Java for Python Programmers

• Comparison of Python and Java Constructs
• Reading: L&C, App B
General Formatting

• Shebang
  #!/usr/bin/env python

• Comments
  # comments for human readers - not code
  statement # comments to end of line

  """ start of multiple lines of comments
  end of multiple lines of comments """

• Program Statements
  name = expression

• Blocks (Indenting)
  (maybe indented) a statement ending with :
  (indented to next level) starting statement
  (indented to same level) . . .
  (indented to same level) ending statement
  (indented to original or fewer levels)

• Shebang
  Never used or required in Java source code

• Comments
  // comments for human readers – not code
  statement; // comments to end line

  /* start of multiple lines of comments
  end of multiple lines of comments */

• Program Statements
  (type) name = expression; // must end with ;

• Blocks (Curly Braces)
  {
    starting statement;
    . . .
    ending statement;
  } // indenting is used only for readability!!
Key Words / Reserved Words

• Python Key Words

and  del  from  not  while
as  elif  global  or  with
assert  else  if  pass  yield
break  except  import  print
class  exec  in  raise
continue  finally  is  return
def  for  lambda  try

Notes:
Words in green are not reserved in Java and can be used as identifiers, etc.

There are also some type and constant names:
int, float, True, False, None, etc.
that correspond to reserved words in Java maybe with different spelling or capitalization:
int, float, true, false, null, etc.

• Java Reserved Words

abstract  default  goto*  package  this
assert  do  if  private  throw
boolean  double  implements  protected  throws
break  else  import  public  transient
byte  enum  instanceof  return  true
case  extends  int  short  try
catch  false  interface  static  void
char  final  long  strictfp  volatile
class  finally  native  super  while
cost*  float  new  switch
continue  for  null  synchronized

* Are reserved words, but are not used.

Notes:
Words in black have generally the same semantics in Java as they do in Python.
If you have been using any of the red words in Python, you will need to avoid using them in Java.
## Primitive Data Types

### Numeric Data Types
- **int**  
  Natural Numbers (Integers)
- **long**  
  Large Natural Numbers
- **float**  
  Real Numbers (Decimal)
- **complex**  
  Complex Numbers \((R + I \times j)\)

### Other Data Types
- **boolean**  
  Logical “True” or “False” values
- **class**  
  Any defined class as a type
- **string**  
  An array of characters

### Numeric Data Types
- **byte**  
  8 Bit Numbers
- **char**  
  16 Bit Unicode Characters
- **short**  
  16 Bit Numbers
- **int**  
  32 Bit Numbers
- **long**  
  64 Bit Numbers
- **float**  
  Real Numbers (Decimal)
- **double**  
  Larger/Smaller Real Numbers

### Other Data Types
- **boolean**  
  Logical “true” or “false” values
- **Class**  
  Any defined class as a type
- **String**  
  A somewhat special class
- **Interface**  
  Any defined interface as a type
Primitive Data Constants

- **Type int / long**
  - Decimal: 123  \(\# 123_{10}\)
  - Octal: 0123  \(\# 83_{10}\)
  - Hex: 0x123  \(\# 291_{10}\)
  - Binary: 0b101  \(\# 5_{10}\)
  - long: 1234567890123456789L

- **Type int / long**
  - Decimal: 123  \(\# 123_{10}\)
  - Octal: 0123  \(\# 83_{10}\)
  - Hex: 0x123  \(\# 291_{10}\)
  - Binary: 0b101  \(\# 5_{10}\)
  - long: 1234567890123456789L
  
  Note: In Java, long has a smaller maximum number of digits than in Python

- **Type float**
  - float: 123.0  \(\# 123.0\)
  - float: 1.23e308  // 1.23 \(x\) 10^{308}
  - float: 1.23e-308  // 1.23 \(x\) 10^{-308}

- **Type float / double**
  - float: 123.0f  // 123.0
  - float: 1.23e38f  // 1.23 \(x\) 10^{38}
  - float: 1.23e-38f  // 1.23 \(x\) 10^{-38}
  - double: 1.23e308  // 1.23 \(x\) 10^{308}
  - double: 1.23e-308  // 1.23 \(x\) 10^{-308}

  Note: Type double is default for real in Java

Conversion needed to get desired type:
- \(i = \text{int}(123.4)\)  \(\# i = 123\)
- \(f = \text{float}(i)\)  \(\# f = 123.0\)

Casting needed for narrowing conversions:
- float \(f = (\text{float}) 123.4;\)  // double to float
- int \(i = (\text{int}) f;\)  // float to int 123
Variables

• Declarations
All variables are “reference” types
Variables do not need to be declared.
A variable is created by initializing it and its type is determined by the type of the value assigned:
\[ i = 10 \]  # i is an int
Its type can be changed later:
\[ i = 10.5 \]  # i is a float now
A variable can be deleted (undefined):
\[ \text{del } i \]
Using i in an expression is invalid now unless it is initialized again.

• Declarations
There are primitive and reference variables.
All variables must be declared before use.
A variable is created by declaring it with its data type and optionally initializing it.
A primitive variable is of a built in data type
\[ \text{int } i = 10; \]  // i is an int
Its type can not be changed later:
\[ i = 10.5; \]  // compilation error
A reference variable is of a user defined type based on a class or is reference to an array:
\[ \text{String myString} = \text{“Hello”}; \]
\[ \text{int [ ] myNumbers} = \text{new int[10]}; \]
A variable can not be deleted (undefined).
Operators

• Arithmetic Operators
  + add, e.g. 4 + 2 is 6
  - subtract, e.g. 4 – 2 is 2
  * multiply, e.g. 4 * 2 is 8
  / divide, e.g. 4 / 2 is 2 (dividend)
  % modulo, e.g. 4 % 2 is 0 (remainder)
  ** exponentiation, e.g. 4 ** 2 is 16
  Note: ++ and -- are NOT Python operators

• Logical Operators
  and and (between boolean values)
  or or (between boolean values)
  not not (of a boolean value)
  & Bitwise and (between int values)
  | Bitwise or (between int values)
  ^ Bitwise exclusive or (between int values)
  << Bitwise Left Shift (of an int value)
  >> Bitwise Right Shift (of an int value)

• Arithmetic Operators
  + add, e.g. 4 + 2 is 6
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  ** exponentiation, e.g. 4 ** 2 is 16
  Note: ** is NOT a Java operator
  ++ pre/post increment by one
  -- pre/post decrement by one

• Logical Operators
  && and (between boolean values)
  || or (between boolean values)
  ! not (of a boolean value)
  & Bitwise and (between int values)
  | Bitwise or (between int values)
  ^ Bitwise exclusive or (between int values)
  << Bitwise Left Shift (of an int value)
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Expressions

• Operator Precedence
Same in Python and Java (Algebraic)
Override precedence with parentheses ( )

• Casting / Conversions
  Numeric Casting/Conversions
  Automatic widening type conversions,
  e.g. 1 + 3.0 results in a float 4.0
  Functions required for narrowing conversions,
  e.g. 1 + int(3.0) results in an int 4
  Non-numeric Conversions
  Need to use conversion functions,
  e.g int("string of digits") which
  raises an Error for non-digit characters

• Operator Precedence
Same in Python and Java (Algebraic)
Override precedence with parentheses ( )

• Casting / Conversions
  Numeric Casting/Conversions
  Automatic widening type conversions,
  e.g. 1 + 3.0 results in a double 4.0
  Casting required for narrowing conversions,
  e.g. 1 + (int) 3.0 results in an int 4
  Non-numeric Conversions
  Need to use wrapper class static methods,
  e.g Integer.parseInt("string of digits") which
  throws an Exception for non-digit characters
Stand-alone Functions / Methods

• Function Definition
  def function (parameters):
    statements
    return value

• Invoking a Function
  # no context of an object or class is required
  returnValue = function( . . .)
  e.g.
  length = len(myString)

  // using a function defined in the library
  returnValue = packageName.function( . . .)
  e.g.
  import math  # library package name
  c = math.sqrt(2.0)  # 1.414…

• No Equivalent in Java
  A function can only be defined as a method within the context of a class or an interface. (See Classes)

• Invoking a Method
  // the context of an object or class is required
  // instance method (non static)
  type returnValue = object.method( . . .);
  e.g.
  int length = myString.length();

  // static method (defined in a class, e.g. Math)
  type returnValue = Class.method( . . .);
  e.g.
  double root = Math.sqrt(2.0);  // 1.414…

  // Note: Math class is automatically imported
String Data Type

- **Strings**
  
  ```
  myString = "Hello World"
  myString = 'Hello World'
  myString = """Hello World""
  Note: "\n" is end of line in a string
  ```

- **String Functions**
  
  ```
  n = len(myString)    # n = 11
  c = myString[0]      # c = "H"
  s = myString[0 : 2]  # s = "He"
  s = myString.upper() # s = "HELLO"
  ```

- **String Operations**
  
  ```
  s = myString + "!"    # Concatenation
  s = myString + str(42) # HelloWorld42
  myString == "Hello World"  # True
  ```

- **String Class / char**
  
  ```
  String myString = "Hello World";
  char c = 'a';     // 'a' = char constant for letter a
  Note: '\n' is end of line in a char
  Note: "\n" is end of line in a String
  ```

- **String Methods / char**
  
  ```
  int n = myString.length();   // n = 11
  char c = myString.charAt(0); // c = 'H'
  String s = myString.substring(0, 2); // s = "He"
  s = myString.toUpperCase();   // "HELLO"
  ```

- **String Operations**
  
  ```
  s = myString + "!";          // Concatenation
  s = myString + 42;          // HelloWorld42
  myString.equals("Hello World")  // true
  ```
Multi-valued Data Types

• Lists
Python lists are a dynamic data structure. Java arrays are a FIXED data structure.

anEmptyList = [ ]        # type unspecified
myList = [“you”, “me”, “him”, “her”]
length = len(myList)       # 4
myList[0]                   # “you”

myList[3]                   # “her”
myList[0] = “thee”          # update an element

List methods in Python:
myList.sort()       # sort the elements
myList.reverse()    # reverse the elements
myNums.append(5)    # add an element
myNums.remove(3)    # remove one

• Arrays
Syntax for a Java array looks like a Python list, BUT THE SEMANTICS ARE DIFFERENT!

int [ ] anEmptyArray= new int[10];       // type int
String [ ] myList = {“you”, “me”, “him”, “her”};
int length = myList.length;              // 4
myList[0]                                  // “you”

myList[3]                                  // “her”
myList[0] = “thee”;                        // update an element

There are NO methods for a Java array
No equivalent with Java arrays
No equivalent with Java arrays
No equivalent with Java arrays.
Length of a Java array can’t be changed.
Must use Java Collections class ArrayList<T>. We will cover collection classes in CS210.
Multi-valued Data Types

• Tuples
  ```
person = ("Diana", 32, "New York")
person[0]  # "Diana"
person[1]  # 32
  ```
  ```
person[0] = "Amy"  # not allowed
person = person + person (concatenate)  # Person[3]  # "Diana" (again)
  ```

• Dictionaries
  ```
words = {}  # empty
words["Hello"] = "Bonjour"
words["Goodbye"] = "Adieu"
  ```
  ```
words["Hello"]  # "Bonjour"
words["Yes"]  # raises an Error
KeyError: "Yes"
  ```

• No Equivalent Type in Java
  A Java object can be used as a specific “tuple”.
  Define a class with the needed combo of types.
  - Attributes of the class are the items.
  - Setter and getter methods allow access - not [ ]
  BUT:
  Java can allow updating of item values.
  We can NOT concatenate objects (except String)
  (See Classes)

• No Equivalent Type in Java
  Must use a Java Collections map class
  e.g. HashMap<K,V> or TreeMap<K,V>.
  We will cover these classes in CS210.
Flow of Control Statements

- **If / Else**
  
  ```python
  if boolean expression:
      statement1 or block1
  else: # optional
      statement2 or block2
  ```

  May nest “if” or “else” inside “if” or “else”

- **Conditional Expression Evaluation**
  
  Not supported in Python

- **Conditional Boolean Operators**
  
  ```
  ==  equal
  !=  not equal
  >   greater than
  <   less than
  ```
Flow of Control Statements

- **For**
  
  ```python
  for i in range(0, 10, 1):
      statement or block using i
  ```
  
  ```python
  for item in items:
      # items is a list
      statement or block using item
  ```
  
  - **For**
    
    ```python
    for (int i = 0; i < 10; i++)
        single statement; or {block}
    ```
    
    // sometimes referred to as a “for-each” loop
    
    ```python
    for (type item : items)  // items is an array
        single statement; or {block}
    ```
    
- **While**
  
  ```python
  while boolean expression:
      statement or block for body of loop
  ```
  
  - **While**
    
    ```python
    while (boolean expression)
        single statement; or {block}
    ```
    
  - **Do . . . while**
    
    ```python
    do // always executes body once
        single statement; or {block}
    while (boolean expression);
    ```
  
  Note: Loops may be nested in Python and Java.
Input / Output

• **Input (Command Line)**

  python `script.py tokens separated by spaces`

• **Program Arguments**

  Note: No main function header is required

  ```java
classname `tokens separated by spaces`
  ```

• **Main Method Arguments**

  ```java
public static void main (String[ ] args)
{
    int n = args.length;       // n = 4
    String firstArg = args[0]; // “tokens”
    ...                        
    String lastArg = args[3];  // “spaces”

    // if first token should be an integer,
    int n = Integer.parseInt(arg[0]);

    // if last token should be a double,
    double d = Double.parseDouble(arg[3]);
}
```
Input / Output

• Typed Outputs to User
  print ("Text String")

• User Prompt/Response
  s = input("Prompt")   // token
  n = int(input("Prompt:"))  // integer
  f = float(input("Prompt:"))  // real

• Type Outputs to User
  System.out.println("Text String");

• User Prompt/Response
  import java.util.Scanner;  // at beginning of file
  Scanner keyboard = new Scanner(System.in);
  System.out.println("Prompt:");
  String s = keyboard.next();  // token
  int n = keyboard.nextInt();  // integer
  float f = keyboard.nextFloat();  // real
  double d = keyboard.nextDouble();  // double
  boolean b = keyboard.nextBoolean();  // boolean
File Input: Example

```java
import java.util.Scanner;
import java.io.*;

public class FileDisplay
{
    public static void main (String [] args)
        throws IOException
    {
        Scanner scan = new Scanner(System.in);
        System.out.println("Enter name of file to display");
        File file = new File(scan.nextLine()); // open file

        Scanner fileScan = new Scanner (file);
        while (fileScan.hasNext())
            System.out.println(fileScan.nextLine());
    }
}
```
import java.util.Scanner;
import java.io.*;

public class FileWrite
{
    public static void main (String [] args)
    throws IOException
    {
        Scanner scan = new Scanner(System.in);
        System.out.println("Enter name of file to display");
        File file = new File(scan.nextLine()); // open file

        PrintStream out = new PrintStream(file); // open file
        while (scan.hasNext()) {
            String line = scan.nextLine(); // read keyboard
            out.println(line); // write file
        }
        out.close(); // close file
    }
}
Errors / Exceptions

• Errors
Because Python code is interpreted, many syntax errors are detected only at run time.
```python
>>> while True print 'Hello World'  # no :
while True print 'Hello World'
^  
SyntaxError: invalid syntax
```

To raise an error in your code:
if something bad would happen:
  raise NameOfError("text")

To handle a run time error - not syntax error
try:
  statements that could raise an error
except NameOfError:
  statements to recover from the error
else:
  statements executed if no error raised

• Exceptions
In Java, all syntax errors are caught during compilation and before run time.

Exceptions occur during runtime only if:
1. JVM can’t execute, e.g. int divide by 0
2. Code throws an exception object

To throw an exception in your code:
if (something bad would happen)
  throw new NameOfException("text");

To handle an exception in your code:
try {
  statements that may throw an exception
} catch (NameOfException e) {
  statements to recover from the exception
} finally {
  statements to execute regardless
}