NLP Programming Tutorial 0 - Programming Basics

Graham Neubig
Nara Institute of Science and Technology (NAIST)
About this Tutorial

• 14 parts, starting from easier topics

• Each time:
  • During the tutorial: Learn something new
  • At home: Do a programming exercise
  • Next week: Talk about results with your neighbor

• Programming language is your choice
  • Examples will be in Python, so it is recommended
  • I can help with Python, C++, Java, Perl

• Working in pairs is encouraged
Setting Up Your Environment
Open a Terminal

• If you are on Linux or Mac
  • From the program menu select “terminal”
• If you are on Windows
  • Install cygwin
  • or use “ssh” to log in to a Linux machine
Install Software (if necessary)

- **3 types of software:**
  - **python:** the programming language
  - **a text editor** (gvim, emacs, etc.)
  - **git:** A version control system

- **Linux:**
  - `sudo apt-get install git vim-gnome python`

- **Windows:**
  - Run cygwin setup.exe, select “git”, “gvim”, and “python”
Download the Tutorial Files from Github

• Use the git “clone” command to download the code

```bash
$ git clone https://github.com/neubig/nlptutorial.git
```

• You should find this PDF in the downloaded directory

```bash
$ cd nlptutorial
$ ls download/00-intro/nlp-programming-en-00-intro.pdf
```
Using gvim

- You can use any text editor, but if you are using vim:
- If it is your first time, you may want to copy my vim settings file, which will make vim easier to use:

  ```bash
  $ cp misc/vimrc ~/.vimrc
  $ gvim test.txt
  ```

- Open vim:

  ```bash
  $ gvim test.txt
  ```

- Press “i” to start input and write “test”
- Press escape, and type “:wq” to save and quit (”:w” is save, “:q” is quit)
Using git

- You can use git to save your progress
- First, add the changed file
  
  ```
  $ git add test.txt
  ```
- And save your change
  
  ```
  $ git commit
  ```

(Enter a message like “added a test file”)

- Using git, you can do things like go back to your last commit (git reset), download the latest updates (git pull), or upload code to github (git push)
Basic Programming
Hello World!

1) Open my-program.py in an editor (gvim, emacs, gedit)

```bash
$ gvim my-program.py
```

2) Type in the following program

```python
#!/usr/bin/python3
print("Hello World!")
```

3) Make the program executable

```bash
$ chmod 755 my-program.py
```

4) Run the program

```bash
$ ./my-program.py
Hello World!
```
Main data types used

- **Strings**: “hello”, “goodbye”
- **Integers**: -1, 0, 1, 3
- **Floats**: -4.2, 0.0, 3.14

```python
my_int = 4
my_float = 2.5
my_string = "hello"

print("string: %s\nfloat: %f\ntint: %d" % (my_string, my_float, my_int))
```

```
$ ./my-program.py
string: hello float: 2.500000 int: 4
```
if/else, for

my_variable = 5

if my_variable == 4:
    print("my_variable is 4")
else:
    print("my_variable is not 4")

for i in range(1, my_variable):
    print("i == \%d\" % (i))

$ ./my-program.py
my_variable is not 4
i == 1
i == 2
i == 3
i == 4

Be careful!
range(1, 5) == (1, 2, 3, 4)
# Storing many pieces of data

## Dense Storage

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

## Sparse Storage

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>20</td>
</tr>
<tr>
<td>81</td>
<td>94</td>
</tr>
<tr>
<td>96</td>
<td>10</td>
</tr>
<tr>
<td>104</td>
<td>2</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>apple</td>
<td>20</td>
</tr>
<tr>
<td>banana</td>
<td>94</td>
</tr>
<tr>
<td>cherry</td>
<td>10</td>
</tr>
<tr>
<td>date</td>
<td>2</td>
</tr>
</tbody>
</table>
Arrays (or “lists” in Python)

- Good for dense storage
- Index is an integer, starting at 0

```python
my_list = [1, 2, 4, 8, 16]
my_list.append(32)
print(len(my_list))
print(my_list[3])
print(""")
for value in my_list:
    print(value)
```

Make a list with 5 elements
Add one more element to the end of the list
Print the length of the list
Print the 4th element
Loop through and print every element of the list
Maps (or “dictionaries” in Python)

- Good for sparse storage:
  - create pairs of key/value

```python
my_dict = {"alan": 22, "bill": 45, "chris": 17, "dan": 27}

my_dict["eric"] = 33

print(len(my_dict))
print(my_dict["chris"])

if "dan" in my_dict:
    print("dan exists in my_dict")

for foo, bar in sorted(my_dict.items()):
    print("%s --> %r" % (foo, bar))
```

- add a new entry
- print size
- print one entry
- check whether a key exists
- print key/value pairs in order
defaultdict

- A useful expansion on dictionary with a default value

```python
from collections import defaultdict

my_dict = defaultdict(lambda: 0)  # default value of zero

my_dict["eric"] = 33

print(my_dict["eric"])  # print existing key
print(my_dict["fred"])  # print non-existent key

for foo, bar in sorted(my_dict.items()):
    print("%s --> %r" % (foo, bar))
```
Splitting and joining strings

- In NLP: often split sentences into words

```python
sentence = "this is a pen"
words = sentence.split(" ")
for word in words:
    print(word)
print(" ||| ".join(words))
```

Split string at white space into an array of words

Combine the array into a single string, separating with " ||| "

```
$ ./my-program.py
... this ||| is ||| a ||| pen
```
Functions

• Functions take an input, transform the input, and return an output

```python
def add_and_abs(x, y):
    z = x + y
    if z >= 0:
        return z
    else:
        return z * -1

print(add_and_abs(-4, 1))
```

Function `add_and_abs` takes "x" and "y" as input

Add x and y together and return the absolute value

Call `add_and_abs` with x=-4 and y=1
Using command line arguments/
Reading files

```python
#!/usr/bin/python3

import sys
my_file = open(sys.argv[1], "r")

for line in my_file:
    line = line.strip()
    if len(line) != 0:
        print(line)
```

First argument
Open file for reading with "r"
Read the file one line at a time
Delete the line end symbol "\n"
If the line is not empty, print

```
$ ./my-program.py test.txt
```
Testing Your Code
Simple Input/Output Tests

Example:
Program word-count.py should count the words in a file
1) Create a small input file
2) Count the words by hand, write them in an output file

<table>
<thead>
<tr>
<th>a b c</th>
<th>a 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>b c d</td>
<td>b 2</td>
</tr>
</tbody>
</table>

3) Run the program

./word-count.py test-word-count-in.txt > word-count-out.txt

4) Compare the results

$ diff test-word-count-out.txt word-count-out.txt
Unit Tests

- Write code to test each function
- Test several cases, and print an error if result is wrong
- Return 1 if all tests passed, 0 otherwise

```python
def test_add_and_abs():
    if add_and_abs(3, 1) != 4:
        print("add_and_abs(3, 1) != 4 (== %d)" % add_and_abs(3, 1))
        return 0
    if add_and_abs(-4, 1) != 3:
        print("add_and_abs(-4, 1) != 3 (== %d)" % add_and_abs(-4, 1))
        return 0
    return 1
```
ALWAYS Test your Code

- Creating tests:
  - Makes you think about the problem before writing code
  - Will reduce your debugging time drastically
  - Will make your code easier to understand later
Practice Exercise
Practice Exercise

• Make a program that counts the frequency of words in a file:

  this is a pen
  this pen is my pen

  a 1
  is 2
  my 1
  pen 3
  this 2

• Test it on test/00-input.txt, test/00-answer.txt
• Run the program on the file data/wiki-en-train.word
• Report:
  • The number of unique words
  • The frequencies of the first few words in the list
Pseudo-code

create a dictionary counts

create a map to hold counts

open a file

for each line in the file
    split line into words
    for w in words
        if w exists in counts, add 1 to counts[w]
        else set counts[w] = 1

print key, value of counts