Permutation Sequence

For this problem the goal is to return the k-th lexicographical permutation of numbers [1...n].

Key Idea: Factorial Number System:

Instead of generating all permutations ($O(n!)$), we compute the k-th permutation directly using factorials.

Steps:

1. Precompute factorials for numbers 1...n.
2. Create a list of numbers [1, 2, ..., n].
3. Convert k to 0-based index (k-1).
4. For each position:
   - Determine which number to pick using index = k // factorial[n-1]
   - Append number at index to result.
   - Remove that number from list.
   - Update k = k % factorial[n-1]
   - Decrease n and repeat.

Complexity:

- Time: $O(n^2)$ (due to erase from vector; negligible for $n \leq 9$)
- Space: $O(n)$ for factorial and numbers list.