

CS514: Design and Analysis of Algorithms

Recursion: Backtracking



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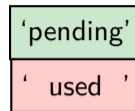
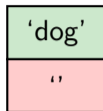
<https://www.iitp.ac.in/~arijit/>

Permutation Generation

- Given the string `dog`, generate all possible permutations

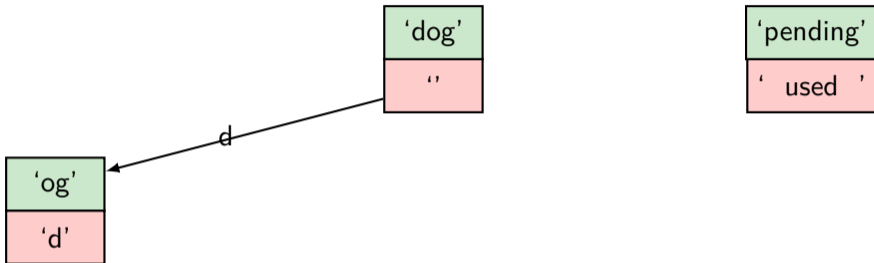
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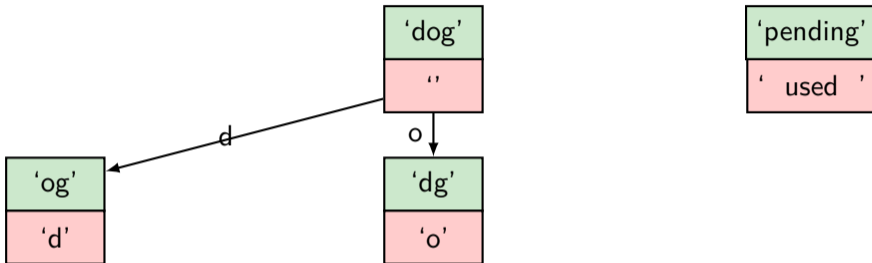
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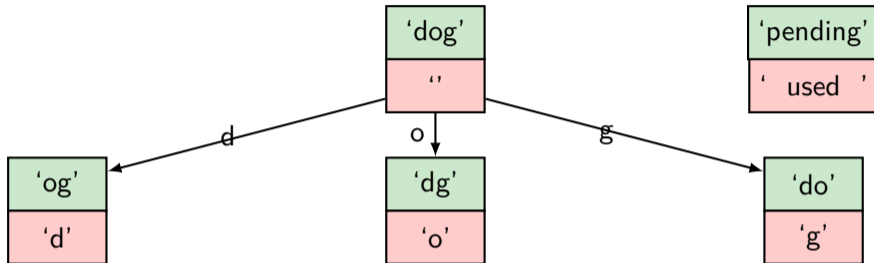
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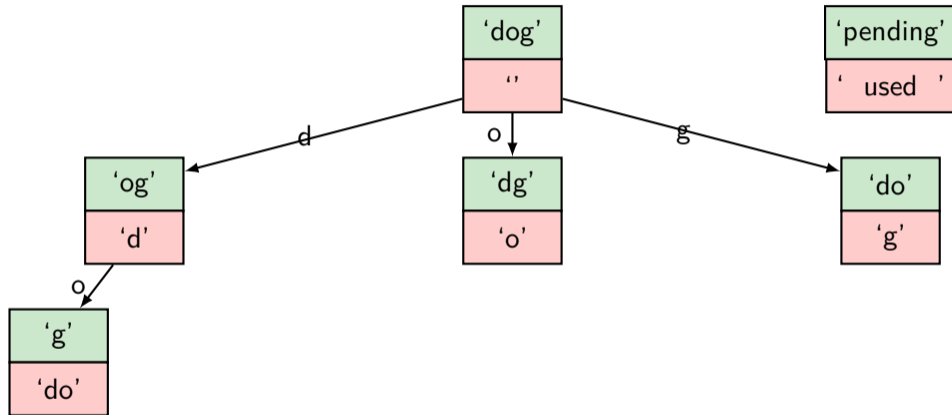
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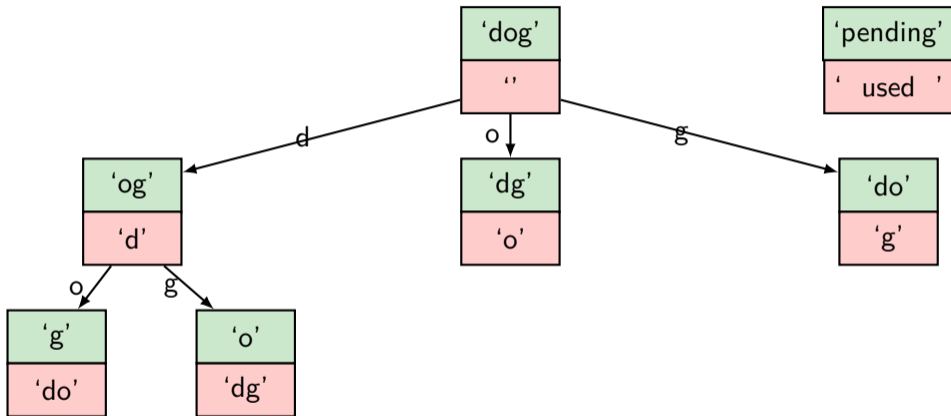
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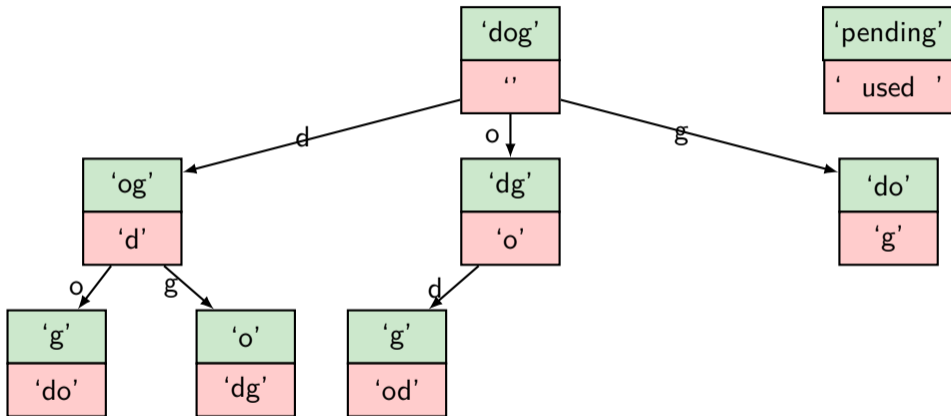
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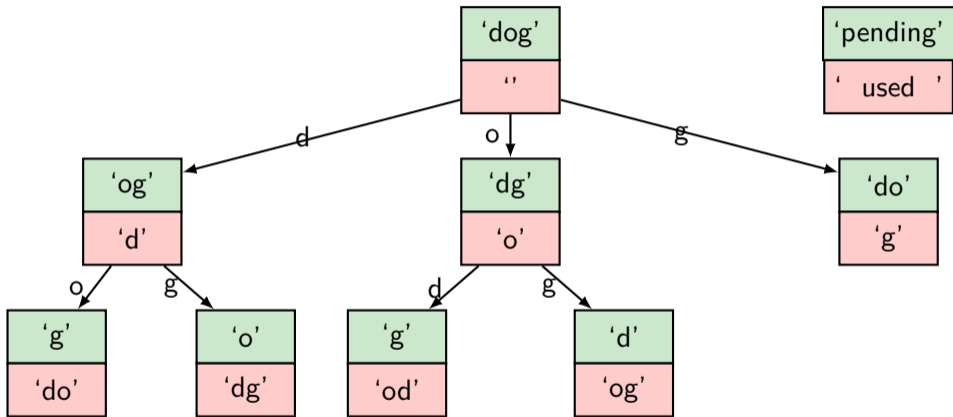
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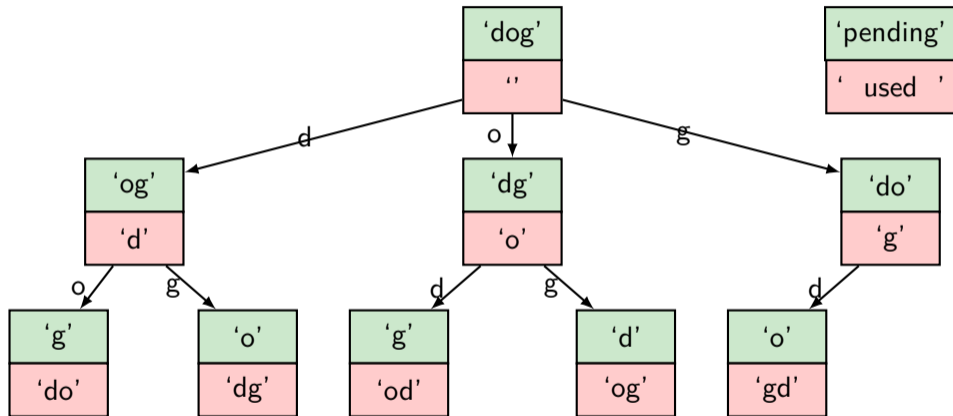
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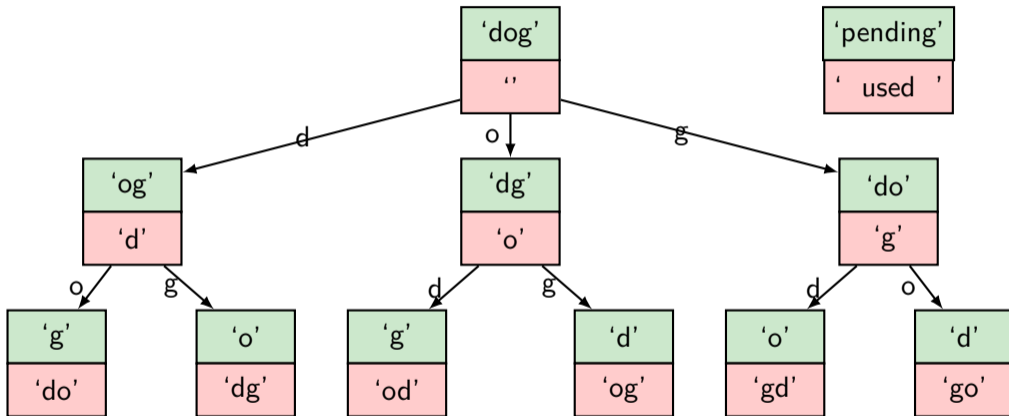
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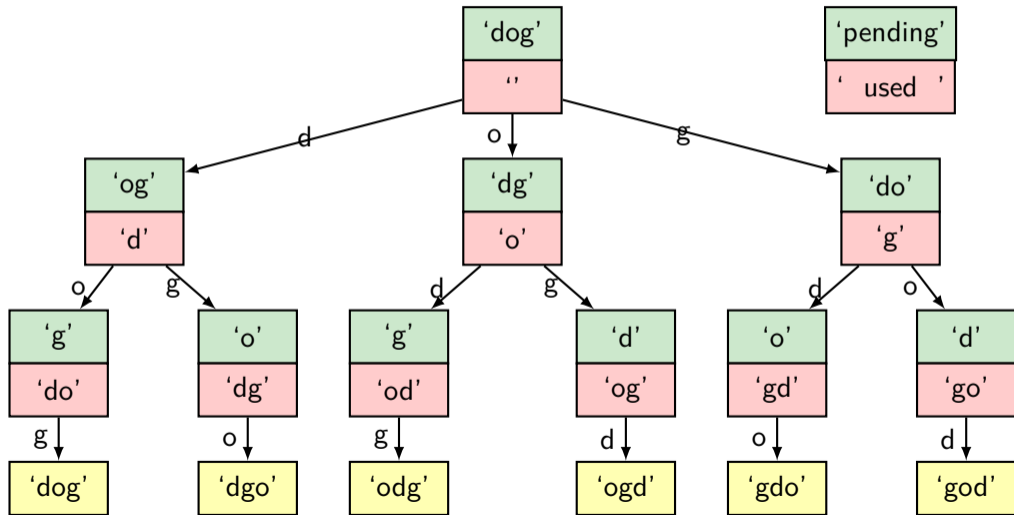
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Permutation Generation

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Permutation Generation

- permutation(pending, used)
 1. if length(pending)==0 { print used; return }
 2. for i=1 to length(pending)
 3. c = pending[i]
 4. rest = pending[1..(i-1)(i+1)...]
 5. permutation(rest, {used}*{c})

Combination Generation

- Given the string `dog`, generate all possible combinations of the characters

Combination Generation

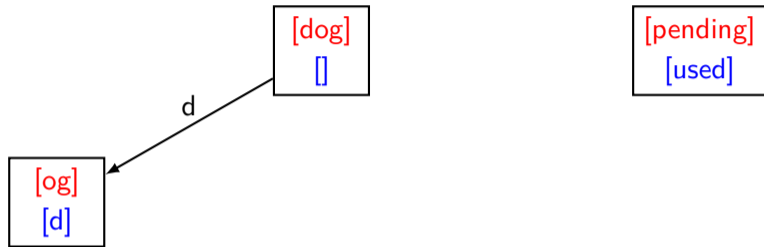
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[dog]
[]

[pending]
[used]

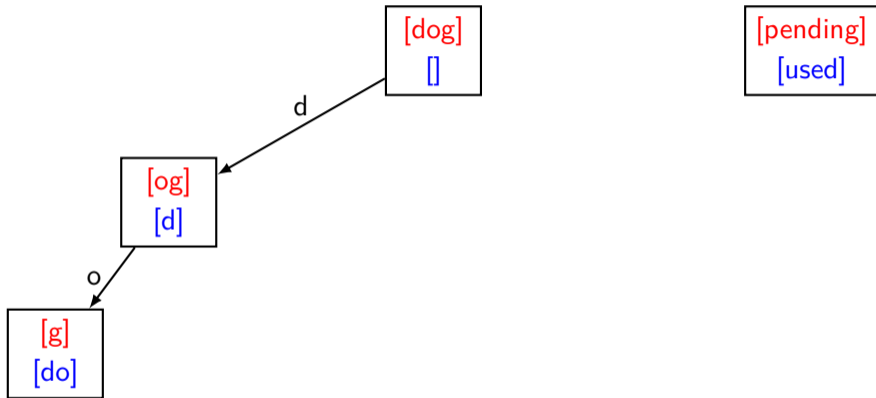
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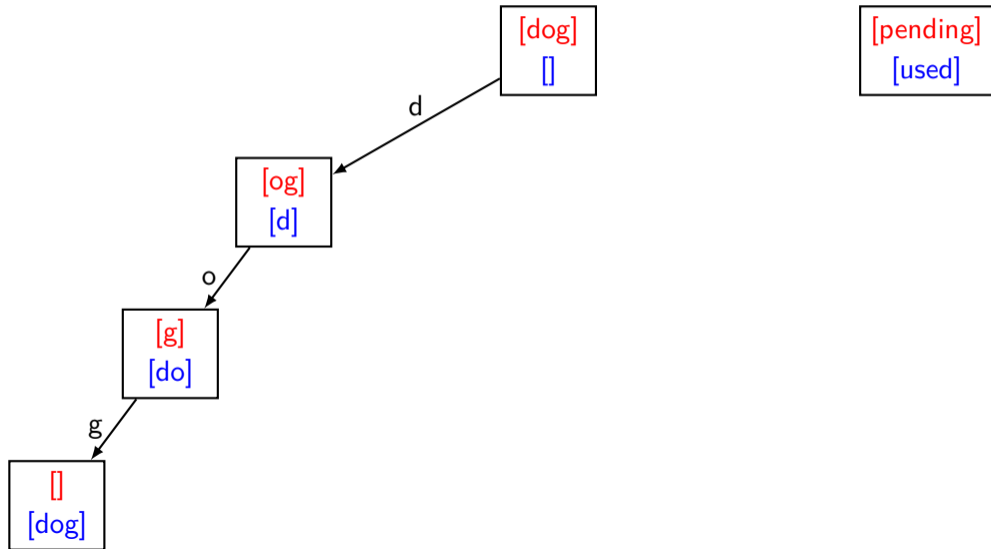
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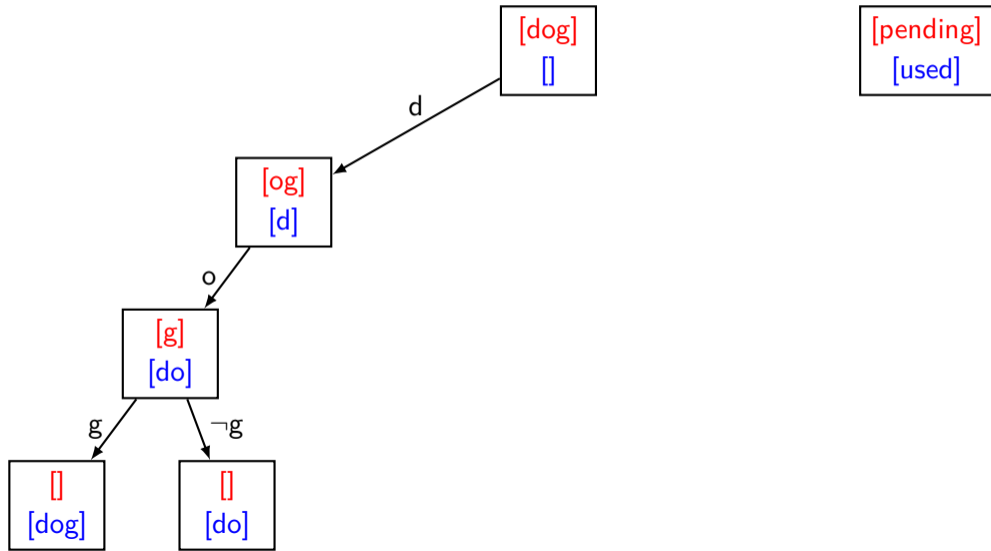
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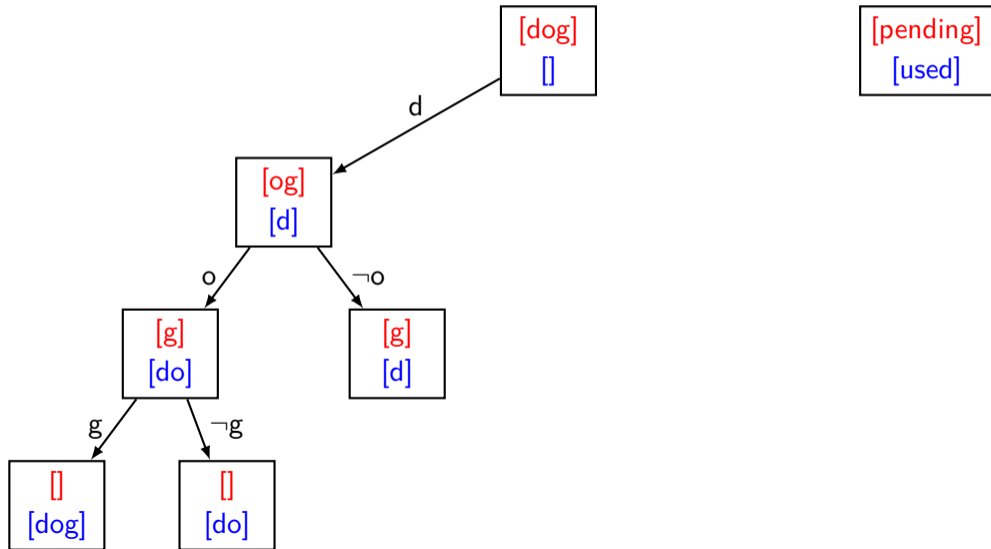
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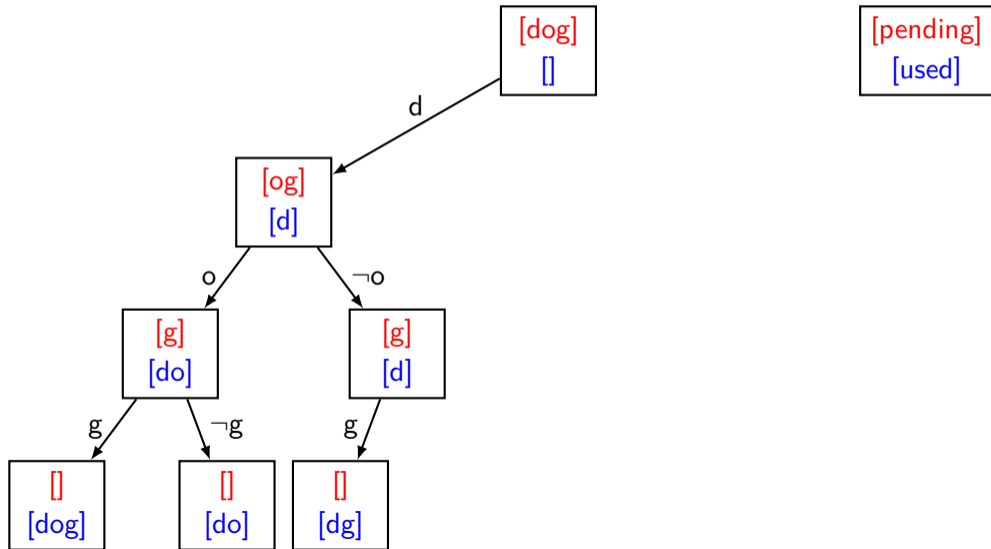
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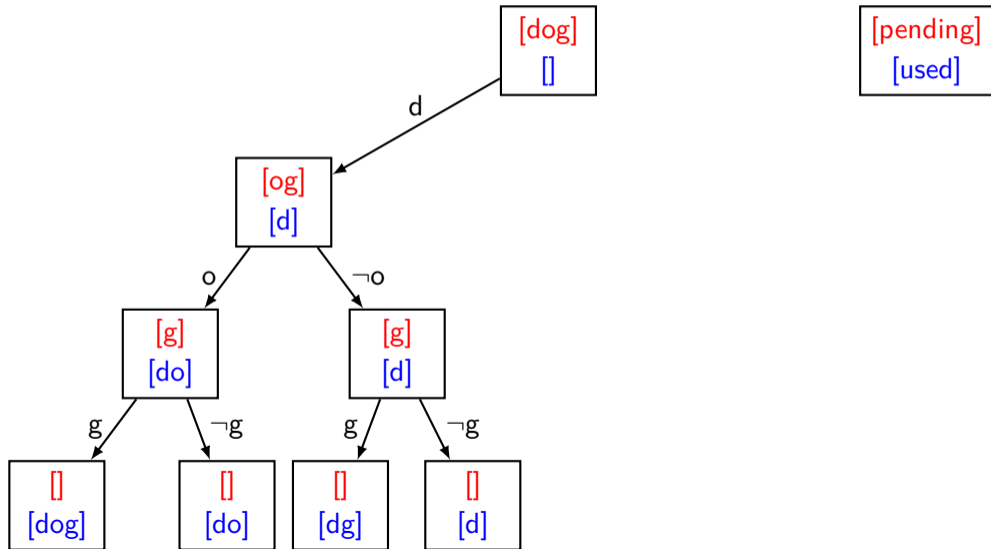
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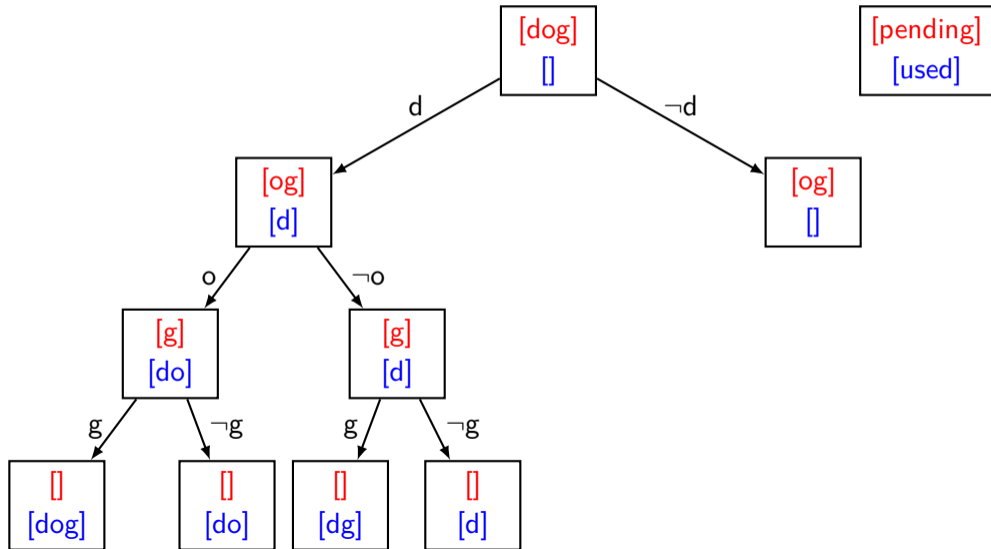
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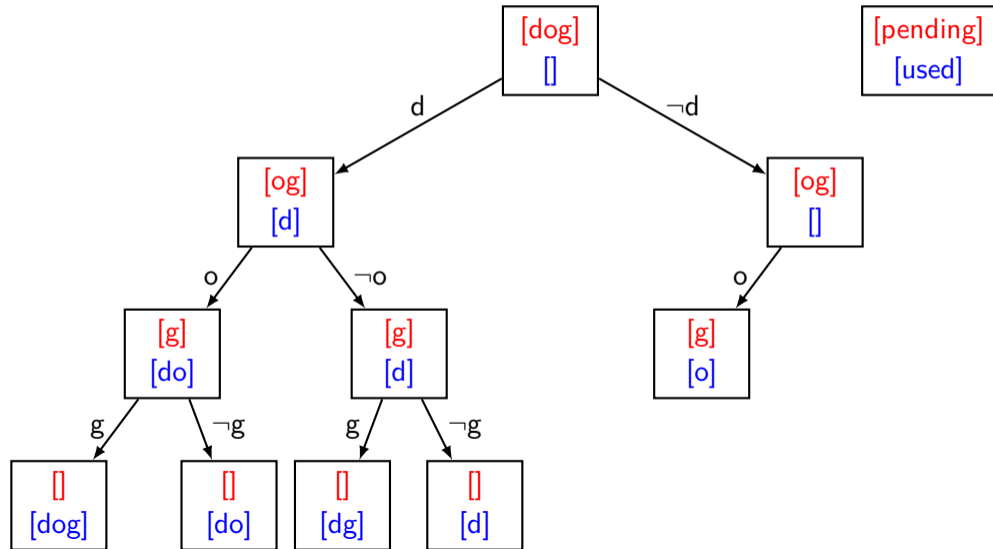
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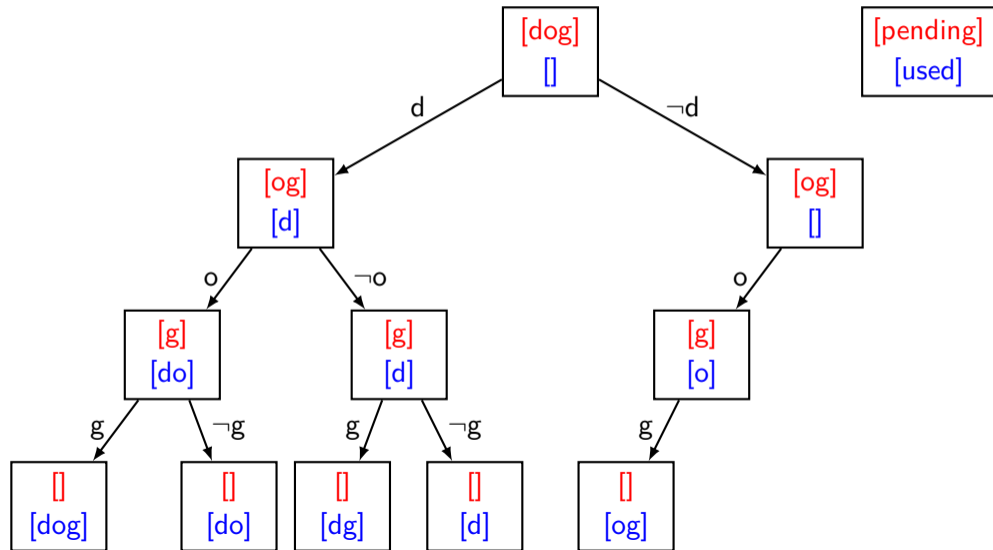
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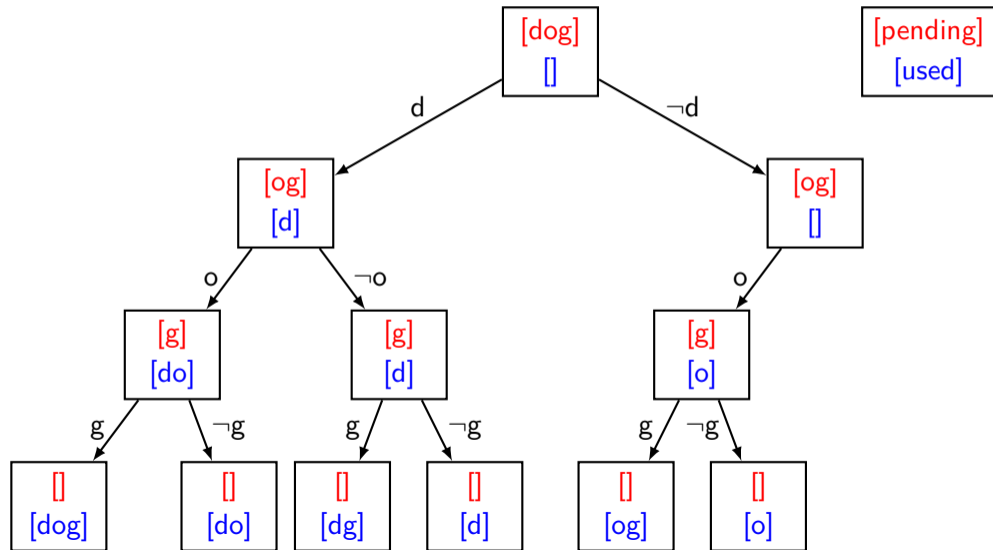
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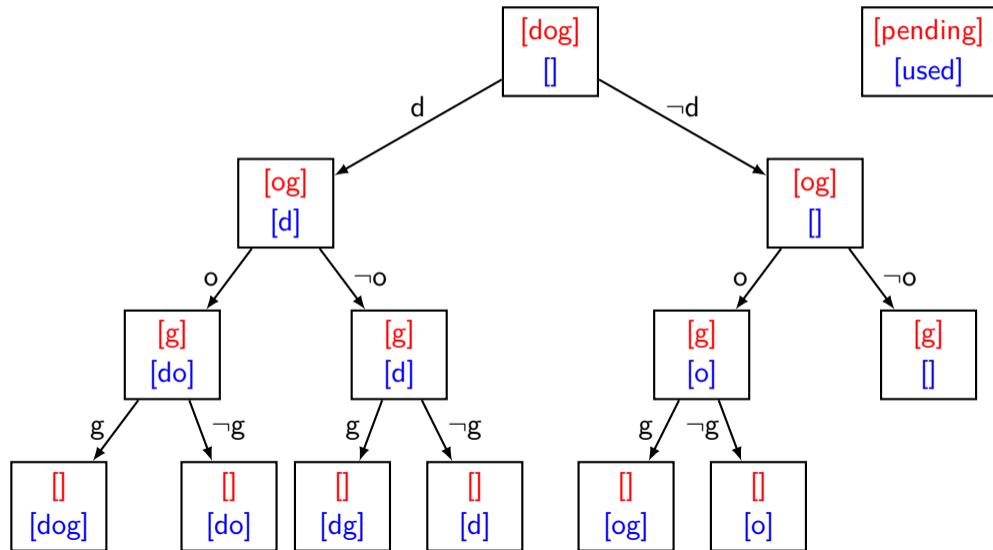
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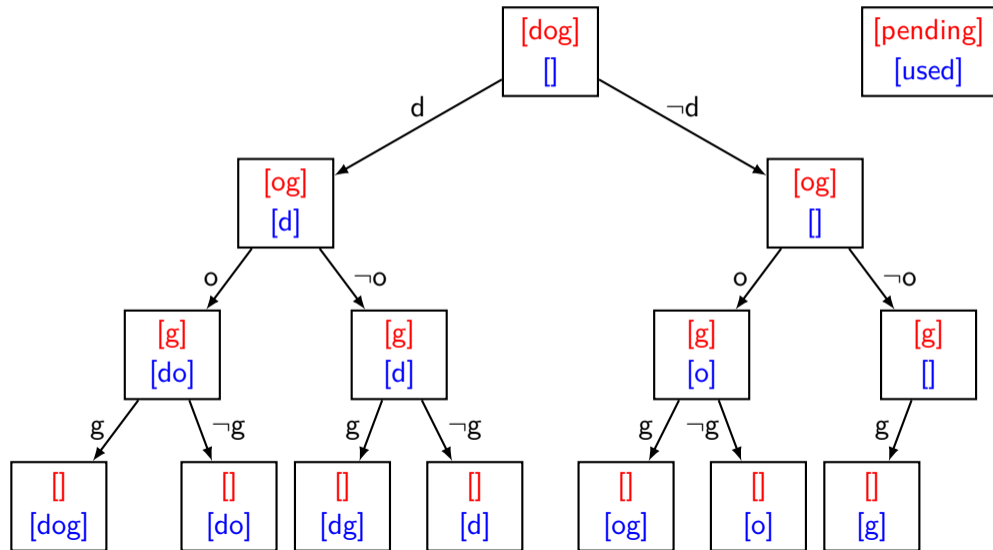
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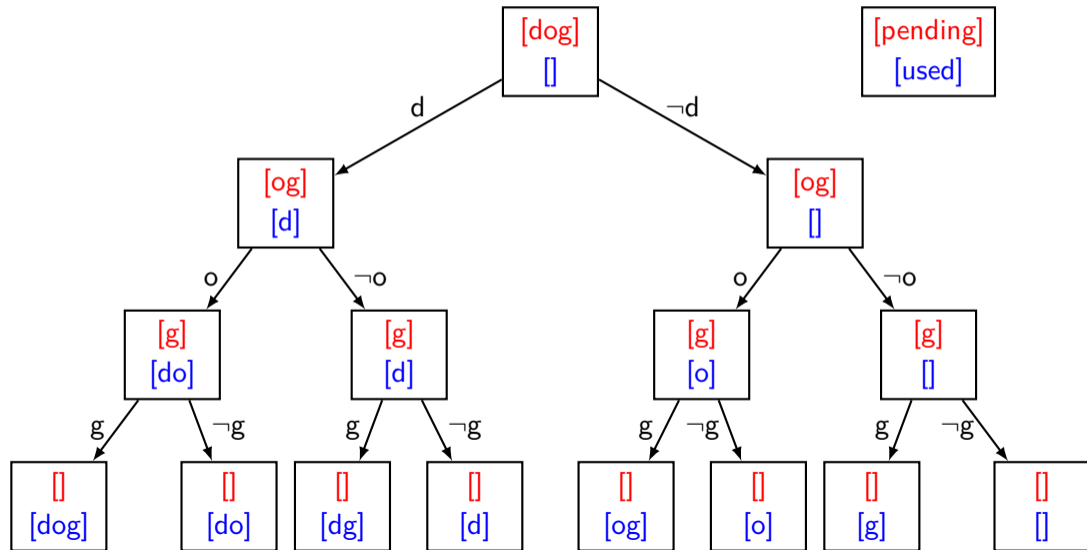
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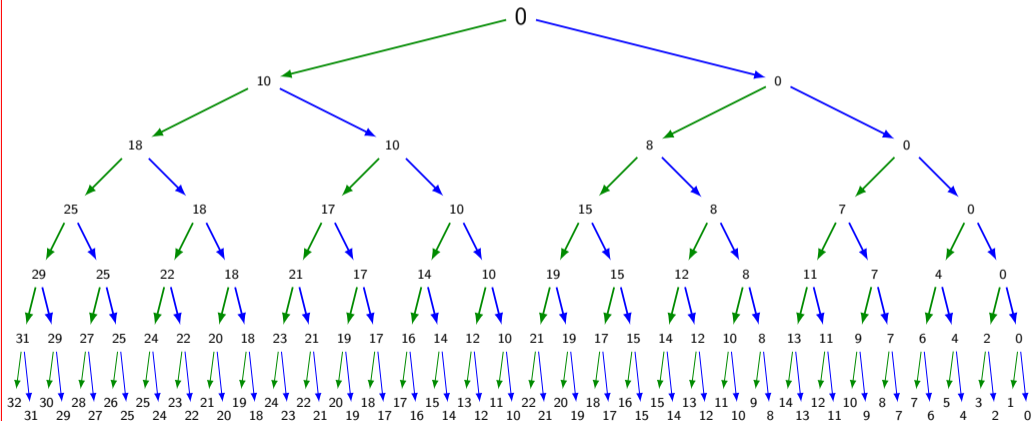
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Coin change

- Given a set of coins C , is it possible to provide a sum S using C ?
- Example: $C = \{1, 2, 4, 7, 8, 10\}$, $S = 15$

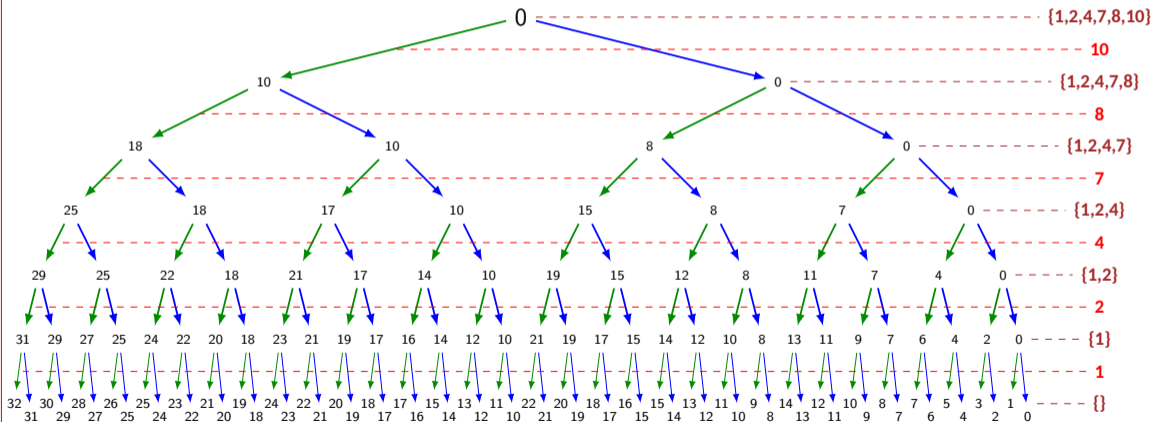
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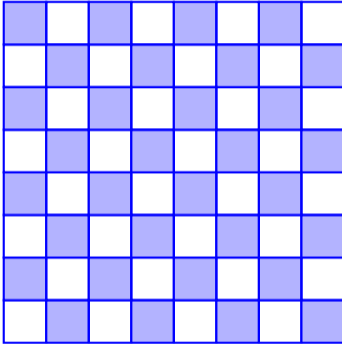


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N-Queens

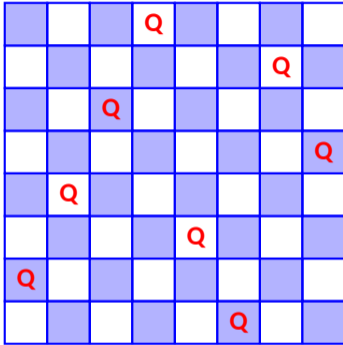


Need to place N-queens on this board

Rules:

- No queens are attacking each other

N-Queens

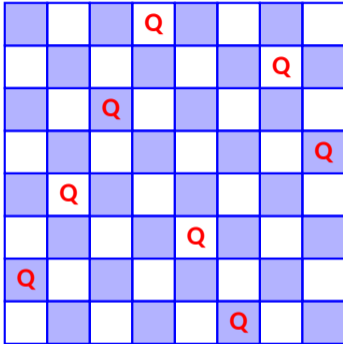


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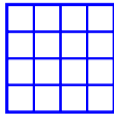
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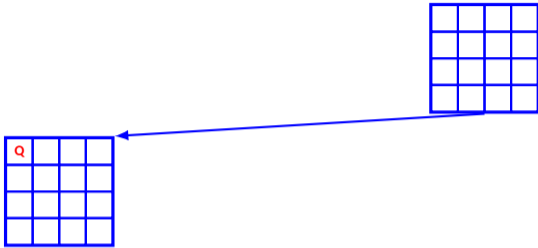
Other variants:

- At least a queen on the main diagonal
- Two queens on the two main diagonals
- Enumeration of all solutions

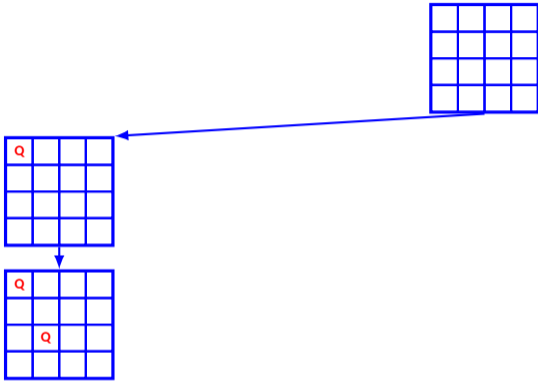
4 Queens



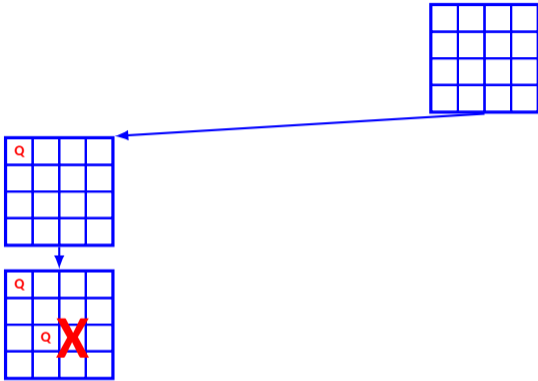
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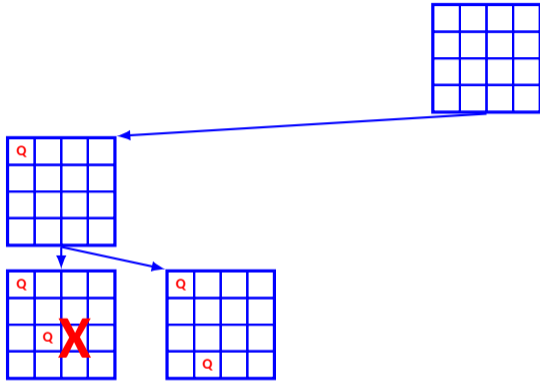
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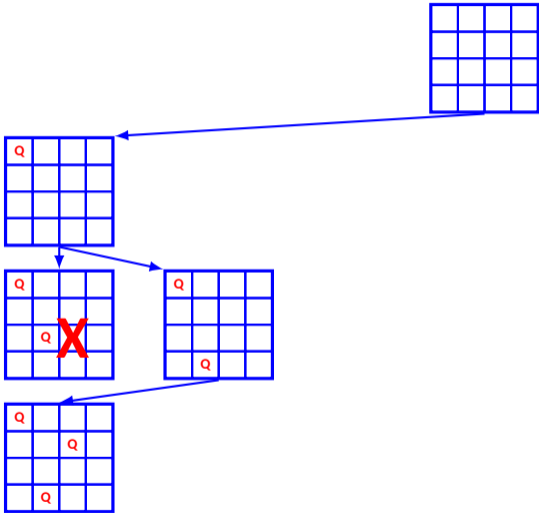
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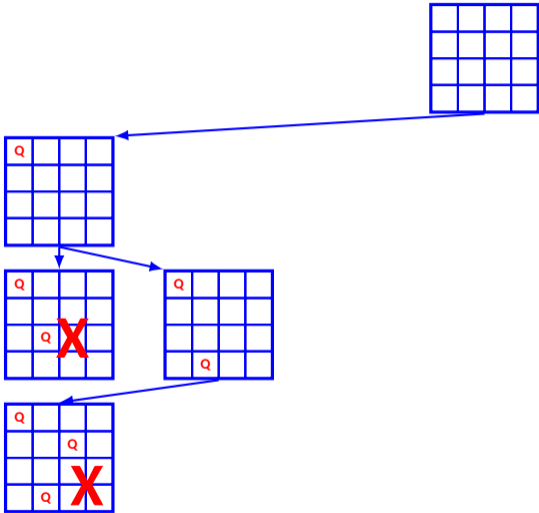
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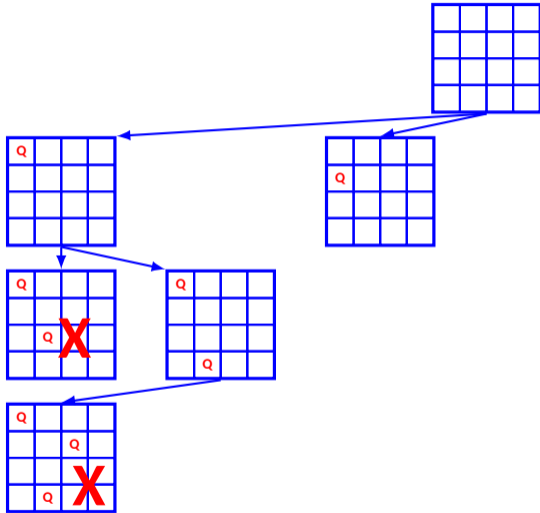
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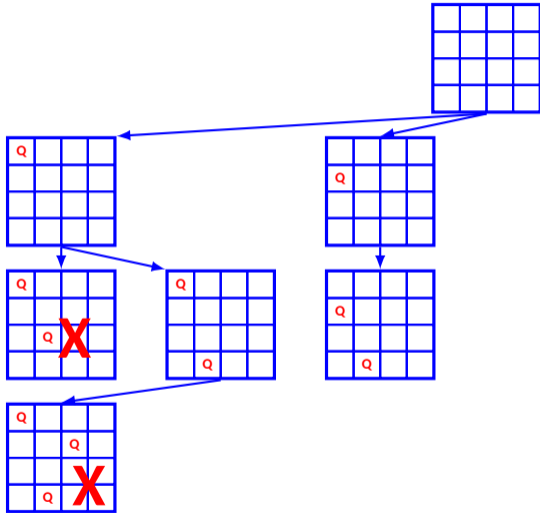
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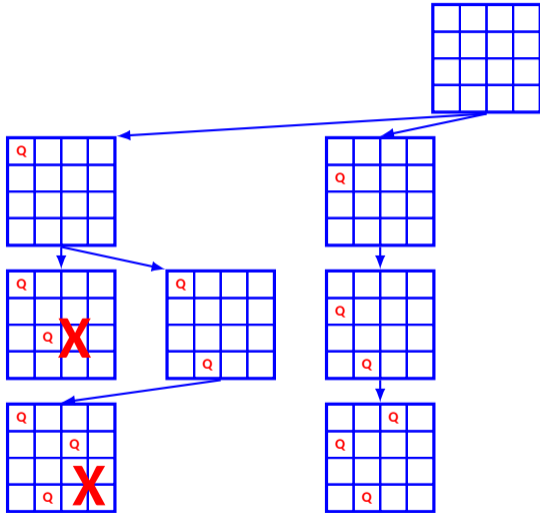
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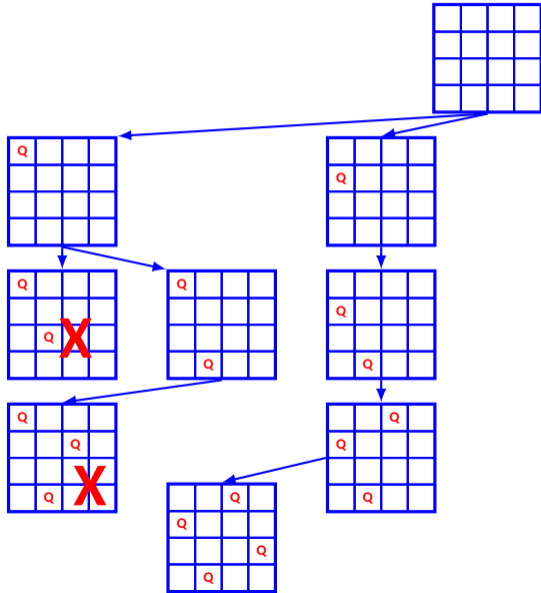
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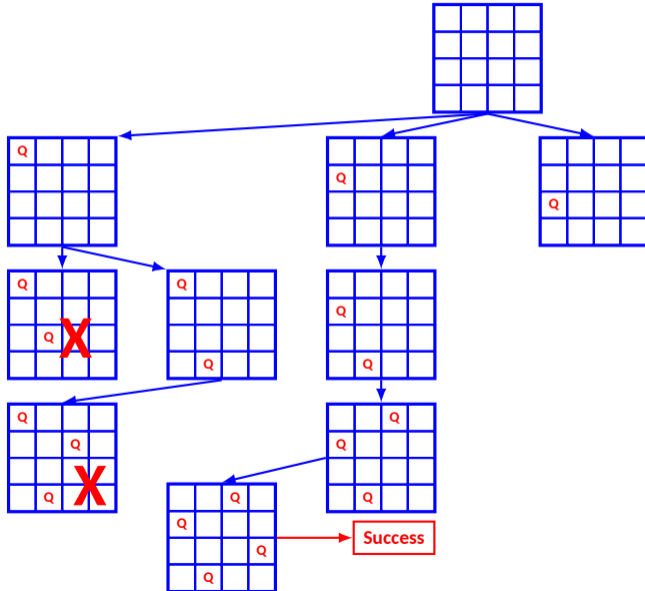
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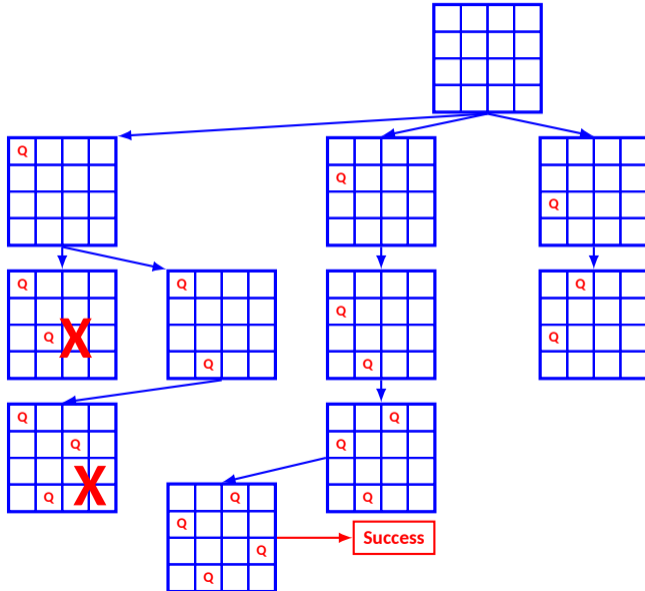
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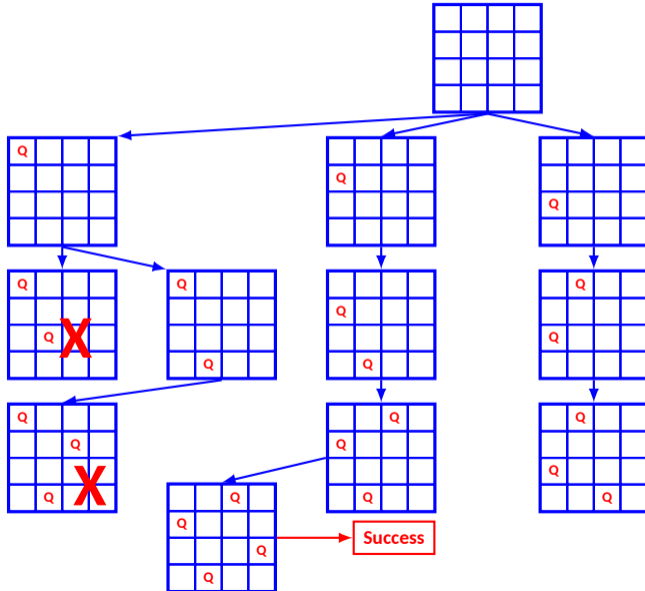
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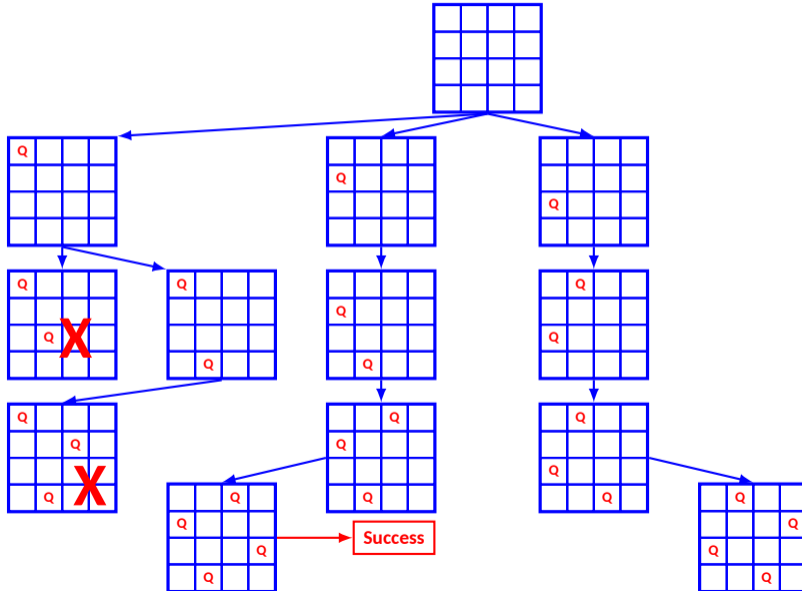
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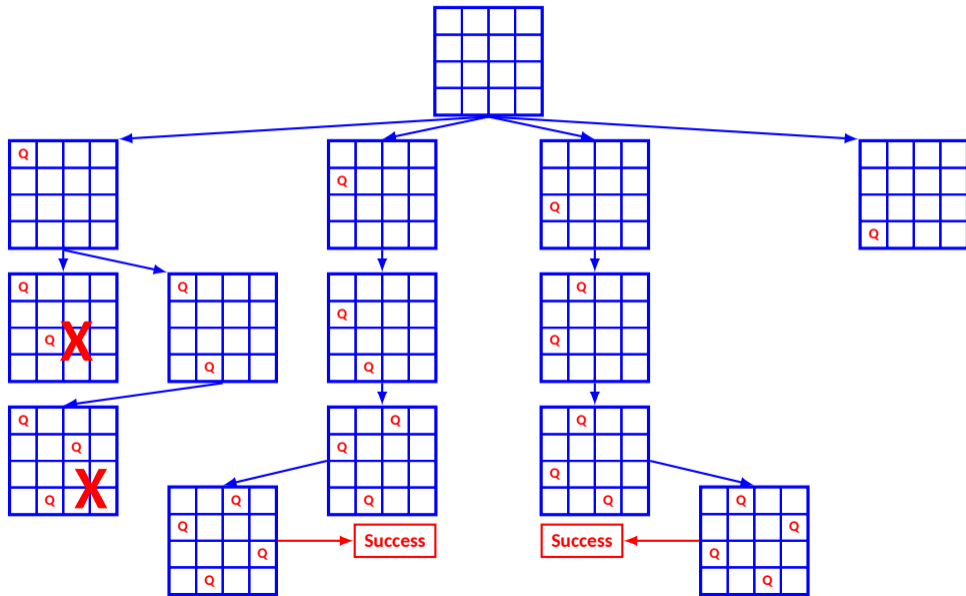
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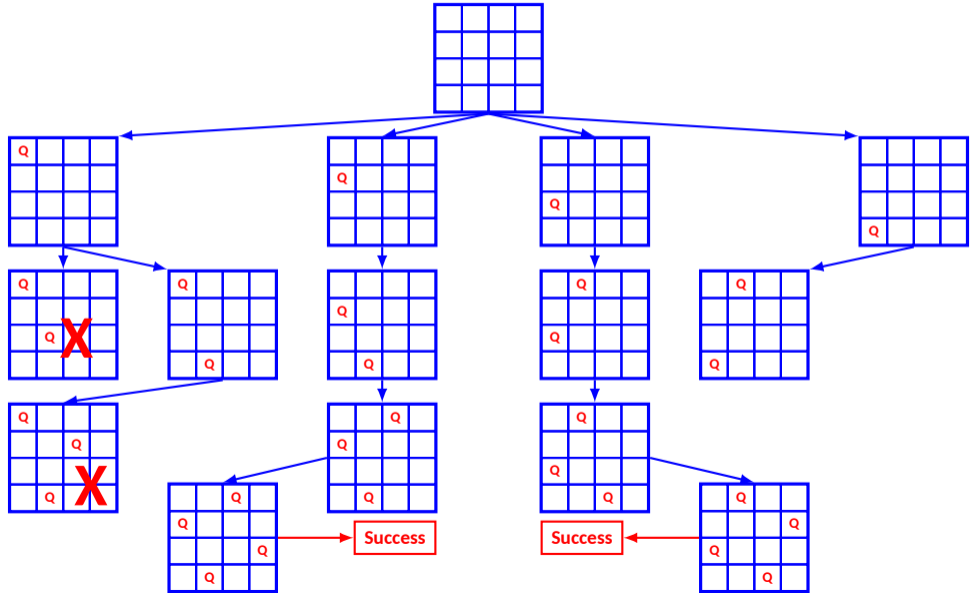
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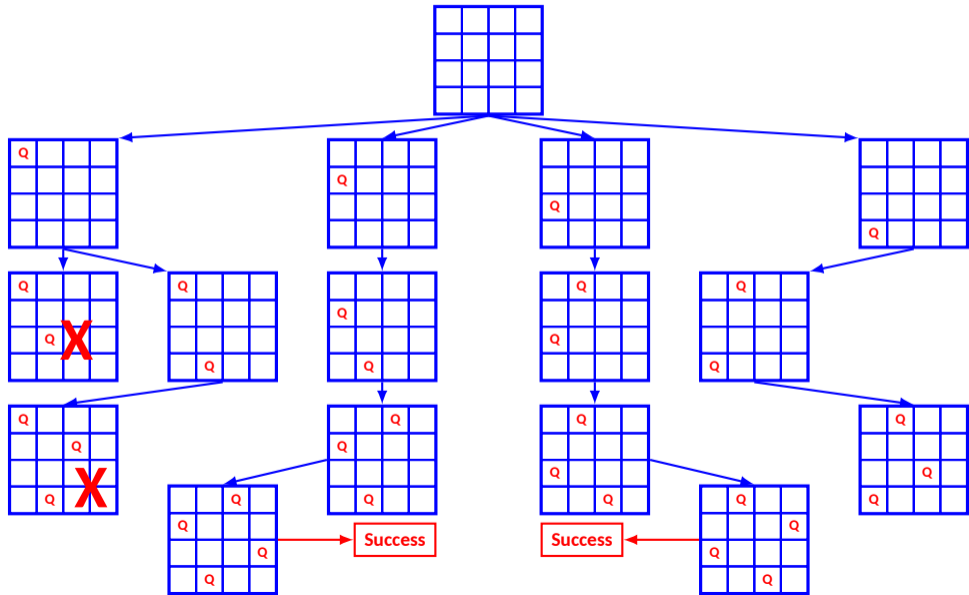
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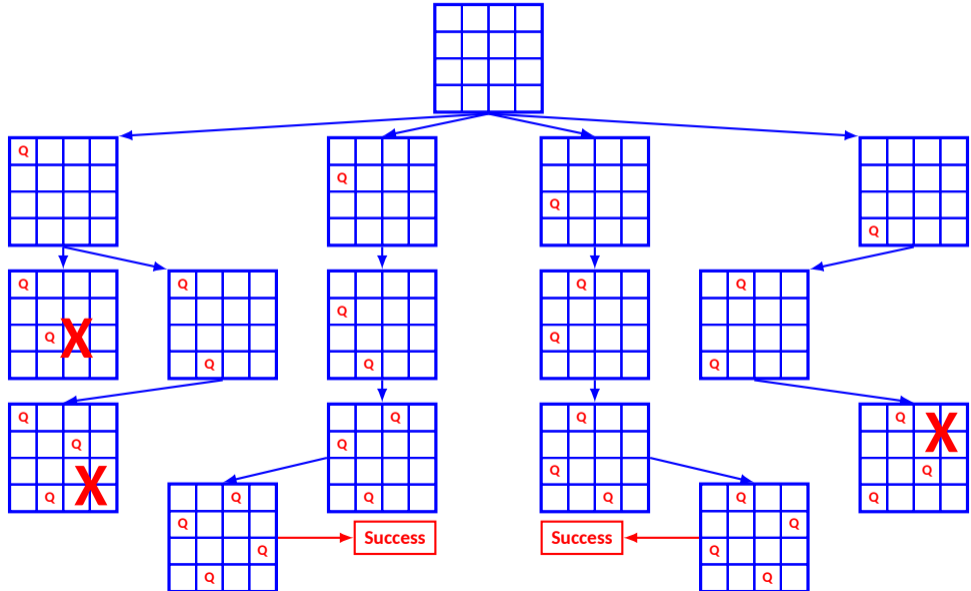
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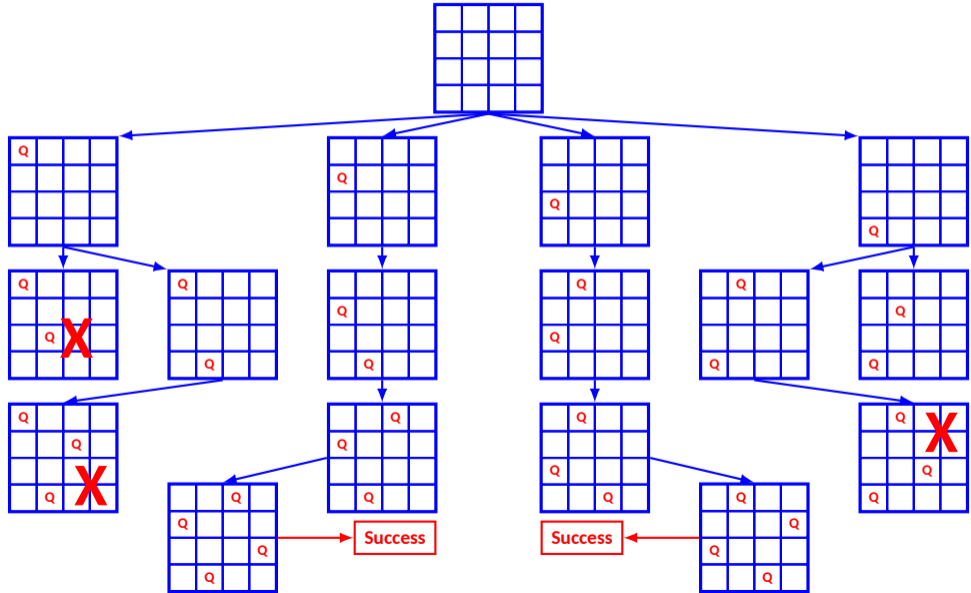
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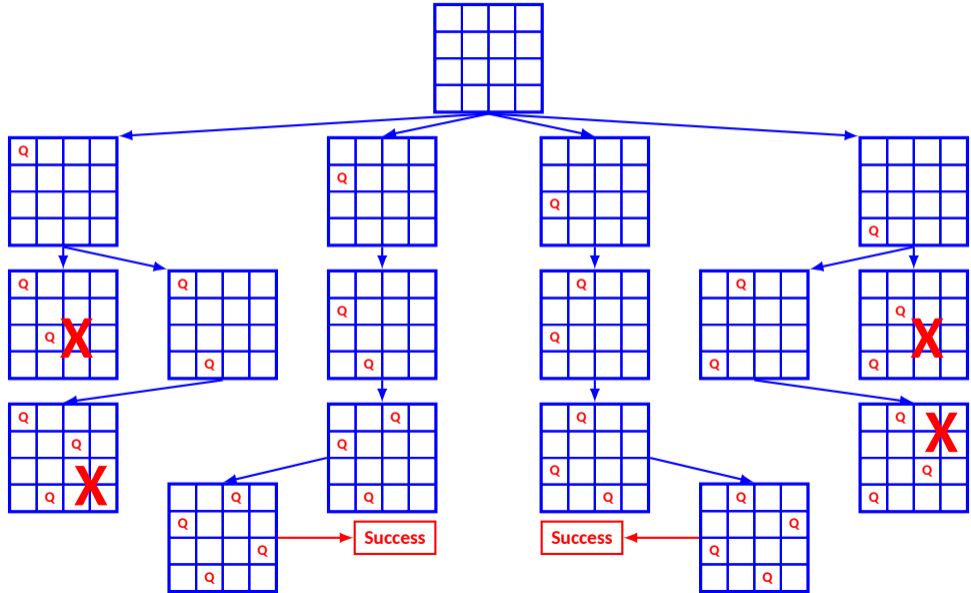
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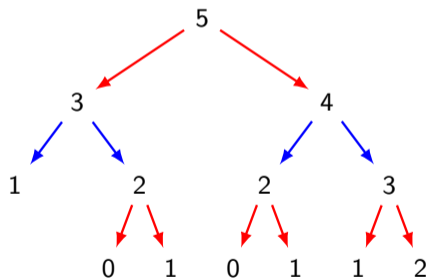


Game trees

- There is a pile of $n = 13$ coins. There are two players. At each step, a player can take either one or two coins from the pile. The player who takes the last coin loses the game. If you are the first one to make a move, what will be your strategy?

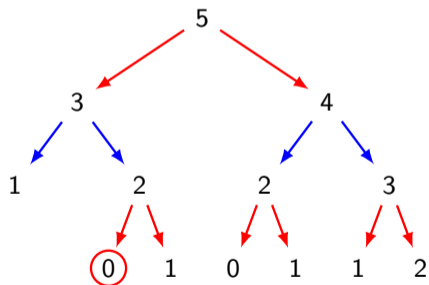
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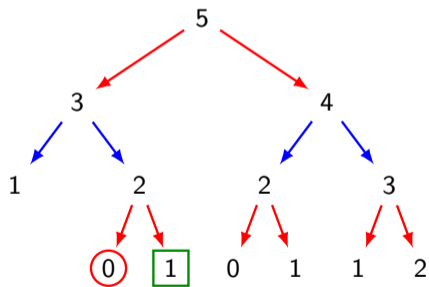
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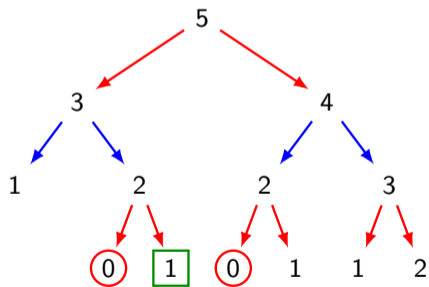
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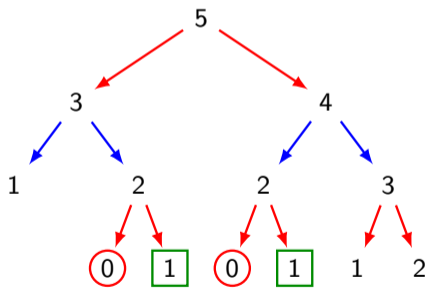
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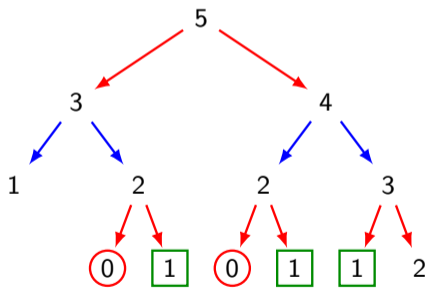
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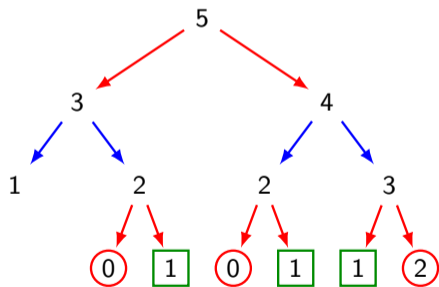
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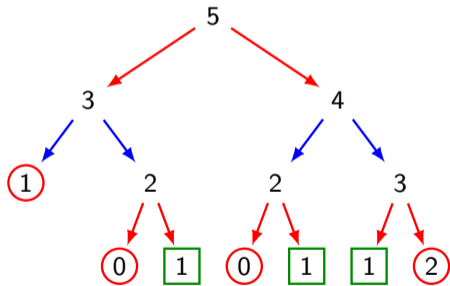
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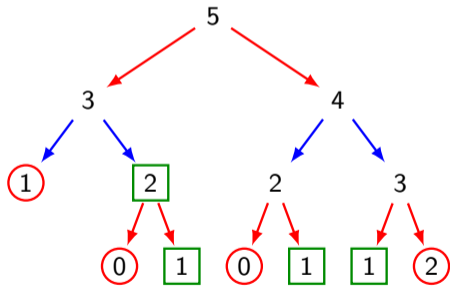
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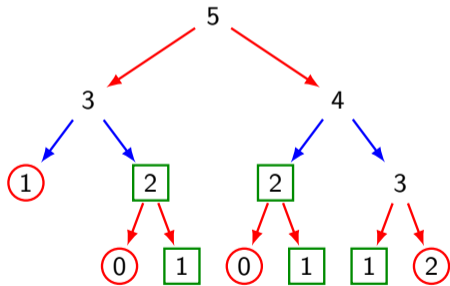
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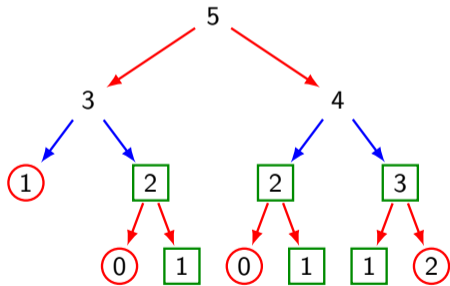
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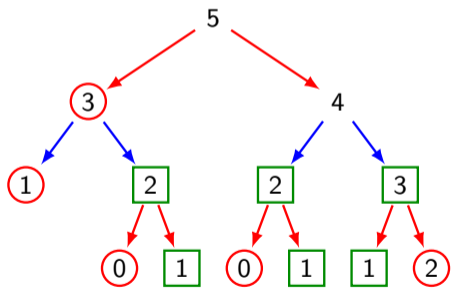
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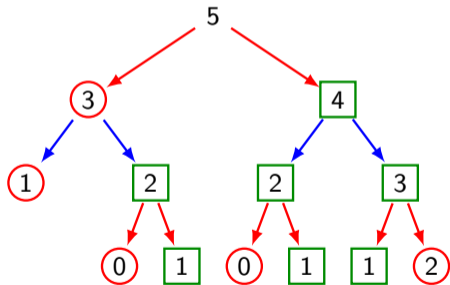
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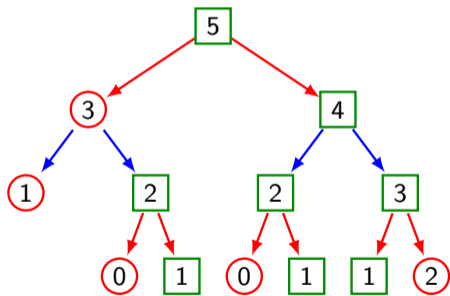
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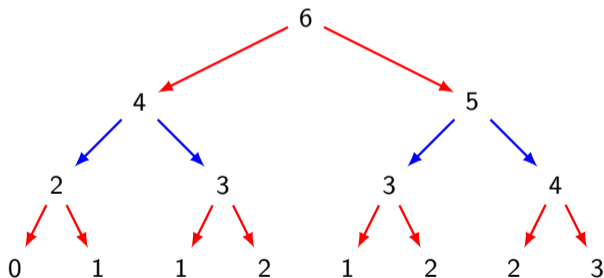
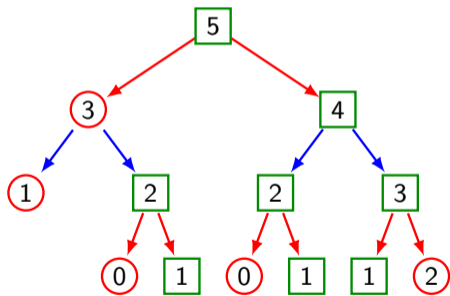
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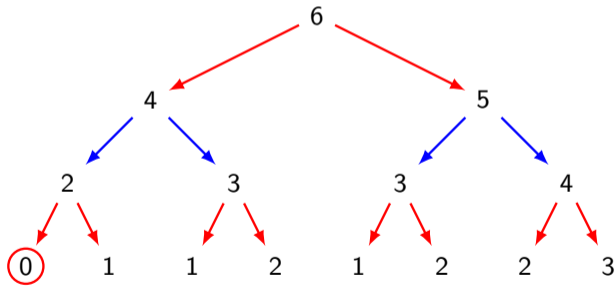
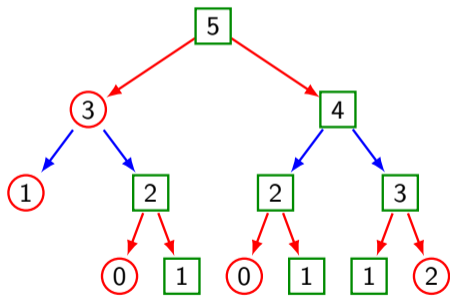
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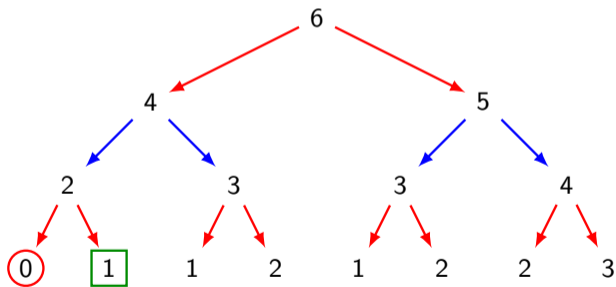
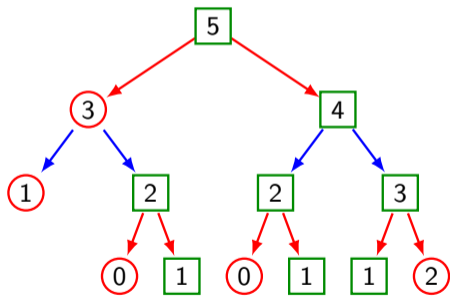
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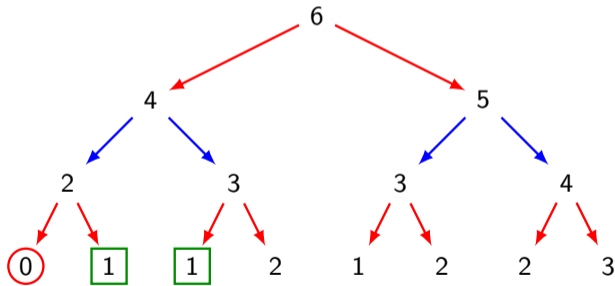
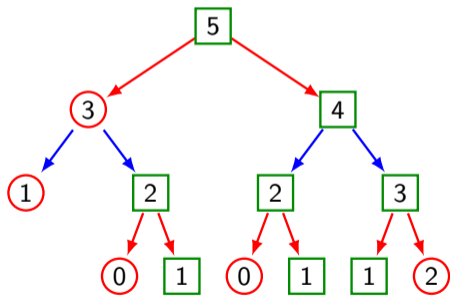
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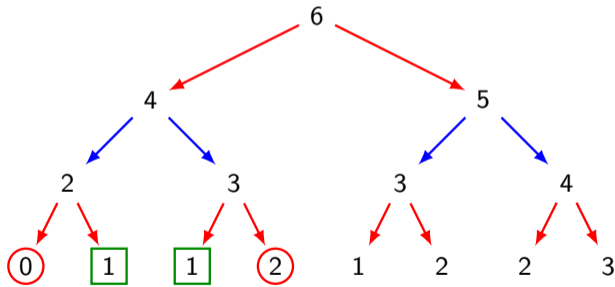
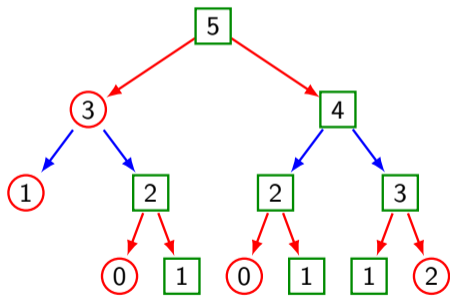
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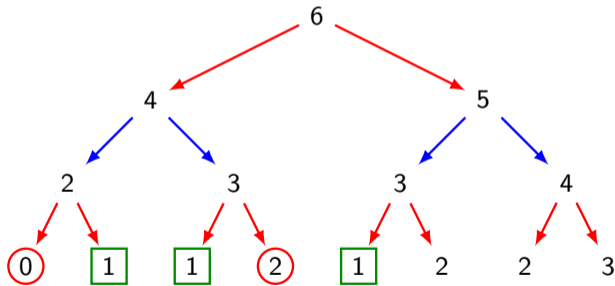
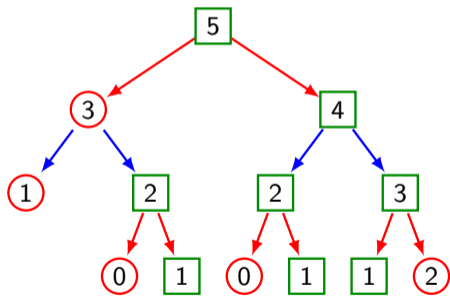
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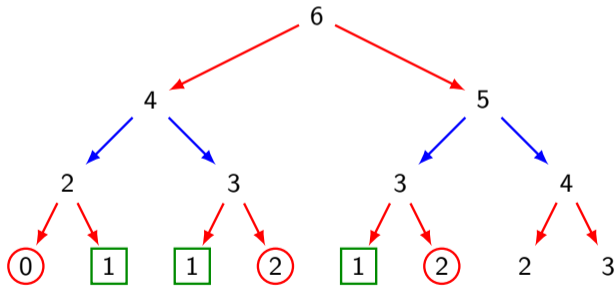
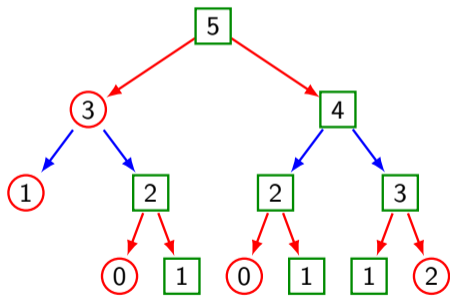
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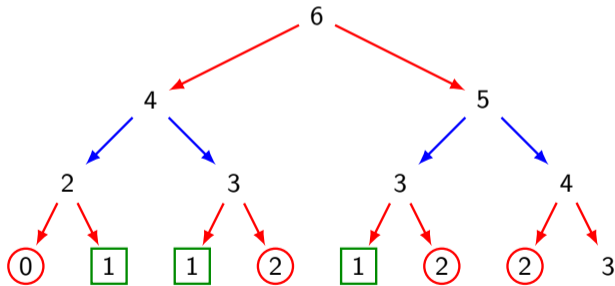
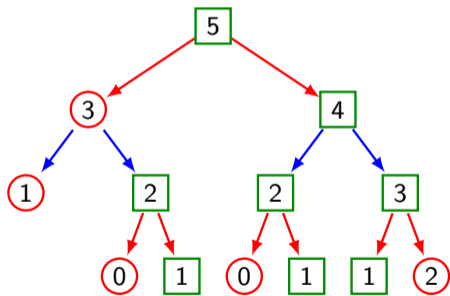
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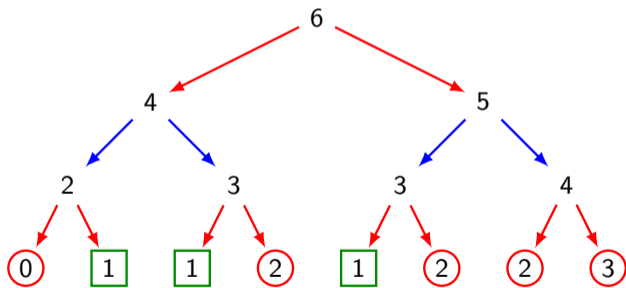
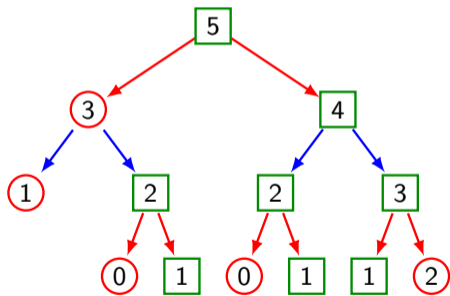
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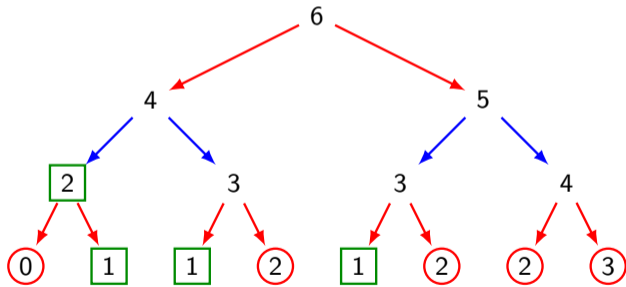
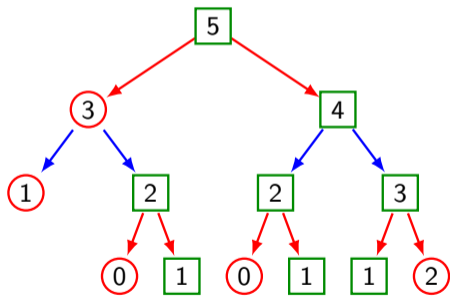
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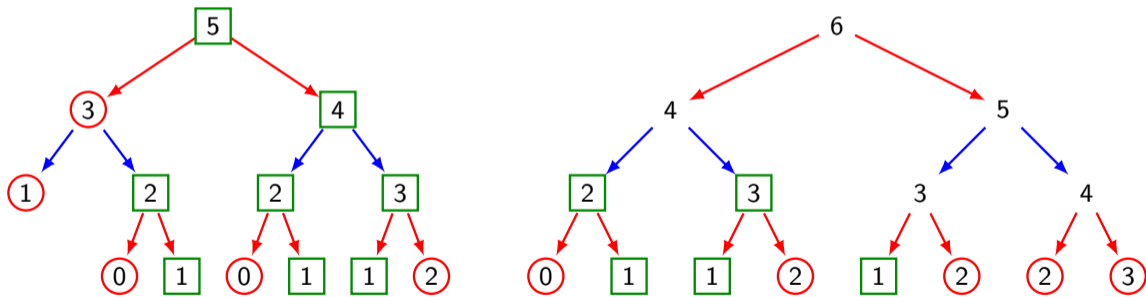
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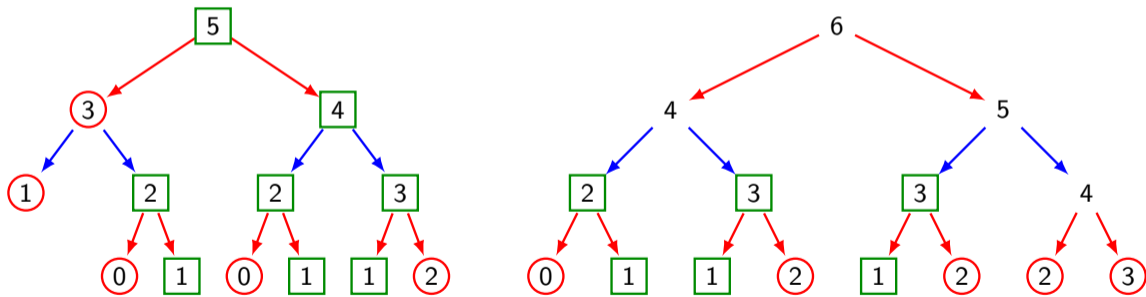
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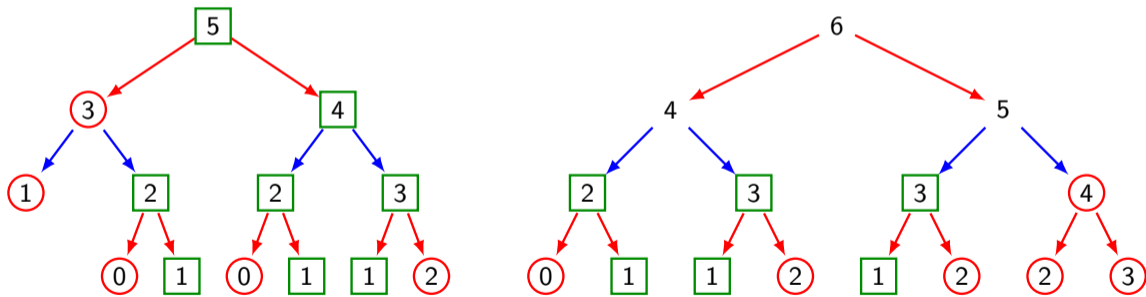
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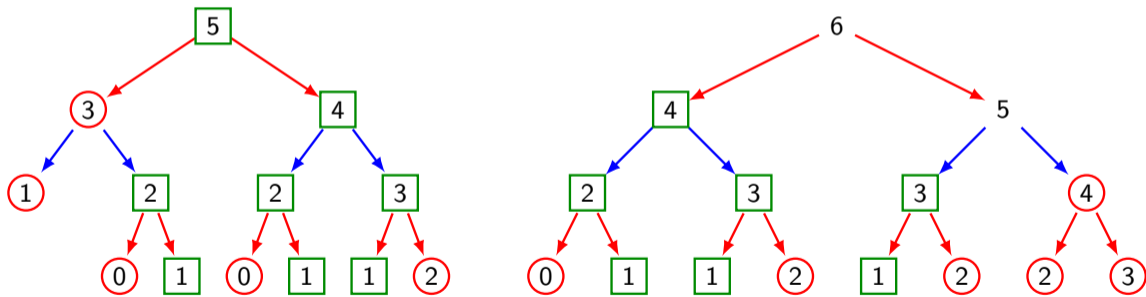
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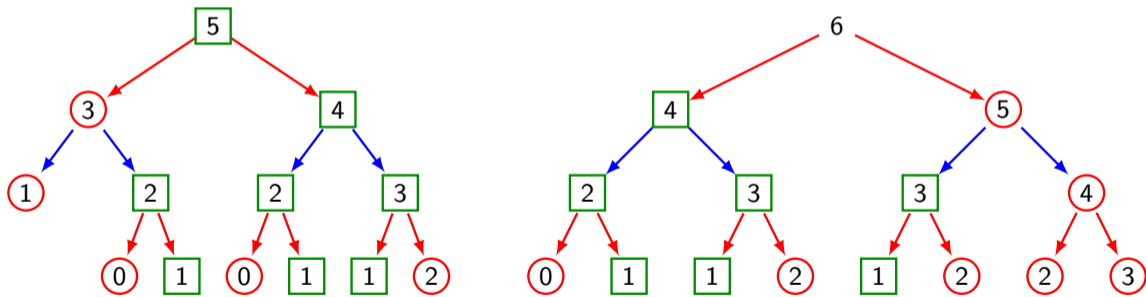
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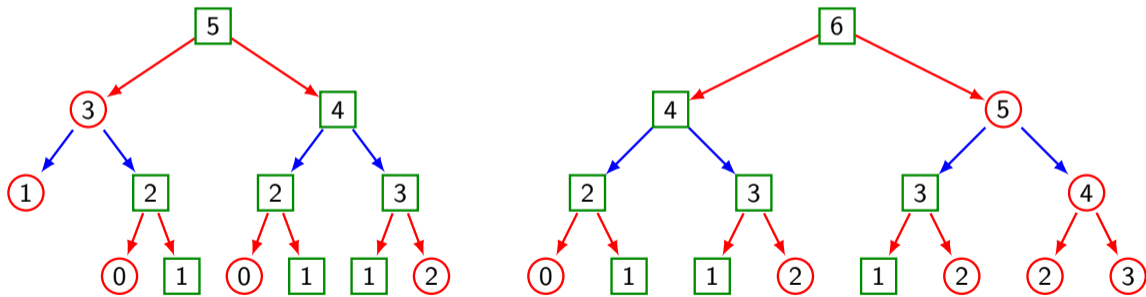
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Exercise-1

- During a robbery, a burglar finds much more loot than he had expected and has to decide what to take. His bag will hold a total weight of at most W kgs. There are n items to pick from, of weight w_1, \dots, w_n and INR value v_1, \dots, v_n . What's the most valuable combination of items he can fit into his bag? Develop state-space exploration based approach.

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- What will happen if repetition is allowed?

Exercise-2

- Suppose you are given a string of letters representing text in some foreign language, but without any spaces or punctuation, and you want to break this string into its individual constituent words. For example
 - **ilikeicecreamandmango:**
 - i like ice cream and mango
 - i like icecream and man go
 - **bothearthandsarturnspin:**
 - both earth and saturn spin
 - bot heart hands at urns pin
- Can you develop a state-space exploration based approach to find all possible break-ups?

Thank you!