

# Lecture 20

Chapter 11 Recursion

11.1 A Bullseye Class

4.3 Case Study: Drawing a Pyramid

# Recursion

There are two forms of recursion:

**Structural Recursion** (data recursion), and  
**Functional Recursion**

**Structural recursion** is when objects are defined in terms of other objects of the same type. The entire class of objects can then be built up from a few initial values and a small number of rules.

**Example:** Pyramid and Bullseye (see on next slide)

**Functional recursion** is a method of defining functions in which the function being defined is applied within its own definition.

**Example:** Fibonacci sequence:

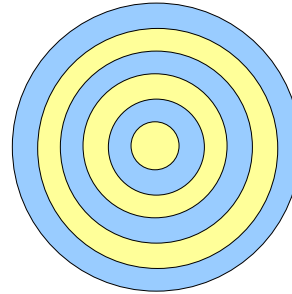
$$F(0)=1 \quad (\text{base case})$$

$$F(1)=1 \quad (\text{base case})$$

$$F(n)=F(n-1) + F(n-2) \text{ for all integers } n>1 \quad (\text{recursive definition})$$

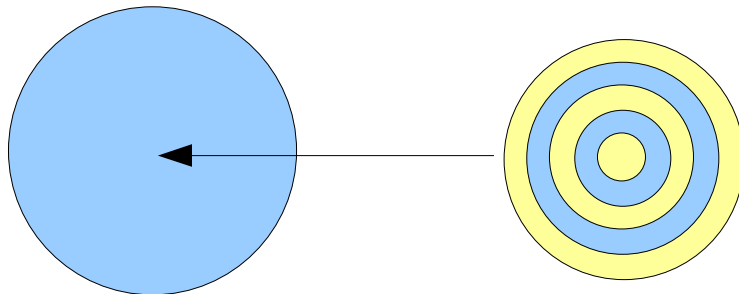
# 11.1 A Bullseye Class

Let's develop a bullseye class using our graphics library (module). We envision a bullseye as a sequence of concentric circles with alternating colors.



We can create this image using a loop, but let's follow this way: a bullseye can be viewed as a single outer circle with a smaller bullseye drawn on top of it.

Comment: of course the smaller bullseye should be positioned so that its center is exactly the same as the outer circle.



# 11.1 A Bullseye Class

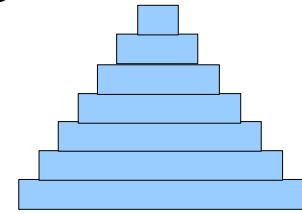
See the program [bullseye.py](#)

And see book

**Figures 11.3** on page 364 and **11.4** on page 365

## 4.3 Case Study: Drawing a Pyramid

There are two ways of drawing a pyramid.



One is using a for loop, and another one is using the structural recursion.

With the for loop:

`base_w`, `base_h` are width and height  
`levels` in the number of levels

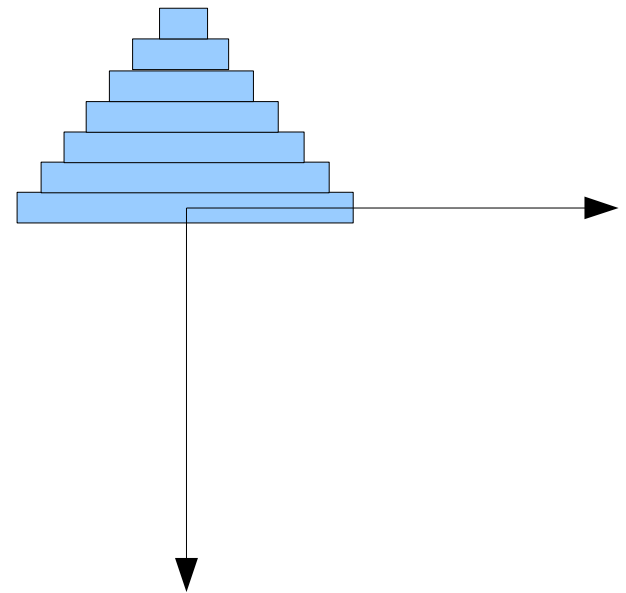
```
step=int(base_w/float(levels))
```

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

```
    level=Rectangle(base_w-i*step,base_h)
```

```
    level.move(paper_w/2,paper_h/2 - i*base_h)
```

```
    paper.add(level)
```



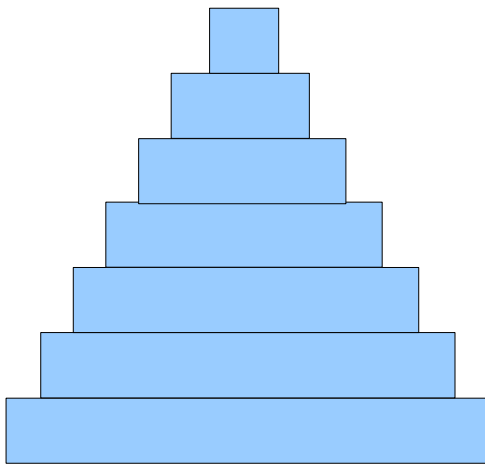
See program [pyramid.py](#)

## 4.3 Case Study: Drawing a Pyramid

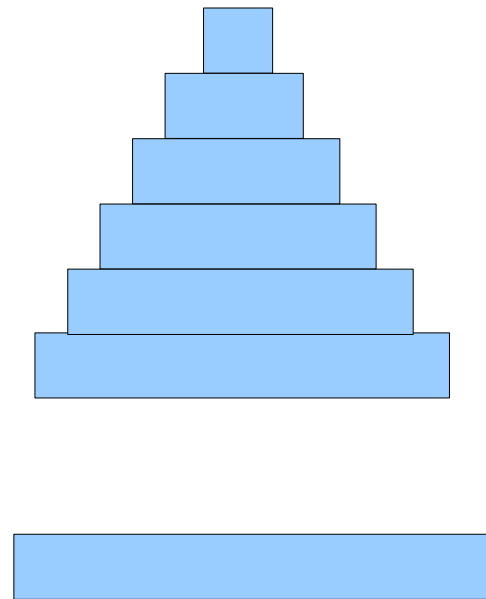
Another method: using the structural recursion.

Here is the idea:

A 7-level pyramid can be viewed as a single bottom level with a 6-level pyramid built on top. The 6-level pyramid is itself a bottom level with a 5-level pyramid built on top, and so on.



7-level pyramid



6-level pyramid

bottom level

# 4.3 Case Study: Drawing a Pyramid

See program [pyramid\\_as\\_class.py](#)

