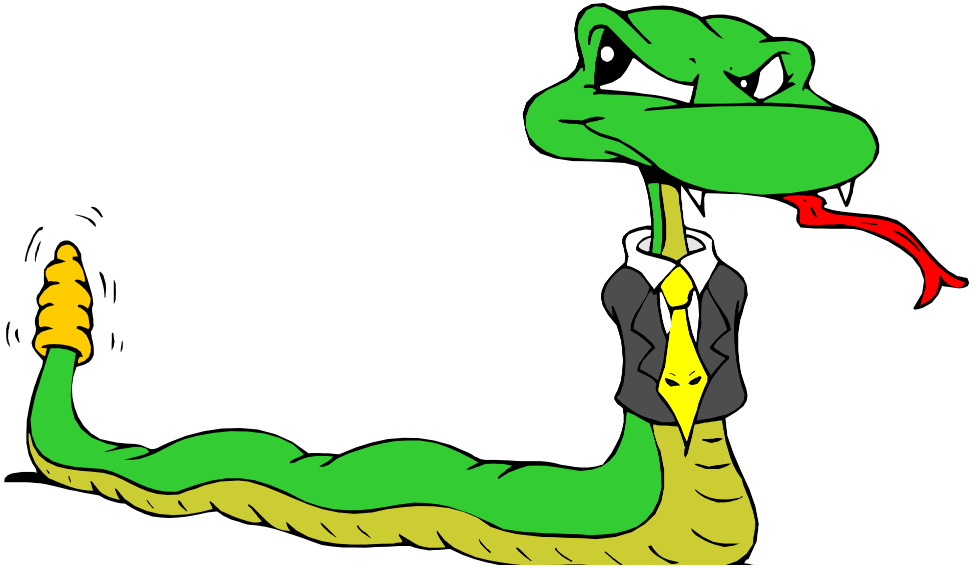
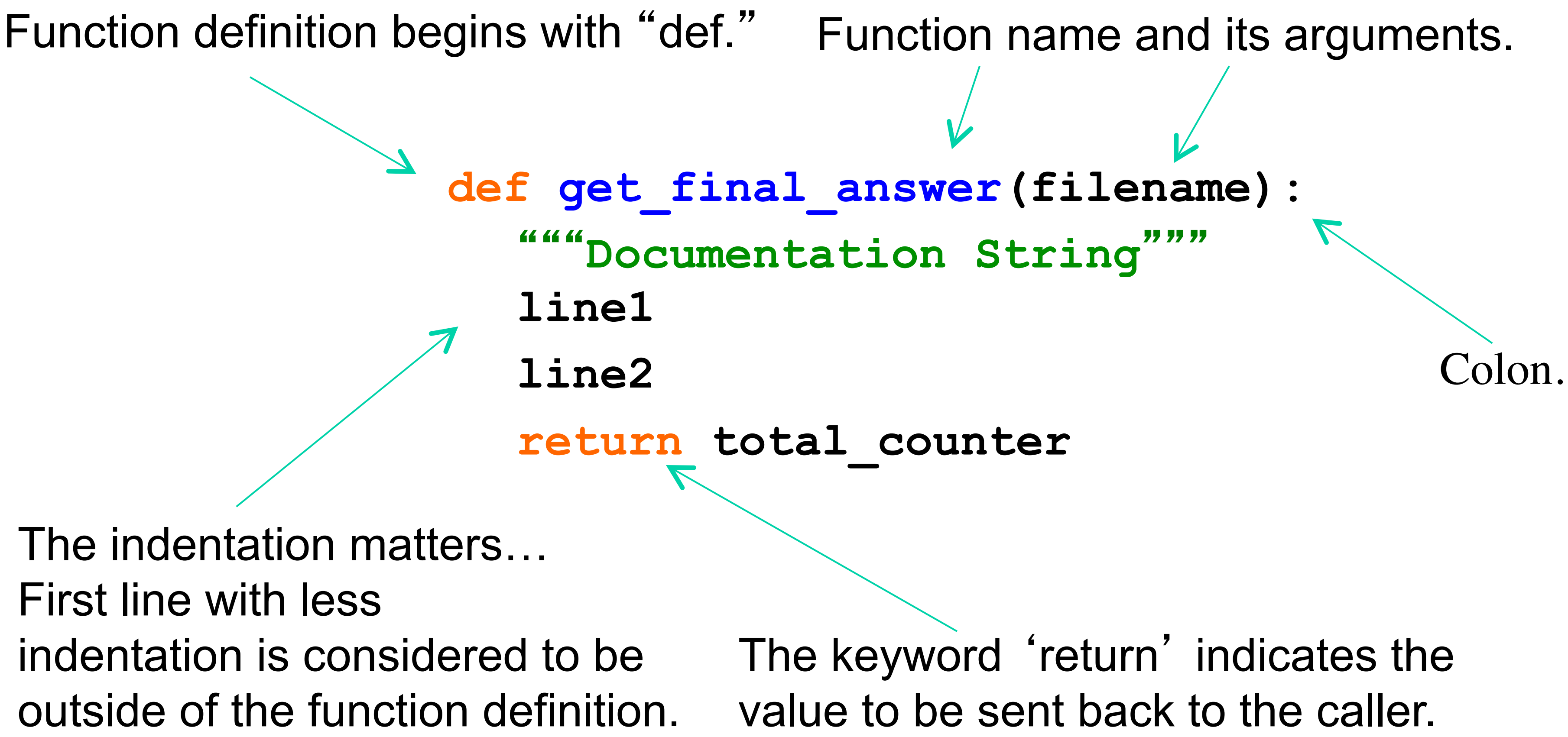
Functions in Python



Defining Functions



Function definition begins with “def.”

Function name and its arguments.

```
def get_final_answer(filename):
    “““Documentation String”””
    line1
    line2
    return total_counter
```

Colon.

The indentation matters…
First line with less
indentation is considered to be
outside of the function definition.

The keyword ‘return’ indicates the value to be sent back to the caller.

No header file or declaration of types of function or arguments

Python and Types

- **Dynamic typing**: Python determines the data types of *variable bindings* in a program automatically
- **Strong typing:** But Python’s not casual about types, it enforces the types of *objects*
- For example, you can’t just append an integer to a string, but must first convert it to a string

```
x = “the answer is ” # x bound to a string
y = 23      # y bound to an integer.
print x + y   # Python will complain!
```

Calling a Function

- The syntax for a function call is:

```
>>> def myfun(x, y):
        return x * y
>>> myfun(3, 4)
12
```

- Parameters in Python are *Call by Assignment*
  - Old values for the variables that are parameter names are hidden, and these variables are simply made to *refer to* the new values
  - All assignment in Python, including binding function parameters, uses *reference semantics.*

Functions without returns

- *All* functions in Python have a return value, even if no *return* line inside the code
- Functions without a *return* return the special value *None*
  - *None* is a special constant in the language
  - *None* is used like *NULL*, *void*, or *nil* in other languages
  - *None* is also logically equivalent to False
  - The interpreter’s REPL doesn’t print *None*

Function overloading? No.

- There is no function overloading in Python
  - Unlike C++, a Python function is specified by its name alone

    The number, order, names, or types of arguments *cannot* be used to distinguish between two functions with the same name
  - Two different functions can’t have the same name, even if they have different arguments
- But: see *operator overloading* in later slides

(Note: van Rossum playing with function overloading for the future)

Default Values for Arguments

- You can provide default values for a function’ s arguments
- These arguments are optional when the function is called

```
>>> def myfun(b, c=3, d=“hello”):
          return b + c
>>> myfun(5,3,”hello”)
>>> myfun(5,3)
>>> myfun(5)
```

All of the above function calls return 8

Keyword Arguments

- Can call a function with some/all of its arguments out of order as long as you specify their names

```
>>> def foo(x,y,z): return(2*x,4*y,8*z)
>>> foo(2,3,4)
(4, 12, 32)
>>> foo(z=4, y=2, x=3)
(6, 8, 32)
>>> foo(-2, z=-4, y=-3)
(-4, -12, -32)
```

- Can be combined with defaults, too

```
>>> def foo(x=1,y=2,z=3): return(2*x,4*y,8*z)
>>> foo()
(2, 8, 24)
>>> foo(z=100)
(2, 8, 800)
```

Functions are first-class objects

Functions can be used as any other datatype, eg:

- Arguments to function
- Return values of functions
- Assigned to variables
- Parts of tuples, lists, etc

```
>>> def square(x): return x*x

>>> def applier(q, x): return q(x)

>>> applier(square, 7)
49
```

Lambda Notation

- Python's lambda creates anonymous functions

```
>>> applier(lambda z: z * 42, 7)
14
```

- Note: only **one** expression in the lambda body; its value is always returned
- Python supports functional programming idioms: map, filter, closures, continuations, etc.

Lambda Notation

Be careful with the syntax

```
>>> f = lambda x,y : 2 * x + y
>>> f
<function <lambda> at 0x87d30>
>>> f(3, 4)
10
>>> v = lambda x: x*x(100)
>>> v
<function <lambda> at 0x87df0>
>>> v = (lambda x: x*x)(100)
>>> v
10000
```

Example: composition

```
>>> def square(x):
        return x*x
>>> def twice(f):
        return lambda x: f(f(x))
>>> twice
<function twice at 0x87db0>
>>> quad = twice(square)
>>> quad
<function <lambda> at 0x87d30>
>>> quad(5)
625
```

Example: closure

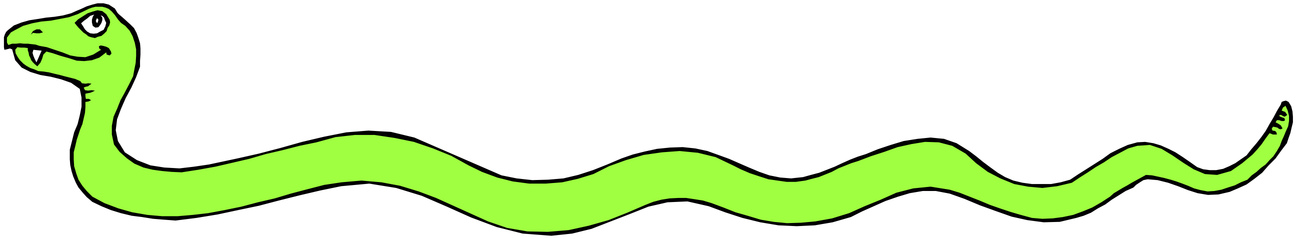
```
>>> def counter(start=0, step=1):
       x = [start]
       def _inc():
           x[0] += step
           return x[0]
       return _inc
>>> c1 = counter()
>>> c2 = counter(100, -10)
>>> c1()
1
>>> c2()
90
```

map, filter, reduce

```
>>> def add1(x): return x+1
>>> def odd(x): return x%2 == 1
>>> def add(x,y): return x + y
>>> map(add1, [1,2,3,4])
[2, 3, 4, 5]
>>> map(+,[1,2,3,4],[100,200,300,400])
map(+,[1,2,3,4],[100,200,300,400])
    ^
SyntaxError: invalid syntax
>>> map(add,[1,2,3,4],[100,200,300,400])
[101, 202, 303, 404]
>>> reduce(add, [1,2,3,4])
10
>>> filter(odd, [1,2,3,4])
[1, 3]
```

Python

functional programming



Functions are first-class objects

Functions can be used as any other datatype, eg:

- Arguments to function
- Return values of functions
- Assigned to variables
- Parts of tuples, lists, etc

```
>>> def square(x): return x*x

>>> def applier(q, x): return q(x)

>>> applier(square, 7)
49
```

Lambda Notation

Python’s lambda creates anonymous functions

```
>>> lambda x: x + 1
<function <lambda> at 0x1004e6ed8>
>>> f = lambda x: x + 1
>>> f
<function <lambda> at 0x1004e6f50>
>>> f(100)
101
```

Lambda Notation

Be careful with the syntax

```
>>> f = lambda x,y: 2 * x + y
>>> f
<function <lambda> at 0x87d30>
>>> f(3, 4)
10
>>> v = lambda x: x*x(100)
>>> v
<function <lambda> at 0x87df0>
>>> v = (lambda x: x*x)(100)
>>> v
10000
```

Lambda Notation Limitations

- Note: only **one** expression in the lambda body; Its value is always returned
- The lambda expression must fit on one line!
- Lambda will probably be deprecated in future versions of python

    Guido is not a lambda fanboy

Functional programming

- Python supports functional programming idioms
- Builtins for map, reduce, filter, closures, continuations, etc.
- These are often used with lambda

Example: composition

```
>>> def square(x):
        return x*x
>>> def twice(f):
        return lambda x: f(f(x))
>>> twice
<function twice at 0x87db0>
>>> quad = twice(square)
>>> quad
<function <lambda> at 0x87d30>
>>> quad(5)
625
```

Example: closure

```
>>> def counter(start=0, step=1):
       x = [start]
       def _inc():
           x[0] += step
           return x[0]
       return _inc
>>> c1 = counter()
>>> c2 = counter(100, -10)
>>> c1()
1
>>> c2()
90
```

map

```
>>> def add1(x): return x+1
>>> map(add1, [1,2,3,4])
[2, 3, 4, 5]
>>> map(lambda x: x+1, [1,2,3,4])
[2, 3, 4, 5]
>>> map(+, [1,2,3,4], [100,200,300,400])
map(+,[1,2,3,4],[100,200,300,400])
    ^
SyntaxError: invalid syntax
```

map

- + is an operator, not a function
- We can define a corresponding add function

```
>>> def add(x, y): return x+y
>>> map(add,[1,2,3,4],[100,200,300,400])
[101, 202, 303, 404]
```

- Or import the operator module

```
>>> from operator import *
>>> map(add, [1,2,3,4], [100,200,300,400])
[101, 202, 303, 404]
>>> map(sub, [1,2,3,4], [100,200,300,400])
[-99, -198, -297, -396]
```

filter, reduce

- Python has buiting for reduce and filter

```
>>> reduce(add, [1,2,3,4])
10
>>> filter(odd, [1,2,3,4])
[1, 3]
```

- The map, filter and reduce functions are also at risk ☹