Basics of Programming

L01

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Overview

- Basics of programming
- Need for
  - variables
  - variable types
  - loop
  - function definition
- L02: Writing correct programs

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/
- Python for everybody
  - https://www.py4e.com
- Web Applications for everybody
  - https://www.wa4e.com
- Turtle Graphics
  - https://docs.python.org/3/library/turtle.html
- Online Turtle graphics
  - https://repl.it/languages/python_turtle

What is Programming

- A creative activity by CS Engineer
- An engineer's pride
  - Build thing and see it working/used
- A CS engineer pride
  - Create programs and see it getting used
    - Meets (exceeds) given requirements
      - Anticipate future requirements and make provisions
    - No crashes
    - No side effects
    - Scope for enhancement
- Goal: Learn how to make computers do things we need

What is a Program?

- Program
  - A precise description of the calculations we want the computer to perform
  - By feeding different programs to a computer you can make it do different calculations.
- This course
  - Introduces you to tenets of programming
- Programming language
  - A language that is used to write programs
    - Java, python, C/C++, SQL, …

Starters

- Work with pictures (polygons)
- Turtle
  - Moves on the screen
  - It has a pen, so it draws on the screen
    - pen should be down
  - When pen is up, it just moves, but does not draw
- Drawing pictures is fun based learning
  - Mastering of pictures drawing will make you learn lot of basics of programming
- Basic APIs:
  - `forward(), left(), right(),`
  - `penup(), pendown()`
  - `wait()`

Turtle: Drawing a Square

```
from turtle import *
# Draw a square of each side 100 pixels
forward(100)
left(90)
forward(100)
left(90)
forward(100)
left(90)
forward(100)
left(90)
```

Q: How to make square of each side of 150 pixels?
How many changes we need to make?

Drawing a Square: Use Variable

```
from turtle import *
# Draw a square whose length can be changed.
x=150
forward(x)
left(90)
forward(x)
left(90)
forward(x)
left(90)
forward(x)
left(90)
```

Q: How to draw a pentagon, hexagon or a general polygon

Drawing a Pentagon

```
from turtle import *
# Draw a pentagon whose length can be changed.
x=150
forward(x); left(72)
forward(x); left(72)
forward(x); left(72)
forward(x); left(72)
forward(x); left(72)
```

Q: How to draw a hexagon?

Drawing a Hexagon

```
from turtle import *
# Draw a Hexagon
x=150
forward(x); left(60)
forward(x); left(60)
forward(x); left(60)
forward(x); left(60)
forward(x); left(60)
```

Q: How to draw a polygon of `n` sides

Do you need to repeat writing `n` lines

Can program repeat these using some kind of loop

Drawing a Octagon: Using loops

```
from turtle import *
x=150
n=8
angle = 360//n # integer division
# repeat the set of lines n times.
for i in [1,2,3,4,5,6,7,8]:
 forward(x); left(angle)
# alternatively
for i in range(n):
 forward(x); left(angle)
```

Q: Can we draw a heptagon?

Drawing a Octagon: Using loops

```
from turtle import *
x=150
n=7
angle = 360//n # integer division
# repeat the set of lines n times.
for i in range(n):
 forward(x); left(angle)
```

Q: What happens? Do you notice a gap? why?

- We need real number value for angle.
  - 360 is not perfectly divisible by 7.
- Replace `angle = 360/7` #real number division

Consecutive Polygons

- Draw 2 consecutive squares

```
from turtle import *
x=100
n=4
angle = 360//n # integer division
# repeat the set of lines n times.
for i in range(n):
 forward(x); left(angle)
penup()
forward(x)
pendown()
for i in range(n):
 forward(x); left(angle)
```

Draw 3 Consecutive Squares

```
from turtle import *
x=100; n=4
angle = 360//n # integer division
# repeat the code 3 times
for i in range(n):
  forward(x); left(angle)
penup(); forward(x); pendown()
for i in range(n):
  forward(x); left(angle)
penup(); forward(x); pendown()
for i in range(n):
  forward(x); left(angle)
penup(); forward(x); pendown()
```

Need of Function

- Define a function to be reused
  - avoids rewriting the code again and again.

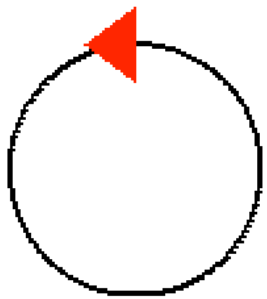
```
from turtle import *
x=100; n=4
angle = 360//n # integer division
# define a function
def polygon(n,x):
  for i in range(n):
    forward(x); left(angle)
  penup(); forward(x); pendown()
#invoke the function
polygon(4,50)
polygon(5,60)
polygon(4,50)
```

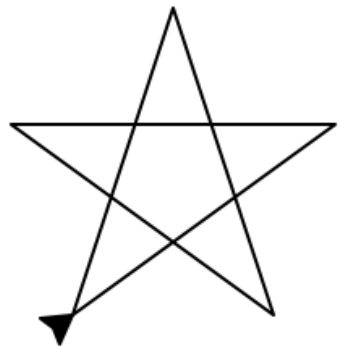
Black Square

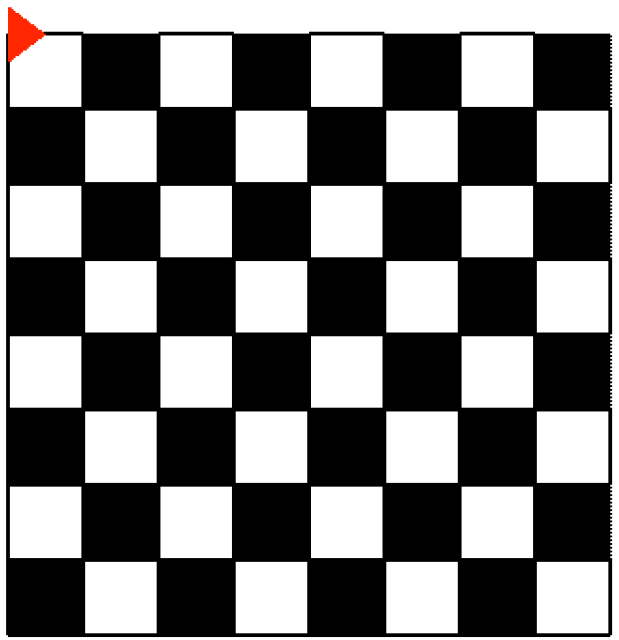
```
from turtle import *

def blacksquare(x):
  angle=90
  for i in range(x//2):
   forward(x); left(90)
   forward(1); left(90)
   forward(x); right(90)
   forward(1); right(90)

blacksquare(100)
```

Exercises

- Write programs to draw following figures
  - Circle (perimeter=360px)
  - Rectangle(sides=100px, 60px)
  - A 5-pointed star
  - A 7-pointed star
    - How many you such stars you can draw
  - A chessboard

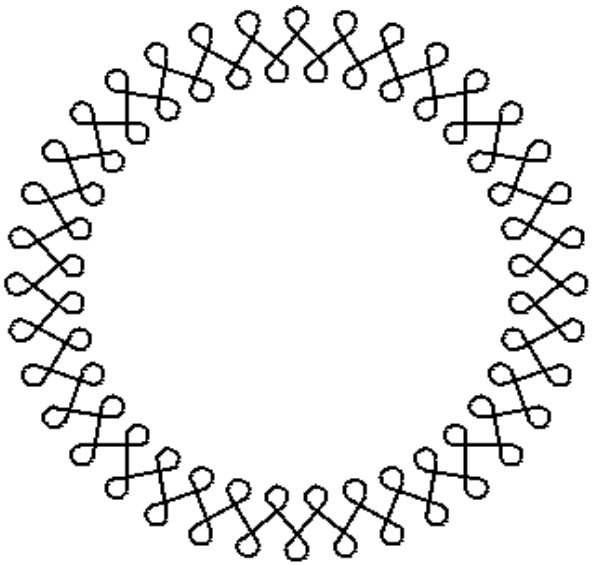


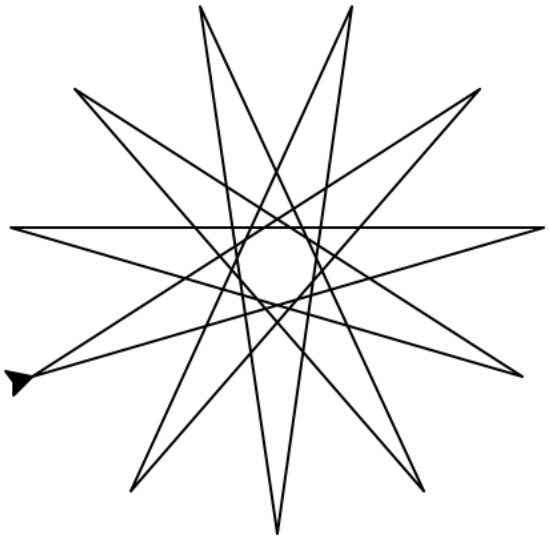


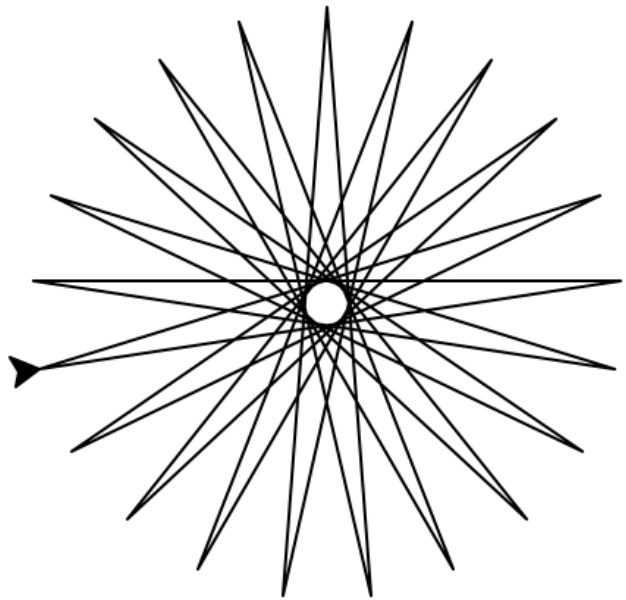


Advanced Exercises

- Draw following pattern with 36 repetitions
  - ref: Chap 01, Book by Abhiram Ranade
- Draw pointed `n`-star polygon e.g. `n=11, n=21`







Summary

- Introduction of
  - Variables
  - Loops (for loop)
  - Function definition invocation
- Logical thinking for drawing figures

Questions