What do you call a computer super hero?

A screen saver!!!

Thank you April!

CMPT 120

Lecture 18 – Graphics and Animation
Python – Turtle and Functions and Recursion

Last Lecture

- Continued learning about **turtle**
- Continued creating animation programs using
  - **Turtle**
  - **Functions**
- Introduced **tuples**

A **tuple**, like a list, is a sequence of items of any type. Unlike lists, however, tuples are immutable. Syntactically, a tuple is a comma-separated sequence of values. Although it is not necessary, it is conventional to enclose tuples in parentheses:

```
julia = ("Julia", "Roberts", 1967, "Duplicity", 2009, "Actress", "Atlanta, Georgia")
```

Today's Menu

- Solve the **chocolate chip cookie problem** using **Turtle** + **Loops** + **Functions**

- Summarize topics related to function using a demo
  - [OperationsOnList.py](#) posted on our course website
  - And the Python Visualizer

- Introduce a new kind of algorithm: **Recursion**

From last lecture!

- **Step 1 - Problem statement:**
  - Write a program that draws a **chocolate chip cookie** with our Turtle

- **Step 2 – Design**
  - Let's have a look at a possible algorithm

- **Step 3 – Implementation**

We started implementing our Cookie program **incrementally:** implement some code, test, repeat!

  - Let's transform this algorithm into Python code

Let's get to the chocolate chips now! ☺

- **Step 4 – Testing**
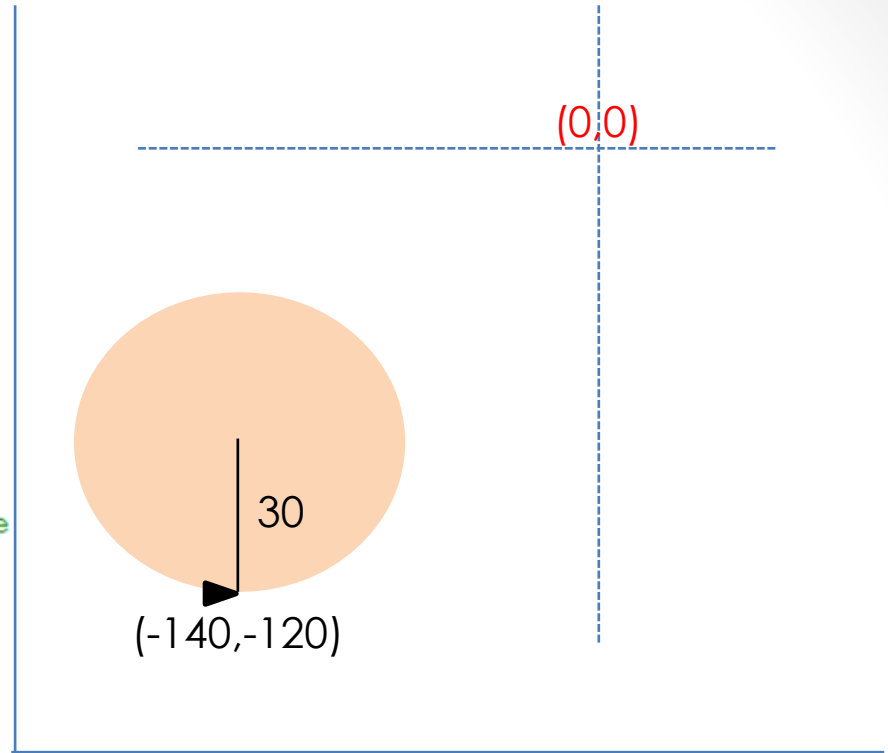 - Does our program work i.e., solve the problem?

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Step 2 – Design

Turtle Canvas

(0,0)

30

(-140,-120)

```python
# Tell tt to draw a chocolate chip cookie
# Draw the contour of the cookie
tt.penup()
tt.goto(-140,-120)
tt.pendown()
tt.circle(30)
tt.penup()

# Draw a chocolate chip in the middle of the cookie

# Draw a chocolate chip in the top left area of the cookie

# Draw a chocolate chip in the bottom left area of the cookie

# Draw a chocolate chip in the bottom right area of the cookie

# Draw a chocolate chip in the top right area of the cookie

# Click on the canvas to exit
canvas.exitonclick()
```

How to draw the chocolate chips?

- Solution:
  - Could we copy and modify the code many times, each instance of the code would be drawing a chocolate chip?

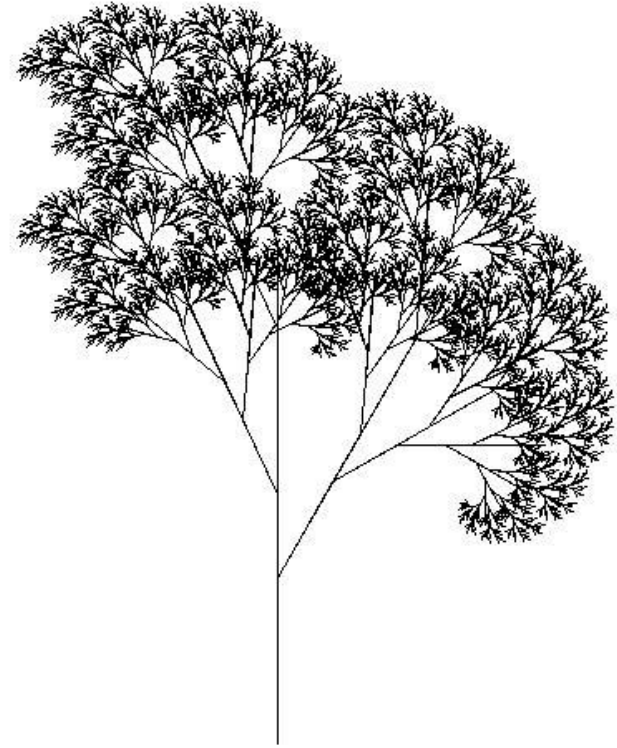- Hum… This solution would lead to a lot of repeating code, which is not a good idea!

Why? Let's have a look!

Function Demo

- Demo using Python Visualizer and OperationsOnList.py posted on our course website:
  1. Arguments and parameters
  2. Default parameters
  3. Differentiate between variables **local** to a function (which has local **scope**) versus variables used outside of a function
     - Shadowing
  4. Lists are mutable
     - Passing **lists** as argument(s) to a function
       - What happens when function modifies a list?
  5. Strings and tuples are immutable:
     - Passing **strings** and **tuples** as arguments to a function
       - What happens when function modifies a string, a tuple?

Recursion

Functions that call themselves

Recursion - Definition

From our Readings (16.1)

- **Recursion** is a method of solving problems that involves breaking a problem down into smaller and smaller subproblems until you get to a small enough problem that it can be solved trivially.
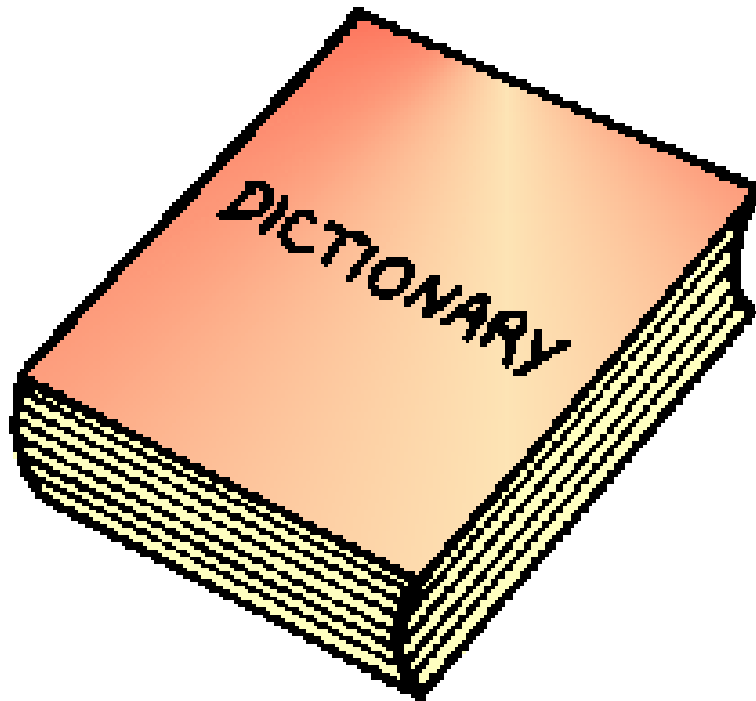
Recursion in the real world

- Russian dolls

Recursion in the real world

- Searching for the word "guffaw" in a dictionary

Source: http://www.eslstation.net/ESL310L/310L_dict.htm

Recursion in the real world

- Droste Effect

The picture is in the picture which is in the picture …

Next Lecture

- Our midterm is coming up soon!
- Let's have **practice exam #5**!
  - Please, bring paper, pens/pencils and all your questions to our lecture on Wednesday!

- We shall continue investigating the topic of **Recursion** on Friday!

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