COL1000
Introduction to Programming

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Most (if not all) of the content is borrowed from Prof. Subodh Kumar's slides

Is it a tail recursion or not?

```
def f(n):
    if n <= 1:
        return n
    return f(n-10) + f(n/10)
```

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def risky_div(a, b):
    if b == 0:
        raise ZeroDivisionError("b is zero")
    return a / b

def wrapper(x):
    try:
        return risky_div(10, x)
    except ZeroDivisionError:
        print("Caught in wrapper")

for v in [5, 0, 2]:
    print("Result:", wrapper(v))
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How many times is the function “count” called? Write the complete output.

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def count(n):
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count(3)
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```
Result: 2.0
Caught in wrapper
Result: None
Result: 5.0
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Problem Specification

What is a problem specification ?

A problem specification tells:

What inputs are expected (what kind of data the program expects)

What outputs are produced (what it will produce)

The relationship between inputs and outputs

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Specification is how we tell the computer what problem we are solving — precisely, unambiguously, and completely.

Write a program to find the larger number?

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Good specification.

Input: Two integers a and b

Output: An integer m such that m == a or m == b, and m >= a and m >= b

If a == b, the function returns either one.

Compute factorial of a number.

Bad specification.

Compute factorial of a number.

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Doesn’t say what range of numbers is allowed?
Doesn’t say what kind of numbers (integers? floats?)?
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Doesn’t say what happens if input is zero

Good specification.

Input: An integer $n \geq 0$
Output: An integer f satisfying $f = 1 \times 2 \times \ldots \times n$
Special case: If $n = 0$, return 1.

Problem Specification

A **specification** is a **mathematically precise statement** of the problem.

It should describe *what* the program must accomplish, not *how* it should do it.

Given an answer, it should be possible to **verify** whether it is **correct**.

Verification means applying a *logical condition* that returns True if and only if the answer is correct.

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Sometimes the "solution" is **a set or list of answers** (e.g., all divisors, all prime numbers ≤ N).
Then we must check:

1. **Soundness (correctness):** Every produced answer satisfies the condition.
2. **Completeness:** Every valid answer according to the condition appears in the output.

The logical condition should be **computable** for every possible instance of the output, hence for every possible input.

Term	Meaning	Example
Correctness (Soundness)	Every produced answer satisfies the specification	Every output factor divides n
Completeness	Every valid answer appears in output	All divisors of n are printed

Print all integers x in the range 1 to 8 (8 including), such that$8 \% x == 0$

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Output = {1,2,8} -> it is sound (correct) but incomplete.

Output = {1,2,4,8} -> it is sound and complete.

“What Makes a Specification Good?”

Unambiguous: Every valid input maps to exactly one interpretation of the task.

Verifiable: We can check if an answer satisfies it.

Computable: The condition can be evaluated by a program.

Correct: Reflects the intended problem (no false goals).

Complete: Covers all input and output cases.

Program Correctness ?

```
—> 1
a = 10
b = 2
—> 2
c = a / b
—> 3
```

Start: a,b undefined
Midway: a=10,b=2,c undefined
End: a=10,b=2,c=5

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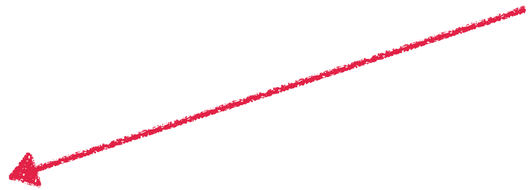

A program state is a snapshot of all variable values at a given point.

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If an assertion fails, the program reached an *illegal* state.

Assertions are like checkpoints — ensuring we're still on track.

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Python executes this like:

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if not (x > y):
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So yes — under the hood it raises an exception object, exactly like you could write manually.
But:
The purpose of “assertion” exception is not to recover or handle user-facing errors; It’s a signal that the program’s logic or assumptions have failed — the program has entered an invalid internal state. That’s why we usually don’t try/except around assertions. If an assertion fails, it means something is fundamentally wrong with the code.

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assert x > y, "x should stay larger than y"
```

Python executes this like:

assert = “Something that should never fail.”
try–except = “Something that might fail, and we’ll handle it.”

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if not (x > y):
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