Unit 4: Programming Activities

Seminar 2: Recursion & Regex

QUESTION 1: **Recursion**

- One of the classic programming problems that is often solved by recursion is the towers of Hanoi problem. A good explanation and walkthrough are provided by Cormen & Balkcom (n.d.) - the link is in the reading list. (the code they used for their visual example is provided on their website as well).
- Read the explanation, study the code and then create your own version using Python (if you want to make it more interesting you can use asterisks to represent the disks).

I. Create a version that asks for the number of disks and then executes the moves, and then finally displays the number of moves executed – for answers see slides 3, 4, 5.

II. What is the (theoretical) maximum number of disks that your program can move without generating an error? The more disks – the more number of moves. (2^n-1 , where n=no of disks).

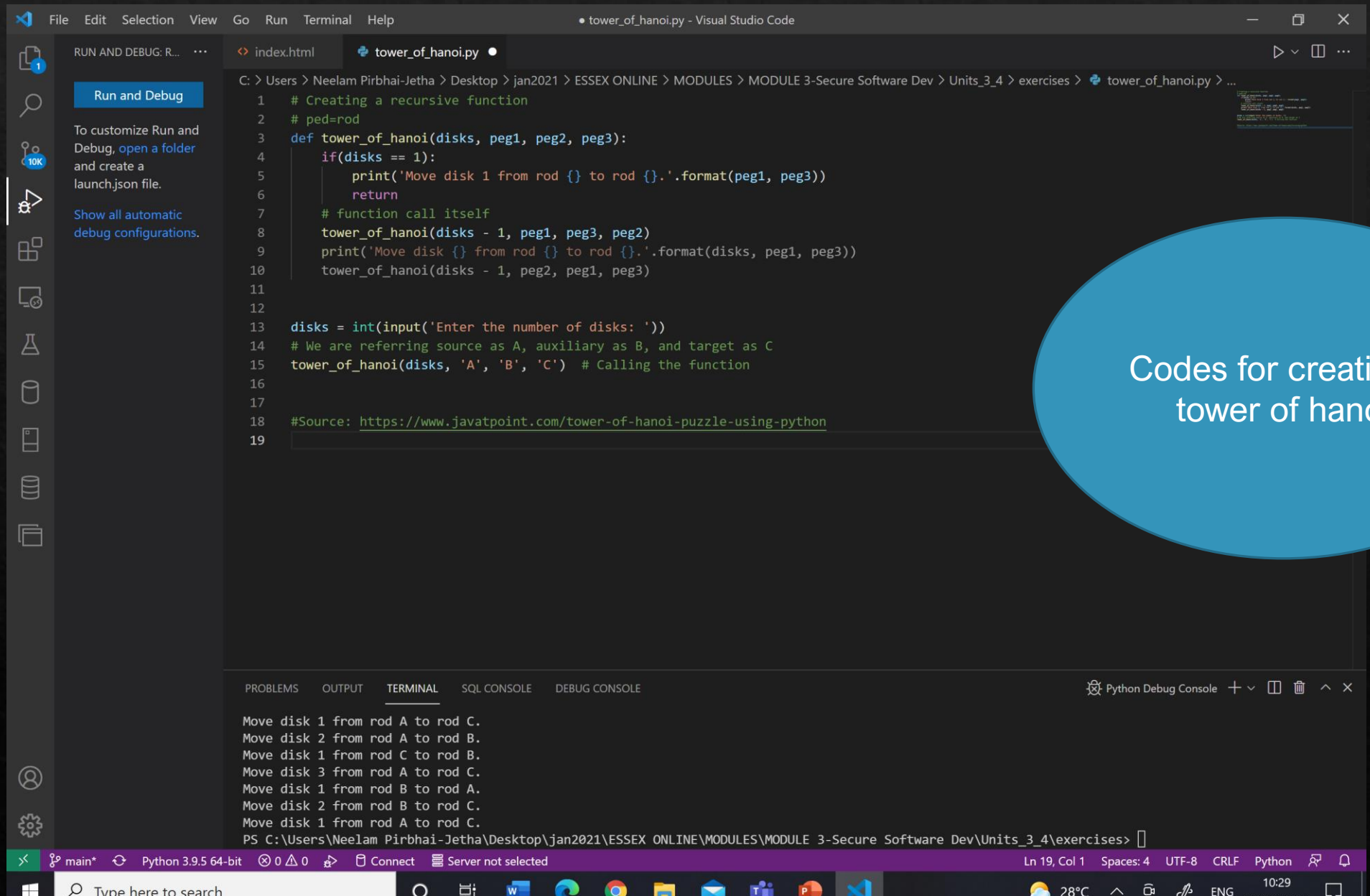
III. What limits the number of iterations?

   I. Python's default recursion limit is **1000**, meaning that Python won't let a function call on itself more than 1000 times. [source: https://www.pythoncentral.io/resetting-the-recursion-limit/#:~:text=Python's%20default%20recursion%20limit%20is,exactly%20make%20for%20lightweight%20code.]

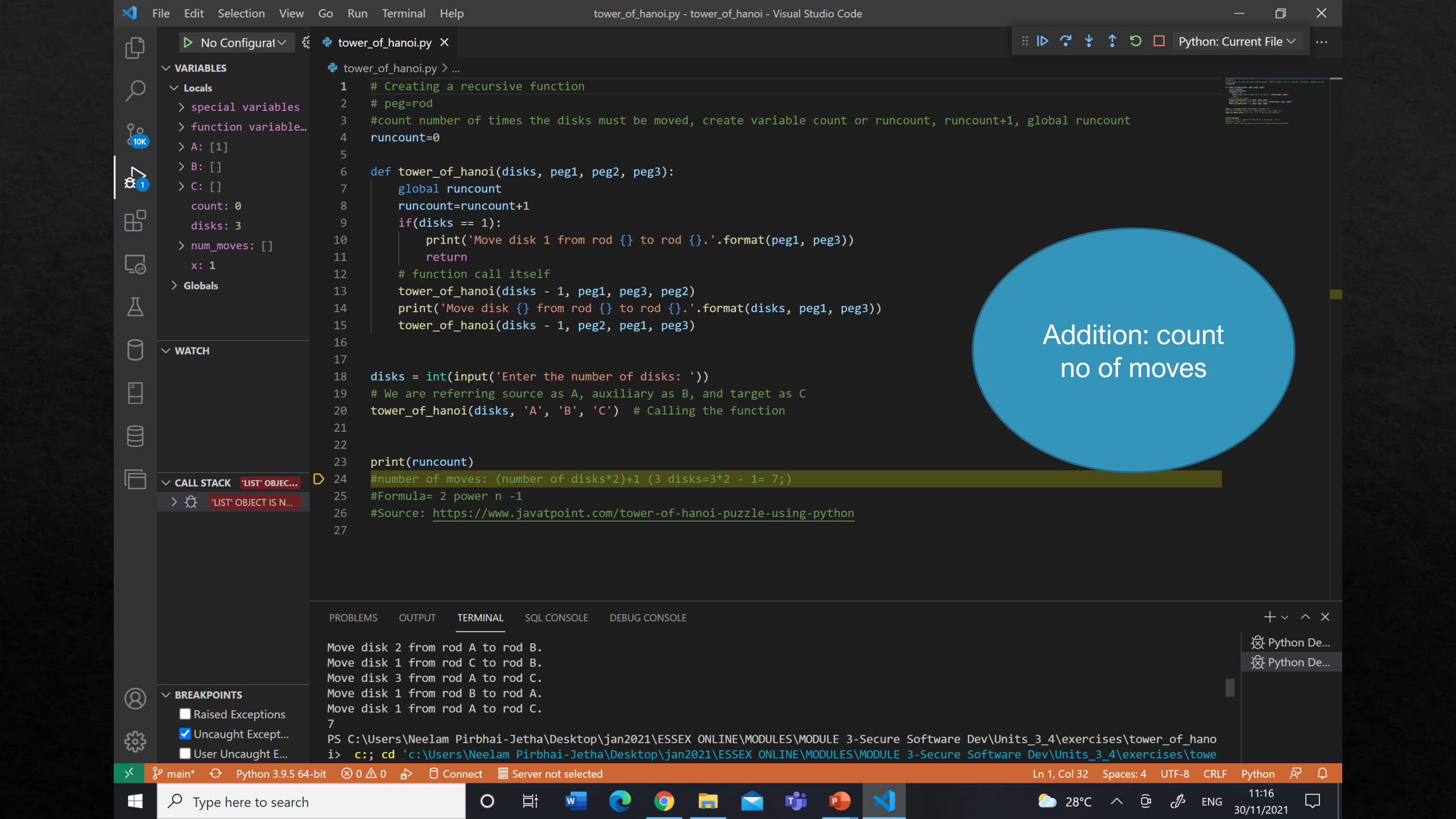
   II. Runtime will be too long – no of moves too many E.g if 10 disks = 1023 moves…

IV. What is the implication for application and system security? See Evil Regex – attacking due to repetition+runtime, stack overflow

Create a version that asks for the number of disks and then executes the moves, and then finally displays the number of moves executed. [Source: https://www.youtube.com/watch?v=kxJzTdfaHQk



Codes for creating a tower of hanoi


File Edit Selection View Go Run Terminal Help
tower_of_hanoi.py - tower_of_hanoi - Visual Studio Code
No Configurat
tower_of_hanoi.py
Python: Current File
VARIABLES
Locals
special variables
function variable...
A: [1]
B: []
C: []
count: 0
disks: 3
num_moves: []
x: 1
Globals
WATCH
CALL STACK 'LIST' OBJEC...
'LIST' OBJECT IS N...
BREAKPOINTS
Raised Exceptions
Uncaught Except...
User Uncaught E...
tower_of_hanoi.py > ...
1 # Creating a recursive function
2 # peg=rod
3 #count number of times the disks must be moved, create variable count or runcount, runcount+1, global runcount
4 runcount=0
5
6 def tower_of_hanoi(disks, peg1, peg2, peg3):
7 global runcount
8 runcount=runcount+1
9 if(disks == 1):
10 print('Move disk 1 from rod {} to rod {}.'.format(peg1, peg3))
11 return
12 # function call itself
13 tower_of_hanoi(disks - 1, peg1, peg3, peg2)
14 print('Move disk {} from rod {} to rod {}.'.format(disks, peg1, peg3))
15 tower_of_hanoi(disks - 1, peg2, peg1, peg3)
16
17
18 disks = int(input('Enter the number of disks: '))
19 # We are referring source as A, auxiliary as B, and target as C
20 tower_of_hanoi(disks, 'A', 'B', 'C') # Calling the function
21
22
23 print(runcount)
24 #number of moves: (number of disks*2)+1 (3 disks=3*2 - 1= 7;)
25 #Formula= 2 power n -1
26 #Source: https://www.javatpoint.com/tower-of-hanoi-puzzle-using-python
27
Addition: count no of moves
PROBLEMS OUTPUT TERMINAL SQL CONSOLE DEBUG CONSOLE
Move disk 2 from rod A to rod B.
Move disk 1 from rod C to rod B.
Move disk 3 from rod A to rod C.
Move disk 1 from rod B to rod A.
Move disk 1 from rod A to rod C.
7
PS C:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hano
i> c:; cd 'c:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\towe
Python De...
Python De...
main* Python 3.9.5 64-bit 0 0 Connect Server not selected Ln 1, Col 32 Spaces: 4 UTF-8 CRLF Python
Type here to search
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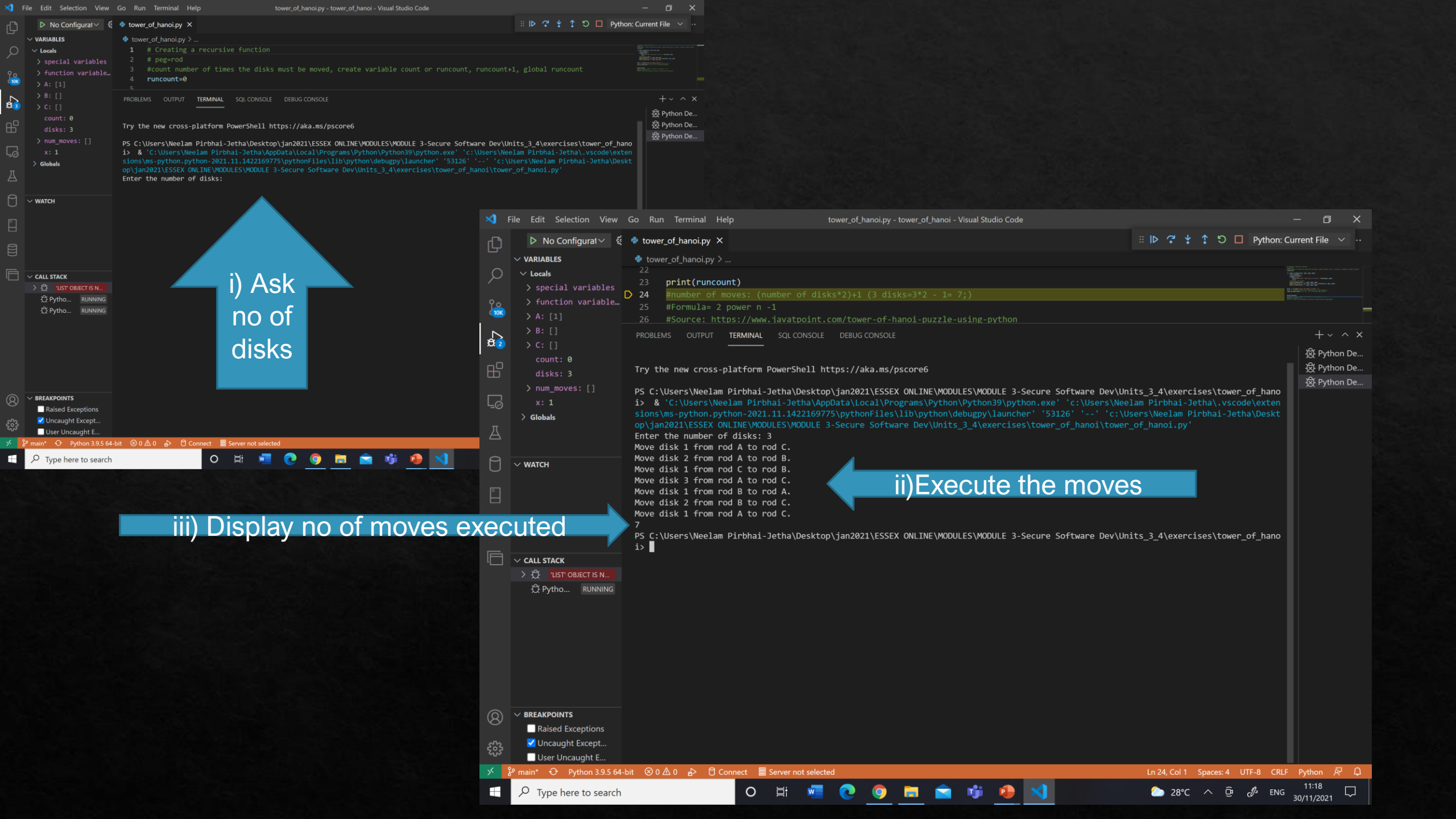
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22
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Python De...
Python De...
Python De...
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS C:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi> & 'C:\Users\Neelam Pirbhai-Jetha\AppData\Local\Programs\Python\Python39\python.exe' 'c:\Users\Neelam Pirbhai-Jetha\.vscode\extensions\ms-python.python-2021.11.1422169775\pythonFiles\lib\python\debugpy\launcher' '53126' '--' 'c:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi\tower_of_hanoi.py'
Enter the number of disks: 3
Move disk 1 from rod A to rod C.
Move disk 2 from rod A to rod B.
Move disk 1 from rod C to rod B.
Move disk 3 from rod A to rod C.
Move disk 1 from rod B to rod A.
Move disk 2 from rod B to rod C.
Move disk 1 from rod A to rod C.
7
PS C:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi>
main* Python 3.9.5 64-bit 0 0 Connect Server not selected
Ln 24, Col 1 Spaces: 4 UTF-8 CRLF Python
Type here to search
28°C ENG 11:18 30/11/2021
i) Ask no of disks
ii)Execute the moves
iii) Display no of moves executed

QUESTION 2: **Regex**

- The second language concept we will look at is regular expressions (regex). We have already presented some studies on their use, and potential problems, above. The lecturecast also contains a useful link to a tutorial on creating regex. Re-read the provided links and tutorial (Jaiswal, 2020) and then attempt the problem presented below:
- The UK postcode system consists of a string that contains a number of characters and numbers – a typical example is ST7 9HV (this is not valid – see below for why). The rules for the pattern are available from idealpostcodes (2020).

I. Create a python program that implements a regex that complies with the rules provided above – test it against the examples provided.

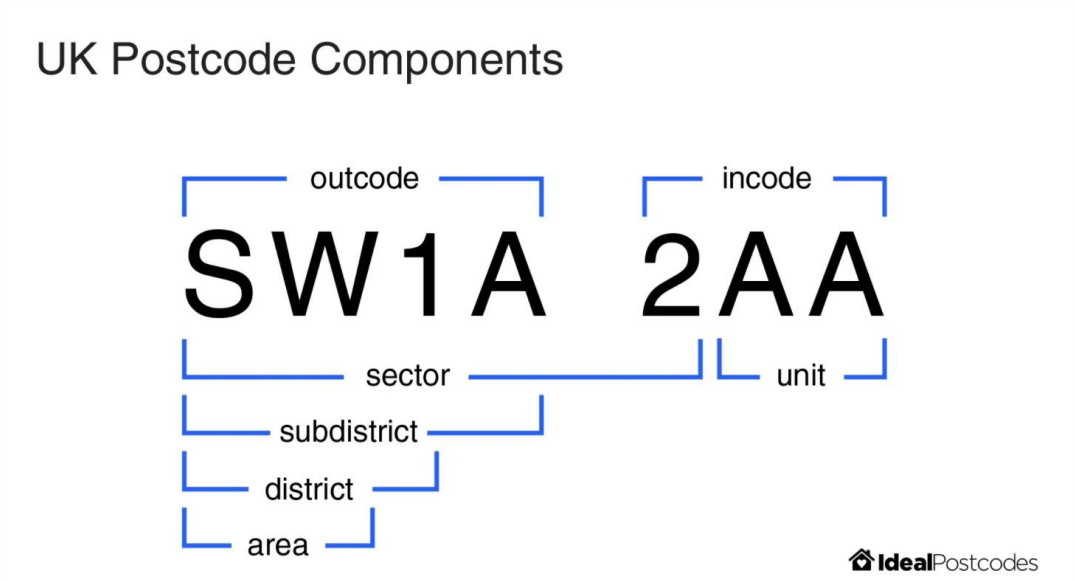
- Examples:
- M1 1AA
- M60 1NW
- CR2 6XH
- DN55 1PT
- W1A 1HQ
- EC1A 1BB

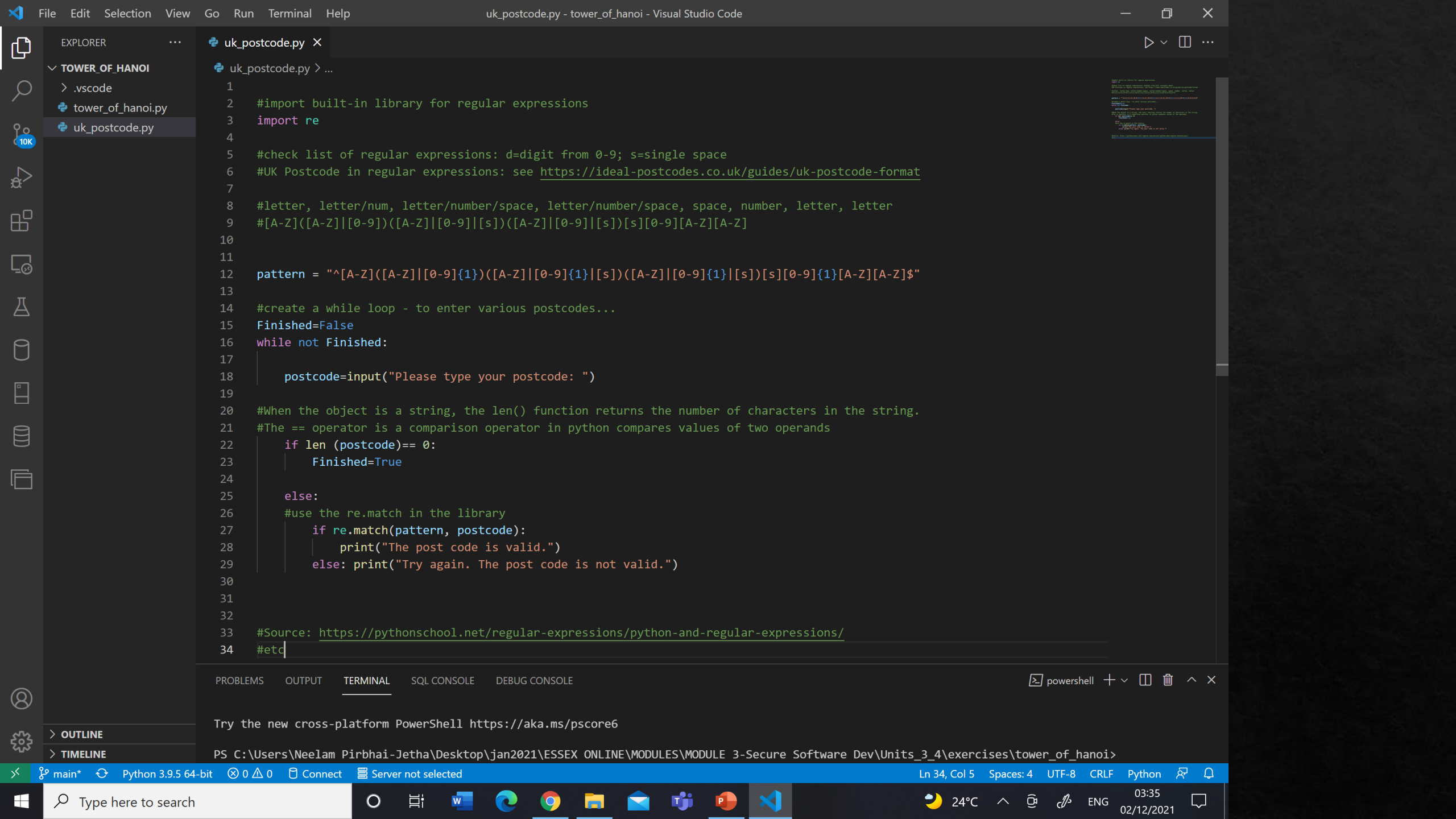
II. How do you ensure your solution is not subject to an evil regex attack?

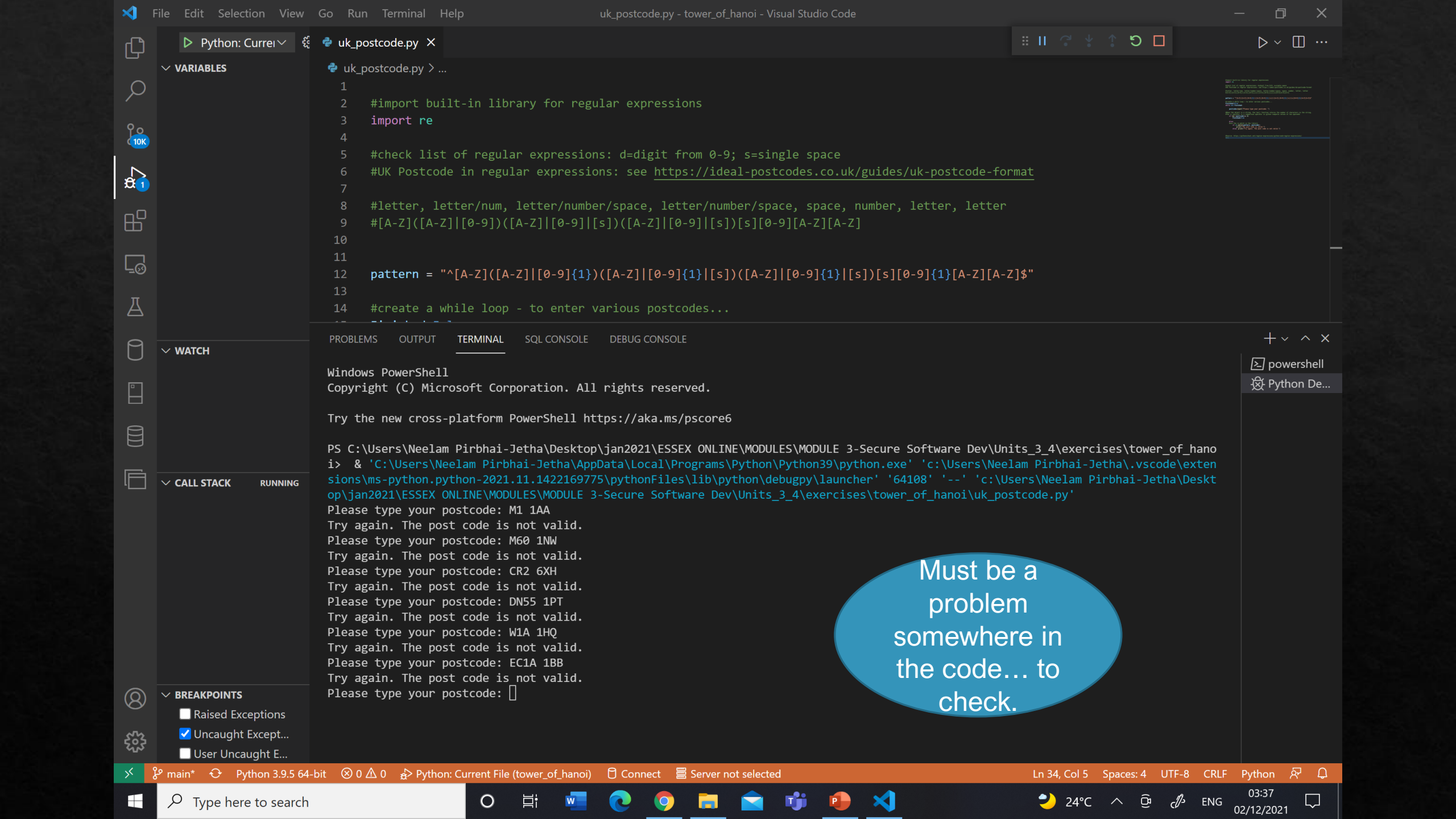
N/A means not applicable

Postcode Components

Postcodes can also be broken down into meaningful constituent components.




File Edit Selection View Go Run Terminal Help
uk_postcode.py - tower_of_hanoi - Visual Studio Code
EXPLORER
TOWER_OF_HANOI
.vscode
tower_of_hanoi.py
uk_postcode.py
uk_postcode.py
uk_postcode.py > ...
#import built-in library for regular expressions
import re
#check list of regular expressions: d=digit from 0-9; s=single space
#UK Postcode in regular expressions: see https://ideal-postcodes.co.uk/guides/uk-postcode-format
#letter, letter/num, letter/number/space, letter/number/space, space, number, letter, letter
#[A-Z]([A-Z]|[0-9])([A-Z]|[0-9]|[s])([A-Z]|[0-9]|[s])[s][0-9][A-Z][A-Z]
pattern = "^[A-Z]([A-Z]|[0-9]{1})([A-Z]|[0-9]{1}|[s])([A-Z]|[0-9]{1}|[s])[s][0-9]{1}[A-Z][A-Z]$"
#create a while loop - to enter various postcodes...
Finished=False
while not Finished:
postcode=input("Please type your postcode: ")
#When the object is a string, the len() function returns the number of characters in the string.
#The == operator is a comparison operator in python compares values of two operands
if len (postcode)== 0:
Finished=True
else:
#use the re.match in the library
if re.match(pattern, postcode):
print("The post code is valid.")
else: print("Try again. The post code is not valid.")
#Source: https://pythonschool.net/regular-expressions/python-and-regular-expressions/
#etc
PROBLEMS OUTPUT TERMINAL SQL CONSOLE DEBUG CONSOLE
powershell
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS C:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi>
OUTLINE
TIMELINE
main* Python 3.9.5 64-bit 0 0 Connect Server not selected
Ln 34, Col 5 Spaces: 4 UTF-8 CRLF Python
Type here to search
24°C
ENG
03:35
02/12/2021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uk_postcode.py - tower_of_hanoi - Visual Studio Code
Python: Curre
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VARIABLES
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CALL STACK RUNNING
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uk_postcode.py > ...
#import built-in library for regular expressions
import re
#check list of regular expressions: d=digit from 0-9; s=single space
#UK Postcode in regular expressions: see https://ideal-postcodes.co.uk/guides/uk-postcode-format
#letter, letter/num, letter/number/space, letter/number/space, space, number, letter, letter
#[A-Z]([A-Z]|[0-9])([A-Z]|[0-9]|[s])([A-Z]|[0-9]|[s])[s][0-9][A-Z][A-Z]
pattern = "^[A-Z]([A-Z]|[0-9]{1})([A-Z]|[0-9]{1}|[s])([A-Z]|[0-9]{1}|[s])[s][0-9]{1}[A-Z][A-Z]$"
#create a while loop - to enter various postcodes...
PROBLEMS OUTPUT TERMINAL SQL CONSOLE DEBUG CONSOLE
powershell
Python De...
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS C:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi> & 'C:\Users\Neelam Pirbhai-Jetha\AppData\Local\Programs\Python\Python39\python.exe' 'c:\Users\Neelam Pirbhai-Jetha\.vscode\extensions\ms-python.python-2021.11.1422169775\pythonFiles\lib\python\debugpy\launcher' '64108' '--' 'c:\Users\Neelam Pirbhai-Jetha\Desktop\jan2021\ESSEX ONLINE\MODULES\MODULE 3-Secure Software Dev\Units_3_4\exercises\tower_of_hanoi\uk_postcode.py'
Please type your postcode: M1 1AA
Try again. The post code is not valid.
Please type your postcode: M60 1NW
Try again. The post code is not valid.
Please type your postcode: CR2 6XH
Try again. The post code is not valid.
Please type your postcode: DN55 1PT
Try again. The post code is not valid.
Please type your postcode: W1A 1HQ
Try again. The post code is not valid.
Please type your postcode: EC1A 1BB
Try again. The post code is not valid.
Please type your postcode:
Must be a problem somewhere in the code… to check.
main*
Python 3.9.5 64-bit
0 0
Python: Current File (tower_of_hanoi)
Connect
Server not selected
Ln 34, Col 5
Spaces: 4
UTF-8
CRLF
Python
Type here to search
24°C
ENG
03:37
02/12/2021

II. How do you ensure your solution is not subject to an evil regex attack? Source:https://owasp.org/www-community/attacks/Regular_expression_Denial_of_Service_-_ReDoS

Evil Regex contains:
- Grouping with repetition
- Inside the repeated group:
  - Repetition
  - Alternation with overlapping

Examples of Evil Regex:
- (a+)+
- ([a-zA-Z]+)*
- (a|aa)+
- (a|a?)+
- (.*a){x} for x \> 10

Check for creating regex

- https://blog.securityinnovation.com/blog/2011/03/input_validation_using_regular_expressions.html