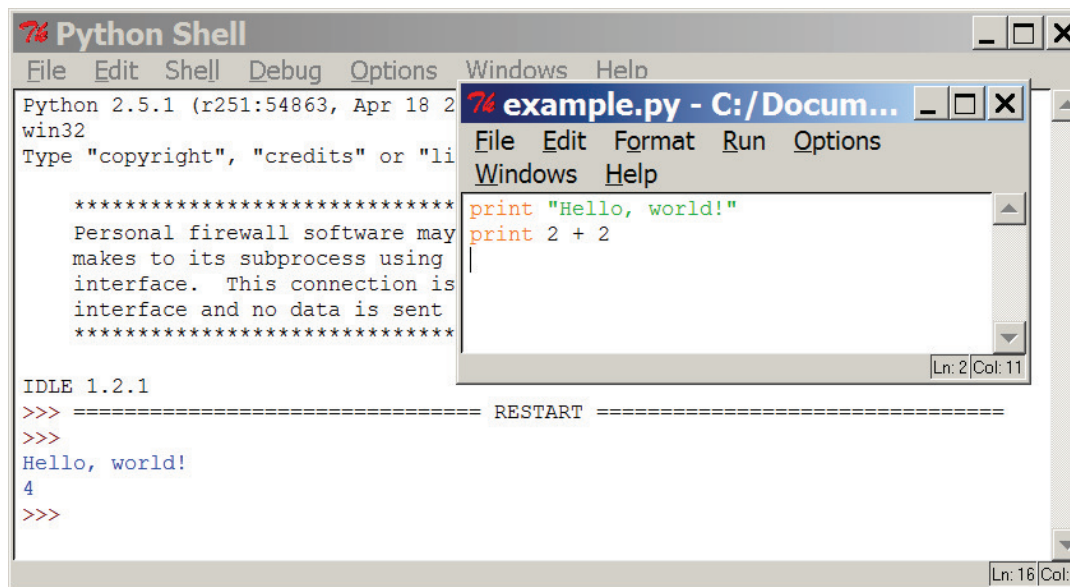


Programming basics

- **code** or **source code**: The sequence of instructions in a program.
- **syntax**: The set of legal structures and commands that can be used in a particular programming language.
- **output**: The messages printed to the user by a program.
- **console**: The text box onto which output is printed.
 - Some source code editors pop up the console as an external window, and others contain their own console window.

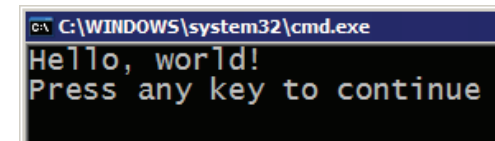


The image shows two overlapping windows. The background window is titled 'Python Shell' and contains the following text:

```
Python 2.5.1 (r251:54863, Apr 18 2006)
win32
Type "copyright", "credits" or "license()" for more
>>>
*****
Personal firewall software may
makes to its subprocess using
interface. This connection is
interface and no data is sent
*****
IDLE 1.2.1
>>> ===== RESTART =====
>>>
Hello, world!
4
>>>
```

The foreground window is titled 'example.py - C:/Docum...' and contains the following code:

```
print "Hello, world!"
print 2 + 2
```

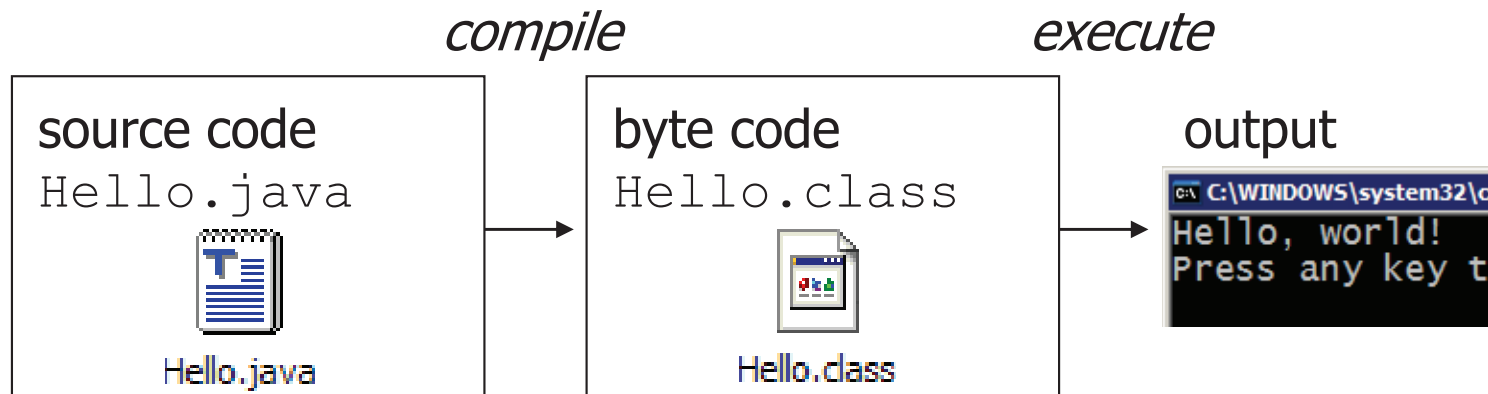


The image shows a command prompt window titled 'C:\WINDOWS\system32\cmd.exe' with the following output:

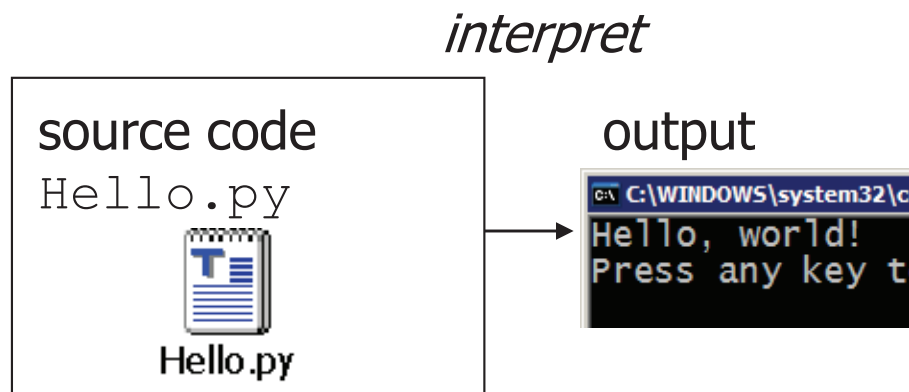
```
Hello, world!
Press any key to continue
```

Compiling and interpreting

- Many languages require you to *compile* (translate) your program into a form that the machine understands.



- Python is instead directly *interpreted* into machine instructions.



The Python Interpreter

- Python is an interpreted language
- The interpreter provides an interactive environment to play with the language
- Results of expressions are printed on the screen

```
>>> 3 + 7
10
>>> 3 < 15
True
>>> 'print me'
'print me'
>>> print 'print me'
print me
>>>
```



Expressions

- **expression:** A data value or set of operations to compute a value.

Examples: $1 + 4 * 3$
42

- Arithmetic operators we will use:

| | | | | |
|------|-----|-----|-----|--|
| $+$ | $-$ | $*$ | $/$ | addition, subtraction/negation, multiplication, division |
| $\%$ | | | | modulus, a.k.a. remainder |
| $**$ | | | | exponentiation |

- **precedence:** Order in which operations are computed.

- $*$ $/$ $\%$ $**$ have a higher precedence than $+$ $-$

$1 + 3 * 4$ is 13

- Parentheses can be used to force a certain order of evaluation.

$(1 + 3) * 4$ is 16



Integer division

- When we divide integers with $/$, the quotient is also an integer.

$$\begin{array}{r} 3 \\ 4 \overline{) 14} \\ \underline{12} \\ 2 \end{array}$$

$$\begin{array}{r} 52 \\ 27 \overline{) 1425} \\ \underline{135} \\ 75 \\ \underline{54} \\ 21 \end{array}$$

- More examples:
 - $35 / 5$ is 7
 - $84 / 10$ is 8
 - $156 / 100$ is 1

- The $\%$ operator computes the remainder from a division of integers.

$$\begin{array}{r} 3 \\ 4 \overline{) 14} \\ \underline{12} \\ \mathbf{2} \end{array}$$

$$\begin{array}{r} 43 \\ 5 \overline{) 218} \\ \underline{20} \\ 18 \\ \underline{15} \\ \mathbf{3} \end{array}$$

Real numbers

- Python can also manipulate real numbers.
 - Examples: 6.022 -15.9997 42.0 2.143e17
- The operators + - * / % ** () all work for real numbers.
 - The / produces an exact answer: 15.0 / 2.0 is 7.5
 - The same rules of precedence also apply to real numbers:
Evaluate () before * / % before + -
- When integers and reals are mixed, the result is a real number.
 - Example: 1 / 2.0 is 0.5
 - The conversion occurs on a per-operator basis.

$$\begin{array}{r} 7 / 3 * 1.2 + 3 / 2 \\ \underline{2} * 1.2 + 3 / 2 \\ 2.4 + \underline{3 / 2} \\ 2.4 + \underline{1} \\ \underline{3.4} \end{array}$$

Math commands

- Python has useful commands (or called functions) for performing calculations.

| Command name | Description |
|--|-----------------------|
| <code>abs(value)</code> | absolute value |
| <code>ceil(value)</code> | rounds up |
| <code>cos(value)</code> | cosine, in radians |
| <code>floor(value)</code> | rounds down |
| <code>log(value)</code> | logarithm, base e |
| <code>log10(value)</code> | logarithm, base 10 |
| <code>max(value1, value2)</code> | larger of two values |
| <code>min(value1, value2)</code> | smaller of two values |
| <code>round(value)</code> | nearest whole number |
| <code>sin(value)</code> | sine, in radians |
| <code>sqrt(value)</code> | square root |

| Constant | Description |
|----------|--------------|
| e | 2.7182818... |
| pi | 3.1415926... |

- To use many of these commands, you must write the following at the top of your Python program:

```
from math import *
```

Numbers: Floating Point

- `int(x)` converts `x` to an integer
- `float(x)` converts `x` to a floating point
- The interpreter shows a lot of digits

```
>>> 1.23232
1.232320000000000001
>>> print 1.23232
1.23232
>>> 1.3E7
13000000.0
>>> int(2.0)
2
>>> float(2)
2.0
```



Variables

- **variable:** A named piece of memory that can store a value.

- Usage:

- Compute an expression's result,
- store that result into a variable,
- and use that variable later in the program.



- **assignment statement:** Stores a value into a variable.

- Syntax:

name = value

- Examples:

$x = 5$

$gpa = 3.14$

x 5

gpa 3.14

- A variable that has been given a value can be used in expressions.

$x + 4$ is 9

- **Exercise:** Evaluate the quadratic equation for a given a , b , and c .

Example

```
>>> x = 7
```

```
>>> x
```

```
7
```

```
>>> x+7
```

```
14
```

```
>>> x = 'hello'
```

```
>>> x
```

```
'hello'
```

```
>>>
```



print

- `print` : Produces text output on the console.

- **Syntax:**

```
print "Message"
```

```
print Expression
```

- Prints the given text message or expression value on the console, and moves the cursor down to the next line.

```
print Item1, Item2, ..., ItemN
```

- Prints several messages and/or expressions on the same line.

- **Examples:**

```
print "Hello, world!"
```

```
age = 45
```

```
print "You have", 65 - age, "years until retirement"
```

Output:

```
Hello, world!
```

```
You have 20 years until retirement
```

Example: print Statement

- Elements separated by commas print with a space between them
- A comma at the end of the statement (`print 'hello',`) will not print a newline character

```
>>> print 'hello'
```

```
hello
```

```
>>> print 'hello', 'there'
```

```
hello there
```



input

- `input` : Reads a number from user input.
 - You can assign (store) the result of `input` into a variable.
 - Example:

```
age = input("How old are you? ")
print "Your age is", age
print "You have", 65 - age, "years until retirement"
```

Output:

```
How old are you? 53
Your age is 53
You have 12 years until retirement
```
- **Exercise:** Write a Python program that prompts the user for his/her amount of money, then reports how many Nintendo Wiis the person can afford, and how much more money he/she will need to afford an additional Wii.



Input: Example

```
print "What's your name?"  
name = raw_input("> ")  
  
print "What year were you born?"  
birthyear = int(raw_input("> "))  
  
print "Hi ", name, "! ", "You are ", 2016 - birthyear
```

```
% python input.py  
What's your name?  
> Michael  
What year were you born?  
> 1980  
Hi Michael! You are 31
```