

H2 Computing Practical Worksheet 2

Set 1 – Please attempt the following questions by implementing the solutions using Python 3. For each question, you are to implement both an iterative version and a recursive version of the function specified.

- 1 Write a function that takes in a positive integer n , and returns $n!$. You may not import the math module.
- 2 Without using the `*` operator, write a function that takes in (as input) two integers and returns (as output) their product. You may not import the math module.
- 3 Write a function that takes in a positive integer n , and prints out the digits in word form. For example, when given as input: 3214, the function should print: “three two one four”.
- 4 Without using the `**` operator, write a function that takes in 2 inputs: (i) a base, x , and (ii) an exponent n , and then returns the value x^n . You may not import the math module, and you may not use the built-in `pow(..)` function.
- 5 Write a function that takes in a positive integer n , and prints the numbers from n to 0.
- 6 Write a function that takes in a positive integer n , and prints the numbers from 0 to n .
- 7 Write a function that takes in a positive integer n , and returns the sum of all the integers from 1 to n . You may not import the math module.
- 8 Write a function that takes in a positive integer n , and returns the number of digits in n . You may not use the built-in `str(..)` function.
- 9 Write a function that takes in a string, s , and returns a reversed copy of s . The only string operation you are allowed to use is string concatenation.
- 10 Write a function that takes in a list of integers and returns the sum of the integers in that list. You may not import the math module, and you may not use the `sum(..)` built-in function.
- 11 Write a function that takes in a list of real numbers and returns the mean of all the values in the list. You may not import the math module, and you may not use the `sum(..)` built-in function.
- 12 Write a function that takes in a list of real numbers and returns the minimum value from that list. You may not use the built-in `min(..)` and `sorted(..)` functions, and you may not use the `list.sort(..)` method.

Set 2 – Please attempt the following questions by implementing the solutions using Python 3. For each question, you are to implement both an iterative version and a recursive version of the function specified.

- 13 Write a function that takes in a positive integer n , and then computes F_n , the n th value of the Fibonacci sequence. Recall that the Fibonacci sequence is defined by the recurrence relation $F_n = F_{n-1} + F_{n-2}$, where $F_0 = 0$ and $F_1 = 1$.
- 14 Write a function that takes in a positive integer, n , and returns True if n is a prime number.
- 15 Write a function that takes in a list of positive integers, N , and returns the greatest common divisor (i.e., the highest common factor) of all integers in N .

Set 3 – Please attempt the following questions by implementing the solutions using Python 3. For each question, you are to implement both an iterative version and a recursive version of the function specified.

- 16 The power set of a given set, A , is the set containing all the subsets of A . For example, if $A = \{1, 2, 3\}$, then the power set of A , $P(A) = \{\{\}, \{1\}, \{2\}, \{3\}, \{1, 2\}, \{1, 3\}, \{2, 3\}, \{1, 2, 3\}\}$.

Write a function, that takes a list of non-repeating integers and returns of the power set of those elements.

- 17 Write a function that takes in a positive integer n , and prints all the possible legal permutations of n brackets. For example, given the input 2, the function should print: " $()()$ ", and " $()()()$ ".

- 18 The following is the Knight's tour problem.

Is it possible to have a knight visit every position on a chess board? You may assume any starting position.

Write a function that specifies a starting position for the knight and then outputs the sequence of moves that completes the knight's tour.

- 19 The following is the 8 Queens problem.

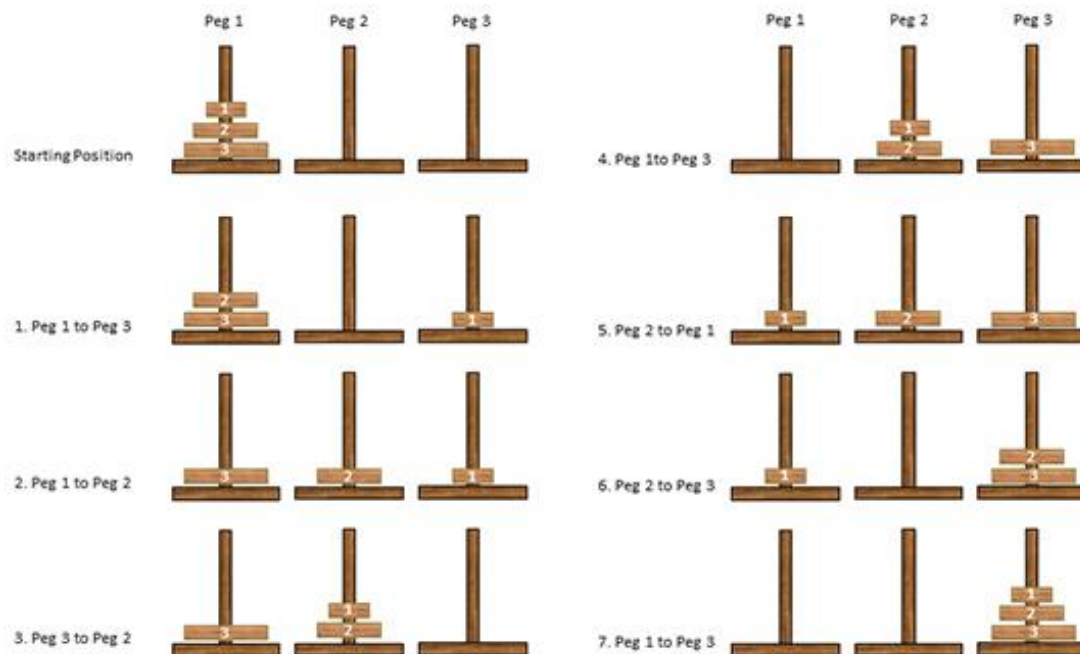
Is it possible to place eight queens on an empty chessboard so that no queen is attacking any other, i.e., no two queens are in the same row, the same column, or along the same diagonal?

Write a function to solve this problem. If the answer is yes, also output the positions of the queens.

Optional Extension 1: let your function take an input n , and then output n unique solutions.

Optional Extension 2: write your function such that it outputs all possible unique solutions.

20 The following image depicts the Towers of Hanoi puzzle.



Using a list of integers to represent each peg, with each integer representing a disk (such that, e.g., 3 represents a disk that is larger than 2), write a function that takes in a positive integer n , which refers to the number of disks, and then outputs the sequence of moves that will solve that puzzle (note that regardless of the size of n , you are to always use 3 pegs – i.e., 3 towers).

The output should be a list of lists, with each sub-list containing 2 integers: the first is origin of the disk to be moved, and the second is its destination. For example, the solution stated in the image would be represented by: `[[1, 3], [1, 2], [3, 2], [1, 3], [2, 1], [2, 3], [1, 3]]`

Additional References

- “How to Think Like a Computer Scientist” Chapters 5:
<http://www.greenteapress.com/thinkpython/thinkCSpy/html/chap05.html>
- “Python Programming” Section on Functions:
https://en.wikibooks.org/wiki/Python_Programming/Functions
- “Python Programming” Section on Scoping:
https://en.wikibooks.org/wiki/Python_Programming/Scoping
- “How to Think Like a Computer Scientist” Chapters 4.8 – 4.11:
<http://www.greenteapress.com/thinkpython/thinkCSpy/html/chap04.html>

There are many other exceptional resources available on the internet. If you find any, please share with the class via group chat.