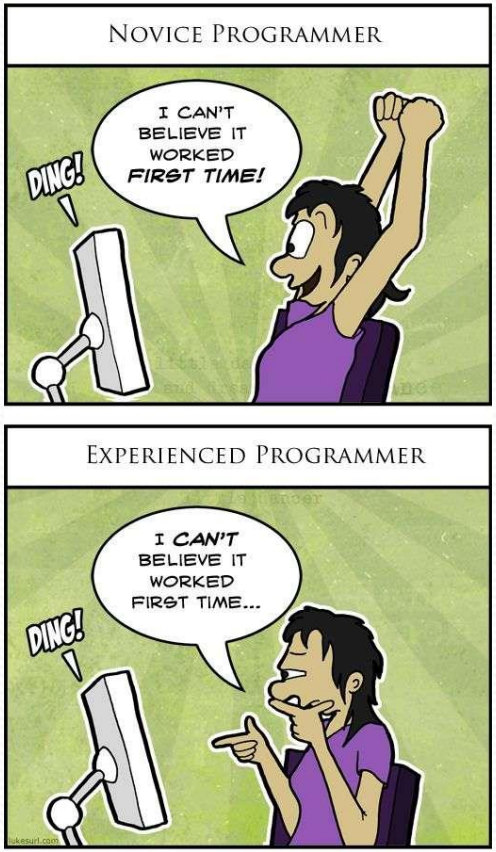
# CS 115, Autumn 2021

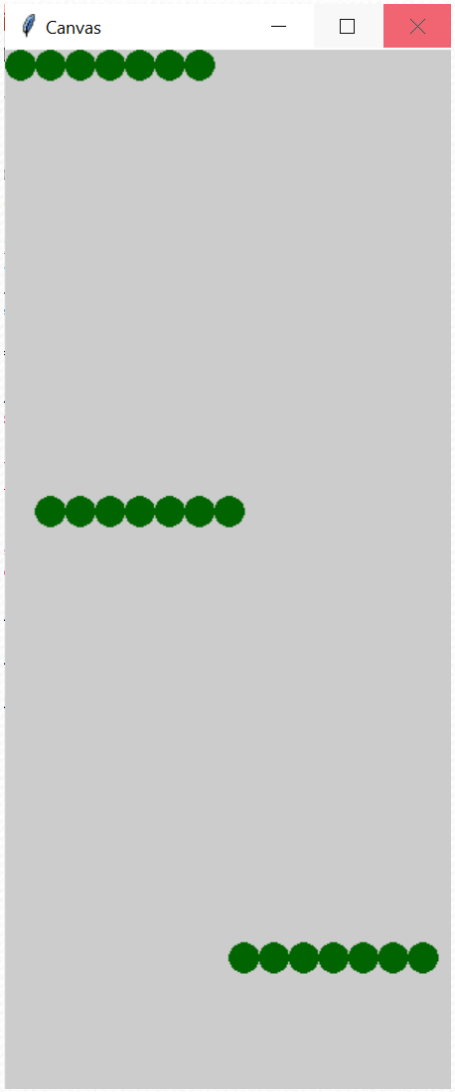
Lecture 25: parameters; returns




Thanks to Marty Stepp and Stuart Reges for parts of these slides

# Exercise: `green_circles`

- Alter the code used to produce the picture to the left which contains a separate function for each line of green circles to just contain one green circle drawing function.



# Exercise: `draw_circles`

- Can we write a function that can draw a row of circles that is different lengths?

- What about a row of circles in a different color?

# Other types as parameters

```
def main():
    say_hello("Merlin")
    cat = "Sir Purrcival"
    say_hello(cat)

def say_hello(name):
    print("Welcome,", name)

main()
```

Output:

```
Welcome, Merlin
Welcome, Sir Purrcival
```

# Circles solution

```
def main():
    panel = drawing_panel(300, 700, "#CCCCCC")
    green_circles(0, 0, 7, "green")
    green_circles(20, 300, 4, "yellow")
    green_circles(150, 600, 12, "#CC5555")

def green_circles(panel, x, y, count, color):
    for i in range(0, count + 1):
        panel.fill_oval(x + i * 20, y, 20, 20, color)

main()
```

# A "Parameter Mystery" problem

```
def main():
    x = 9
    y = 2
    z = 5

    mystery(z, y, x)

    mystery(y, x, z)
```

```
def mystery(      x,          z,          y):
    print(str(z), "and", str(y - x))


main()
```

# Getting data from functions

- The following code prints the biggest number successfully
  - What if we wanted to use this number later on in our program?
    - Can we print `highest` in main or use it in a computation?

```
def main():
    num1 = int(input("First? "))
    num2 = int(input("Second? "))
    num3 = int(input("Third? "))
    biggest(num1, num2, num3)

def biggest(num1, num2, num3):
    highest = num1
    if num2 > num1 and num2 > num3:
        highest = num2
    elif num3 > num1 and num3 > num2:
        highest = num3
    print("The biggest number is", highest)
main()
```

# Getting data from functions

- The following code prints the biggest number successfully
  - What if we wanted to use this number later on in our program?
    - Can we print `highest` in main or use it in a computation?

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def biggest(num1, num2, num3):
    highest = num1
    if num2 > num1 and num2 > num3:
        highest = num2
    elif num3 > num1 and num3 > num2:
        highest = num3
    print("The biggest number is", highest)
main()
```

# Problem: scope

- Variables only exist in the function they are created in
  - `highest` doesn't exist in `main`!

```
def main():
        num1 = int(input("First? "))
        num2 = int(input("Second? "))
        num3 = int(input("Third? "))
        biggest(num1, num2, num3)
        print("The biggest number is", highest)

def biggest(num1, num2, num3):
        highest = num1
        if num2 > num1 and num2 > num3:
                highest = num2
        elif num3 > num1 and num3 > num2:
                highest = num3
        print("The biggest number is", highest)

main()
```

# Scope

- How have we fixed scope problems before?
  - Parameters!
    - Can we use parameters to fix this?

```
def biggest(num1, num2, num3, highest):
        highest = num1
        if num2 > num1 and num2 > num3:
                highest = num2
        elif num3 > num1 and num3 > num2:
                highest = num3
```

This wont work!

# Value semantics

- **value semantics**: When value types (`int`, `double`) are passed as parameters, their values are copied.
  - Modifying the parameter will not affect the variable passed in.

```
def main():
    x = 23
    strange(x)
    print("2. x =", x)

def strange(x):
    x = x + 1
    print("1. x =", x)

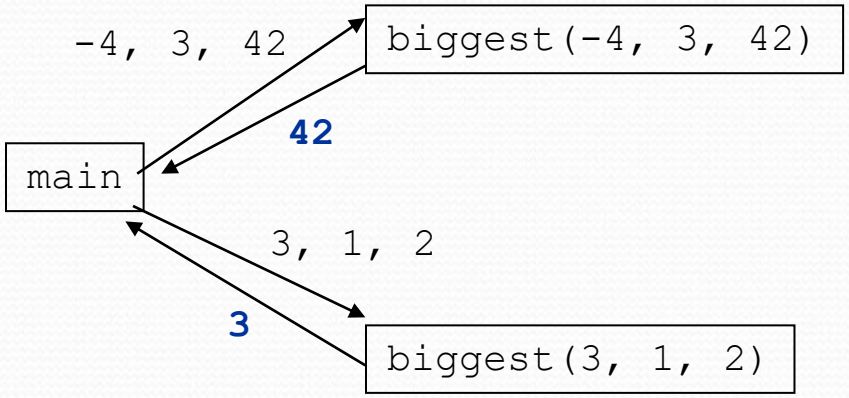
main()
```

Output:

```
1. x = 24
2. x = 23
```

# Solution: `return`

- **return**: To send out a value as the result of a function.
  - Return values send information *out* from a function to its caller.
    - A call to the function can be used as part of an expression.
  - (Compare to parameters which send values *into* a function)



# Returning a value

```
def name(parameters):
    statements
    ...
    return expression
```

- When Python reaches a return statement:
  - it evaluates the expression
  - it substitutes the return value in place of the call
  - it goes back to the caller and continues after the function call

# Return examples

```
# Converts degrees Fahrenheit to Celsius.
def f_to_c(degrees_f):
    degrees_c = 5.0 / 9.0 * (degrees_f - 32)
    return degrees_c

# Computes triangle hypotenuse length given its side lengths.
def hypotenuse(a, b):
    c = (a * a + b * b)**(1/2)
    return c
```

- You can shorten the examples by returning an expression:

```
def f_to_c(degrees_f):
    return 5.0 / 9.0 * (degrees_f - 32)
```

# Common error: Not storing

- Many students incorrectly think that a `return` statement sends a variable's name back to the calling function.

```
def main():
    slope(0, 0, 6, 3)
    print("The slope is", result);  # ERROR: cannot find
                                    #        symbol: result

def slope(x1, x2, y1, y2):
    dy = y2 - y1
    dx = x2 - x1
    result = dy / dx
    return result

main()
```

# Fixing the common error

- Returning sends the variable's *value* back. Store the returned value into a variable or use it in an expression.

```
def main():
    s = slope(0, 0, 6, 3)
    print("The slope is", s)

def slope(x1, x2, y1, y2):
    dy = y2 - y1
    dx = x2 - x1
    result = dy / dx
    return result

main()
```

# Fixing the common error

- We have actually used functions that return values before:
  - `randint`

```
number = randint(1, 10)
```

  - `input`

```
answer = input("What is the answer? ")
```

  - `drawing_panel`

```
panel = drawing_panel(300, 300)
```

- Notice that whenever we have called these functions, we have stored the result in a variable

# Exercise

- In physics, the *displacement* of a moving body represents its change in position over time while accelerating.
  - Given initial velocity $v_0$ in m/s, acceleration $a$ in m/s$^2$, and elapsed time $t$ in s, the displacement of the body is:
  - Displacement = $v_0 t + \frac{1}{2} a t^2$

- Write a function `displacement` that accepts $v_0$, $a$, and $t$ and computes and returns the change in position.
  - example: `displacement(3.0, 4.0, 5.0)` returns `65.0`

# Exercise solution

```
def displacement(v0, a, t):
    d = v0 * t + 0.5 * a * (t ** 2)
    return d
```

# Exercise

- If you drop two balls, which will hit the ground first?
  - Ball 1: height of 600m, initial velocity = 25 m/sec downward
  - Ball 2: height of 500m, initial velocity = 15 m/sec downward
- Write a program that determines how long each ball takes to hit the ground (and draws each ball falling).
- Total time is based on the force of gravity on each ball.
  - Acceleration due to gravity $\cong 9.81$ m/s$^2$, downward
  - Displacement = $v_0 t + \frac{1}{2} a t^2$

# Ball solution

```
# Simulates the dropping of two balls from various heights.
def main():
    panel = drawing_panel(600, 600)

    ball1x = 100
    ball1y =   0
    v01 = 25
    ball2x = 200
    ball2y = 100
    v02 = 15

 # draw the balls at each time increment
    for time in range(60):
        disp1 = displacement(v01, time/10, 9.81)
        panel.fill_oval(ball1x, ball1y + disp1, ball1x + 10, ball1y + 10 + disp1)
        disp2 = displacement(v02, time/10, 9.81)
        panel.fill_oval(ball2x, ball2y + disp2, ball2x + 10, ball2y + 10 + disp2)

        panel.sleep(50)    # pause for 50 ms
        panel.clear()
...
```