

# Topic 6: Functions

What's a function?

How can we use functions to write better software?

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## Textbook

- Strongly Recommended Exercises
  - The Python Workbook: 85, 86, 98 and 103
- Recommended Exercises
  - The Python Workbook: 84, 88, 92, 93, 101 and 102
- Recommended Readings
  - Starting Out with Python
    - Chapter 3 and Chapter 6 (2<sup>nd</sup> Ed.) / Chapter 5 (3<sup>rd</sup> Ed.)

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# What is a Function?

- What is a function?
  - A named set of statements
  - Perform some task
- Functions:
  - May take parameters
  - May return values
- What functions have you already used?

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## Motivation

- Ideally, a function should
  - perform a clearly defined specific single purpose
  - hide details from the caller
  - be sufficiently small to be easily understood
  - be well documented

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# Defining a Function

- Creates a function for later use
  - The function does not execute until it is called
  - Function may be called many times (from different places) after it has been defined
- General form:
  - `def functionName (parameters) :`  
    statement(s)

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## Example

- Create a function that draws a music note
  - Head will be a solid oval, 20 pixels wide and 10 pixels high
  - Stem will be 50 pixels tall on the right side
  - Center the head of the note at 100, 100

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# Calling Our Function

- A function does not execute when it is defined
  - It must be called
- Execution for the entire program begins at the first statement outside of a function

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## Example

- What's the problem with our function?
- How do we fix it?

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# Parameters

- Allow us to provide data to a function
  - Data is placed in brackets after the function name when the function is called
  - Parameter variables appear in brackets after the function name in the function definition
  - Values appear in parameter variables when the function executes
  - Parameters are positional

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# Terminology

- Actual Parameter
  - The value placed in brackets after the function name when the function is called
- Formal Parameter
  - The name of the parameter variable in the function definition

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# Example

- Extend our note drawing function so that it takes two parameters that control the position of the note

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## Named Parameters

- Positional parameters assign values to parameter variables in the order that they occur
- Named parameters allow us to assign values in any order
  - Allow for optional parameters / default values for some parameters
  - May still be used in a positional manner

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# Example

- Extend the note drawing function so that it takes additional parameters that specify the color of the note

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## Default Parameter Values

- Python permits default values for parameters
  - If the function call does not supply a value then the default is used
  - If the call includes a value for that parameter then the default value is overridden

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# Functions Can Call Functions

- Create a second function for drawing a note
  - Head will be a solid oval, 20 pixels wide and 10 pixels high
  - Stem will be 50 pixels tall on the right side
  - Flag will be a curve

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# Functions Can Call Functions

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# Functions Can Return a Result

- Returning a result allows a value to move from the function to the location where it was called
  - Accomplished using a return statement inside the function
  - When the function is called it is often on the right side of an assignment statement

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# Functions Can Return a Result

- Write a function that determines the number of real roots of an equation of the form  $ax^2 + bx + c = 0$

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# Variables & Functions

- Variables can be defined inside functions
  - A variable defined inside of a function can only be used inside that function
  - Behaves just like the variables we have used previously

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# Variables & Functions

- Variables can be defined outside of functions
  - Referred to as global variables
  - Can be read anywhere in the program after it is assigned a value
  - All of the constants we have created are global variables that we choose not to change
  - Use of global variables (other than as constants) is strongly discouraged

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# Variables & Functions

- Changing global variables
  - By default, an assignment statement inside of a function creates a new variable within that function
    - Even if a global variable with that name already exists
  - Want to change a global variable?
    - Include a global statement at the beginning of the function

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## Example

- Create a function that computes n-factorial

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# Returning Multiple Values

- What if we need to return more than one value from a function?
  - Comma separated tuple of values in return statement
  - Comma separated tuple of variables to the left of the equals sign

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## Scope

- Scope determines the portion of a program where a name can be used
  - Impacts functions, variables, ...
- Functions
  - Functions can't be called before they have been defined
  - Functions in other modules cannot be used until after the import statement for that module

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# Scope

- Variables
  - Cannot be read before they are given a value
  - Can be used from the point where they are first assigned a value until the end of the function
  - Variables created inside a function are destroyed when the function exits

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## Formal Parameters

- Formal Parameter variables hold values passed to a function from the calling scope
  - Formal parameters are normally read
  - It is also possible to store a new value into a formal parameter (we don't usually do this!)
    - Value of the variable will change in the called function
    - For the types we have used so far, the value will **not** change in the main program

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# Why Functions are Useful

- Facilitate Code Reuse
  - Write once, use many times
- Reduce Complexity
  - Low level details are hidden
  - Programmer can concentrate on higher level problems
- Ease Maintenance
  - Bugs only need to be corrected once
  - Functions can be tested separately

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## Comments

- Every function should begin with a comment
  - Describe the action taken by the function
  - Describe the parameters that need to be provided
  - Describe the value returned by the function

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# Preconditions / Postconditions

- Function comments may also describe
  - Preconditions:
    - Conditions that must be true before the function executes
    - If any precondition is not met, the function may not behave correctly
  - Postconditions:
    - Conditions that are guaranteed to be true after the function executes
    - If the function doesn't make a post-condition true then the function contains a bug that must be fixed

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## Example

- Addition and multiplication practice:
  - 10 random questions that involve adding or multiplying 2 integers between 1 and 10

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# Example

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## Testing

- Test each function you write individually
  - Errors are easier to find
    - Generally only need to look inside the function being tested
  - Only use the function in the rest of your program once you have tested it thoroughly

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# Design

- How do functions relate to top down design?
  - Use top down design to break the problem into smaller pieces
  - Each smaller piece is a good candidate for a function
  - Look at each function
    - Is it too big?
    - Does it contain repeated code?
    - Should it call other functions?

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# Modules

- Functions can be placed in modules to promote reuse
  - Place the functions in a different .py file
  - Import it just like math or SimpleGraphics
  - Add an if statement to prevent the main program from running in the imported file

```
if __name__ == "__main__":  
    main()
```

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# Wrapping Up

- Functions
  - A named group of statements that perform a task
  - Allow us to break our program into separate units that each have a specific purpose
  - Ease program creation and debugging

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## Where Are We Going?

- Now that we can write larger programs we want to be able to manage more data
  - How can we work with many values at the same time in a reasonable way?
  - How do we read and write values in files?

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