NPTEL MOOC

PROGRAMMING, DATA STRUCTURES AND ALGORITHMS IN PYTHON

Week 6, Lecture 3

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Backtracking

- Systematically search for a solution
- Build the solution one step at a time
- If we hit a dead-end
  - Undo the last step
  - Try the next option

Generating permutations

- Often useful when we need to try out all possibilities
  - Each potential columnwise placement of N queens is a permutation of {0,1,…,N-1}
- Given a permutation, generate the next one
- For instance, what is the next sequence formed from `{a,b,…,m}` , in dictionary order after

```
d c h b a e g l k o n m j i
```

Generating permutations

- Smallest permutation — all elements in ascending order

  `a b c d e f g h i j k l m`

- Largest permutation — all elements in descending order

  `m l k j i h g f e d c b a`

- Next permutation — find shortest suffix that can be incremented
  - Or longest suffix that cannot be incremented

Next permutation

- Longest suffix that cannot be incremented
  - Already in descending order

d c h b a e g l k $\boxed{\texttt{o n m j i}}$

Next permutation

- Longest suffix that cannot be incremented
  - Already in descending order

$$\mathtt{d\ c\ h\ b\ a\ e\ g\ l\ \boxed{k\ o\ n\ m\ j\ i}}$$

- The suffix starting one position earlier can be incremented

Next permutation

- Longest suffix that cannot be incremented
  - Already in descending order

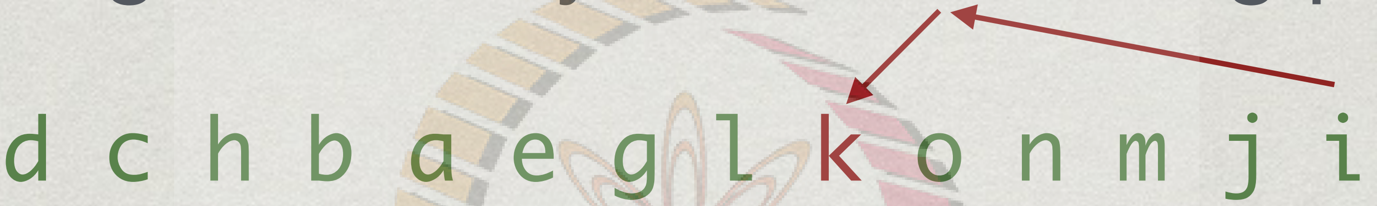
d c h b a e g l k o n m j i

- The suffix starting one position earlier can be incremented
  - Replace k by next largest letter to its right, m
  - Rearrage k o n j i in ascending order

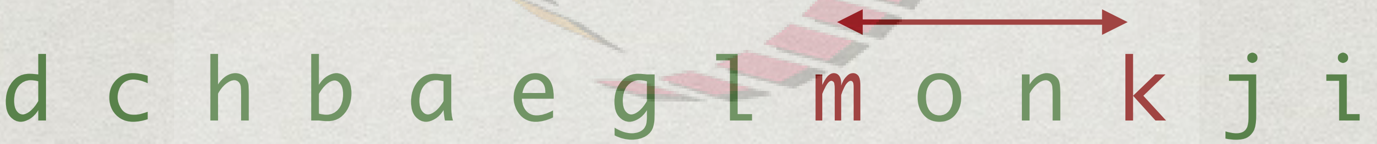
d c h b a e g l m i j k n o

Implementation

- From the right, identify first decreasing position


d c h b a e g l k o n m j i

- Swap that value with its next larger letter to its right


d c h b a e g l m o n k j i

  - Finding next larger letter is similar to insert

- Reverse the increasing suffix

d c h b a e g l m i j k n o