WEEK TEN

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WHAT HAPPENS IF WE CALL A METHOD FROM INSIDE ITSELF?

```java
public static void sayHi(){
    System.out.println("Hi!");
    sayHi();
}
```

```
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
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Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Hi!
Hi!   Hi!   Hi!   Hi!   Hi!   Exception in thread "main" java.lang.StackOverflowError
```

WHAT JUST HAPPENED?

Recursion!

RECURSION

- **Recursive method:** any method that calls itself
- Starts with a complicated problem and breaks it down into smaller and smaller problems
  - aka divide and conquer decomposition
- Why use recursion?
  - Sometimes simpler/easier to understand and maintain
  - Sometimes more flexible
  - Sometimes faster
  - **Short answer:** it's another tool in your toolbox

OKAY, BUT HOW DO WE AVOID A STACK OVERFLOW ERROR?

An endpoint

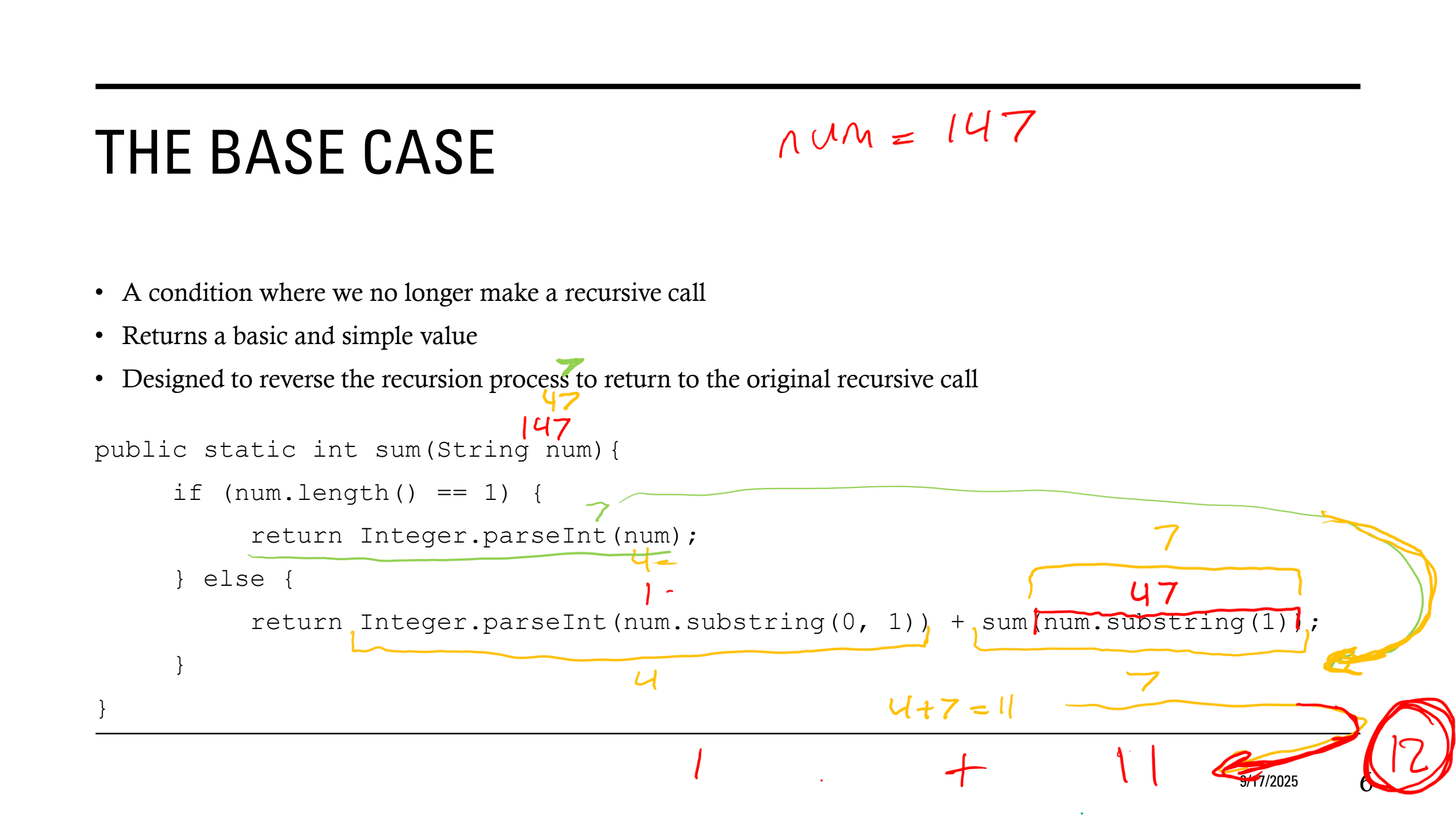
Termination condition

A base case!

THE BASE CASE

- A condition where we no longer make a recursive call
- Returns a basic and simple value
- Designed to reverse the recursion process to return to the original recursive call

```
public static int sum(String num){
      if (num.length() == 1) {
            return Integer.parseInt(num);
      } else {
            return Integer.parseInt(num.substring(0, 1)) + sum(num.substring(1));
      }
}
```



HOW TO UNDERSTAND RECURSION

- **A few very simple base cases (often just one)**
- **Rules to break down complex cases into simpler cases of the same general problem**
- **Are we done yet? If so, return the results.**
- **If not, simplify the problem (move towards the base case), by constructing a solution from smaller similar problems**
- **If you have an already solved similar but simpler problem, how can that help you solve a more complex problem?**

PRACTICE TOGETHER

- Reverse a word
- **Input:** hello **output:** olleh
- What is our base case?
- What small step can we take before making the recursive call?

YOUR TURN

- Write a recursive method that counts how many even numbers are in a String
- You can assume the String will only include numbers
- **Input:** “2395832” **Output:** 3

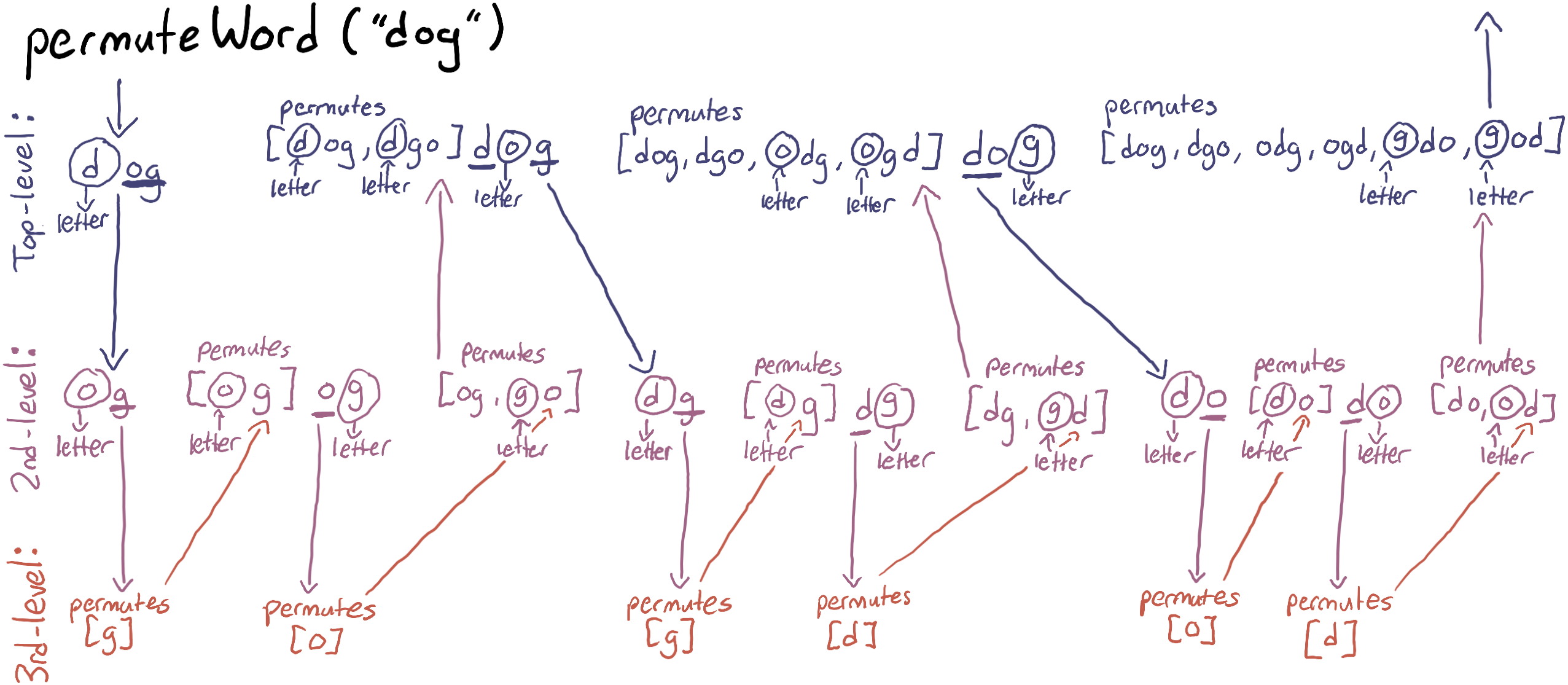
HOW ABOUT ONE MORE?

- Write a recursive method that takes in an ArrayList of comparable generic types
- The method should find and return the “max” value of the ArrayList
- **Input:** [4, 1, 4, 6, 3, 9, -3, -6, 8] **Output:** 9
- **Input:** ["hi", "smile", "zoo", "laugh", "kind", "apple“] **Output:** “zoo”

LET'S TRY SOMETHING A BIT MORE DIFFICULT

- Write a recursive method that takes in a single word and returns every possible permutation of that word in a list
- **Input:** "cat“ **Output:** [cat, cta, act, atc, tca, tac]
- What's our base case going to be?
- How do we break the problem down?
- What other structures may we need to use?

WHAT ACTUALLY HAPPENS WHEN A RECURSIVE CALL OCCURS IN A LOOP?


permuteWord ("dog")
Top-level:
2nd-level:
3rd-level:
letter
permutes
[dog, dgo, odg, ogd, gdo, god]
[dg, gd]
[do, od]
[g]
[o]
[d]

ACTIVITY

- Print all combinations of numbers from 1 to `n` having sum `n`
- **Input:** 4 **Output:** { 4 } { 1, 3 } { 2, 2 } { 1, 1, 2 } { 1, 1, 1, 1 }

ACTIVITY

- Scramble the characters in a String
- **In:** “happy” **Out:** “pyaph”