2 Multimedia Programming with Python and Pygame

2.1 Introduction to Python

2.2 Pygame:
Multimedia/Game Frameworks for Python

2.3 SDL: Background of Pygame

Literature:

G. van Rossum and F. L. Drake, Jr., An Introduction to Python - The Python Tutorial (version 3.2), Network Theory 2011

python™

- Guido van Rossum, 1991, CWI Amsterdam
- Now open source, current main versions:
  - 2.7.11 and 3.5.1
- Targeted at programming novices
- Characteristics:
  - Interpreted scripting language
  - Compiled to intermediate byte code (similar to Java)
  - Multi-paradigm language: imperative/structured, object-oriented, functional, aspect-oriented
  - Dynamic typing
  - Automatic garbage collection
- Do you really understand all these terms?

QUIZ:
How is the foot related to Python?

Images: Wikipedia

Java to Python: Imperative Example (Java)

```java
public class Main {

    public static int sequentialSearch(int q, int[] a) {
        for(int i = 0; i < a.length; i++) {
            if(a[i]==q) {
                return i;
            }
        }
        return -1;
    }

    public static void main(String[] args) {

        int[] a = {11, 22, 33, 44, 55, 66};
        System.out.println("Array a: "+a);
        System.out.println("Search for 55: "+sequentialSearch(55,a));
        System.out.println("Search for 23: "+sequentialSearch(23,a));

    }

}
```

Java to Python: Imperative Example (Python)

```
def sequentialSearch (q, a):
  for i in range(0,len(a)):
     if a[i]==q:
          return i
  return -1

a = [11, 22, 33, 44, 55, 66]
print("Array a: ", a)
print("Search for 55: ",sequentialSearch(55,a))
print("Search for 23: ",sequentialSearch(23,a))
```

QUIZ:
What are the differences to Java?

First Observations on Python

- Very compact code
- Data types are not specified
- Powerful but simple built-in list datatype

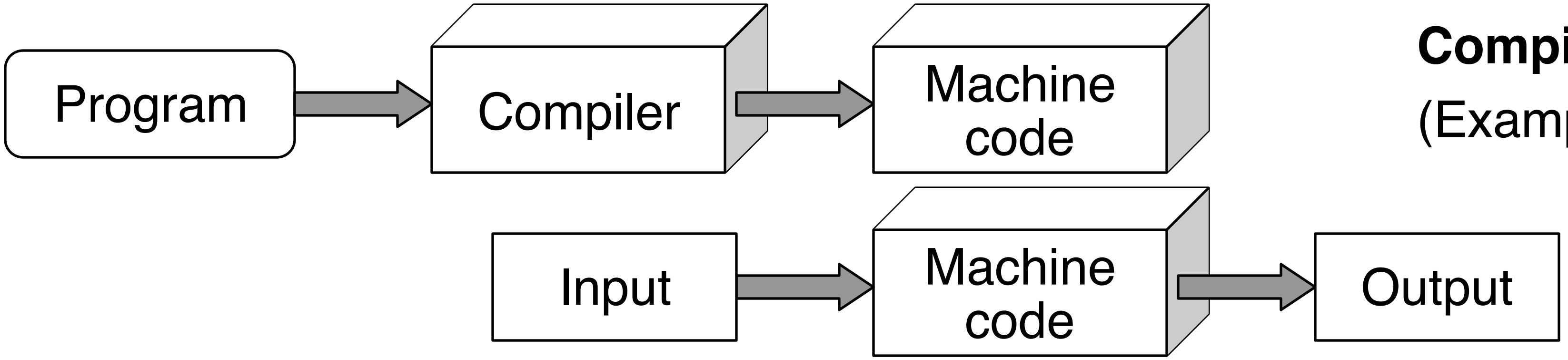
- Indentation (white space) is important for program semantics !!!
  - Block levels given by indentation
  - What is done in Java with {} brackets, is done here with indentation
- Example: A different (wrong!) algorithm:

```
def sequentialSearch (q, a):
     for i in range(0,len(a)):
          if a[i]==q:
               return i
          return -1
```

Scripting Language

- Traditionally:
  A *scripting language* is a programming language that is used to control some application software
  - Command languages for operating systems
  - Task automatization in user interfaces
  - Scripts for Web browsers, word processors, spreadsheet software, …
- Historically, considered slow in execution and limited in program size
- Modern general-purpose scripting languages
  - Have inherited many features from traditional scripting languages
  - Are considered as full application programming languages:
  - Examples: Rexx, Perl, **Python**, Ruby

Compilation, Interpretation and Others



Program

Compiler

Machine code

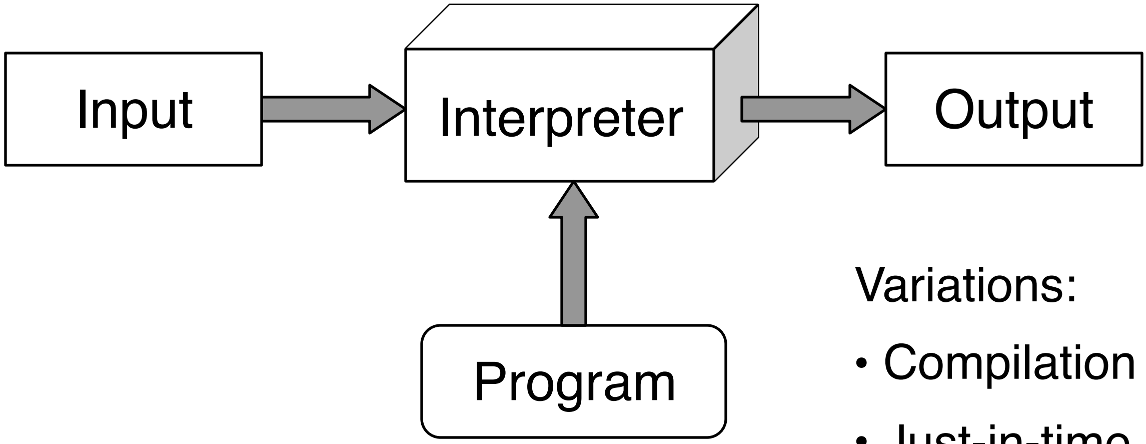
Input

Machine code

Output

Compilation

(Example: C)



Input

Interpreter

Output

Program

Interpretation

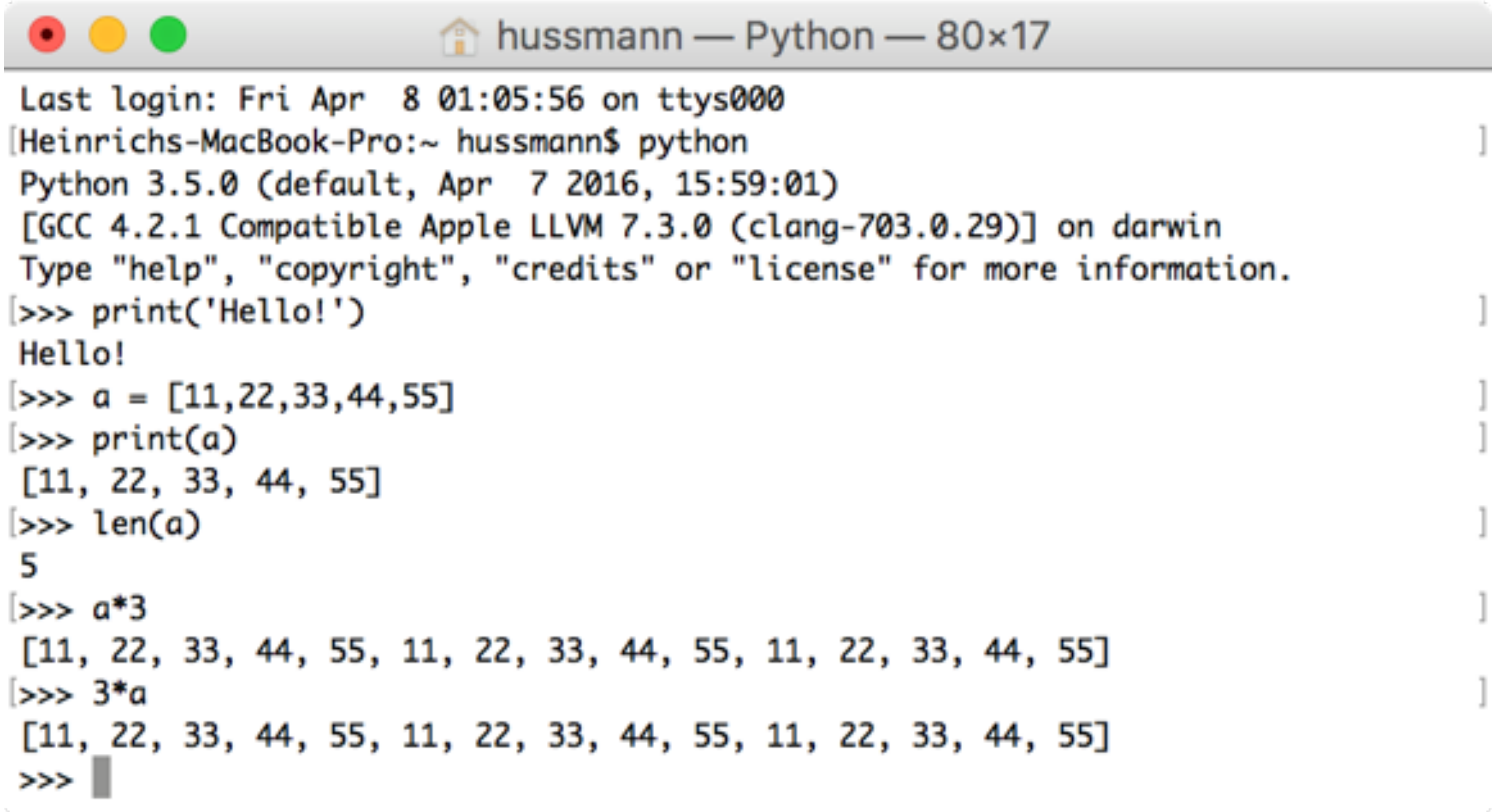
(Example: Python)

Variations:

- Compilation to intermediate code (Java)
- Just-in-time compilation
- Internal compilation to intermediate code in interpreter (Python/ CPython)

Interactive Interpreter

- Interpreted languages can easily be executed line-by-line
- Interactive execution is helpful for understanding
  - See BASIC, Logo etc.



```
Last login: Fri Apr  8 01:05:56 on ttys000
Heinrichs-MacBook-Pro:~ hussmann$ python
Python 3.5.0 (default, Apr  7 2016, 15:59:01)
[GCC 4.2.1 Compatible Apple LLVM 7.3.0 (clang-703.0.29)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print('Hello!')
Hello!
>>> a = [11,22,33,44,55]
>>> print(a)
[11, 22, 33, 44, 55]
>>> len(a)
5
>>> a*3
[11, 22, 33, 44, 55, 11, 22, 33, 44, 55, 11, 22, 33, 44, 55]
>>> 3*a
[11, 22, 33, 44, 55, 11, 22, 33, 44, 55, 11, 22, 33, 44, 55]
>>> 
```

Static and Dynamic Typing

- Type checking:
  - Simple, automatically executable form of proof for program correctness (in certain limited respects)
  - Avoids operations to be applied to unsuitable arguments
- ***Static*** typing:
  - Type information is checked **before execution** of program (at compile time)
  - Program code has to specify (explicitly or implicitly) types for all variables
  - Examples: Java, Pascal, C, Standard ML
- ***Dynamic*** typing:
  - Type information is checked **during execution** of program (at run time)
  - Type information for variables only exists after value assignment
  - Examples: Smalltalk, Python, JavaScript
- In practice, static and dynamic tying are sometimes mixed:
  - See the dynamic type check for *downcast* operations in Java!

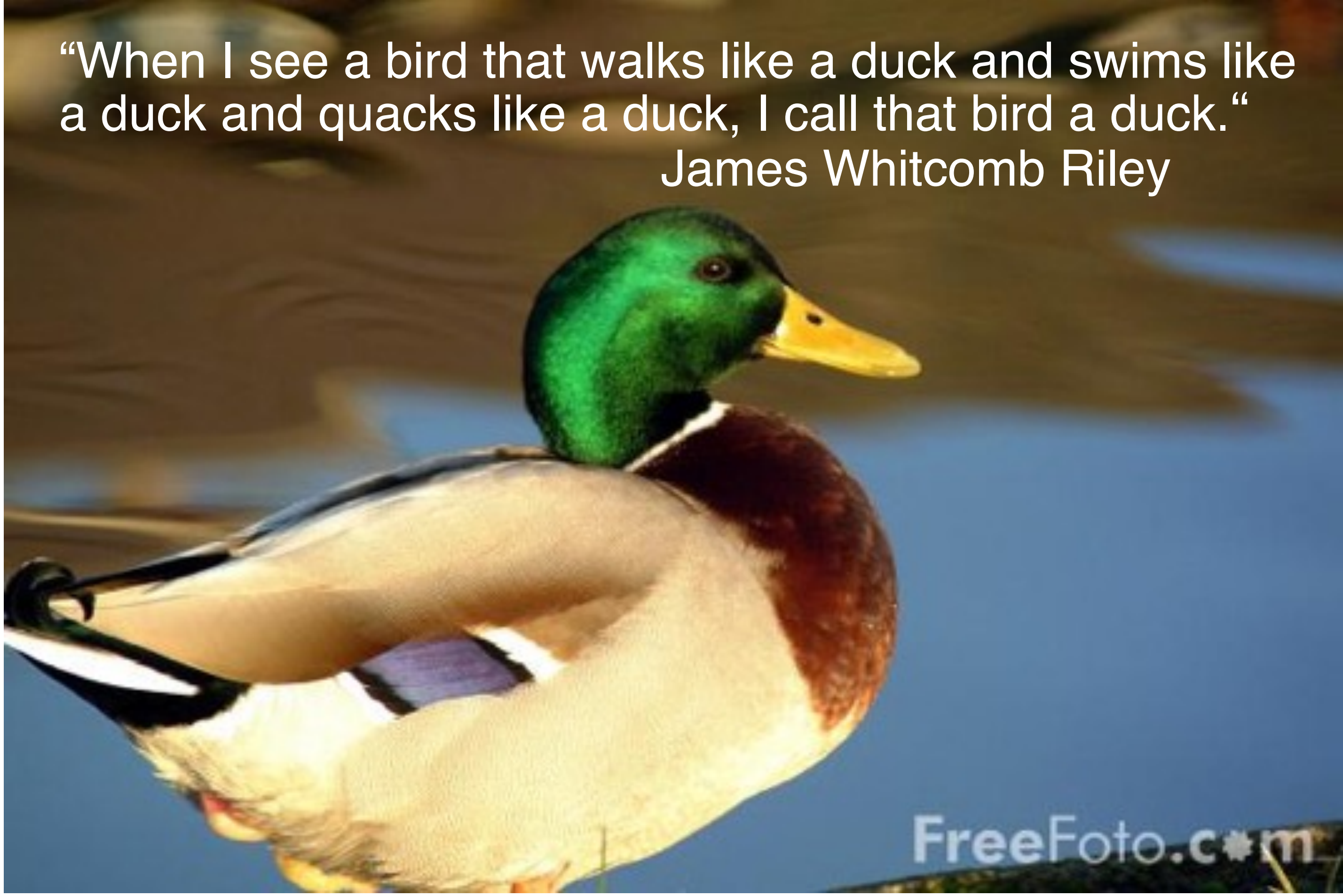
Strong and Weak Typing

- Surprisingly ill-defined terms!
  - Do not take this classification too serious!
- ***Strong*** typing:
  - Basic idea: “Strong” typing provides no (or only very limited) possibility to evade the restrictions of the type system
  - Examples of strongly typed languages:

    Java, Pascal, Standard ML, **Python**
- ***Weak*** typing:
  - Implicit type conversions
  - Type conversions with undefined result
  - Examples of weakly typed languages:

    Visual Basic, C, JavaScript

Duck Typing



“When I see a bird that walks like a duck and swims like a duck and quacks like a duck, I call that bird a duck.“
James Whitcomb Riley

- The type of an object is determined only by the fact whether it has the features required from it.
- Appropriate for object-oriented programming languages with dynamic types - like Python.

String Operations in Python

Operations valid for all sequence types:

- Indexing: ***str*[5]** (*str* is the string object)
- Negative indexing: ***str*[-5]** (counting from the end)
- Slicing: ***str*[2:5], *str*[:5], *str*[2:6:2], *str*[::-1]**
  - Omitted index is begin or end, third value is step size (covers reversion)
- Operations:

  len(*str*), min(*str*), max(*str*), x in *str*

Numerous methods specific for strings like:

- **capitalize()**
- **count(*substr*)**
- **find(*substr*)**
- **isalpha()**
- **partition(*sep*)**
- **replace**
- **split(*sep*)**
- **upper()**
- **title()**

Lists in Python

- List: Sequential collection of objects (of arbitrary, also varying type)
- Can be easily used as stack or queue data structures
- Flexible creation of lists e.g. by *list comprehension:*

  ```
  l = [3*x for x in range(1,4)]
  ```
- Lists are mutable (can be even changed through slices)
- List methods:
  - **`append`**
  - **`count`**
  - **`extend`**
  - **`index`**
  - **`insert`**
  - **`pop`**
  - **`remove`**
  - **`reverse`**
  - **`sort`**

Sets in Python

- Set: Unordered collection without duplicates
- Constructor
  - **`set`** builds a set from a list
- Basic mathematical operations for sets:
  - Union (I)
  - Intersection (&)
  - Difference (-)
  - Symmetric difference (^)
- Example:

```
set('multimedia') & set('programming')
```

Java to Python: Imperative Example (Python)

```
def sequentialSearch (q, a):
  return q in a

a = [11, 22, 33, 44, 55, 66]
print(a)
print("Array a: ", a)
print("Search for 55: ",sequentialSearch(55,a))
print("Search for 23: ",sequentialSearch(23,a))
```

Tuples and Dictionaries in Python

- Tuple: immutable collection of objects (of arbitrary type)

  ```
  N = ('max','muster')
  ```

  ```
  N = 'max','muster'
  ```

  Strange: One-element tuple written as `'max',`

- Easy unpacking of tuples:

  ```
  vorname, nachname = ('max','muster')
  ```

- Dictionary: Mutable collection of object maps (of arbitrary type)

  ```
  age = {'anna':23, 'max':22}
  ```

  – Key entries can only be of immutable type (strings, numbers, tuples)

  – Key entries must be *hashable*

  – Main purpose: indexed access `age['anna']`

- Constructor accepts lists or *generator expressions*:

  ```
  dict((x, x*x) for x in range(0,5))
  ```

Java to Python: Object-Oriented Example (Java)

```
public class Counter {

  private int k = 0;

  public void count () {
      k++;
  }

  public void reset () {
      k = 0;
  }

  public int getValue () {
      return k;
  }
}
```

Java to Python: Object-Oriented Example (Python)

```
class Counter:

    def __init__(self):
        self.k = 0
    def count(self):
        self.k += 1
    def reset(self):
        self.k = 0
    def getValue(self):
        return self.k
```

Initialization (constructor)

Instance variable k

“Self” parameter is implicit in method calls but explicitly mentioned in declaration

Constructing Objects, Invoking Methods

- Example:

```
c = Counter()
print(c.getValue())
c.count()
c.count()
c.count()
print(c.getValue())
```

Inheritance in Python

```
class LimitCounter(Counter):

    def __init__(self, limit):
        self.k = 0
        self.limit = limit
    def count(self):
        if self.k != self.limit:
            self.k += 1
```

In contrast to Java, Python allows *multiple inheritance*!

Python Modules

- Module: A file containing Python definitions and statements
  - File name is module name with suffix **`.py`**
  - Module name is available as global variable **`__name__`**
  - Statements in a module are executed when the module is imported (initialization)
- Importing a module **`m`**:

```
import m
```

  - Accessing a definition **`f()`** in **`m`**:

```
m.f()
```

```
from m import *
```

  - Accessing a definition **`f()`** in **`m`**:

```
f()
```

Why Python in This Lecture?

Python is **not** a specific multimedia language!

We will use a simple Python-binding for a multimedia/gaming framework…

Generally, knowing Python is a good thing – to get programming tasks done easily.