Programming for Business Computing

Computers and Conditionals

Ling-Chieh Kung

Department of Information Management
National Taiwan University

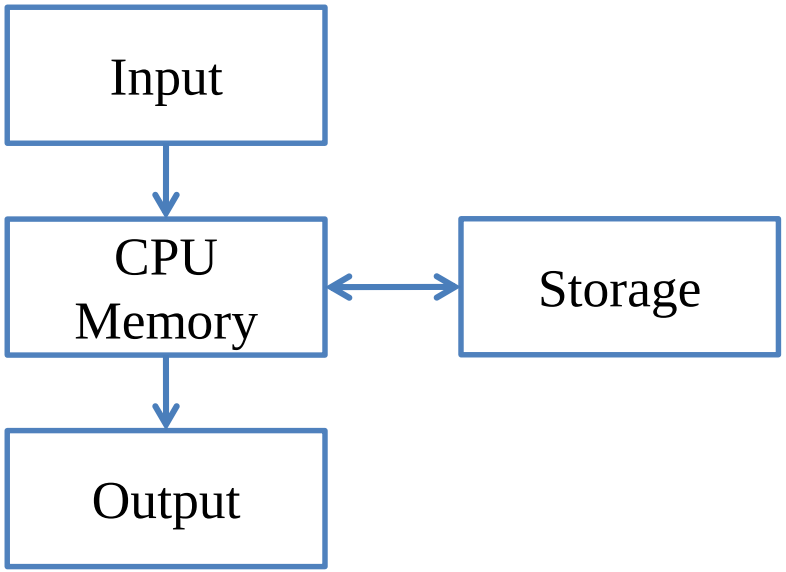
Using Notepad++ to run Python directly

- We may use Notepad++ (or many other editor) to run Python directly.
- To do so:
  - Select “Run” → “Run…”
  - Enter “cmd /k python "$(FULL_CURRENT_PATH)" & PAUSE & EXIT”
  - Select “Save…” and choose a hotkey combination you like.

Outline

Computers

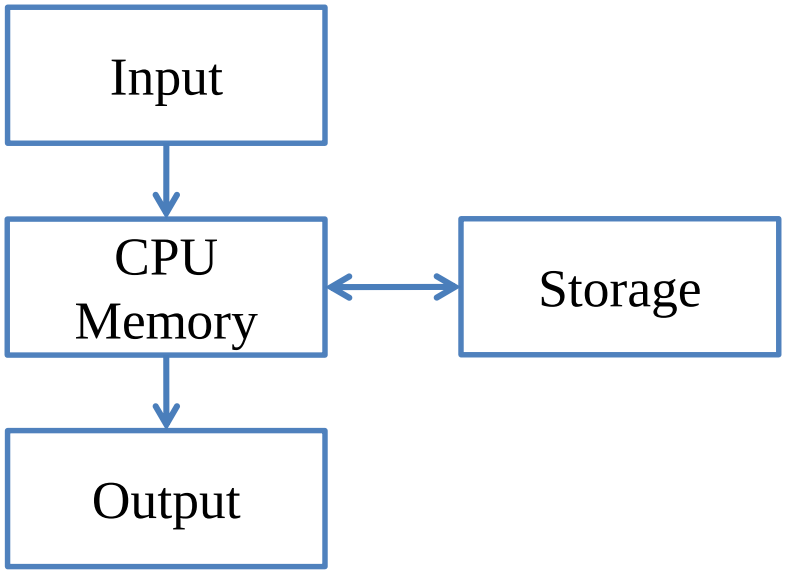
- In a modern computer:
- "**Input**" includes keyboards, mice, touch screens, microphones, etc.
- "**Output**" include screens, speakers, printers, etc.
- "**Storage**" means non-volatile storage, such as hard discs, CDs, DVDs, flash drives, etc.



- "**CPU & Memory**":
  - "CPU" (central processing unit) is where arithmetic operations are done.
  - "Memory" is a volatile storage space.

Programs

- A **program** is a file containing source codes.
  - It is stored in "storage".
- When we execute/run a program:
  - We create **variables** in "memory" to store **values**.
  - We move values into "CPU" for **arithmetic operations**, and then move the results back to "memory".
- We may do more:
  - We (probably) **read** from "input" and **write** to "output".
  - We (probably) **read** from "storage" and **write** to "storage".

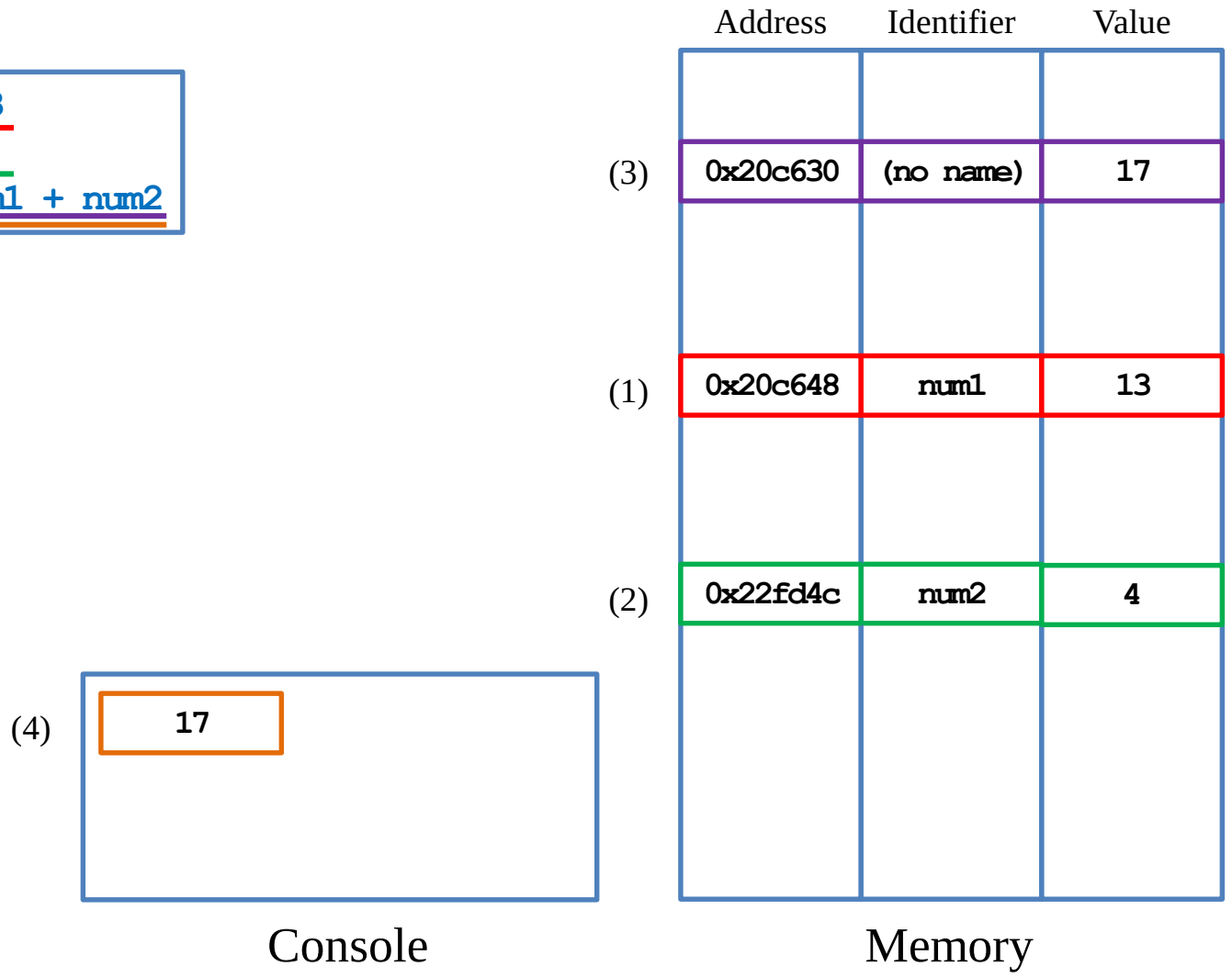


Variables and values

- When we declare a **variable**, the operating system (OS) allocates a space in memory for that variable.
  - Later **values** can be stored there.
  - That value can be read, written, and overwritten.
- The OS records four things for each variable:
  - Address.
  - Name (also called “identifier”).
  - Value.
  - Type.

When we execute this program

```
num1 = 13
num2 = 4
print num1 + num2
```



Types

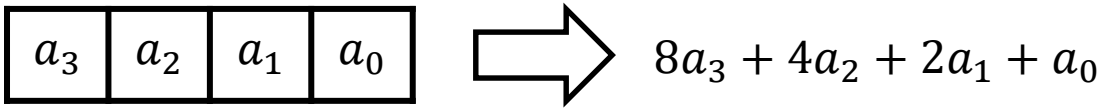
- A variable's type is **automatically** determined by Python according to the type of the initial value.
  - In some other programming languages, the programmer must determine it.
  - E.g.,

```
num1 = 13
num2 = 4.13
str1 = "52"
```

    makes **`num1`** an **integer**, **`num2`** a **floating-point number**, and **`str1`** a **string**.
- These are the most important three types at this moment:
  - An integer is an integer.
  - A string is a sequence of characters.
  - What is a floating-point number?

Integers

- A computer stores values in a **binary system**.
- A binary number $a_3a_2a_1a_0$, where $a_i \in \{0, 1\}$ for all i, equals the decimal number $8a_3 + 4a_2 + 2a_1 + a_0$.

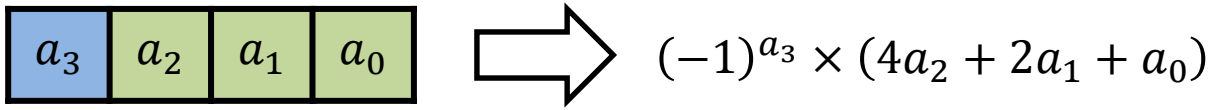


  - See the table at the right for a typical mapping.
  - With four **bits**, a binary variable may store 16 values.
- Today common lengths of an integer are 16 bits, 32 bits, 64 bits, 96 bits, 128 bits, etc.
  - 1 byte = 8 bits.
- In general, with n bits, a binary number $a_{n-1}a_{n-2}\cdots a_1a_0$ equals the decimal number $\sum_{i=0}^{n-1} 2^i a_i$.

Decimal value	Binary value
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
…	…
15	1111

Signed integers

- Integers may be positive, zero, or negative.
- To represent negative numbers, we use **the first bit** to denote the **sign**.
- A binary number $a_3a_2a_1a_0$ equals the decimal number $(-1)^{a_3} \times (4a_2 + 2a_1 + a_0)$ in one mapping system.



Decimal value	Binary value
0	0000
1	0001
2	0010
3	0011
…	…
–5	1101
–6	1110
–7	1111

Integers in Python

- Integers in Python are by default signed.
  - They can represent negative values.
- To create an integer with an **initial value**, simply do it:

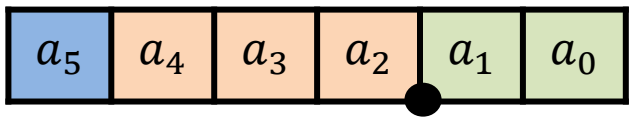
```
i = 52
print i
print type(i)
```

  - The function **`type()`** returns the type of a given variable.
- To create an integer without an initial value, use the function **`int()`**.

```
i = int()
print i
print type(i)
```

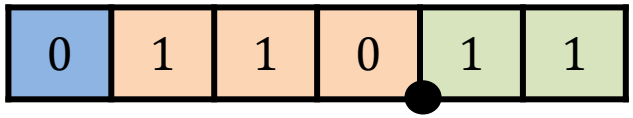
Floating-point numbers

- To represent **fractional numbers**, most computers use **floating-point numbers**.
- The rough idea is:



$$(-1)^{a_5} \times (2a_1 + a_0) \times 2^{(-1)^{a_4} \times (2a_3 + a_2)}$$

- For example,



$$3 \times 2^{-2} = -0.75$$

- Moreover, the "binary point" may "float" to make the mapping flexible.
  - To represent more values or increase precision.
  - This is why a fractional number is called a floating-point number.
- The true standard for floating-point numbers is (a little bit) more complicated.

Floating-point numbers in Python

- A floating-point number (or simply "a float") in Python are by default signed.
- To create a float with an initial value, simply do it:

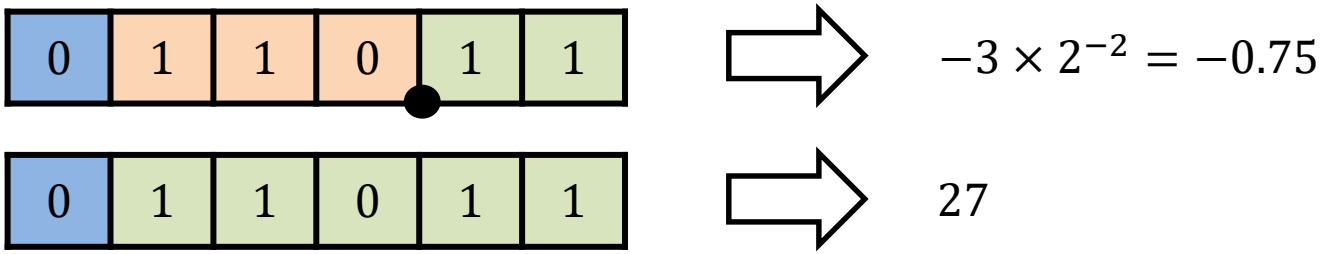
```
i = 52.0
print i
print type(i)
```

- To create a float without an initial value, use the function `float()`.

```
i = float()
print i
print type(i)
```

Memory allocation

- When we declare a variable, its type matters.
  - The OS understands its value based on its type.
  - An integer and a floating-point number represent **different values** even if they store the same sequence of bits.



- This is why each variable needs to have a **type**.

Characters

- A computer cannot store **characters** directly.
- It represents characters by encoding each character into an integer.
- In most PCs, we use the **ASCII code**.
  - ASCII = American Standard Code for Information Interchange.
  - It uses **one byte** (–128 to 127) to represent English letters, numbers, symbols, and special characters (e.g, the newline character).
  - E.g., “0” is 48, “A” is 65, “a” is 97, etc.
  - It does not represent, e.g, Chinese characters.

Characters

- Try this:

```
c = 52
cAsChr = chr(c)
print cAsChr
```

  - An integer **`c`** is created and assigned 52. .
  - The corresponding character “4” in the ASCII table is printed out.
  - **`c`** is an integer (**`int`**), but **`cAsChr`** is a character (**`chr`**).

Characters/strings in Python

- To create a character with an initial value, simply do it:

```
c = "52"
print c
print type(c)
```

  - Note that the type is "str", which means a string.
- A **string** is a sequence of characters.
- In fact, even a single character is considered a string (of length 1) in Python.

```
c = "1"
print c
print type(c)
```

String operations in Python

- The function **`len()`** returns the **length** (i.e., number of characters) of a string.

```
s = "52"
print s
print len(s)
```

- Strings are **concatenated** by the string concatenation operator (**+**).

```
s1 = "52"
s2 = " is good"
s = s1 + s2
print s
print len(s)
print s2 + s1
print len(s2 + s1)
```

Non-English characters and symbols

- To represent Chinese (and other non-English) characters, we need other encoding standards.
  - Common standards include UTF-8, Big-5, etc.
- Special symbols (like 「, 、, ～, etc.) also need to be encoded.
  - English characters and symbols are all **halfwidth**.
  - All **fullwidth** symbols are non-English symbols.
- In this course, we will try to play with English characters and symbols only.

Outline

- Basics of computers
- **Casting, `raw_input`, `print`, and division**
- Conditionals: the first example
- Formatting a program

Casting

- We may convert a value from one type to another type.
  - Type conversion is called **casting**.
- To cast a float or a string to an integer, use **`int()`**.

```
f = 52.0
i = int(f)
print f
print i
print type(f)
print type(i)
```

```
s = "52"
i = int(s)
print s
print i
print type(s)
print type(i)
```

- What will happen if we try to cast 52.6 or “52 is great” to an integer?

Casting

- To cast an integer or a string to an float, use **`float()`**.

```
i = 52
f = float(i)
print i
print f
print type(i)
print type(f)
```

```
s = "52"
f = float(s)
print s
print f
print type(s)
print type(f)
```

- Casting an integer to a float creates no error.
- What will happen if we try to cast “52 is great” to a float?

Casting

- To cast an integer or a float to a string, use **`str()`**.

```
i = 52
s = str(i)
print i
print s
print type(i)
print type(s)
print len(s)
```

```
f = 52.0
s = str(f)
print f
print s
print type(f)
print type(s)
print len(s)
```

  - **`len()`** returns the **length** (i.e., number of characters) of a string.

More about raw_input

- The operator **raw_input** reads a user input from the keyboard (typically).
- Whatever the user types, **raw_input** read it as a string.
  - Sometimes we need to cast the input by ourselves.
- What is the difference between these two programs?

```
num1 = int(raw_input())
num2 = int(raw_input())
print num1 + num2
```

```
num1 = raw_input()
num2 = raw_input()
print num1 + num2
```

  - Strings are **concatenated** by the string concatenation operator (**+**).

More about raw_input

- One may include a **prompt** (as a message to the user) in **raw_input**.

```
num1 = int(raw_input("Input the first number: "))
num2 = int(raw_input("Input the second number: "))
print num1 + num2
```

- When you submit your homework, **remove** those prompts!

More about `print`

- The operator **`print`** prints whatever behind it.
  - Those things are actually converted to strings before being printed.
- As strings can be **concatenated**, we may put multiple pieces of variables/values (sometimes called "tokens") behind a **`print`** to print all of them.
  - To do the separation, use the comma operator (`,`).
- As an example:

```
num1 = int(raw_input())
num2 = int(raw_input())
print "the sum is", num1 + num2
```

  - There are two items in this print operation.
  - The second item **`num1 + num2`** is first **cast to a string**.
  - The two strings are then concatenated to form a string to be printed out.

More about print

- Note that there is a **white space** between "s" and the sum.

```
num1 = int(raw_input())
num2 = int(raw_input())
print "the sum is", num1 + num2
```

  - Python **automatically** insert a white space between two neighboring items.
- Sometimes it is bad:

```
income = int(raw_input())
print "My income is $", income
```

- How to remove the space between the dollar sign and **income**?

More about `print`

- There are many ways in Python to remove the white spaces.
- The easiest way (though may not be the best way) is to **concatenate** those items into a string **manually** (using **+**).

```
income = int(raw_input())
print "My income is $" + str(income)
```

  - We need to first **cast** **`income`** (or any other non-string items) **into a string** by **`str()`** to avoid a run-time error.

More about print

- As another example, to print out two input numbers as a vector, we may:

```
num1 = int(raw_input())
num2 = int(raw_input())
print "the vector is (", num1, ",", num2, ")"
```

- To remove the three bad white spaces, we may:

```
num1 = int(raw_input())
num2 = int(raw_input())
print "the vector is (" + str(num1) + ",", str(num2) + ")"
```

or (which one is better?)

```
num1 = int(raw_input())
num2 = int(raw_input())
print "the vector is (" + str(num1) + ", " + str(num2) + ")"
```

More about division

- Recall the program we wrote last time:

```
num1 = 13
num2 = 4

print num1 - num2
print num1 * num2
print num1 / num2
print num1 % num2
print num1 ** num2
```

- Two questions:
  - Why that **division** results in 3?
  - How to obtain 3.25?

More about division

- The division operator (in Python 2) is implemented to **behave differently** according to the **types of operands**.
  - When both the numerator and denominator are integers, it truncates the fractional part of the ratio and returns only the integer part.
  - When one of the two operands is a float, it does not truncate anything.
- Which one works?

```
num1 = 13
num2 = 4

print float(num1) / num2
```

```
num1 = 13
num2 = 4

print float(num1 / num2)
```

- In Python 3, it never does the automatic truncation.

Outline

- Basics of computers
- Casting, **`raw_input`**, **`print`**, and division
- **Conditionals: the first example**
- Formatting a program

Conditionals

- So far all our programs execute statements line by line.
- In practice, we may **select** what to do (or what to skip) upon some **conditions**.
- To do the selection, we use **conditionals**.
- In Python, we use **`if`**, **`else`**, and **`elif`**.

The first example

- The income tax rate often varies according to the level of income.
  - E.g., 2% for income below $10000 but 8% for the part above $10000.
- How to write a program to calculate the amount of income tax based on an input amount of income?

```
print "Please enter your income:"
income = float(raw_input())

if income <= 10000:
  tax = 0.02 * income
if income > 10000:
  tax = 0.08 * (income - 10000) + 200

print "Tax amount: $" + str(tax)
```

The first example

- We use the **if** statement to control the sequence of executions.

```
if condition:
  statements
```

  - If ***condition*** is **true**, do ***statements*** sequentially.
  - Otherwise, skip those ***statements***.

– The ***statements*** are said to be inside **the if block**.

```
print "Please enter your income:"
income = float(raw_input())

if income <= 10000:
  tax = 0.02 * income
if income > 10000:
  tax = 0.08 * (income - 10000) + 200

print "Tax amount: $" + str(tax)
```

The `if` statement

- The **colon** (`:`) is required.

```
a = 0
if a < 1
  print "a < 1"
```

- There can be multiple statements inside an **`if`** block.
- Statements inside an **`if`** block must all have **one level of indention**.

```
a = 0
if a < 1:
  print "a < 1"
  print "great!"
```

- Statements with no indention are considered outside the if block.

```
a = 0
if a < 1:
  print "a < 1"
print "great!"
```

Indention

- Statements inside an **`if`** block must all have **one level of indention**.
- There is **no indention-size restriction**; all we need is to make it **consistent** for all statements inside the same block.
- Which are good and which are bad?

```
a = 0
if a < 1:
 print "a < 1"
 print "great!"
```

```
a = 0
if a < 1:
    print "a < 1"
    print "great!"
```

```
a = 0
if a < 1:
    print "a < 1"
  print "great!"
```

```
a = 0
if a < 1:
 print "a < 1"
  print "great!"
```

The `if-else` statement

- In many cases, we hope that conditional on whether the condition is true or false, we do different sets of statements.
- This is done with the **`if-else`** statement.
  - Do ***`statements 1`*** if ***`condition`*** returns **`true`**.
  - Do ***`statements 2`*** if ***`condition`*** returns **`false`**.
- An **`else`** must have an associated **`if`**.

```
if condition:
   statements 1
else:
   statements 2
```

The `if-else` statement

- The previous example may be improved with the **`else`** statement:

```
income = float(0)
tax = float(0)

print "Please enter your income:"
income = float(raw_input())

if income <= 10000:
  tax = 0.02 * income
if income > 10000:
  tax = 0.08 * (income - 10000) + 200

print "Tax amount: $" + str(tax)
```

```
income = float(0)
tax = float(0)

print "Please enter your income:"
income = float(raw_input())

if income <= 10000:
  tax = 0.02 * income
else:
  tax = 0.08 * (income - 10000) + 200

print "Tax amount: $" + str(tax)
```

The `if-else` statement

- Is this right or wrong?

```
income = float(0)
tax = float(0)

print "Please enter your income:"
income = float(raw_input())

if income <= 10000:
  tax = 0.02 * income
  else:
    tax = 0.08 * (income - 10000) + 200

print "Tax amount: $" + str(tax)
```

The comparison operators

- We may use the following comparison operators:
  - **>**: bigger than
  - **<**: smaller than
  - **>=**: not smaller than
  - **<=**: not bigger than
  - **==**: equals
  - **!=**: not equals
- Note that “equals” is **==**, not **=**!

Outline

- Basics of computers
- Casting, **`raw_input`**, **`print`**, and division
- Conditionals: the first example
- **Formatting a program**

Formatting a program

- Maintaining the program in a good **format** is very helpful.
- While each programmer may have her own programming style, there are some general guidelines for Python.
  - Add proper white spaces and empty lines.
  - Give variables understandable names.
  - Write comments.

Write spaces and empty lines

- Some suggestions about white spaces and empty lines are useful.
  - Add **two white spaces** around a binary operator.
  - Add a white space after each comma.
  - Use **empty lines** to separate groups of codes.
- Which one do you prefer?

```
print "Please enter one number:"
num1 = int(raw_input())
print "Please enter another number:"
num2 = int(raw_input())

print "The sum is", num1 + num2
```

```
print"Please enter one number:"
num1 =int(raw_input())
print "Please enter another number:"
num2= int(raw_input())
print"The sum is",num1 + num2
```

Variable declaration

- When declare variables:
  - Give variables **understandable names**.
- Which one do you prefer?

```
dice1 = int(raw_input())
dice2 = int(raw_input())

sum = dice1 + dice2

print sum
```

```
a = int(raw_input())
b = int(raw_input())

c = a + b

print c
```

Comments

- **Comments** are programmers' **notes** and will be ignored by the compiler.
- In Python, there are two ways of writing comments:
  - A single line comment: Everything following a **#** in the same line are treated as comments.
  - A block comment: Everything within a pair of """ (may across multiple lines) are treated as comments.

```
"""
Ling-Chieh Kung's work
for the first lecture
"""

print "Hello World! \n" # the program terminates correctly
```

- Hotkeys are very helpful. Use them!