Computers and Programs

Zelle - Chapter 1

Charles Severance - www.dr-chuck.com

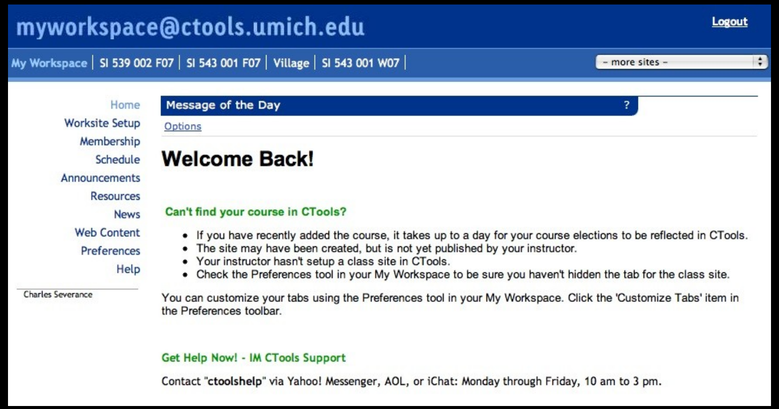
Textbook: Python Programming: An Introduction to Computer Science, John Zelle

Users .vs. Programmers

- Users see computers as a set of tools - word processor, spreadsheet
- Programmers have some tools that allow them to build new tools
- Programmers sometimes write tools for lots of users and sometimes programmers write little widgets for themselves to automate a task

Why do we program?

- To get some task done - part of some non-programming job
    - Clean up survey data
- To produce something for others to use - a real programming job
    - Fix a performance problem in the Sakai software



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Can't find your course in CTools?

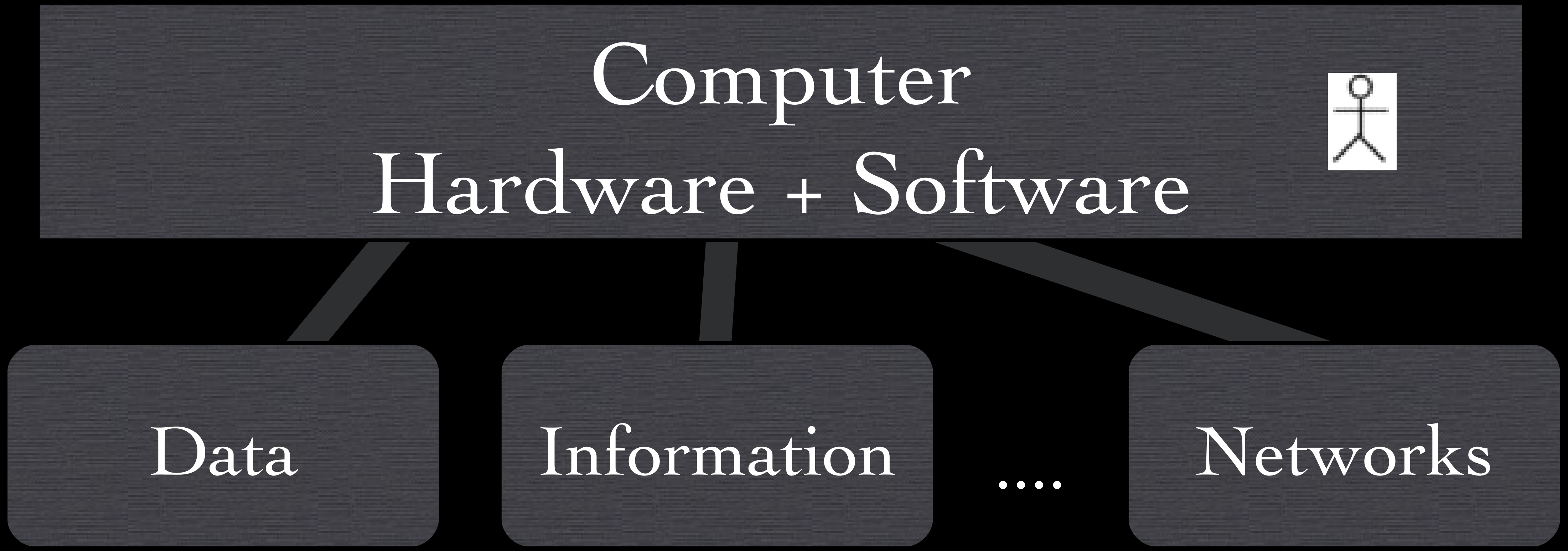
- If you have recently added the course, it takes up to a day for your course elections to be reflected in CTools.
- The site may have been created, but is not yet published by your instructor.
- Your instructor hasn't setup a class site in CTools.
- Check the Preferences tool in your My Workspace to be sure you haven't hidden the tab for the class site.

You can customize your tabs using the Preferences tool in your My Workspace. Click the 'Customize Tabs' item in the Preferences toolbar.

Get Help Now! - IM CTools Support

Contact "**ctoolshelp**" via Yahoo! Messenger, AOL, or iChat: Monday through Friday, 10 am to 3 pm.

User



Creators

From a software creator's point of view, we build the software. The end users (stakeholders/actors) are our masters - who we want to please - often they pay us money when they are pleased. But the data, information, and networks are our problem to solve on their behalf. The hardware and software are our friends and allies in this quest.

What is Code? Software? A Program?

- A set of stored instructions
  - It is a little piece of our intelligence in the computer
  - It is a little piece of our intelligence we can give to others - we figure something out and then we encode it and then give it to someone else to save them the time and energy of figuring it out
- A piece of performance art

How Many Lines in a File?

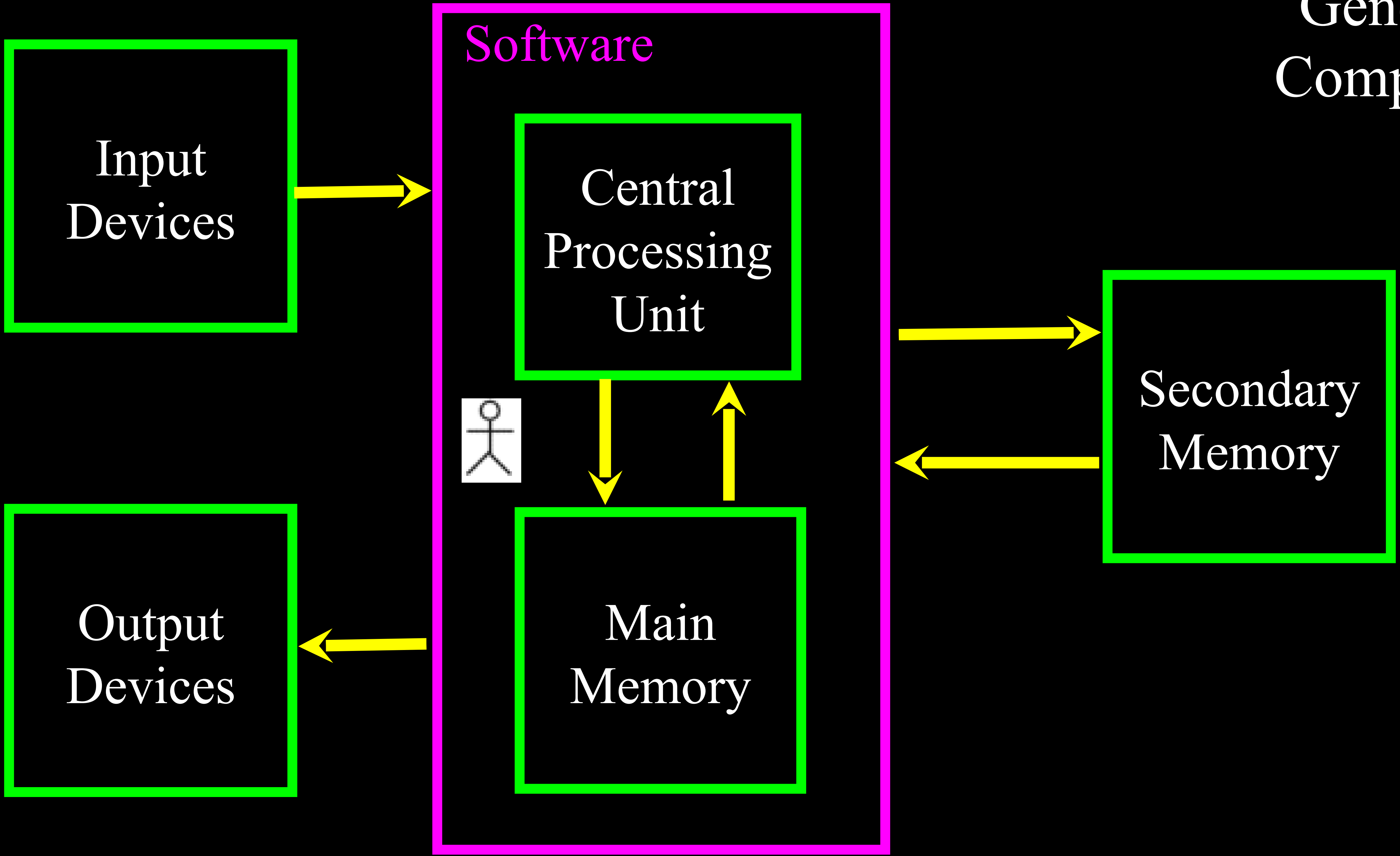
- You could read and understand
  - Chapter 4 page 110
  - Chapter 11 Page 341
  - Appendix A Page 447

Or I could send you this in E-Mail:

```
infile = open("mbox", "r")
print len(infile.readlines())
```

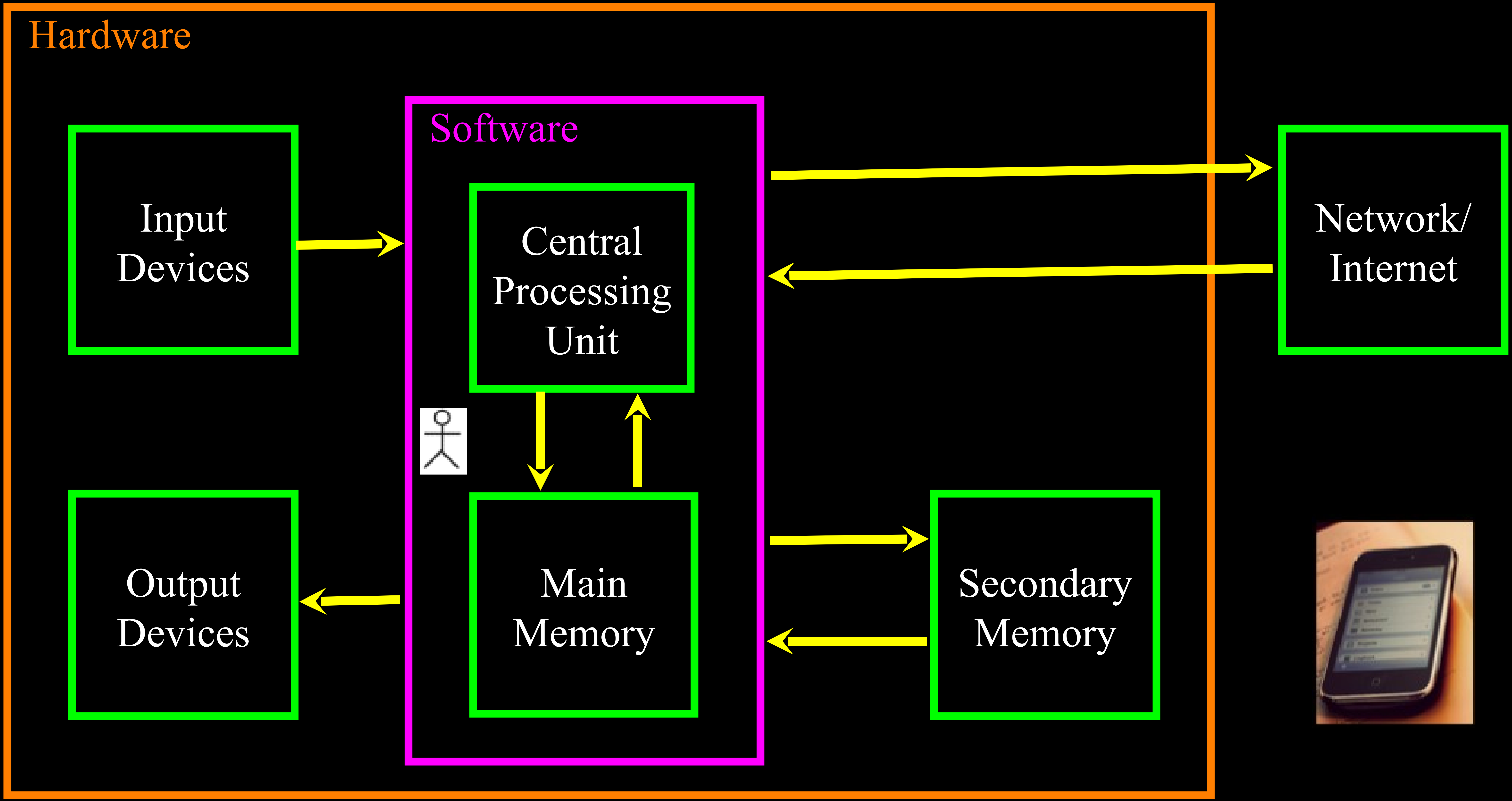
Hardware Architecture

Generic Computer



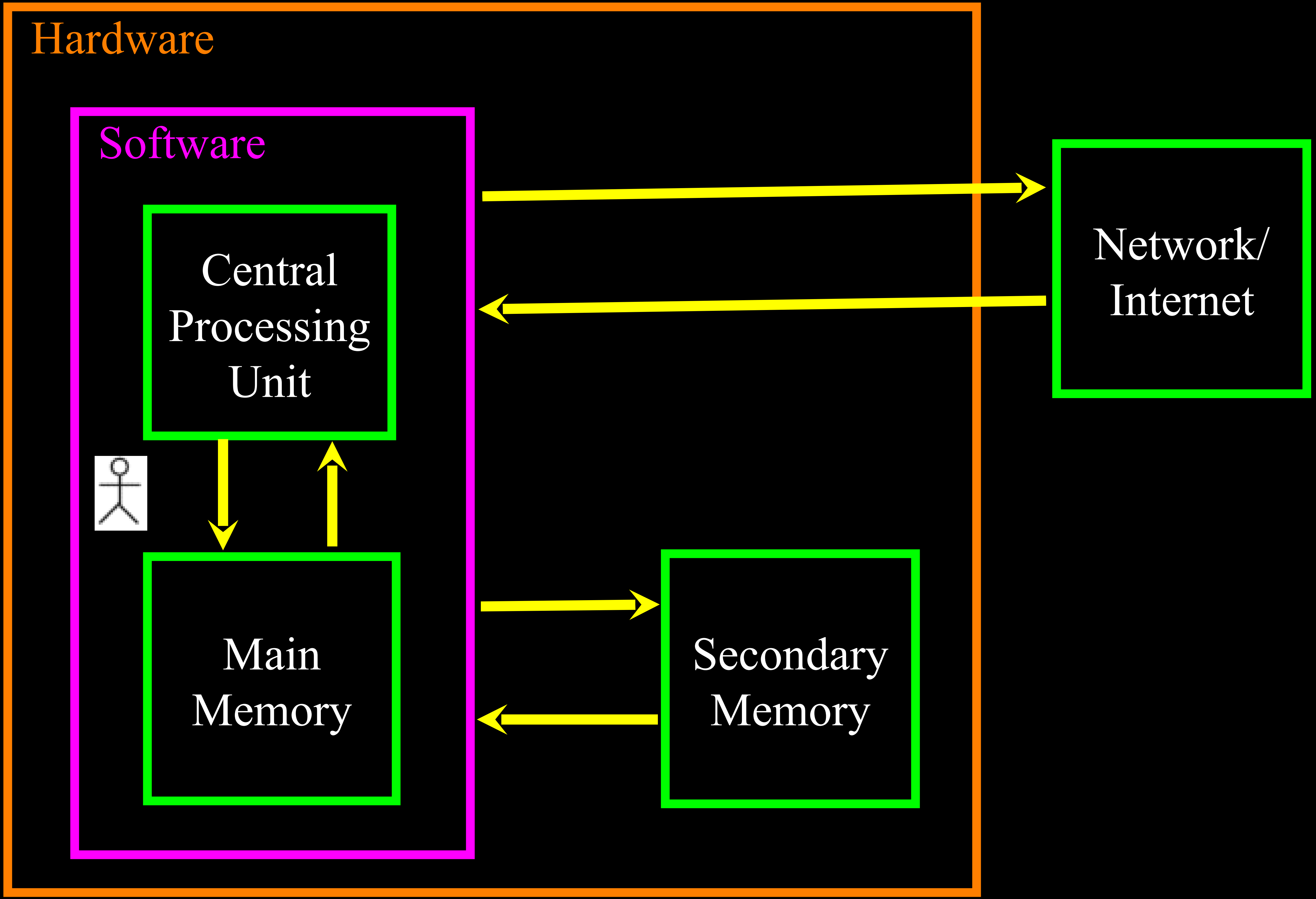
Definitions

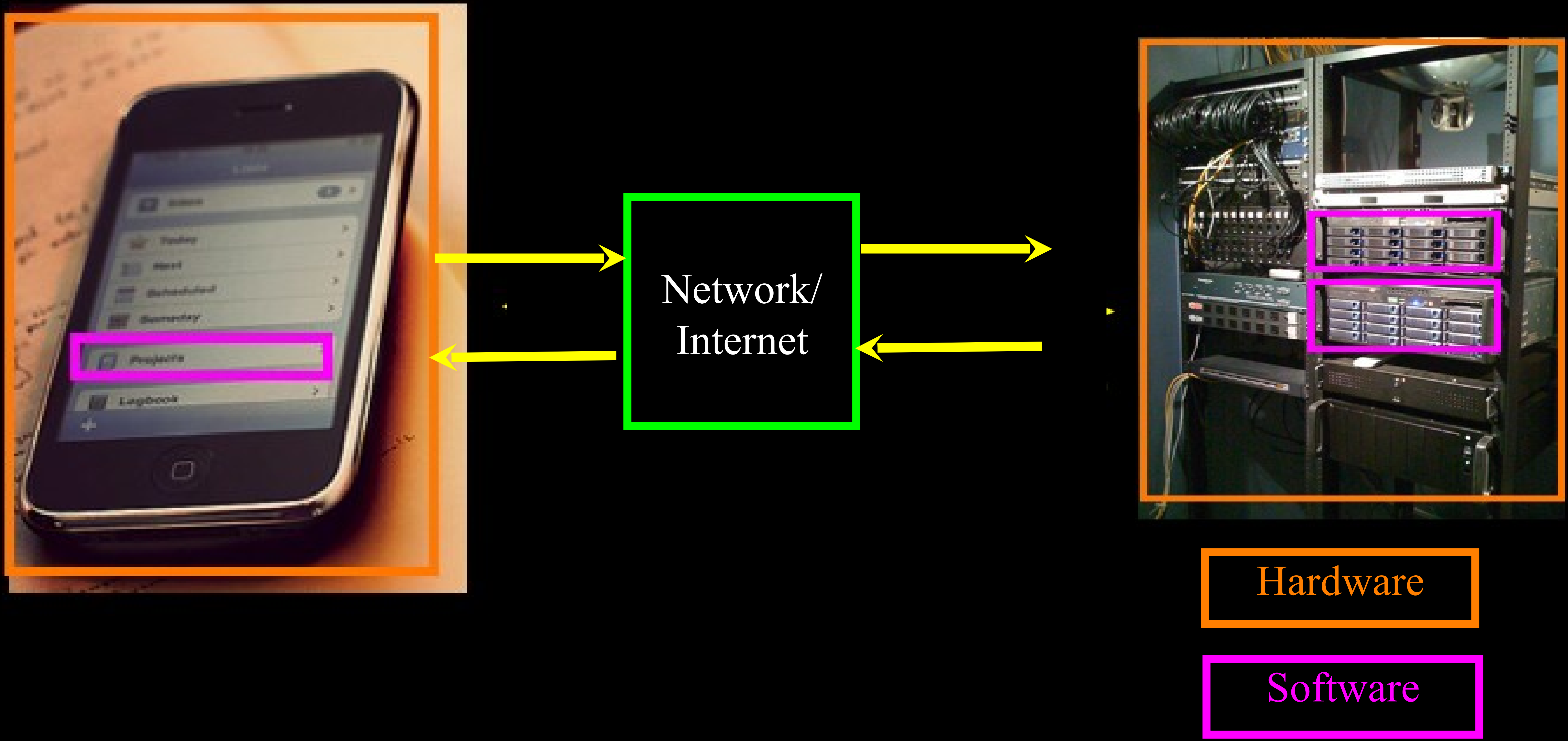
- Input Devices: Keyboard, Mouse, Touch Screen
- Output Devices: Screen, Speakers, Printer, DVD Burner
- Central Processing Unit: Runs the Program - AKA The CPU is always wondering “what to do next”? Not the brains exactly - very dumb but very very fast
- Main Memory: Fast small temporary storage - lost on reboot - aka RAM
- Secondary Memory: Slower large permanent storage - lasts until deleted - disk drive / memory stick


Hardware
Software
Input Devices
Central Processing Unit
Network/ Internet
Main Memory
Output Devices
Secondary Memory

Web Server

A web server often functions with no input or output devices connected to the system. It takes incoming requests from the network - does some work with those requests and send output back across the network.




Inbox
Today
Next
Scheduled
Someday
Projects
Logbook
Network/ Internet
Hardware
Software

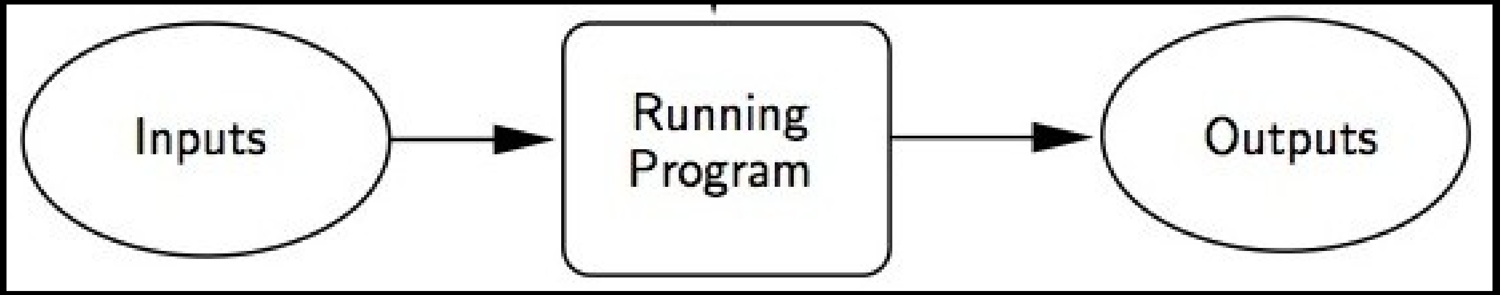
Programmer Tools

Becoming a Programmer

- We use the computer - we just have to learn some programmer tools
  - Compiler - Takes our code and makes it executable
  - Interpreter - Reads our code and runs it
  - Development Environment - Helps us write code

When a Program Runs...

- When a program runs it:
  - Takes some input data
  - Processes the data using a set of instructions (a program)
  - Produces some output
- Think of it as "value add"



An example program takes a text file as its input and counts the lines in the file and prints out the number of lines in the file.

Programmer Tools

- We use the computer - we just have some new tools
  - Development Environment - A “Word Processor” or “Text Editor” for Programmers - we write code in a development environment
  - Compiler - Takes our code and makes an executable version of our program
  - Interpreter - Reads our code and runs it directly - Python is an interpreted language - Python is an interpreter

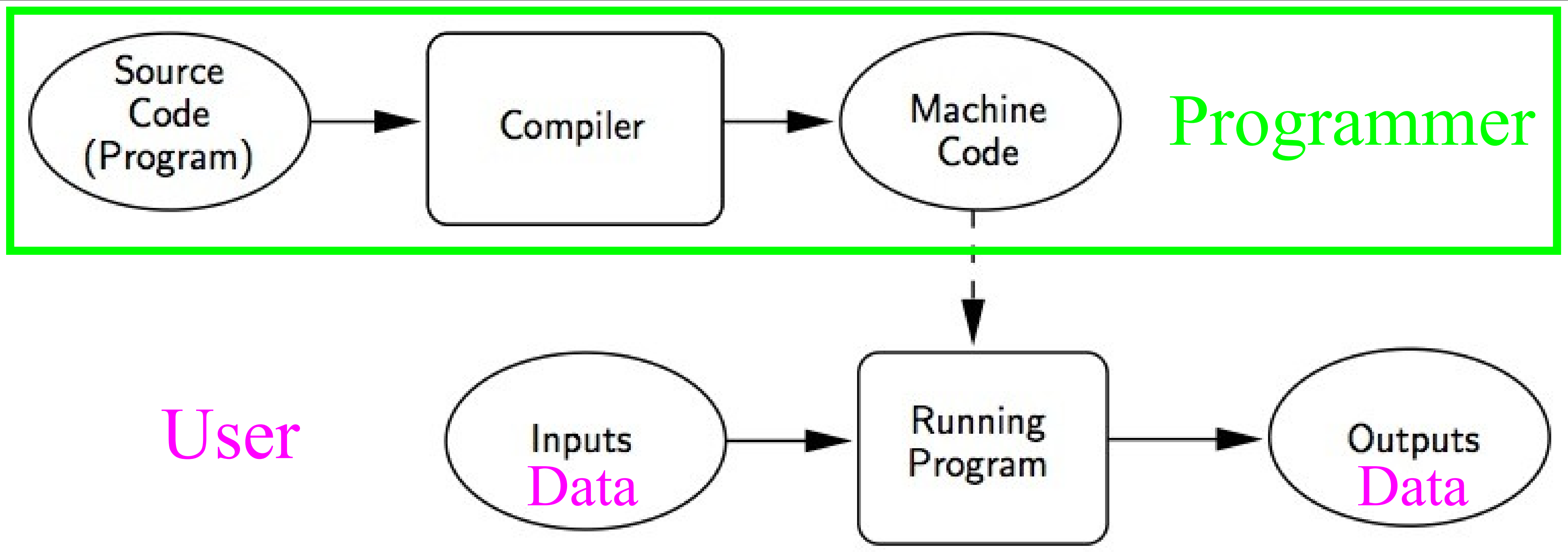


Figure 1.2: Compiling a High-Level Language

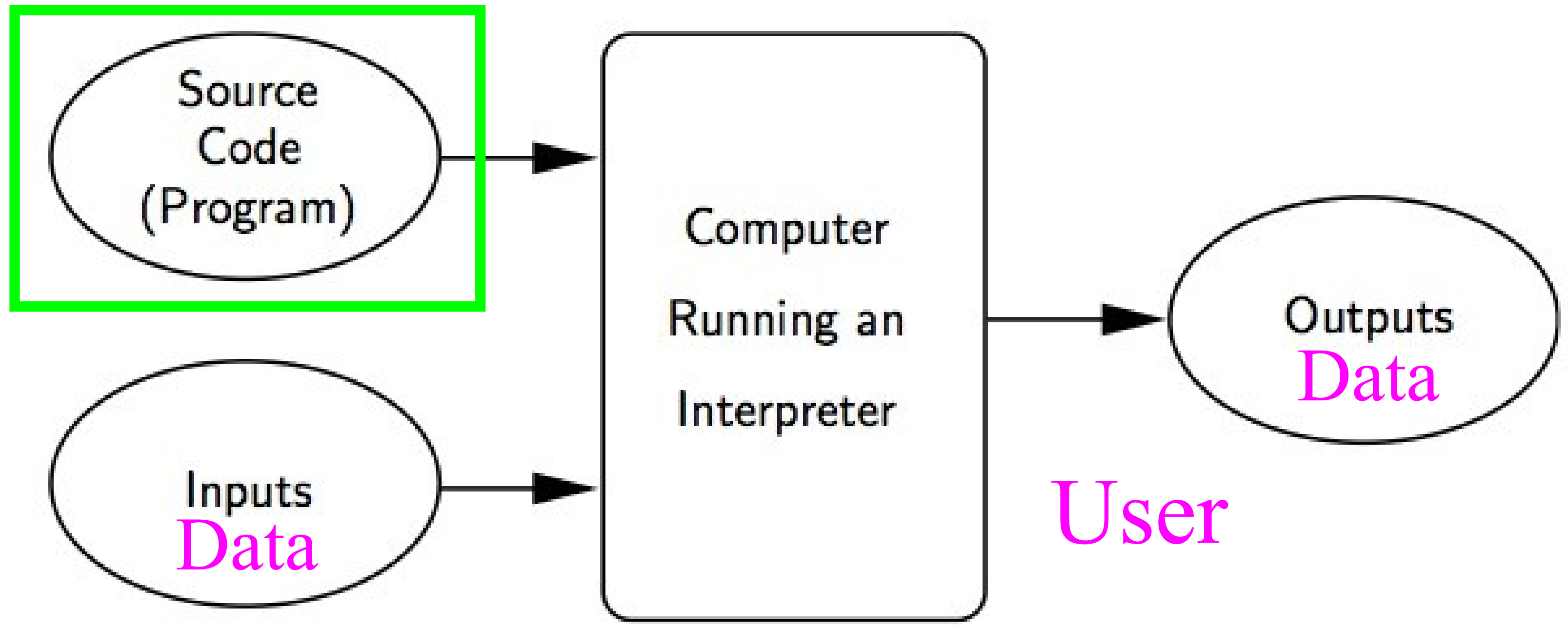


Figure 1.3: Interpreting a High-Level Language.

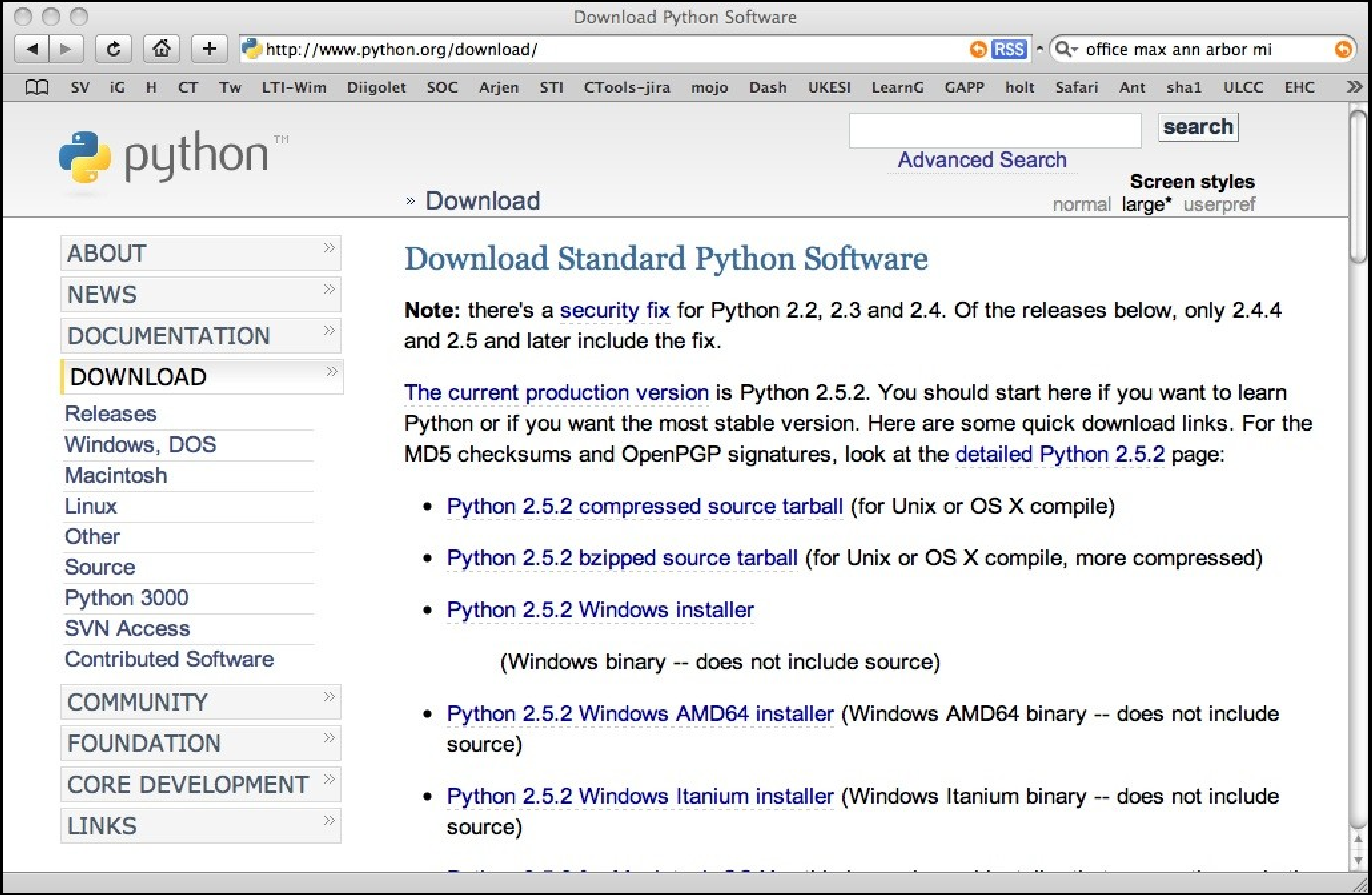
A programmer develops a program.

If a compiler is used the compiler translated the source to machine code for distribution.

If an interpreter is used, the programmer simply distributes the source code.

Terms

- Source code - the programs we humans write - and read - written in a programming language - source code is generally portable across systems
- Machine code - what really runs on the machine - not very readible - produced by a compiler - machine code is unique to hardware and operating system.



Download Python Software

http://www.python.org/download/

office max ann arbor mi

Download Standard Python Software

Note: there's a security fix for Python 2.2, 2.3 and 2.4. Of the releases below, only 2.4.4 and 2.5 and later include the fix.

The current production version is Python 2.5.2. You should start here if you want to learn Python or if you want the most stable version. Here are some quick download links. For the MD5 checksums and OpenPGP signatures, look at the detailed Python 2.5.2 page:

- Python 2.5.2 compressed source tarball (for Unix or OS X compile)
- Python 2.5.2 bzipped source tarball (for Unix or OS X compile, more compressed)
- Python 2.5.2 Windows installer

  (Windows binary -- does not include source)
- Python 2.5.2 Windows AMD64 installer (Windows AMD64 binary -- does not include source)
- Python 2.5.2 Windows Itanium installer (Windows Itanium binary -- does not include source)

Your
Source
Code

```
main() {
  printf("Hello world\n");
}
```

```
^@^@^@^@__DATA^@^@^@^@^@^@^@^@^@
^@^@^@0^@^@^@^@q^@^@
^@^@^@^@^B^@^@^@^@^@^@^@^@^@^@^@
^@^@^@^@^@^@^@^@__nl_symbol_pt
r^@__DATA^@^@^@^@^@^@^@^@^@^@^@^
@0t^@^@^@^P^@^@
t^@^@^@^B^@^@^@^@^@^@^@^@^@^@^@^
F^@^@^@^Q^@^@^@^@__la_symbol_ptr
^@__DATA^@^@^@^@^@^@^@^@^@^@^@^@
0<84>^@^@^@D^@^@@^A^@^@/usr/lib/
libmx.A.dylib^@^@^@^@^@^L^@^@^@4
^@^@^@^XC½m¥^@X^A^C^@^A^@^@/usr/
lib/libSy
```

The C Language Compiler Reads your source code and produces your machine code.

Your
Machine
Code

```
^?
ELF^A^A^A^@^@^@^@^@^@^@^@^@^B^@^C^@^A^@^@^@\xa0\x82^D^H4^@^@^@\x90^]^@^@^@^@^@^@4^
@ ^@^G^@(^@$^@!
^@^F^@^@^@4^@^@^@4\x80^D^H4\x80^D^H\xe0^@^@^@\xe0^@^@^@^E^@^@^@^D^@^@^@^C^@^@^@^T^
A^@^@^T\x81^D^H^T\x81^D^H^S^@^@^@^S^@^@^@^D^@^@^@^A^@^@^@^A\^D^HQVhT\x83^D^H\xe8\x
b7\xff\xff\xff\xf4\x90\x90U\x89\xe5S\xe8^@^@^@^@[\x81\xc3_^R^@^@P\x8b\x83\xfc\xff\
xff\xff\x85\xc0t^B\xff\xd0\x8b]\xfc\xc9\xc3\x90\x90\x90\x90\x90\x90\x90\x90\x90\x9
0U\x89\xe5\x83\xec^H\x80=L\x95^D^H^@t^L\xeb^\\x83\xc0^D\xa3H\x95^D^H\xff\xd2\xa1H\
x95^D^H\x8b^P\x85\xd2u\xeb\xc6^EL\x95^D^H^A\xc9\xc3\x90U\x89\xe5\x83\xec^H\xa1\\x9
4^D^H\x85\xc0t!\xb8^@^@^@^@\x85\xc0t^X\xc7^D$\\x94^D^H\xe8\xbc|\xfb\xf7\x8d\xb6^@^
@^@^@\x8d\xbf^@^@^@^@\xc9\xc3\x90\x90U\x89\xe5\x
```

print “hello world”

```
è^@^@^Qp^@^@^@^B^@^@^@^@^@^@^@^@<80>^@^D^@^@^@^@^@^@^@^@^@__picsy
mbol_stub__TEXT^@^@^@^@^@^@^@^@^@^@^@,X^@^@^@^@^@^@^\X^@^@^@^B^
@^@^@^@^@^@^@^@<80>^@^@^H^@^@^@^@^@^@^@$__symbol_stub^@^@^@__TEXT
^@^@^@^@^@^@^@^@^@^@^@^@,X^@^@^@^@^@^@^\X^@^@^@^B^@^@^@^@^@^@^@^@
<80>^@^@^H^@^@^@^@^@^@^@^T__picsymbolstub1__TEXT^@^@^@^@^@^@^@^@^
@^@^@^@,`^@^@^B
^@^@^\`^@^@^@^E^@^@^@^@^@^                H^@^@^@^@^@^@^@
__cstring^@^@^@^@^@^@^@__T                @^@^@^@^@^@^@.<80>^@^@^AX
^@^@^^<80>^@^@^@^B^@^@^@^@                ^B^@^@^@^@^@^@^@^@^@^@^@^
A^@^@^AĐ__DATA^@^@^@^@^@^@                @^@^@^P^@^@^@
^@^@^@^P^@^@^@^@^G^@^@^@^C                ^@__data^@^@^@^@^@^@^@^@^
@^@__DATA^@^@^@^@^@^@^@^                  ^@q^@^@
^@^@^@^@^B^@^@^@^@^@^@^@^                 ^@^@^@^@^@__nl_symbol_ptr
^@__DATA^@^@^@^@^@^@^@^@^                 ^P^@^@
t^@^@^@^B^@^@^@^@^@^@^@^                  Q^@^@^@^@__la_symbol_ptr^
@__DATA^@^@^@^@^@^@^@^@^                  ^@D^@^@
<84>^@^@^@^B^@^@^@^@^@^@^@^@^@^@^G^@^@^@^U^@^@^@^@__dyld^@^@^@^
@^@^@^@^@^@^@__DATA^@^@^@^@^@^@^@^@^@^@^@0È^@^@^@^\^@^@
È^@^@^@^B^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@__bss^@^@^@^@^@^
@^@^@^@^@^@__DATA^@^@^@^@^@^@^@^@^@^@^@0ä^@^@^@^D^@^@^@^@^@^@^@
^B^@^@^@^@^@^@^@^@^@^@^@^@^A^@^@^@^@^@^@^@^@__common^@^@^@^@^@^@^@^
@__DATA^@^@^@^@^@^@^@^@^@^@^@0ð^@^@^@4^@^@^@^@^@^@^@^D^@^@^@^@^
@^@^@^@^@^@^@^@^A^@^@^@^@^@^@^@^@^@^@^@^A^@^@^@8__LINKEDIT^@^@^@^@^
@^@^@^@@@^@^@^@^F^D^@^@0^@^@^@^F^D^@^@^@^G^@^@^@^A^@^@^@^@^@^@^@^D
```

Machine Code for the Python Interpreter

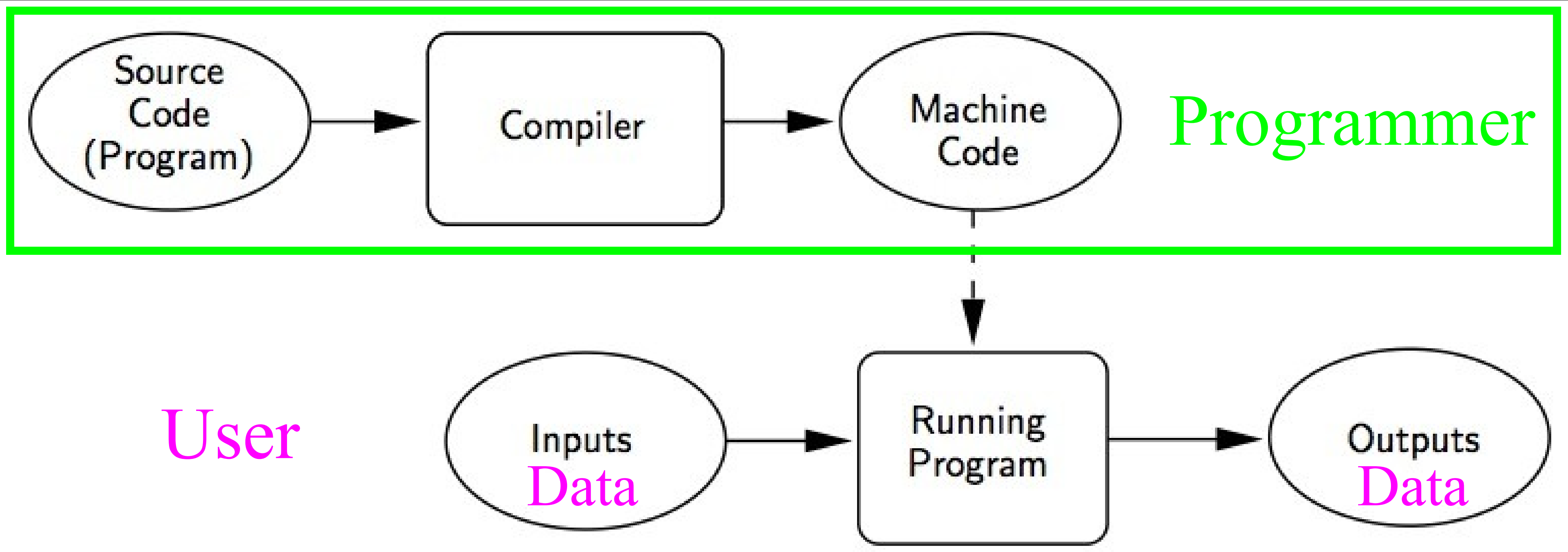


Figure 1.2: Compiling a High-Level Language

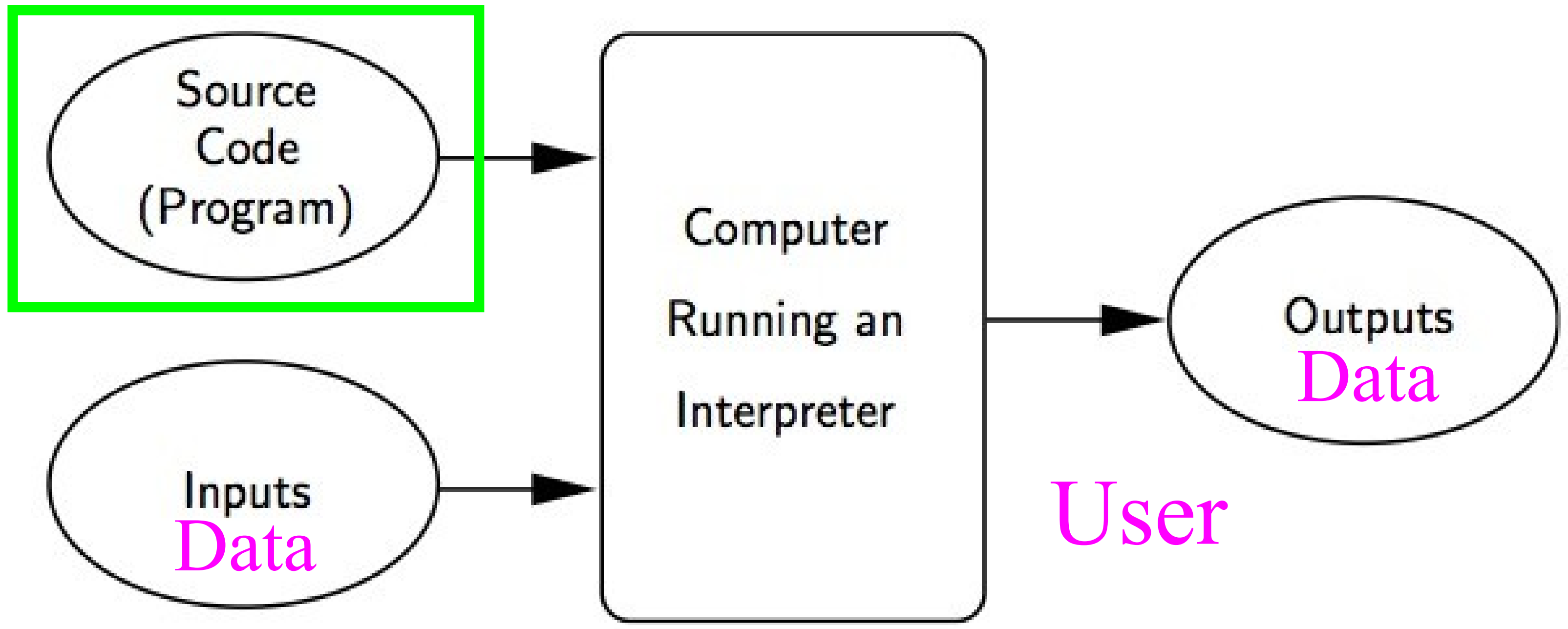


Figure 1.3: Interpreting a High-Level Language.

A programmer develops a program.

If a compiler is used the compiler translated the source to machine code for distribution.

If an interpreter is used, the programmer simply distributes the source code.

Compiler .vs. Interpreter

- Only the programmer needs to have the compiler - once the compiler is done - the executable program is self-contained
  - The programmer keeps the source code and distributes the executable - different executables are needed for Mac, PC, etc.
- Both the programmer and user need to have the Interpreter installed on their system
  - Generally the programmer distributes the source code of the program

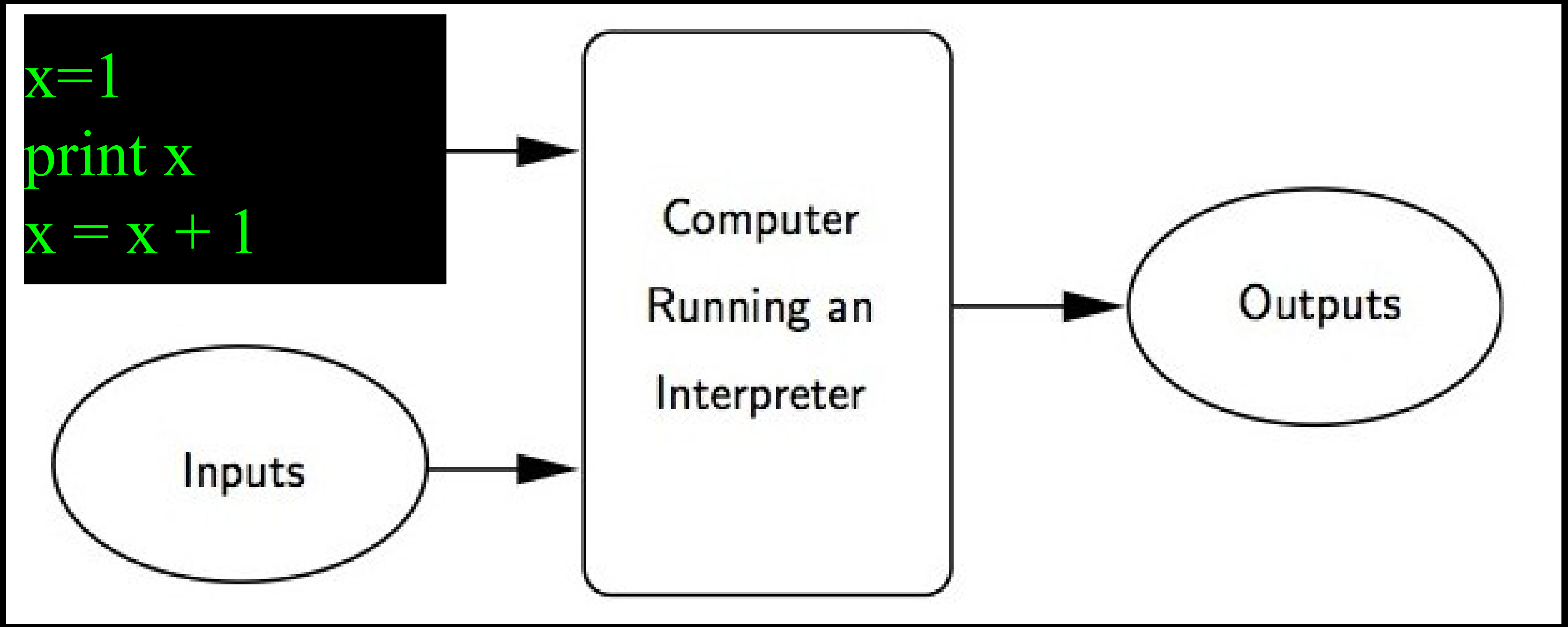
Python is an Interpreter

- To run Python programs, users must install Python on their computers
- Development is quick and easy - we simply make a change to our program and run it again in a single step
- For data analysis - Python is just a tool that you keep on your desktop or laptop
- Interpreters are more convenient when the user and programmer are the same person

Running Python Interactively

Python Interactive

- Since Python is interpreted we can just type programs directly into Python
- See Also http://datamech.com/devan/trypython/trypython.py



```
x=1
print x
x = x + 1
```

```
csev$ python
Python 2.5 (r25:51918, Sep 19 2006, 08:49:13)
 [GCC 4.0.1 (Apple Computer, Inc. build 5341)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> x = 1
>>> print x
1
>>> x = x + 1
>>> print x
2
>>> exit()
```

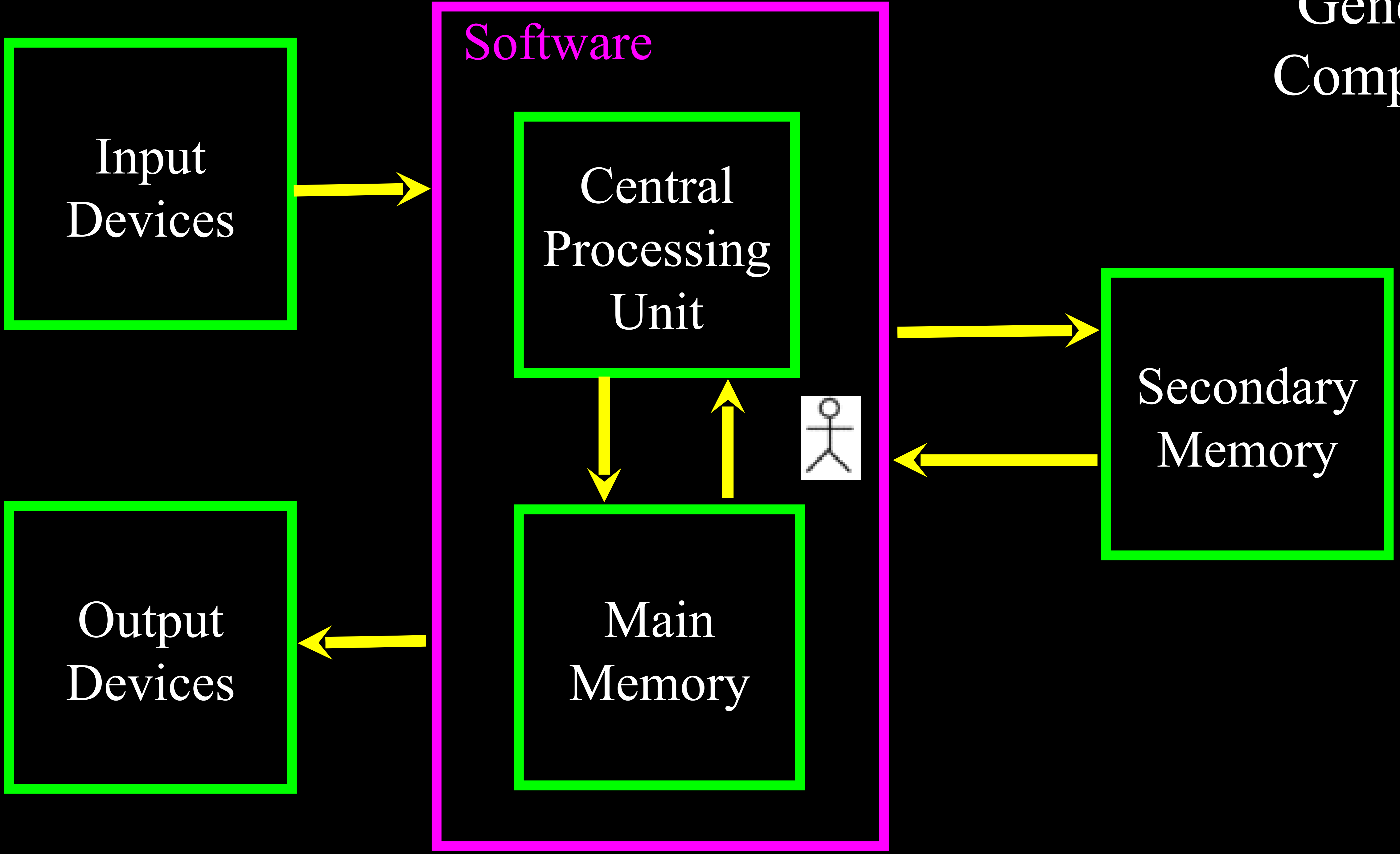
This is a good test to make sure that you have python correctly installed.

Syntax Errors

- The computer has a language where you an tell it what you want to do - this is Python
- It seems unfair when you submit a program to the computer and it says "syntax error" - given that it *knows* the language and you are just learning it. It seems rude and cruel.
- You must remember that you are intelligent and *can* learn - the computer is simple and very fast - but cannot learn - so it is easier for you to learn Python than for the computer to learn English...

The Essence of Programming

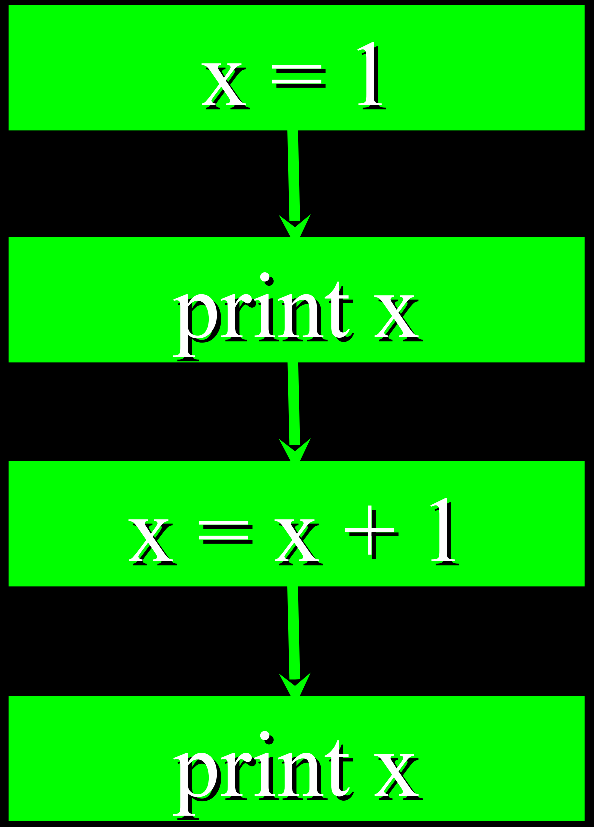
Generic Computer



Program Steps or Program Flow

- Like a recipe or installation instructions, a program is a sequence of steps to be done in order
- Some steps are conditional - they may be skipped
- Sometimes a step or group of steps are to be repeated
- Sometimes we store a set of steps to be used over and over as needed several places throughout the program

Sequential Steps



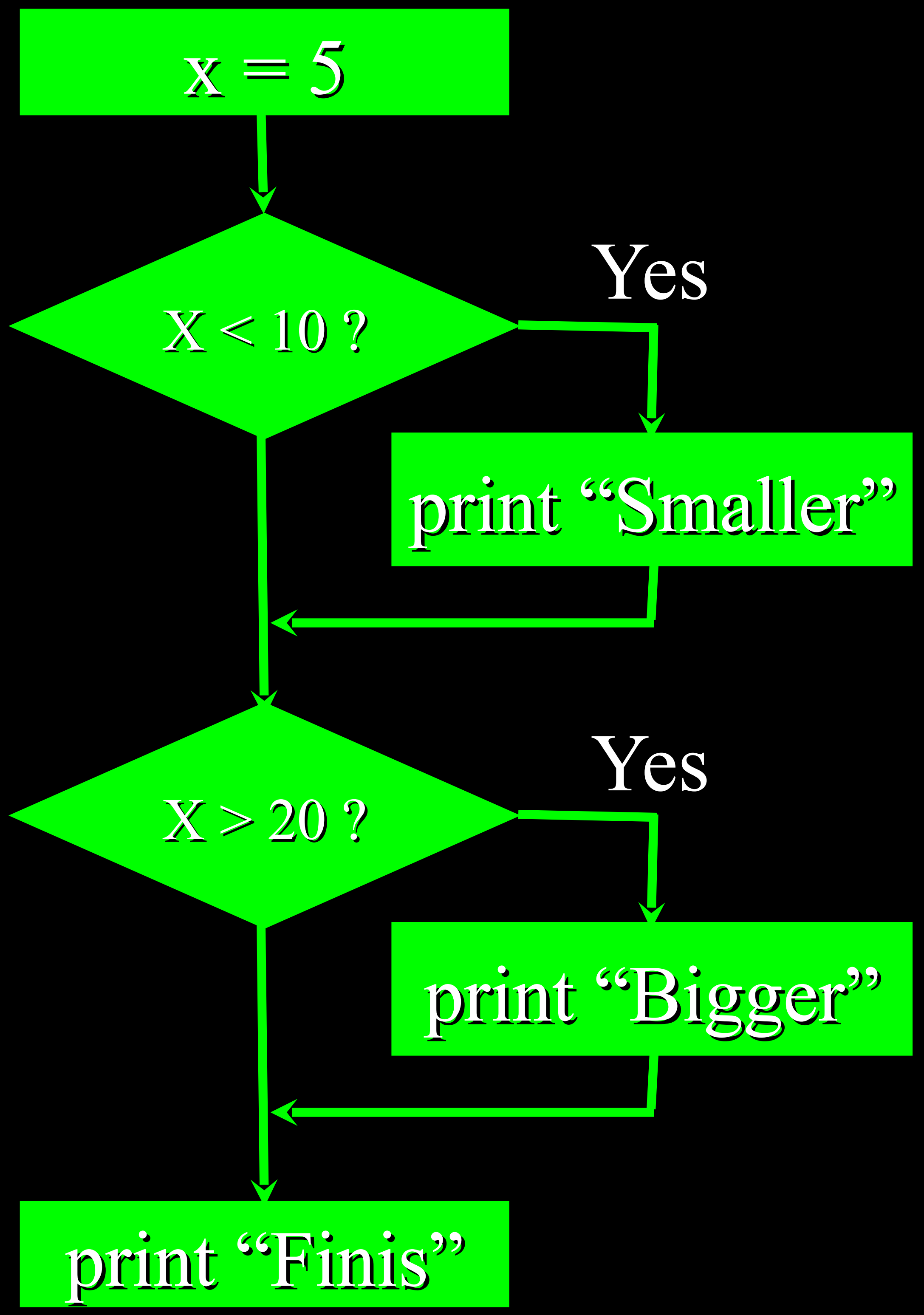
Program:

```
x = 1
print x
x = x + 1
print x
```

Output:

```
1
2
```

When a program is running, it flows from one step to the next. We as programmers set up “paths” for the program to follow.



Conditional Steps

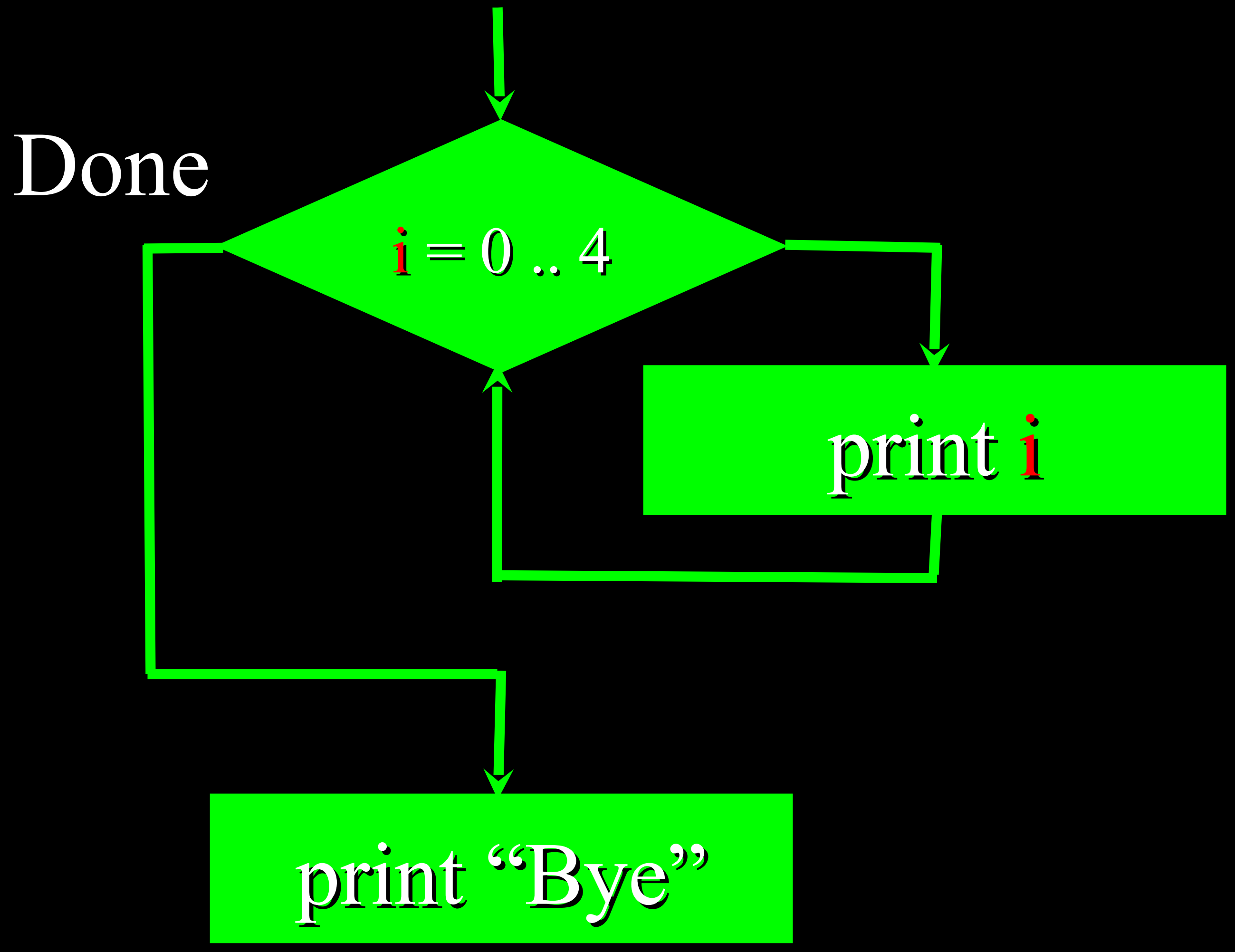
Program:

```
x = 5
if x < 10:
    print "Smaller“

if x > 20:
    print "Bigger"

print “Finis”
```

Output:

```
Smaller
Finis
```

Repeated Steps



Program:

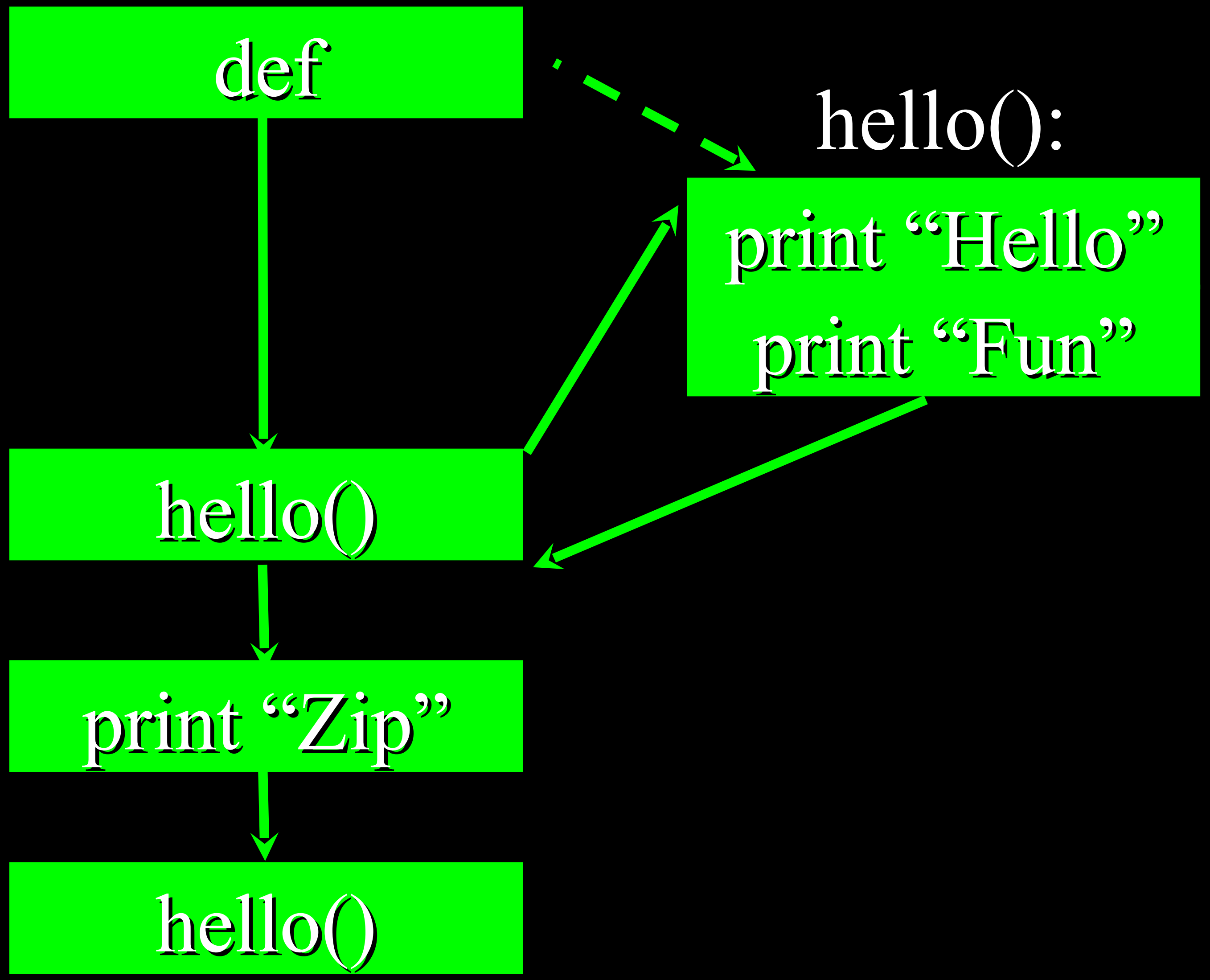
```
for i in range(5) :
    print i

print "Bye"
```

Output:

```
0
1
2
3
4
Bye
```

Loops (repeated steps) have iteration variables that change each time through a loop. Often these iteration variables go through a sequence of numbers.

Stored (and reused) Steps



Program:

```
def hello():
  print "Hello"
  print "Fun"

hello()
print “Zip
”hello()
```

Output:

```
Hello
Fun
Zip
Hello
Fun
```

We call these little stored chunks of code “subprograms” or “functions”.

A Python Program

```
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)
     print x

main()
```

```
$ python chaos.pyThis program illustrates a
chaotic functionEnter a number between 0
and 1: 0.6
0.936
0.2336256
0.698274248196
0.821680557759
0.571434313164
0.955098841721
0.16725167263
0.543186347468
0.96772626363
0.121805355011
```

Stored steps

Calling the stored steps

```
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)
    print x

main()
```

Output

Input

```
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)
     print x

main()
```

Repeated Code

```
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)
     print x

main()
```

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

```
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)
        print x

main()
```

The colon (:) starts a block of indented code

Indented code continues until a line is encountered that is less indented.

```
def main():

 print "This program illustrates a chaotic function"
 x = input("Enter a number between 0 and 1: ")
 for i in range(10): ⟵ Start
   x = 3.9 * x * (1 - x)
   print x
                           ⟵ End

main()
```

The colon (:) starts a block of indented code

Indented code continues until a line is encountered that is less indented.

```
def main():                                    ← Start

 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)
    print x
                                      ← End
main()
```

Variables and Assignment Statements

Variables and Assignments

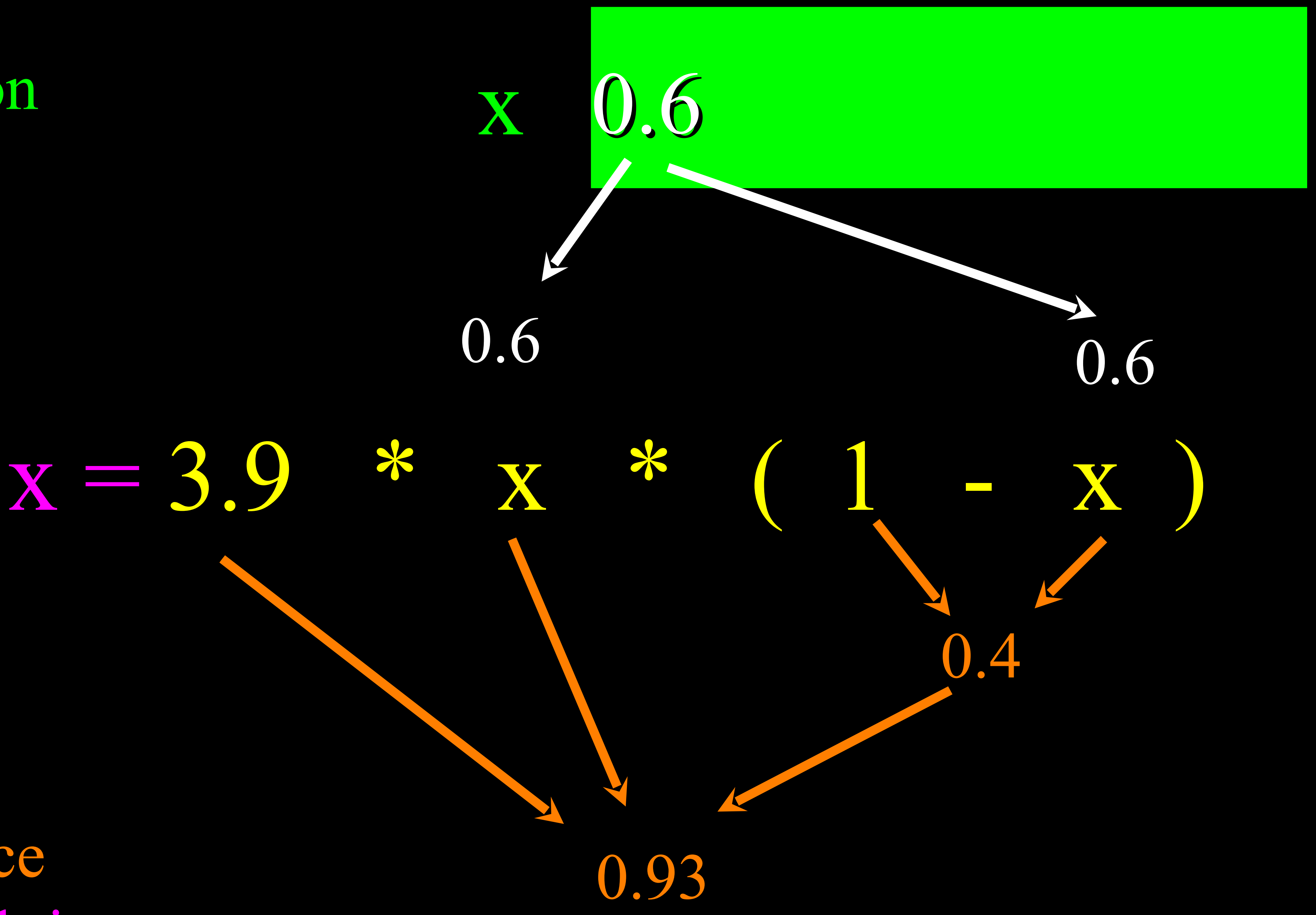
- A variable is a scratch local to store some value such as a number or a string
- An assignment statement consists of an expression on the right hand side and a variable to store the result

$$x = 3.9 * x * (1 - x)$$

Assignment Statement into the variable named x

```
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)
        print x

main()
```

A variable is a memory location used to store a value (0.6).



Left side is an expression. Once expression is evaluated, the result is placed in (assigned to) x.

A variable is a memory location used to store a value. The value stored in a variable can be updated by replacing the old value (0.6) with a new value (0.93).

x ~~0.6~~ 0.93

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

0.93

Right side is an expression. Once expression is evaluated, the result is placed in (assigned to) the variable on the left side (i.e. x).

Comments in Python

Comments in Python

- Anything after a # is ignored by Python
- Why comment?
  - Describe what is going to happen in a sequence of code
  - Document who wrote the code or other ancillary information
  - Turn off a line of code - perhaps temporarily

Comments can document our programs.

Comments can also be used to temporarily turn off lines of code without deleting those lines in case we want them back later.

```
# 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):
     # print i
     x = 3.9 * x * (1 - x)
     print x

main()
```

Summary

- This is a quick overview of Chapter 1
- We will revisit these concepts throughout the course
- Focus on the big picture