CS101: Intro to Computing
Spring 2016

Lecture 3
Administrivia

• i>clicker attendance starts **Monday**
  – Make sure you’ve registered on Compass!
• Homework 1 is due **Friday**
  – I removed some questions
• Homework 2 will be assigned **Monday**
  – Due Friday (shorter time!)
REVIEW
\[ x=10 \]
\[ y=x+1 \]
\[ y=x*y \]

What is the value of \( y \)?

a) 11
b) 100
c) 110
d) None of the above.
$x=10$

$y=x+1$

$y=x*y$

What do we call $x$?

a) a literal
b) a variable
c) an expression
d) a statement
What do we call 10?

a) a literal
b) a variable
c) an expression
d) a statement
What do we call $y=x*y$?

a) a literal
b) a variable
c) an expression
d) a statement
DATA TYPES
Processor

x = 3 * 5

Memory

x 15

3 * 5

15
Encoding

01001000010001010100110001001111

• What does this binary data represent?
• How does the processor know?
• Unless we know the encoding we cannot interpret the data.
Types

- *Types* define the encoding in Python
- All values in Python have a *type*
- Defines how data is represented in memory
- Defines the operations that are allowed and how they work
NUMERIC TYPES
Encoding Numbers

• Numeric types are represented in binary
  – Fixed-length (only a certain number of bytes)
    1: 0001  2: 0010  3: 0011  4: 0100
    5: 0101  6: 0110  7: 0111  8: 1000
    … 15: 1111
• If we add more, this causes an overflow
  – We’ve run out of bits!
• Negative numbers? Add a sign bit
Integers

- So far, this has been our only type
- Represent integers
  - Positive and negative whole numbers
- Literals are just integers (e.g. -128)
- Cannot represent all integers
  - Python scales integer sizes
  - Only integers that fit in memory
  - Bigger integers = SLOWER program
Integer operations

• Evaluating an expression of integers will generally result in an integer answer
  – $3 + 5$

• EXCEPTION: DIVISION!
  – $3/4 = .75$

• Integer division operator
  – $3\,\div\,4 = 0$
    – Floor of division
Floats

- Referenced in the homework.
- Represent real numbers
  - Anything with a decimal point
- Literals have a decimal point (e.g. 3.0)
- Cannot represent all reals
  - Some are too large/small
  - Can not represent arbitrary precision (e.g. π)
Floating point operations

• Evaluating an expression of floats will result in a floating point answer
• Engineers and scientists will need to be careful about precision of operations
Floats with Integers

- We can use floats and integers in the same expressions.
- The resulting value is a *floating point*.
- Operations default to most general numeric type
Complexes

• Represent numbers on complex plane
  – Numbers with an imaginary component
• Imaginary component referred to with j
  • e.g. 2+1.3j
• They’re “jimaginary” numbers!
x=4
y=3+1j
z=33.3333
print(x+y+z)

What is printed?

a) 40
b) 40.3333
c) 40.3333+1j
d) None of the above
Attribute operator

• “Reaches in” to a value to access part of its data (called an attribute)
• Extracts special variables stored “inside” the type.

```python
print(x.real)
print(x.imag)
```
• Both of these components are floats.
\[ x = (3.5 + 1j) \]
\[ y = 1 \]
\[ z = x + y \]

What is the value of \( z.\text{imag} \)?

a) 4.5 + 1j
b) 4.5
c) 1.0j
d) 1.0
STRING TYPE
Encoding Text

• Each *symbol* is stored individually.
  – Each symbol is one byte long
  – Represented by ASCII code

01001000 01000101 01001100
01001100 01001111

72       69       76

76       79
### ASCII Table

<table>
<thead>
<tr>
<th>Code</th>
<th>ASCII</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x05</td>
<td>5</td>
<td>ENQ Enquiry</td>
</tr>
<tr>
<td>0x06</td>
<td>6</td>
<td>ACK Acknowledge</td>
</tr>
<tr>
<td>0x07</td>
<td>7</td>
<td>BELL Bell</td>
</tr>
<tr>
<td>0x08</td>
<td>8</td>
<td>BS Backspace</td>
</tr>
<tr>
<td>0x09</td>
<td>9</td>
<td>TAB Horizontal tab</td>
</tr>
<tr>
<td>0x0A</td>
<td>10</td>
<td>LF New line</td>
</tr>
<tr>
<td>0x0B</td>
<td>11</td>
<td>VT Vertical tab</td>
</tr>
<tr>
<td>0x0C</td>
<td>12</td>
<td>FF Form Feed</td>
</tr>
<tr>
<td>0x0D</td>
<td>13</td>
<td>CR Carriage return</td>
</tr>
<tr>
<td>0x0E</td>
<td>14</td>
<td>SO Shift out</td>
</tr>
<tr>
<td>0x0F</td>
<td>15</td>
<td>SI Shift in</td>
</tr>
<tr>
<td>0x10</td>
<td>16</td>
<td>DLE Data link escape</td>
</tr>
<tr>
<td>0x11</td>
<td>17</td>
<td>DC1 Device control 1</td>
</tr>
<tr>
<td>0x12</td>
<td>18</td>
<td>DC2 Device control 2</td>
</tr>
<tr>
<td>0x13</td>
<td>19</td>
<td>DC3 Device control 3</td>
</tr>
<tr>
<td>0x14</td>
<td>20</td>
<td>DC4 Device control 4</td>
</tr>
<tr>
<td>0x15</td>
<td>21</td>
<td>NAK Negative ack</td>
</tr>
<tr>
<td>0x16</td>
<td>22</td>
<td>SYN Synchronous idle</td>
</tr>
<tr>
<td>0x17</td>
<td>23</td>
<td>ETB End transmission block</td>
</tr>
<tr>
<td>0x18</td>
<td>24</td>
<td>CAN Cancel</td>
</tr>
<tr>
<td>0x19</td>
<td>25</td>
<td>EM End of medium</td>
</tr>
</tbody>
</table>
Strings

- Literals: text surrounded by quotes
  - e.g. “TACO”
- Each symbol is called a **character**
- Unlike numeric types, strings can vary in length!
String operations

• **Concatenation**: combine two strings
  – Uses the + symbol
  – Example: “CS” + ”101”

• **Repetition**: repeat a string
  – Uses the * symbol
  – Example: “HELLO!” *10

• **Formatting**: used to encode other data as a string
  – Uses % symbol
Formatting operator

• Creates a string with a value stuck inside
  – Formatting them nicely
  – Have to indicate the **type** of the value INSIDE
    the string with a special code

```
x=100 * 54
s="String is: %i" % x
print s
```
Example

name="Ryan"
grade=2/3
m1="Hello, %s!" % name
m2="Your grade is: %f" % grade
print m1
print m2
x=3
s=("%i" % (x+1))*x**(5%x)
print(s)

What is the output of this program?
a) 3333333333333333
b) 44444444444
b) 9999
b) %i%i%i%i%i
Indexing operator

• Extracts a *single* character
• Use an integer surrounded by brackets
  – e.g. a[0]
  – Call integer the “index”

**WARNING**: We start counting from 0

• Can use negative numbers
  – Starts from end (e.g. -1 is the last character)
s="ABCDE"
i=3
x=s[i]

What is the value of x?

a) A  
b) B  
c) C  
d) D  
e) E
s="ABCDE"
i=25%3
x=s[i]
What is the value of x?
a) A  
b) B  
c) C  
d) D  
e) E
s="ABCDE"
i=(11\%3)−7
x=s[i]

What is the value of x?

a) A
b) B
c) C
d) D
e) E