Intro to Coding with Python– Recursion Pt. 1

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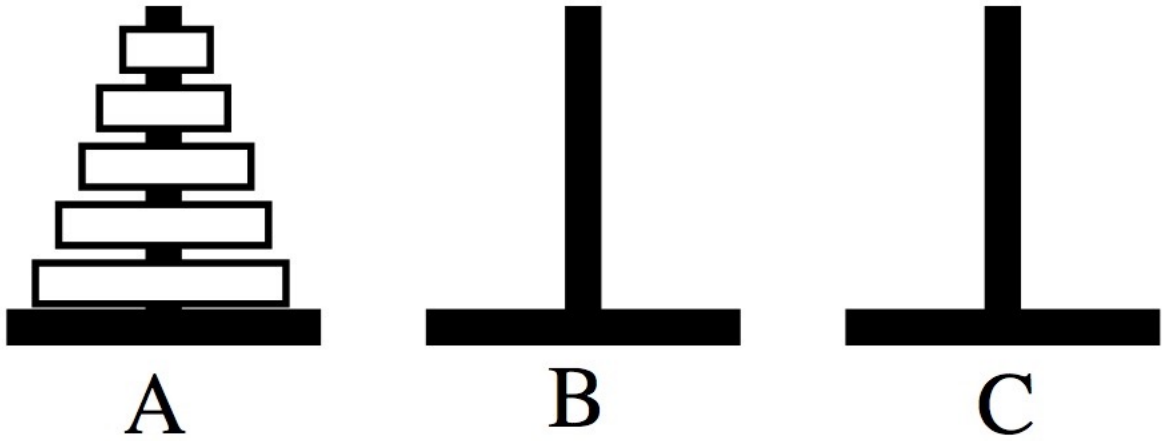
Slides based off slides courtesy of Jordan Crouser (https://jcrouser.github.io/)

Plan for Today

- Motivating example: Towers of Hanoi
- Tough problems, simple solutions

Towers of Hanoi



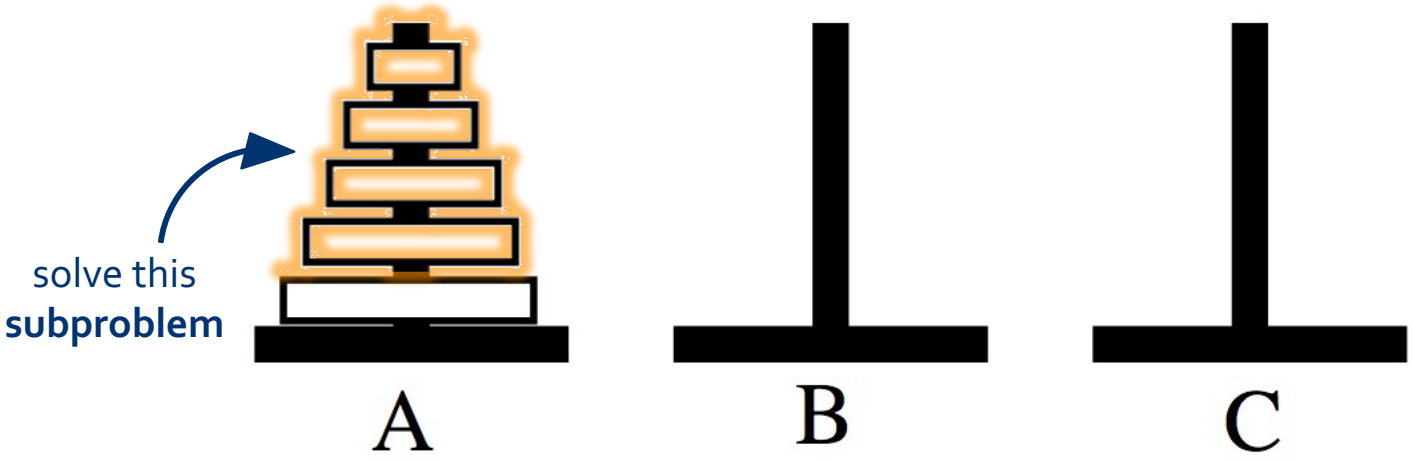
Rules of the game

- You can only move **one** disk at a time
- You can only move a disk to a pole where it will be the **smallest** (i.e. you can't put a disk on top of a larger one)
- You can only remove the **smallest** disk from a pole (i.e. you can't lift up the stack to get a larger disk from below)

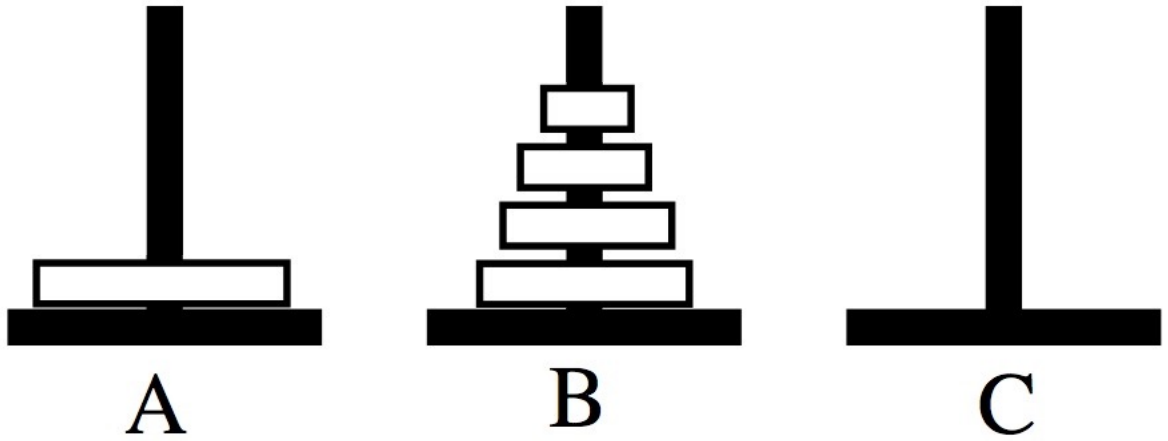
Discussion

Notice any **patterns**?

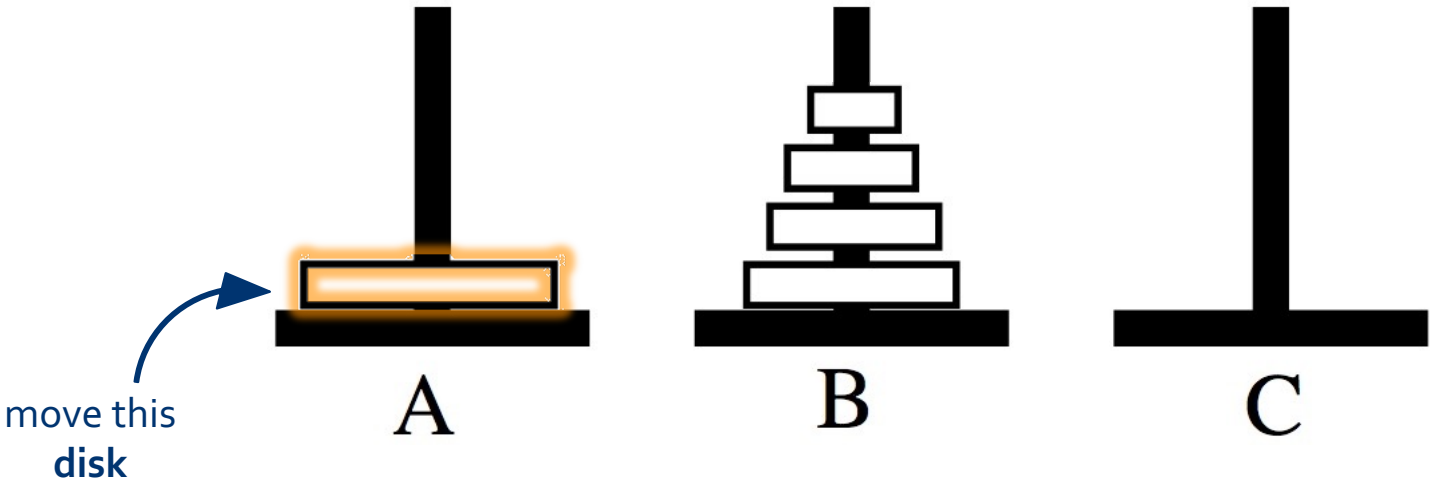
Recursive Towers



Recursive Towers



Recursive Towers



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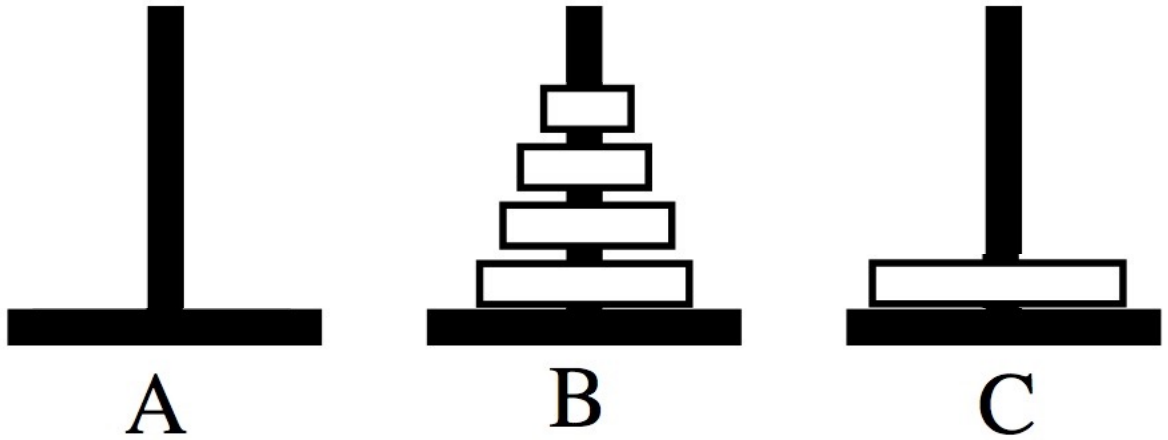
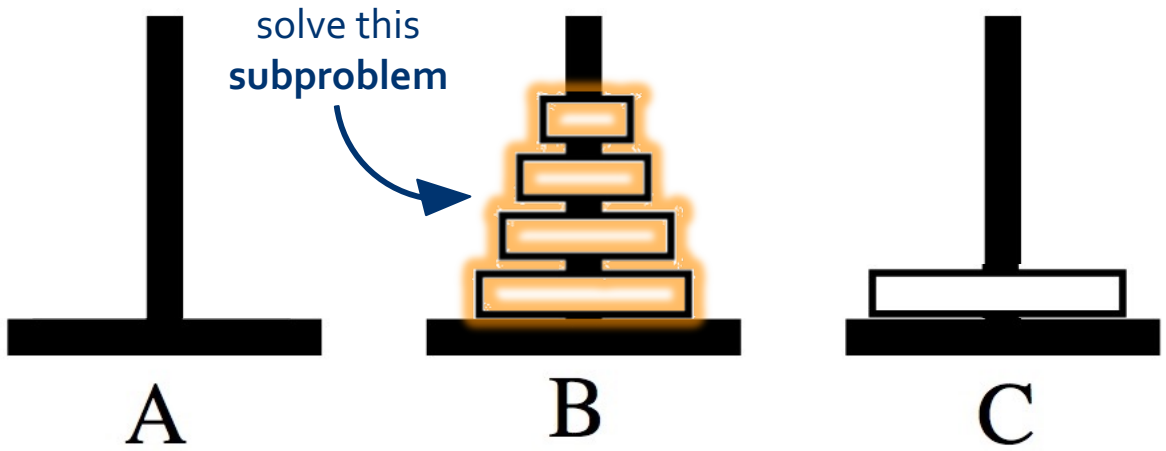


Recursive Towers



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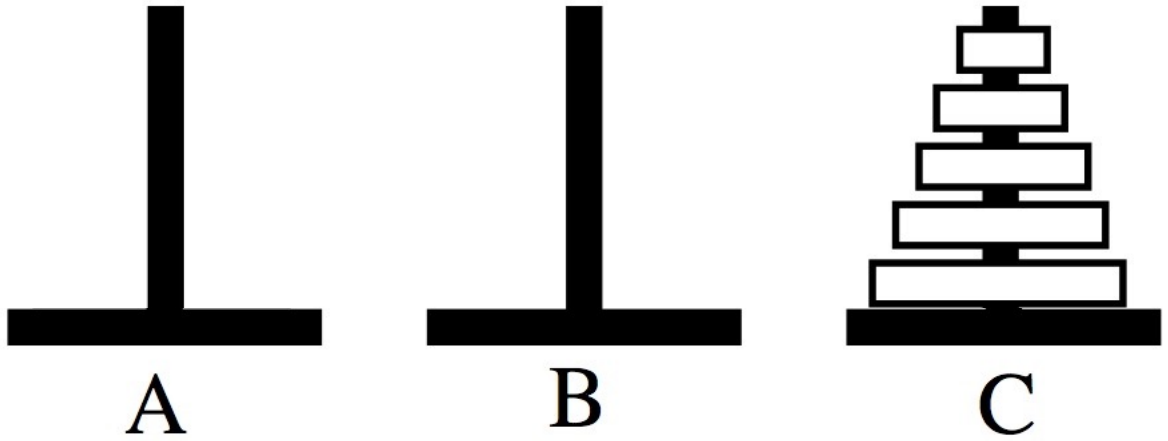

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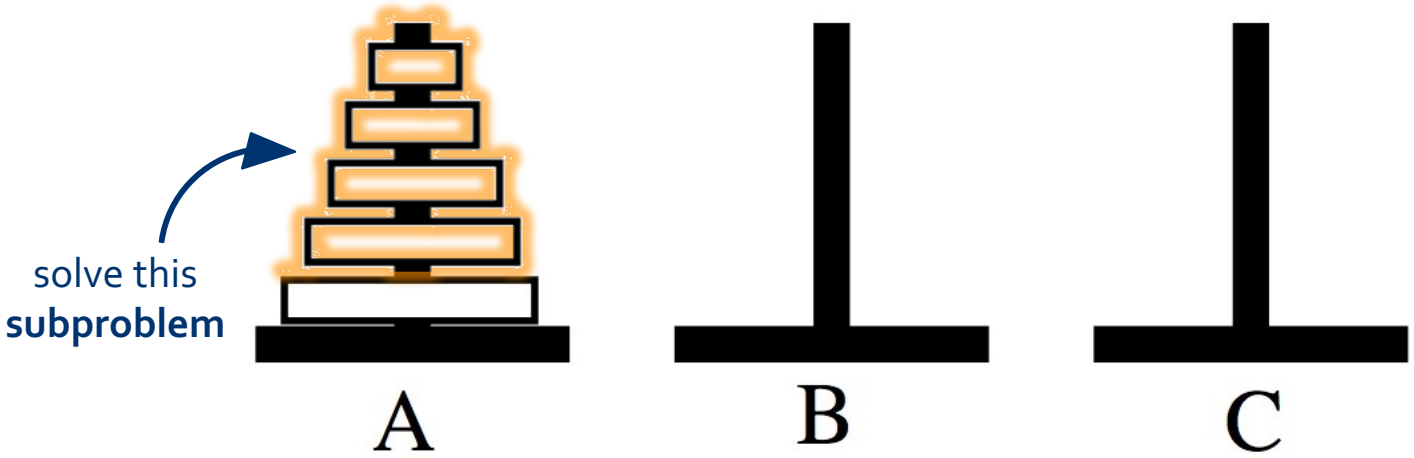

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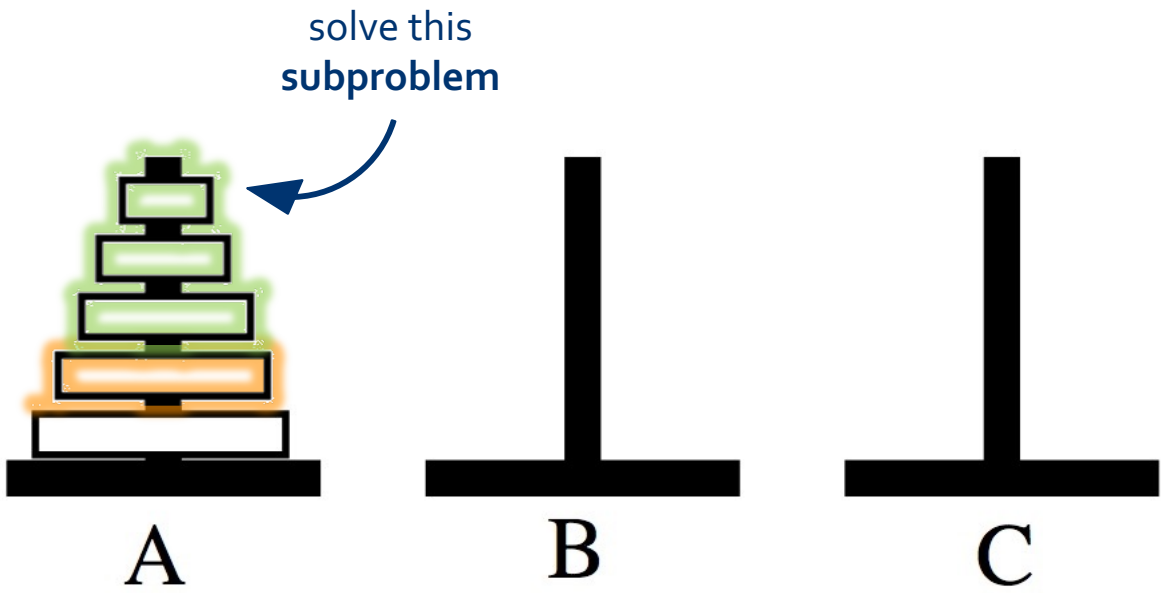

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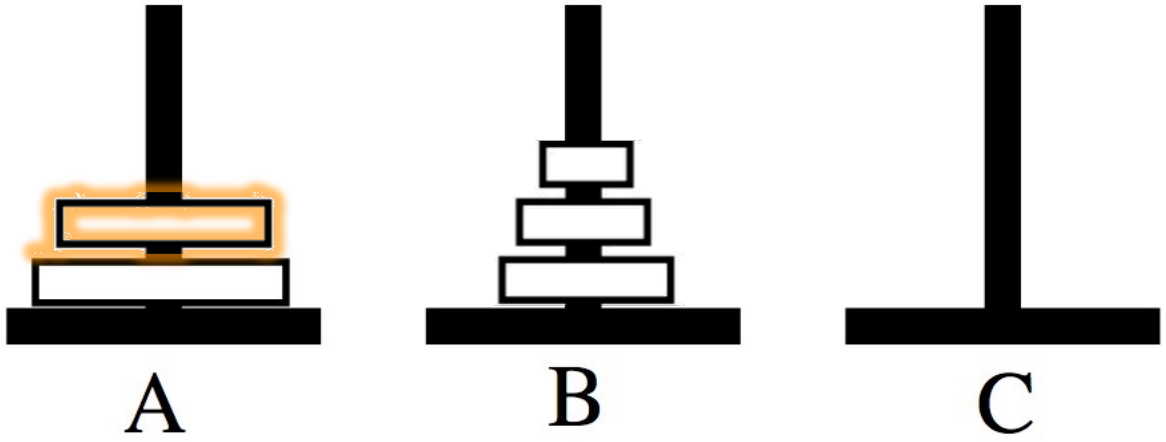
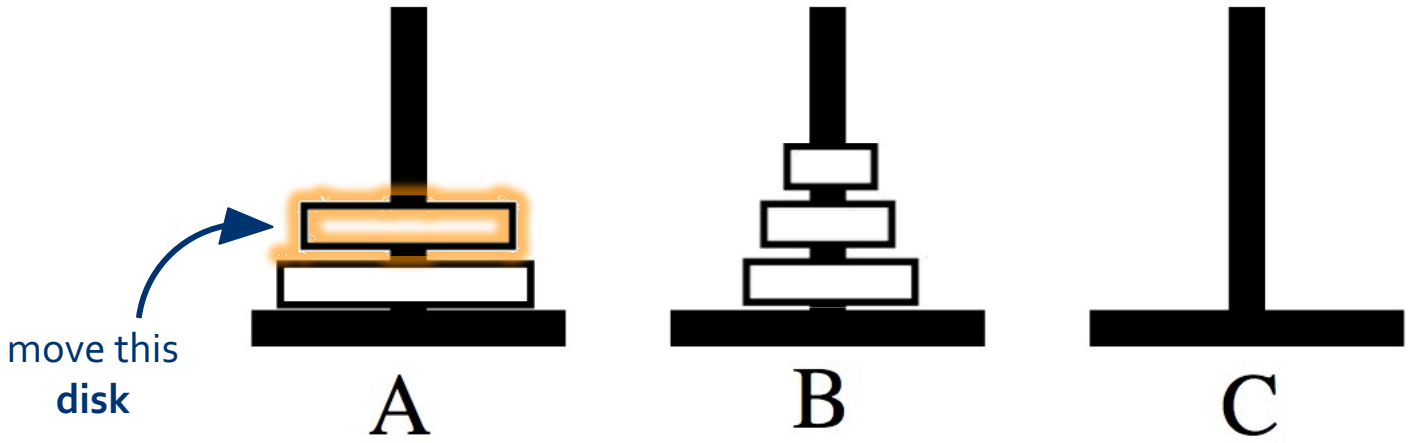
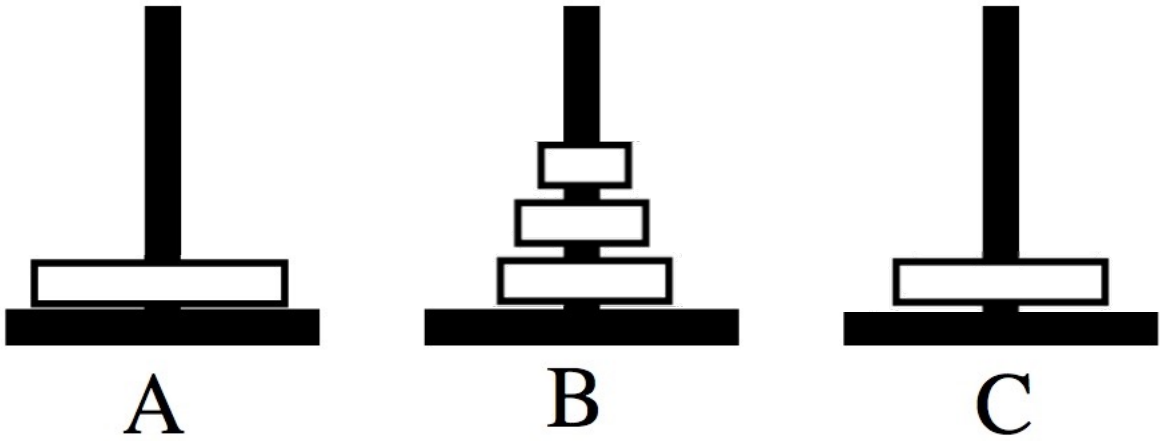


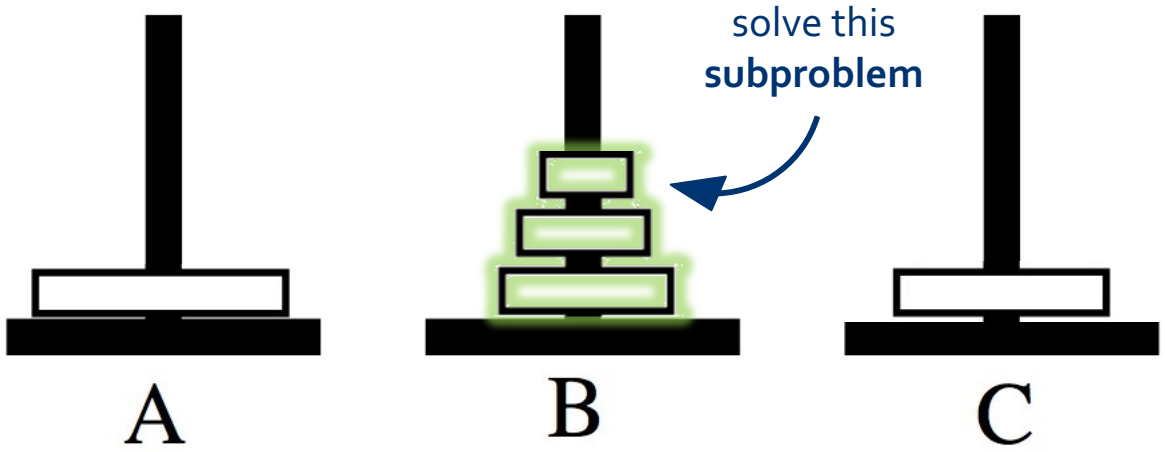
Recursive Towers



Recursive Towers



Recursive Towers



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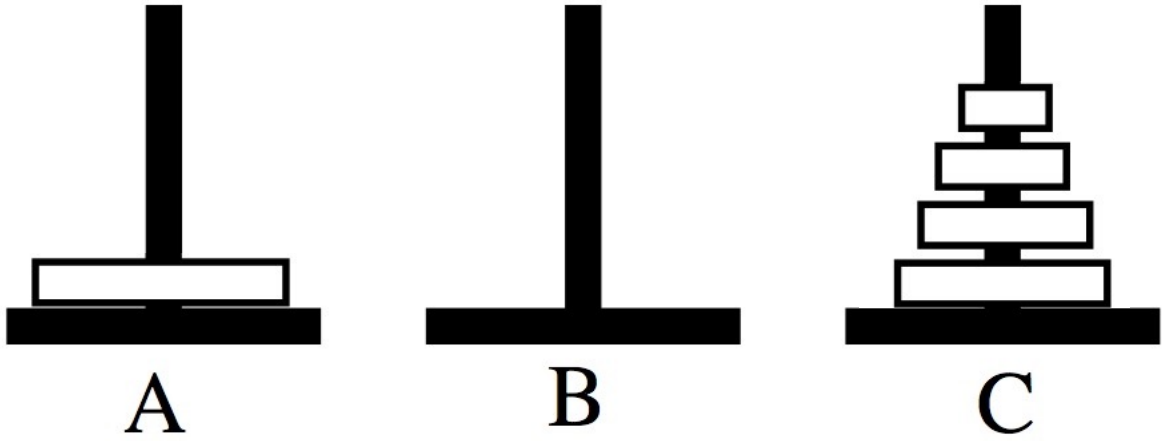

...and so on!

Discussion

How many **moves** does it take?

Algorithmic analysis

nDisks	nMoves
1	1
2	3
3	7
4	15
5	31
6	64
7	127

Notice any **patterns**?

$$nMoves = 2^{nDisks} - 1$$

Basic structure of a recursive algorithm

- **A base case**: what to do in the simplest possible case (i.e. when you have a single disk)
- **A recursive step**: break the original problem into one or more smaller problems, and solve that (saving the intermediate result)

Demo: Towers of Hanoi in Python