

# Recursion (Factorial and Fibonacci)

Ali Akbari

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# Factorial Example

- ▶ **Problem:** Compute  $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$ .
- ▶ Define  $n! = n \times (n - 1)!$ , base case  $1! = 0! = 1$ .
- ▶ **Step-by-Step:**
  1.  $5! = 5 \times 4!$
  2.  $4! = 4 \times 3! = 4 \times 3 \times 2!$
  3.  $2! = 2 \times 1! = 2 \times 1 = 2$
  4. Final:  $5 \times 24 = 120$

# Fibonacci Example

- ▶ **Problem:** Find 6th Fibonacci number:  $F(0) = 0$ ,  $F(1) = 1$ ,  $F(n) = F(n-1) + F(n-2)$ .
- ▶ Compute  $F(6) = 8$ .
- ▶ **Step-by-Step:**
  1.  $F(6) = F(5) + F(4)$
  2.  $F(5) = F(4) + F(3) = 3 + 2 = 5$
  3.  $F(4) = F(3) + F(2) = 2 + 1 = 3$
  4. Final:  $F(6) = 5 + 3 = 8$

# Recursion

- ▶ Function calls itself with smaller input until base case.
- ▶ **Factorial:**  $O(n)$  time,  $O(n)$  space (recursion stack).
- ▶ **Fibonacci:**  $O(2^n)$  time (naive),  $O(n)$  space.
- ▶ Caution: Naive recursion can be slow (e.g., Fibonacci).