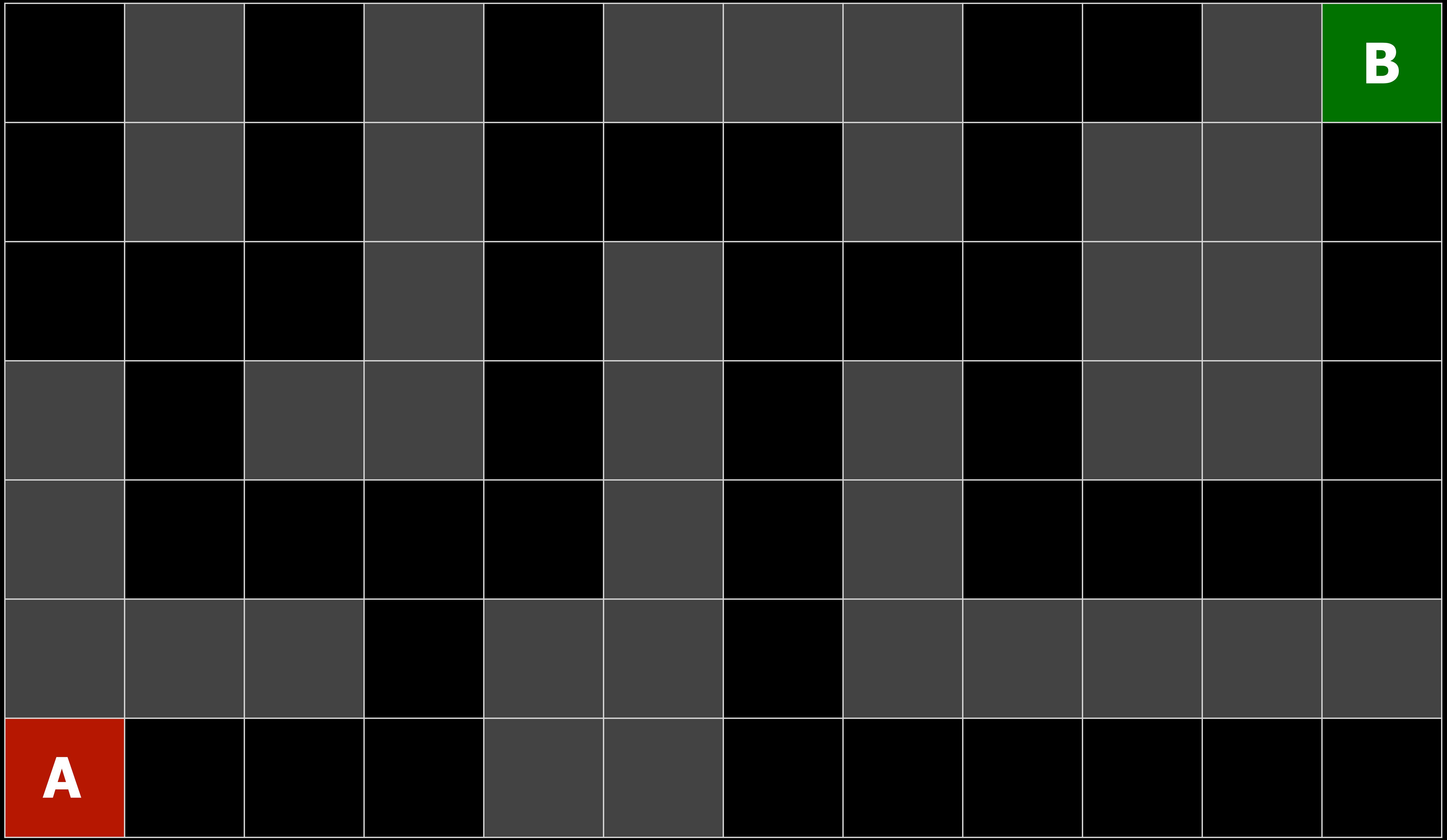
F

Explored Set

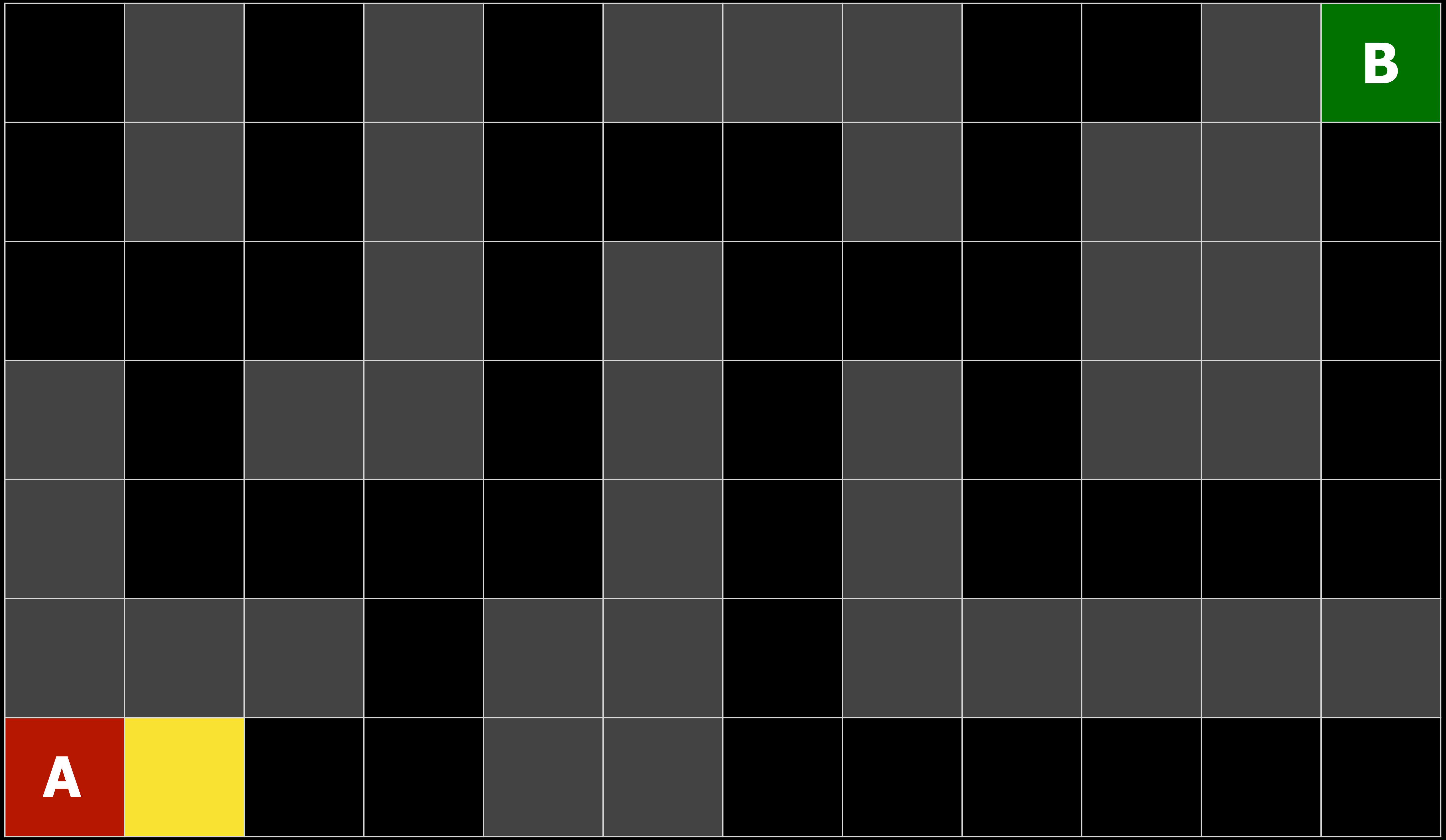
A B C D



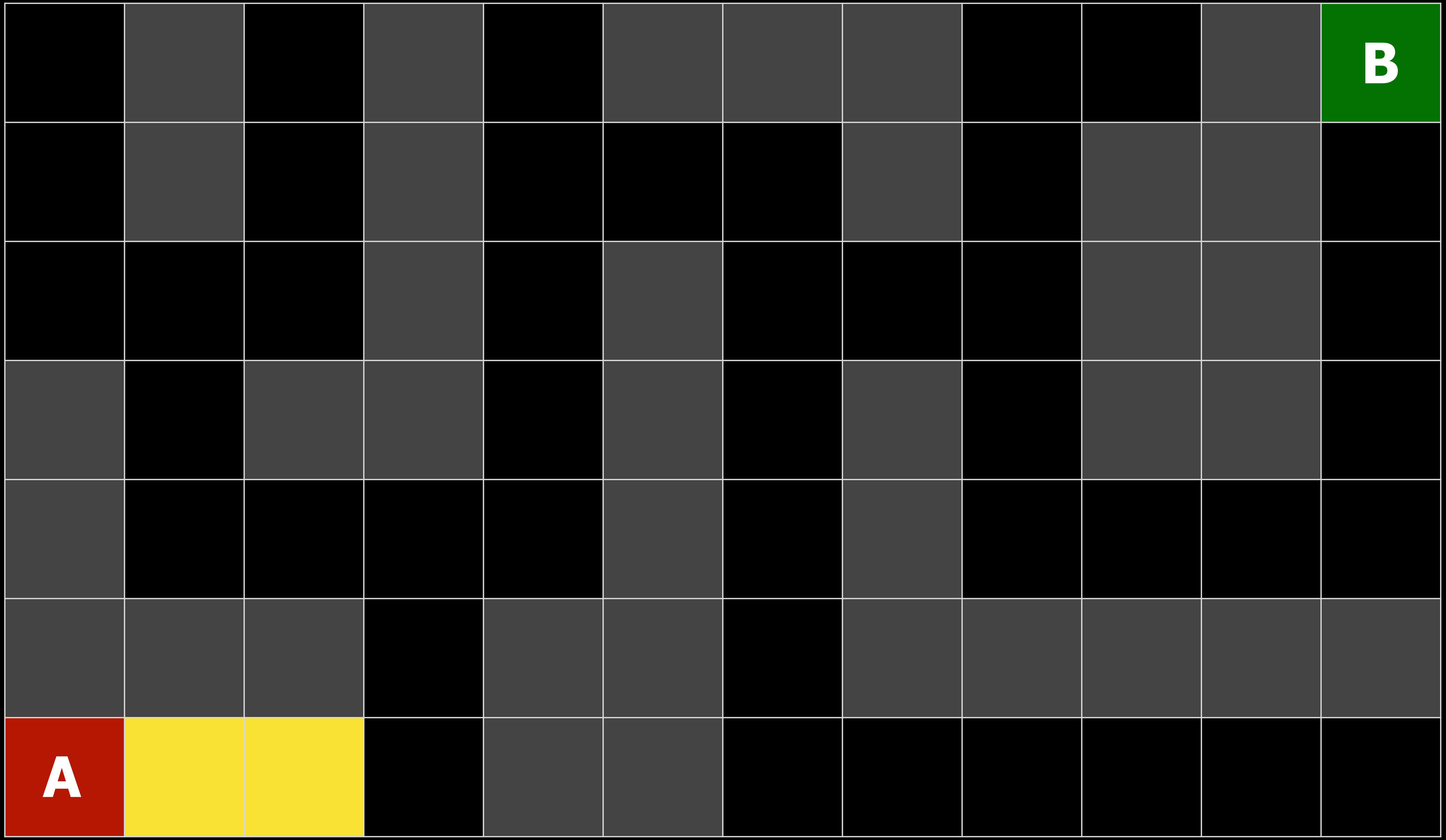
Depth-First Search



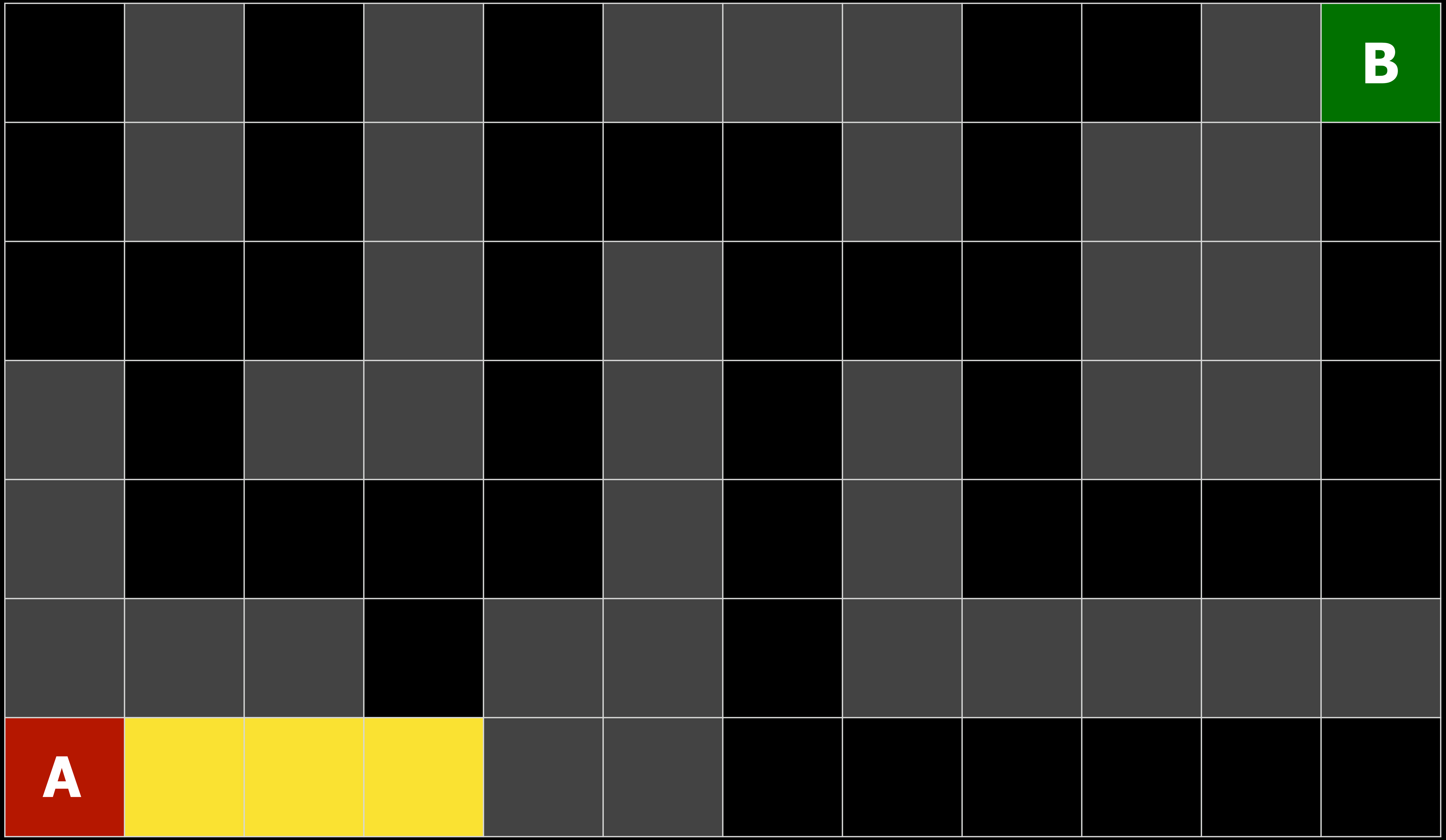
Depth-First Search



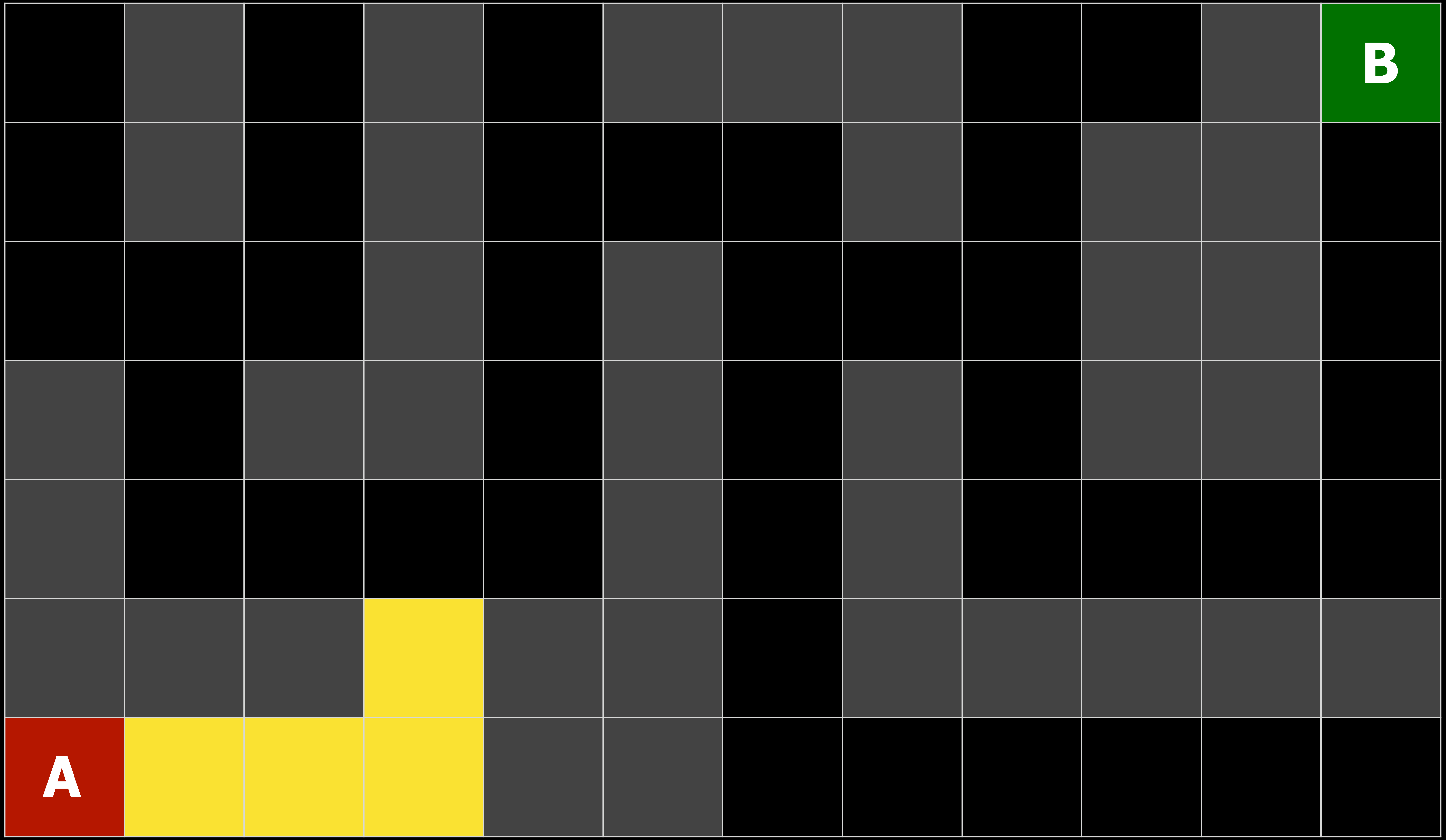
Depth-First Search



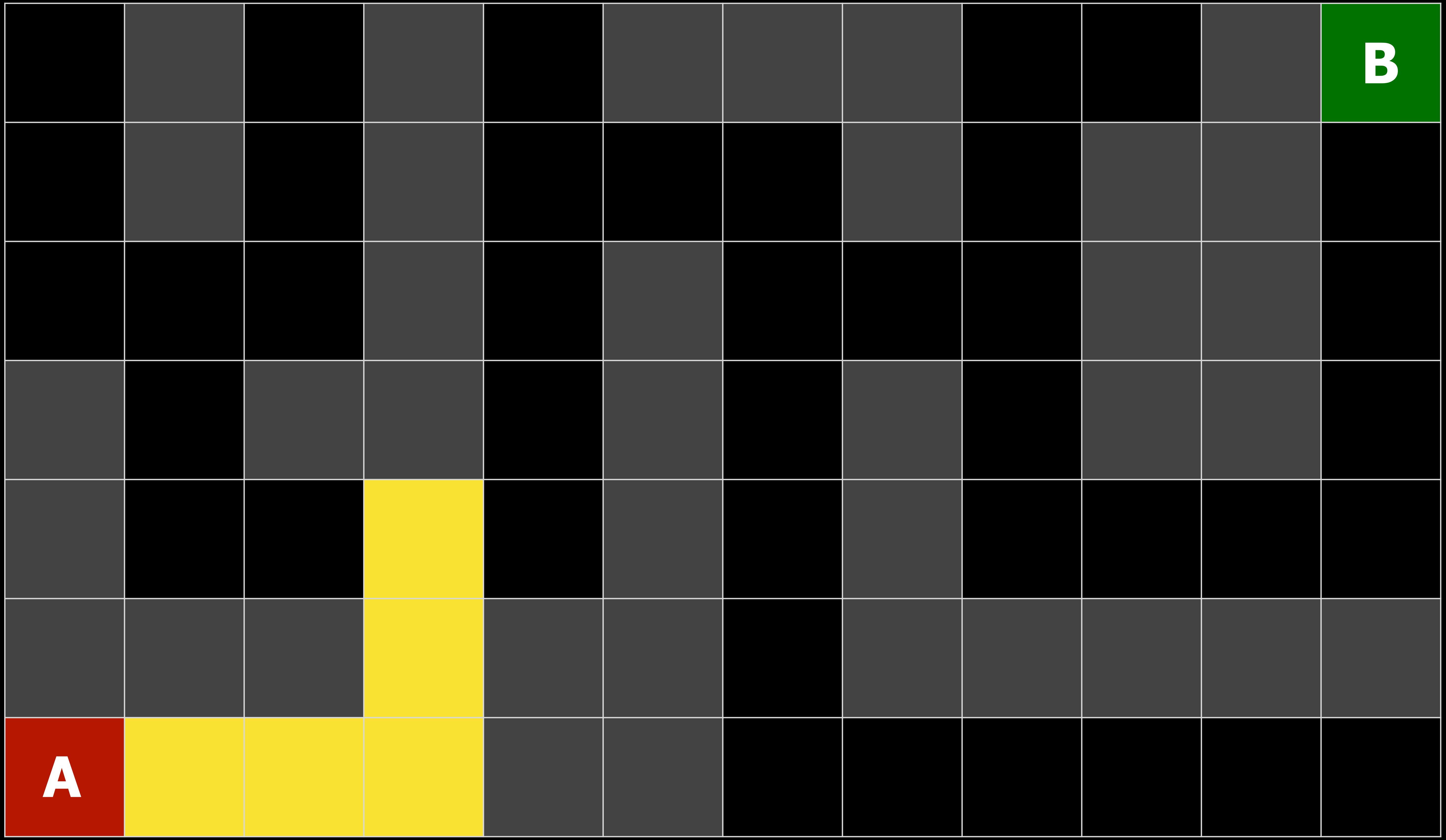
Depth-First Search



Depth-First Search



Depth-First Search



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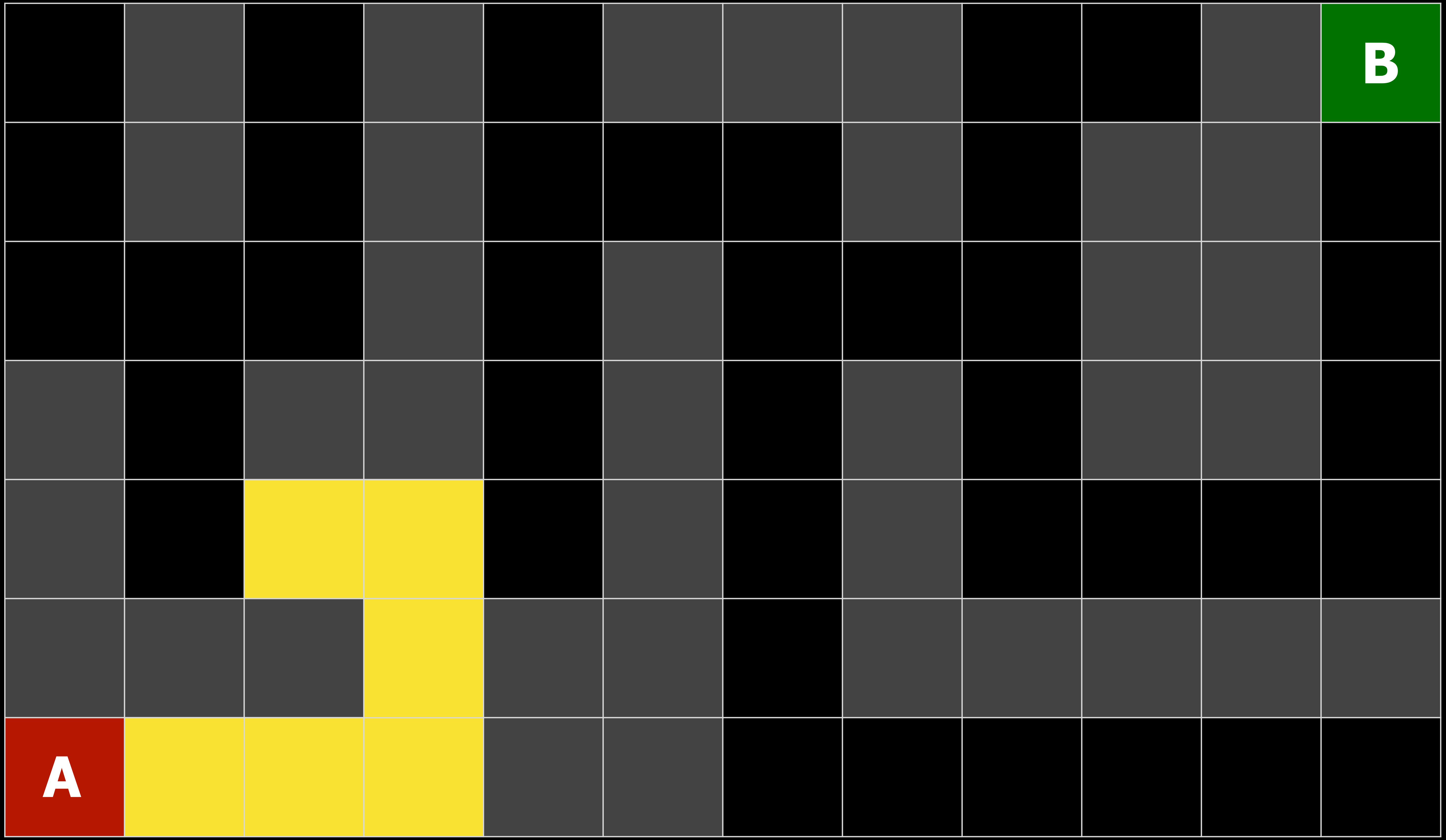

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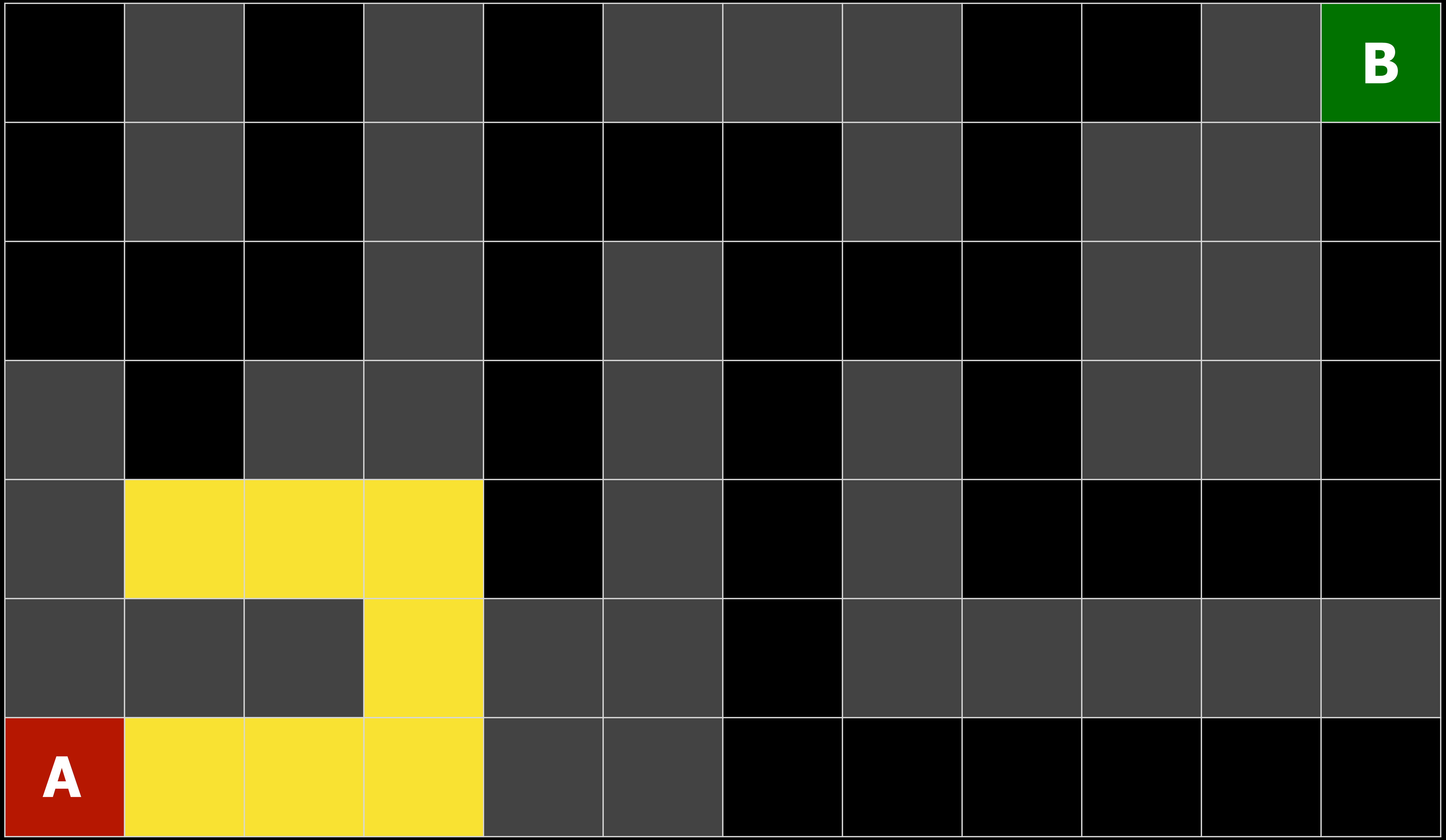
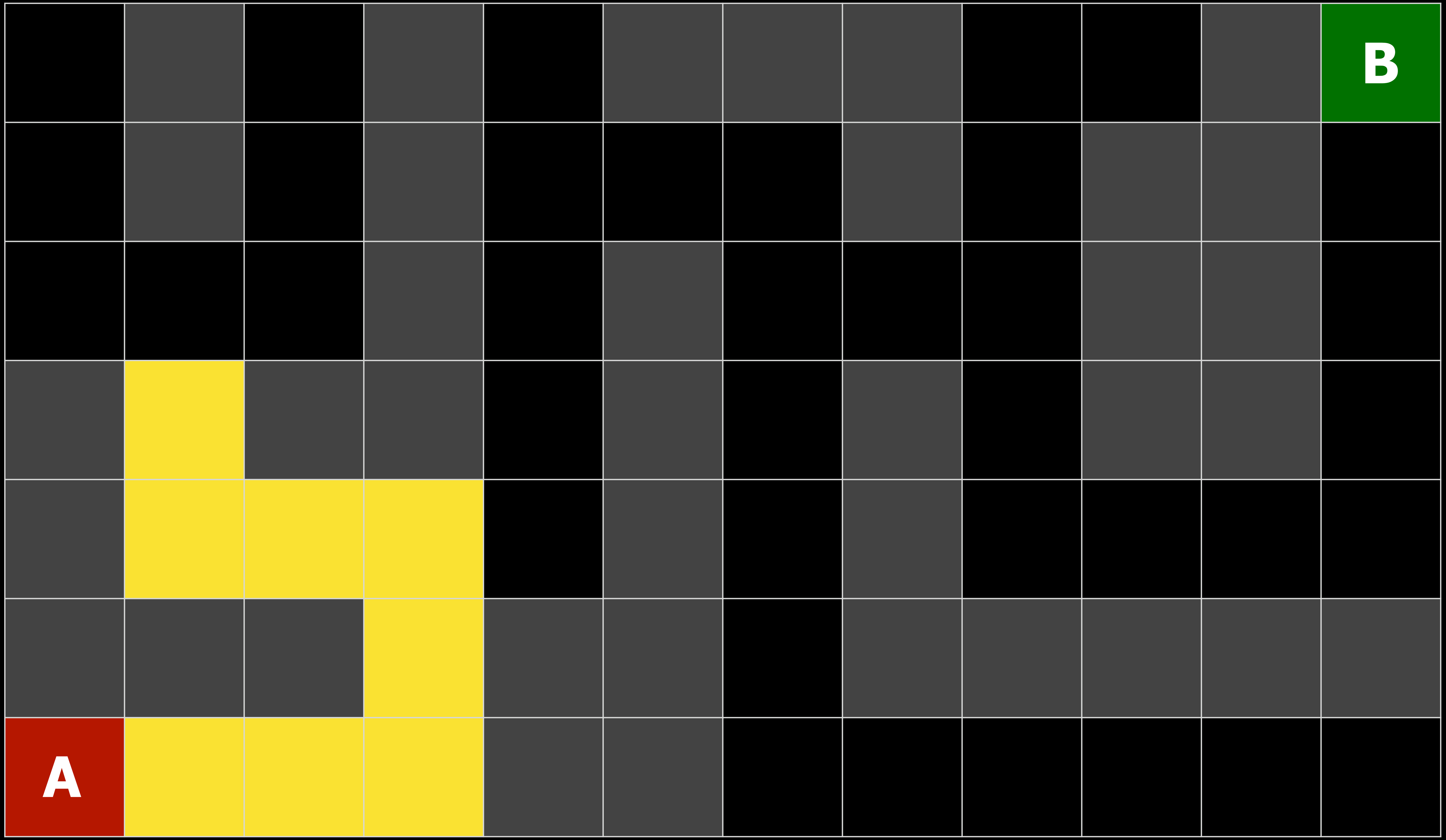
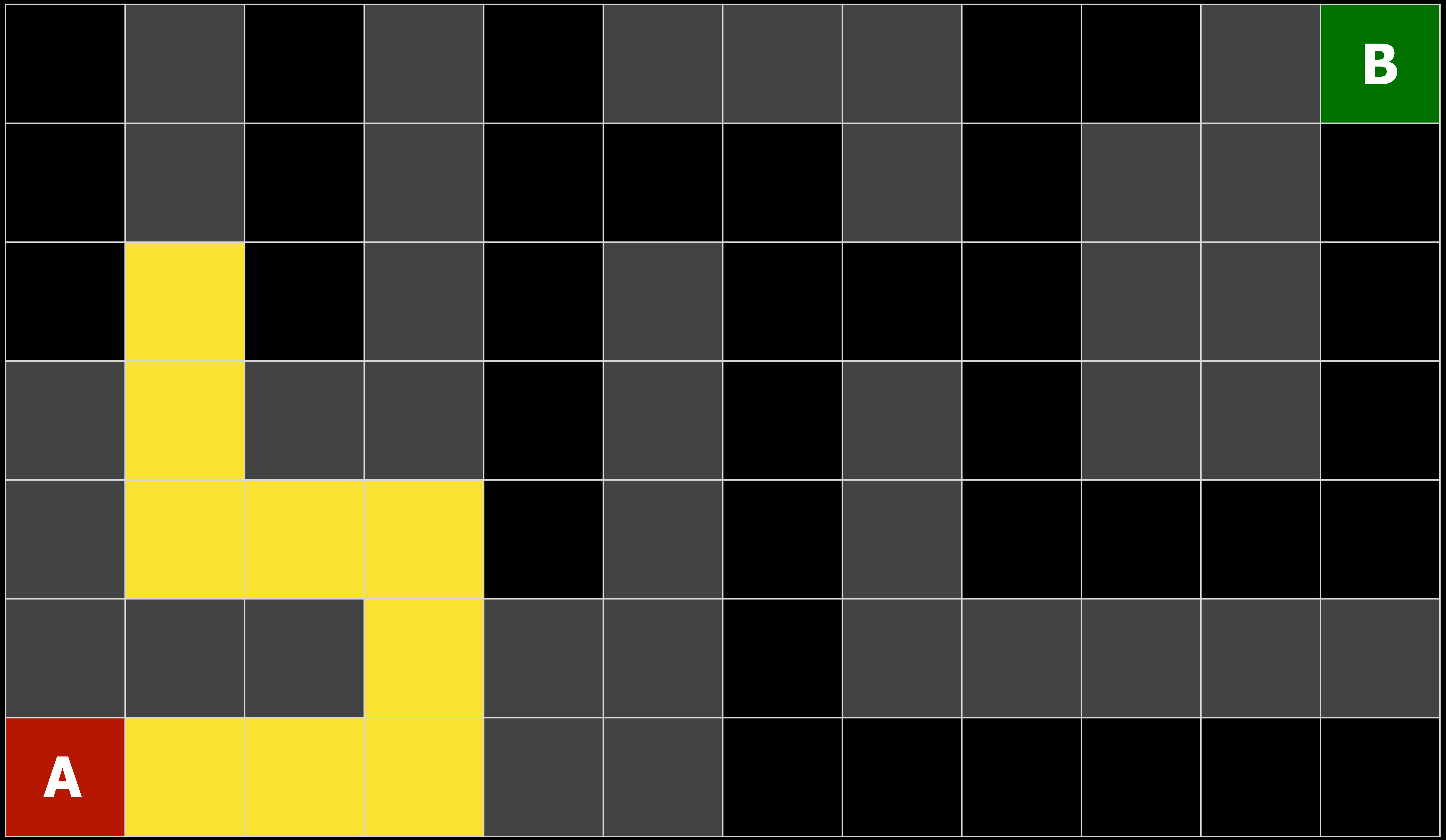


Depth-First Search



Depth-First Search



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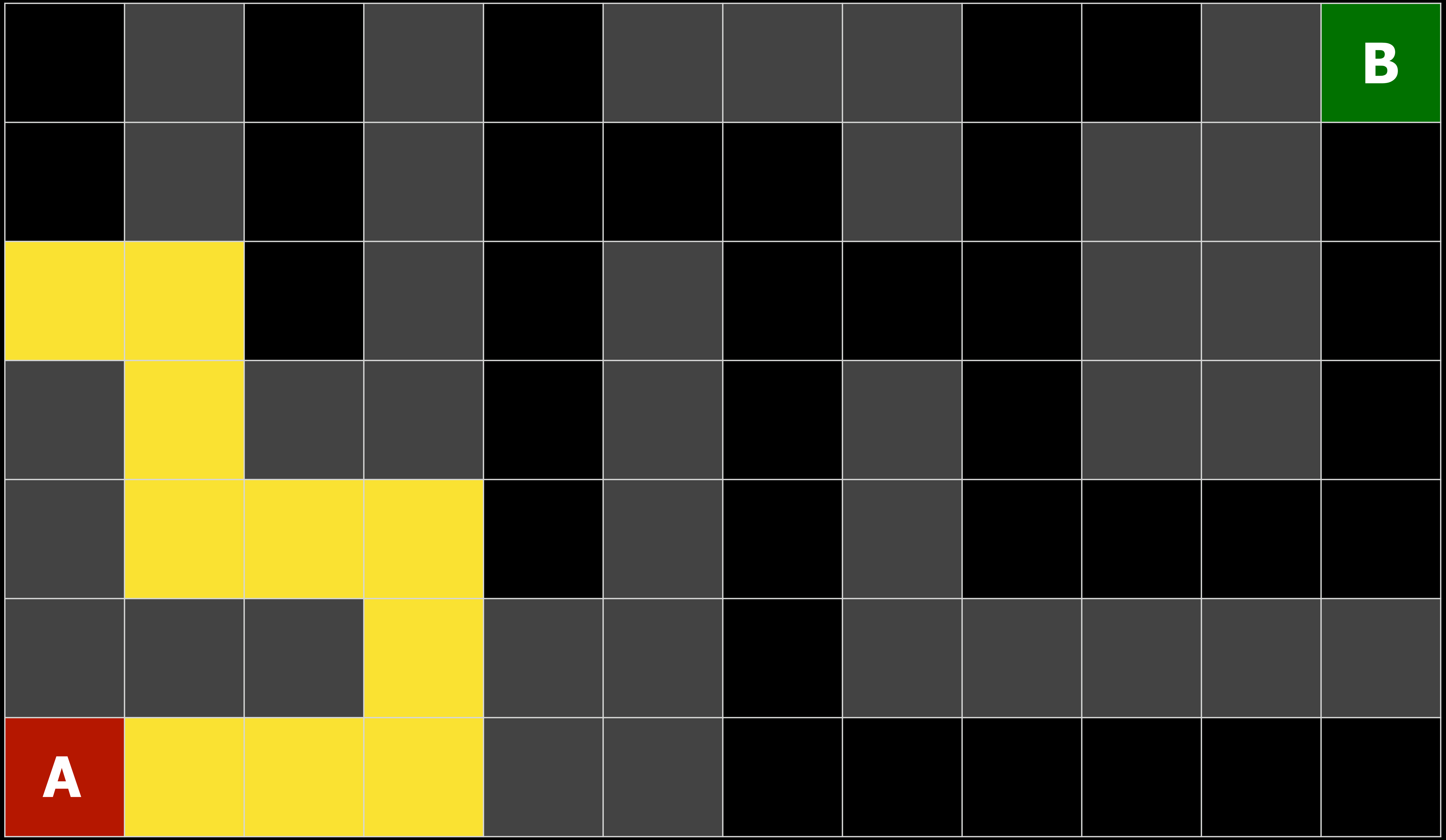

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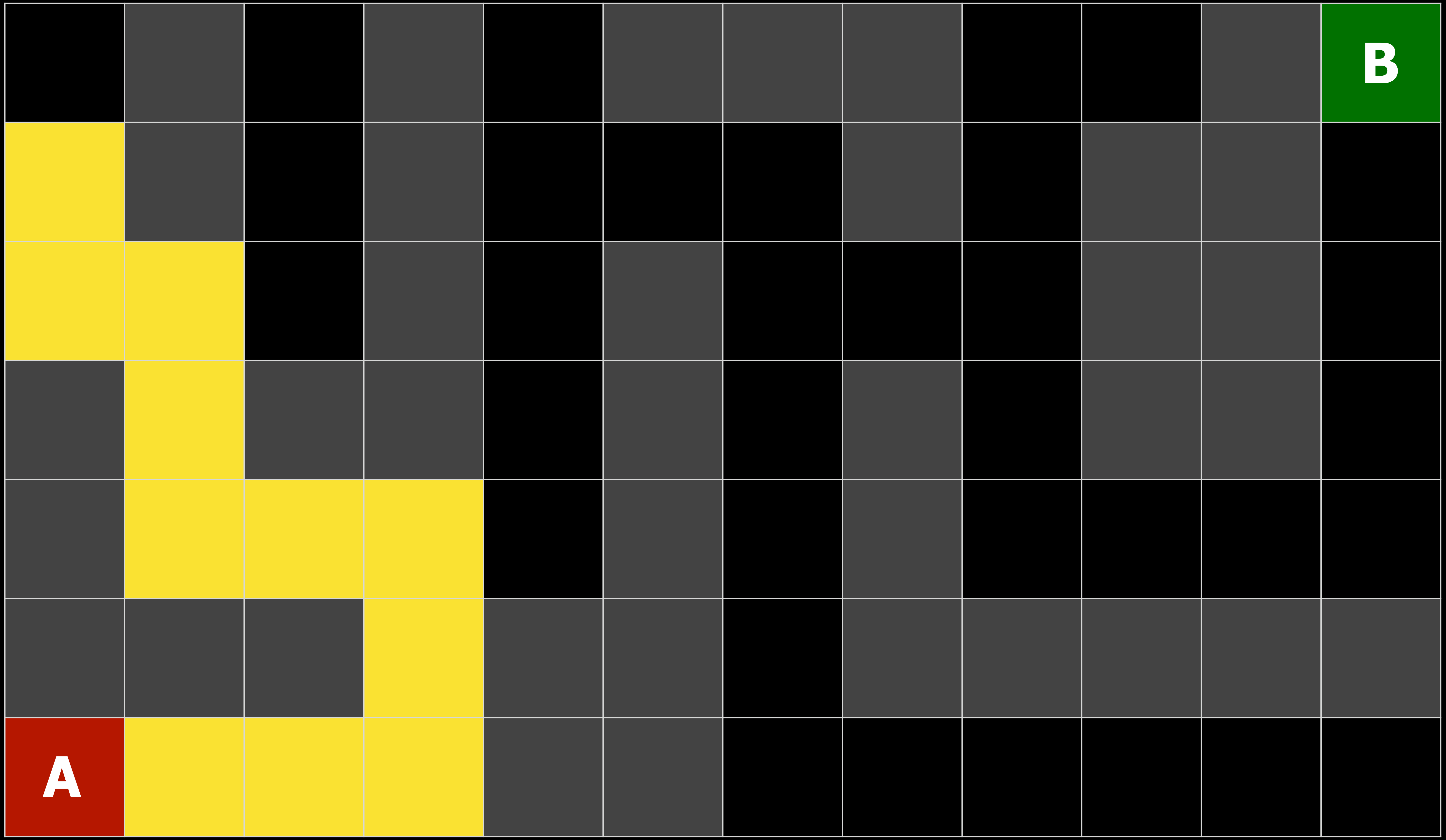

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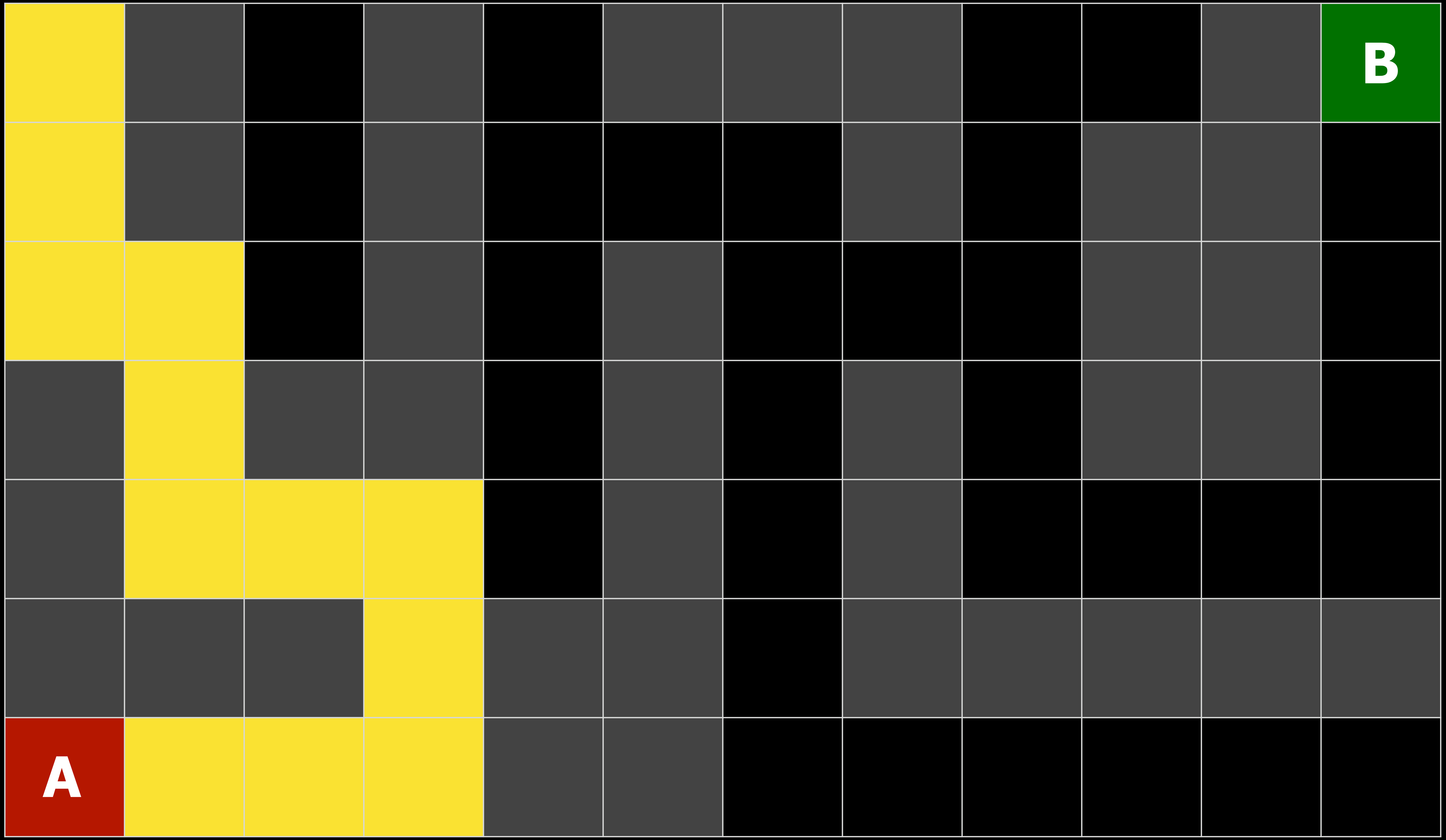
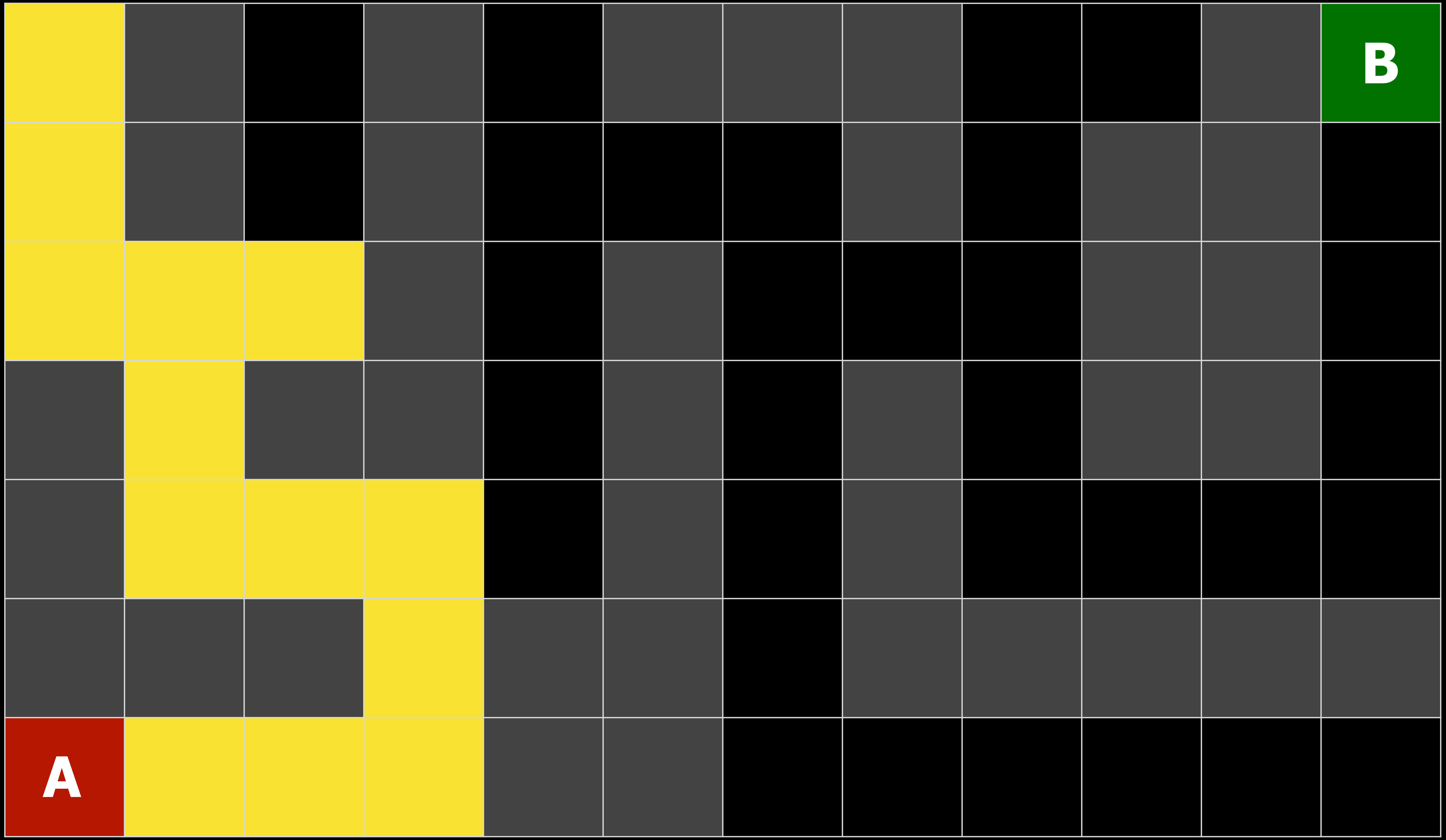
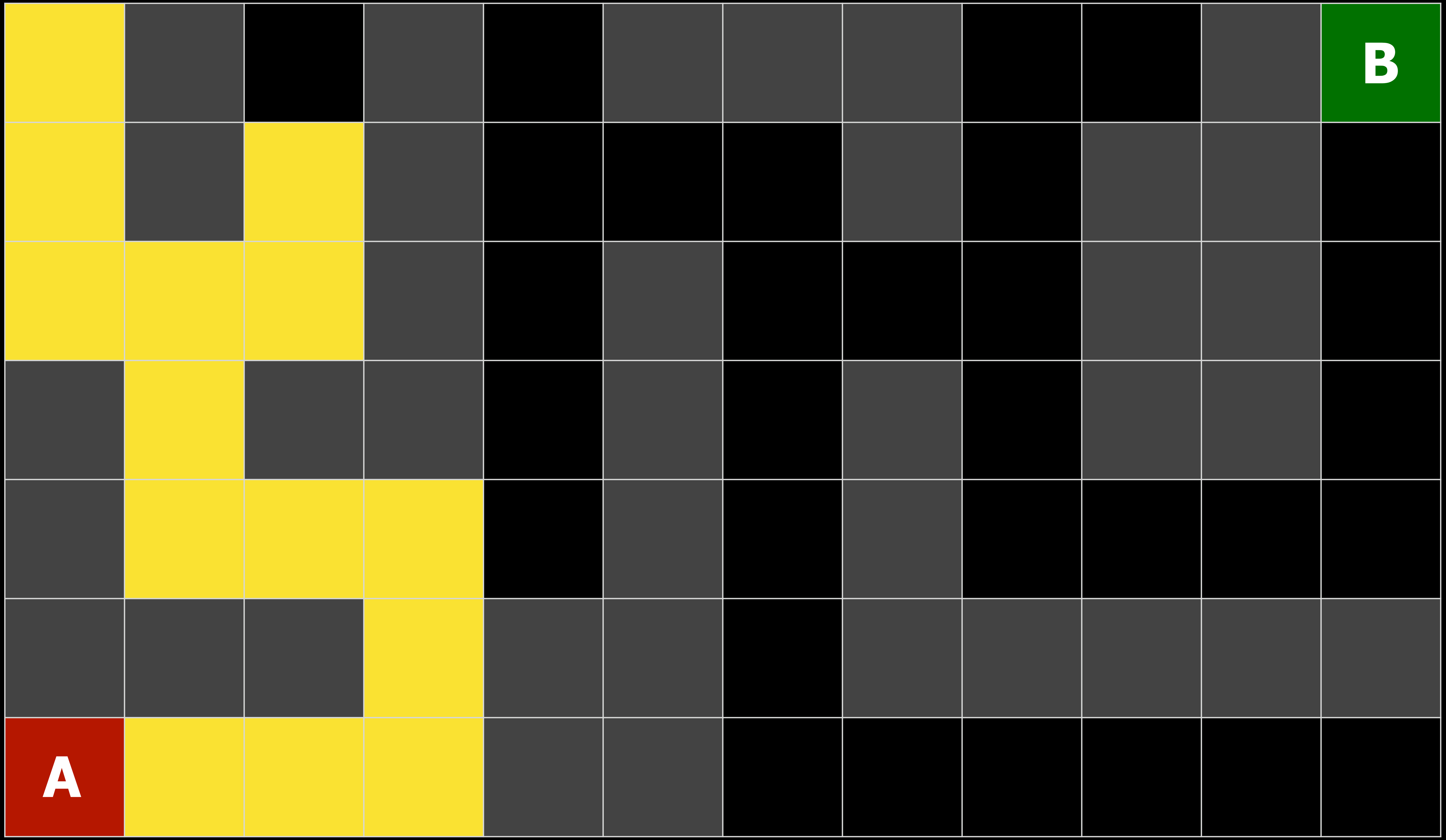


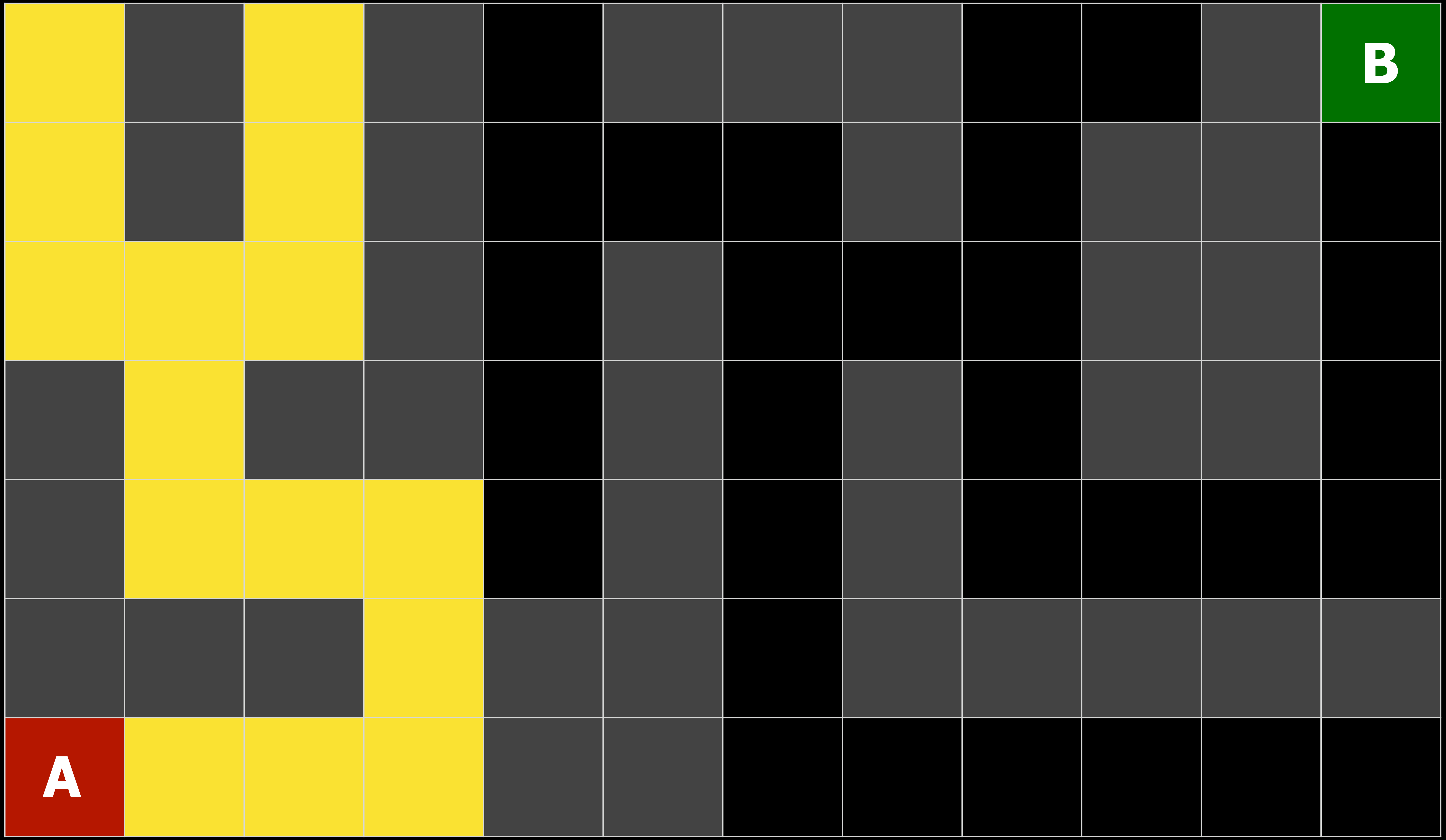
Depth-First Search



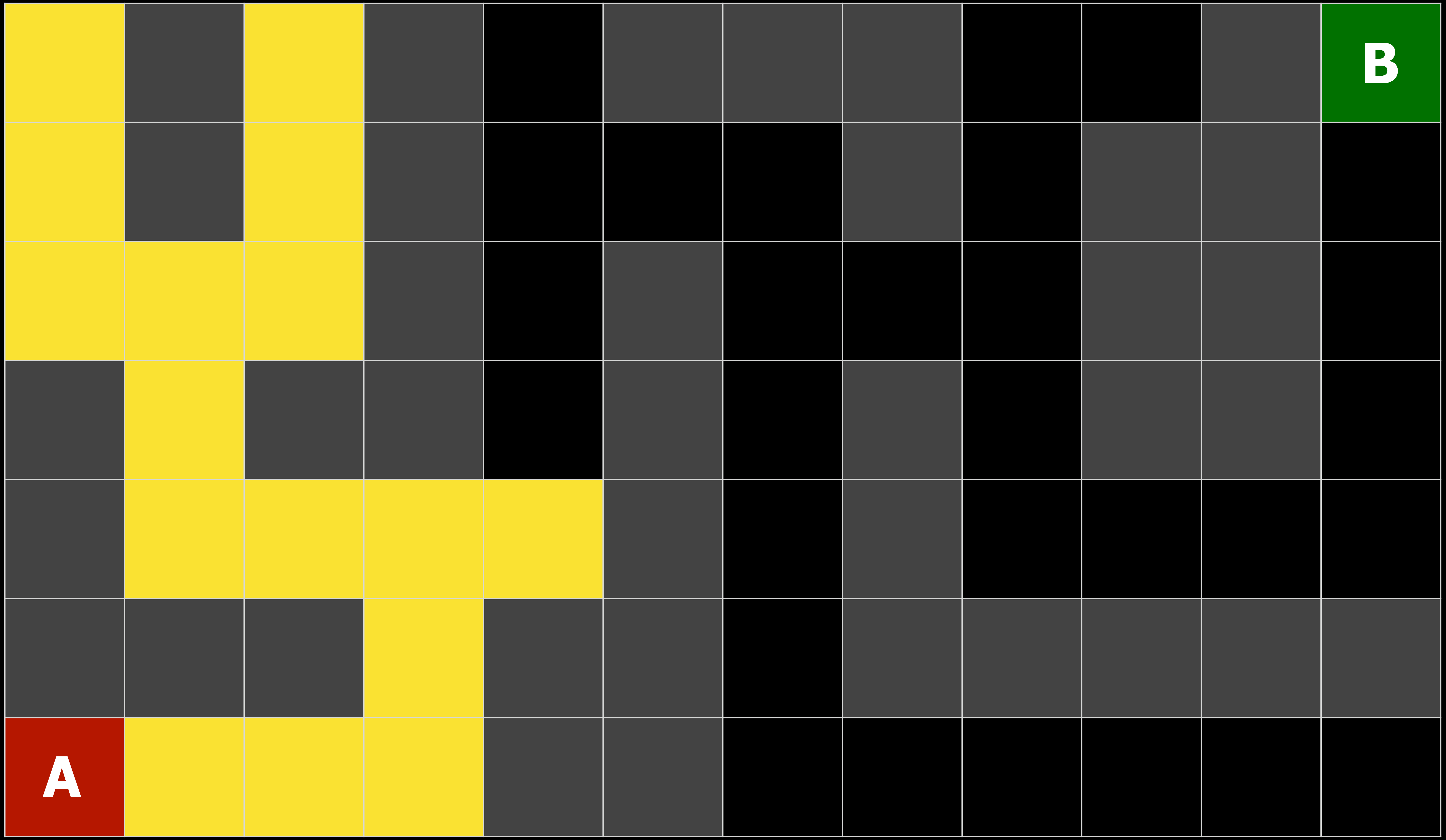
Depth-First Search



Depth-First Search



Depth-First Search



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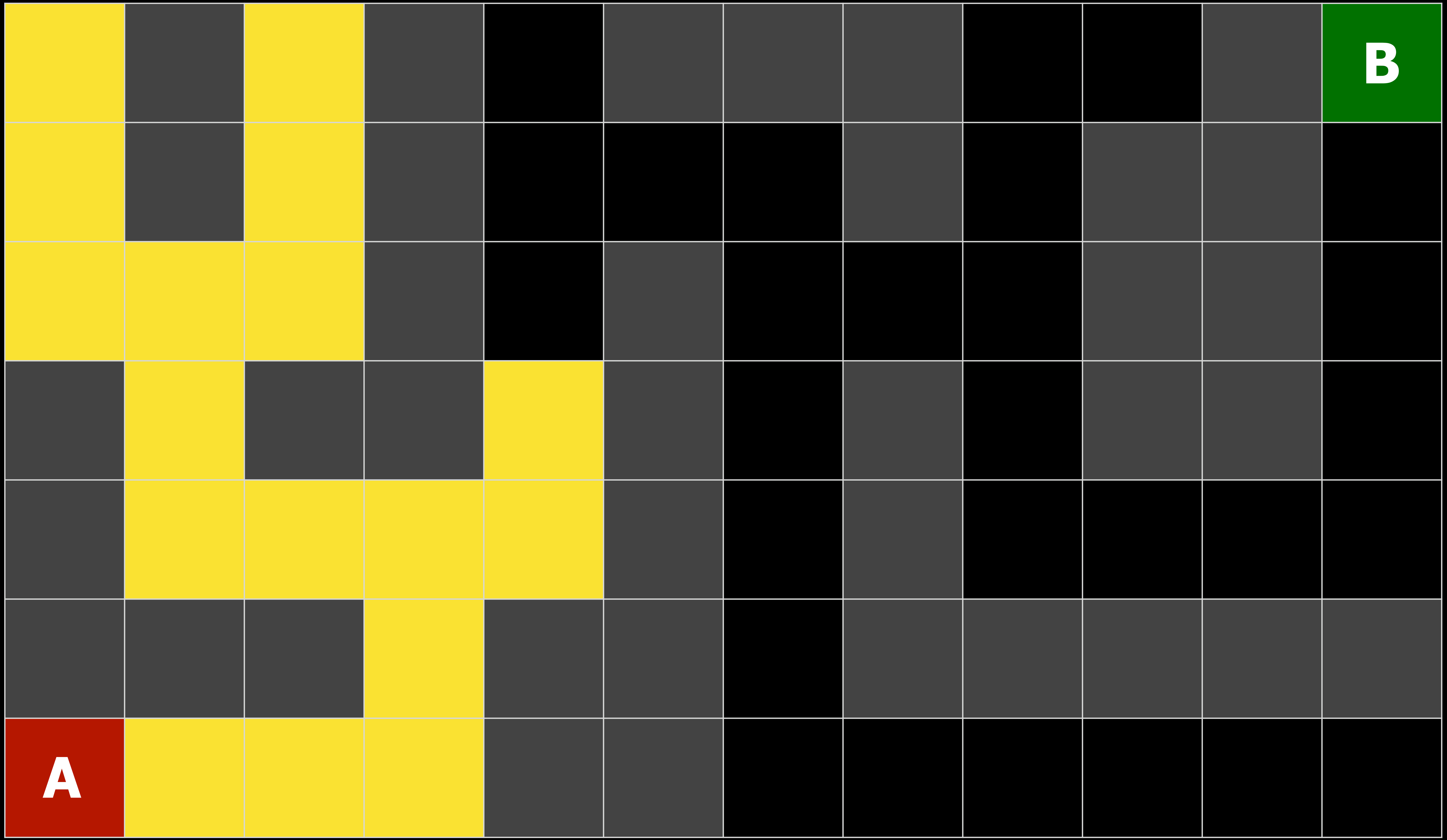

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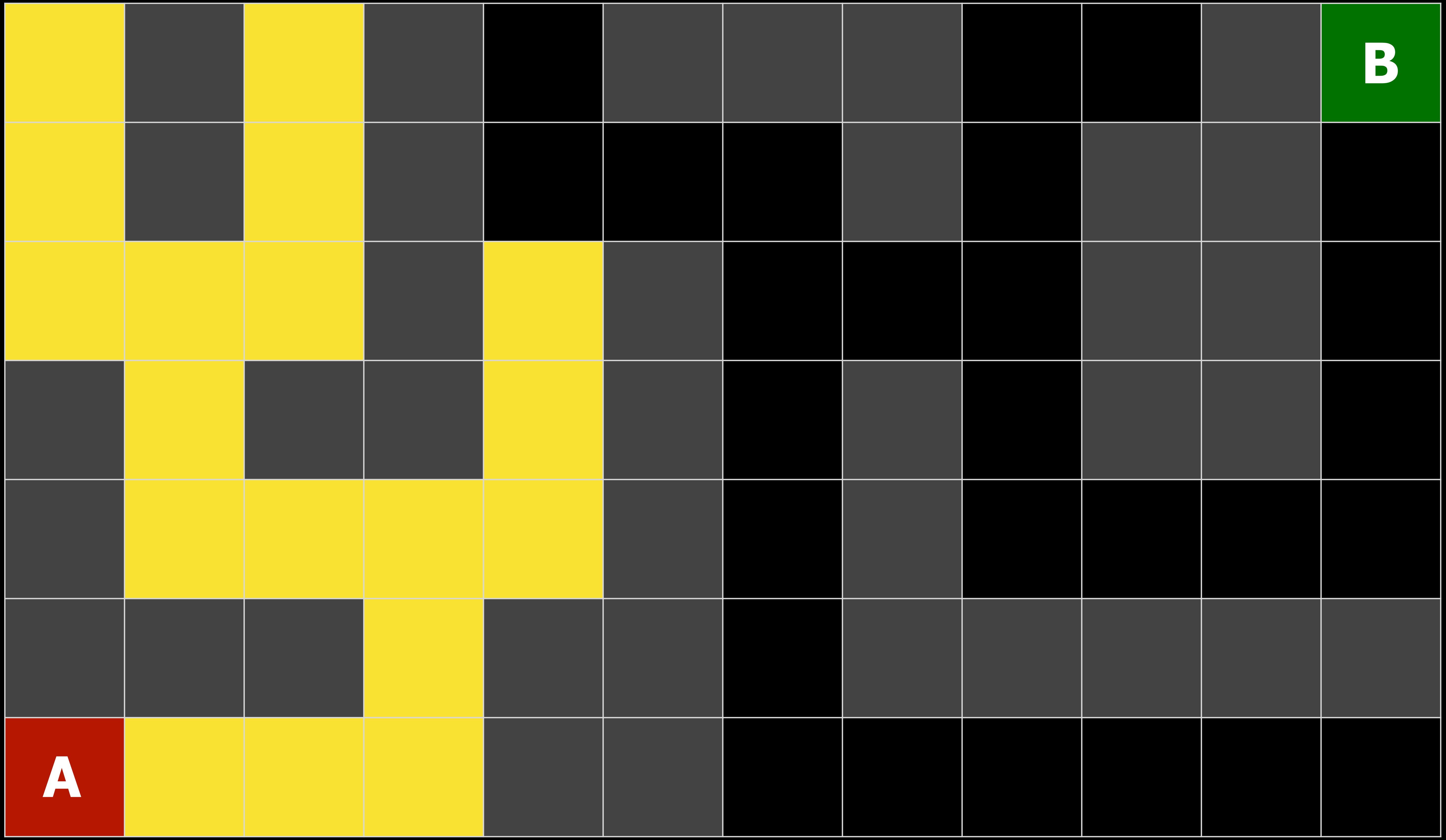
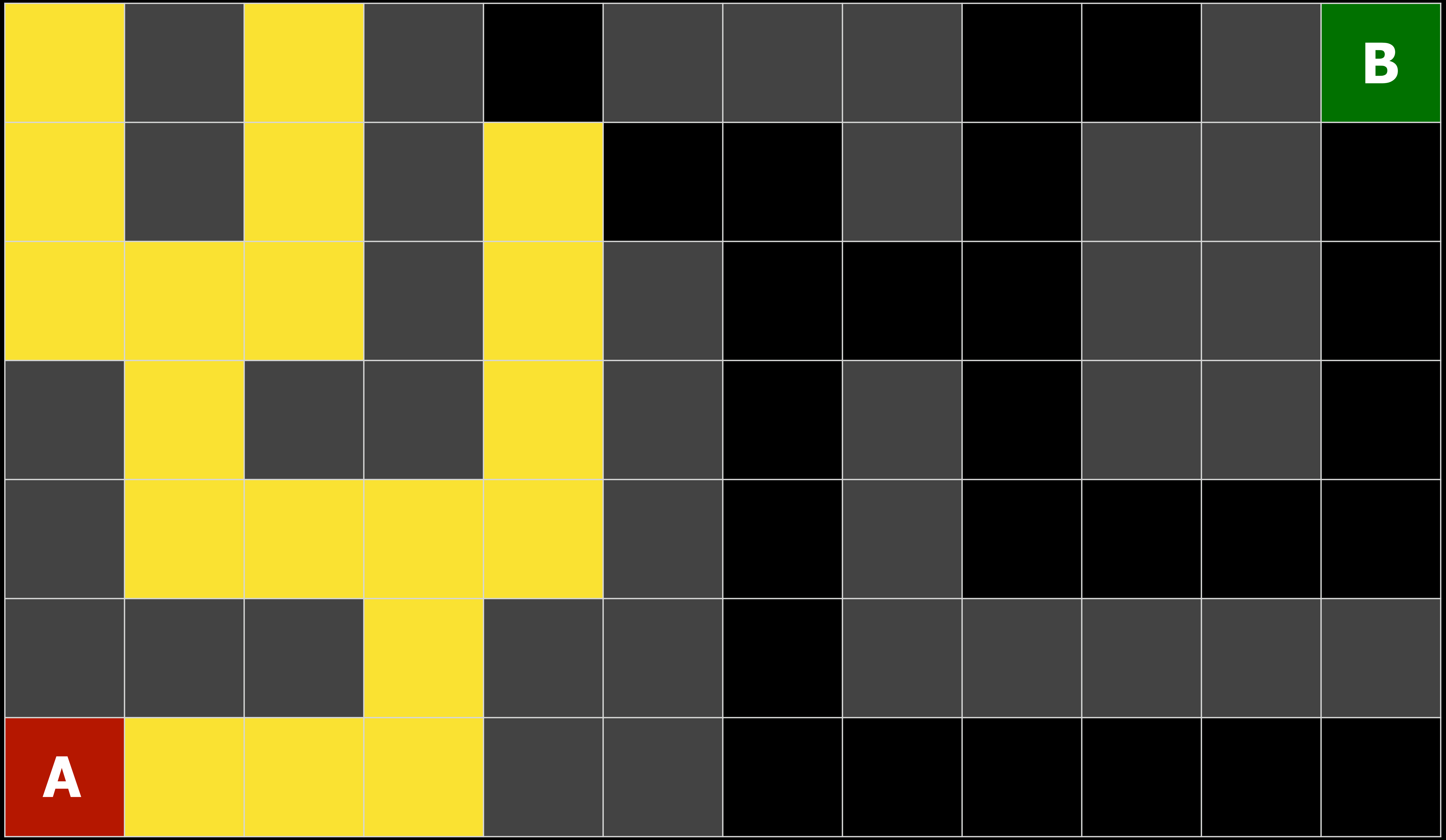


Depth-First Search



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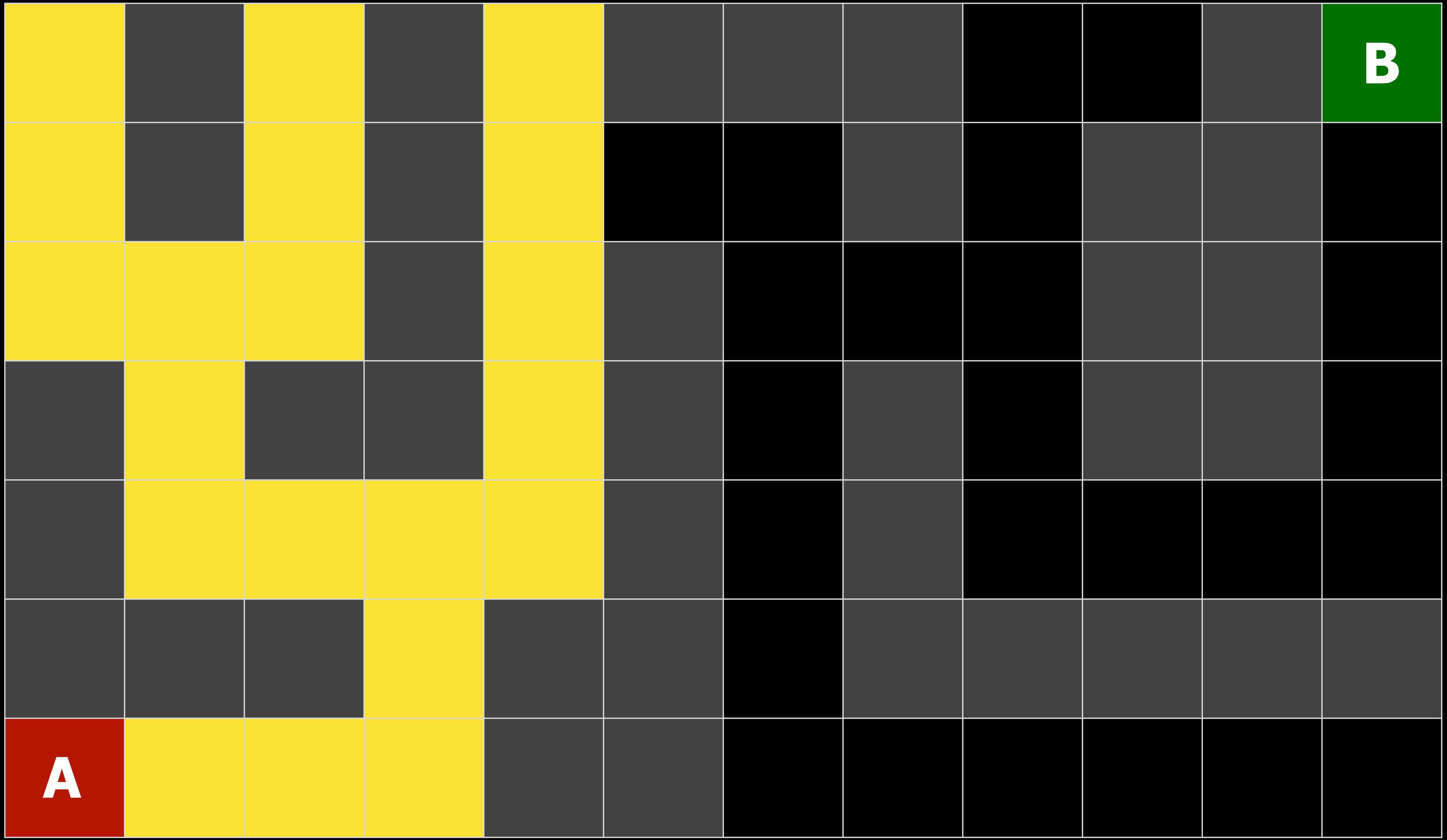

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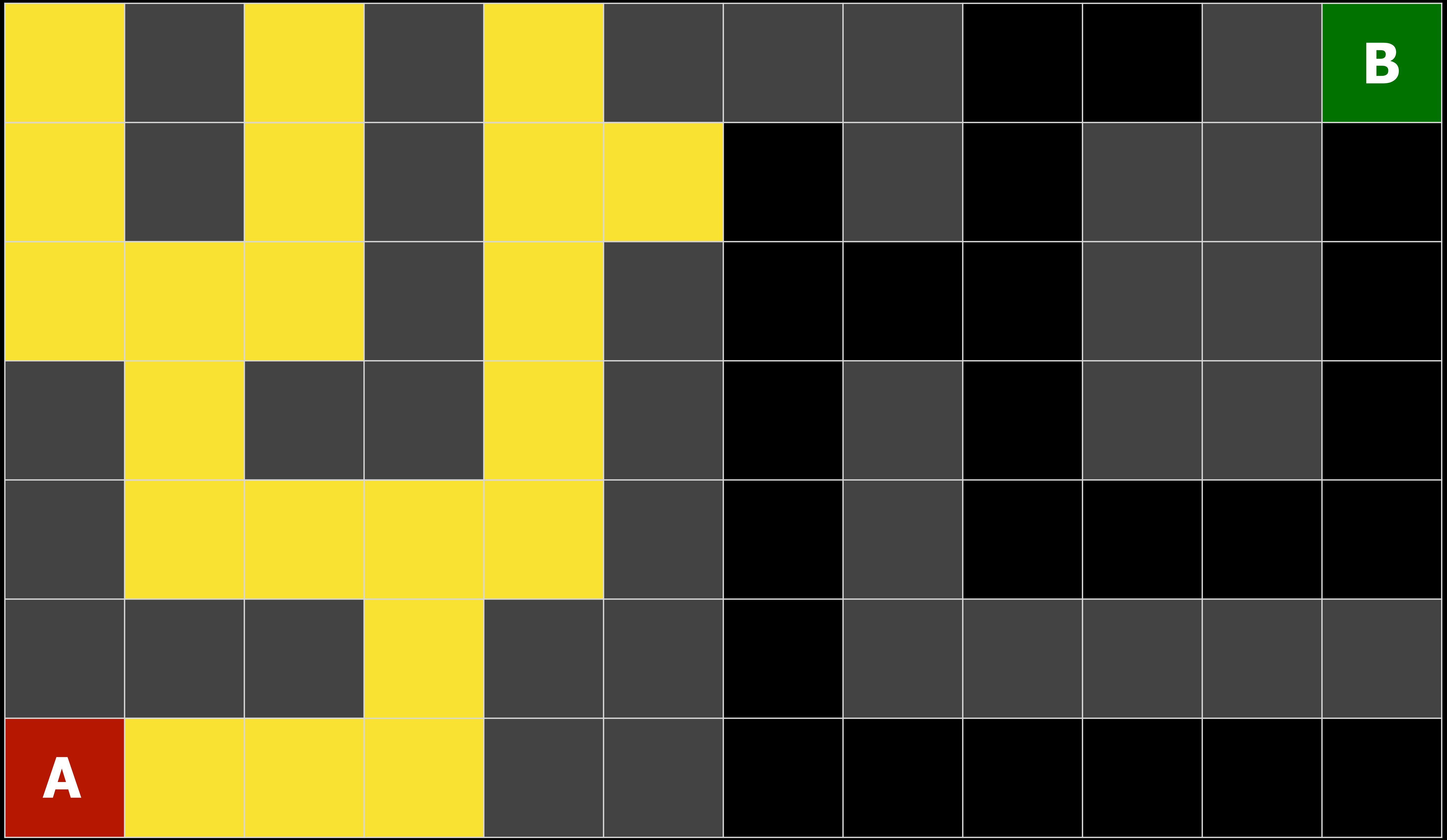

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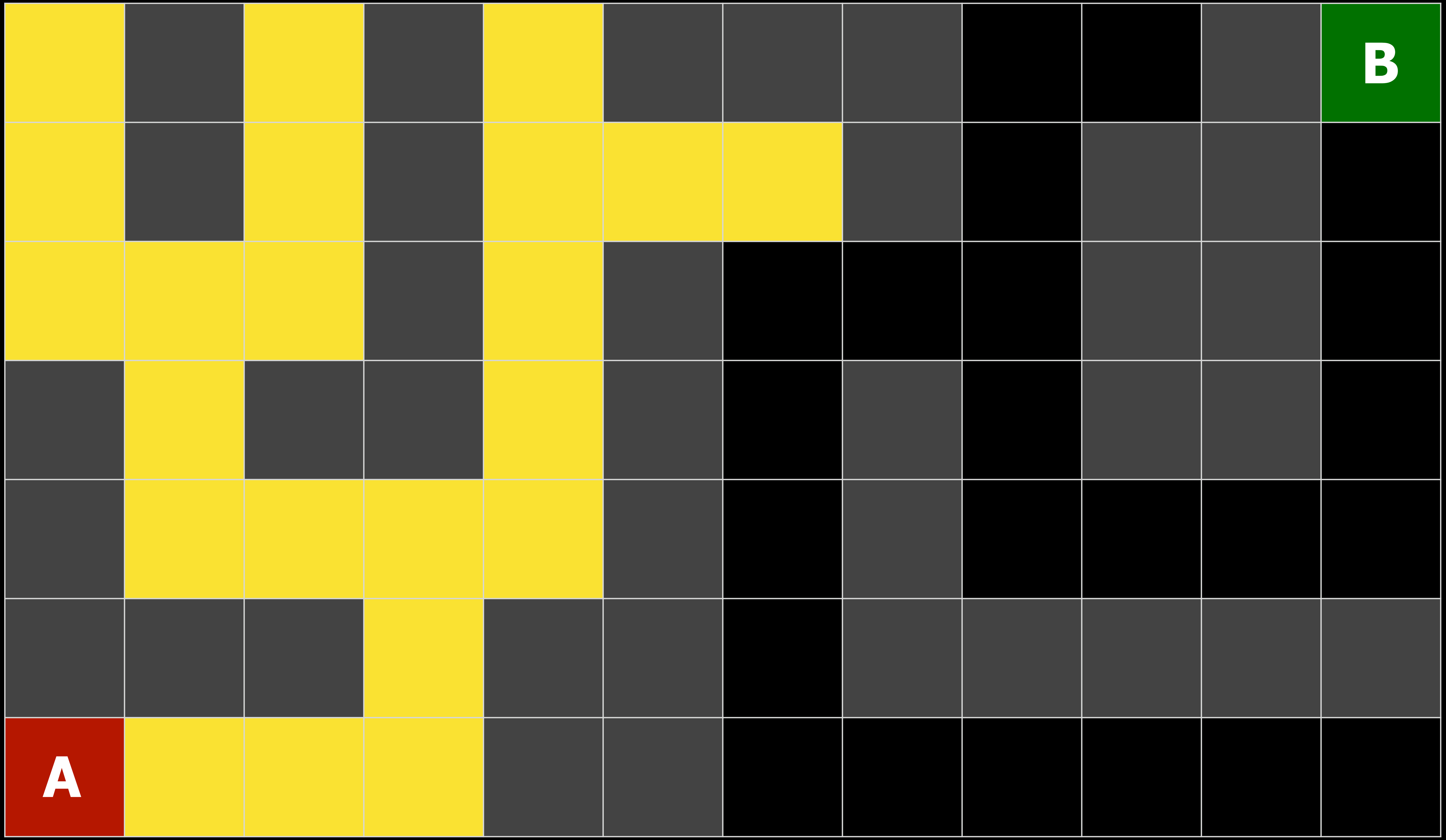

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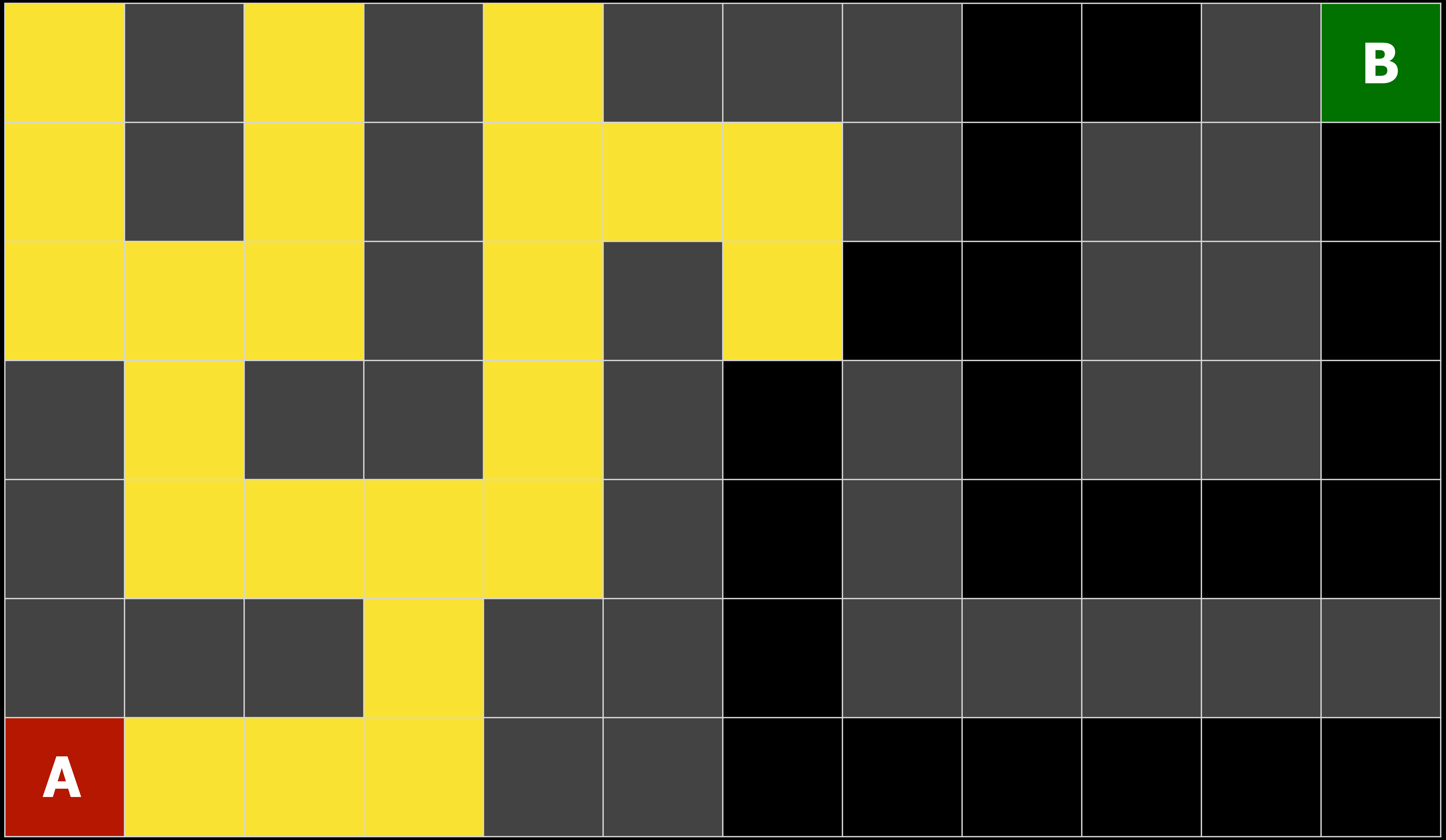
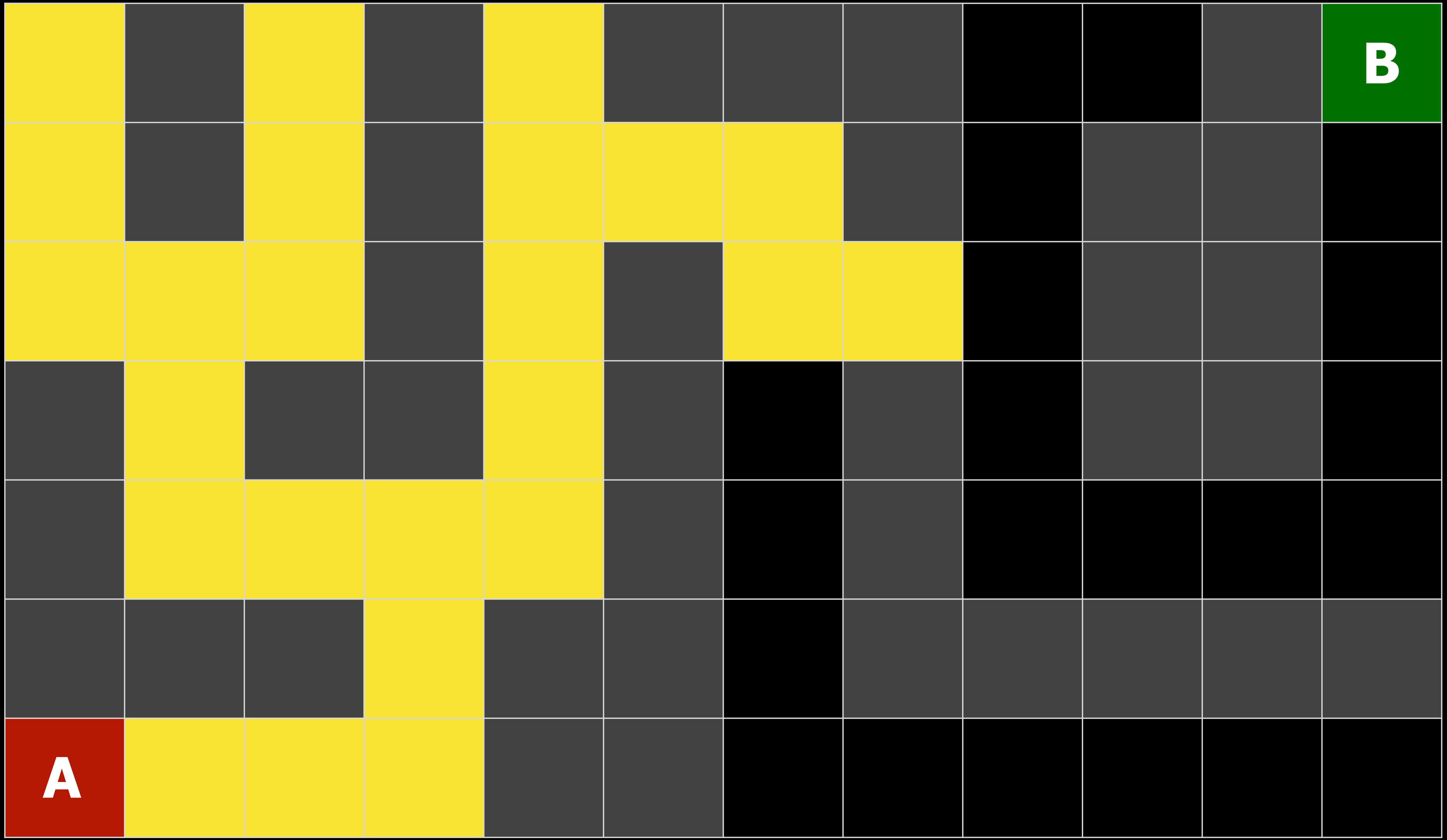
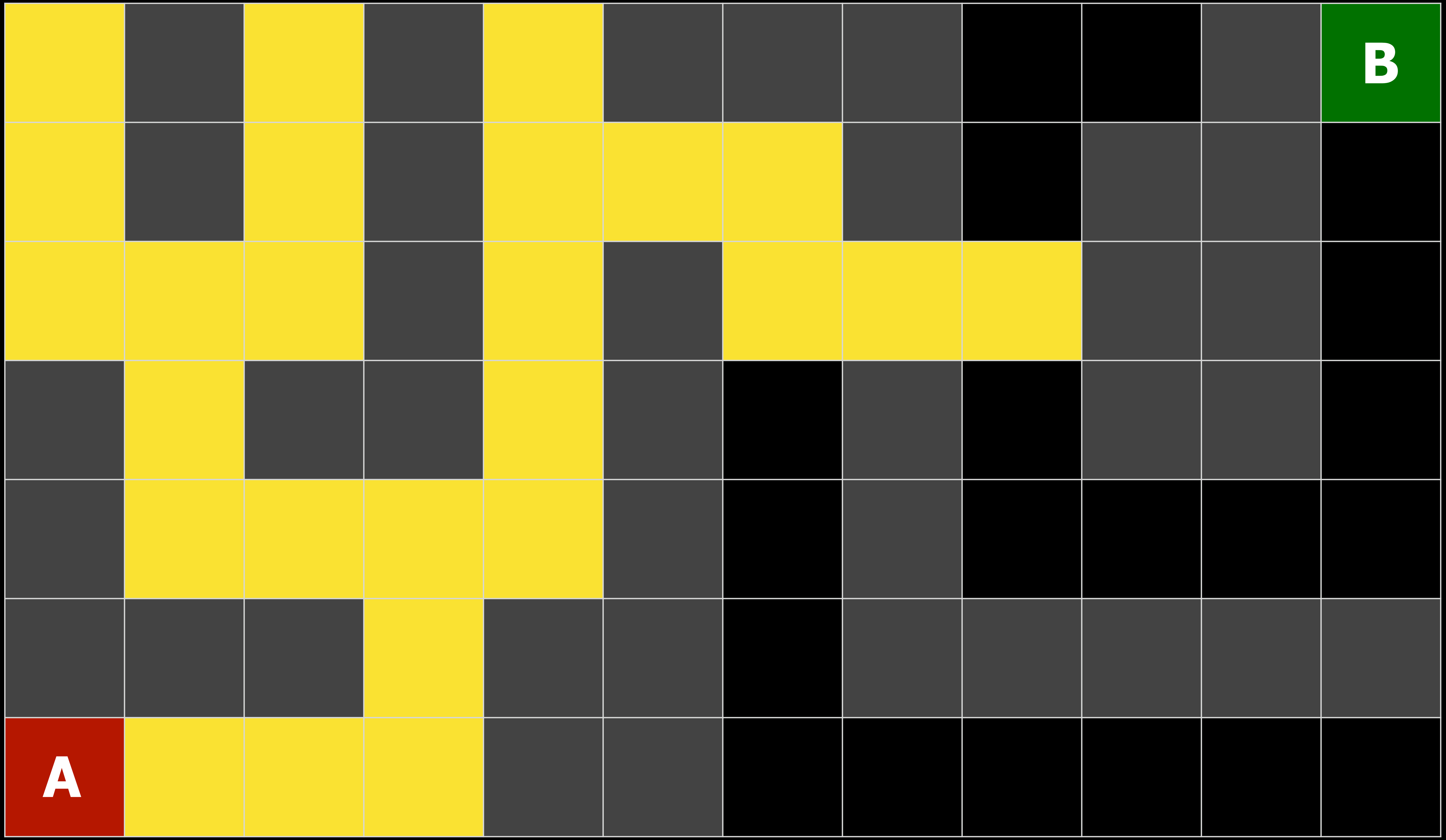


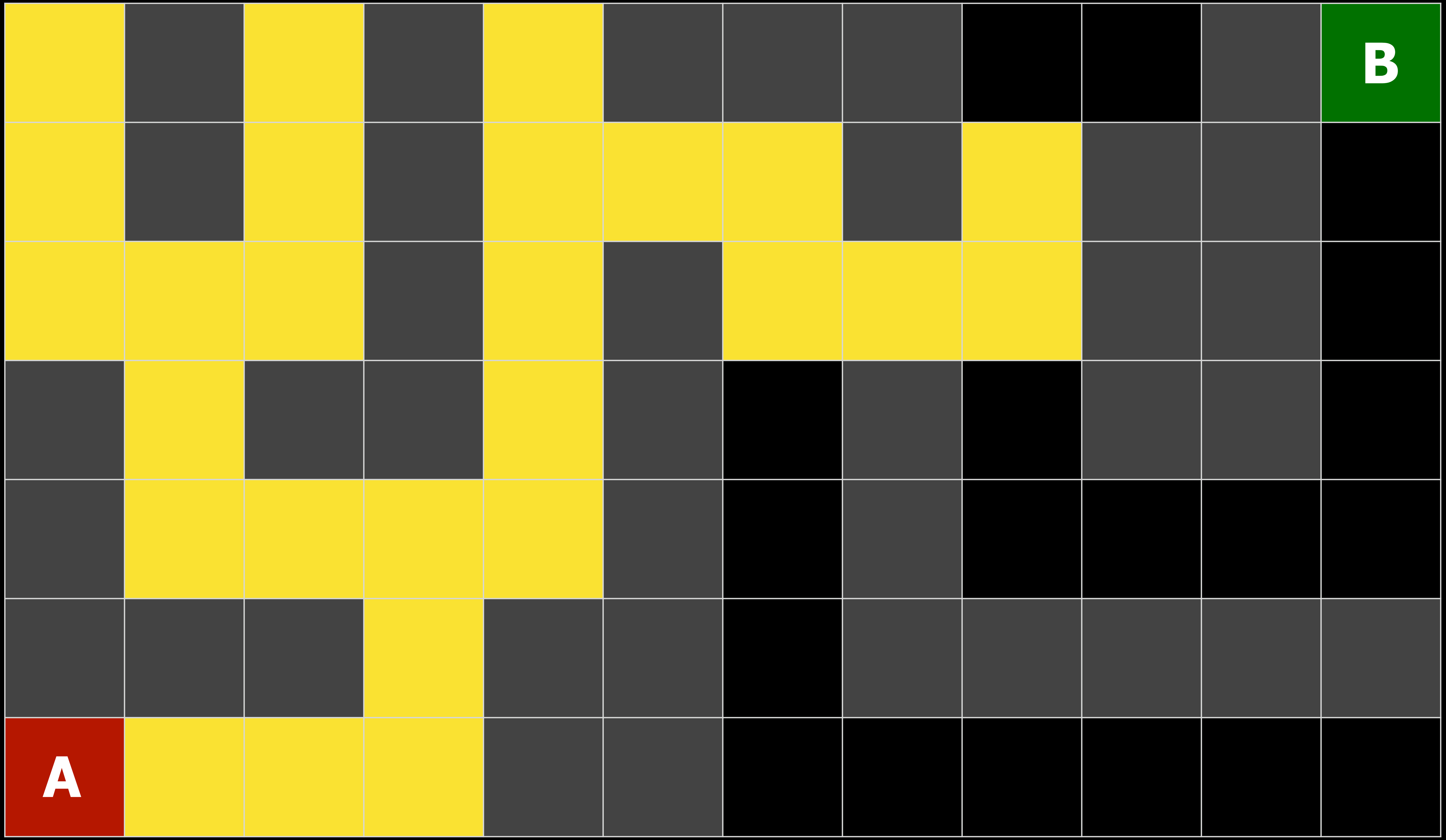
Depth-First Search



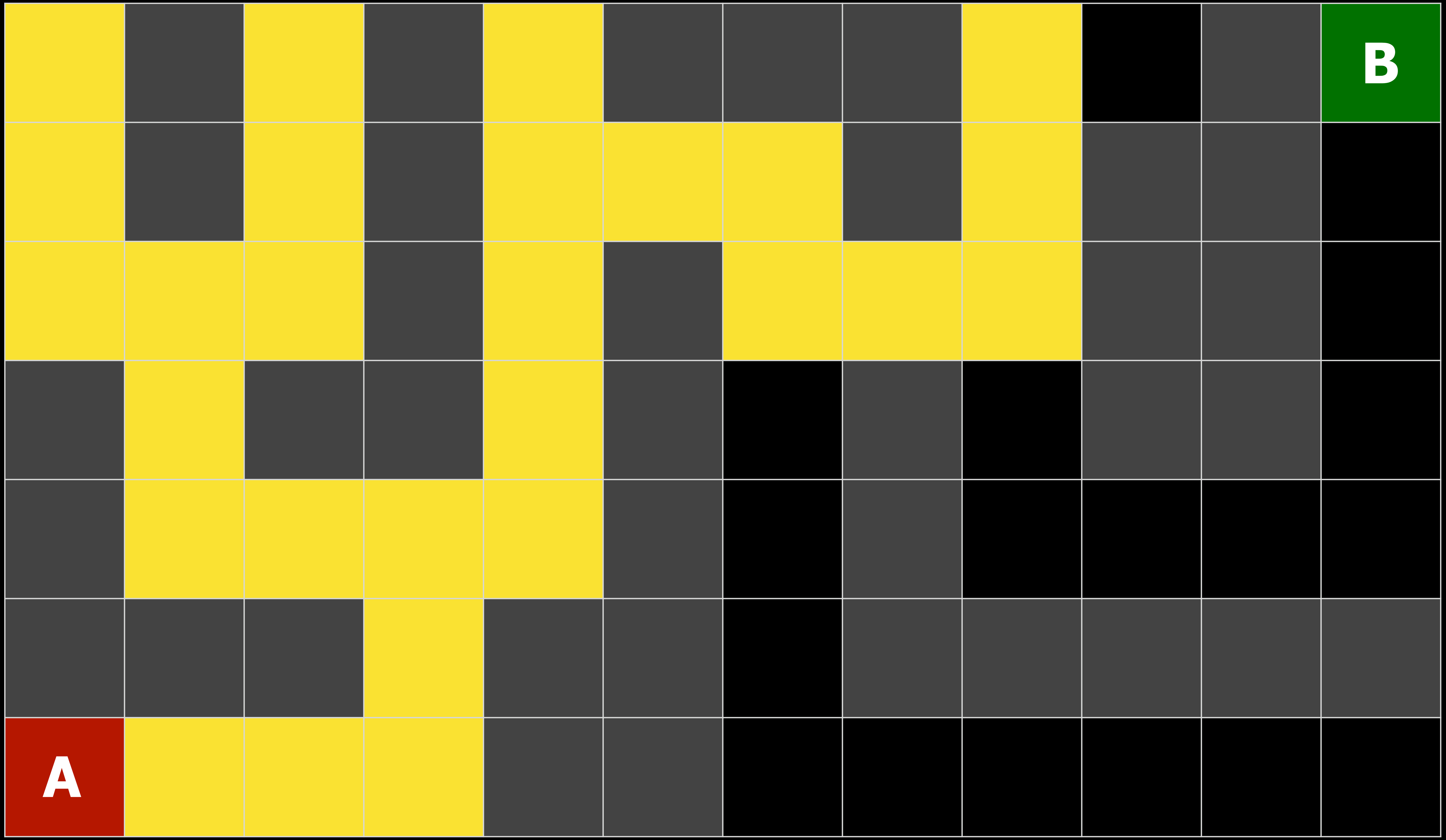
Depth-First Search



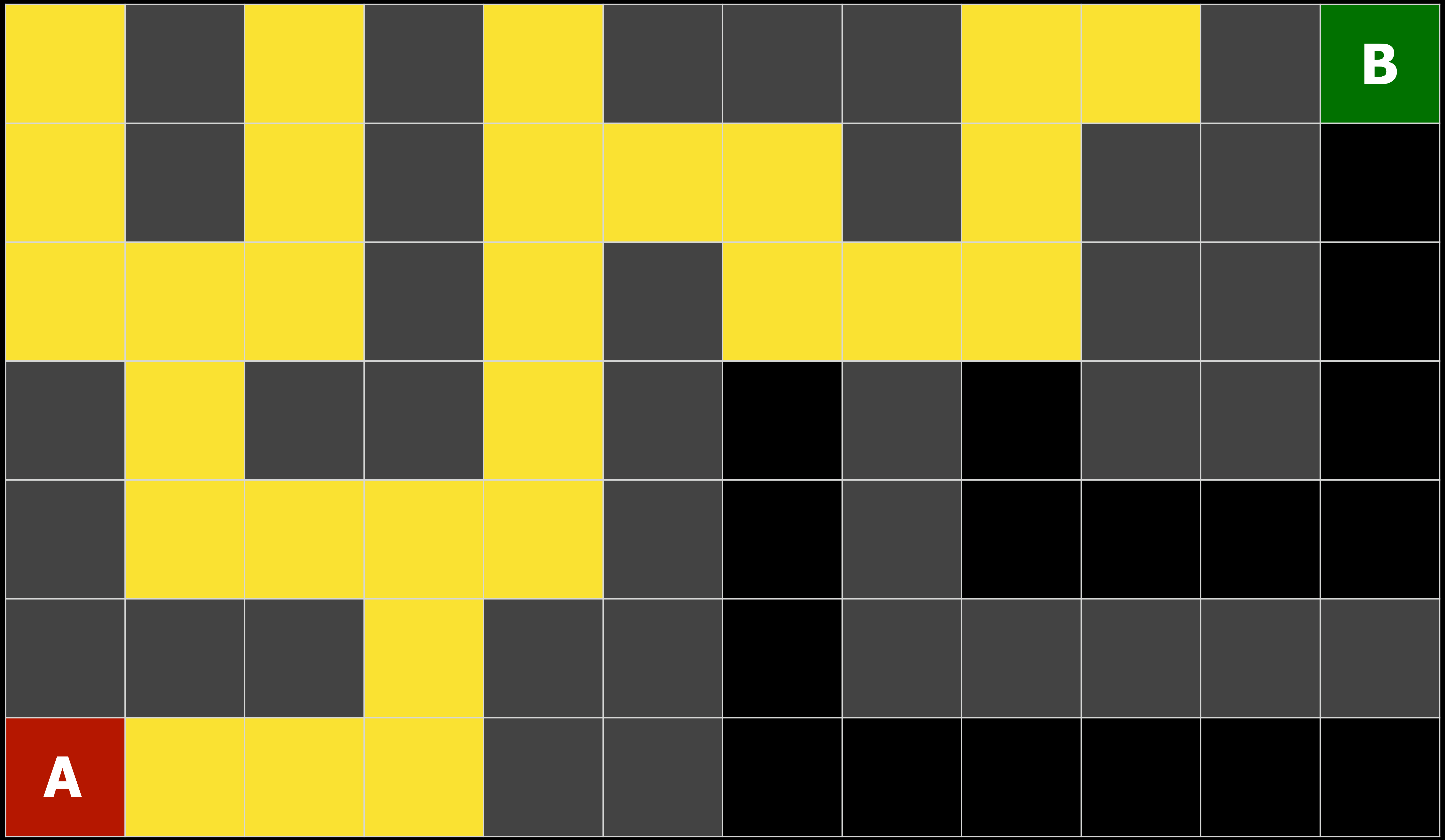
Depth-First Search



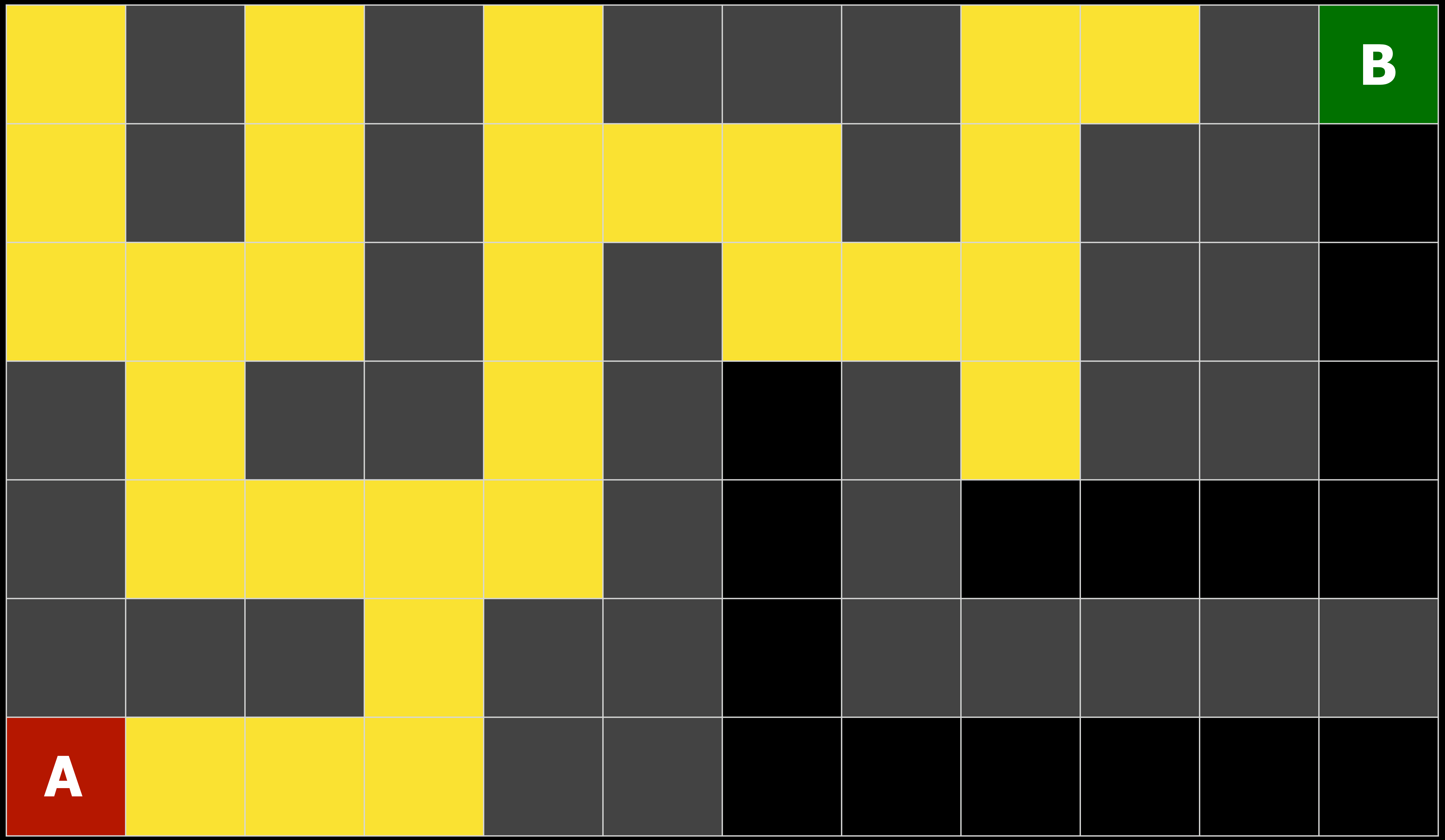
Depth-First Search



Depth-First Search



Depth-First Search



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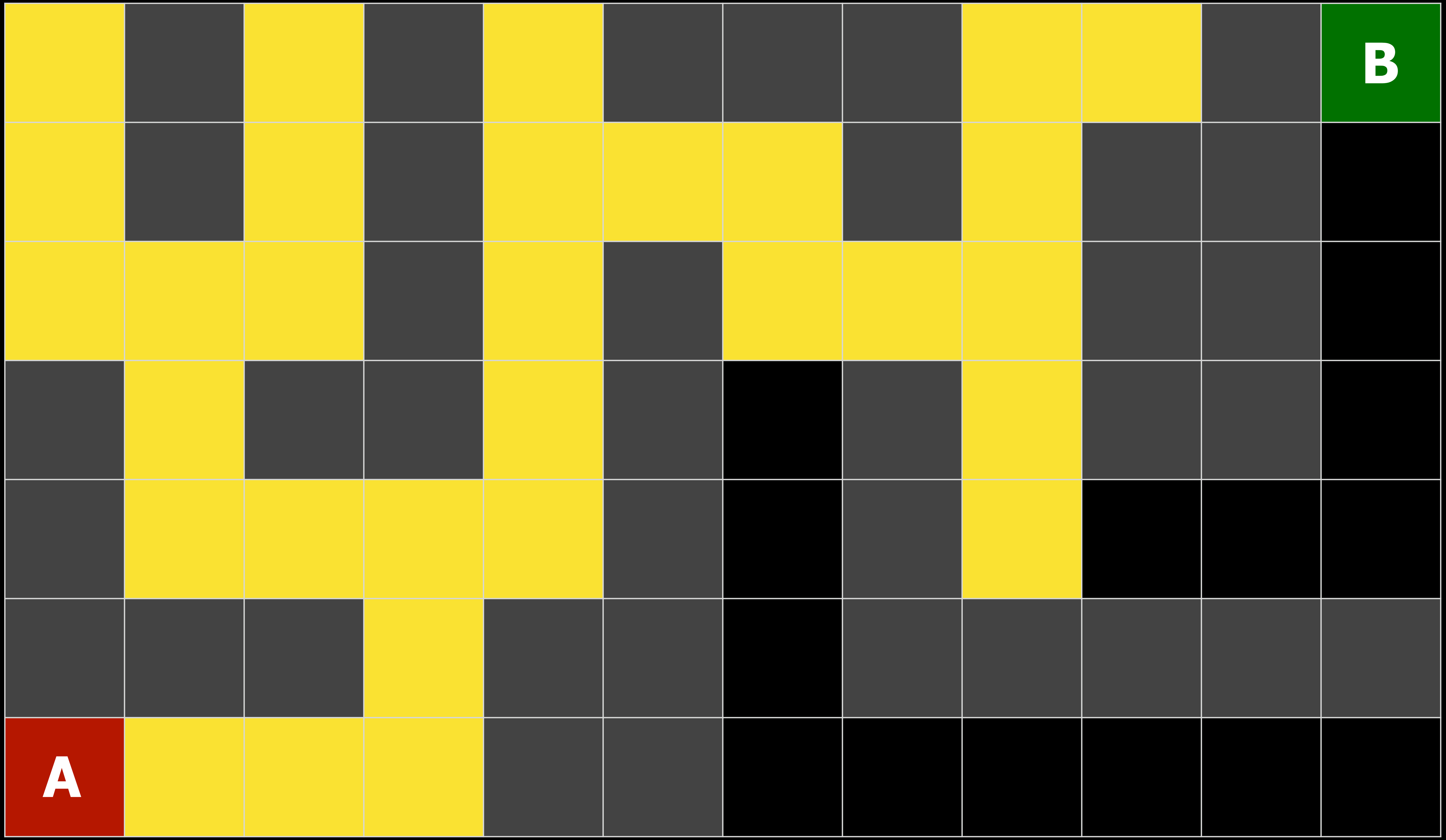

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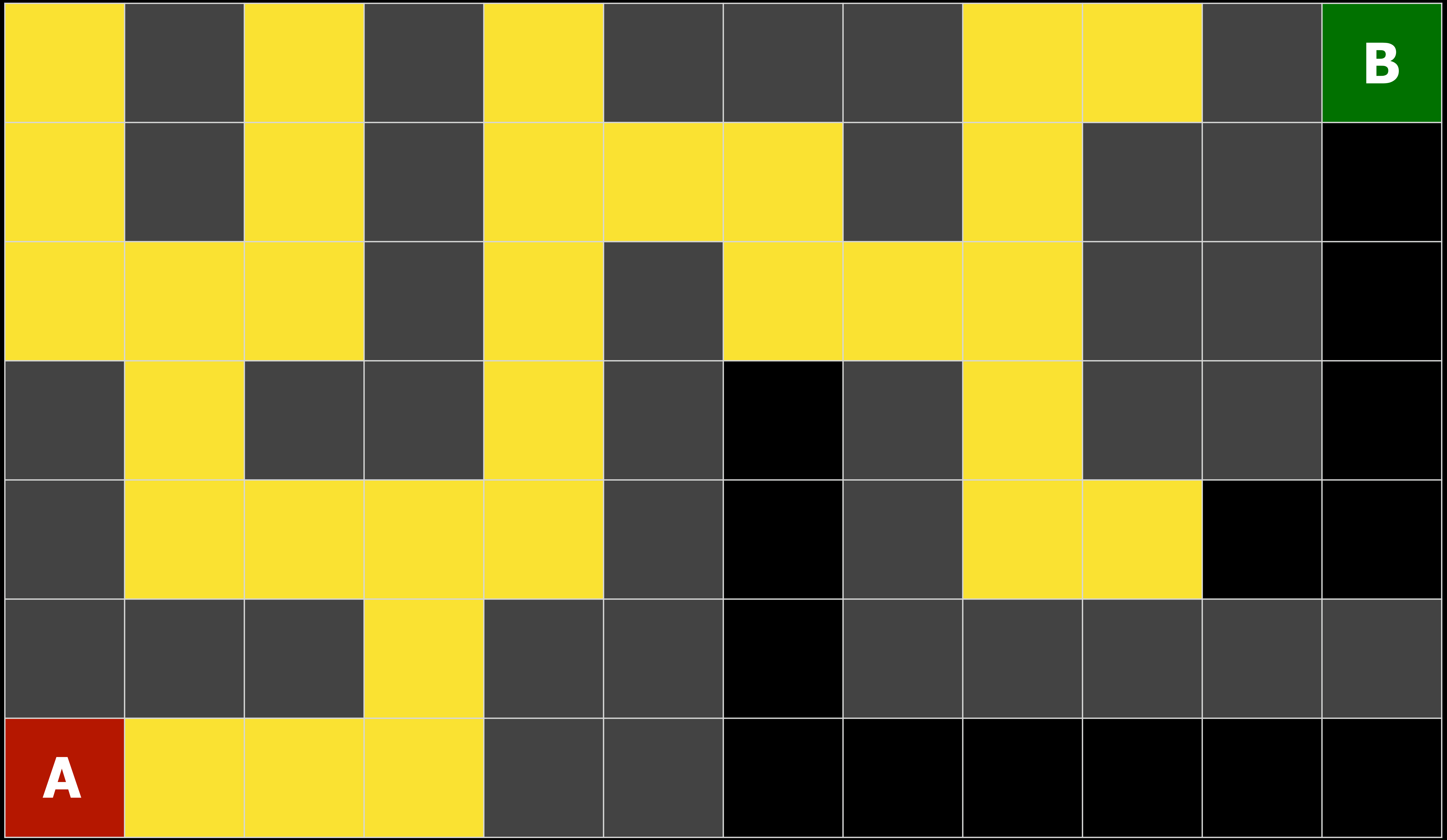

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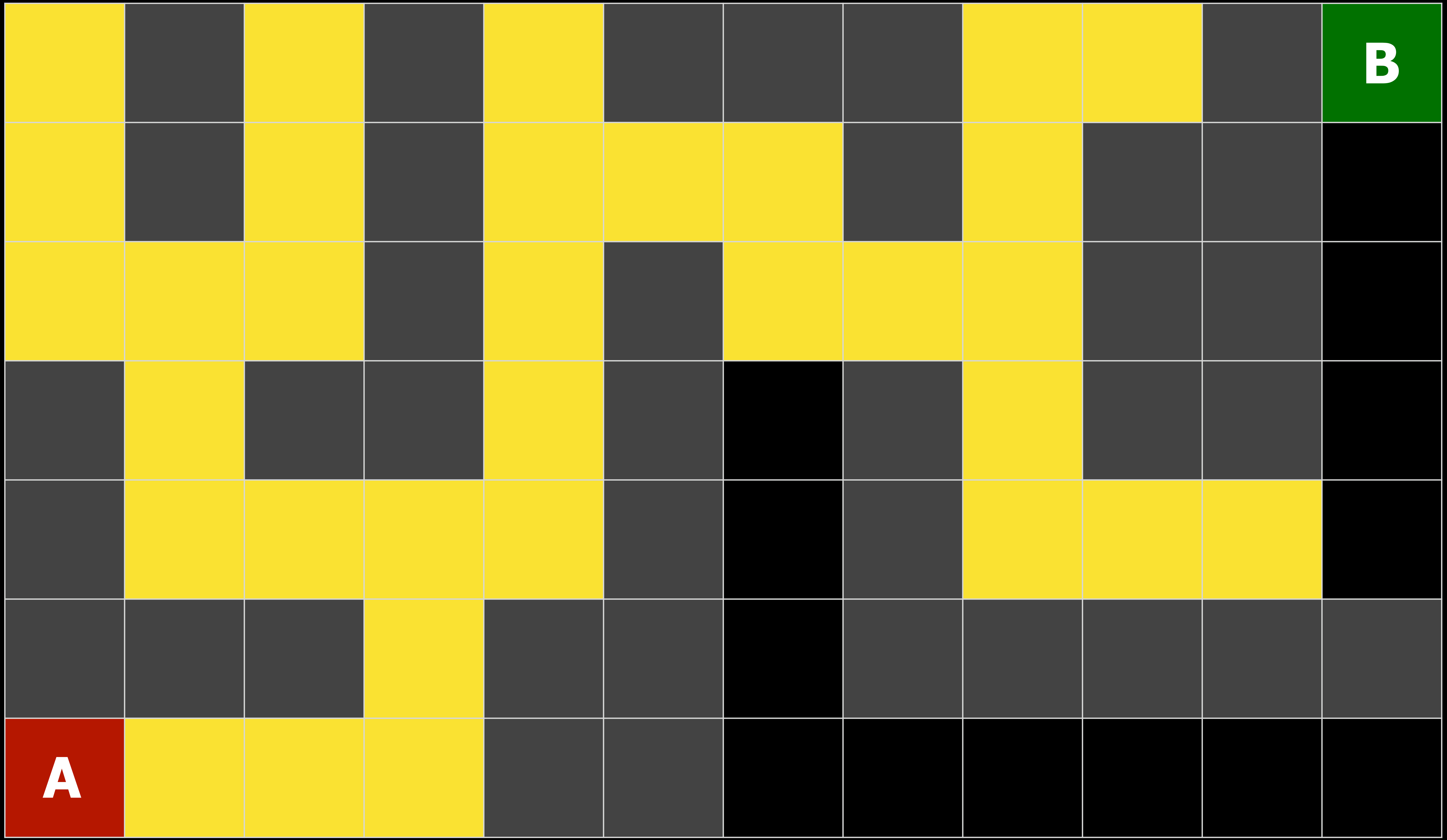

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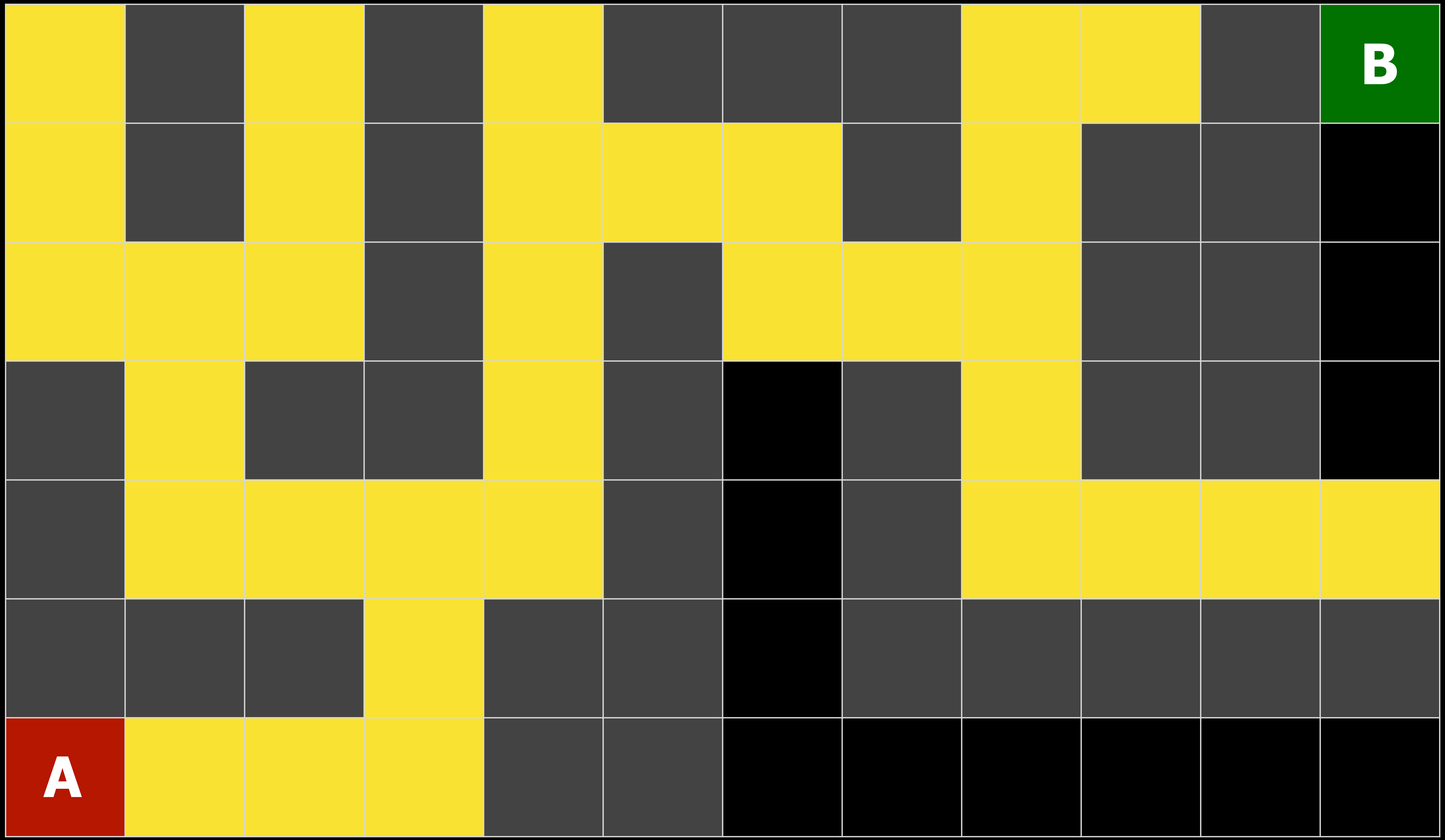

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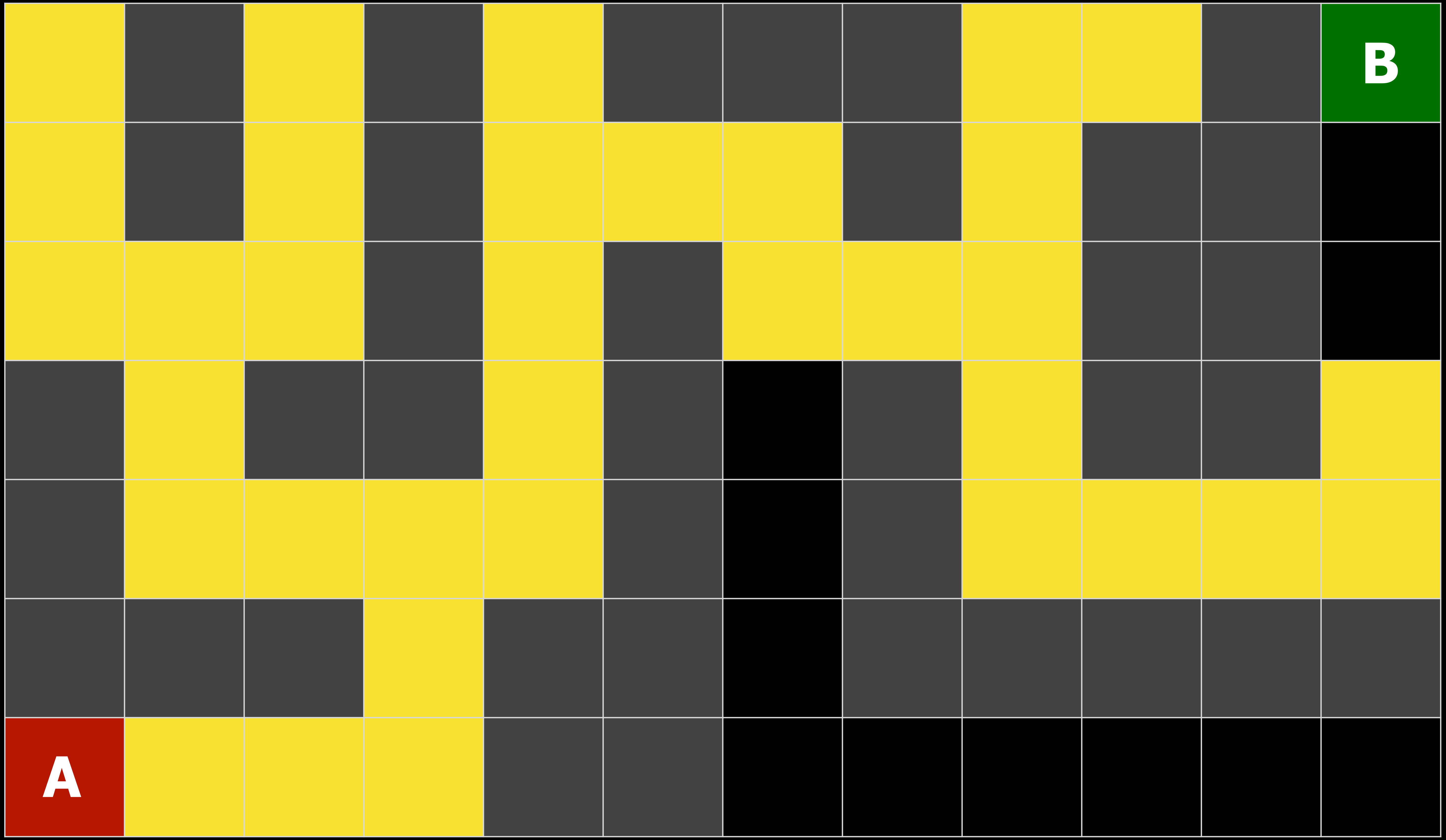

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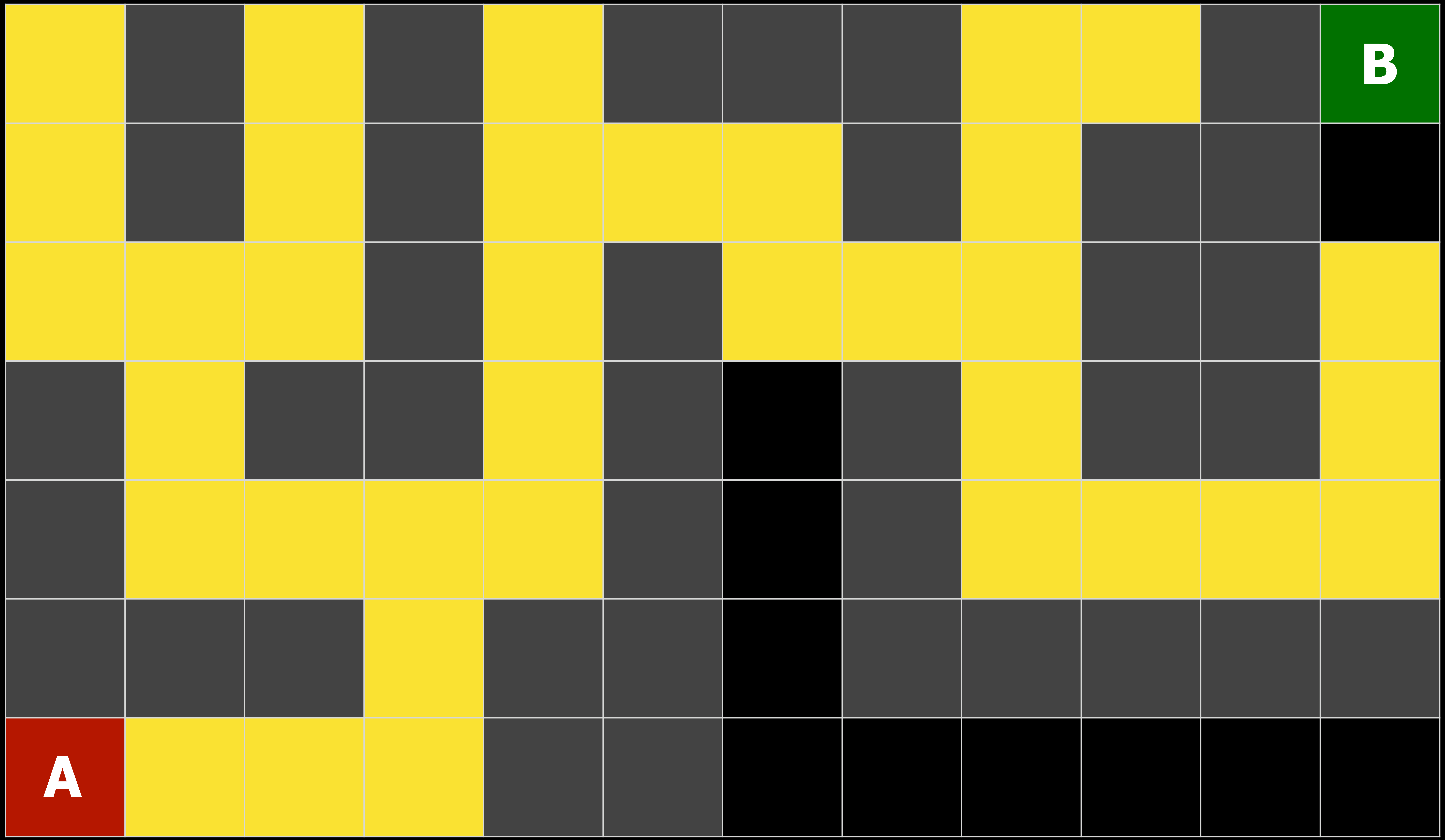

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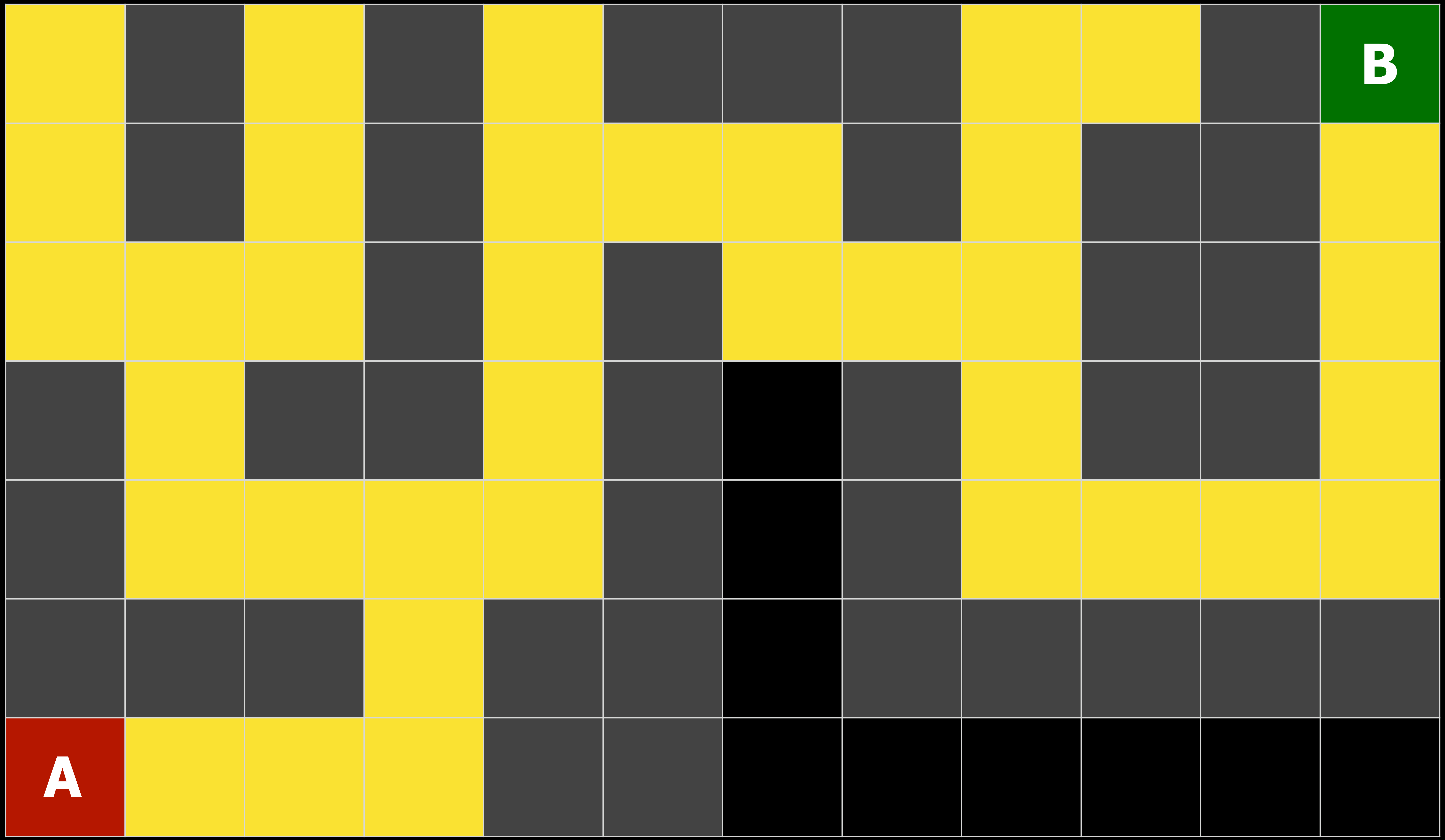
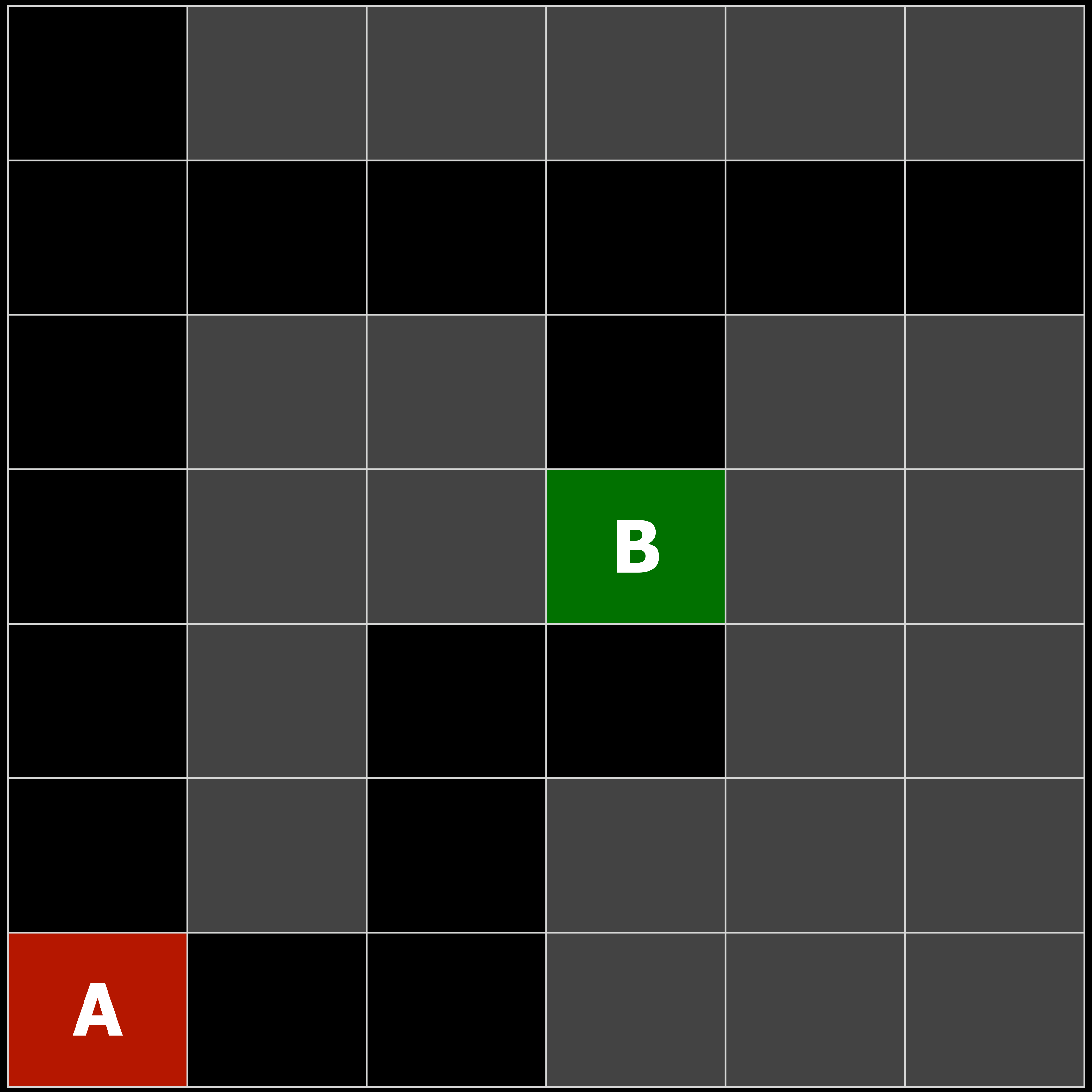
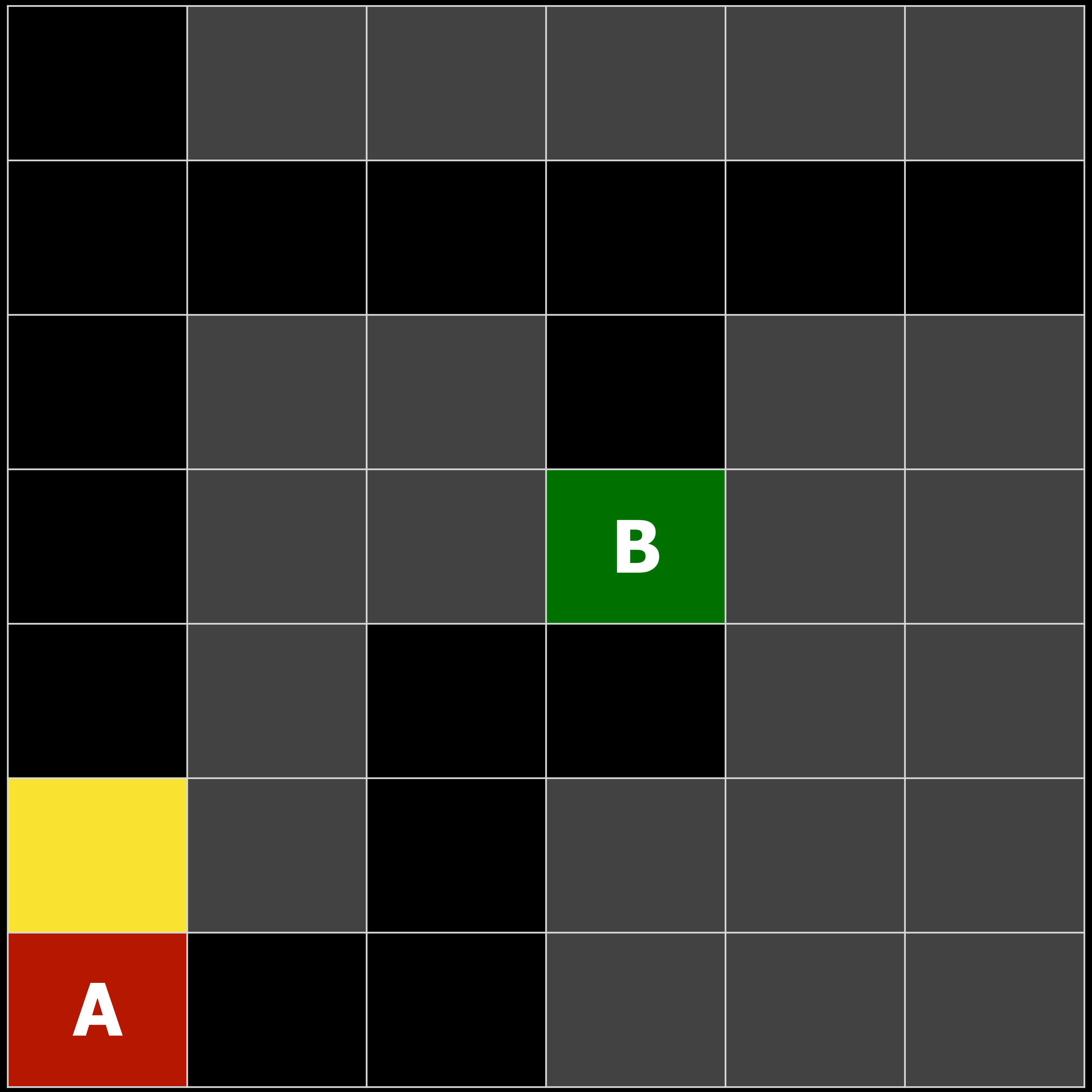


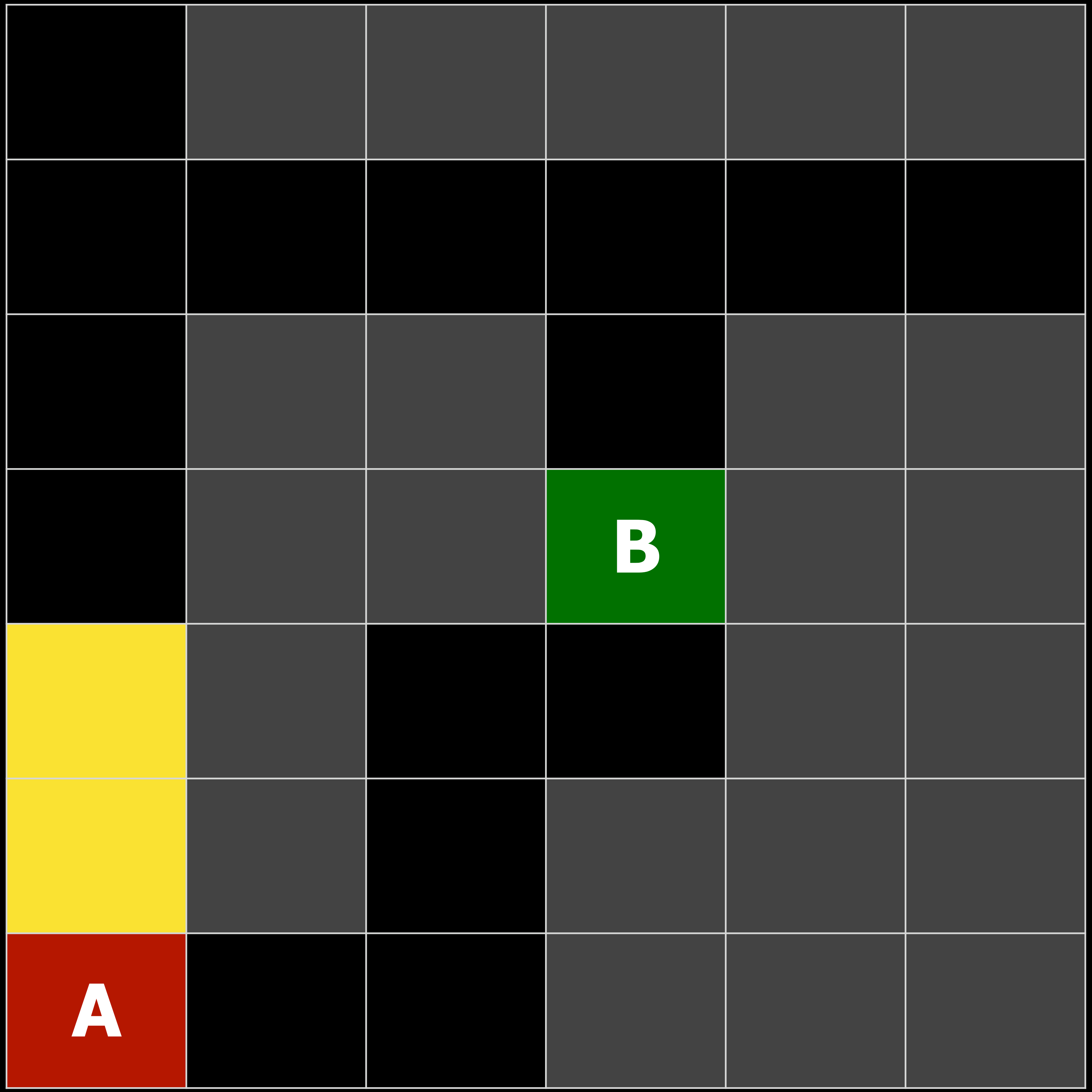
Depth-First Search



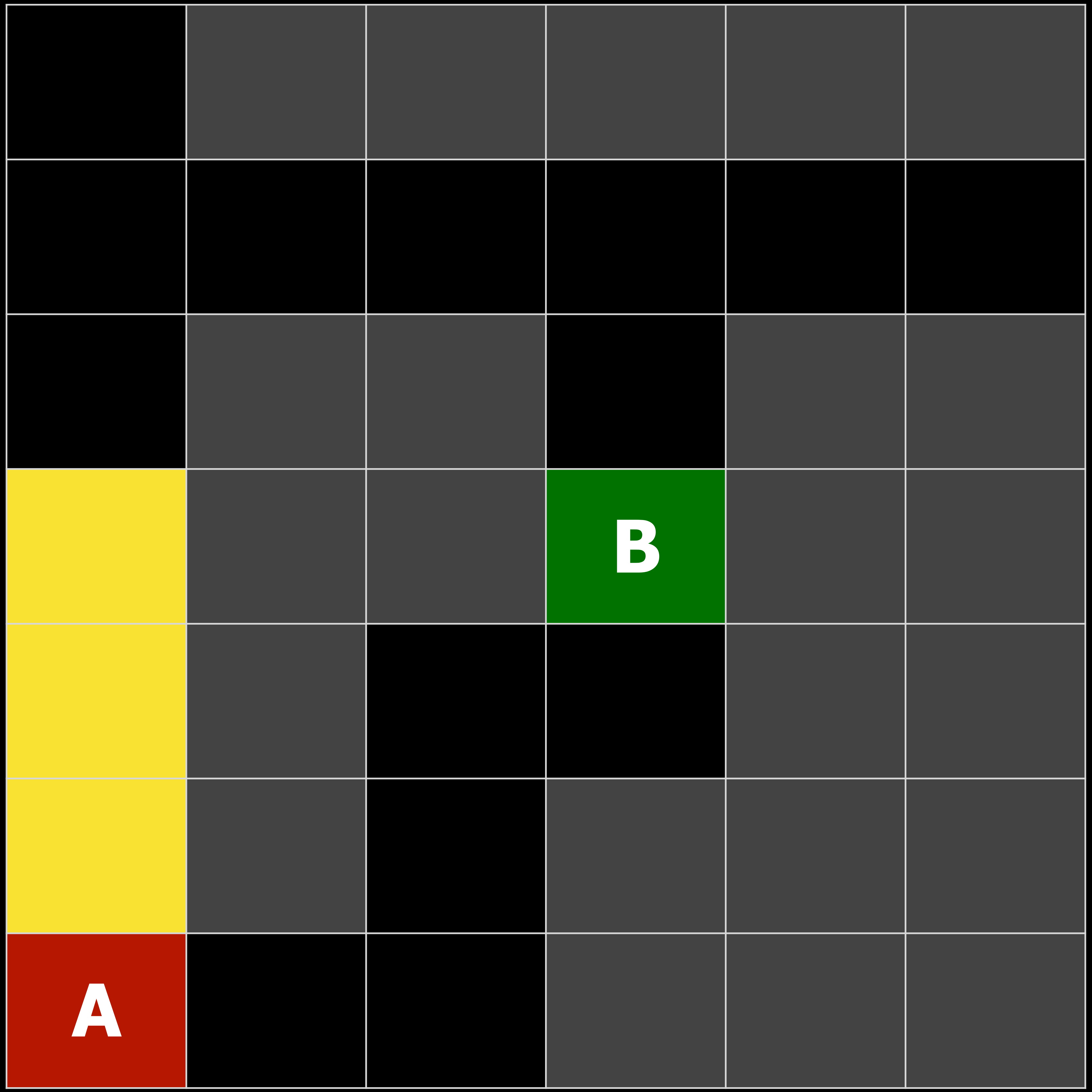
Depth-First Search



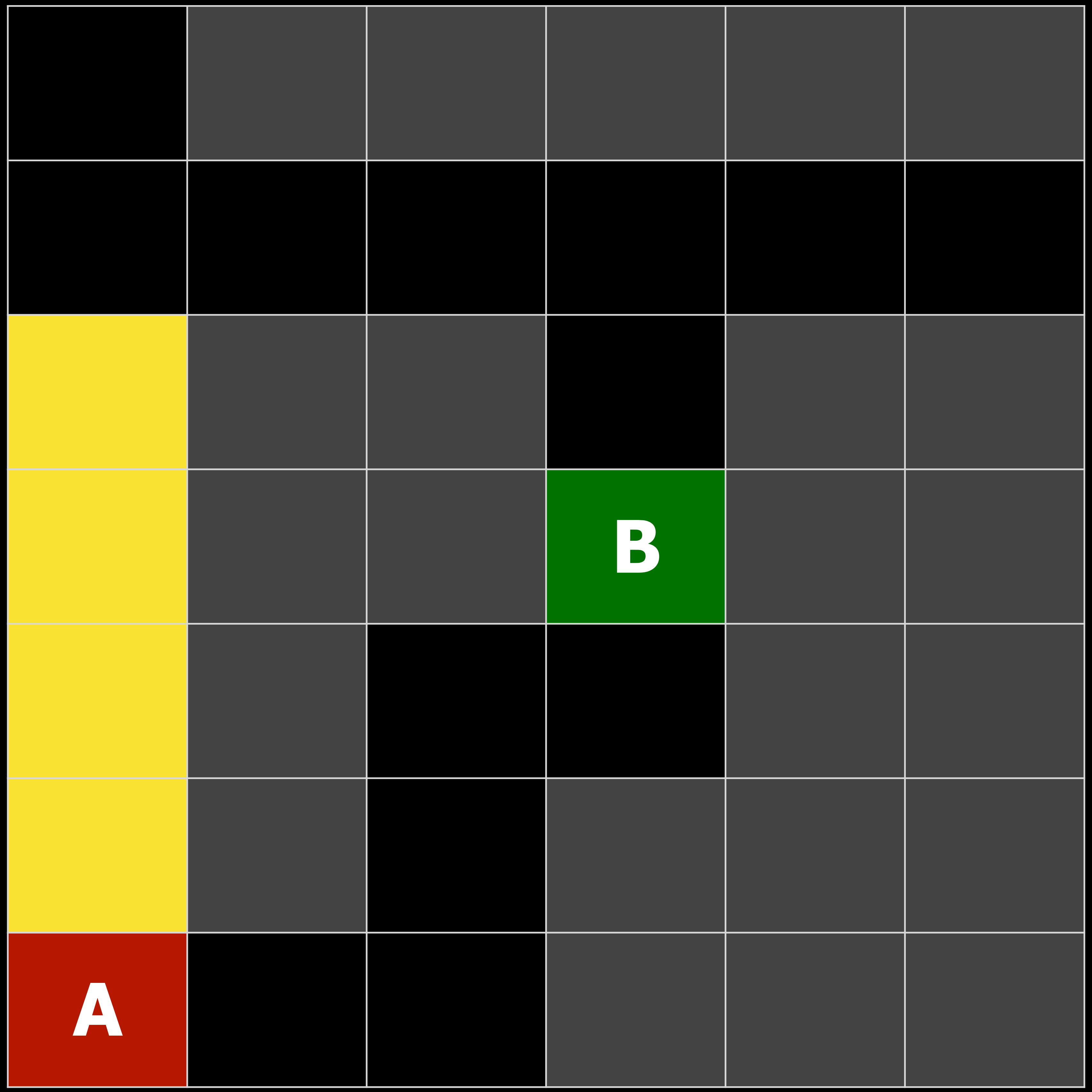
Depth-First Search



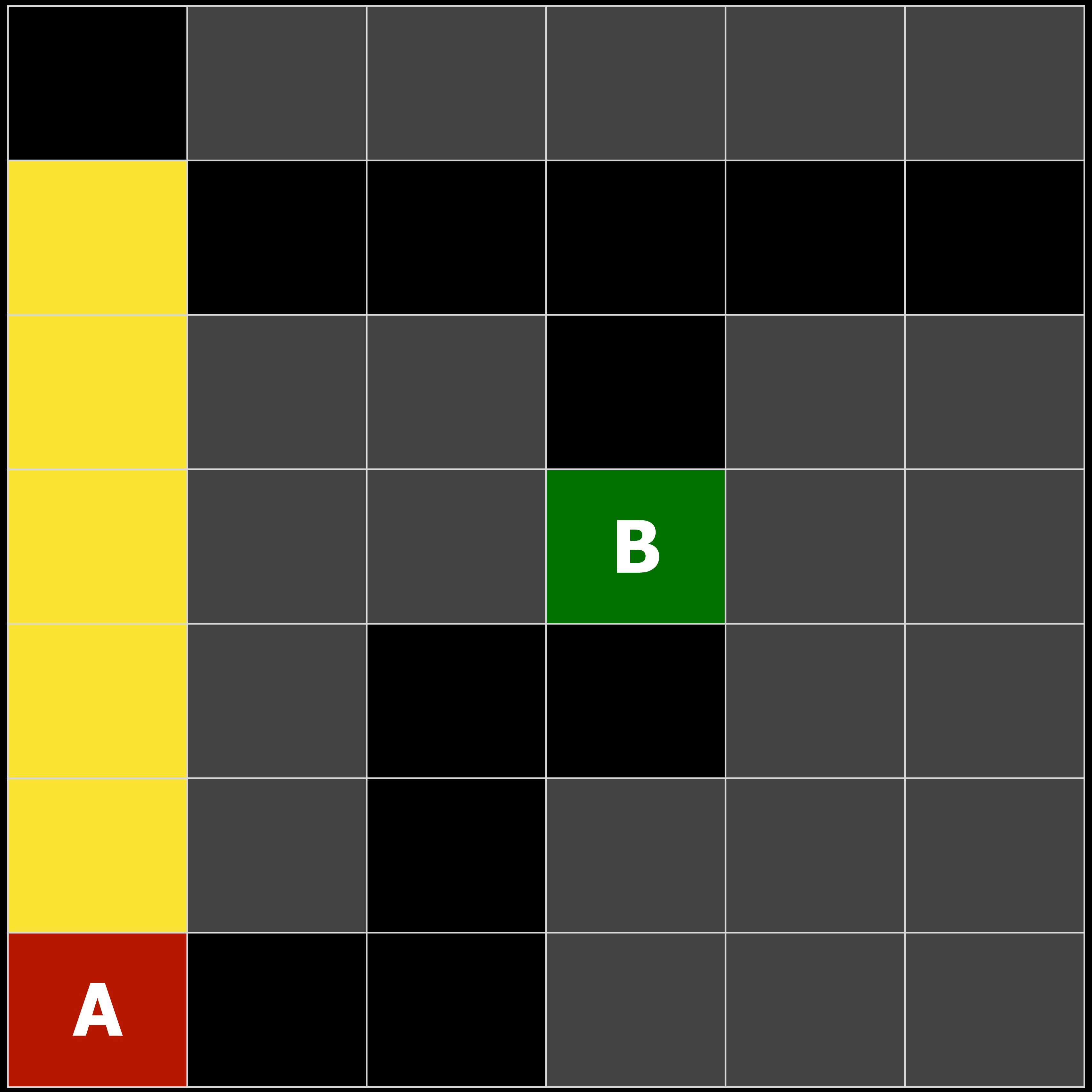
Depth-First Search



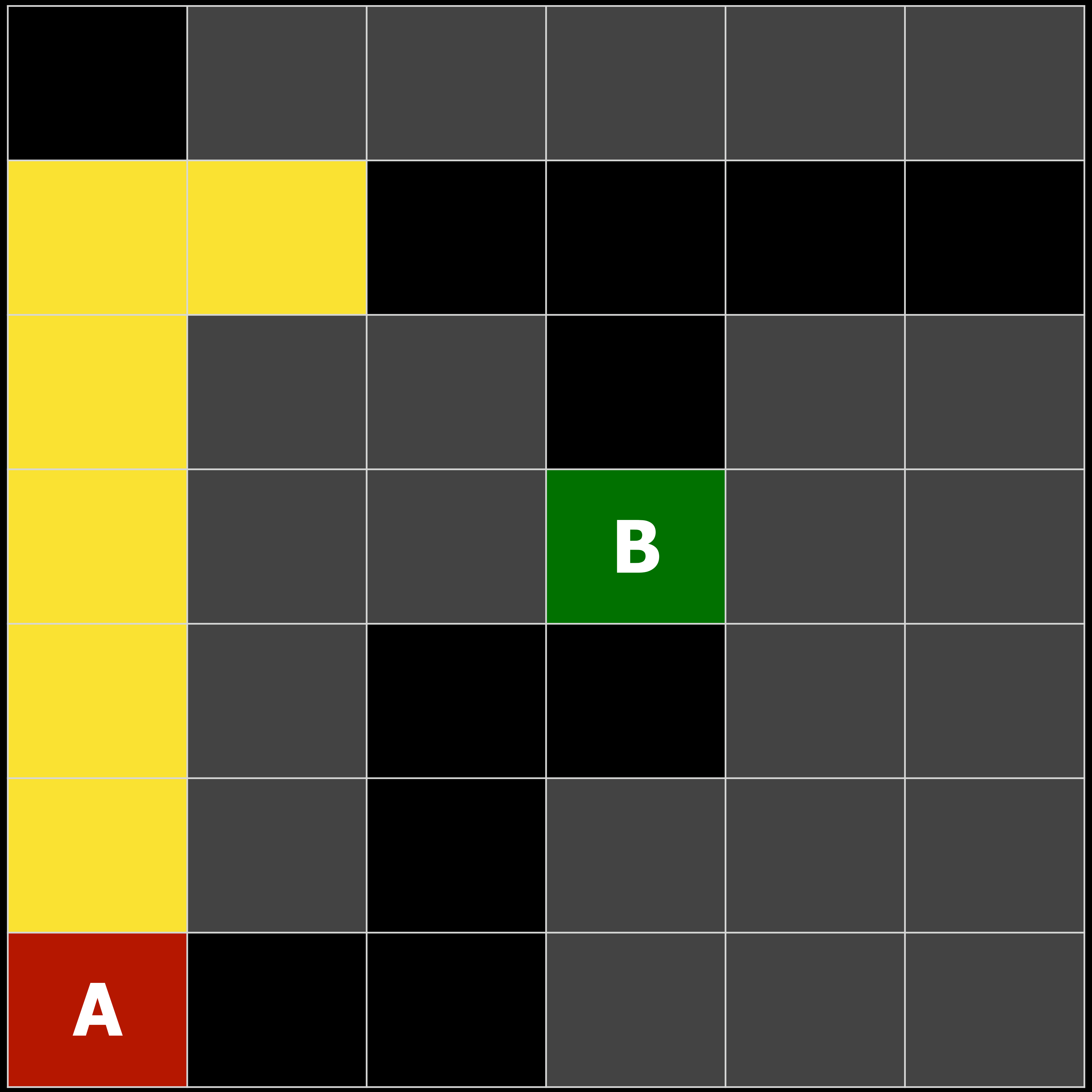
Depth-First Search



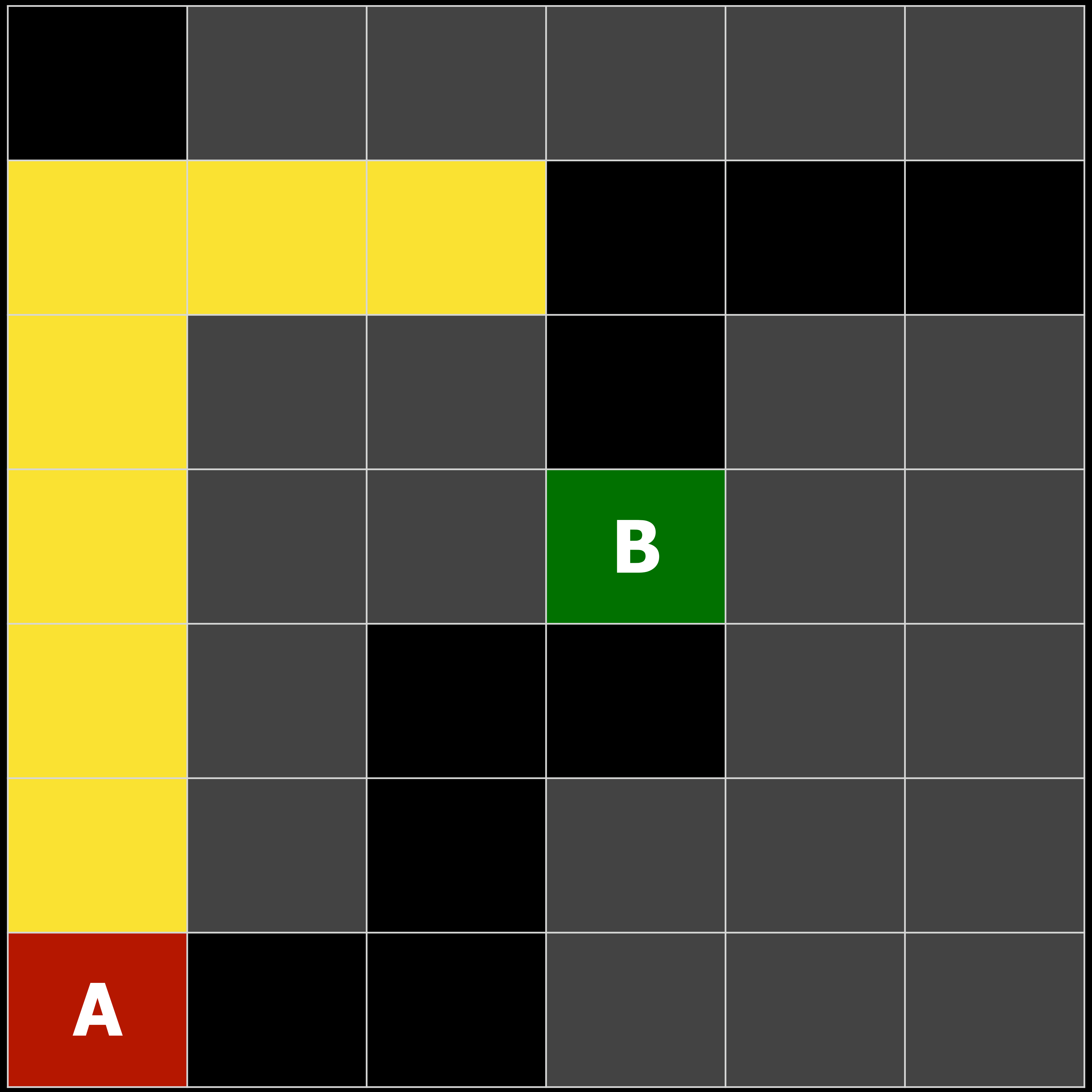
Depth-First Search



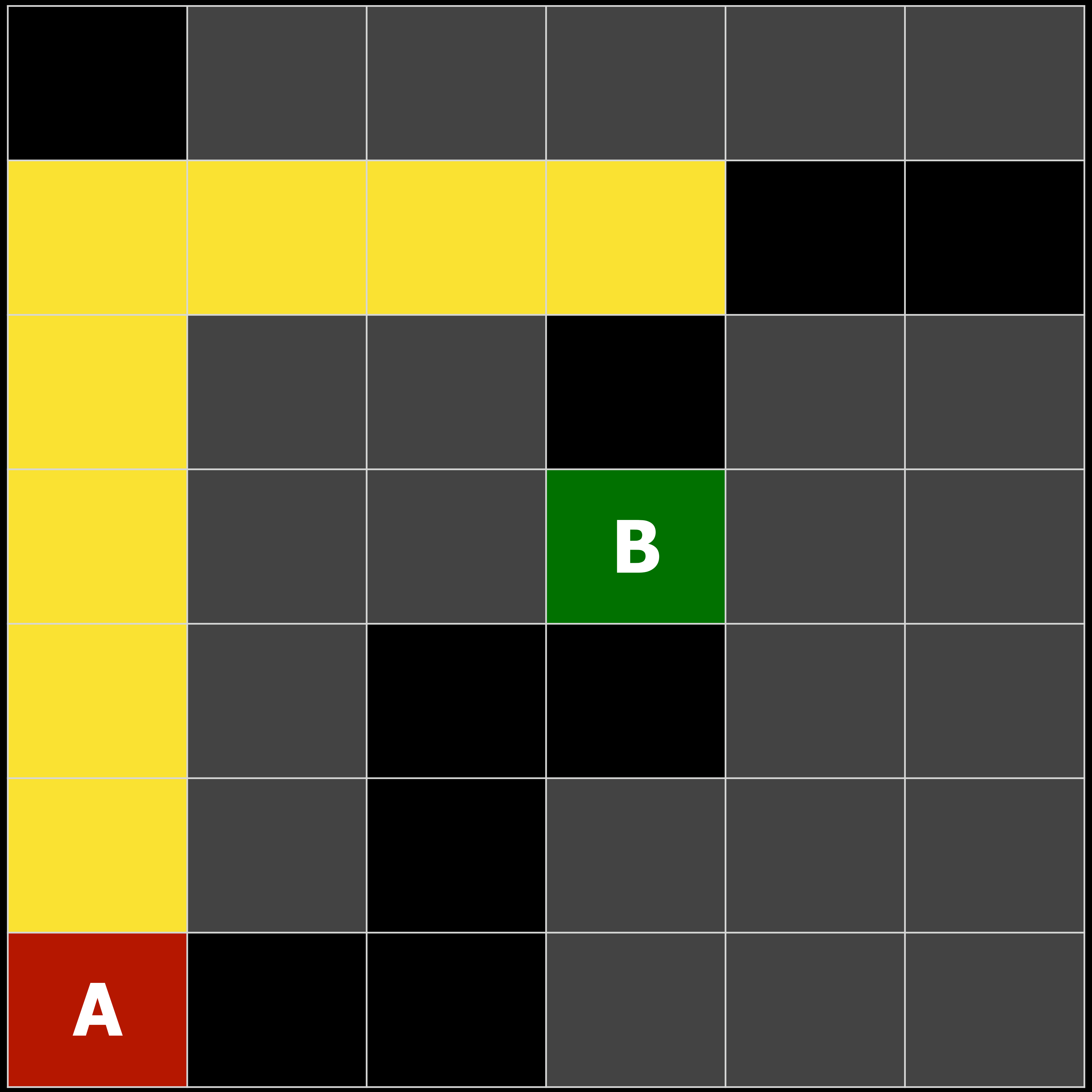
Depth-First Search



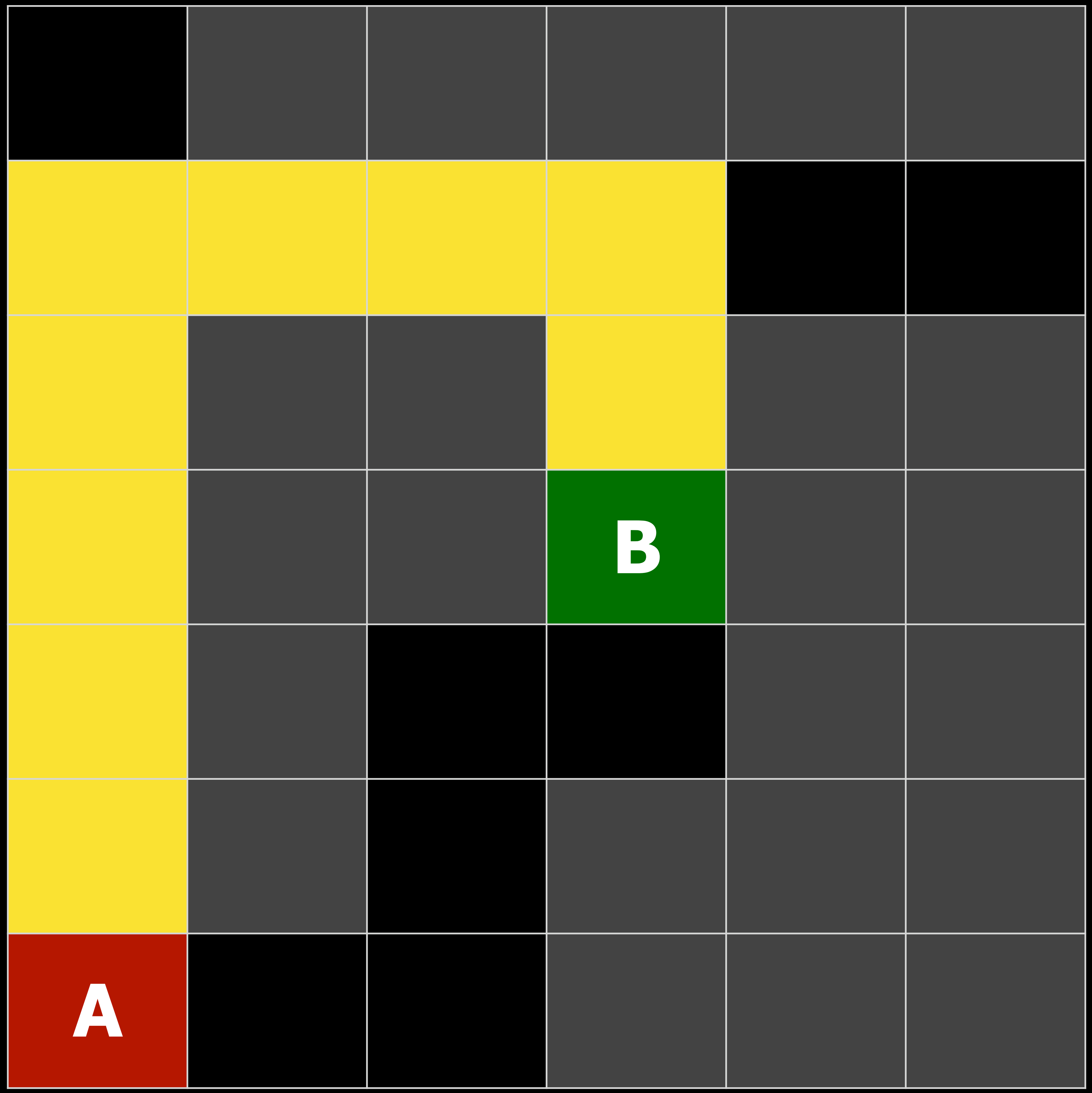
Depth-First Search



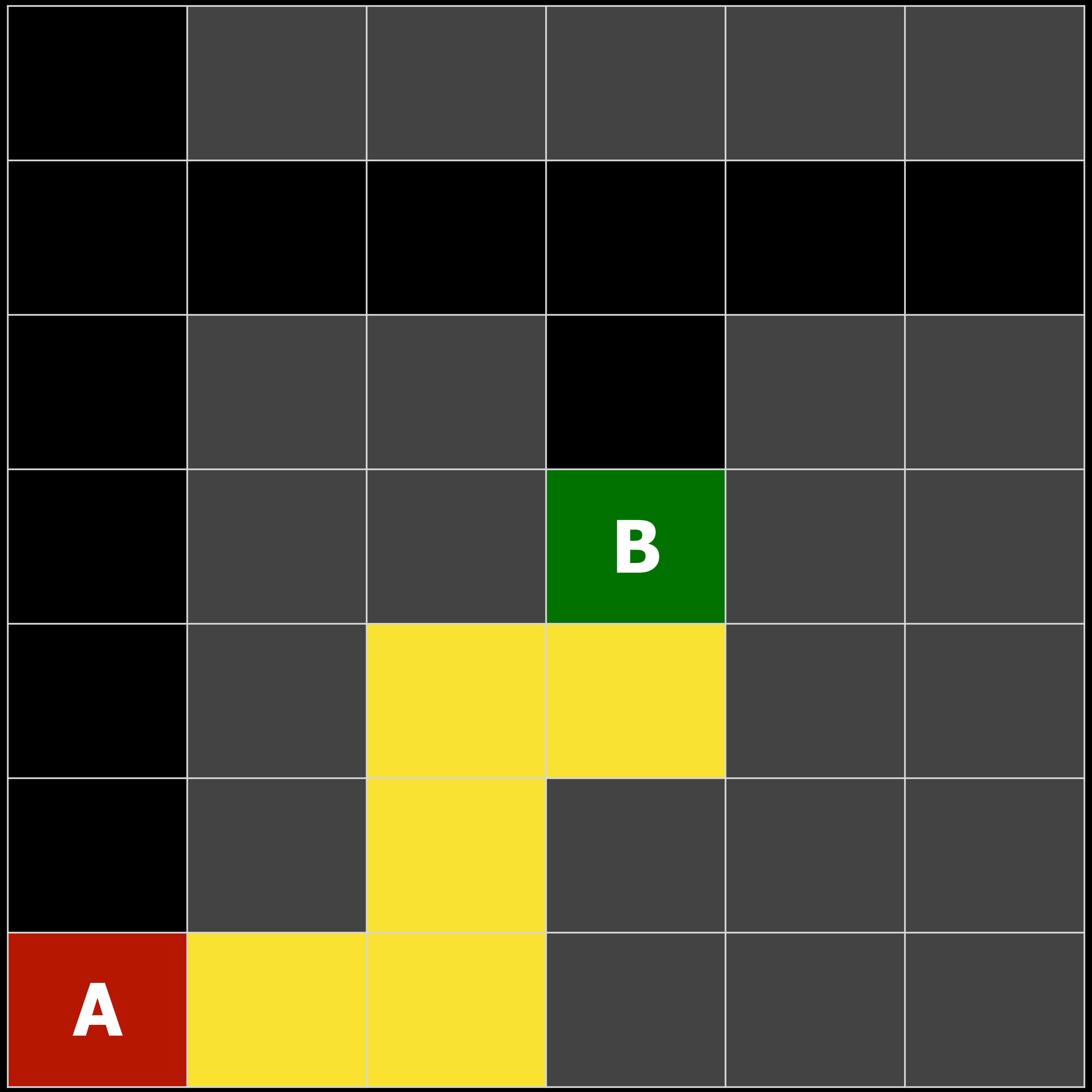
Depth-First Search



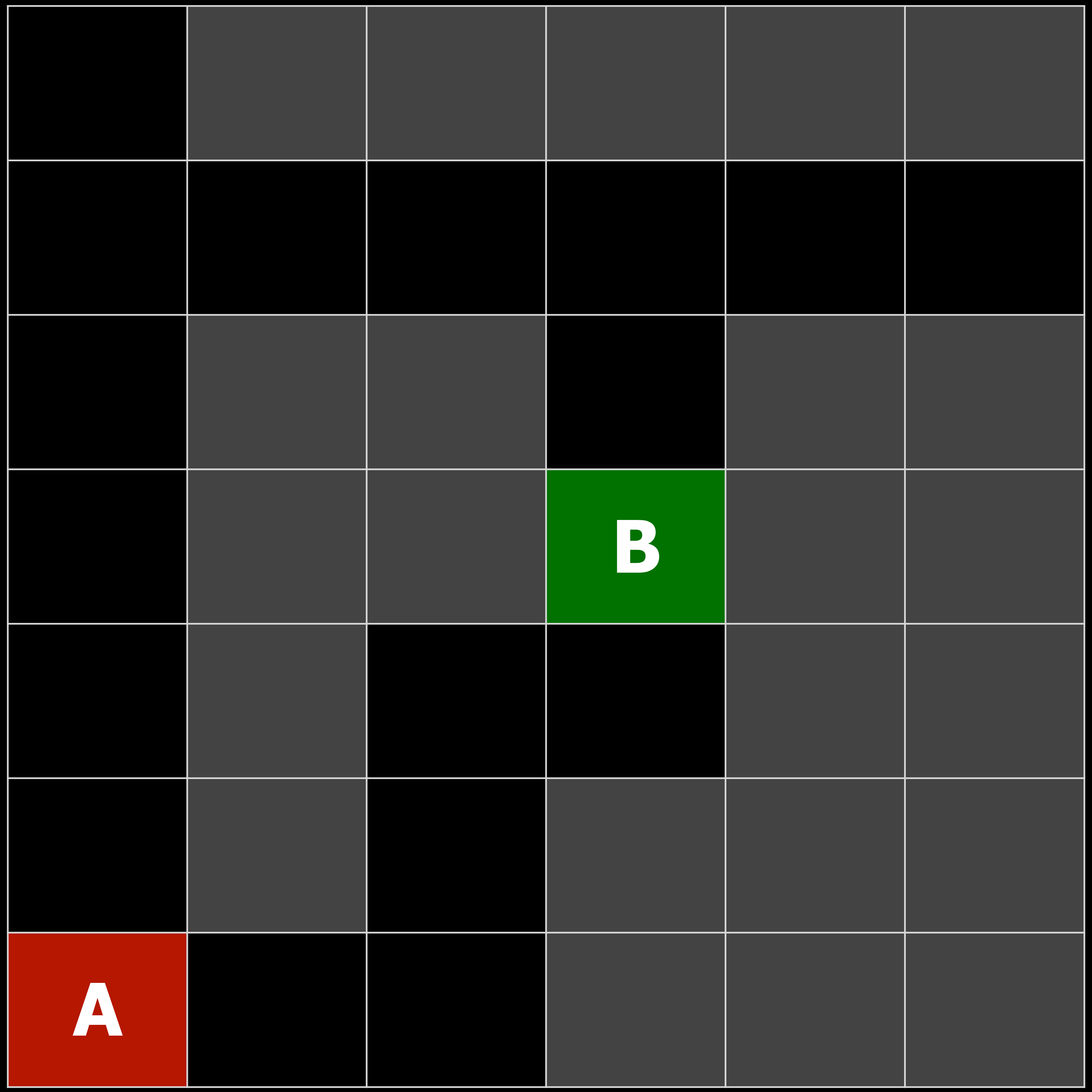
Depth-First Search



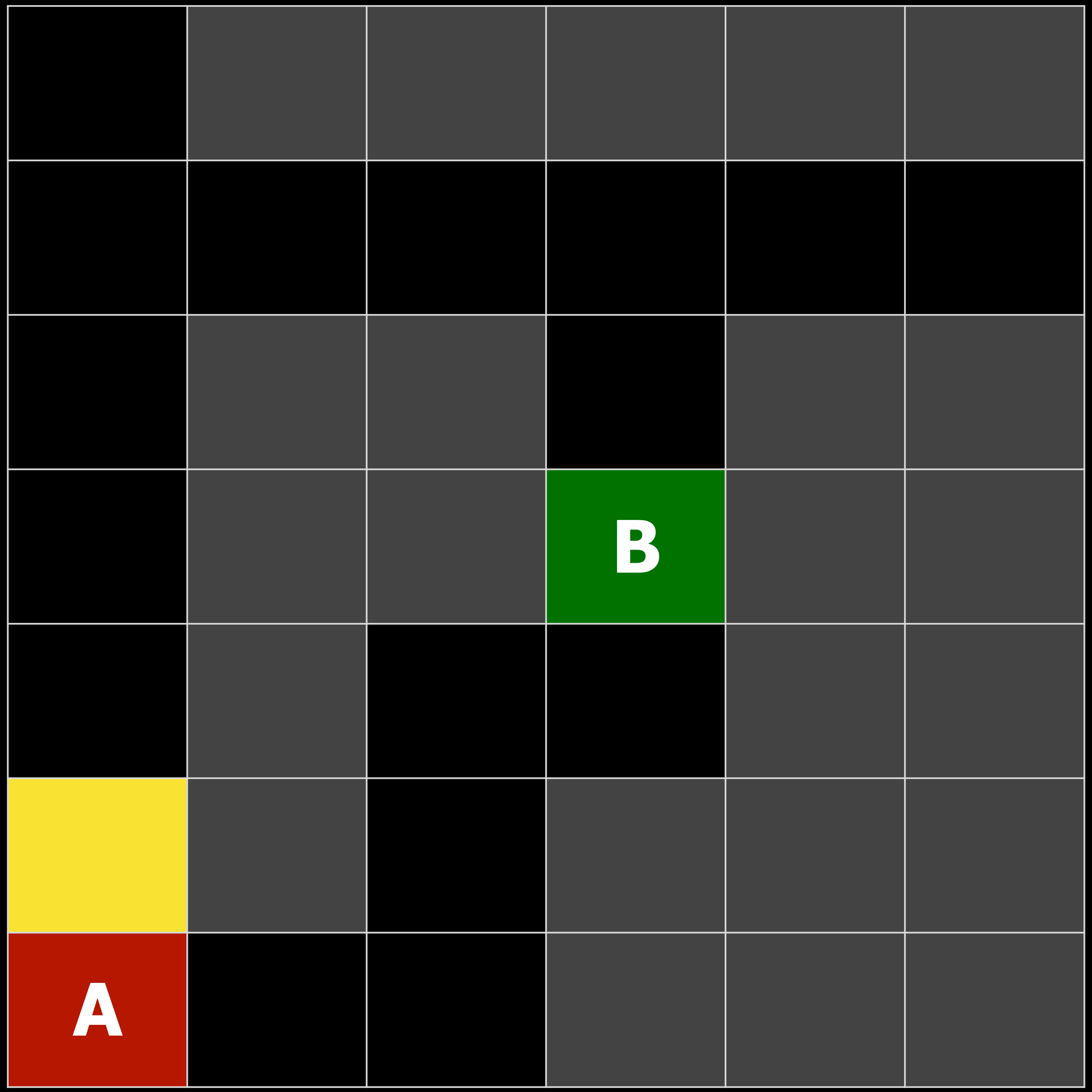
Depth-First Search



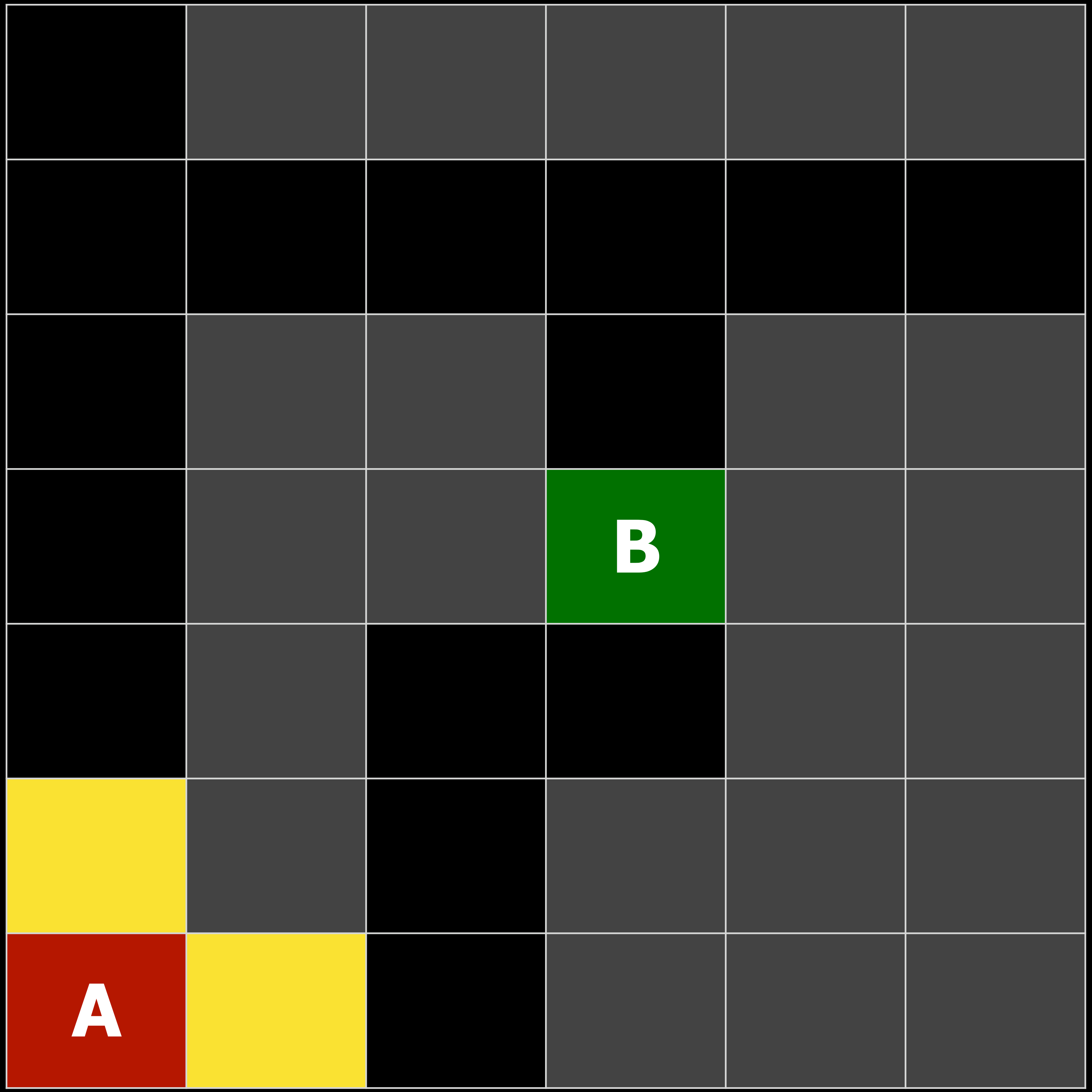
Breadth-First Search



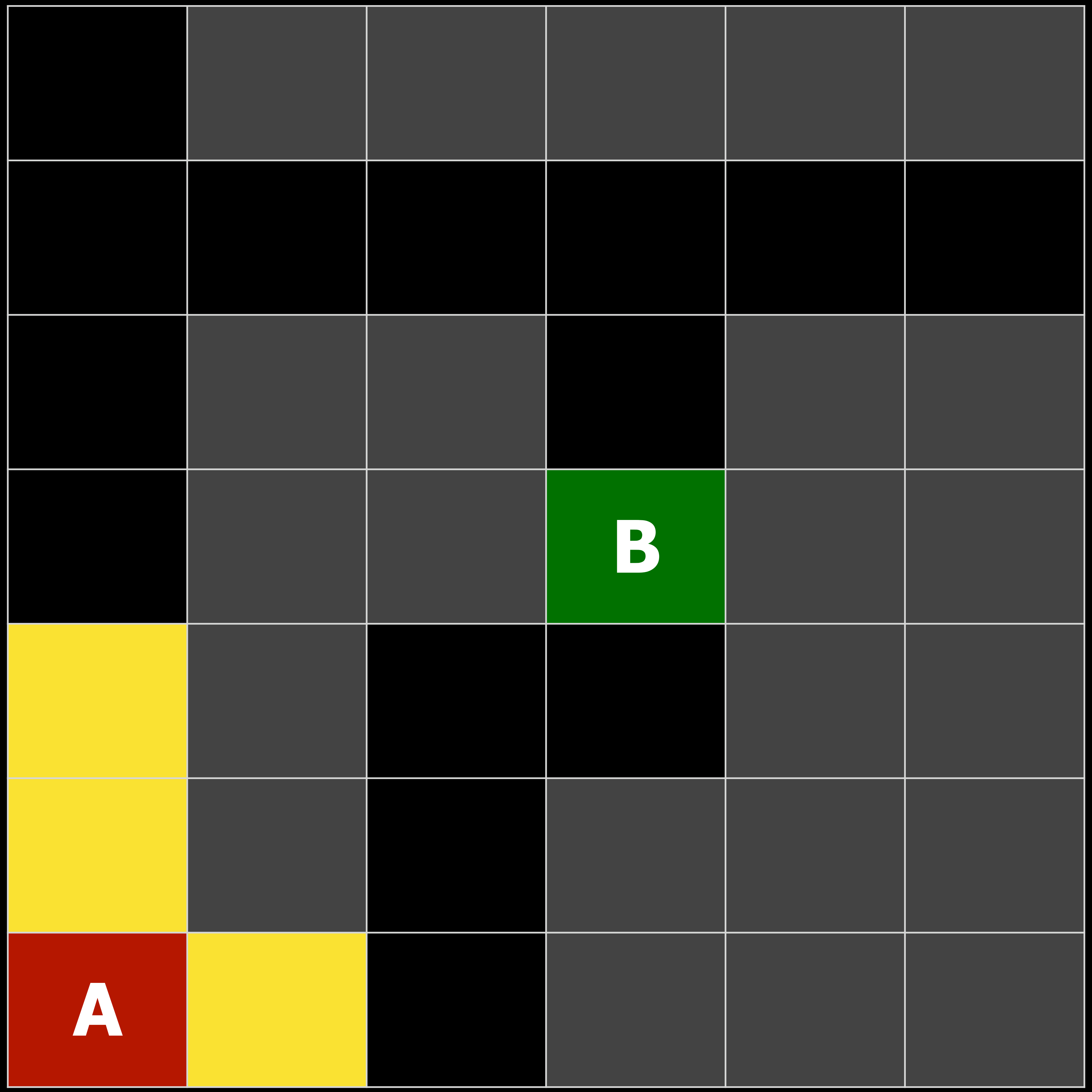
Breadth-First Search



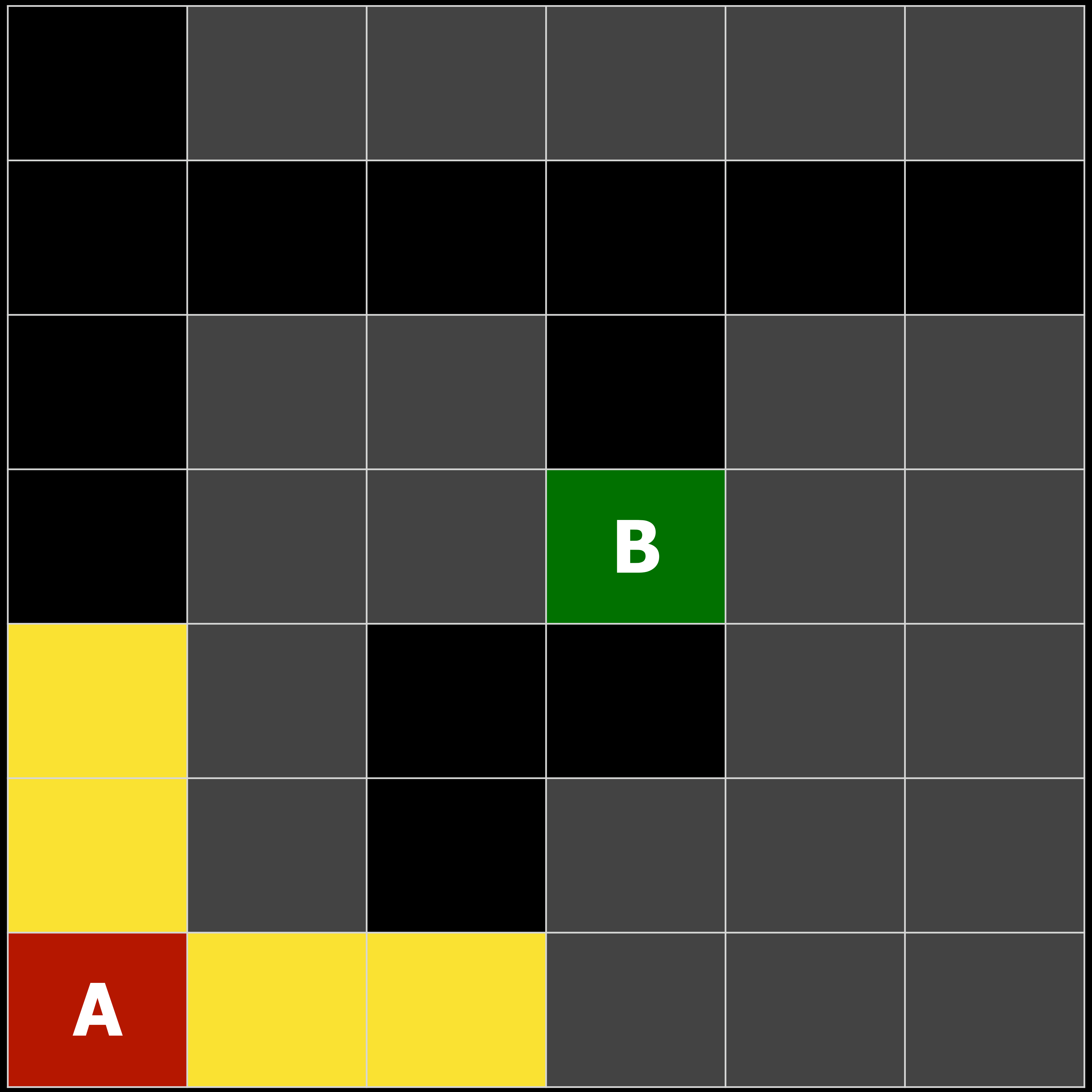
Breadth-First Search



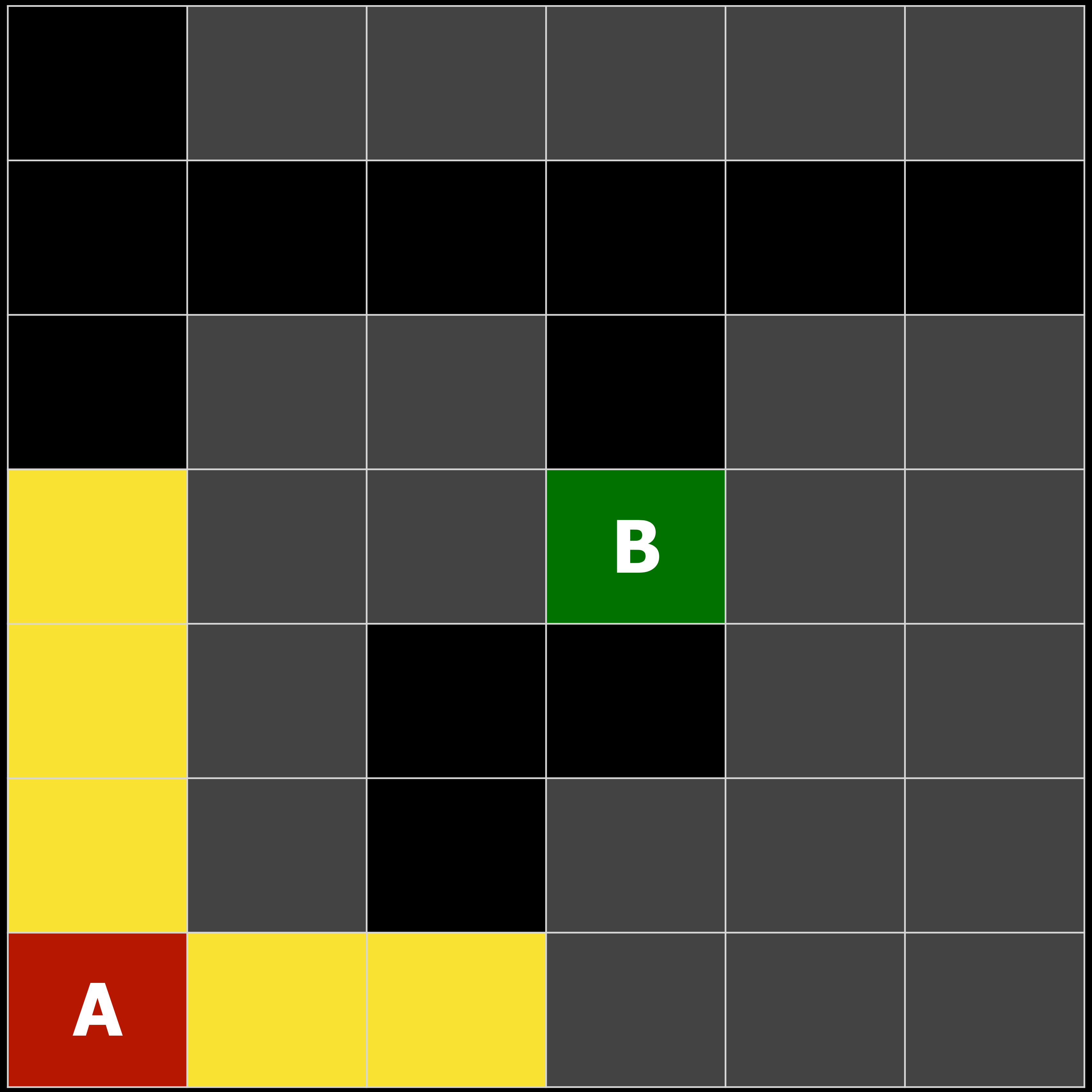
Breadth-First Search



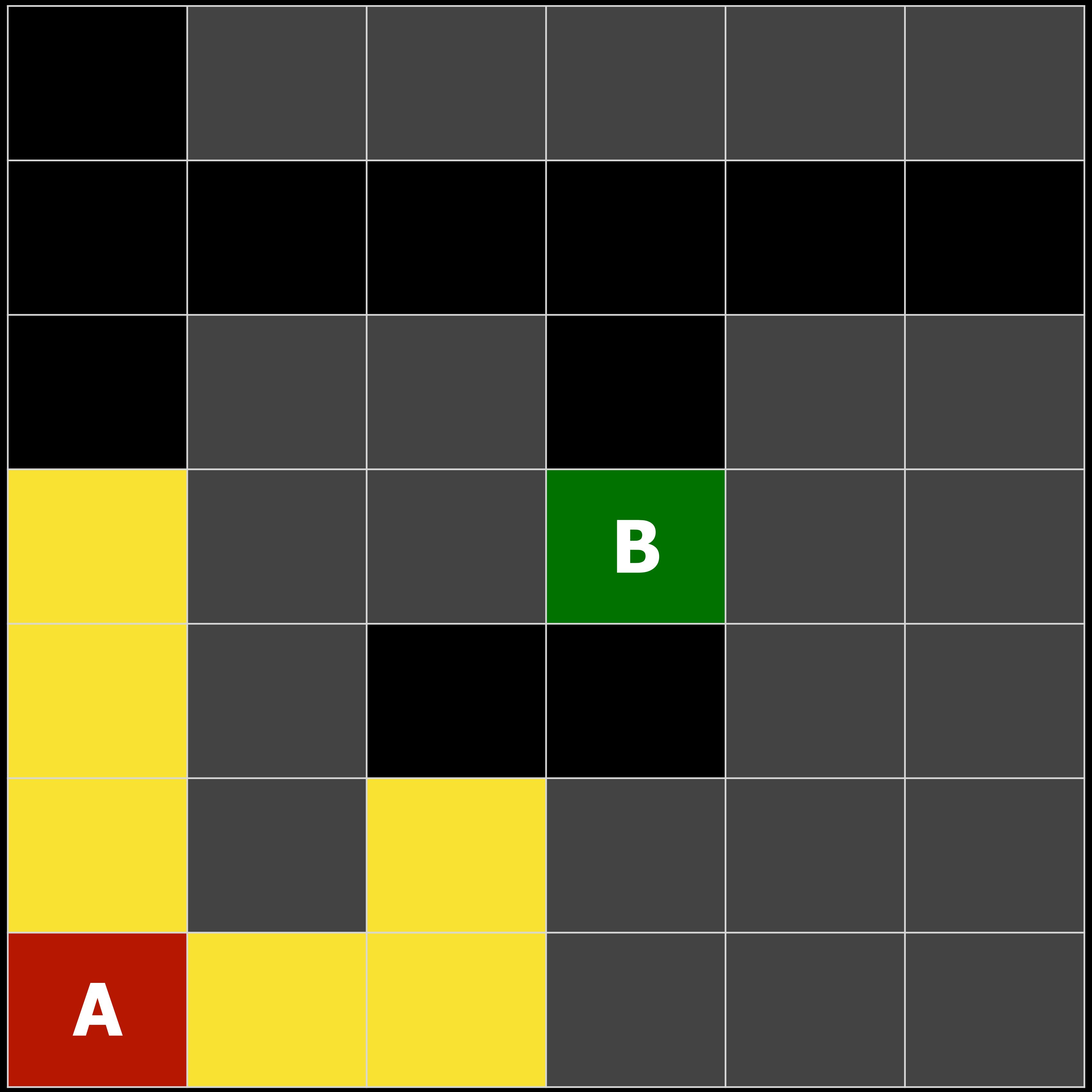
Breadth-First Search



Breadth-First Search



Breadth-First Search



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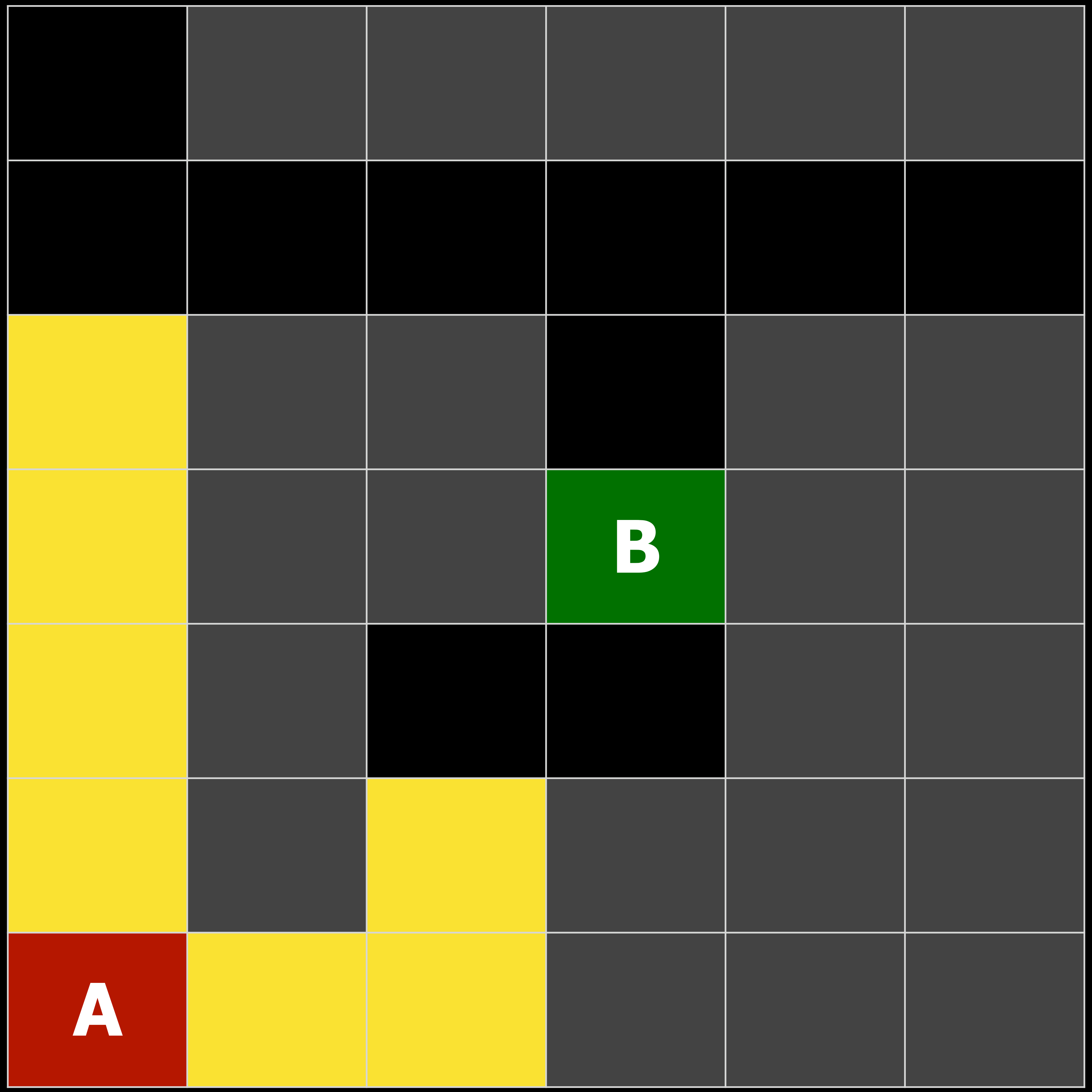

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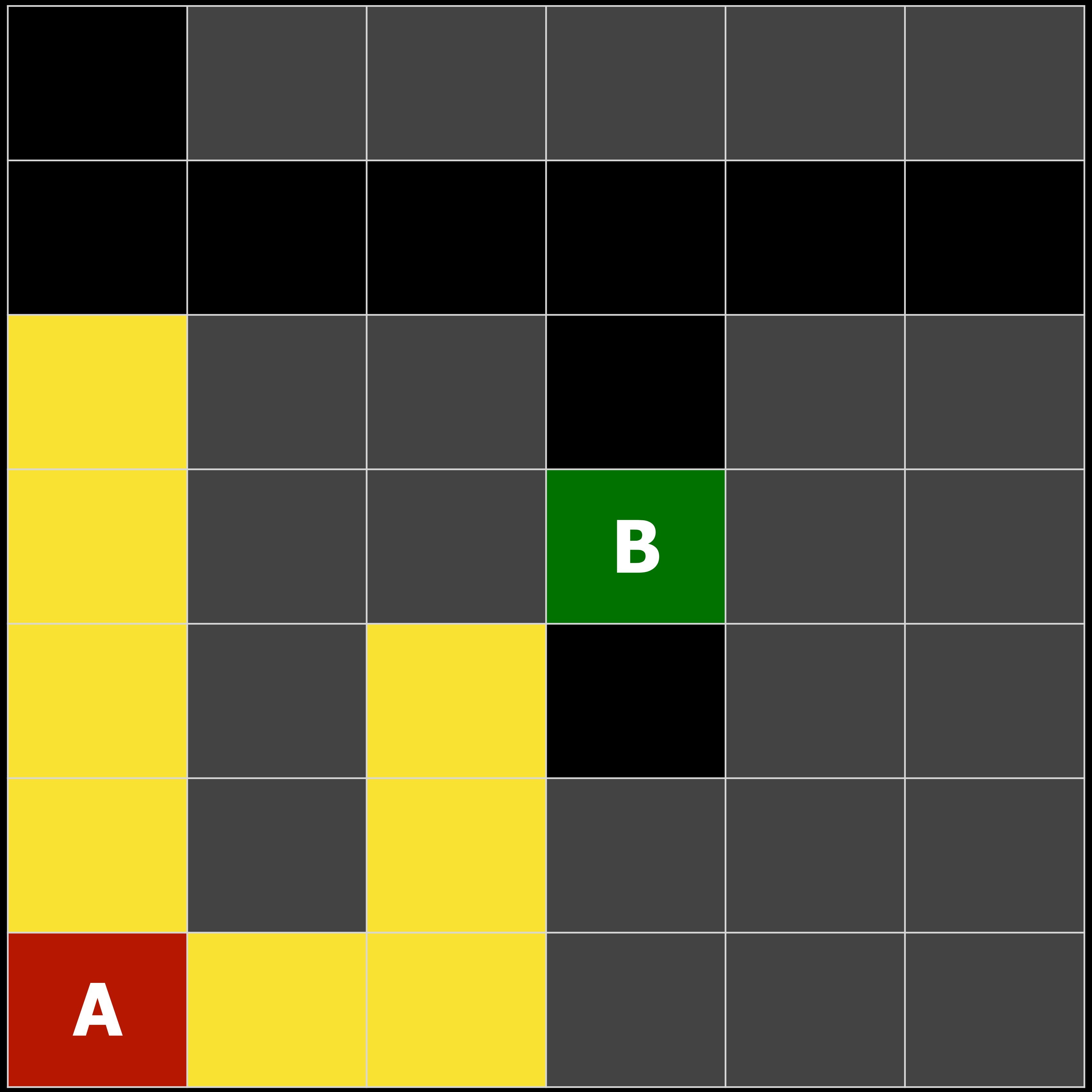

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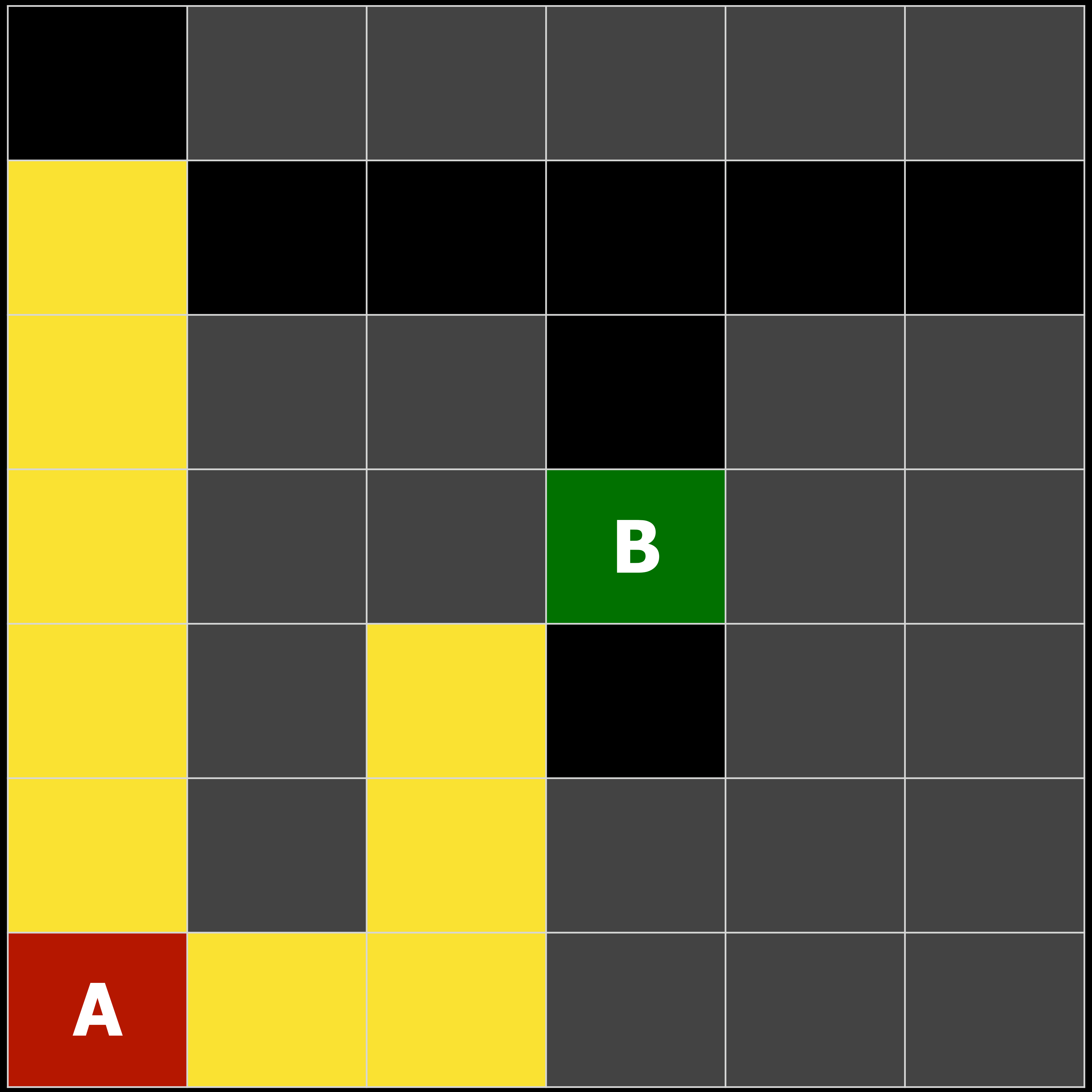

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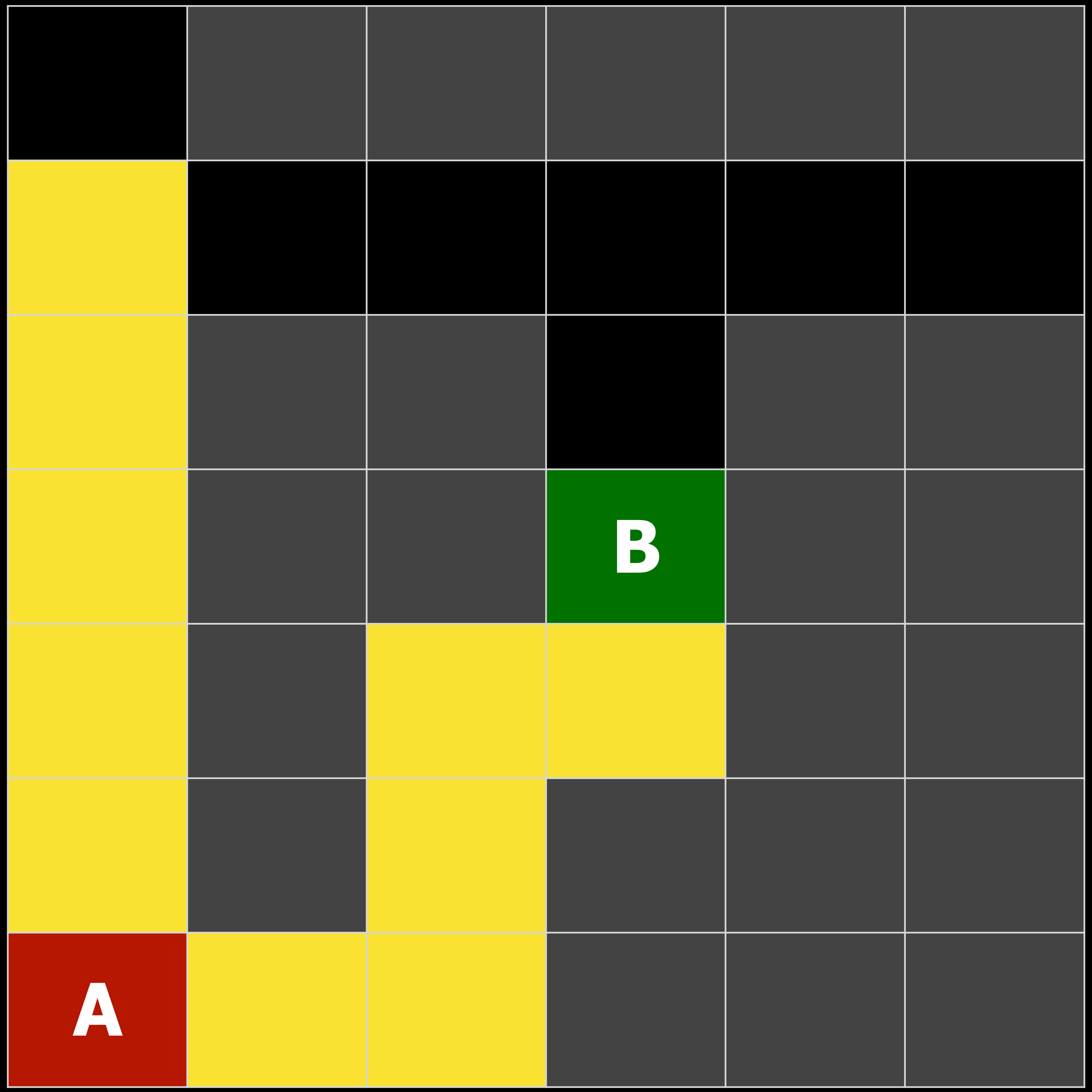

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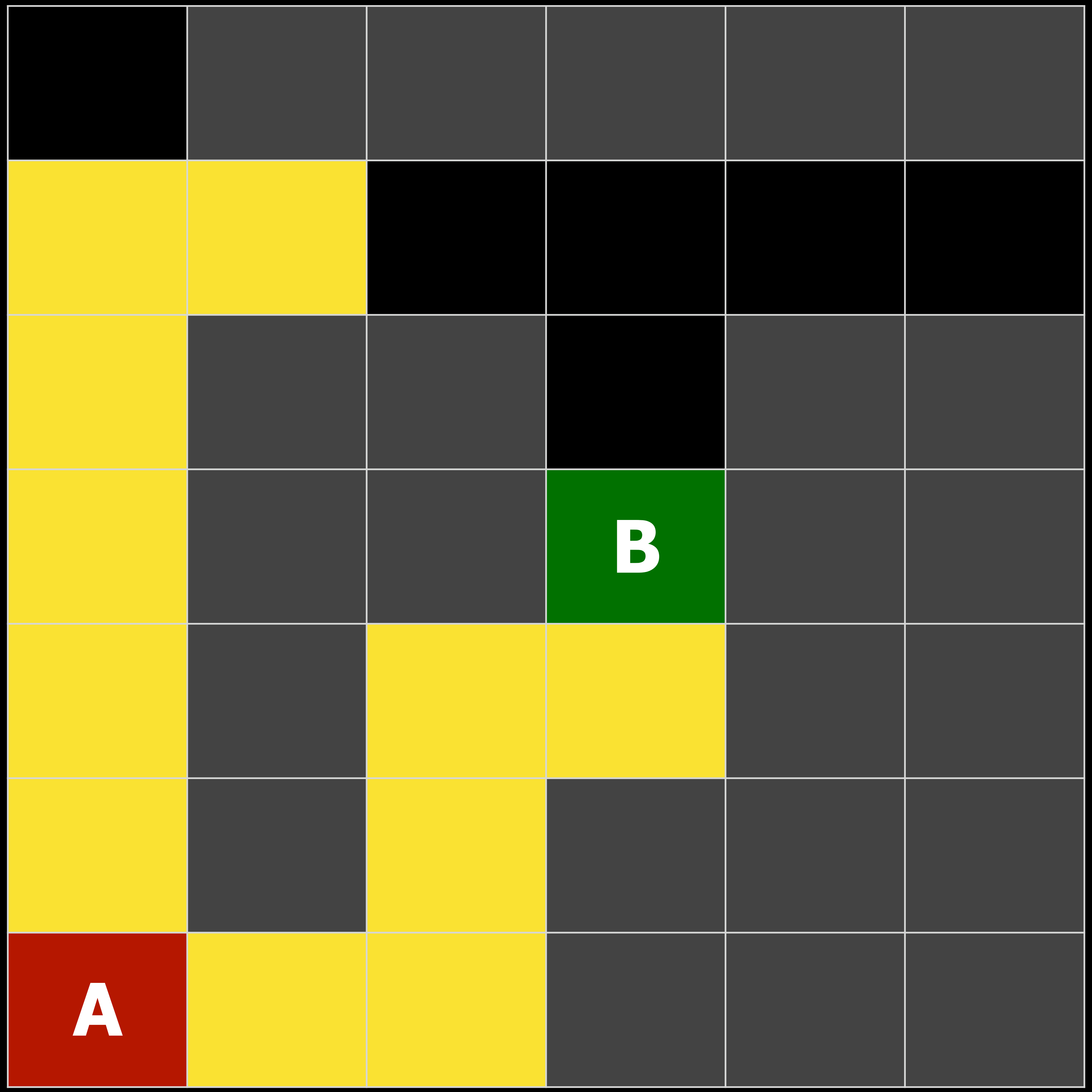

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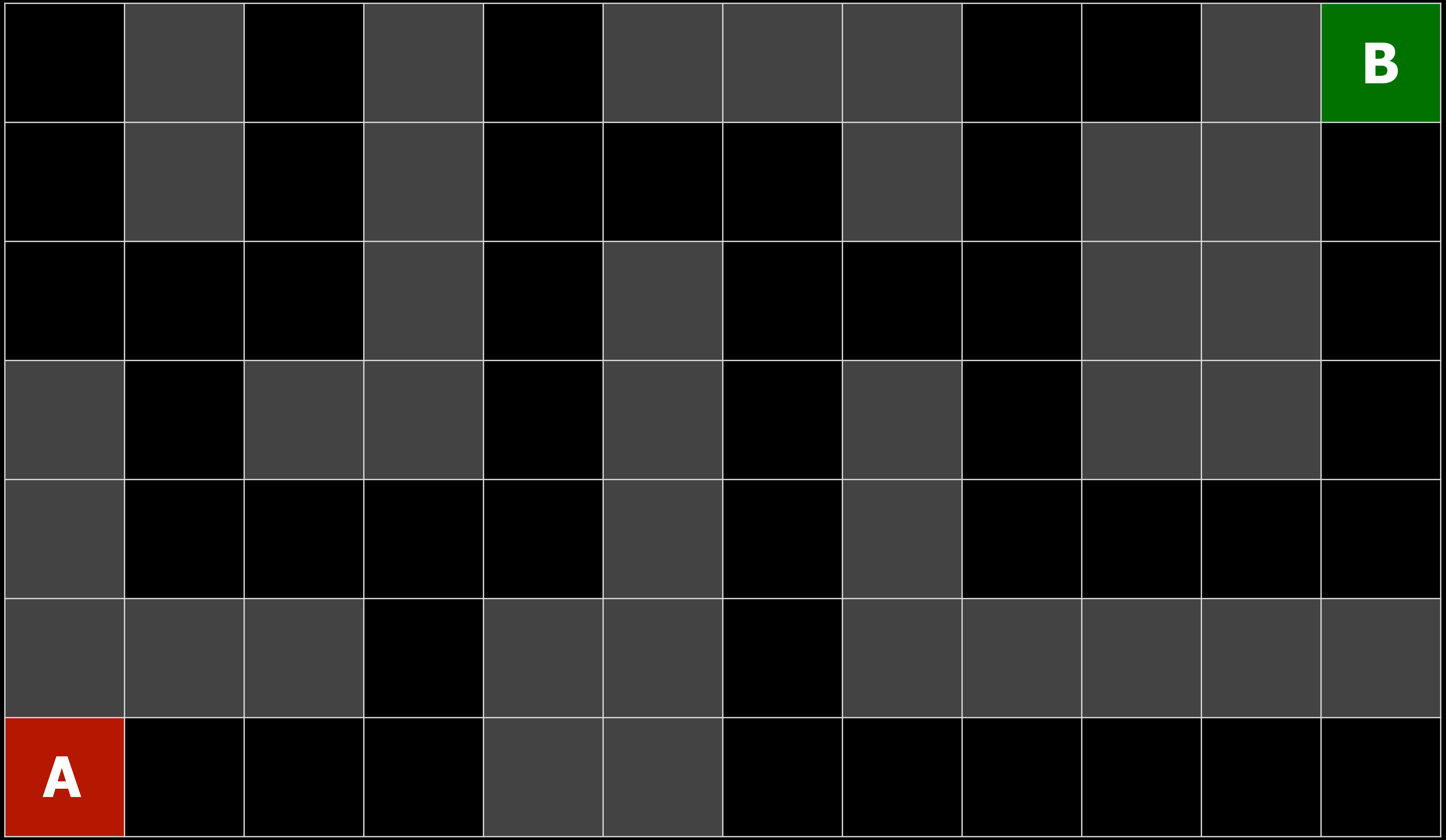

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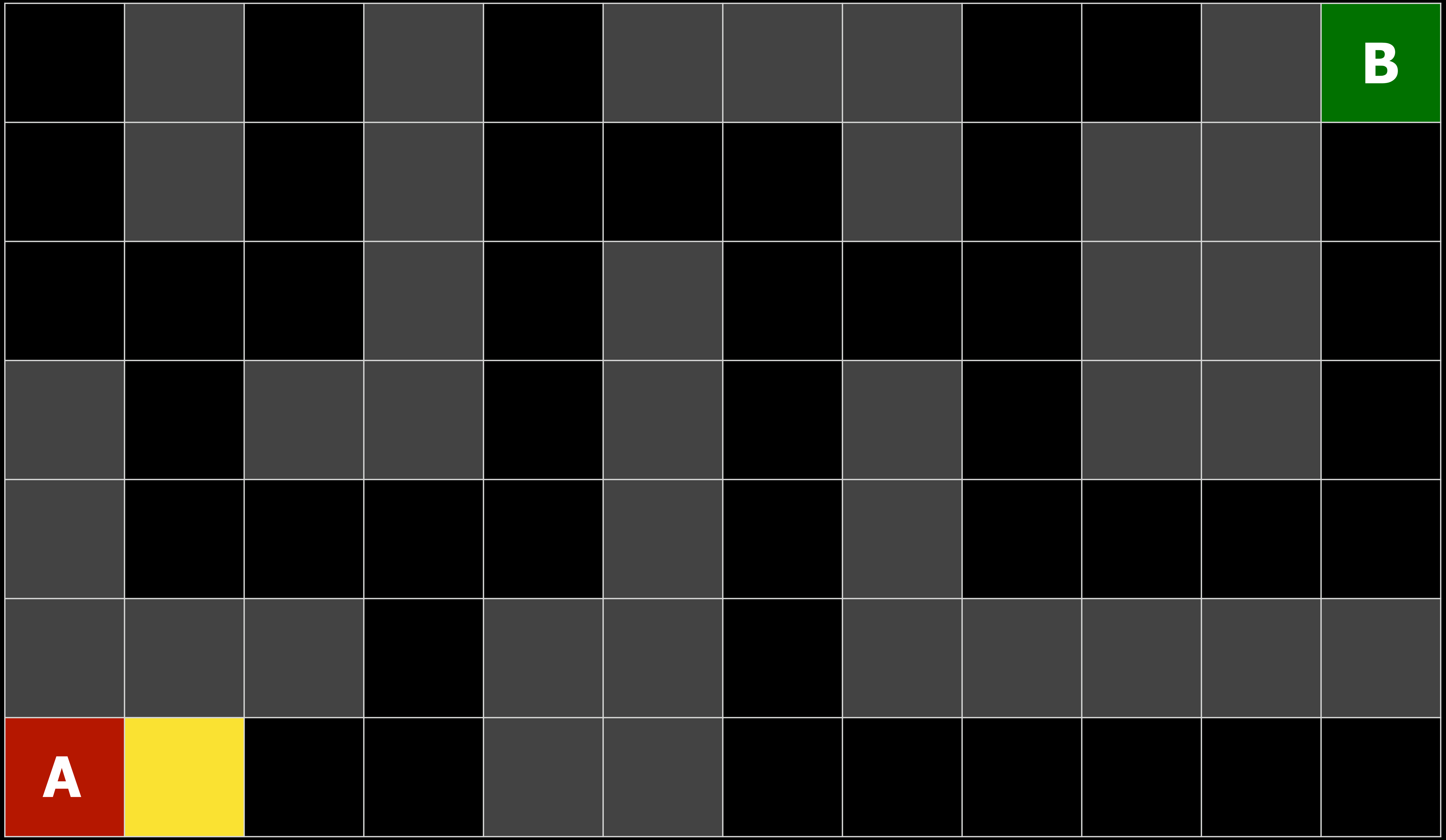

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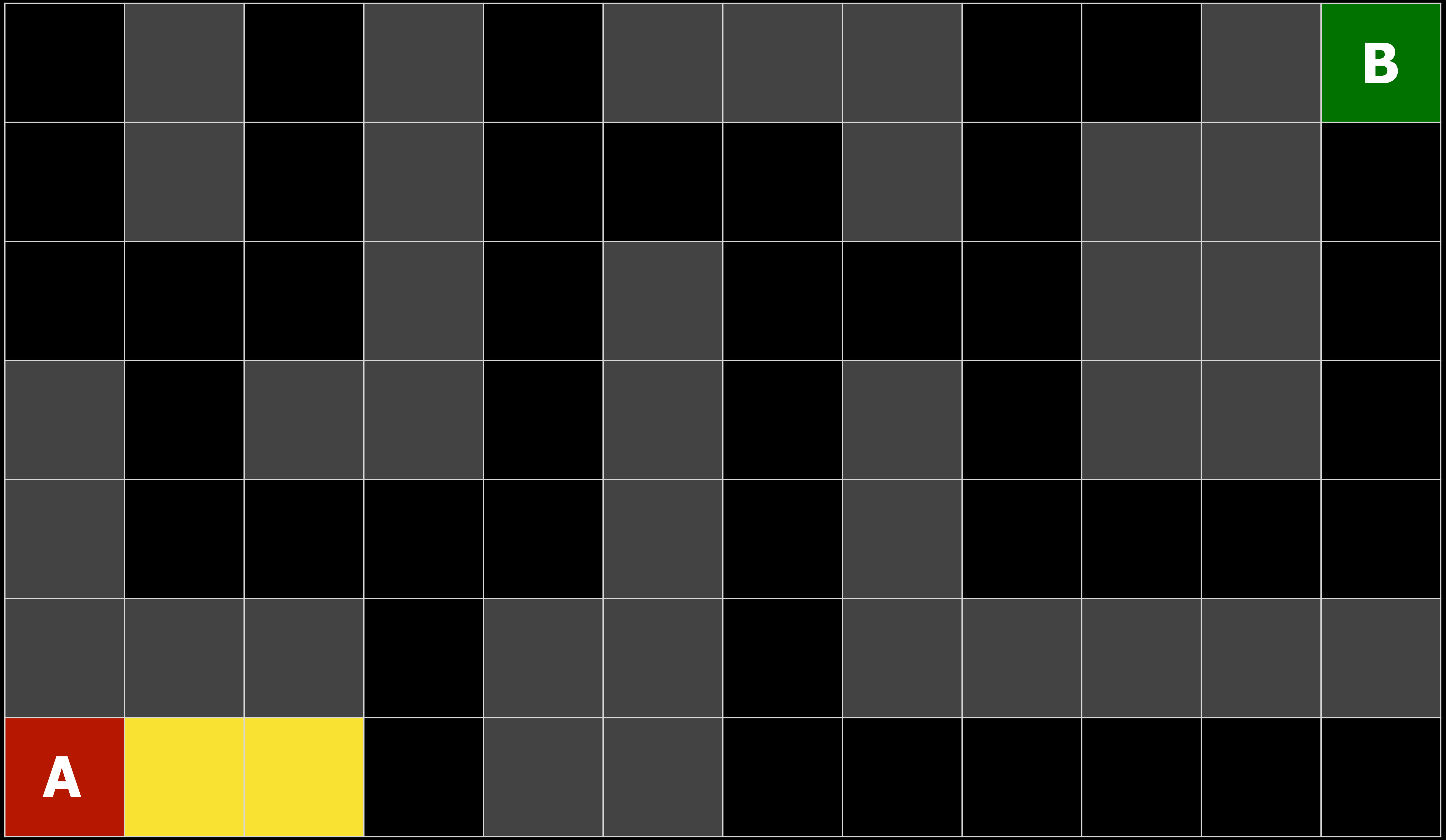

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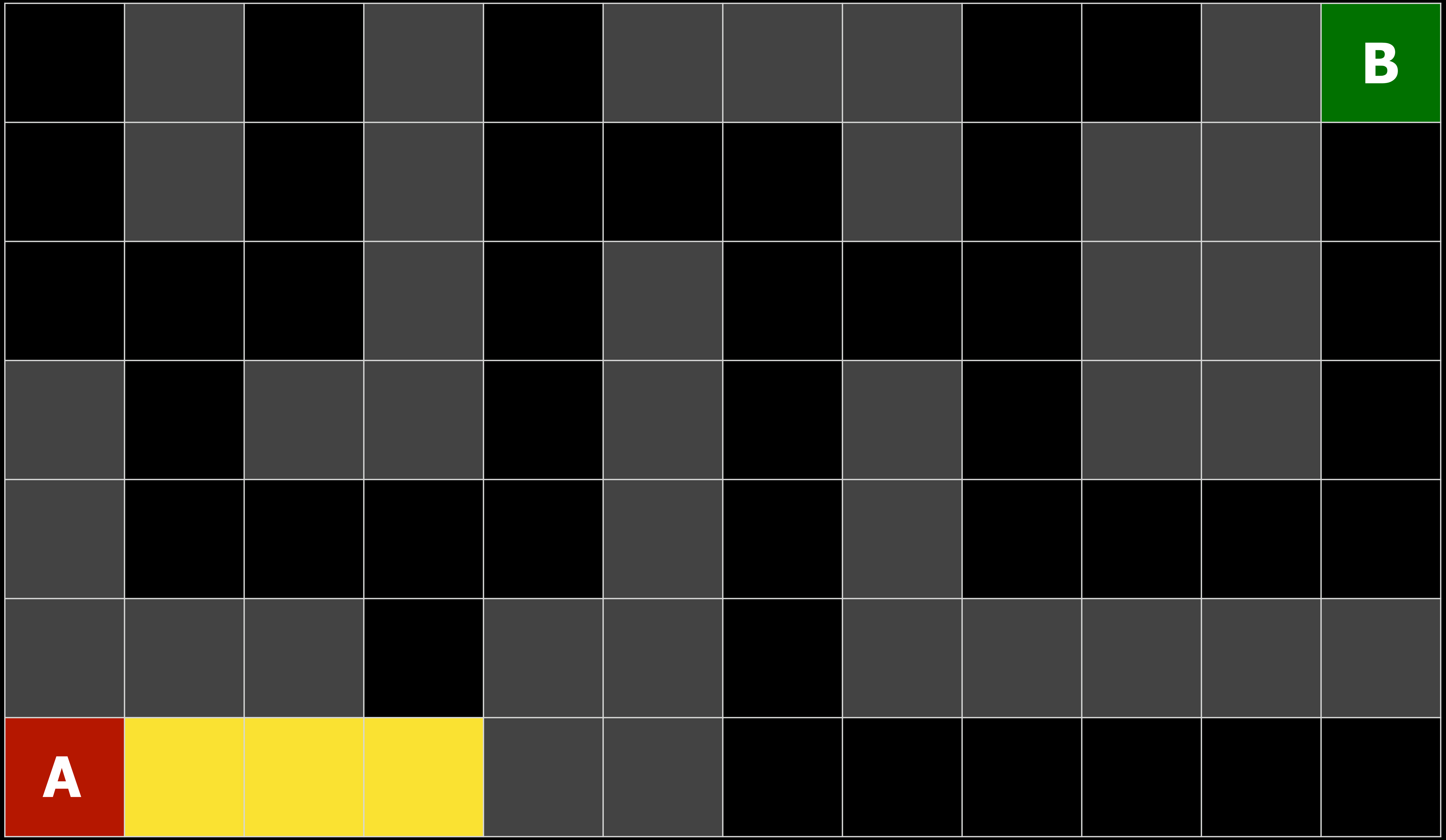

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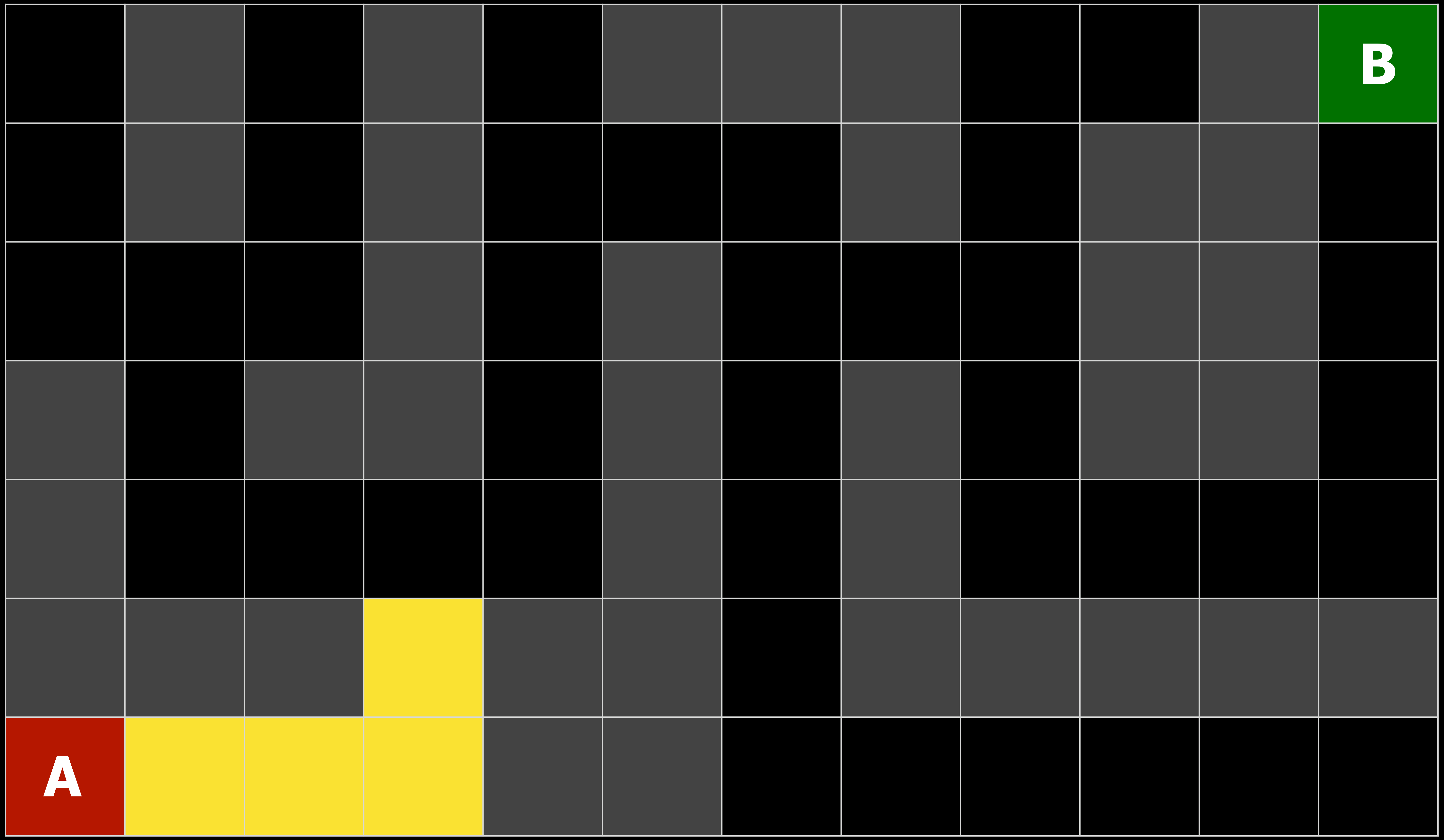

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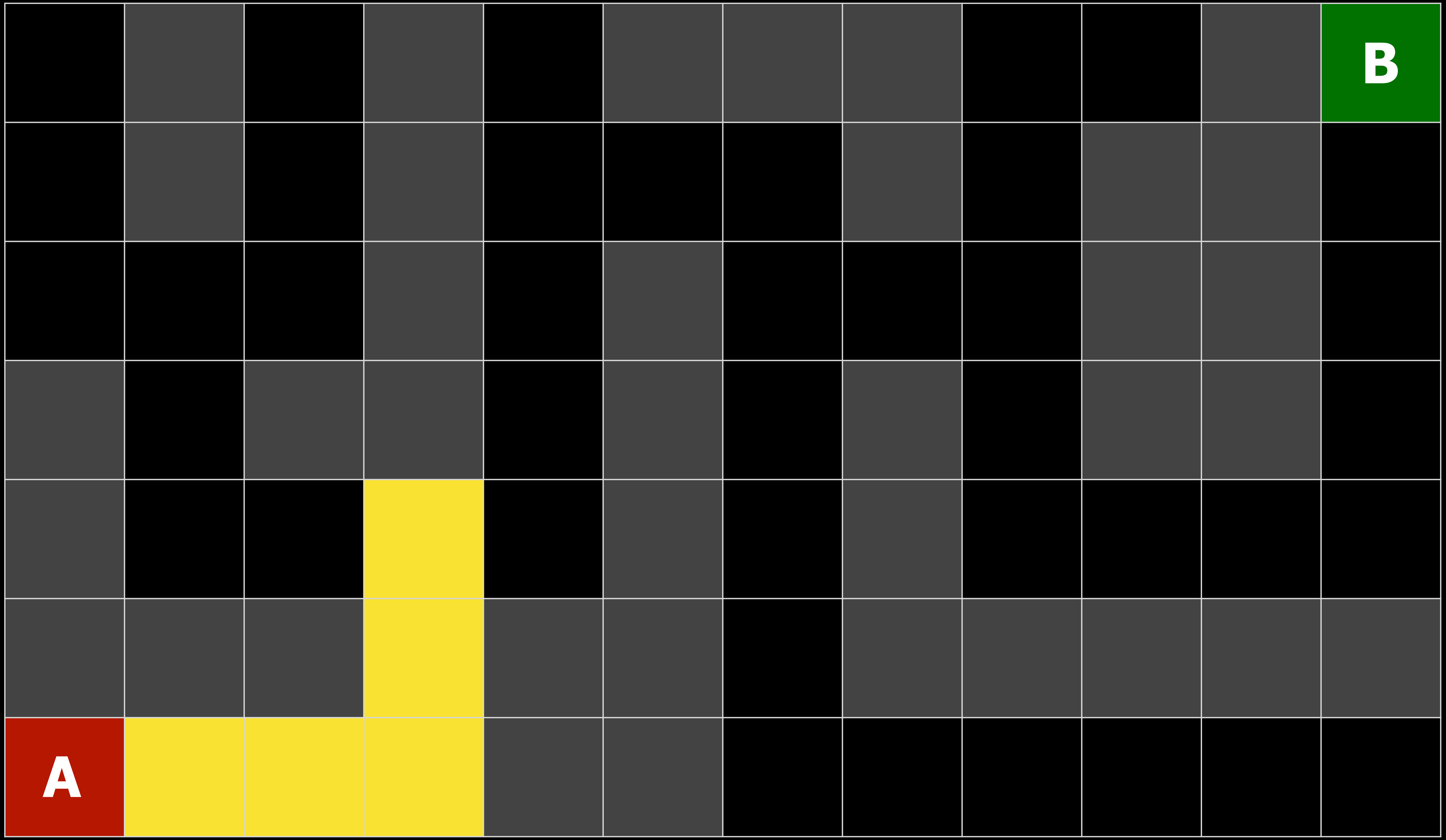

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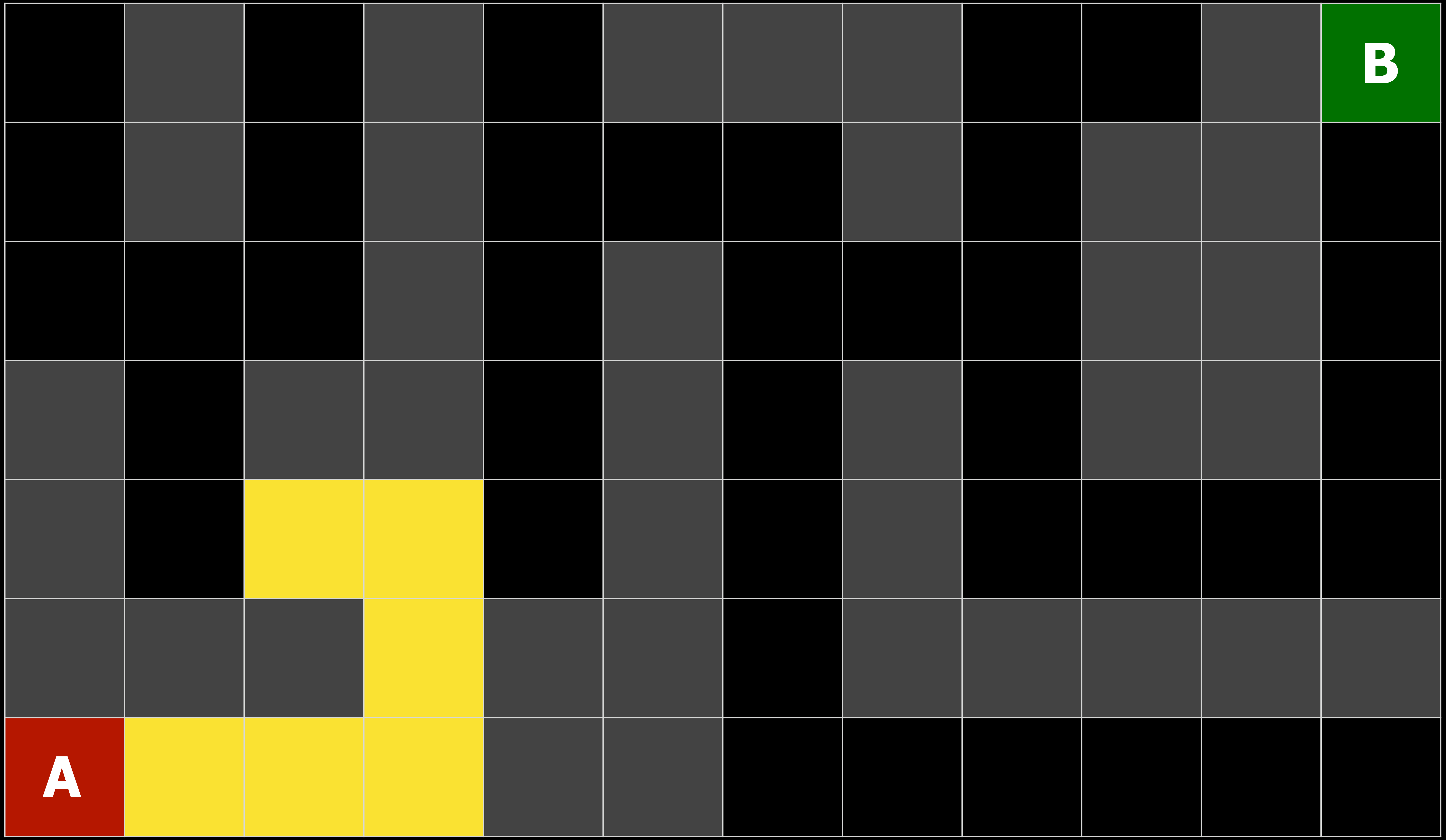

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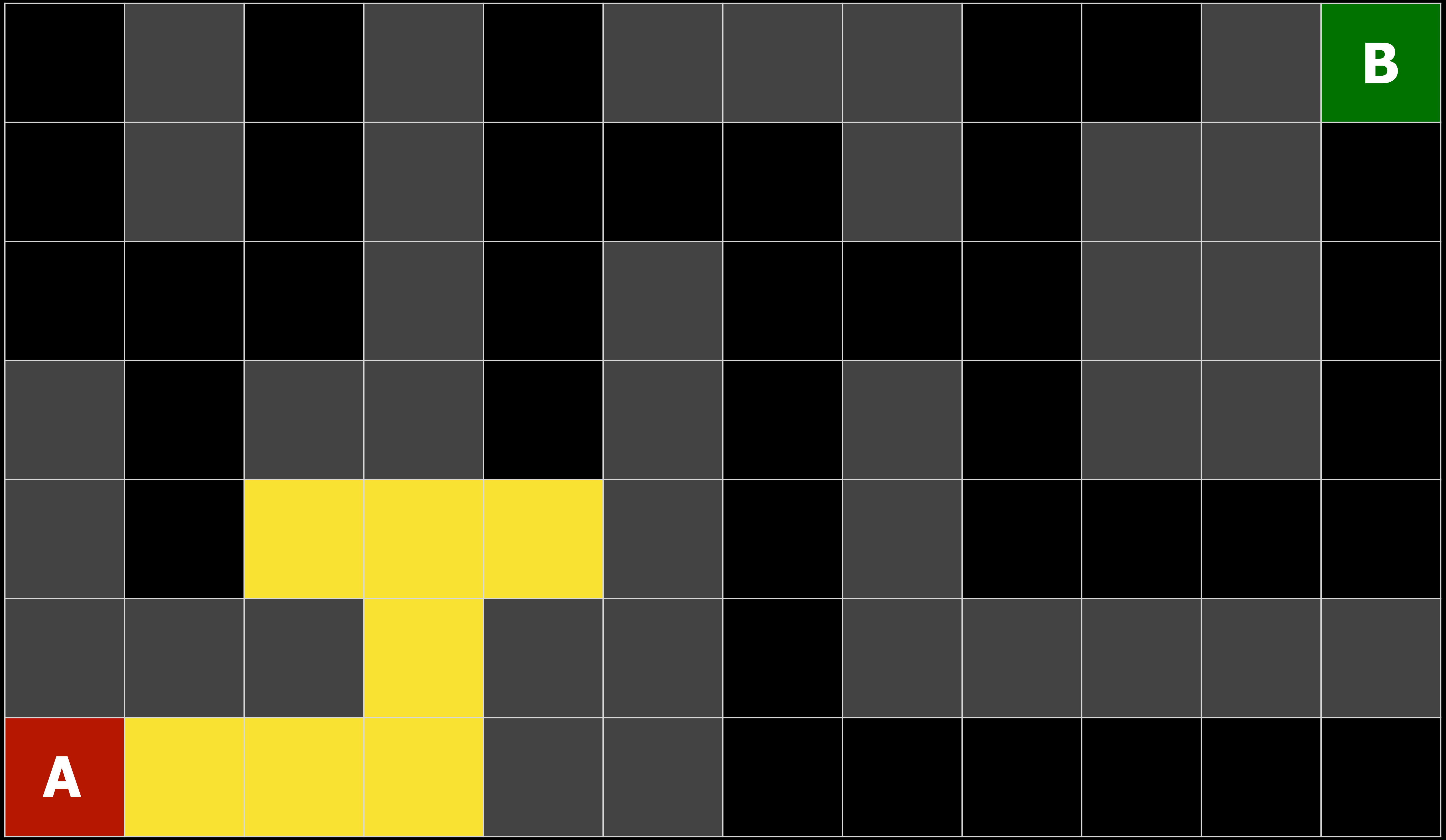

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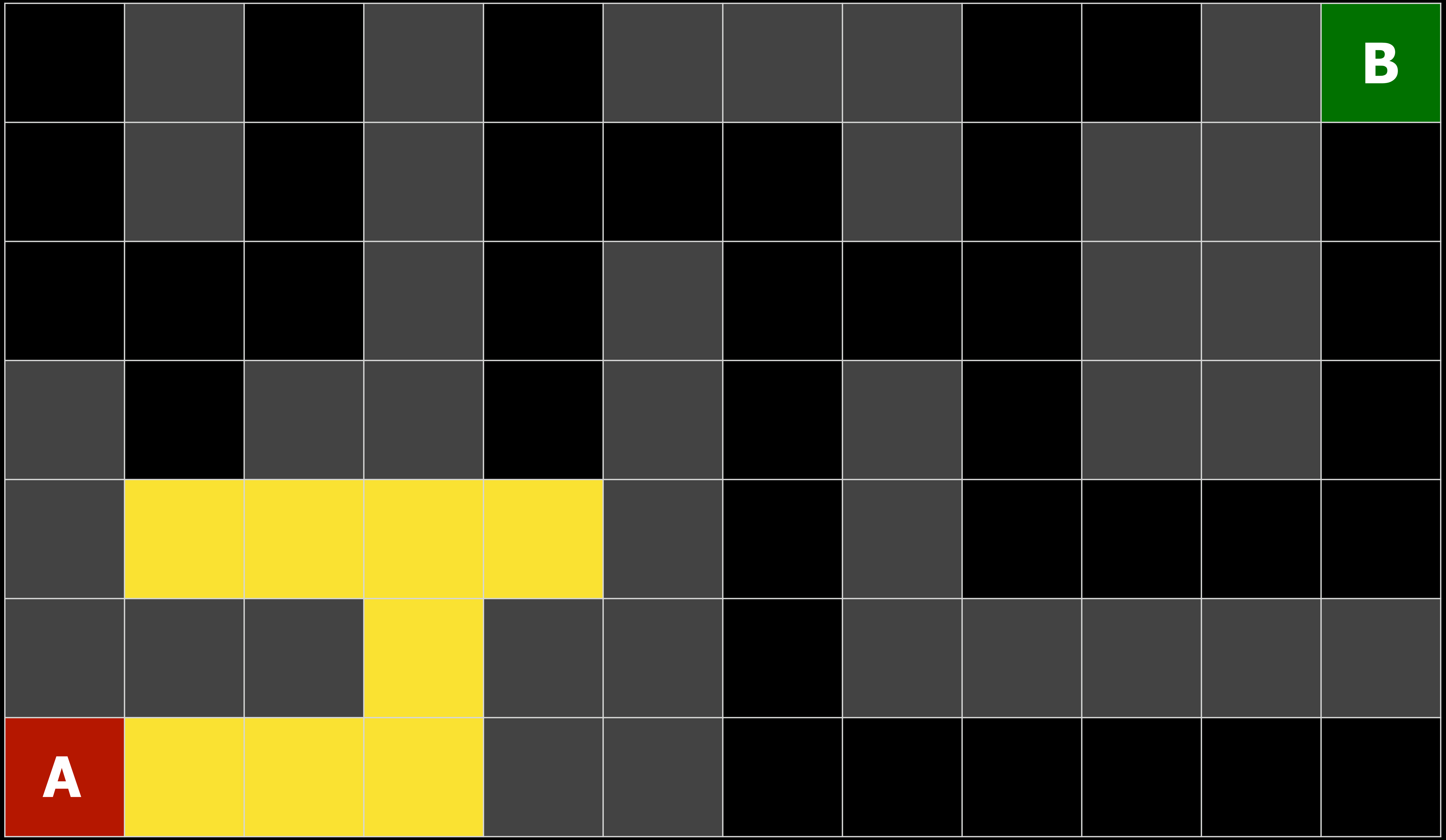

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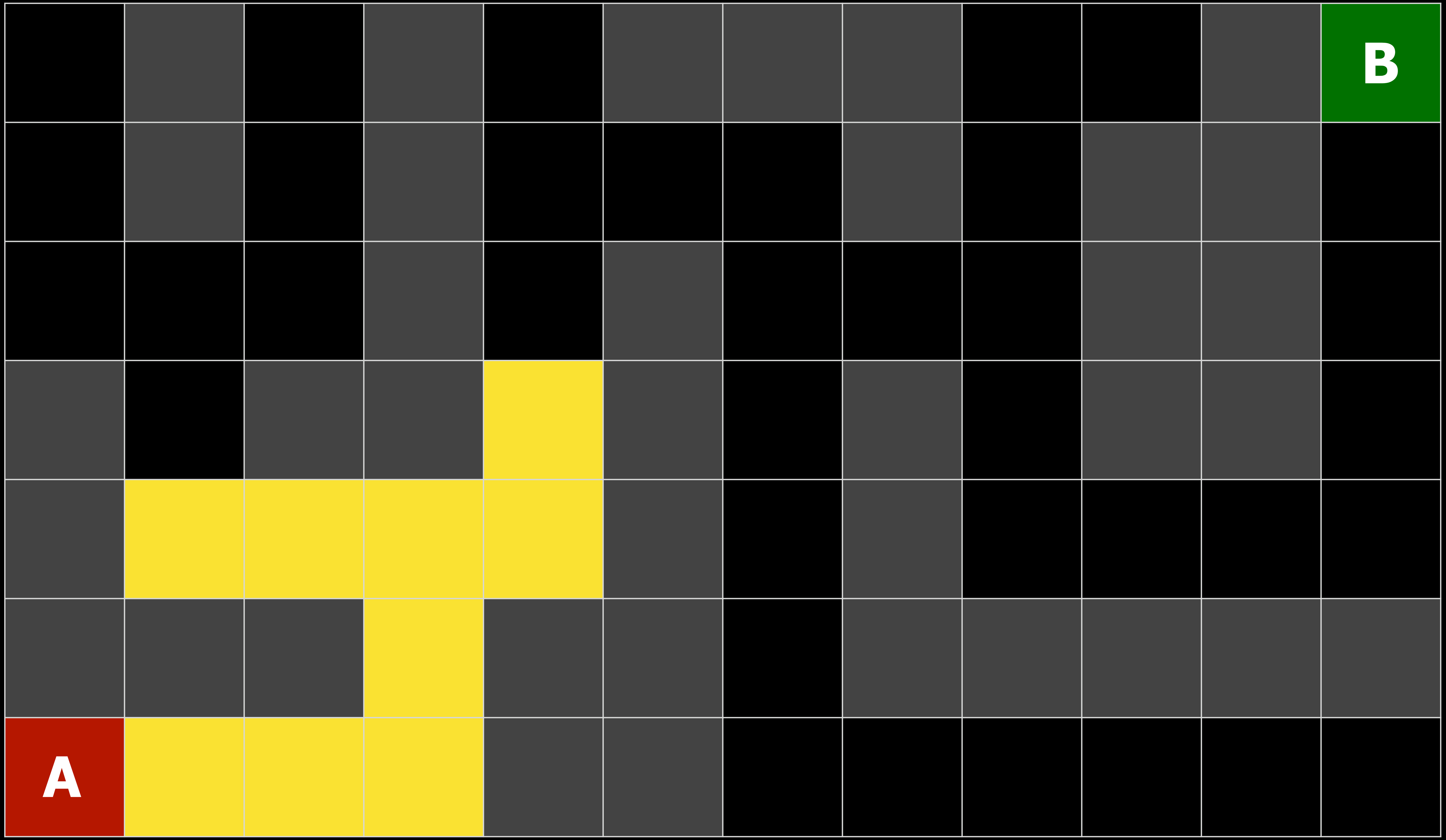

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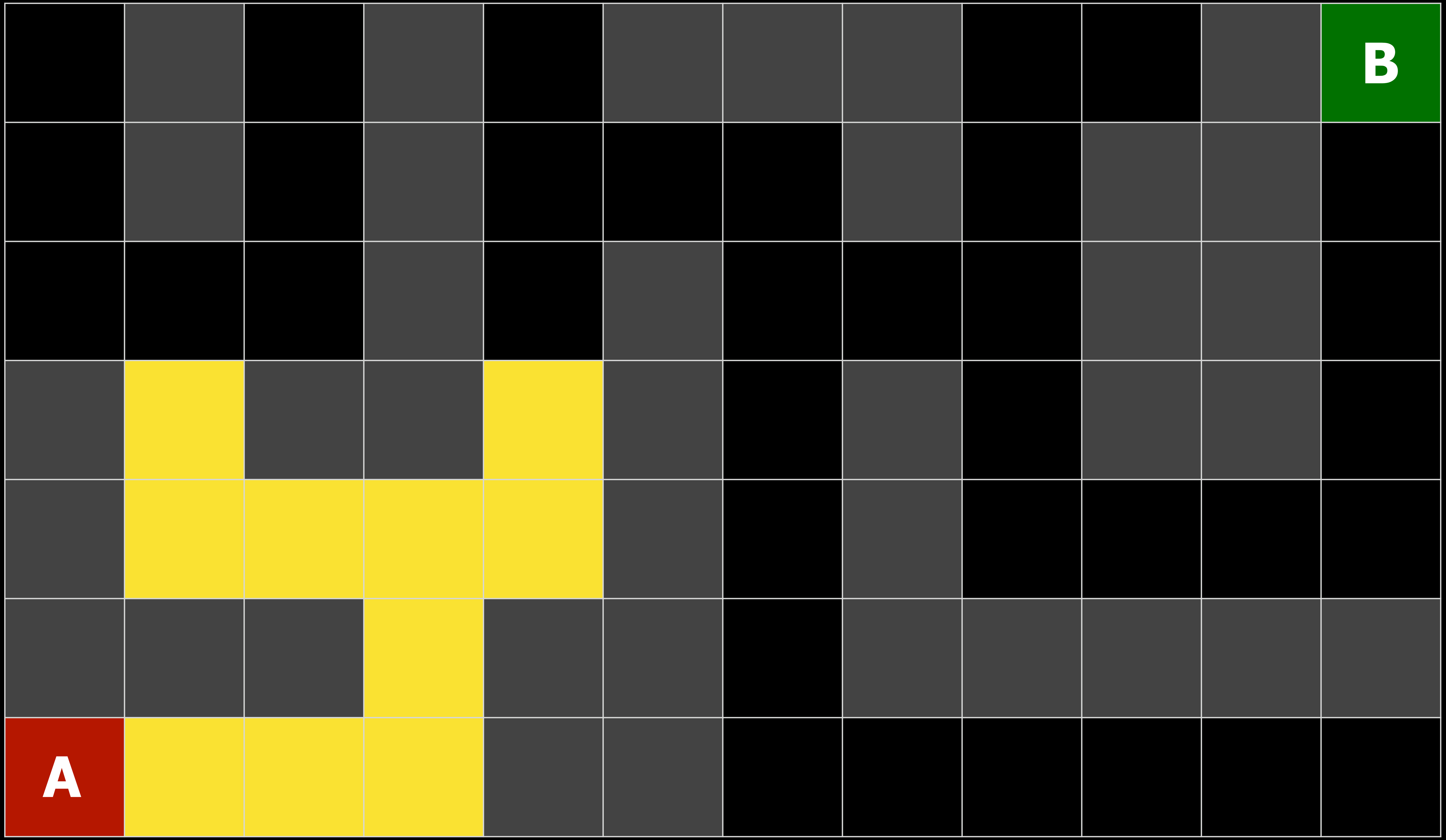

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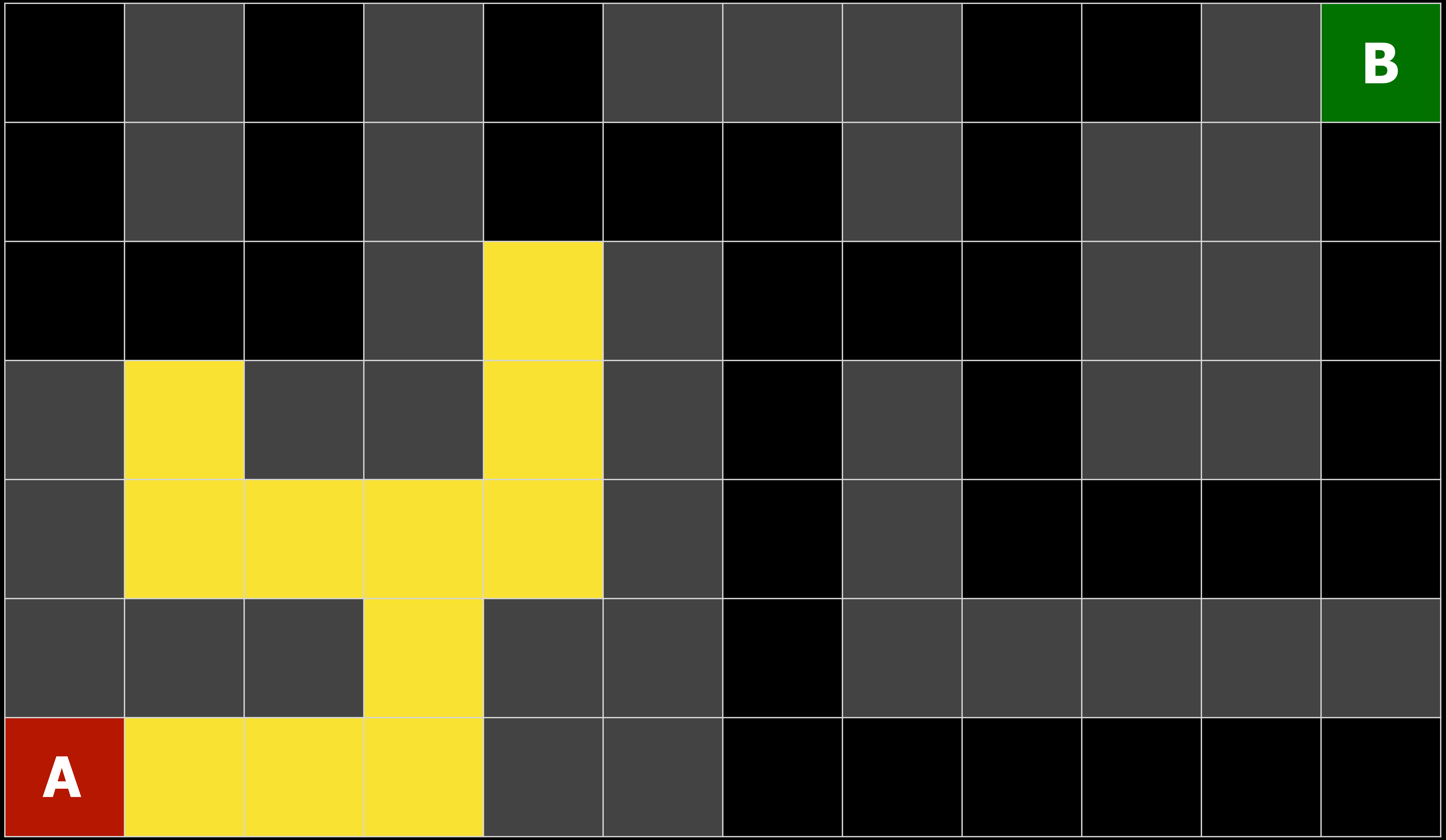

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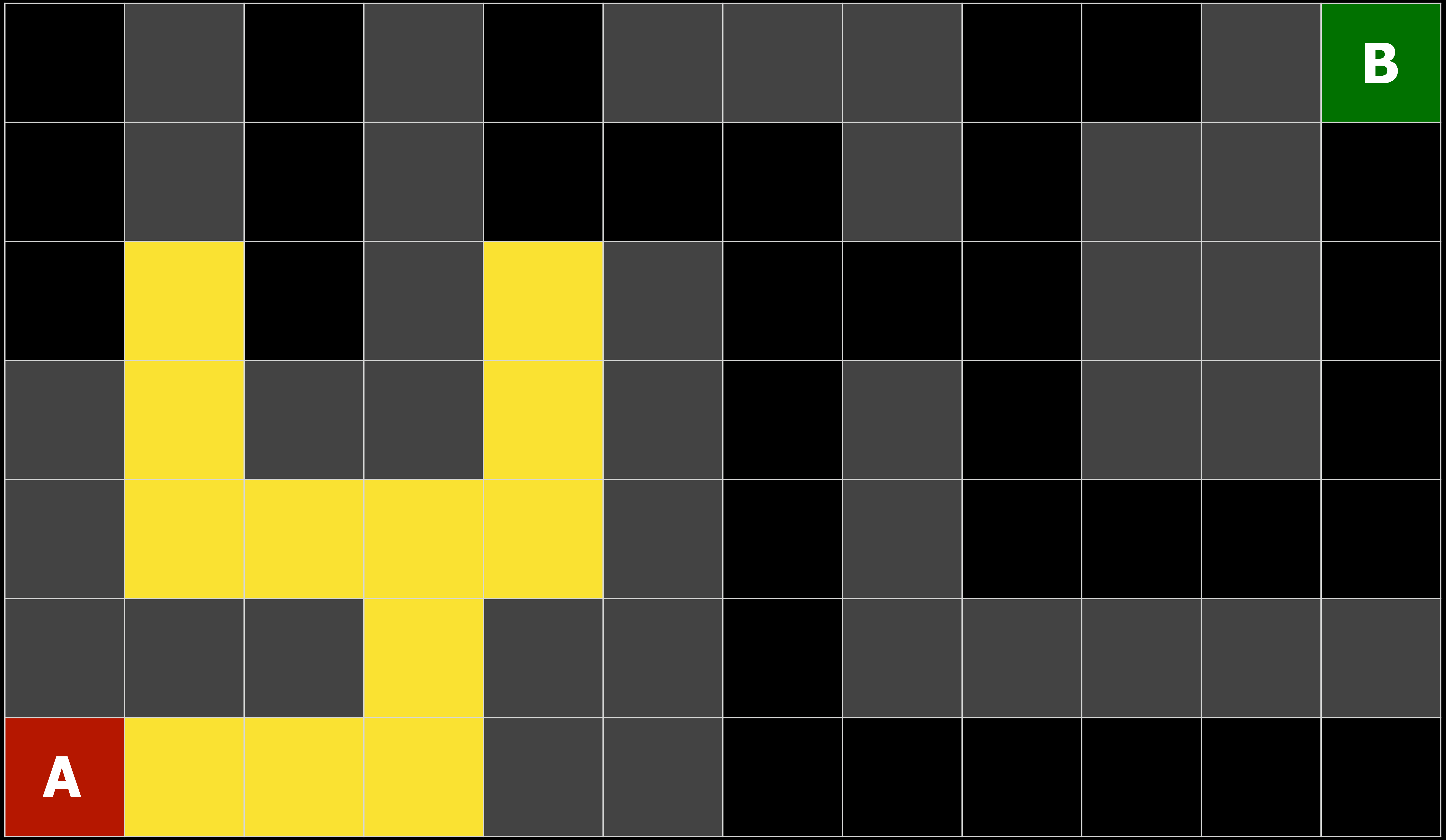

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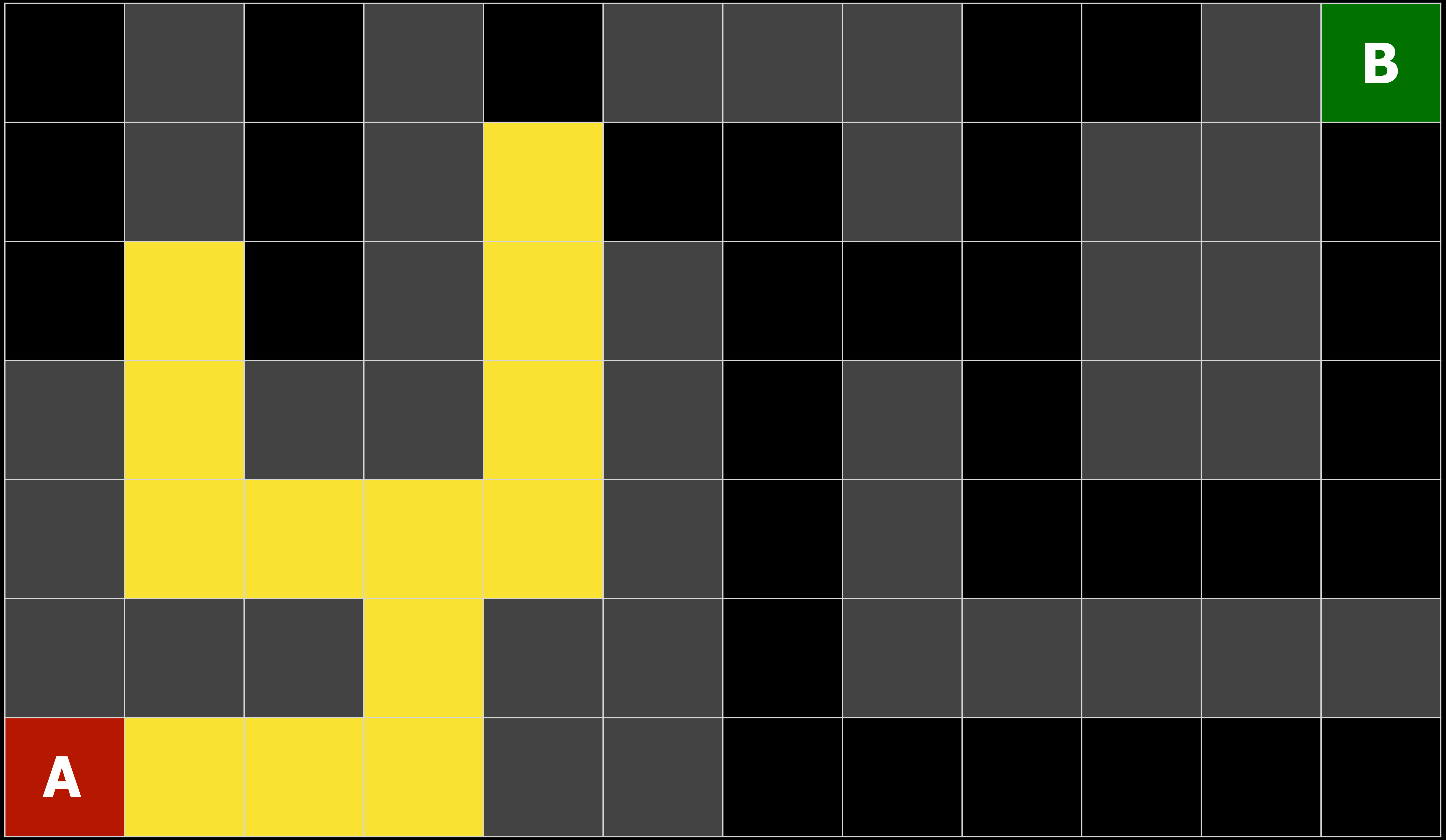

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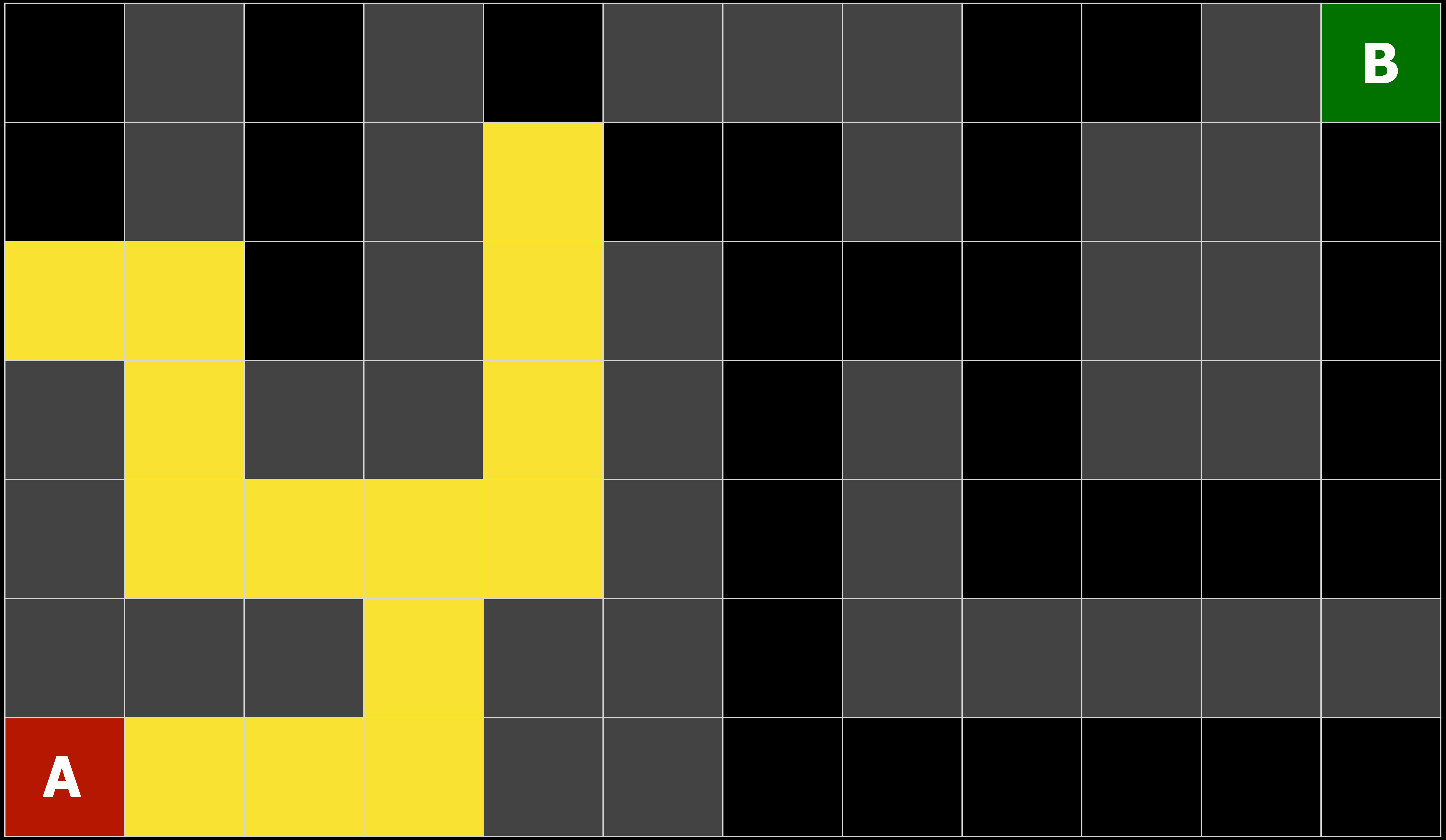

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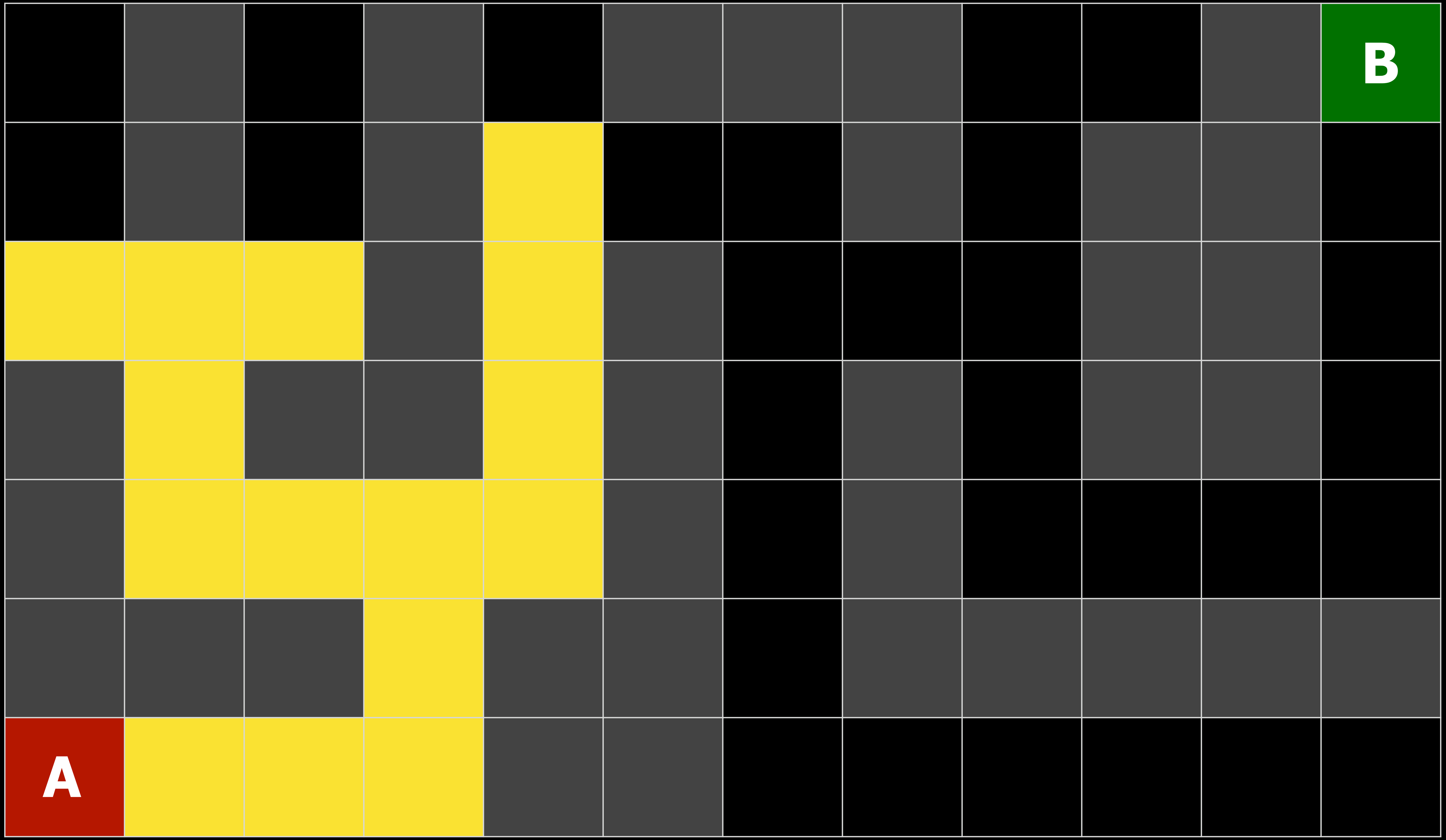

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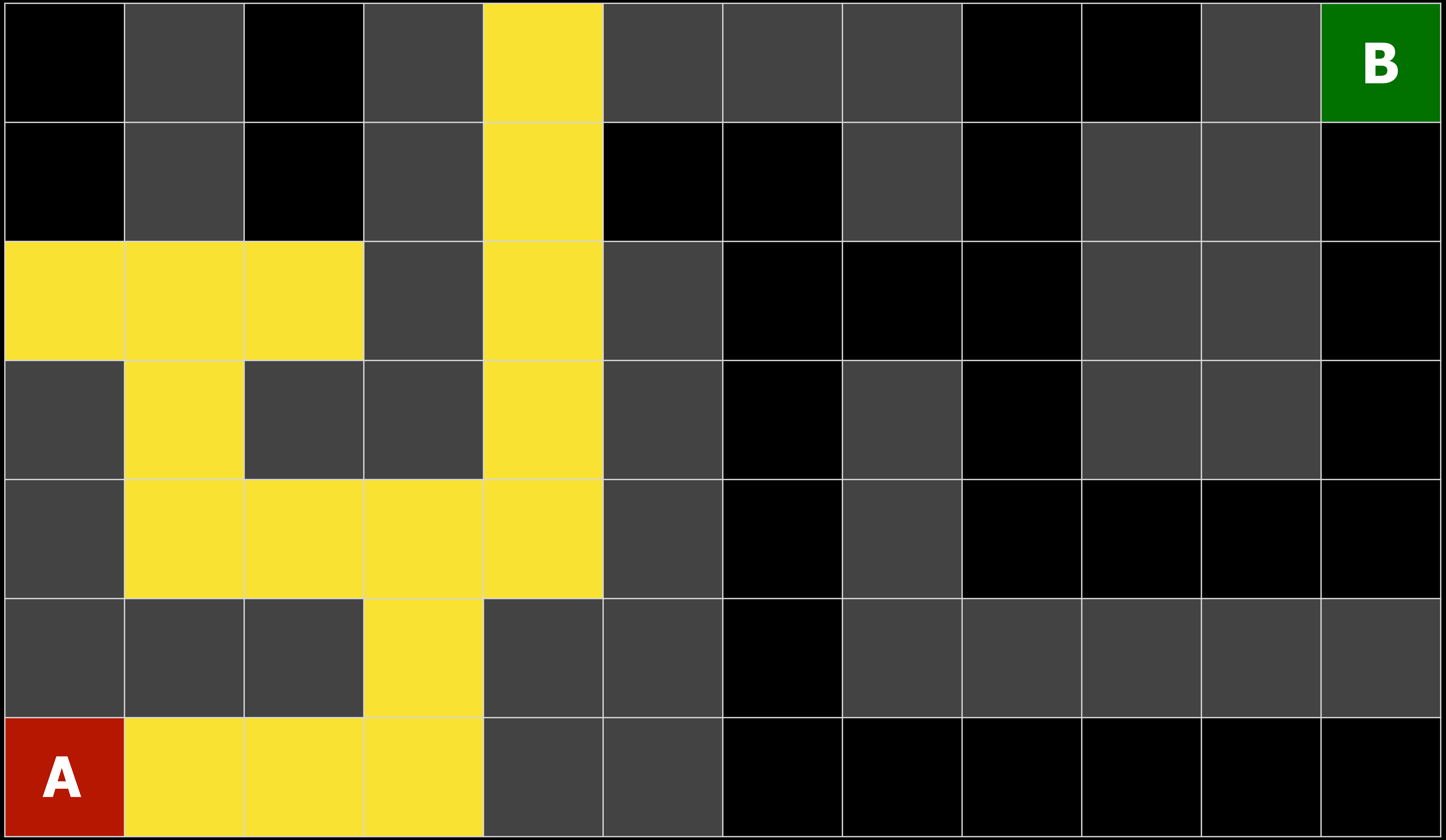

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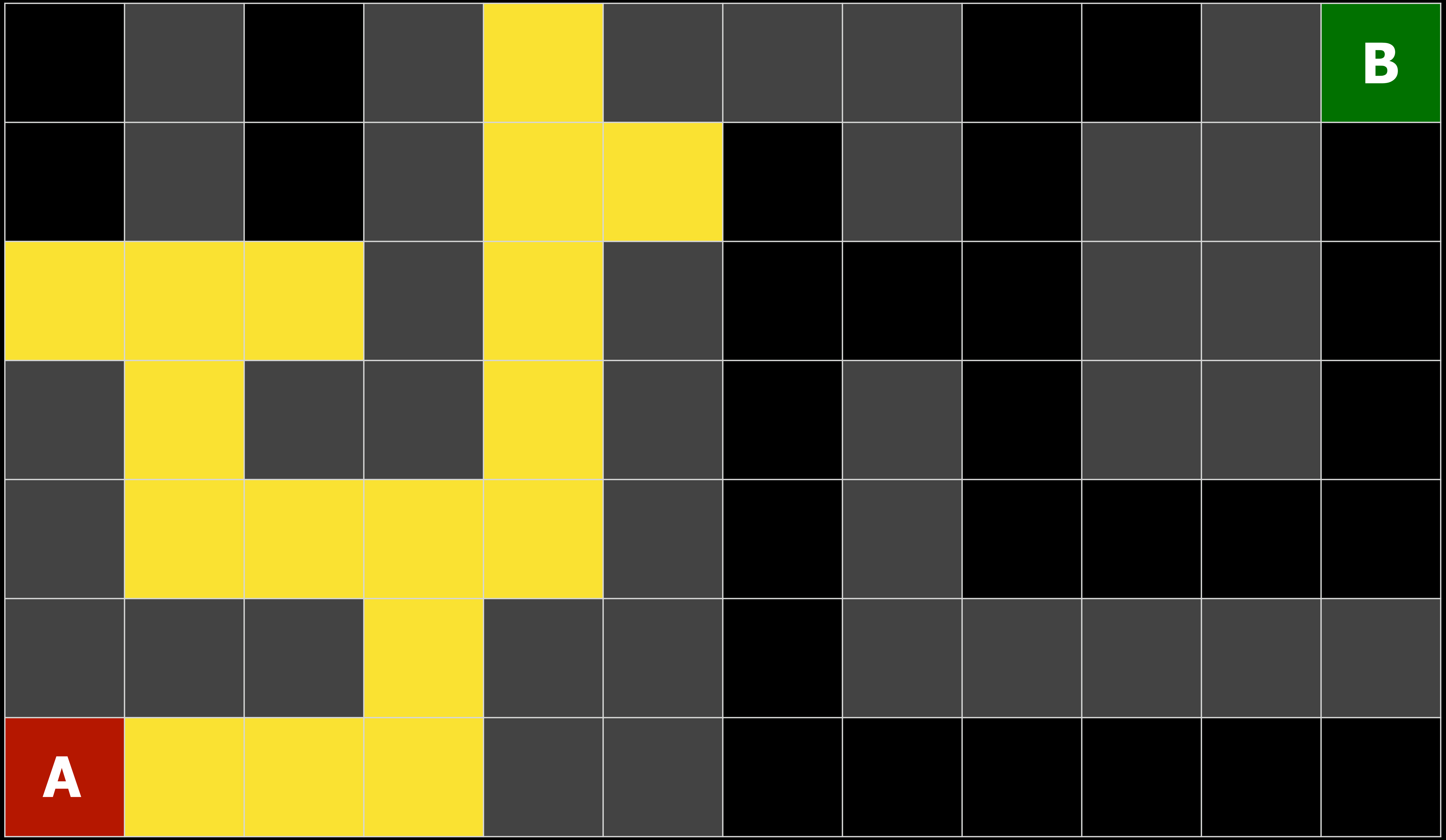

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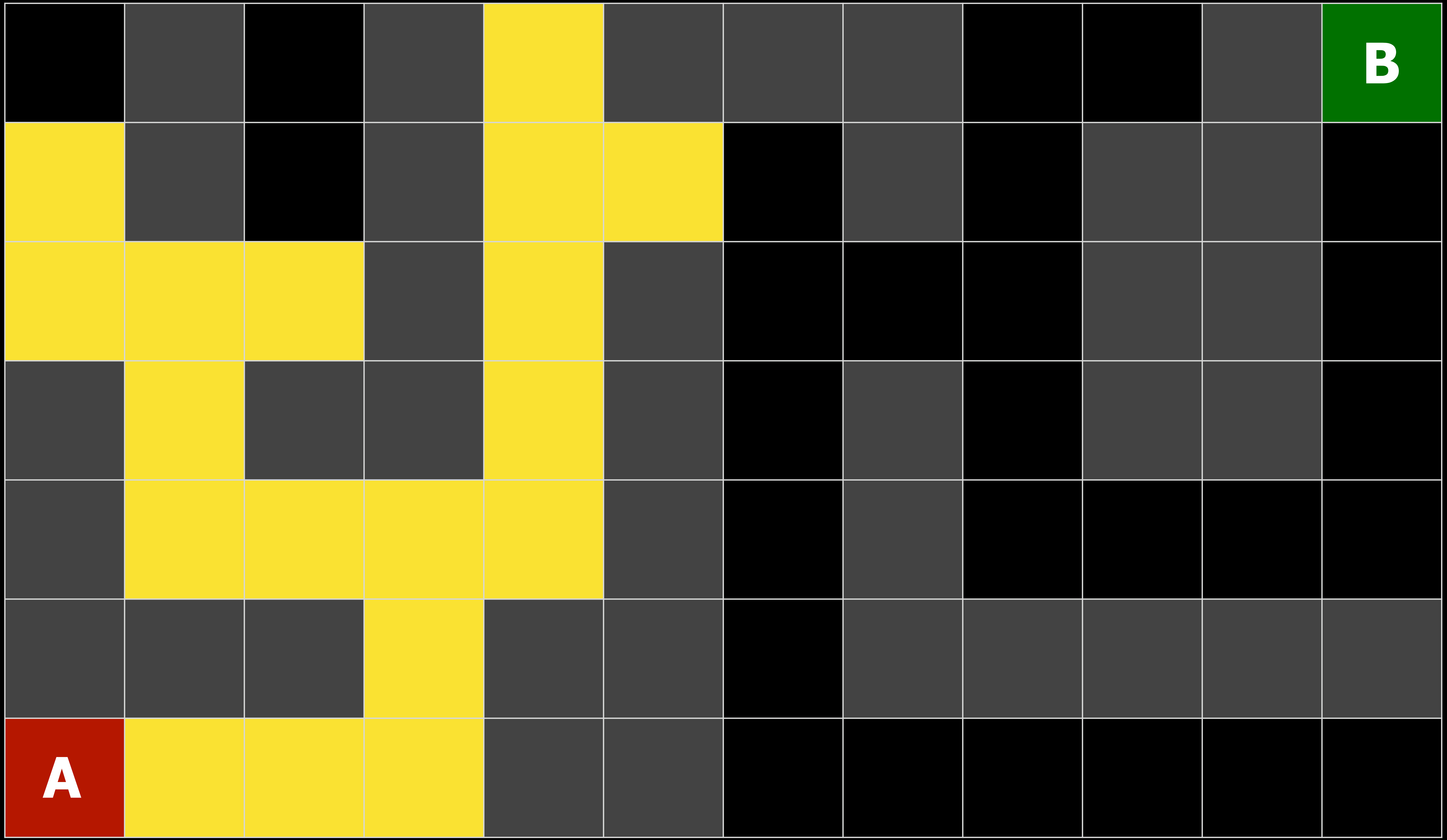

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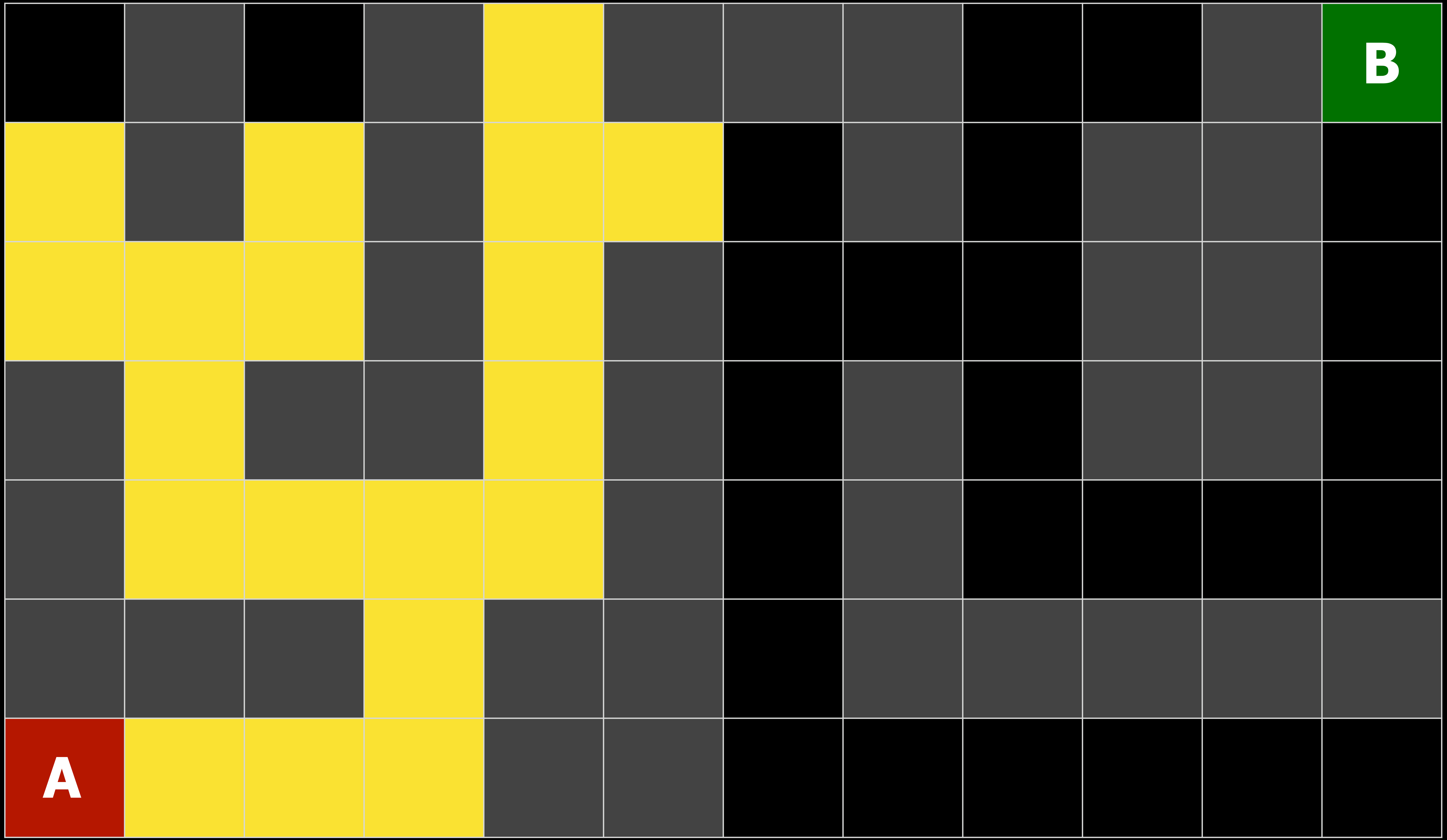

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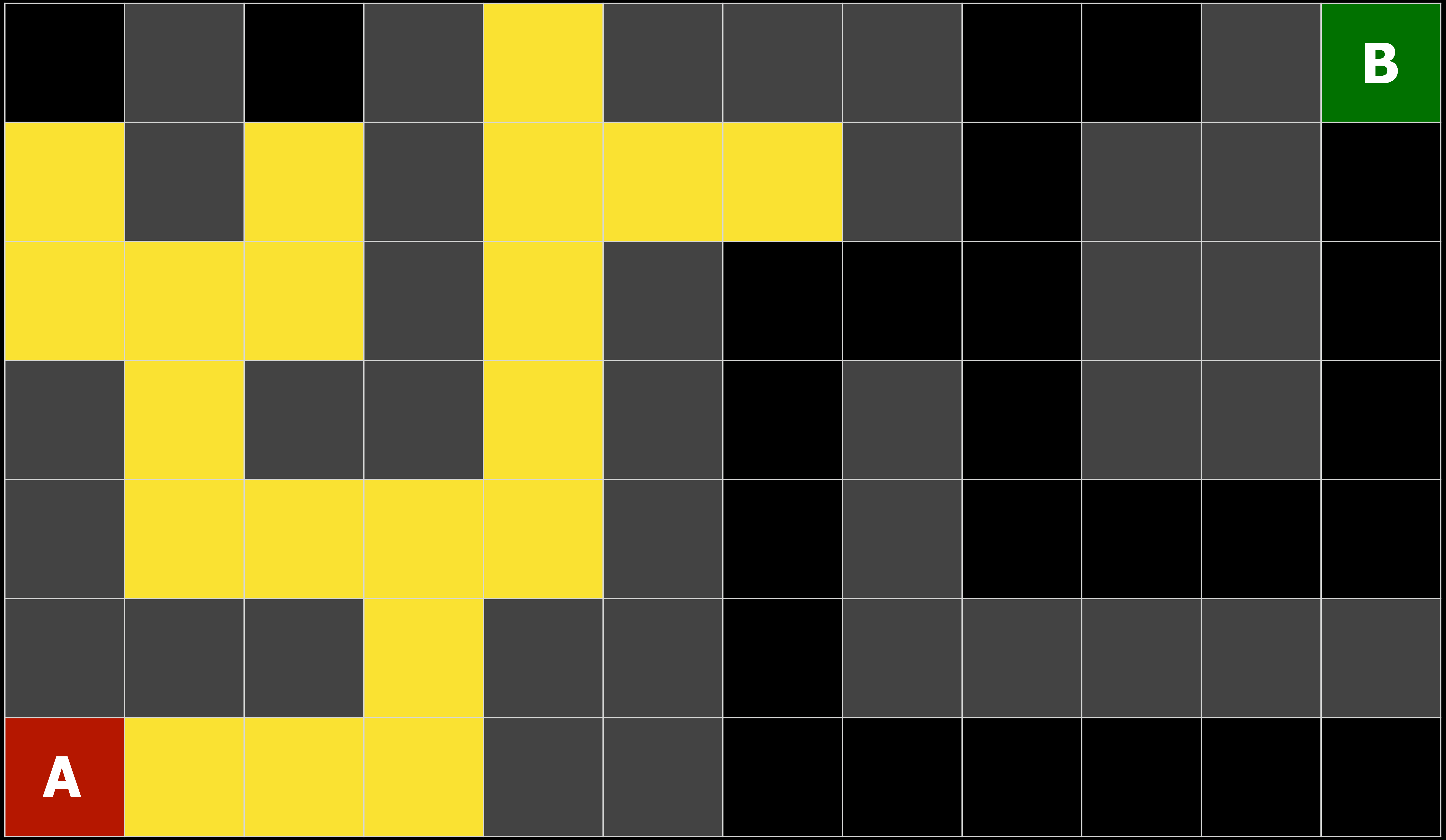

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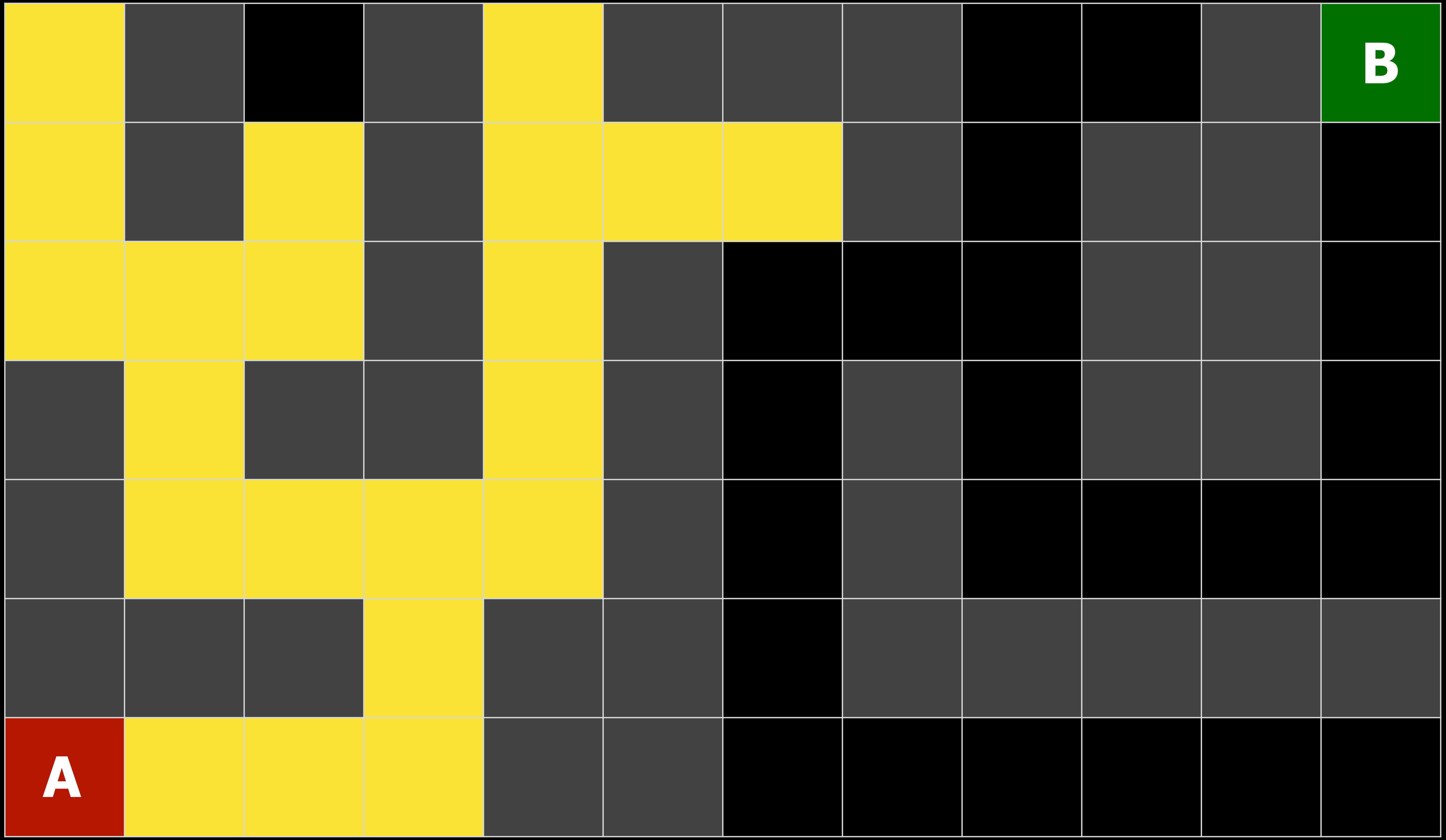

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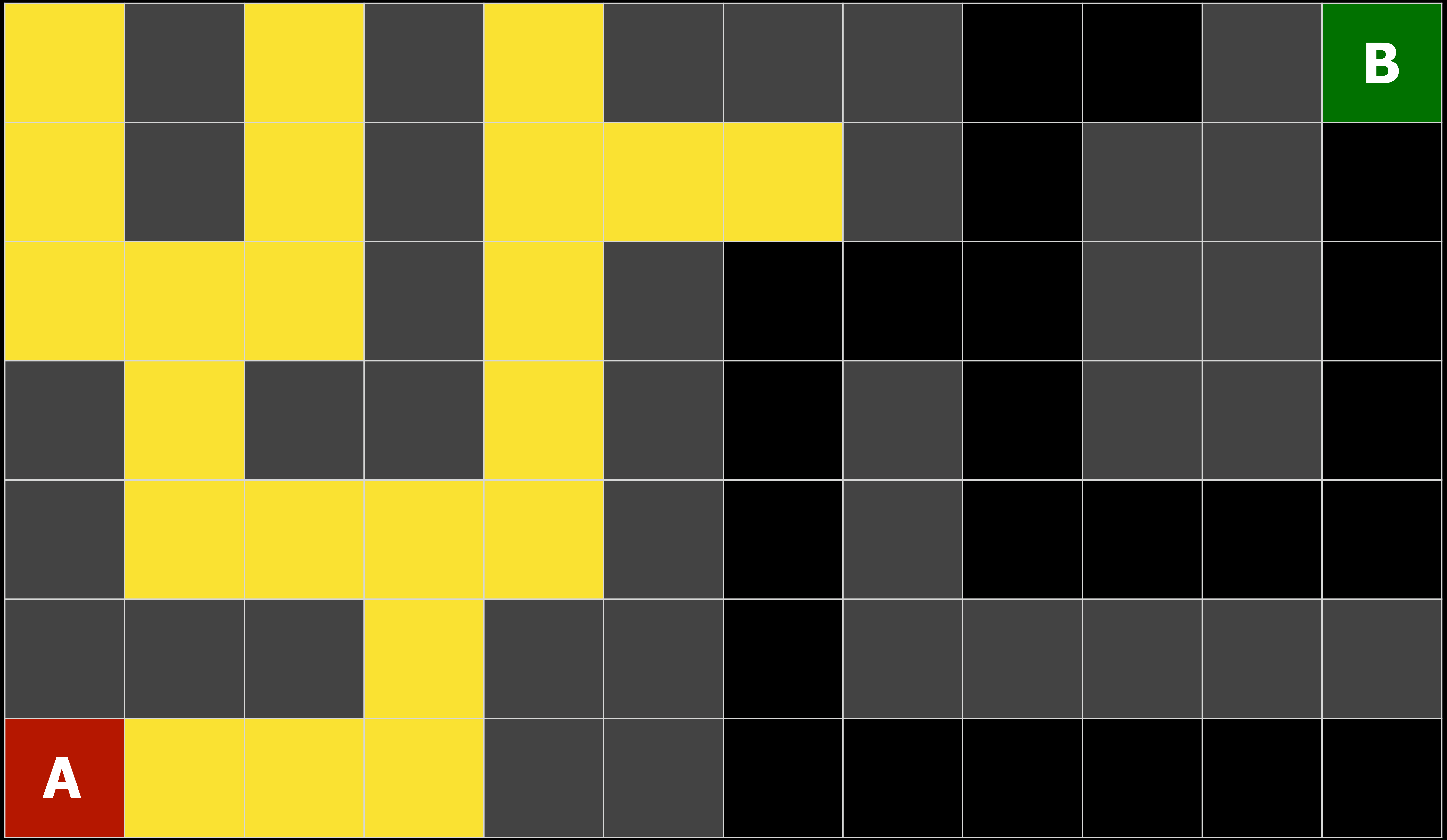

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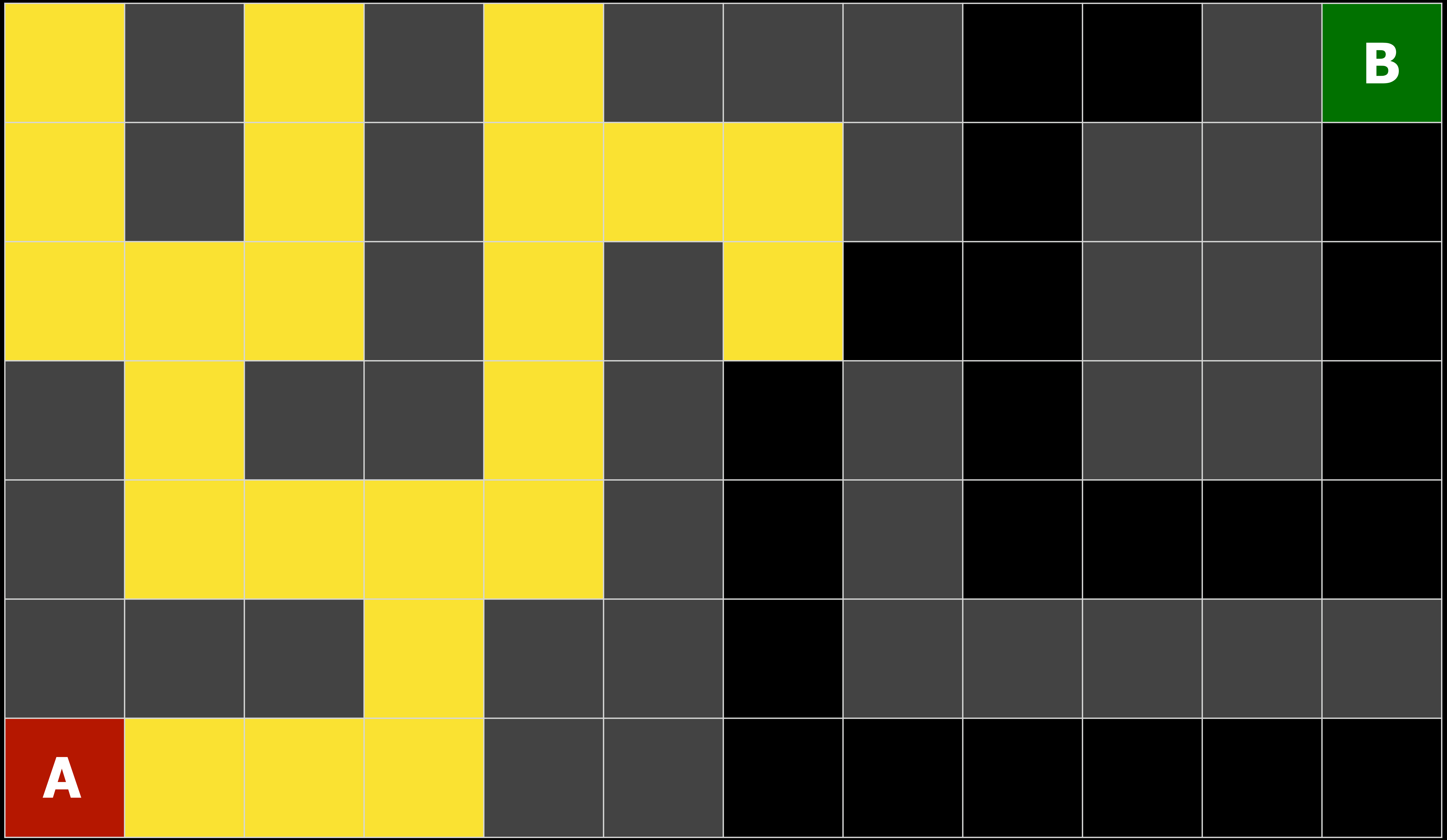

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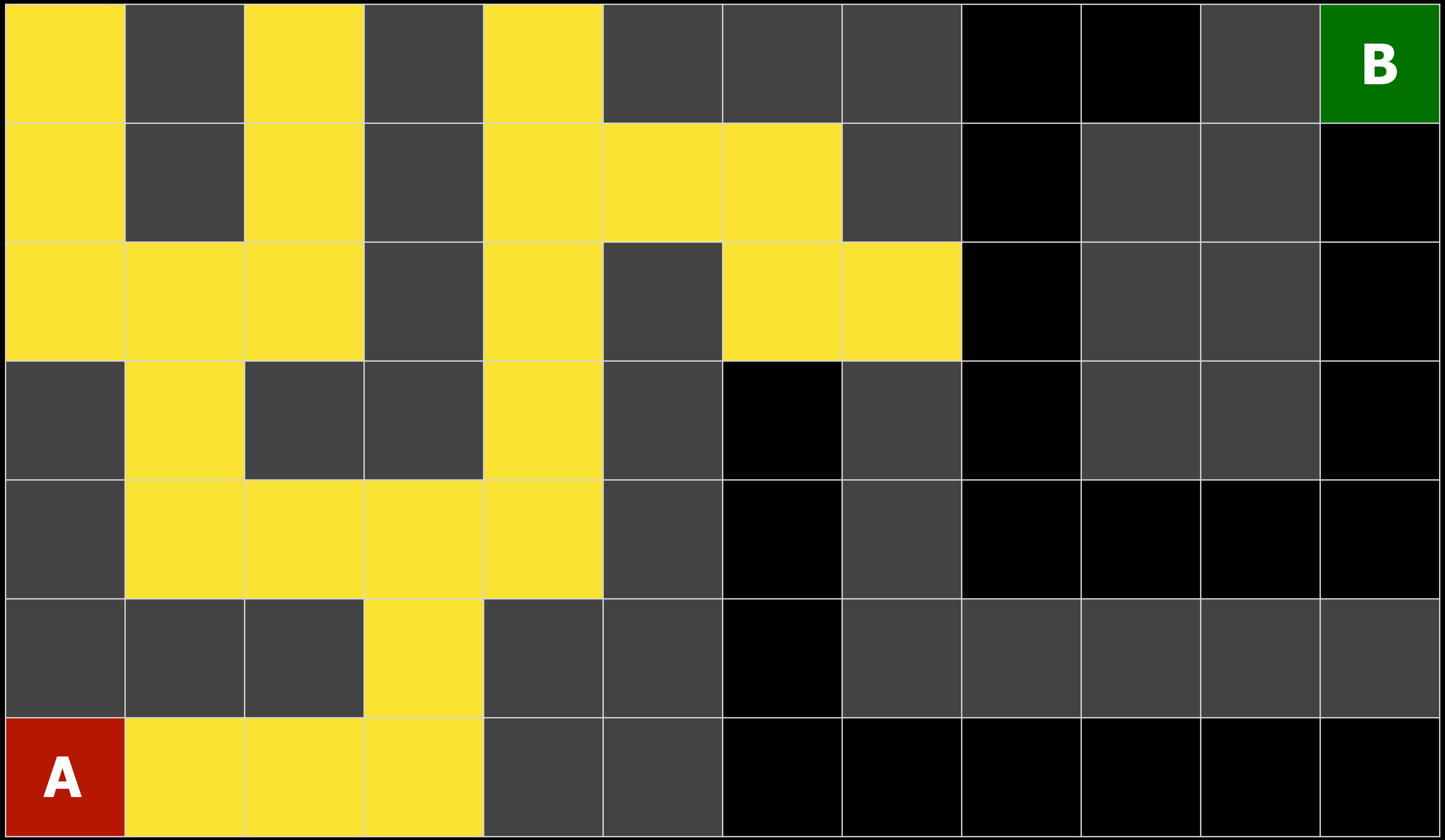

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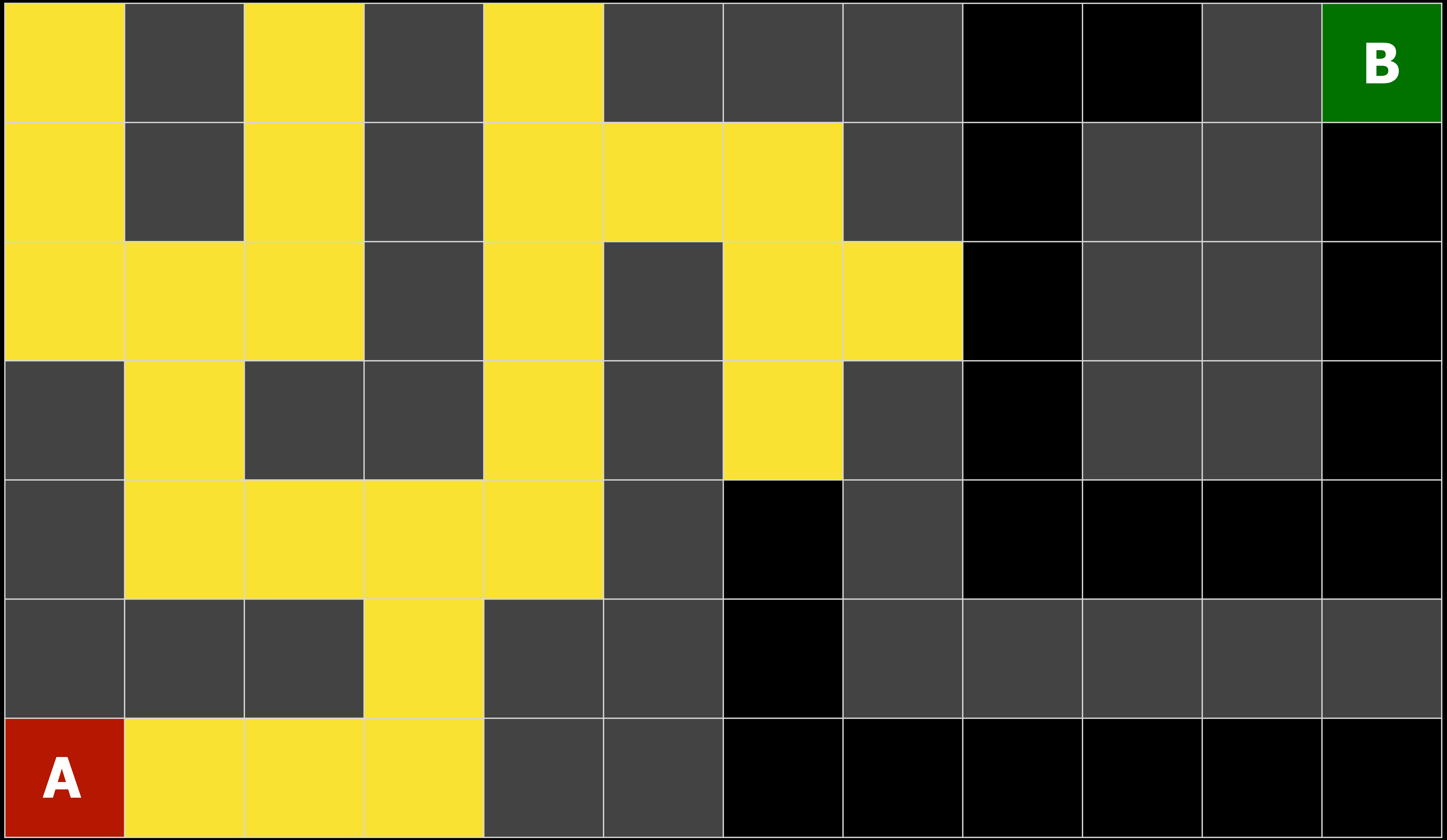

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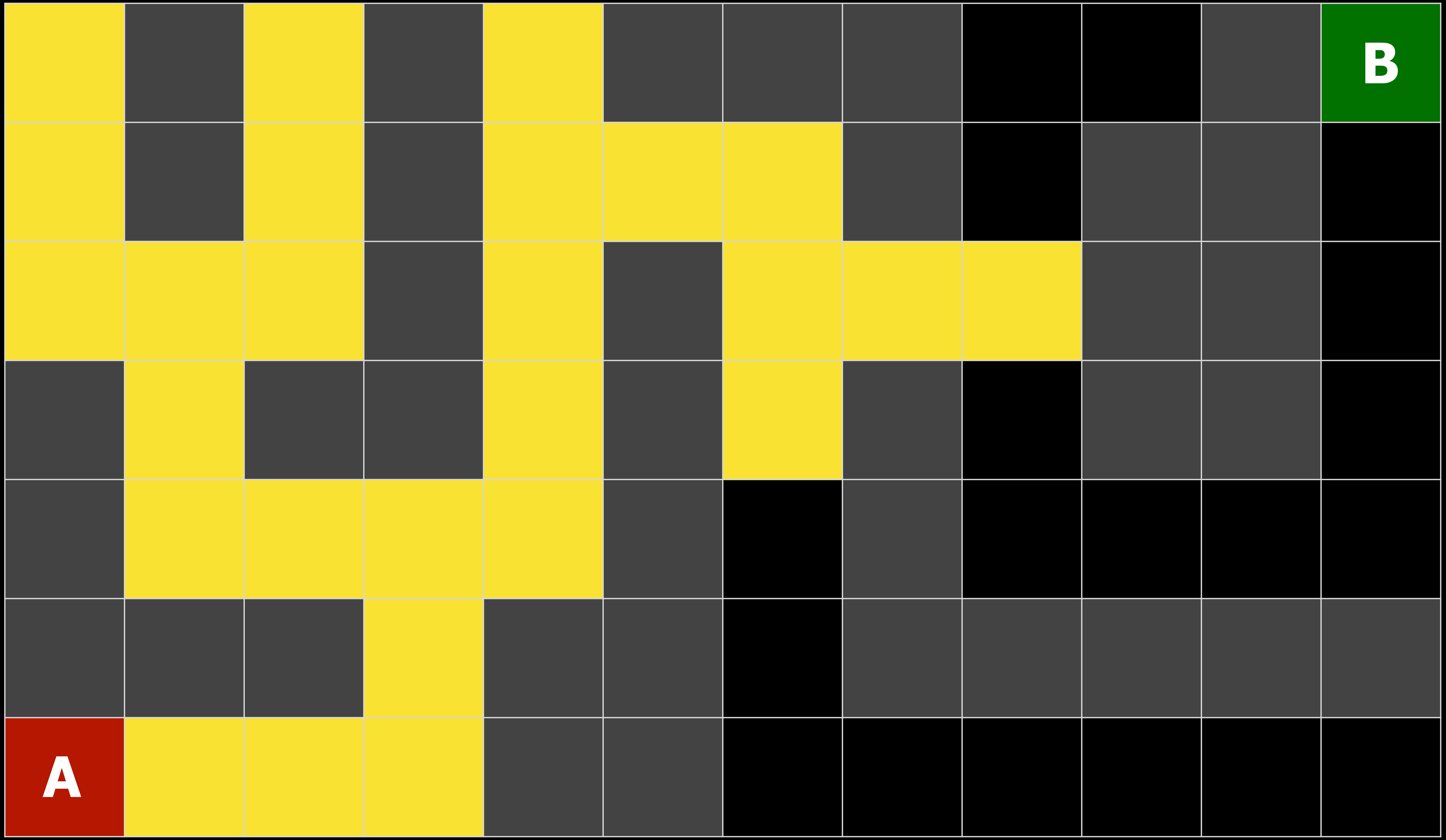

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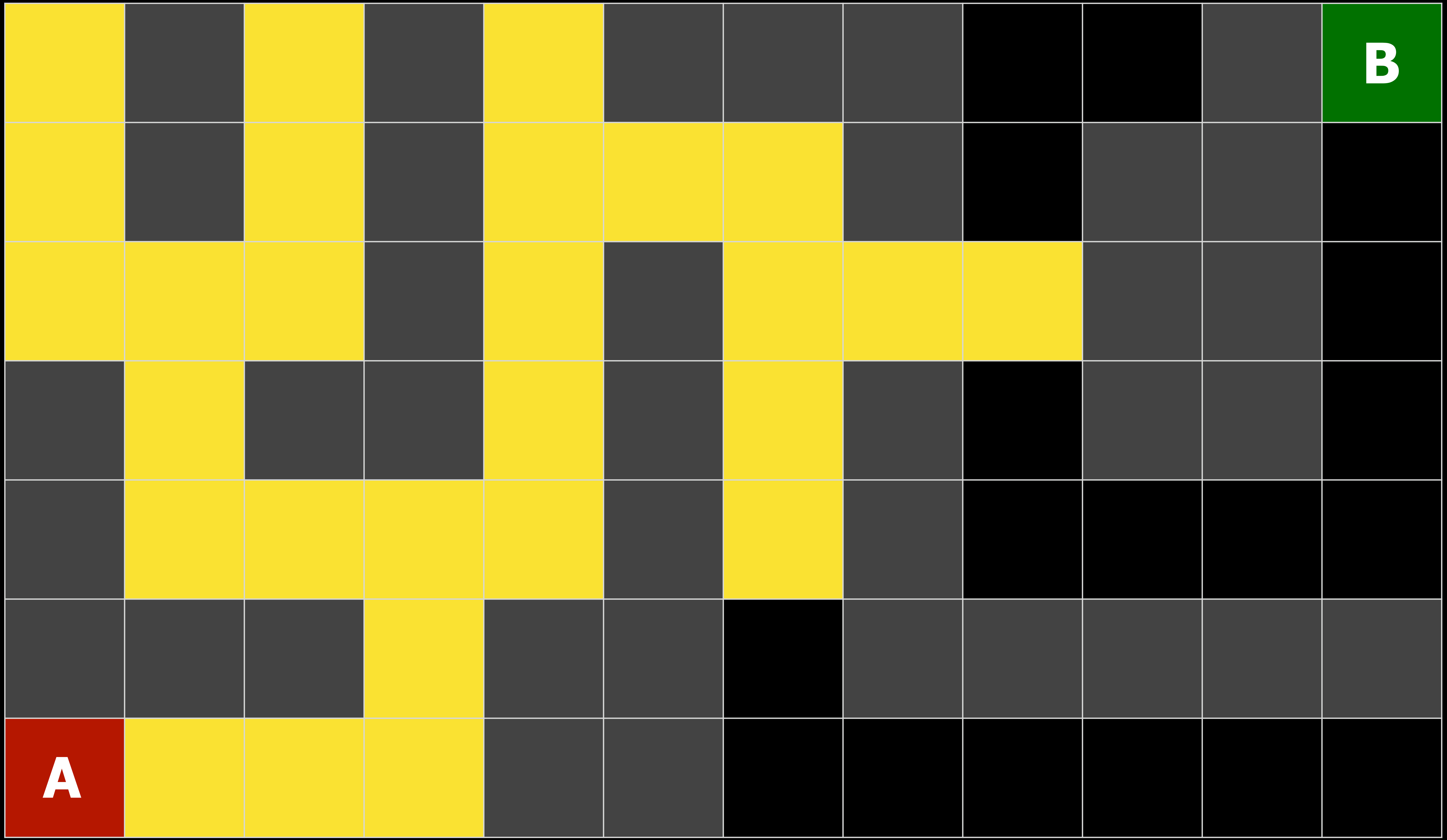

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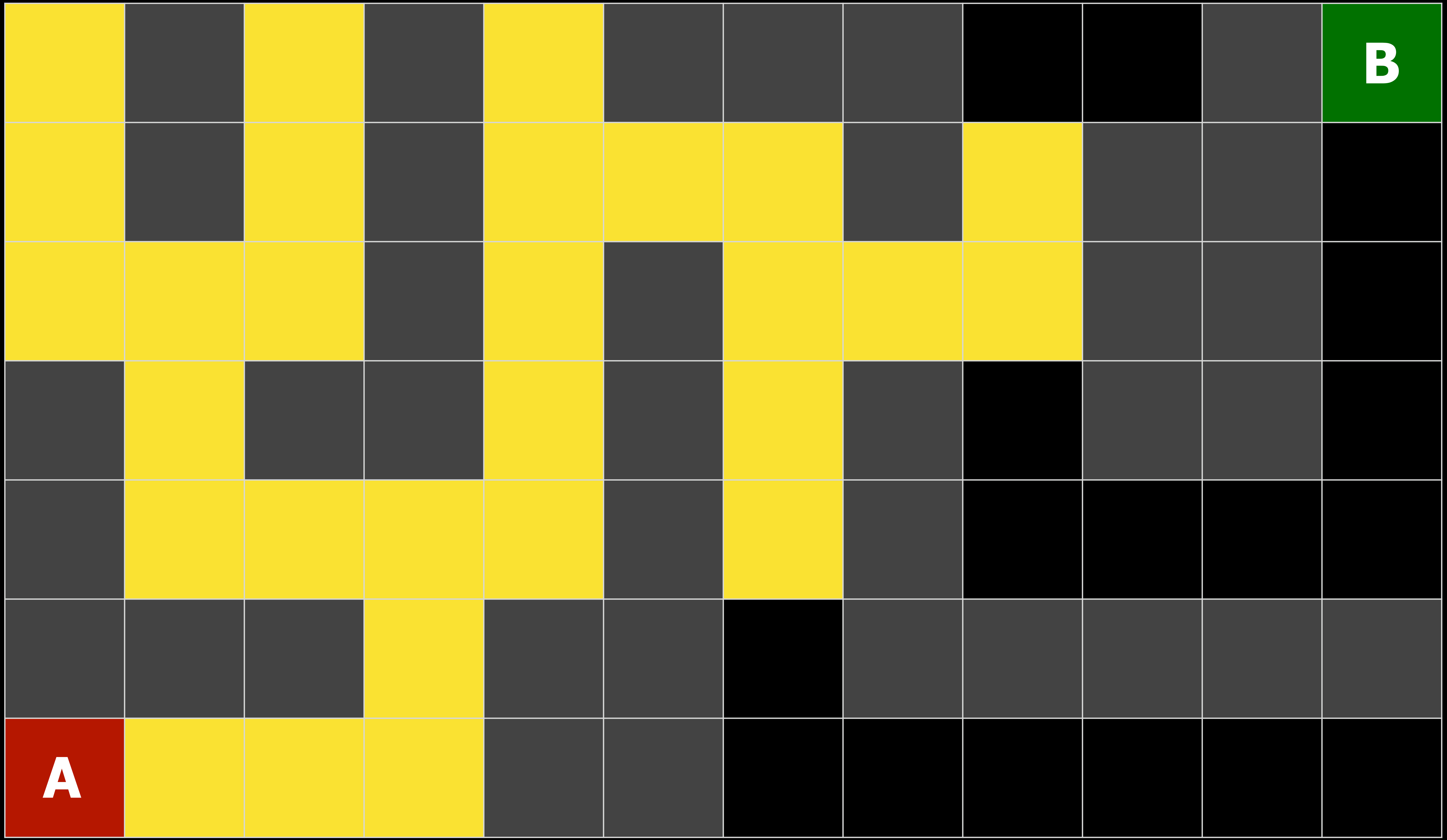

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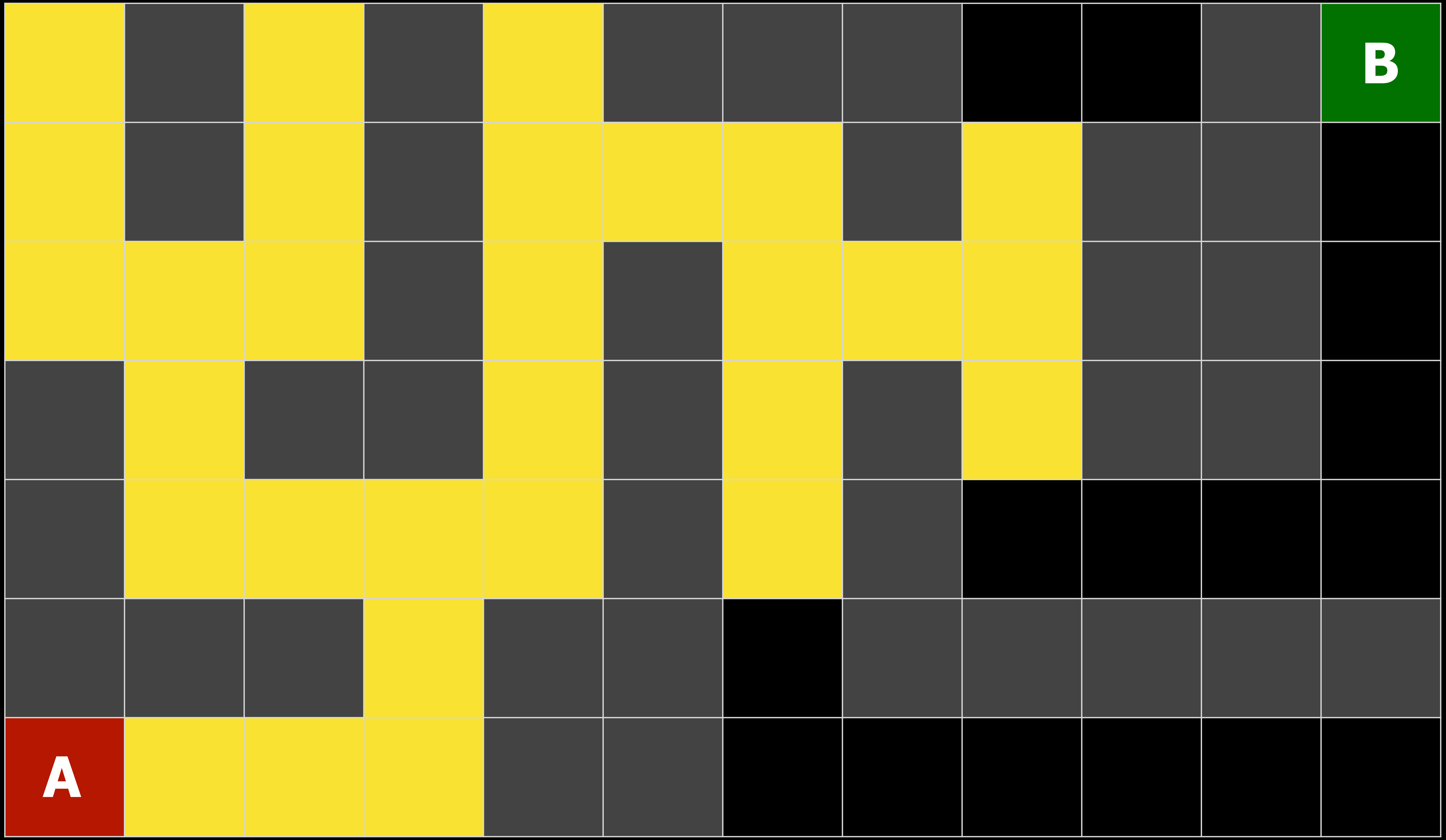

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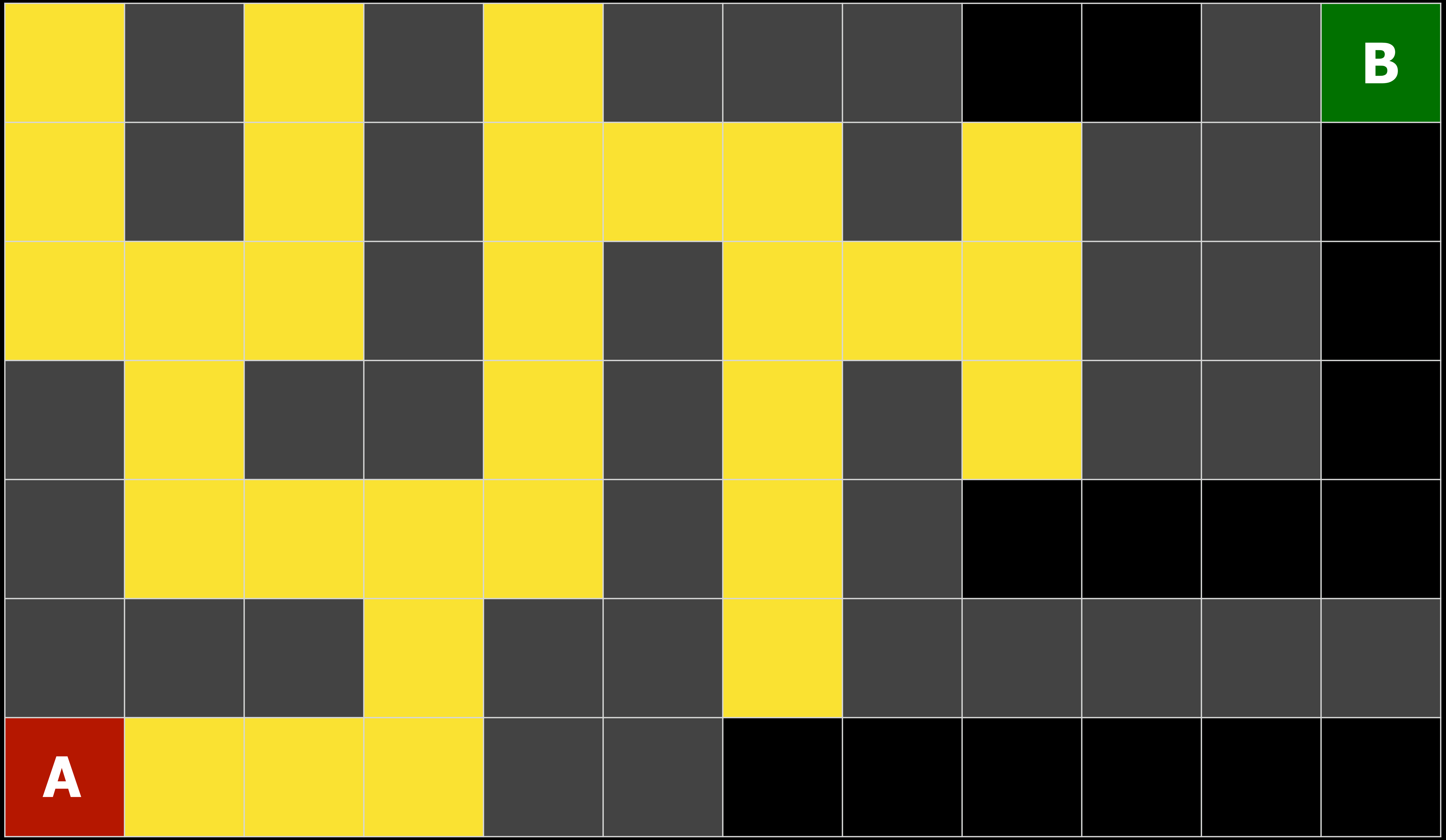

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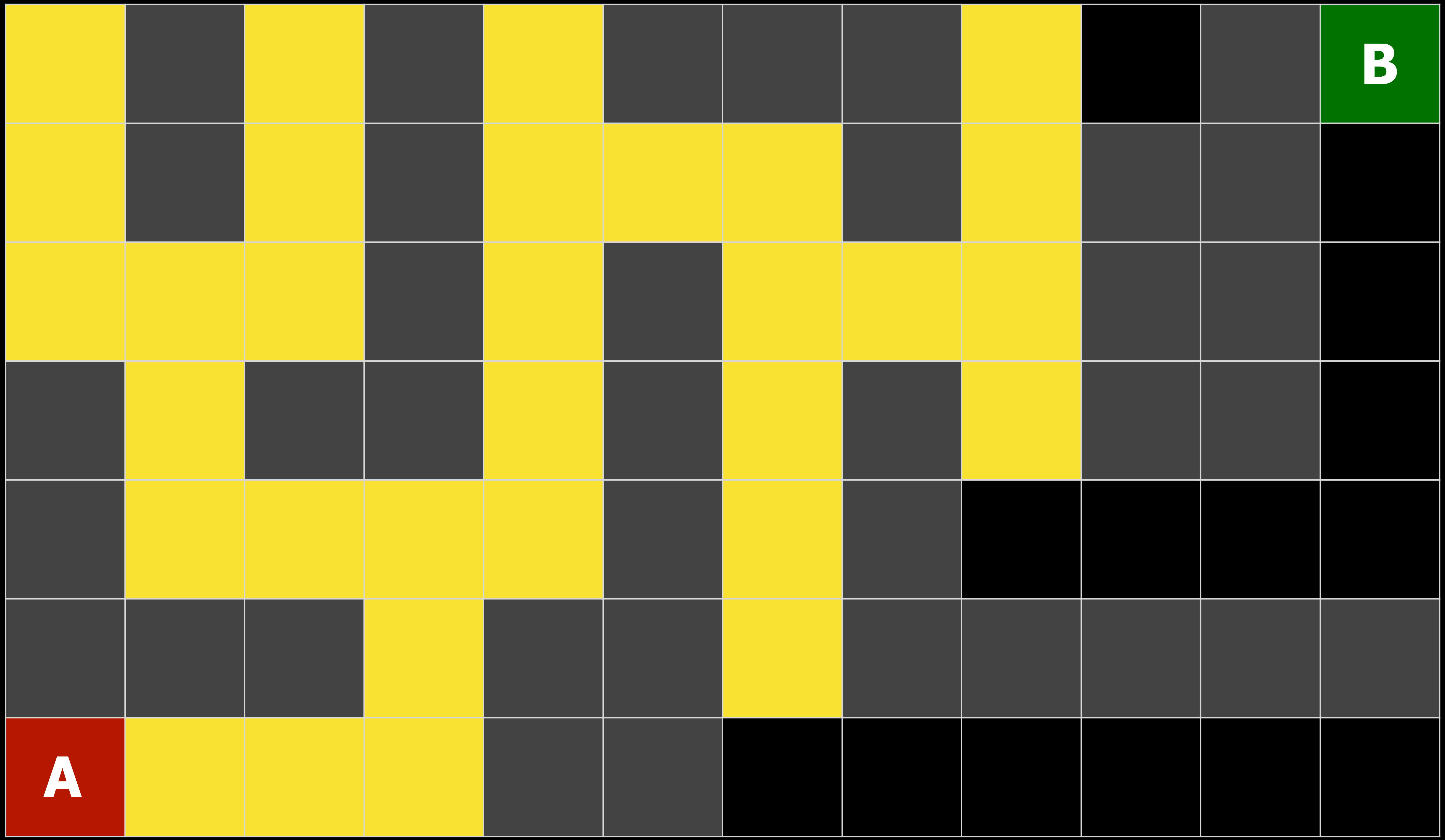

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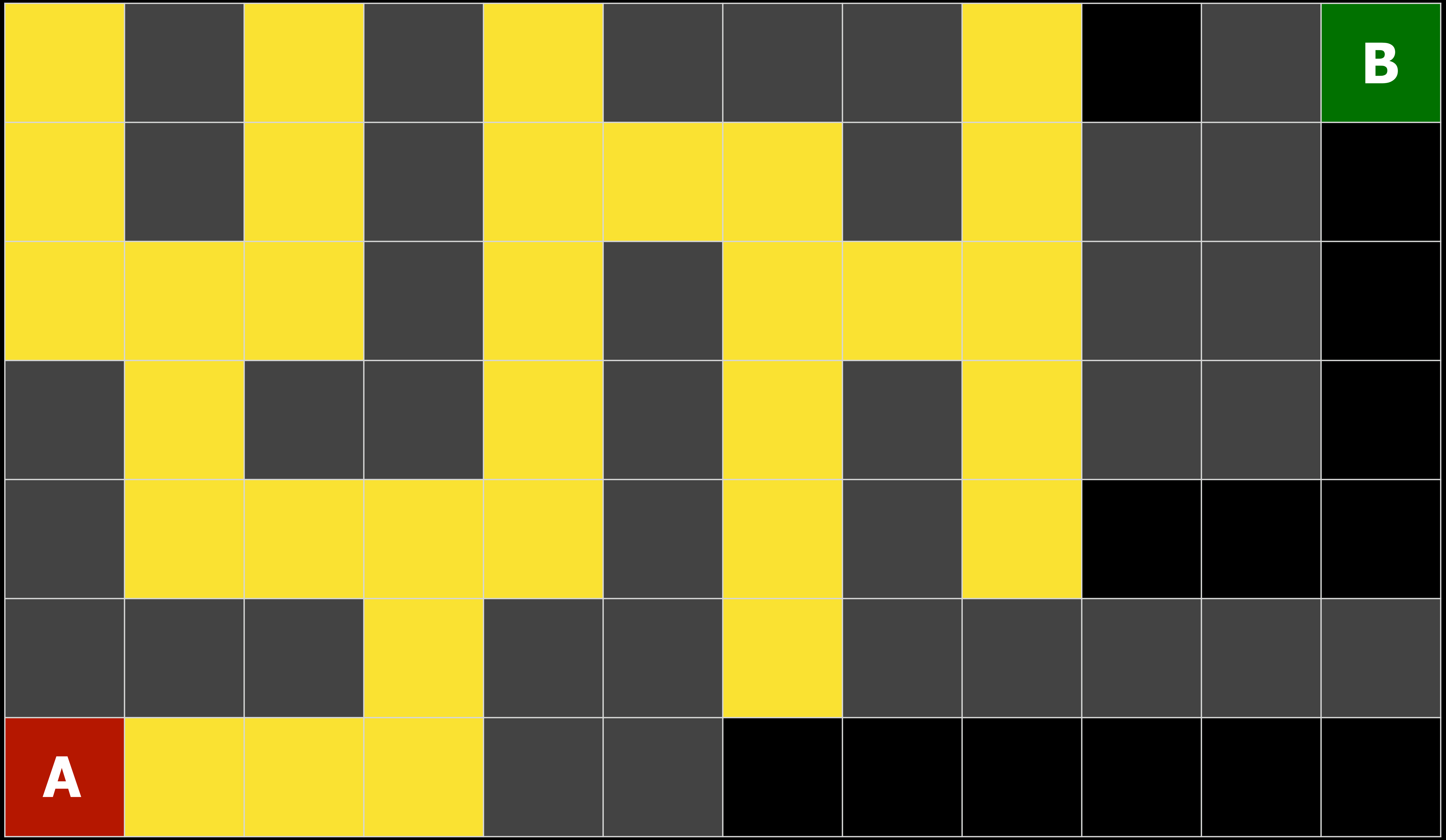

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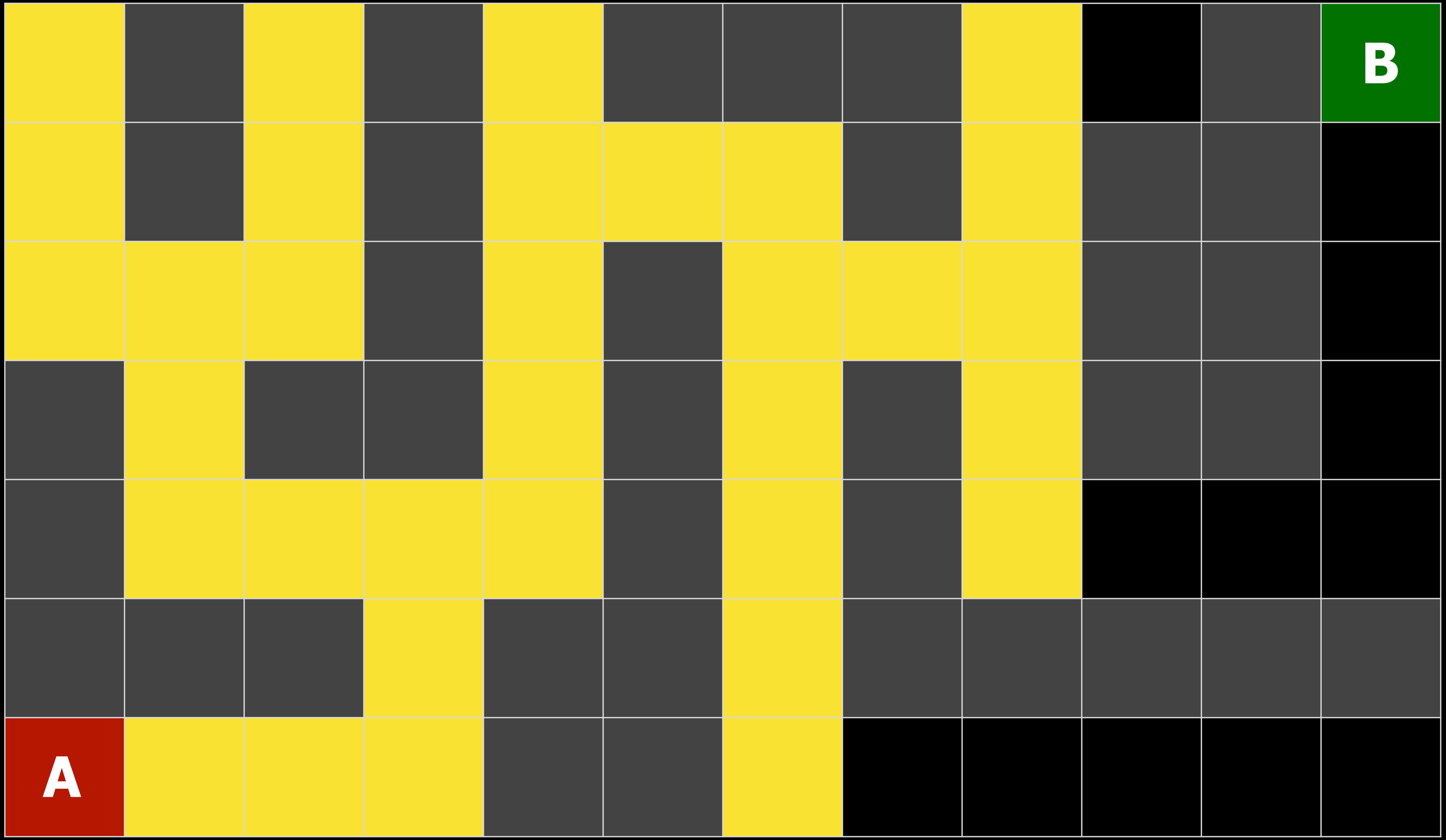

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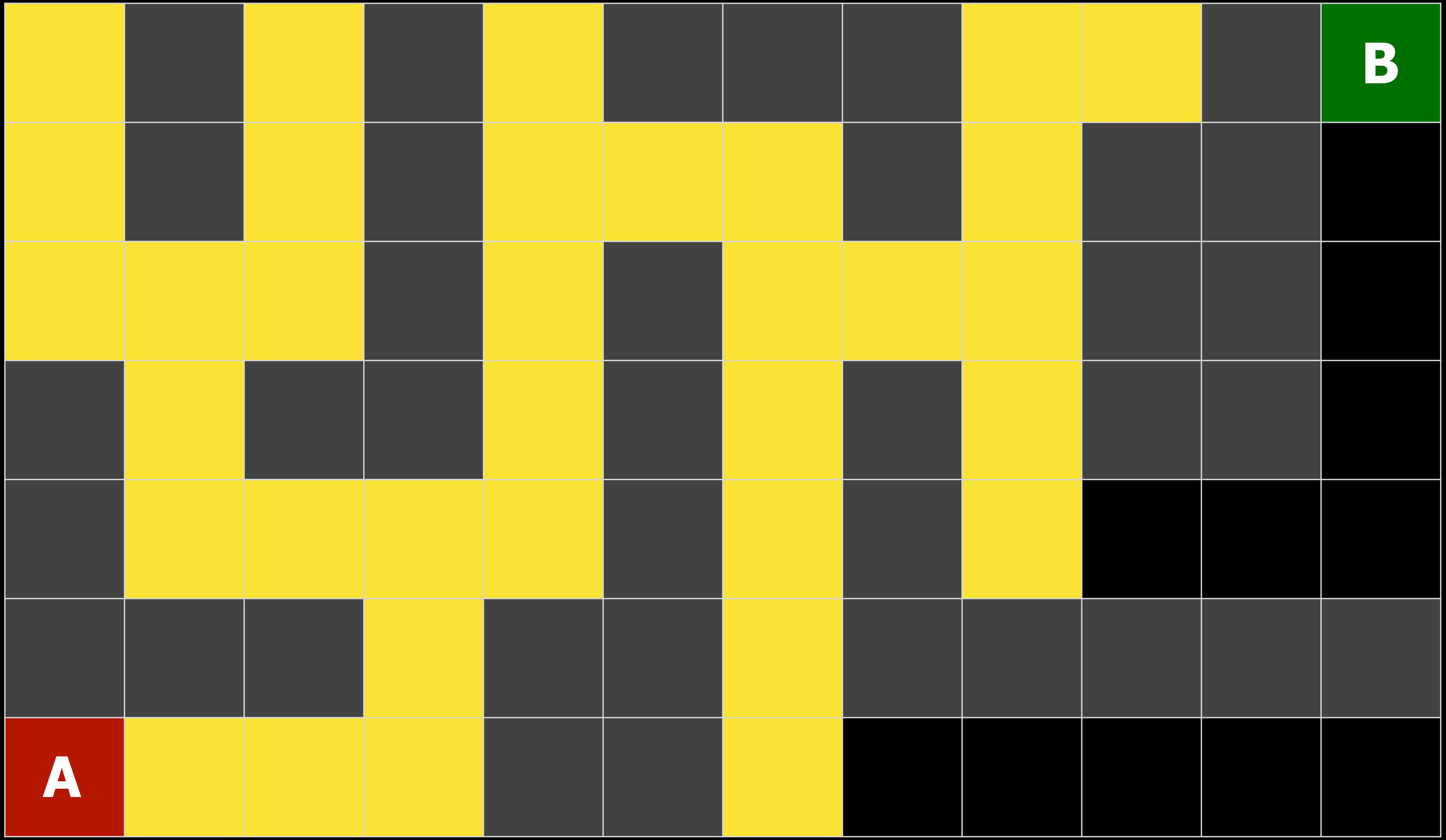

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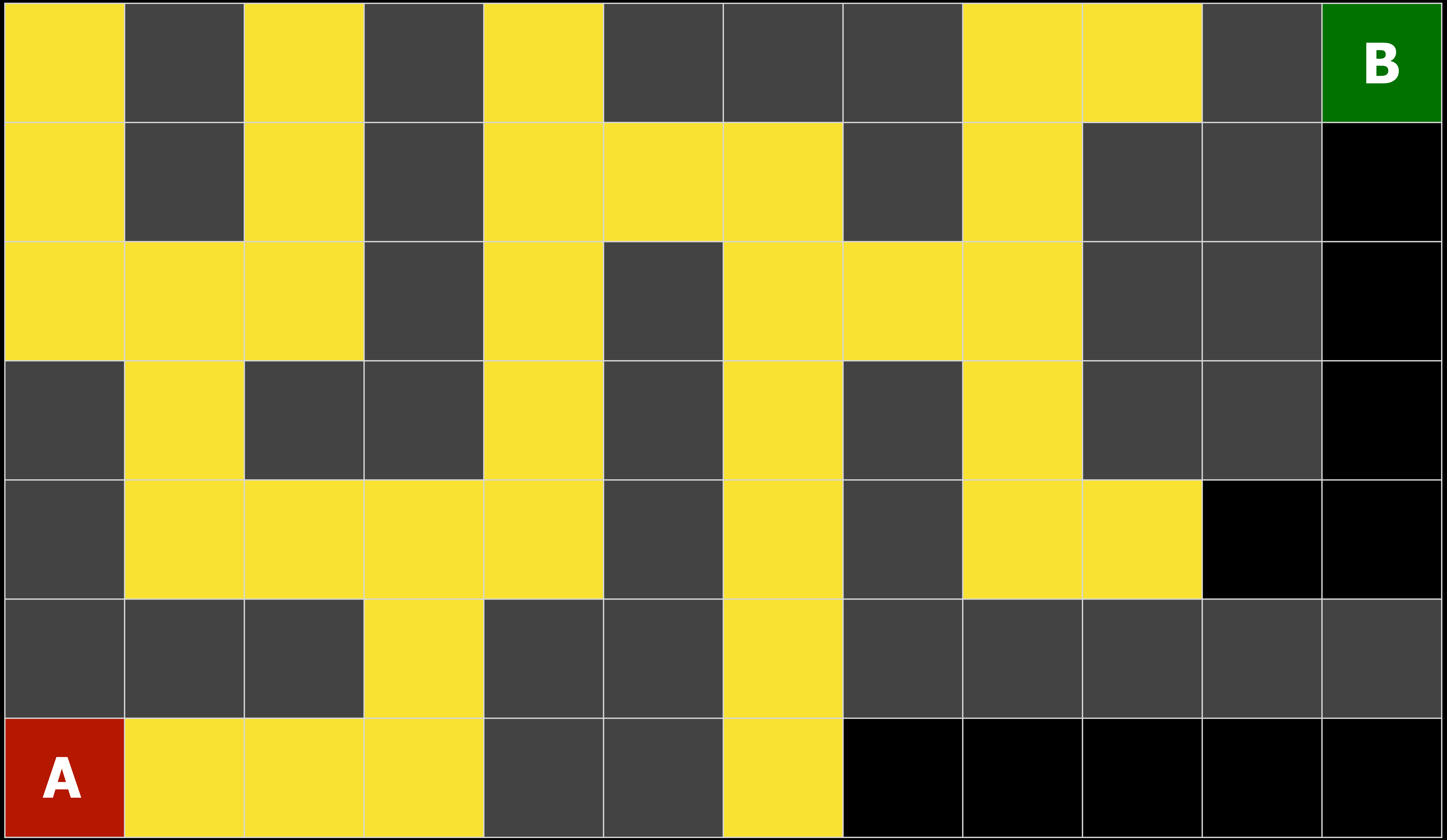

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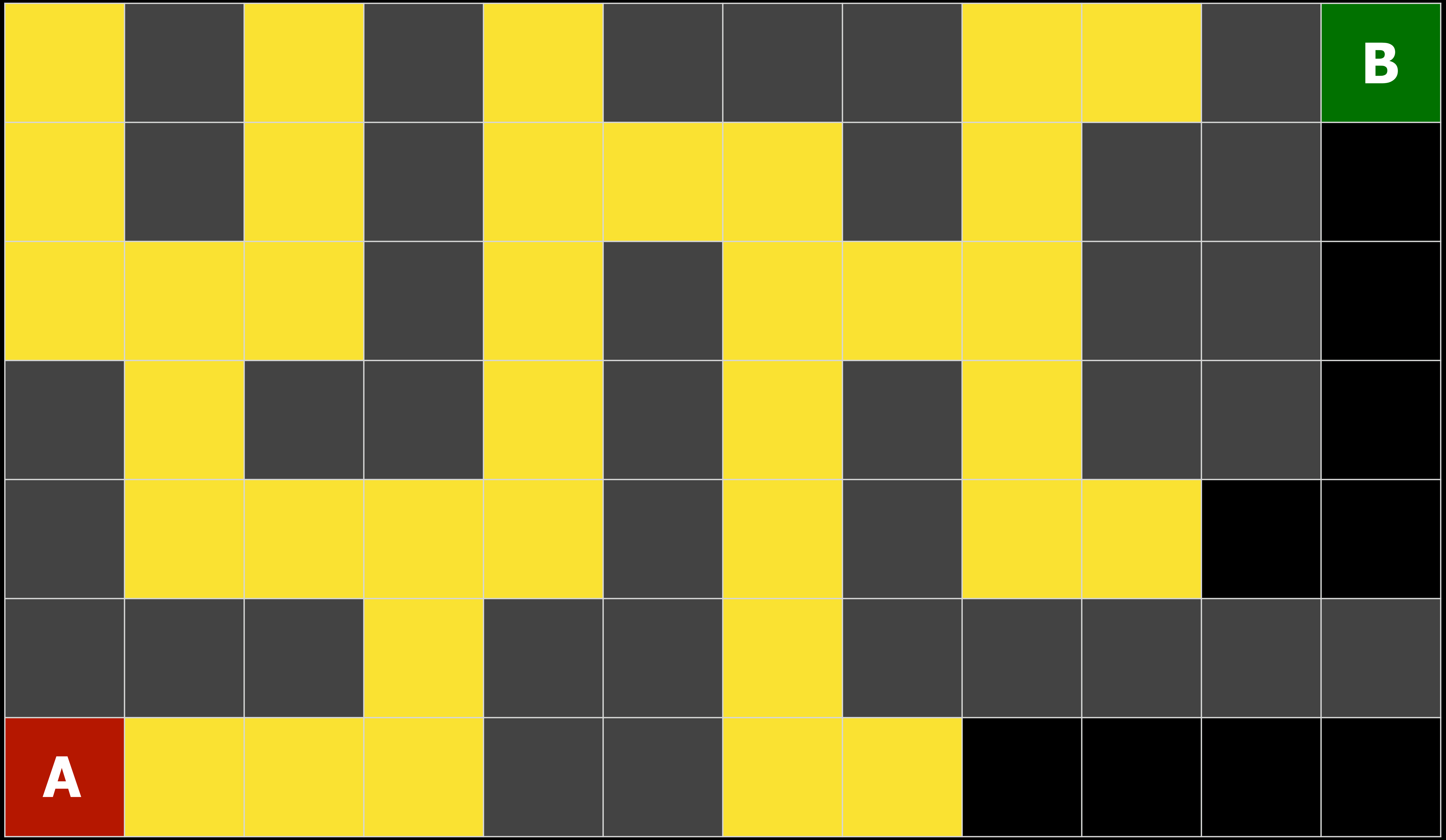

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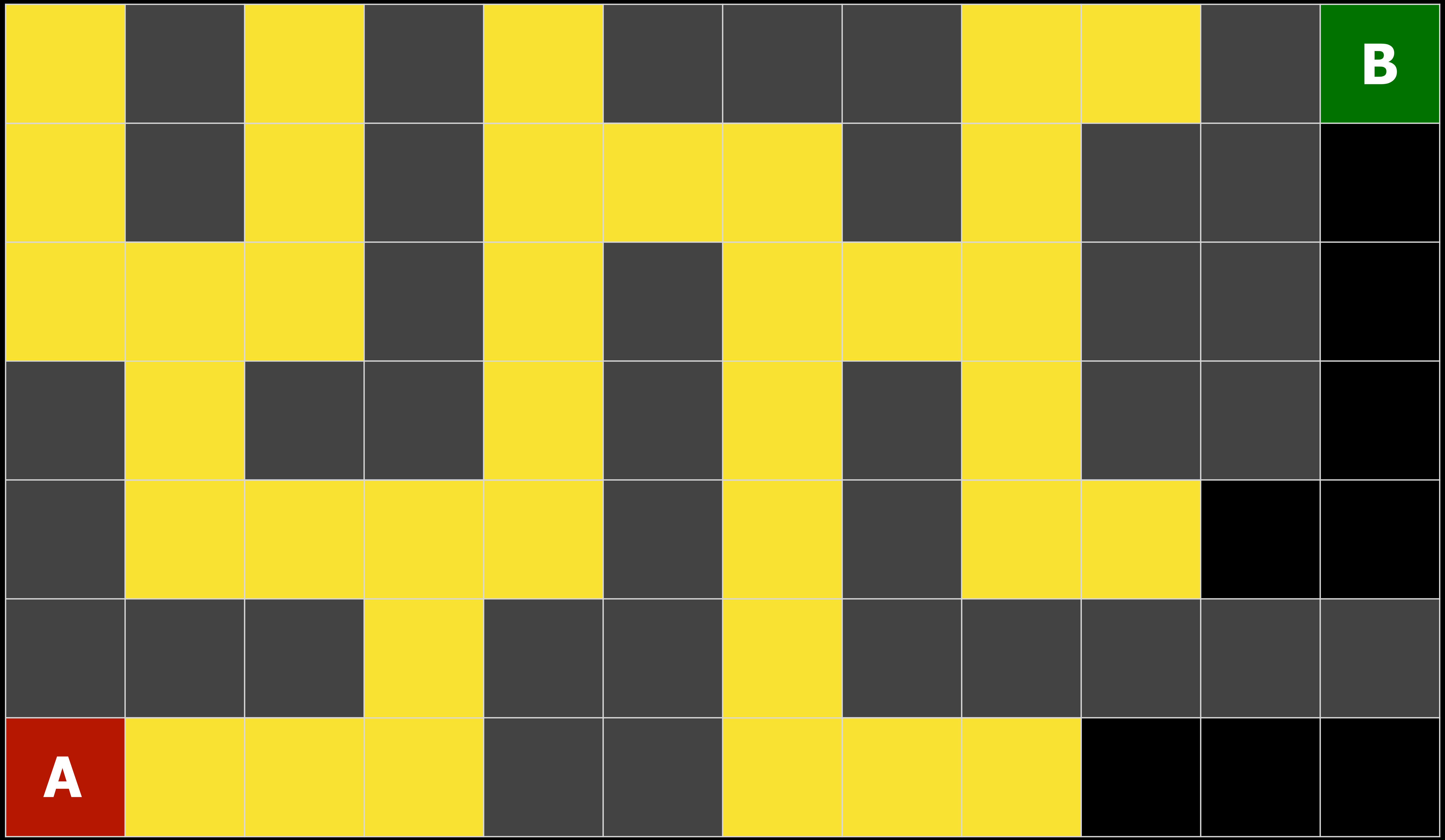

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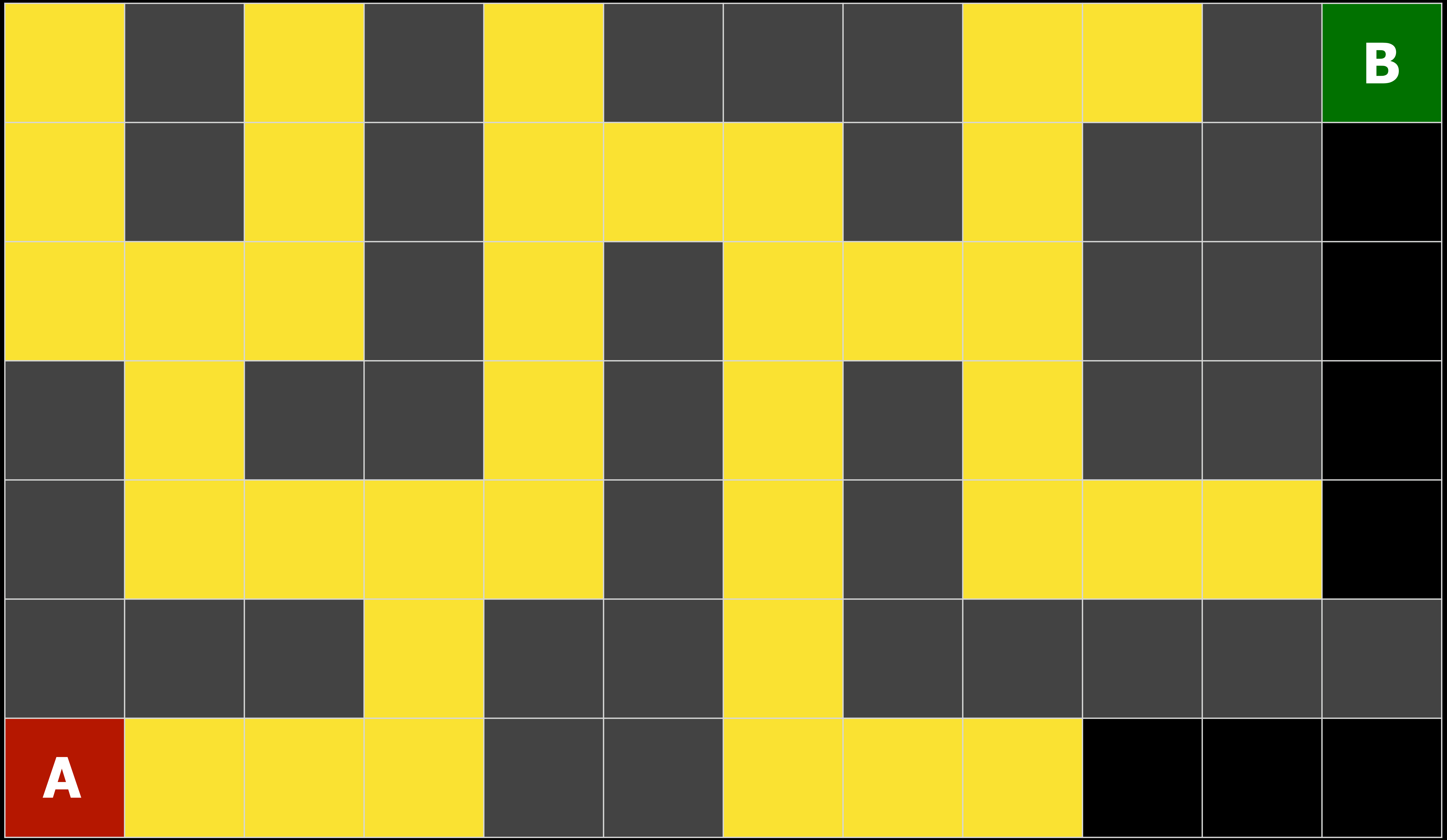

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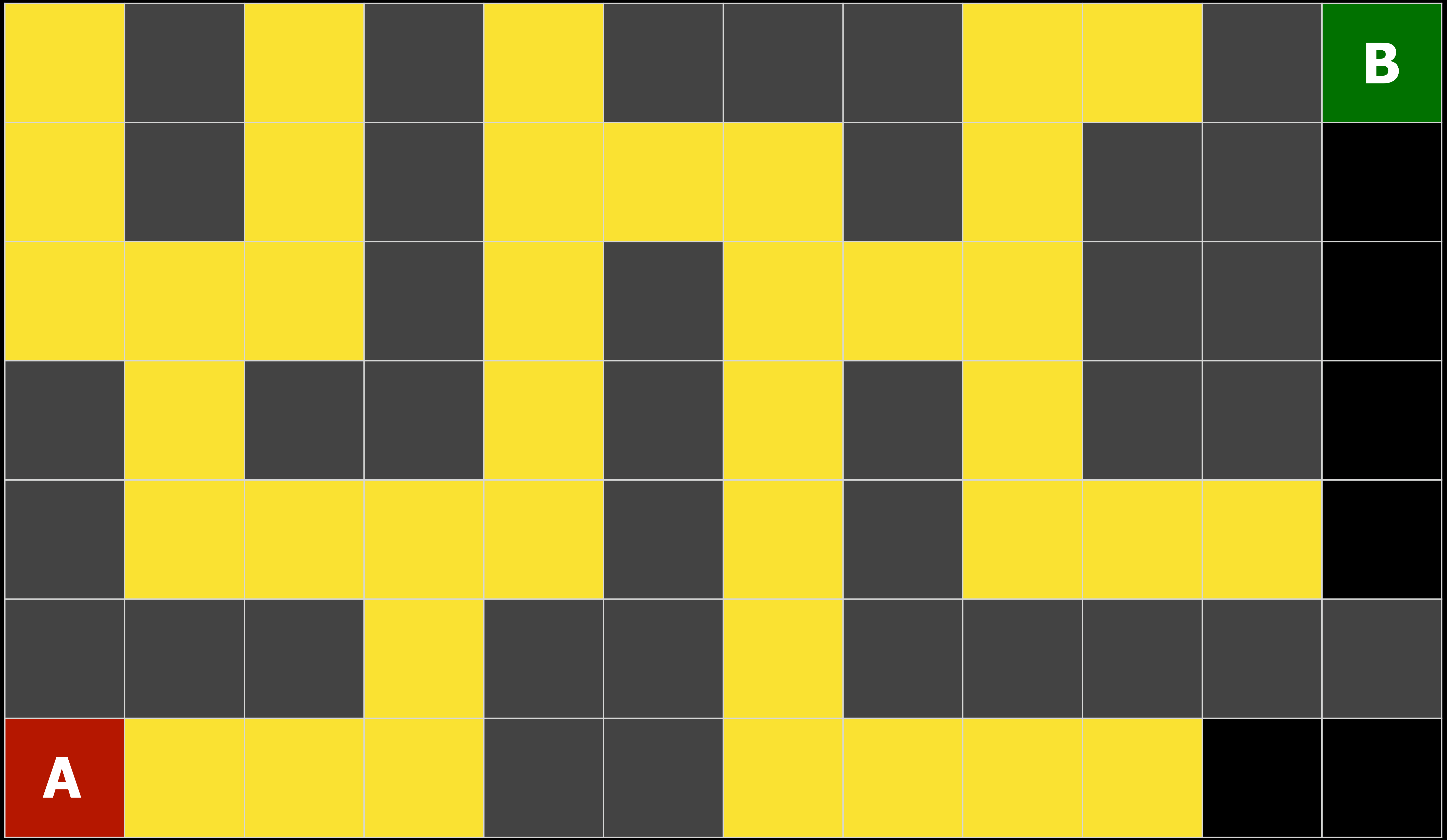

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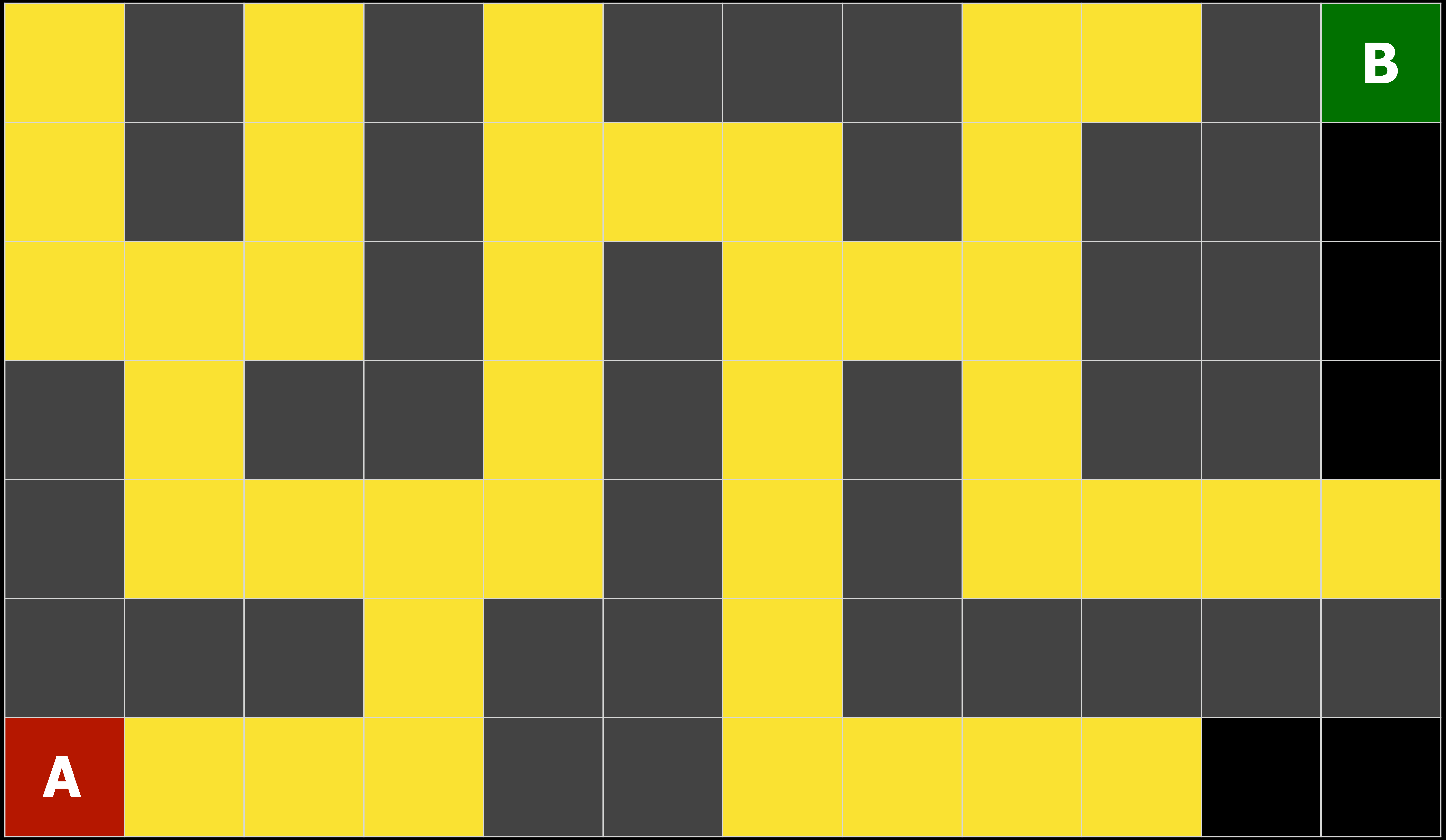

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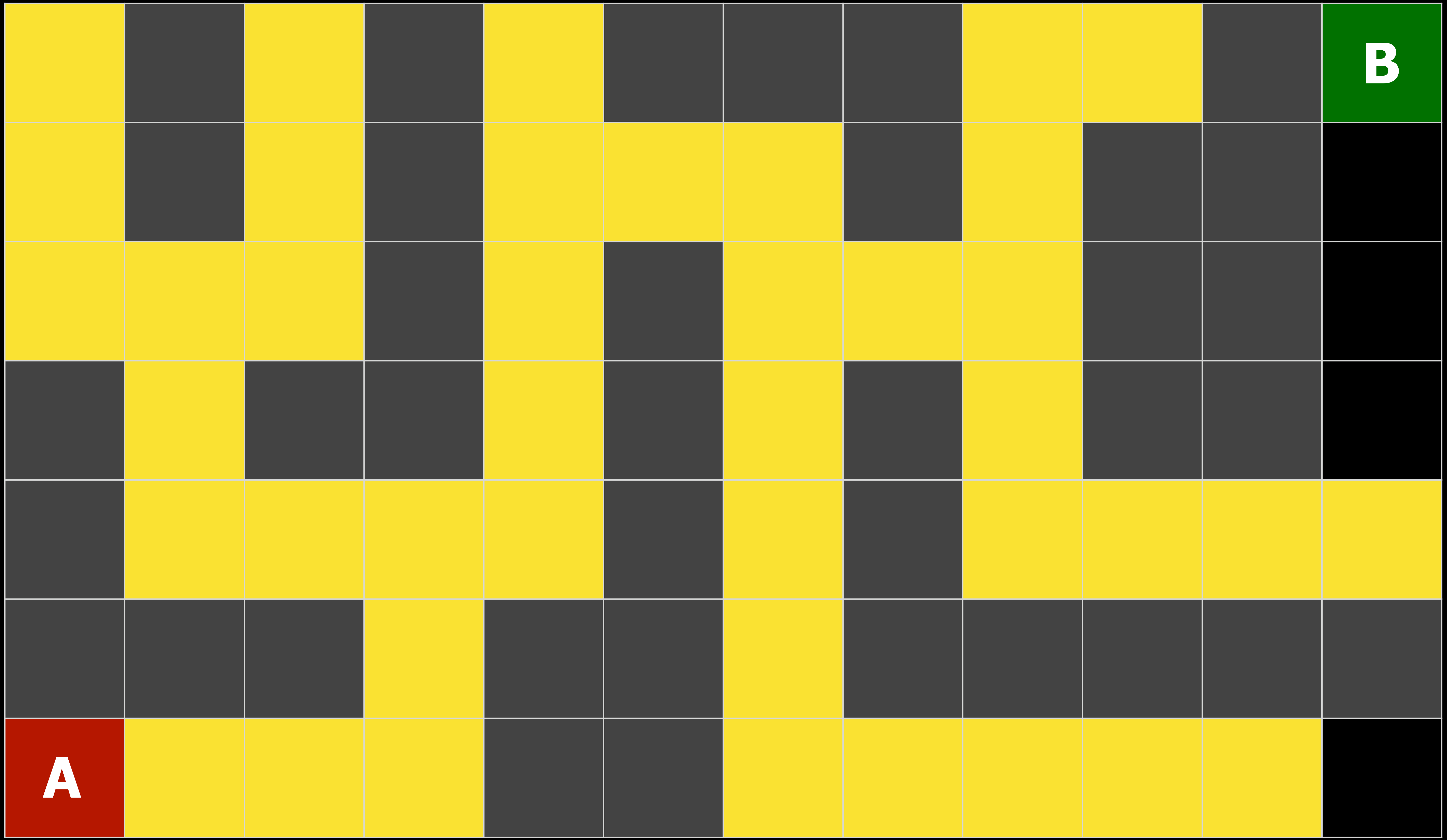

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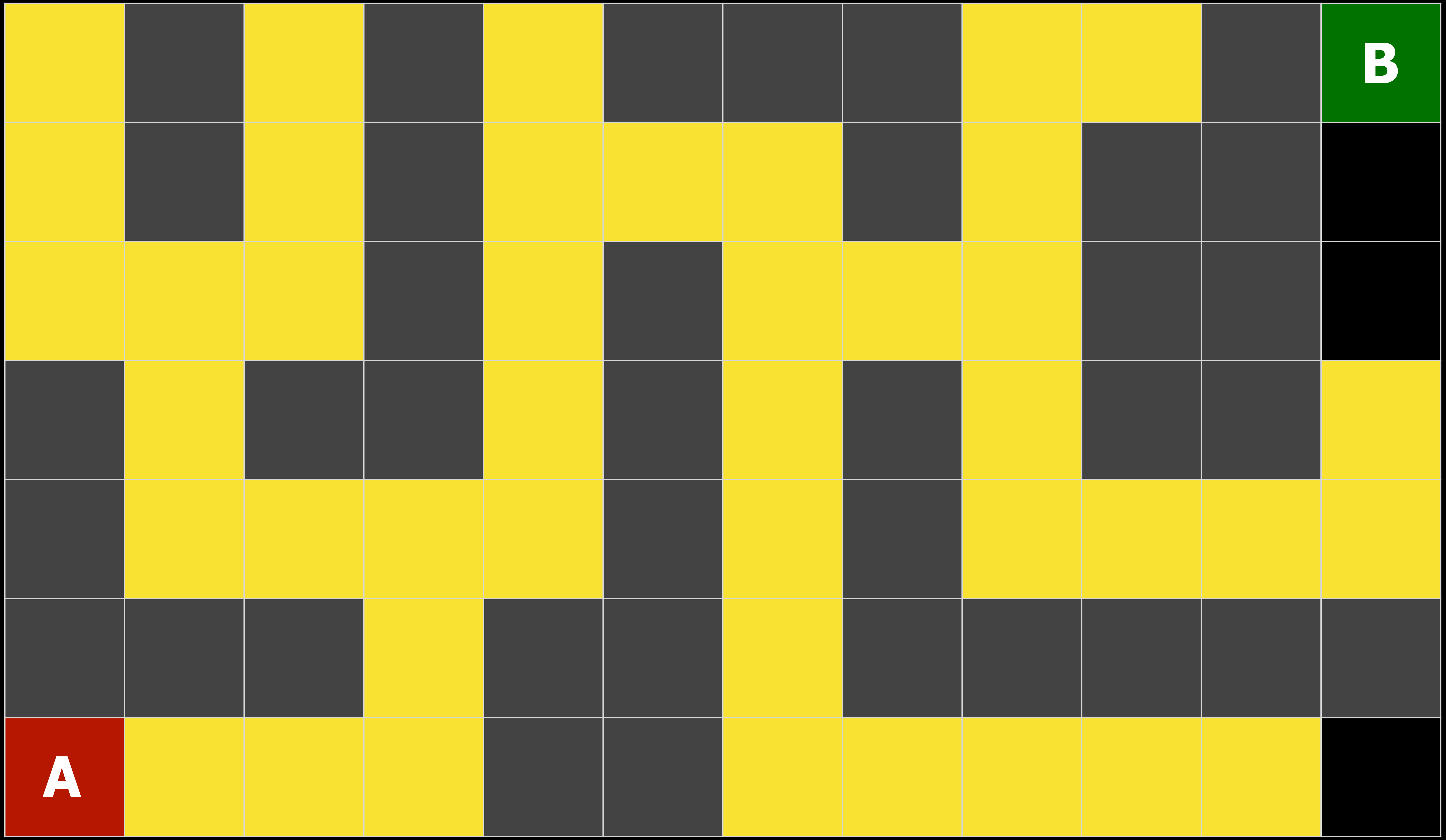

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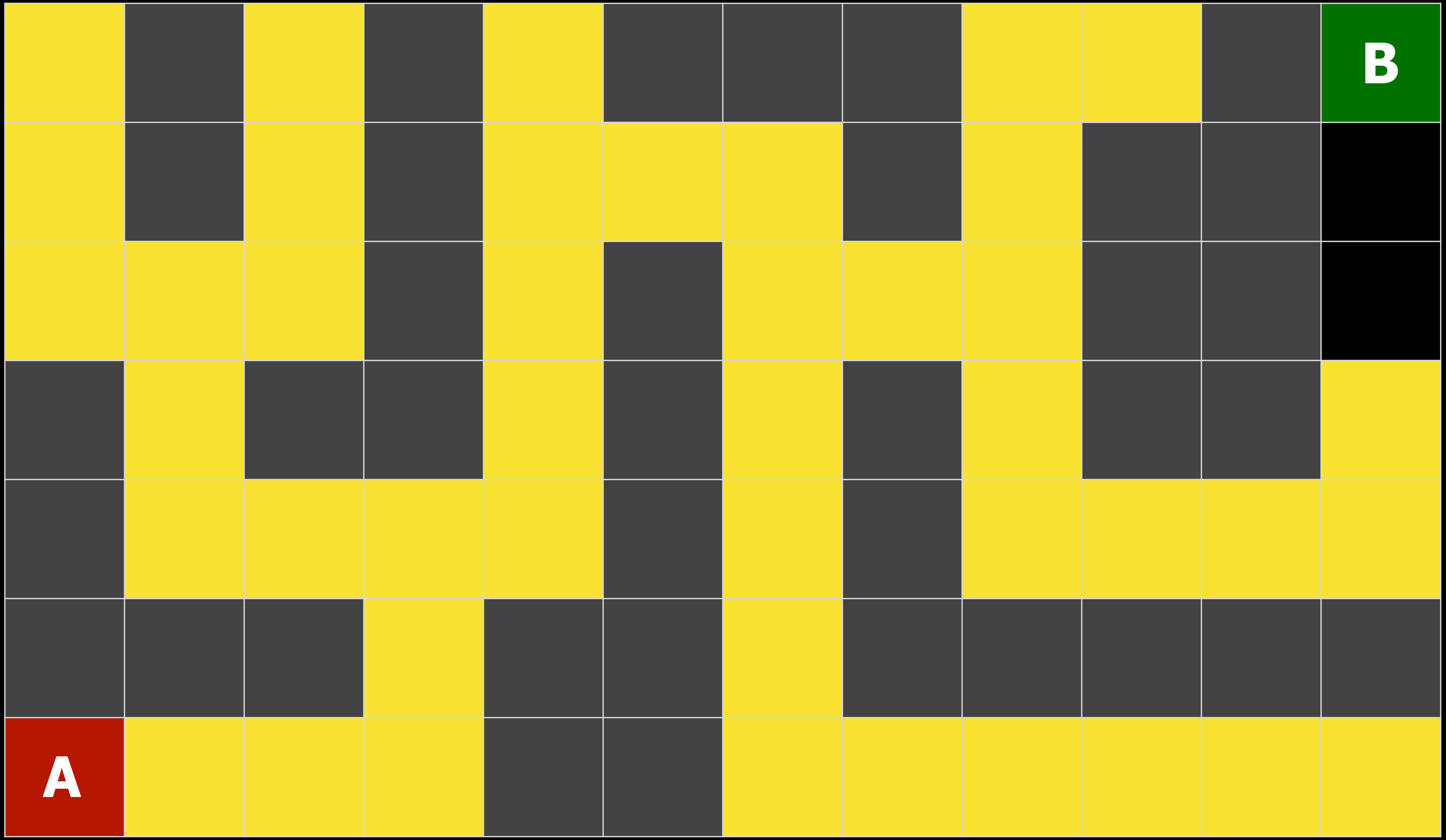

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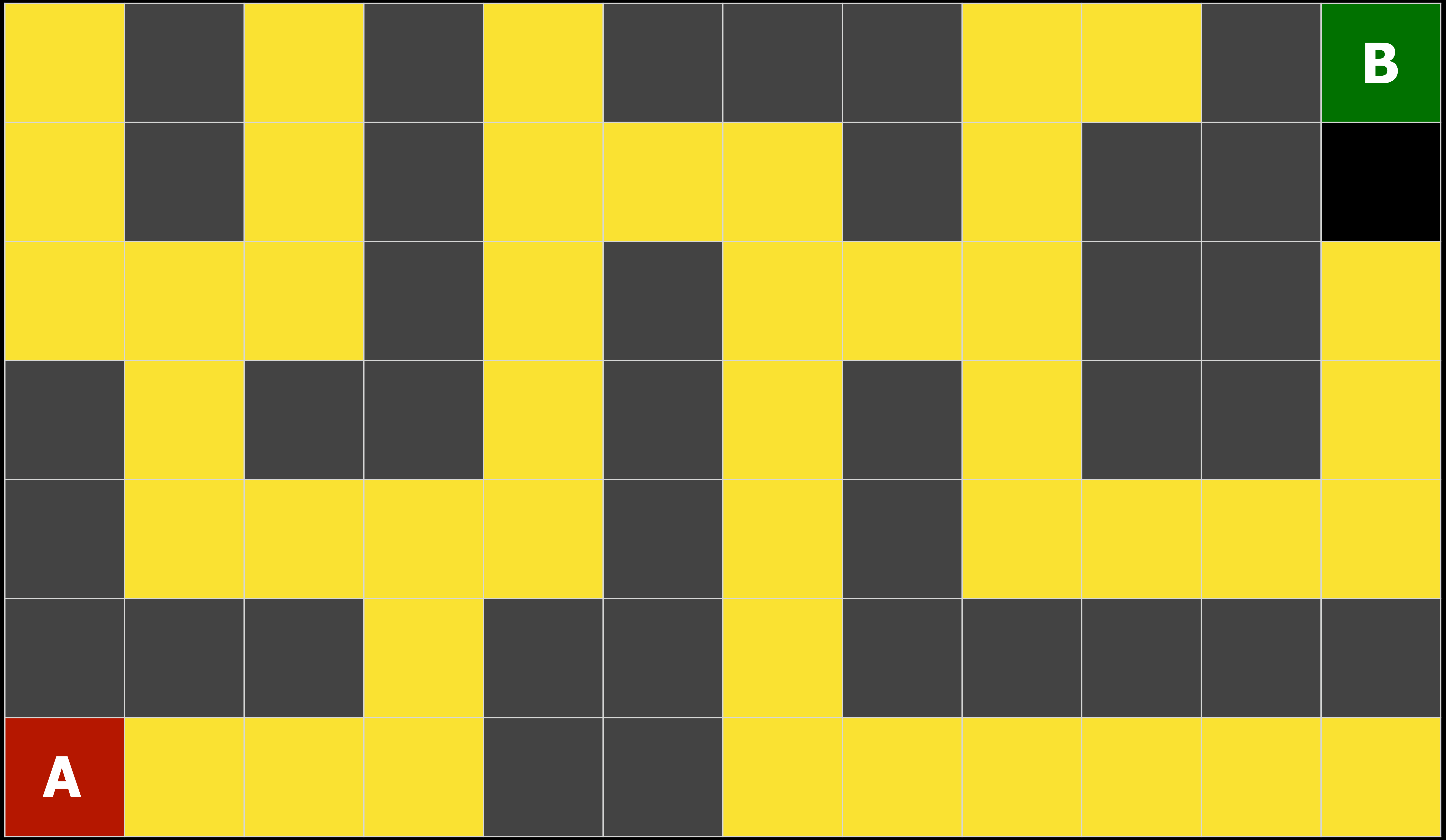

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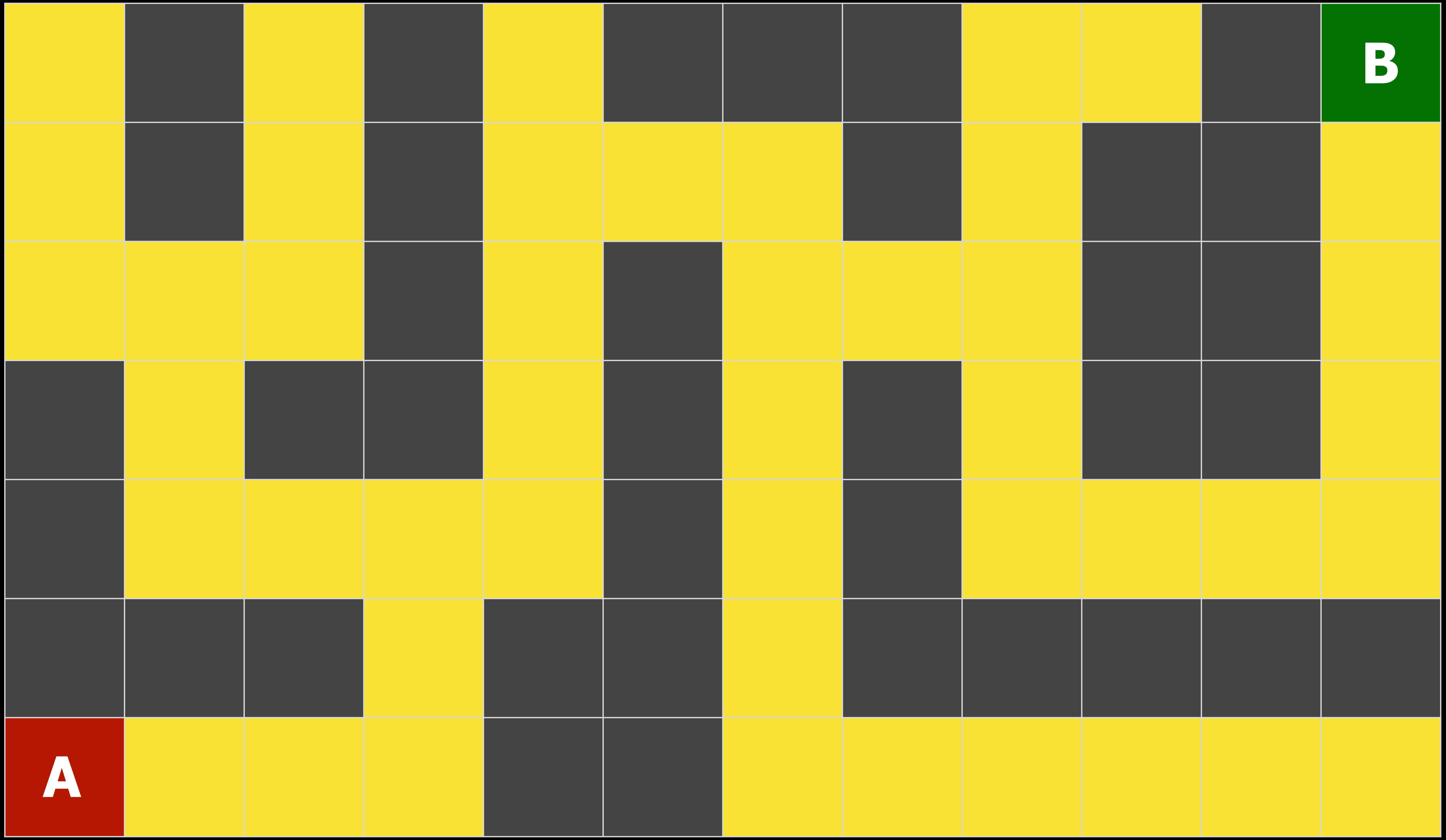

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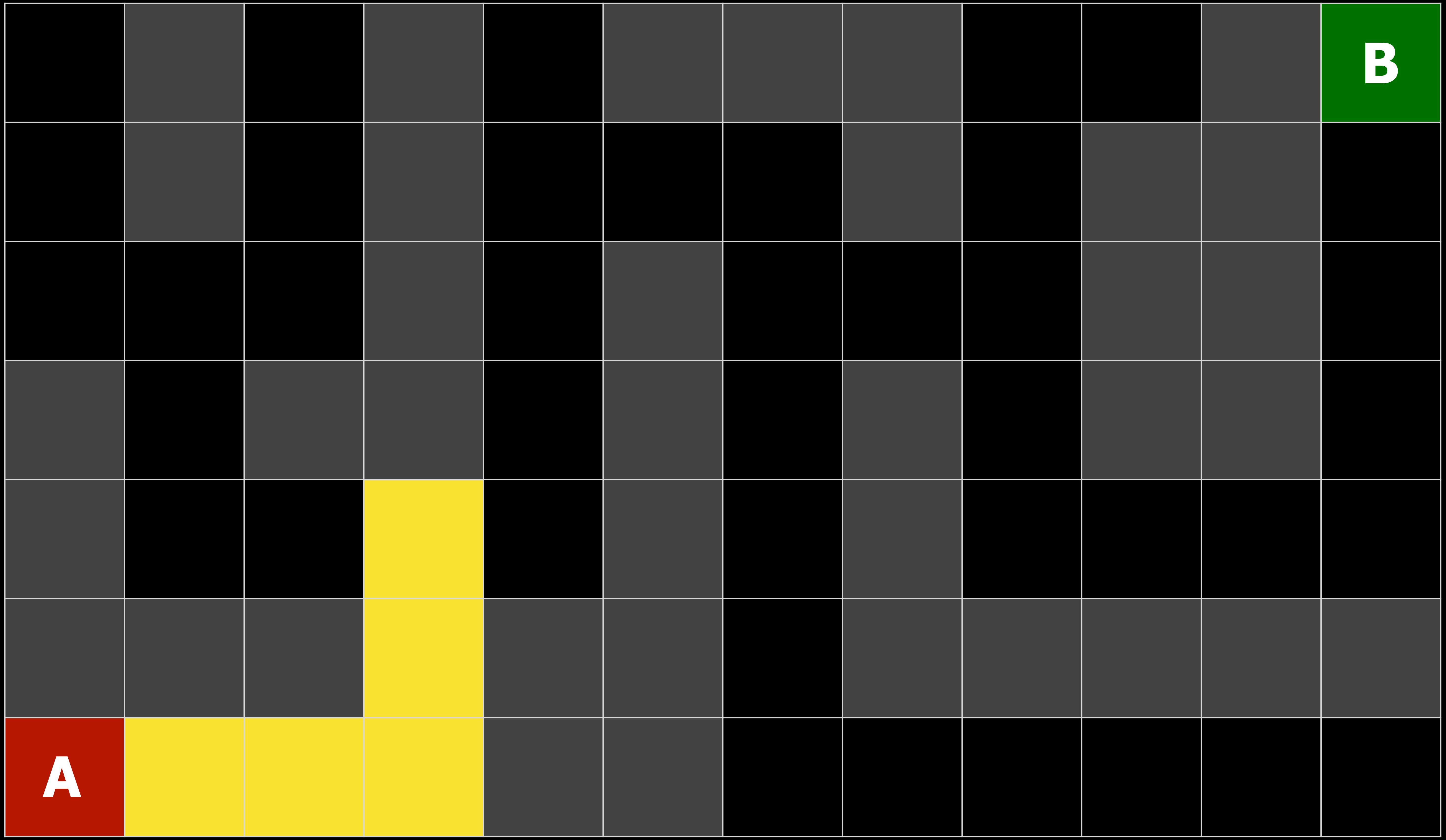

uninformed search

search strategy that uses no problem-specific knowledge.

Ex. : DFS and BFS

Thanks