

# Lecture 15: Recursion

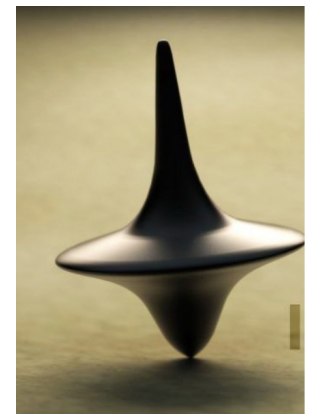
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CS 51P

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he/him/his



# Definition

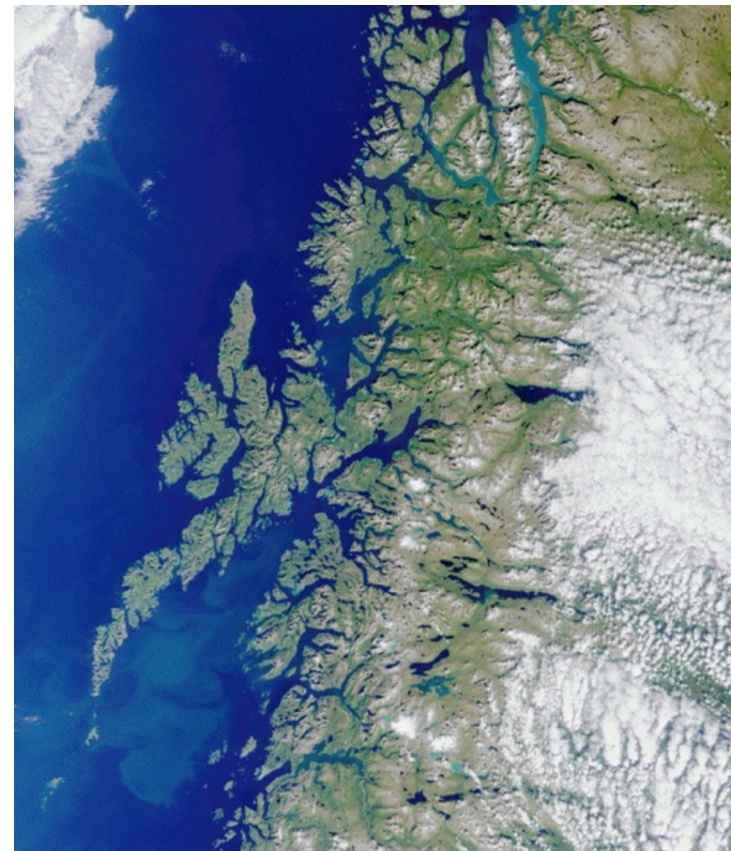
- Recursion: (noun) see recursion.
- A technique where a function, in order to accomplish a task, calls itself with a smaller part of the task
- 2 main parts:
  - Base case(s) – problem is simple, solved directly
  - Recursive case(s)
    - Divide the problem into 1 or more simpler/smaller parts
    - Invoke the function (recursively) on each part
    - Combine the solutions of the parts into a solution for the problem

# Writing recursive code

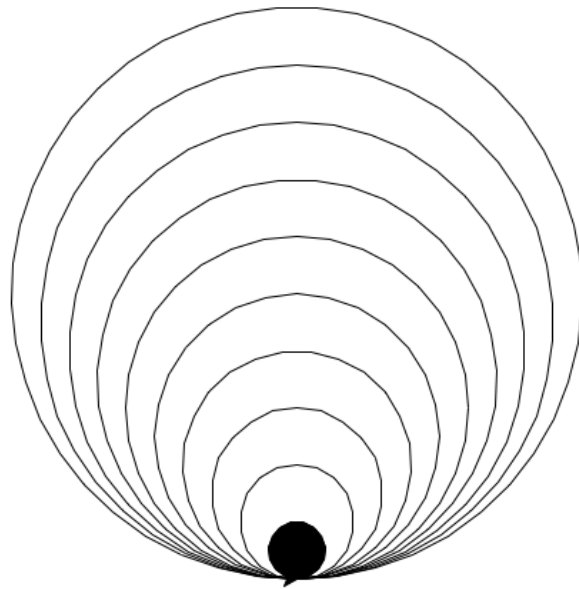
- Base case is **usually easier**, the case when you **stop**
- For recursive step
  - How do we break the problem down into 2 parts:
    - 1) One part that can be handled now
    - 2) The answer from the smaller piece of the problem
  - Assume recursive call does the right thing on the smaller problem
  - How do we combine the 2 parts to get the overall answer
- Lots of practice

# Self-Similarity

- Solving problems recursively involves identifying self-similarity
- An object is self-similar if it contains smaller copies of itself

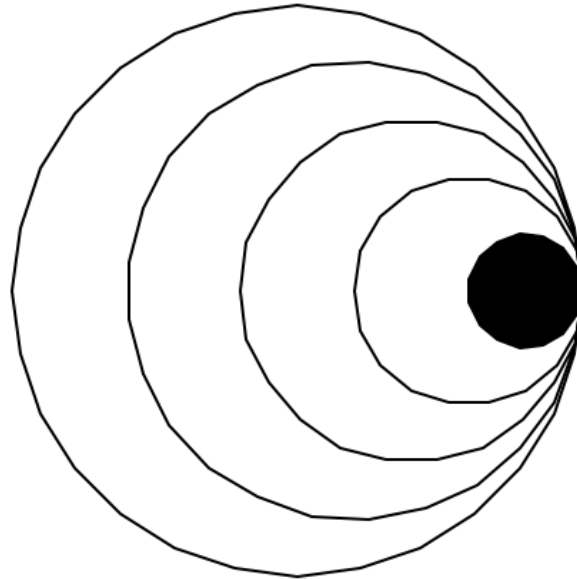


# circle\_drawing\_1



- Draw a set of circles (each circle has radius 20 smaller than the circle outside it), same bottommost point
- Once the radius is  $< 20$ , draw filled in circle

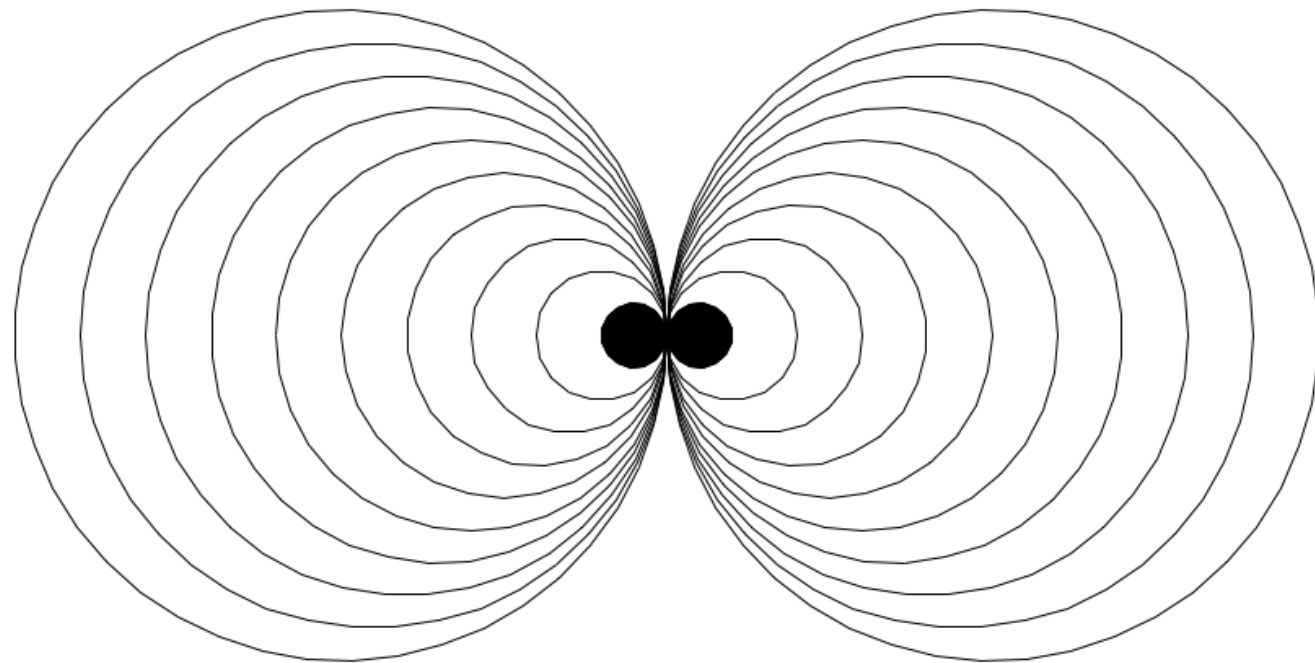
# circle\_drawing\_1b



- Draw a set of circles (each circle has radius 20 smaller than the circle outside it), same rightmost point
- Once the radius is  $< 20$ , draw filled in circle



# Extra practice: circle\_drawing\_2

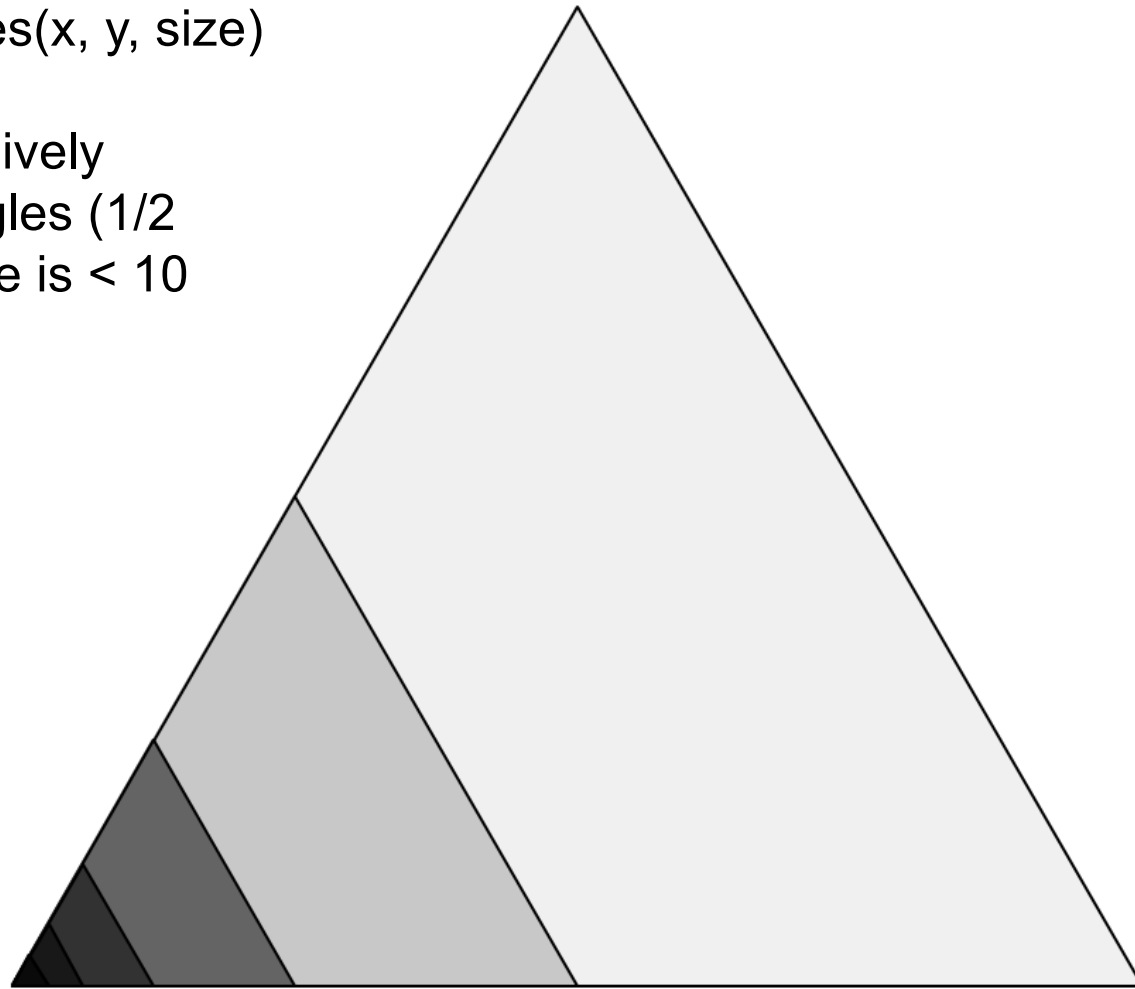


- Symmetric version circle\_drawing\_1
- The circle() function draws in a counter-clockwise fashion

# Exercise - Recursive Graphics

`draw_triangles(x, y, size)`

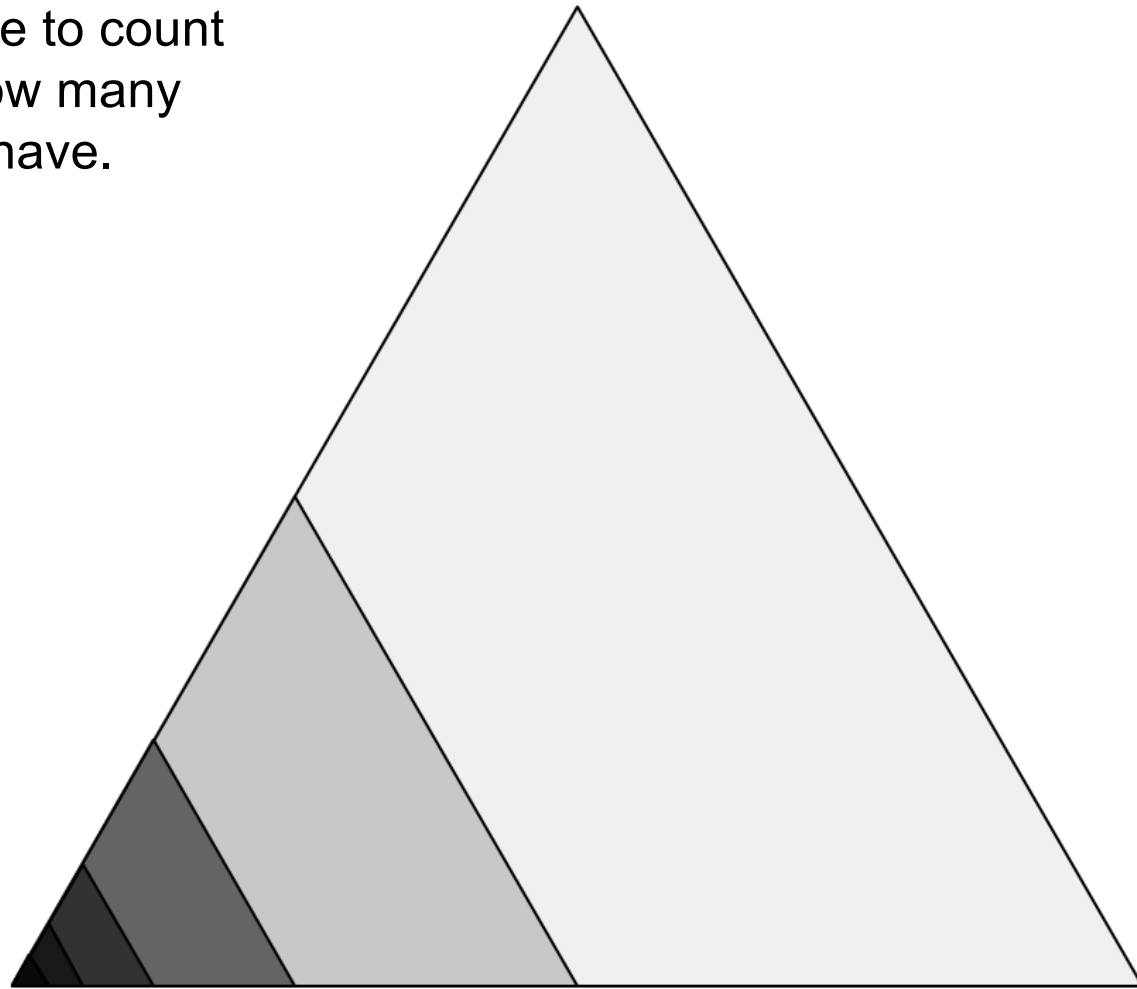
Draws recursively  
smaller triangles (1/2  
size) until size is  $< 10$





# Exercise - Recursive Graphics

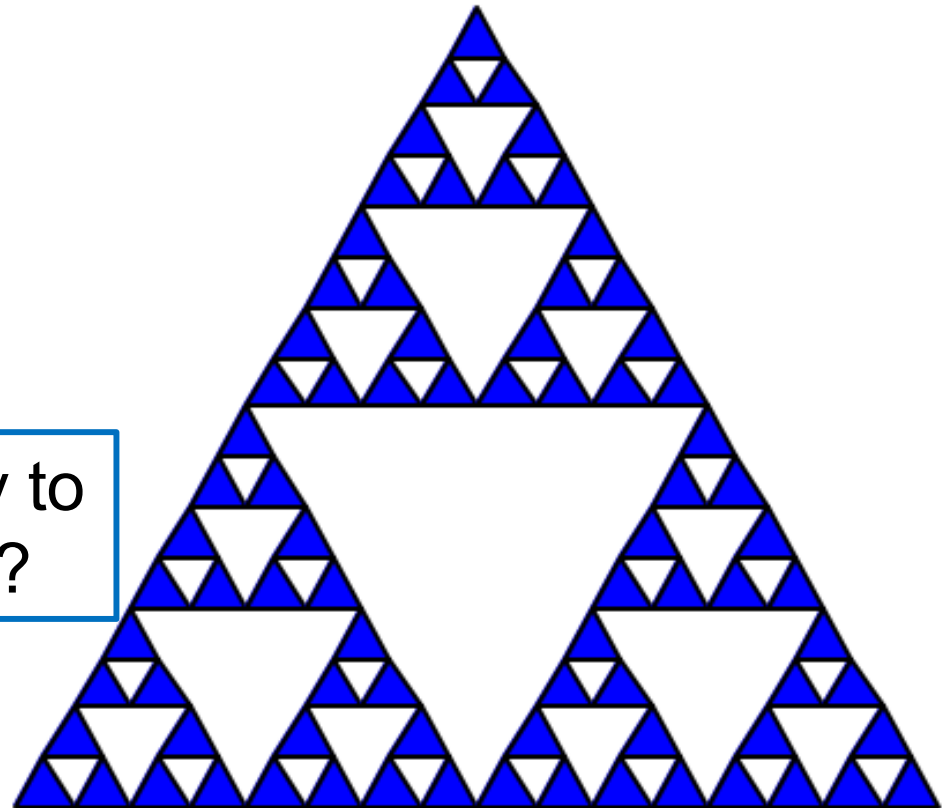
Now add code to count and return how many triangles we have.



# triangle\_drawing example

- What is the pattern being repeated?

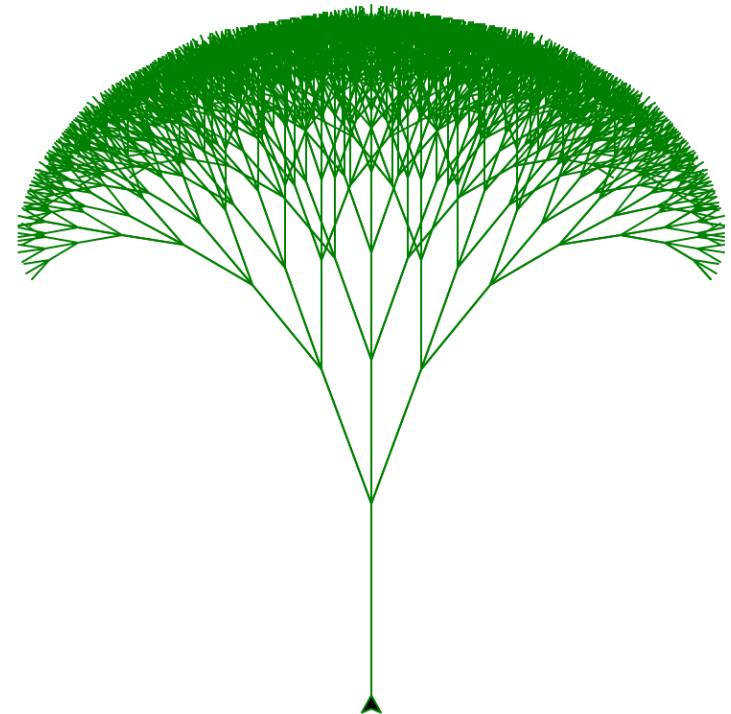
What do you need to specify to describe the smaller objects?



# Extra practice: `tree_drawing(n, l, c)`

- What is the pattern being repeated?

What do you need to specify to describe the smaller objects?



# Fun recursive drawing website

<http://recursivedrawing.com>

