



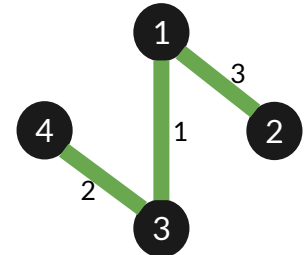
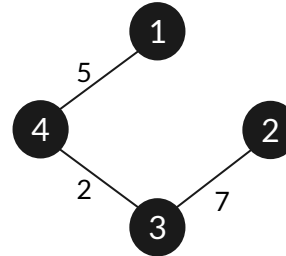
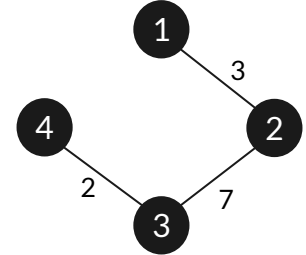
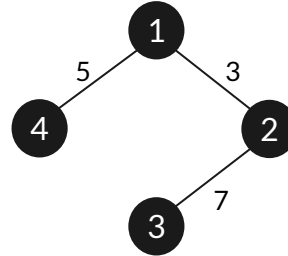
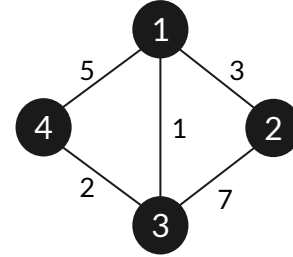
CIS 263 Introduction to Data Structures and Algorithms

Backtracking

Minimum Spanning Tree

- We have to find spanning Trees with the minimum cost
 - Search all combinations
 - Approximation Algorithms
 - **Greedy Algorithms**
 - Prim's Algorithm
 - Kruskal's Algorithm

- Uses heuristics
- Solution may not be optimal





Optimization Problems

Greedy Algorithms

- Mainly Heuristics based

Bruteforce

- Constraints based



Optimization Problems

Greedy Algorithms

- Mainly Heuristics based

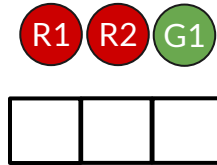
Bruteforce

- Constraints based
- Backtracking



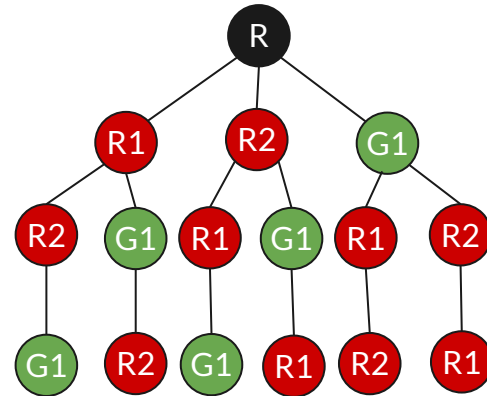
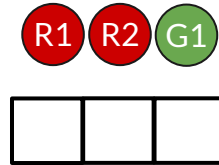
Backtracking

- You have to fill the boxes
- No condition
- $3!$ solutions



Backtracking

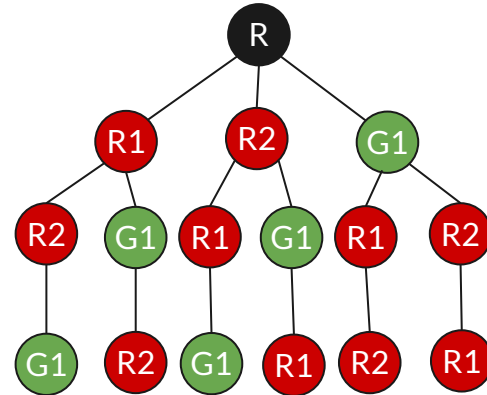
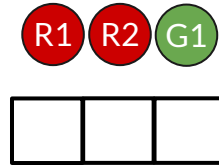
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State Space Tree

Backtracking

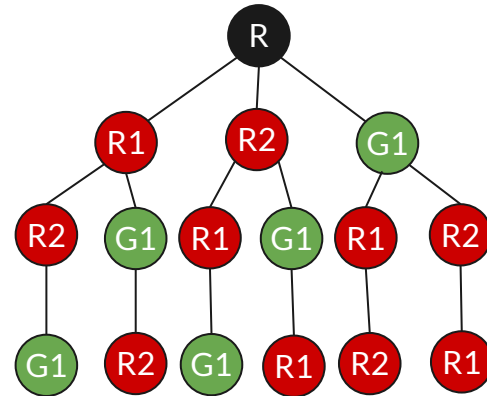
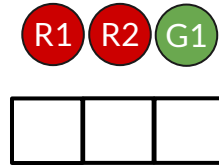
- You have to fill the boxes
- Conditions
 - Green cannot be in the middle
- Exclude some of the 3! Solutions
- Bruteforce search
 - Apply condition as a bounding function
 - Apply Backtracking



State Space Tree

Backtracking

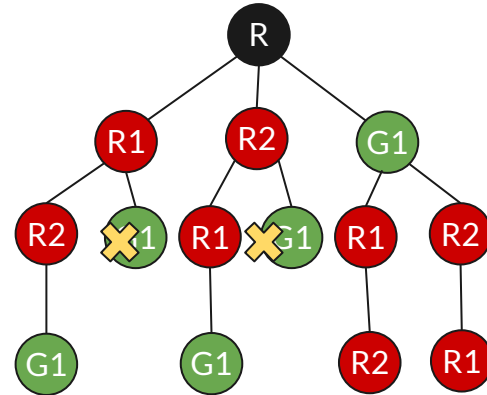
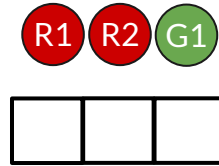
- You have to fill the boxes
- Conditions
 - Green cannot be in the middle
- Exclude some of the 3! Solutions
- Bruteforce search
 - Apply condition as a bounding function
 - Apply Backtracking (Preorder Traversal)



State Space Tree

Backtracking

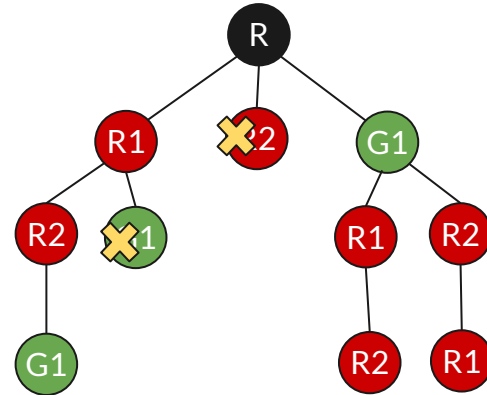
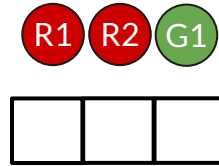
- You have to fill the boxes
- Conditions
 - Green cannot be in the middle
- Exclude some of the 3! Solutions
- Brute force search
 - Apply condition as a bounding function
 - Apply Backtracking (Preorder Traversal)



State Space Tree

Backtracking

- You have to fill the boxes
- Conditions
 - Green cannot be in the middle
 - **R2 cannot be in the first box**
- Exclude some of the 3! Solutions
- Bruteforce search
 - Apply condition as a bounding function
 - Apply Backtracking (Preorder Traversal)

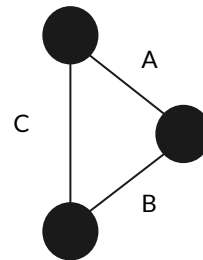


State Space Tree

Backtracking

Graph Coloring Problem

- Condition: Two adjacent nodes cannot have the same color
- Can we do it with 2 colors say {Red, Green}?





Backtracking

?? Problem

- You are asked to make a NHL schedule, and here are the conditions:
 - You have 4 teams: {A, B, C, D}
 - A team can play only one game a day
 - Teams play following a certain format
- Q: What's the minimum number days your schedule will require?



Backtracking

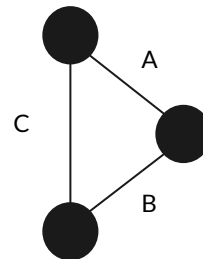
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 - You have 4 teams: {A, B, C, D}
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- Q: What's the minimum number days your schedule will require?
- Lets first try for 3 teams

Backtracking

?? Problem

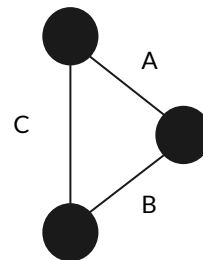
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- Lets first try for 3 teams: {A, B, C}



Backtracking

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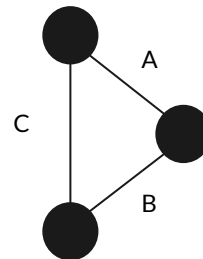
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- Q: What's the minimum number days your schedule will require?
- Lets first try for 3 teams: {A, B, C}
- An equivalent question is: What's the minimum number of colors you will require so no two adjacent colors are the same?



Backtracking

Graph Coloring Problem

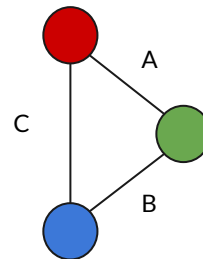
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 - Graph Coloring Problem



Backtracking

Graph Coloring Problem

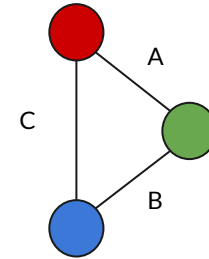
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- Lets first try for 3 teams: {A, B, C}
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 - Graph Coloring Problem
- Answer: 3 days
- Can we do it in less than 3 days?
 - Answer: No



Backtracking

Graph Coloring Problem

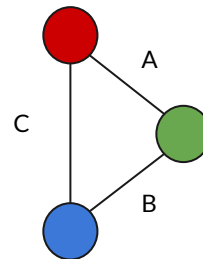
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 - Graph Coloring Problem
- Answer: 3 days
- Can we do it in less than 3 days?
 - Answer: No
- What are your scheduling options; or How many combinations of days/dates you may have?



Backtracking

Graph Coloring Problem

- You are asked to make a NHL schedule, and here are the conditions:
 - You have 4 teams: {A, B, C, D}
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- Q: What's the minimum number days your schedule will require?
- Lets first try for 3 teams: {A, B, C}
- An equivalent question is: What's the minimum number of colors you will require so no two adjacent colors are the same?
 - Graph Coloring Problem
- Answer: 3 days
- Can we do it in less than 3 days?
 - Answer: No
- What are your scheduling options; or How many combinations of days/dates you may have?
 - Answer: We have to generate a SBT for all possibilities just like we did it in our toy example



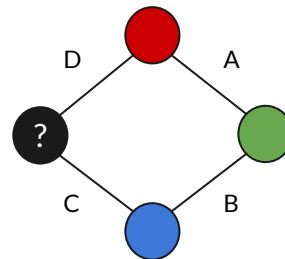


Let's go back to our original question!

Let's go back to our exact question!

Graph Coloring Problem

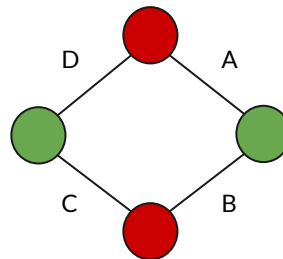
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 - You have 4 teams: {A, B, C, D}
 - A team can play only one game a day
 - Teams play following a certain format
- Q: What's the minimum number days your schedule will require? 4 or 3 or some other number of days ?



Let's go back to our exact question!

Graph Coloring Problem

- You are asked to make a NHL schedule, and here are the conditions:
 - You have 4 teams: {A, B, C, D}
 - A team can play only one game a day
 - Teams play following a certain format
- Q: What's the minimum number days your schedule will require? or 3 or some other number of days ?
- Answer: 2 days (2 colors), for the setup on the right.

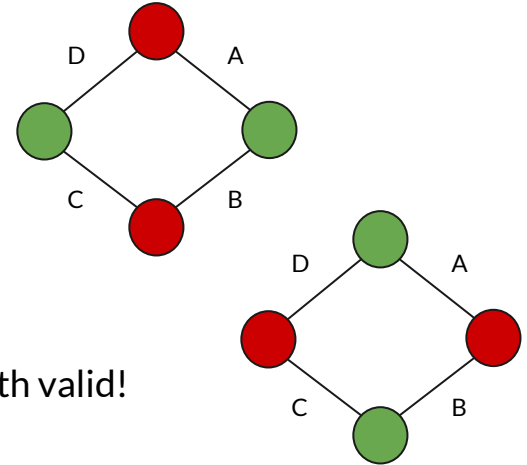


Is this the only solutions?

Let's go back to our exact question!

Graph Coloring Problem

- You are asked to make a NHL schedule, and here are the conditions:
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- Q: What's the minimum number days your schedule will require? or 3 or some other number of days?
- Answer: 2 days (2 colors), for the setup on the right.
- What are your scheduling options; or How many combinations of days/dates you may have?

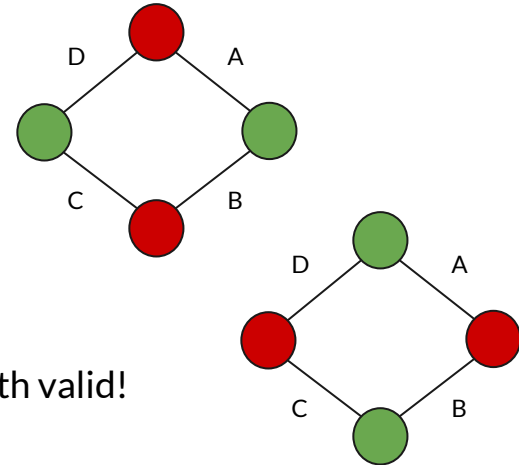


Both valid!

Let's go back to our exact question!

Graph Coloring Problem

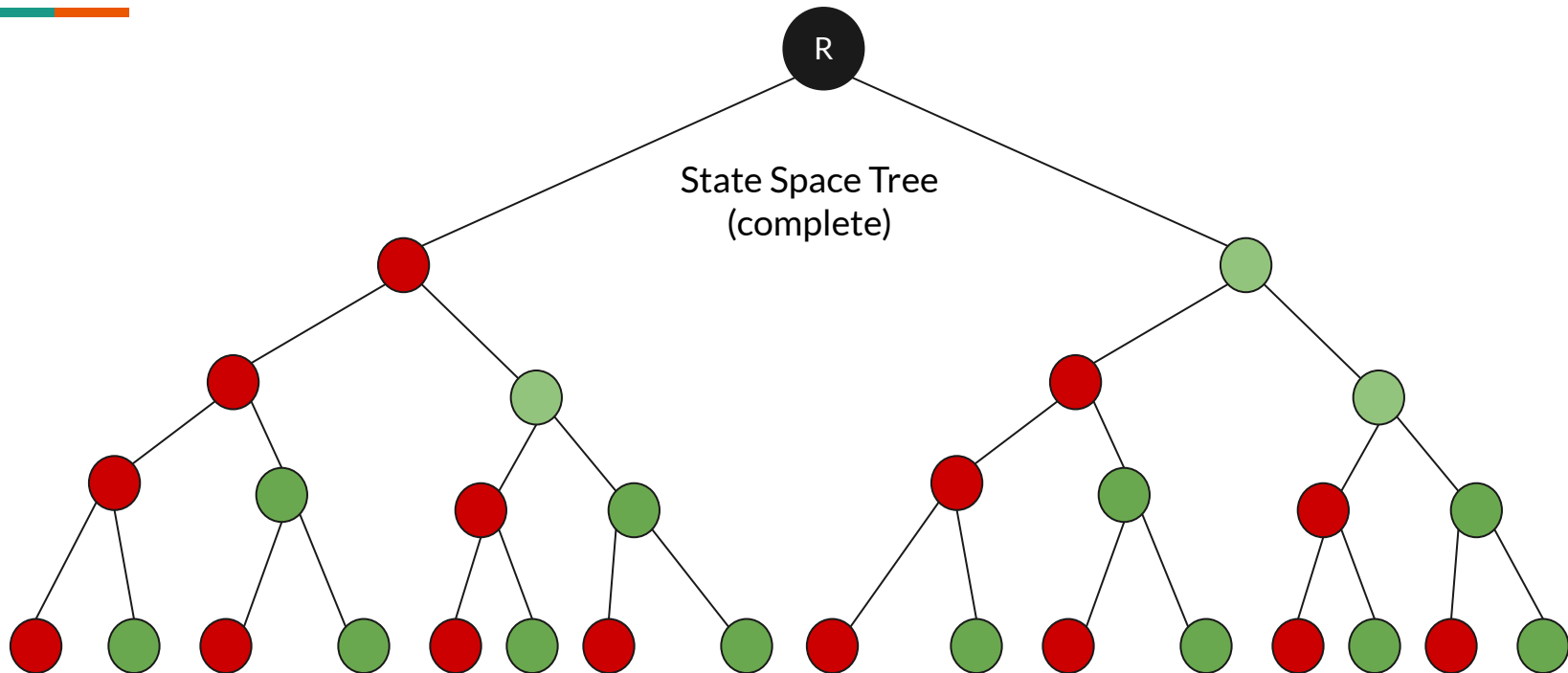
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 - You have 4 teams: {A, B, C, D}
 - A team can play only one game a day
 - Teams play following a certain format
- Q: What's the minimum number days your schedule will require? 4 or 3 days?
- Answer: 2 days (2 colors), for the setup on the right.
- What are your scheduling options; or How many combinations of days/dates you may have?
 - Backtracking solution



Both valid!



A
B
C
D
A





A
|
B
|
C
|
D
|
A

