

Basics of Programming

L04: Loops

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Dr. Ram P Rustagi
Professor, CSE Dept
KRP, KSGI
rprustagi@ksit.edu.in

Resources and Acknowledgements

- Intro to Programming with C++
 - Abhiram Ranade, Prof CSE, IIT Bombay
- A first course in programming
 - <https://introcs.cs.princeton.edu/python/home/>
 - <https://introcs.cs.princeton.edu/java/home/>
- Python for everybody
 - <https://www.py4e.com>
- Turtle Graphics
 - <https://docs.python.org/3/library/turtle.html>

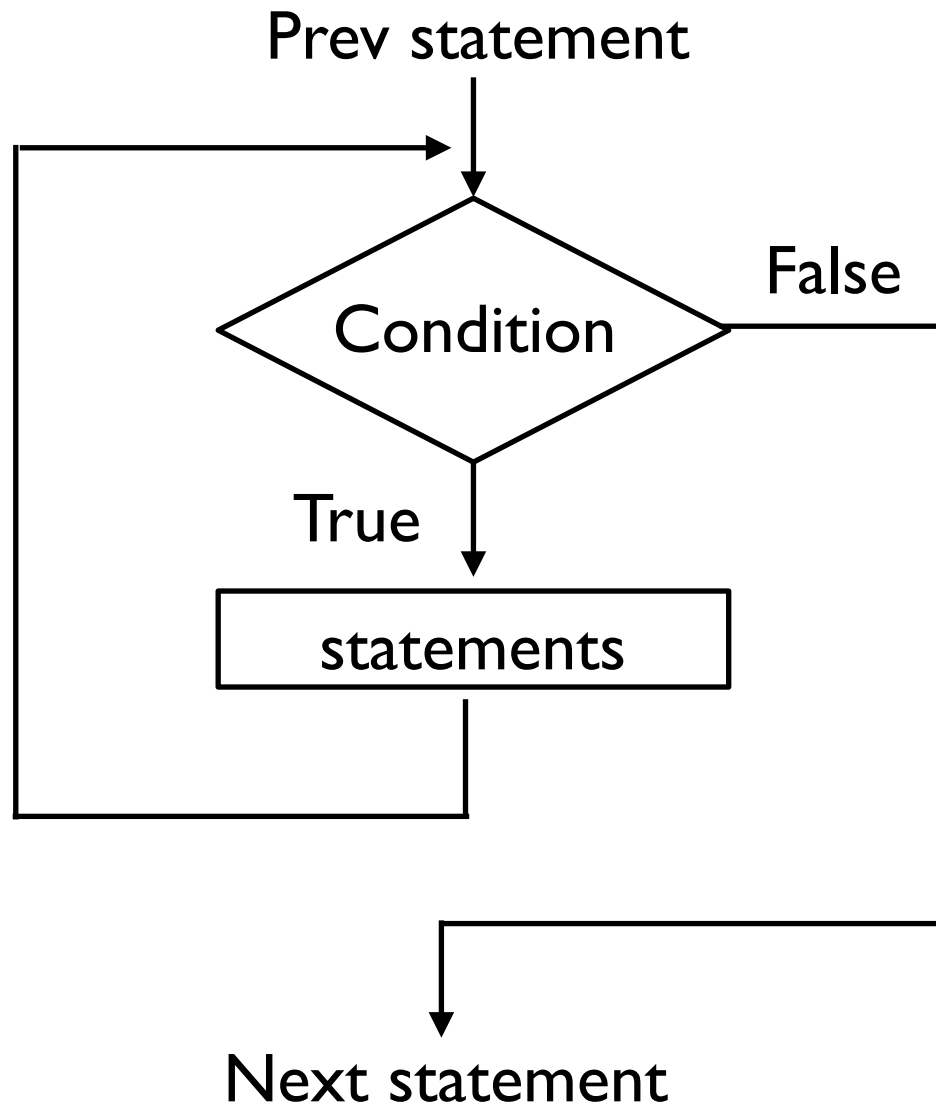
Review: Lecture 03

- Turtle graphics
 - multiple turtles
 - overlapping polygons
- If statement
 - Conditional ifs, Nested ifs
 - Complex conditions
 - `pass` statement
- Simple loops, early closure of loops
 - `break`, `continue`
- Exercises
 - Make carrom board, GCD implementation
 - Sort 4 (and 5) numbers.
 - Max subsequence, smallest palindrome $>n$.

Loop: While

- Loop statements
 - `while`, `for`
- General structure
 - `while` (condition)
 - body # statements
- Each execution of the body is called iteration.
- Execution ends when condition becomes false
- Body can be any number of statements
- For program to halt
 - condition must become false at some point
 - typically, condition involves some variables
 - Value of variables changes for halting condition

While Flowchart



A Bad While Loop

- Spot the issue in following program segment

```
n=int(input("enter max even number"))
even=2
while (even != n):
    print(even)
    even = even + 2

print("All even numbers up to ", n)
```

- What should be the changes in this program
 - Ensure that condition terminates (halts)

Loop: `for` statement

- `for` statement (3 parts)
 - Initialize an index variable to some value
 - Use a while loop to test terminating (exit) condition
 - Modify the index variable
- It is generally used when count of iterations are kind of known in advance
- Use while loop when count of iterations are unknown
 - Depending upon use case under consideration

Use Cases: for/while loop

- Write first n powers of 2

```
for i in range(n+1):  
    print(2**i)
```

- Write largest power of 2 greater than n

```
power=1  
while (2**power < n):  
    power = power + 1  
print("power of 2(>n)", 2**power)
```


Use Cases: for/while loop

- Write sum of first n even numbers

```
sum = 0
for i in range(n):
    sum = sum + 2*(i+1)
print(sum)
```

- Write a product of first n natural numbers

```
prod = 1
for i in range(1, n+1):
    prod = prod * i
print(prod)
```

Use Cases: `for/while` loop

- Compute `sqrt(num)` till 10 decimal places using newton's method
- Steps:
 - initialize variable `temp = num`
 - repeat below till $(temp - num/temp) < 10^{-10}$
 - `temp = (num/temp + temp) / 2.0`
- Code

```
val = num
while (abs(val - num/val) > 10** -10) :
    val = (val + num/val) / 2.0
print(val)
```

Nesting: Loop and Conditions

- Compute prime factorization of n
 - e.g. for $n=24$, prime factorization is $2*2*2*3$
- Code

```
val = n
factor=2
while (val>factor):
    if (val % factor == 0):
        print(factor)
        val = val // factor
    else:
        factor = factor + 1
print(val)
```

Loop Termination in Block

- Keep computing square and cube of given integer
 - Until user decides to exit (enters 0)

```
while True:
    n=int(input("Enter a number: "))
    if (n == 0):
        break
    print("n^2=", n*n, ", n^3=", n*n*n)

print("Thanks for using the program")
```

Python Programming Considerations

- Should we use TAB in program for indentations?
 - It should be avoided. Many editors treat it differently.
- Can a statement be spread over multiple lines
 - Yes, but be careful
 - Understand how python treats indentation
 - Within parenthesis, splitting works just fine

```
n = (1 + 2 + 3 + 4)
```
 - Otherwise, use backslash(\) as the last character

```
n = 1 + 2 + 3 \ + 4
```
- How to create empty body of statement
 - use `pass` statement

Python Programming Considerations

- Can we use non-boolean expression in conditions?
 - It is not recommended.
 - numeric 0 and empty string is considered `False`.
- Can we change index variable in `for` loop?
 - Yes, but it is not recommended.
 - It may become too difficult to debug.
 - What is the output of following

```
for i in range(10):  
    print(i)  
    i = i + 2
```
- What is the value of index variable upon exit in `for` loop with `range(n)` ?
 - `n`

Exercise

- What does following program do

```
n=10
```

```
f=0
```

```
g=1
```

```
for i in range(n):
```

```
    f=f+g
```

```
    g=f-g
```

```
    print(f)
```

- Answer: ?

Home Work

- H01: Compose a program that takes one command-line argument n , and
 - writes an n -by- n table such that there is an $*$ in row i and column j
 - if the gcd of i and j is 1, i.e.
 - i and j are relatively prime
 - a space in that position otherwise

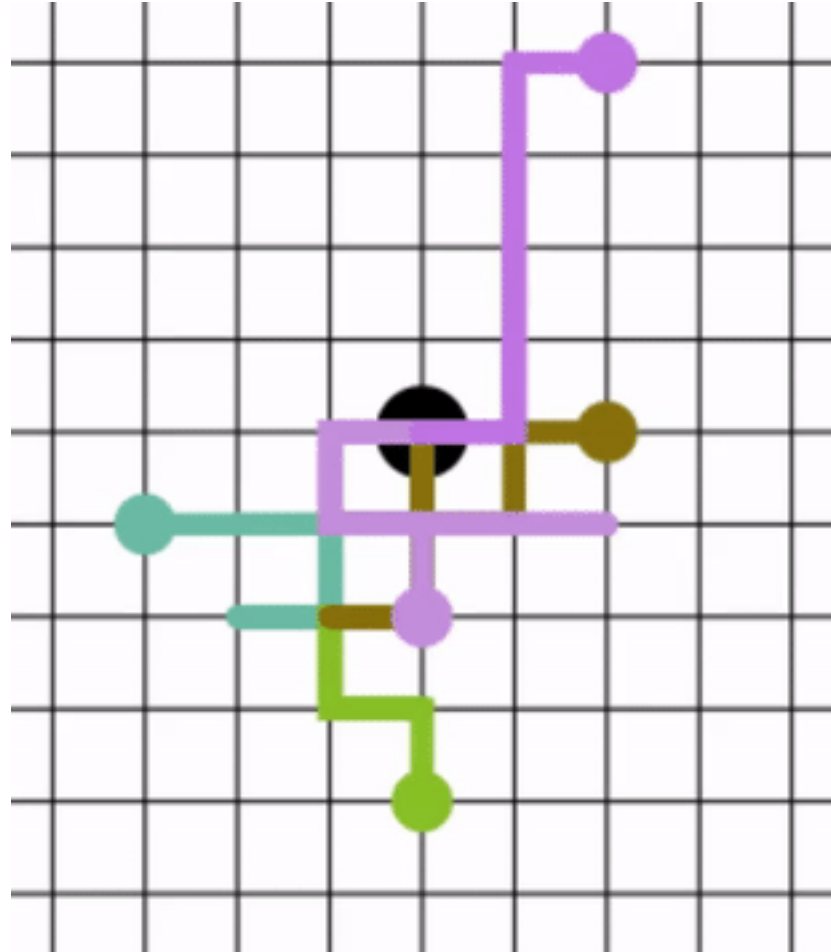
Home Work

- H02: Ramajunjan's taxi number identification using `while` loop (and not `for` loop)
 - Given command-line argument `n`, and
 - Identify if $n = a^3 + b^3 = c^3 + d^3$, where
 - All `a`, `b`, `c`, `d` are distinct positive integers

Home Work

- H02: 2D random walk
 - ref: https://en.wikipedia.org/wiki/Random_walk
 - A two dimensional random walk simulates the behavior of a particle moving in a grid of points.
 - At each step, the random walker moves north, south, east, or west.
 - Each move is with probability $1/4$, independent of previous moves.
 - Compose a program that takes a command-line argument n and estimates how long it will take a random walker to hit the boundary of a square of size $2n+1$ -by- $2n+1$ starting at the centre point.
 - Image of 2D Random walk

2D Random Walk



Home Work

- H03: Median of 5 numbers in max 6 comparisons
 - ref:<http://mathcs.wilkes.edu/~bracken/cs328/fa2014/median5.pdf>
 - Take 5 integers at command line arguments
 - Find the median of these 5 numbers.
 - First use the normal logic you can think of
 - See if you can optimize it using max 6 comparisons
 - See the reference

Home Work

- H04: Let us make a deal (Game Show)
 - A contestant is presented with three doors.
 - Behind one of them is a valuable prize.
 - After contestant chooses a door, host opens one of the other two doors (not the one containing the prize)
 - The contestant is then given the choice to switch to the other unopened door.
 - Should the contestant do so?
 - Write a program to answer this question
 - Run the logic 1000 times to answer
 - Should the contestant switch to other door?

Questions

