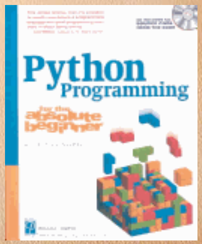
Python Programming: for the absolute beginner

Chapter 1

Modified by Dan Fleck



Coming up: Objectives

Objectives

- Introduction to the class
- Why we program and what that means
- Introduction to the Python programming language

Coming up: What we'll learn in this class

What we'll learn in this class

- How to solve problems using computers
- How computer programs work
- How to write computer programs in Python
- How to debug (fix problems with) computer programs
- How to test your programs

Coming up: Assignment 1

Assignment 1

- Logon to Blackboard: courses.gmu.edu
- Go to CS112
- Click on assignments
- View the picture assignment and complete it
- Also, activate your GMU Email! You can easily forward it to Yahoo or Gmail. Make sure you check the account daily! https://mail.gmu.edu

Coming up: The Universal Machine

The Universal Machine

- A modern computer can be defined as "a machine that stores and manipulates information under the control of a changeable program."
- Two key elements:
  - Computers are devices for manipulating information.
  - Computers operate under the control of a changeable program.

What is a computer program

- A detailed, step-by-step set of instructions telling a computer what to do.
- If we change the program, the computer performs a different set of actions or a different task.
- The machine stays the same, but the program changes!
- The program is *executed* or carried out by the machine

Exercise

- Write the step-by-step instructions for creating a peanut butter and jelly sandwich

Exercise

- Write the step-by-step instructions for creating a peanut butter and jelly sandwich
- Did you write:
  - Spread peanut-butter on bread
  - Spread jelly on bread
  - Put pieces of bread together

Exercise

- A computer cannot understand anything more than you tell it. Computer programming is the art of **knowing what you want to do**, and being able to specify it in **enough detail** that the computer understands.
- Get the jelly from the refrigerator
- Get the peanut-butter from the cupboard
- Open the jelly and the peanut-butter
- Open the knife-drawer and retrieve the knife
- …

You will spend half of the semester trying to break the problem into small enough steps for the computer to understand

Exercise

- Why can't we just say "make me a sandwich"?
- English is MUCH to ambiguous for a computer to understand.
  – Did you mean, create a sandwich or turn the user into a sandwich? How does the computer know the difference between that and "make me a millionaire?"
  – You must use a computer language which is a very structured and specific language. We'll use Python.

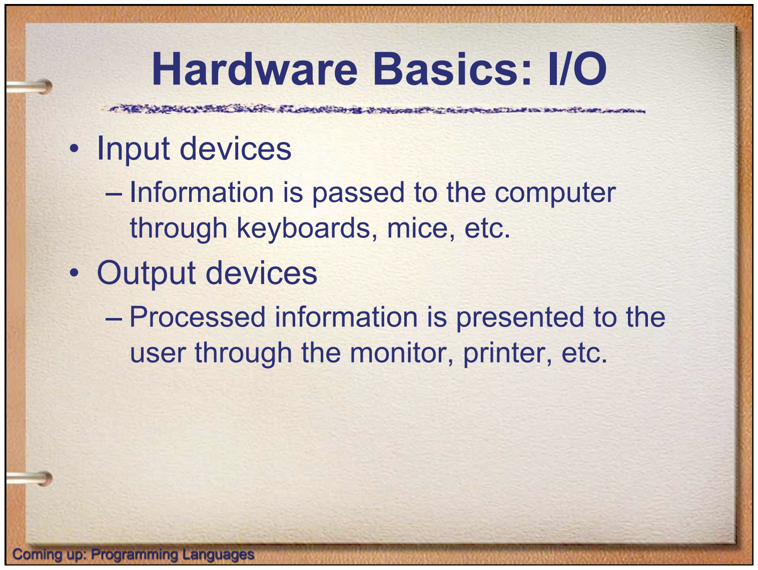
You will spend the other half of the semester trying to find the right words (syntax) to get the computer to understand you.

Hardware Basics : CPU

- The *central processing unit* (CPU) is the "brain" of a computer.
  – The CPU carries out all the basic operations on the data.
  – Examples: simple arithmetic operations, testing to see if two numbers are equal.

Hardware Basics : Memory

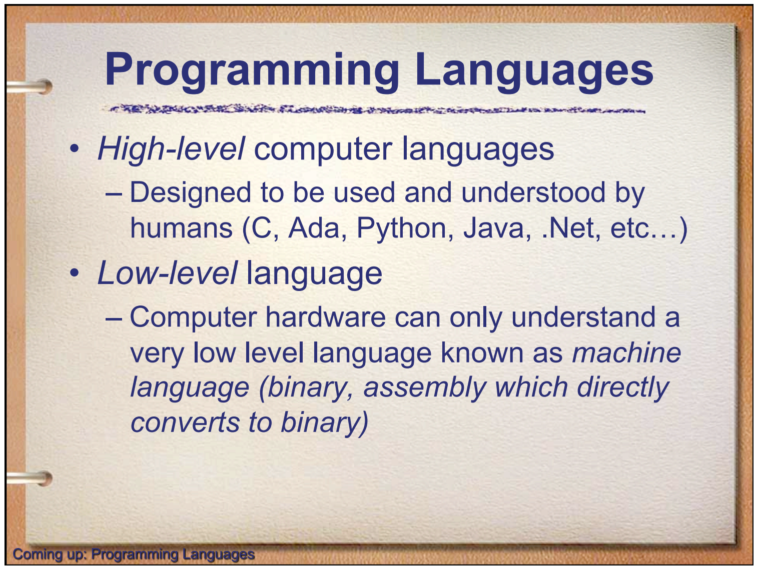
- Memory stores programs and data.
  – CPU can only directly access information stored in *main memory* (RAM or Random Access Memory).
  – Main memory is fast, but *volatile*, i.e. when the power is interrupted, the contents of memory are lost.
  – Secondary memory provides more permanent storage: magnetic (hard drive, floppy), optical (CD, DVD)



Hardware Basics: I/O

- Input devices
  - Information is passed to the computer through keyboards, mice, etc.
- Output devices
  - Processed information is presented to the user through the monitor, printer, etc.

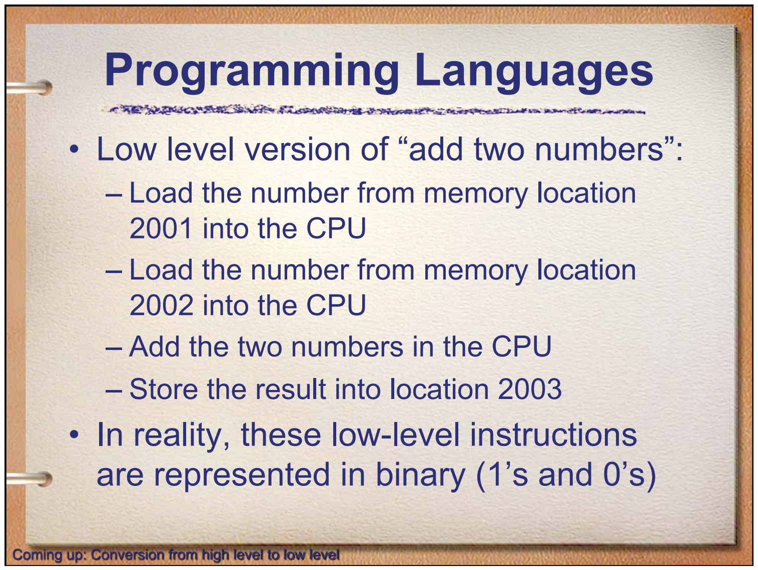
Coming up: Programming Languages



Programming Languages

- *High-level* computer languages
  - Designed to be used and understood by humans (C, Ada, Python, Java, .Net, etc…)
- *Low-level* language
  - Computer hardware can only understand a very low level language known as *machine language (binary, assembly which directly converts to binary)*

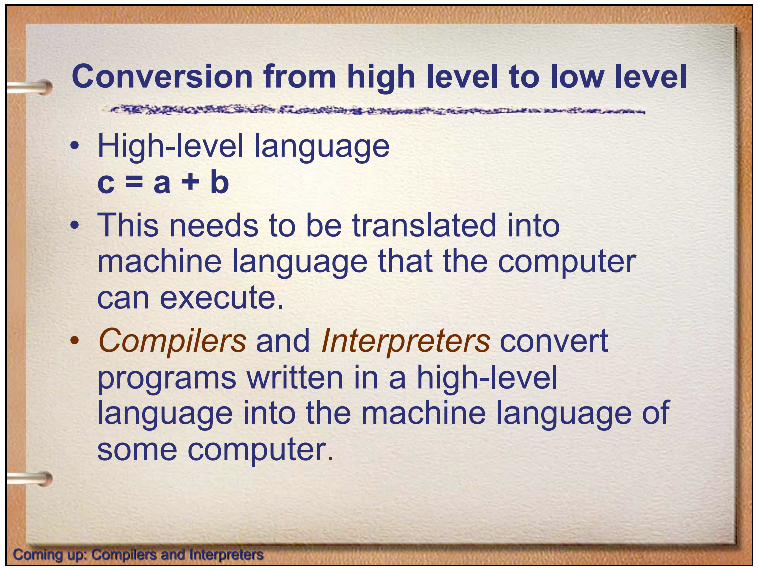
Coming up: Programming Languages



Programming Languages

- Low level version of "add two numbers":
  - Load the number from memory location 2001 into the CPU
  - Load the number from memory location 2002 into the CPU
  - Add the two numbers in the CPU
  - Store the result into location 2003
- In reality, these low-level instructions are represented in binary (1's and 0's)

Coming up: Conversion from high level to low level

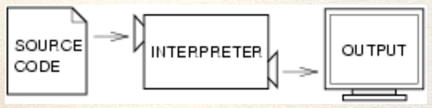


Conversion from high level to low level

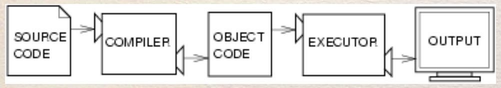
- High-level language
  c = a + b
- This needs to be translated into machine language that the computer can execute.
- *Compilers* and *Interpreters* convert programs written in a high-level language into the machine language of some computer.

Coming up: Compilers and Interpreters

Compilers and Interpreters



Interpreted Language



Compiled Language

Interpreters

- *Interpreters* simulate a computer that understands a high-level language.
- The source program is not translated into machine language all at once.
- An interpreter analyzes and translates the source code instruction by instruction.

Python has both options, but we'll use it in an interpreted way in CS112!

Installing Python

- Download from:
- http://www.python.org/download/
- Choose: 2.6.1 **not 3.0!!**

- Double click and install
- IDLE is Python's built-in Integrated Development Environment (IDE)

The Magic of Python

IDLE is a programming environment for Python. Starting it you will see something like:

```
Python 2.6.1 (r261:67515, Dec  6 2008, 16:42:21)
[GCC 4.0.1 (Apple Computer, Inc. build 5370)] on darwin
Type "copyright", "credits" or "license()" for more information.

    ****************************************************************
    Personal firewall software may warn about the connection IDLE
    makes to its subprocess using this computer's internal loopback
    interface.  This connection is not visible on any external
    interface and no data is sent to or received from the Internet.
    ****************************************************************

IDLE 2.6.1
>>>
```

WARNING: Do NOT use Python 3.0 for this course! It is NOT backward compatible with 2.X!

Python Prompt

- The “>>>” is a Python *prompt* indicating that Python is ready for us to give it a command. These commands are called *statements*.
-
```
>>> print "Hello, world"
Hello, world
>>> print 2+3
5
>>> print "2+3=", 2+3
2+3= 5
>>>
```

Note: A statement “does something”. print x --- prints!

Defining a Python Function

- Usually we want to execute several statements together that solve a common problem. One way to do this is to use a *function*.
-
```
>>> def hello():
    print "Hello"
    print "Computers are Fun"


>>>
```

Defining a Python Function

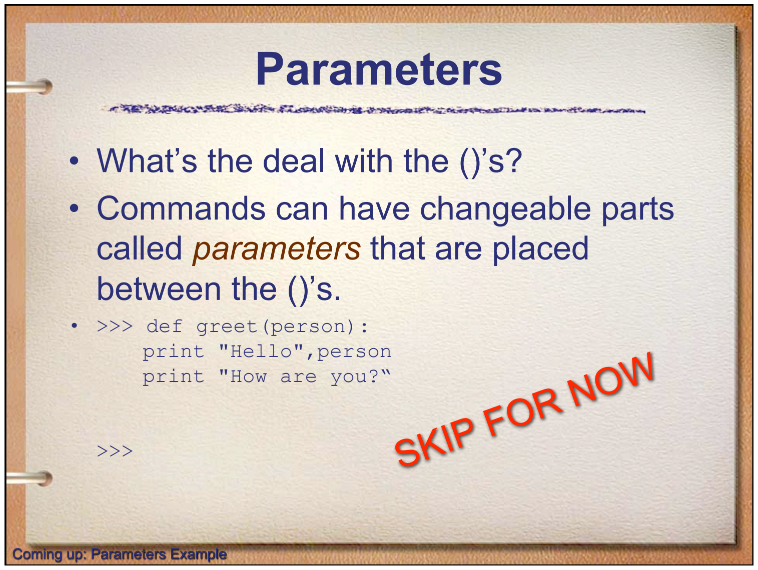
-
```
>>> def hello():
    print "Hello"
    print "Computers are Fun"


>>>
```
- The first line tells Python we are *defining* a new function called hello.
- The following lines are indented to show that they are part of the hello function.
- The blank line (hit enter twice) lets Python know the definition is finished.

Invoking a Function

-
```
>>> def hello():
    print "Hello"
    print "Computers are Fun"


>>>
```
- Notice that nothing has happened yet! We’ve defined the function, but we haven’t told Python to perform the function!
- A function is *invoked* by typing its name.
-
```
>>> hello()
Hello
Computers are Fun
>>>
```



Parameters

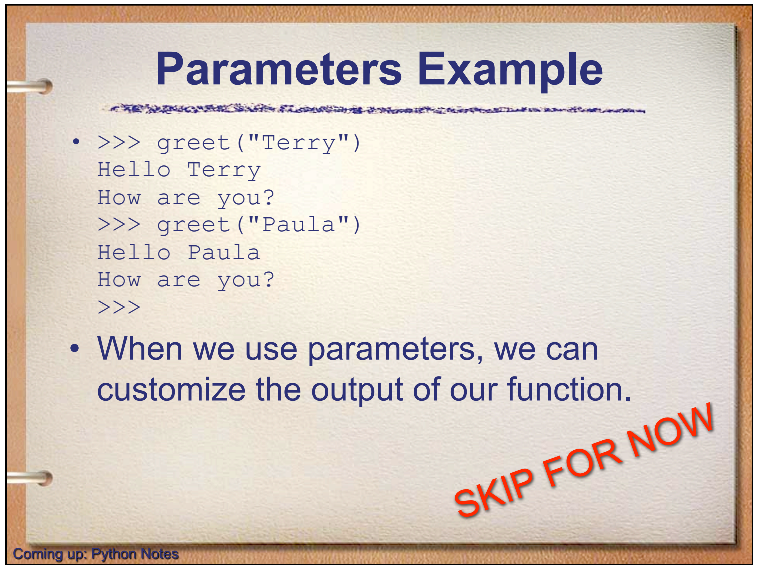
- What's the deal with the ()'s?
- Commands can have changeable parts called *parameters* that are placed between the ()'s.

-
  ```
  >>> def greet(person):
      print "Hello",person
      print "How are you?"


  >>>
  ```

SKIP FOR NOW

Coming up: Parameters Example

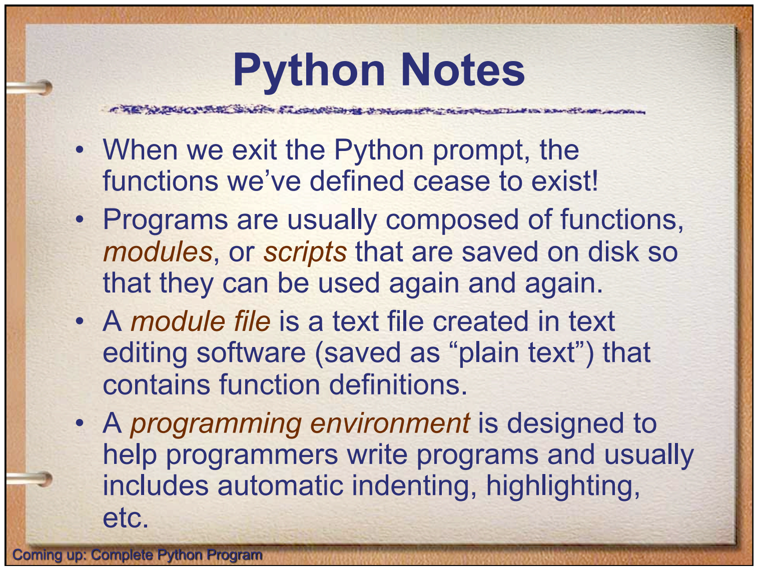


Parameters Example

-
  ```
  >>> greet("Terry")
  Hello Terry
  How are you?
  >>> greet("Paula")
  Hello Paula
  How are you?
  >>>
  ```
- When we use parameters, we can customize the output of our function.

SKIP FOR NOW

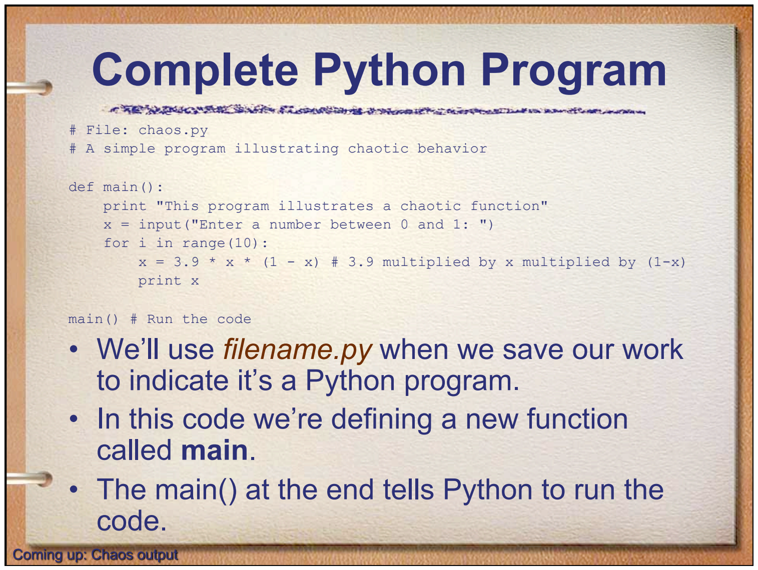
Coming up: Python Notes



Python Notes

- When we exit the Python prompt, the functions we've defined cease to exist!
- Programs are usually composed of functions, *modules*, or *scripts* that are saved on disk so that they can be used again and again.
- A *module file* is a text file created in text editing software (saved as "plain text") that contains function definitions.
- A *programming environment* is designed to help programmers write programs and usually includes automatic indenting, highlighting, etc.

Coming up: Complete Python Program



Complete Python Program

```
# File: chaos.py
# A simple program illustrating chaotic behavior

def main():
    print "This program illustrates a chaotic function"
    x = input("Enter a number between 0 and 1: ")
    for i in range(10):
        x = 3.9 * x * (1 - x) # 3.9 multiplied by x multiplied by (1-x)
        print x

main() # Run the code
```

- We'll use *filename.py* when we save our work to indicate it's a Python program.
- In this code we're defining a new function called **main**.
- The main() at the end tells Python to run the code.

Coming up: Chaos output

Chaos output

```
>>>
This program illustrates a chaotic function
Enter a number between 0 and 1: .5
0.975
0.0950625
0.335499922266
0.869464925259
0.442633109113
0.962165255337
0.141972779362
0.4750843862
0.972578927537
0.104009713267
>>>
```

Comments

```
# File: chaos.py
# A simple program illustrating chaotic behavior
```

- Lines that start with # are called *comments*
- Intended for human readers and ignored by Python
- Python skips text from # to end of line

Inside a Python Program

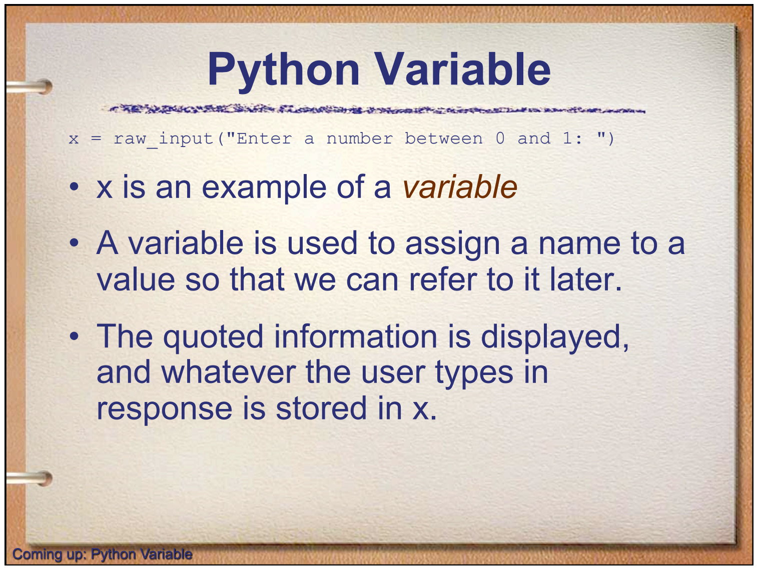
```
def main():
```

- Beginning of the definition of a function called *main*
- Since our program has only this one module, it could have been written without the *main* function.
- The use of *main* is customary, however.

Python Print

```
print "This program illustrates a chaotic function"
```

- This statement causes Python to print a message introducing the program.

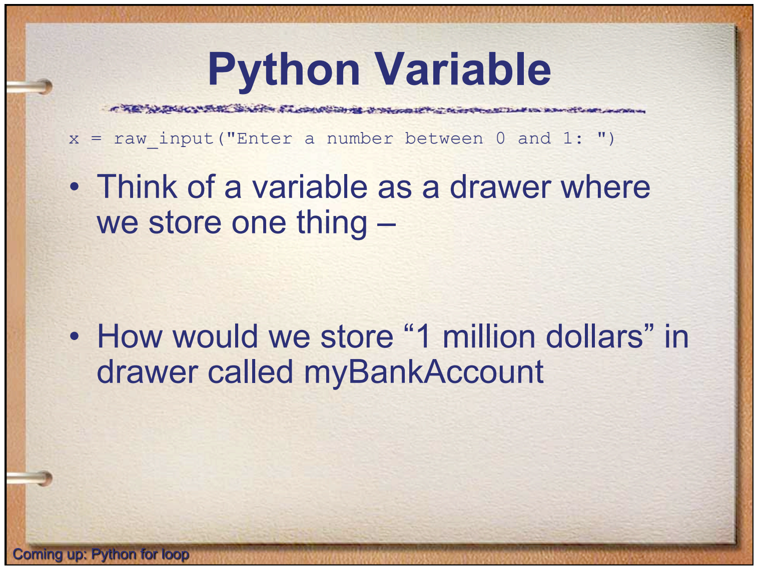


Python Variable

```
x = raw_input("Enter a number between 0 and 1: ")
```

- x is an example of a *variable*
- A variable is used to assign a name to a value so that we can refer to it later.
- The quoted information is displayed, and whatever the user types in response is stored in x.

Coming up: Python Variable

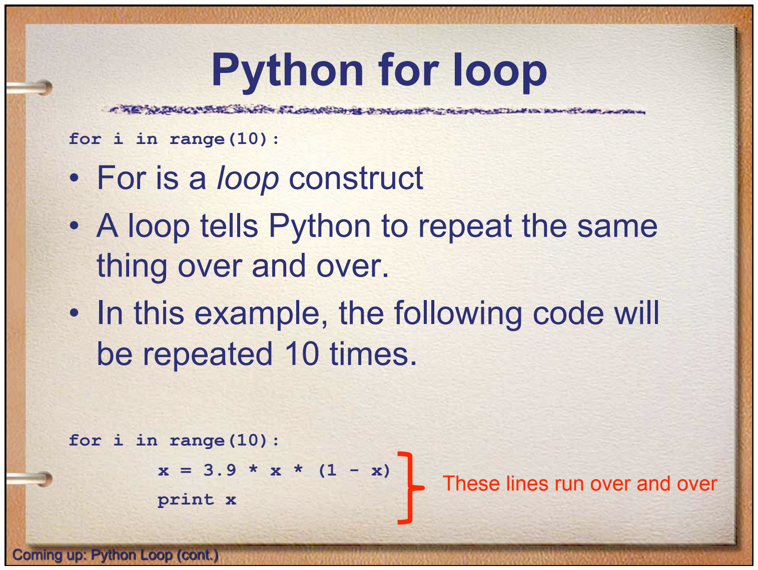


Python Variable

```
x = raw_input("Enter a number between 0 and 1: ")
```

- Think of a variable as a drawer where we store one thing –
- How would we store "1 million dollars" in drawer called myBankAccount

Coming up: Python for loop



Python for loop

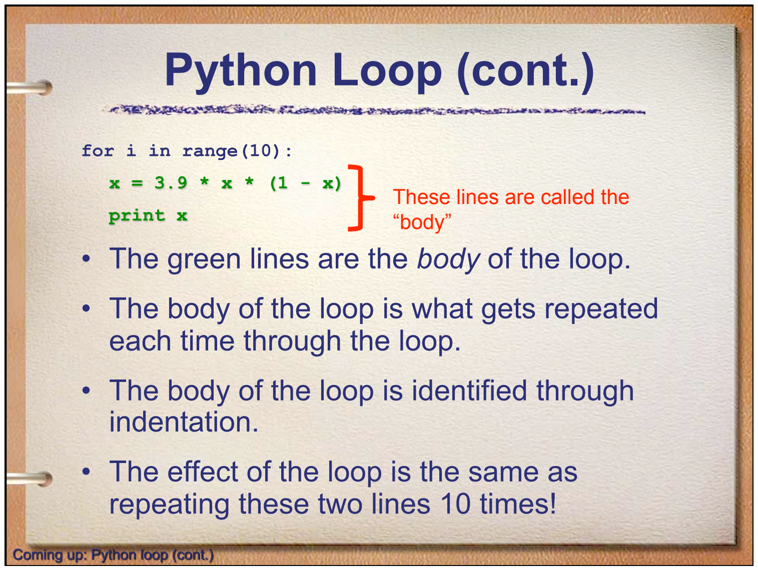
```
for i in range(10):
```

- For is a *loop* construct
- A loop tells Python to repeat the same thing over and over.
- In this example, the following code will be repeated 10 times.

```
for i in range(10):
        x = 3.9 * x * (1 - x)
        print x
```

These lines run over and over

Coming up: Python Loop (cont.)



Python Loop (cont.)

```
for i in range(10):
    x = 3.9 * x * (1 - x)
    print x
```

These lines are called the "body"

- The green lines are the *body* of the loop.
- The body of the loop is what gets repeated each time through the loop.
- The body of the loop is identified through indentation.
- The effect of the loop is the same as repeating these two lines 10 times!

Coming up: Python loop (cont.)

Python loop (cont.)

```
for i in range(10):
        x = 3.9 * x * (1 - x)
        print x
```

```
x = 3.9 * x * (1 - x)
print x
x = 3.9 * x * (1 - x)
print x
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print x
x = 3.9 * x * (1 - x)
print x
x = 3.9 * x * (1 - x)
print x
```

- These pieces of code are equivalent!

Coming up: Python Assignment

Python Assignment

$$\underbrace{x}_{\text{LHS}} = \underbrace{3.9 * x * (1 - x)}_{\text{RHS=Right Hand Side}}$$

- This is called an *assignment* statement
- The part on the right-hand side (RHS) of the “=“ is a mathematical expression.
- * is used to indicate multiplication
- Once the value on the RHS is computed, it is stored back into (*assigned to*) x
- The LHS is what changes value

Coming up: Python Main

Python Main

```
main()
```

- This last line tells Python to *execute* the code in the function *main*
- This calls the function “main” which is defined earlier in the program using this line: `def main():`

Coming up: Print

Print

- Single line:

  print ‘Hello’ # Strings can be single quote

  print “Hello” # or double quote

  print “Hello

  John” **# ERROR: Single/double quoted strings MUST be on one line**

Coming up: Print – Line Breaks

Print – Line Breaks

- To print on two lines:
  - Option 1: Triple quotes “”” or ‘’’

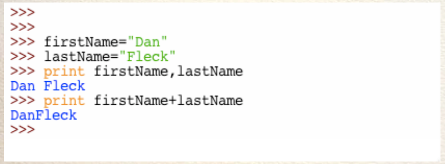
```
print “””This will print EXACTLY
Like I type it, even on multiple
Lines”””
```

  - Option 2: Use the escape character \n:

```
print “This will print\nOn two lines”
```

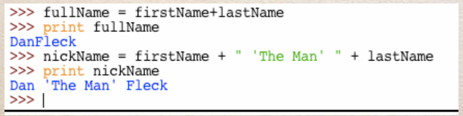
The print function knows some special characters like \n mean “add a newline” \t = tab, and there are others

Print – Multiple strings



```
>>>
>>>
>>> firstName="Dan"
>>> lastName="Fleck"
>>> print firstName,lastName
Dan Fleck
>>> print firstName+lastName
DanFleck
>>>
```

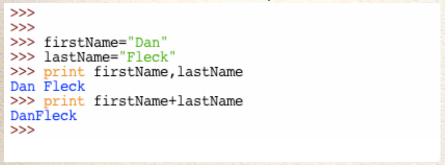
- The difference is a comma “,” separates two strings by a space when printing.
- A “+” is used to concatenate two strings into one big string. This works using variables also:



```
>>> fullName = firstName+lastName
>>> print fullName
DanFleck
>>> nickName = firstName + " 'The Man' " + lastName
>>> print nickName
Dan 'The Man' Fleck
>>> |
```

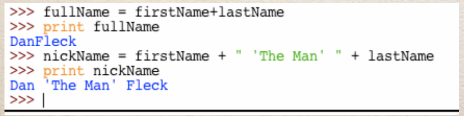
Print – Multiple strings

- The comma also surpresses the newline that is on by default



```
>>>
>>>
>>> firstName="Dan"
>>> lastName="Fleck"
>>> print firstName,lastName
Dan Fleck
>>> print firstName+lastName
DanFleck
>>>
```

- A “+” is used to concatenate two strings into one big string. This is really what happened in the last example. It works using variables also:



```
>>> fullName = firstName+lastName
>>> print fullName
DanFleck
>>> nickName = firstName + " 'The Man' " + lastName
>>> print nickName
Dan 'The Man' Fleck
>>> |
```

Any questions?

References

- http://openbookproject.net//thinkCSpy/chap01.html

End of presentation