

Backtracking in Recursion

Java

Print all Permutations

Time complexity – $O(n \cdot n!)$

```
public class Recursion3 {  
  
    public static void printPermutation(String str, int idx, String perm) {  
        if(str.length() == 0) {  
            System.out.println(perm);  
            return;  
        }  
  
        for(int i=0; i<str.length(); i++) {  
            char currChar = str.charAt(i);  
            String newStr = str.substring(0, i) + str.substring(i+1);  
            printPermutation(newStr, idx+1, perm+currChar);  
        }  
    }  
  
    public static void main(String args[]) {  
        String str = "abc";  
        printPermutation(str, 0, "");  
    }  
}
```

N-Queens

Time complexity – $O(n^n)$

```
class Solution {  
  
    public boolean isSafe(int row, int col, char[][] board) {  
  
        //horizontal
```

```

for(int j=0; j<board.length; j++) {

    if(board[row][j] == 'Q') {

        return false;

    }

}

//vertical

for(int i=0; i<board.length; i++) {

    if(board[i][col] == 'Q') {

        return false;

    }

}

//upper left

int r = row;

for(int c=col; c>=0 && r>=0; c--, r--) {

    if(board[r][c] == 'Q') {

        return false;

    }

}

//upper right

r = row;

for(int c=col; c<board.length && r>=0; r--, c++) {

    if(board[r][c] == 'Q') {

        return false;

```

```

    }

}

//lower left
r = row;

for(int c=col; c>=0 && r<board.length; r++, c--) {

    if(board[r][c] == 'Q') {

        return false;

    }

}

//lower right

for(int c=col; c<board.length && r<board.length; c++, r++) {

    if(board[r][c] == 'Q') {

        return false;

    }

}

return true;

}

public void saveBoard(char[][] board, List<List<String>> allBoards) {

    String row = "";

    List<String> newBoard = new ArrayList<>();

    for(int i=0; i<board.length; i++) {

```

```

        row = "";

        for(int j=0; j<board[0].length; j++) {

            if(board[i][j] == 'Q')

                row += 'Q';

            else

                row += '.';

        }

        newBoard.add(row);

    }

    allBoards.add(newBoard);

}

public void helper(char[][] board, List<List<String>> allBoards, int col) {

    if(col == board.length) {

        saveBoard(board, allBoards);

        return;

    }

    for(int row=0; row<board.length; row++) {

        if(isSafe(row, col, board)) {

            board[row][col] = 'Q';

            helper(board, allBoards, col+1);

            board[row][col] = '.';

        }

    }

}

```

```

    }

    public List<List<String>> solveNQueens(int n) {

        List<List<String>> allBoards = new ArrayList<>();

        char[][] board = new char[n][n];

        helper(board, allBoards, 0);

        return allBoards;

    }
}

```

Homework Problems

1. <https://leetcode.com/problems/permutations/> (Similar to print Permutations)
2. <https://www.hackerrank.com/challenges/knightl-on-chessboard/problem> (Similar to N-Queens)
3. <https://leetcode.com/problems/sudoku-solver/> (Will be discussed in next class)