CS 97 - Discussion 1F
Week 3

Lisp and Python

Reminds

- Assignment 2 is released
  - Due: 2021-01-26
  - **11:55** pm UCLA Time
  - Submission:
    - `which-line.el`
    - `shuf.py`
    - `notes.txt` - answer questions and contain notes/comments
    - No `dribble` files are required
- Project Proposal
  - Due: 2021-01-31
  - Group Sign-up sheet:
    https://docs.google.com/spreadsheets/d/1hURVny1igUp4yw2P9y-jczevA2VNisy1tHDuIWo0E8c/edit?usp=sharing

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0. Programming Language

1. Lisp

a. Why Lisp
b. Printing
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d. Variables and Data Type
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f. Loop
g. Functions

2. Python

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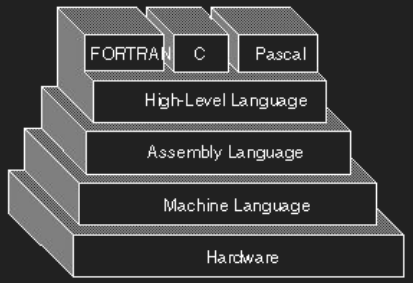
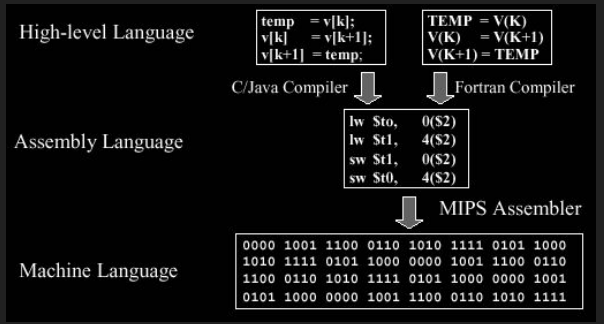
0. Programming Language

- A programming language is a *formal language* comprising a *set* of *instructions* that produce various kinds of *outputs*. A programming language is a *vocabulary* and *set* of *grammatical rules* for *instructing* a *computer* or computing *device* to *perform specific tasks*.
- High-level programming language
  - For human understanding
  - A unique set of keywords and a special syntax => instructions
- Machine language
  - Different CPU has its own unique machine language
- Assembly language
  - Lying between high-level and machine languages
  - Easier to program (allow name substitution)
- High-level programming language => Machine language
  - Compile the program: deal with the whole program at once
    - source code =(heavy)=> object code => (linker) => execute
  - Interpret the program: translate programs on the fly
    - Source code =(light)=> intermediate form => execute





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Most of the Lisp examples in this slides are from http://ergoemacs.org/emacs/elisp_basics.html

1. Lisp -- Why?

- Lisp was first developed in the late 1950s at the MIT for AI research.
- It’s the second-oldest high-level programming language. Only Fortran is older, by one year.

- Why Lisp?
  - Most of the Emacs functions are written in Lisp
    - Although Emacs Lisp is usually thought of in association only with Emacs, it is a full computer programming language
  - Extend Emacs (add/modify functions to Emacs)
  - Better understand fundamentals of programming
  - More importantly, to show you how you can teach yourself to go further

1. Lisp -- Printing

- Print something to stdout
  - `message`
  - String
  - Value of some variables

```
; Semicolon starts a comment

; printing a string
(message "hi")

; printing variable values
(message "Her age is: %d" 16)             ; %d is for number
(message "Her name is: %s" "Vicky")       ; %s is for string
(message "My list is: %S" (list 8 2 3))   ; %S is for any lisp expression
```

1. Lisp -- Variables and Data Types

- Data Types
  - Integer, float

```
;; int to float
(float 3) ; 3.0
(truncate 3.3) ; 3
(floor 3.3) ; 3
(ceiling 3.3) ; 4
(round 3.4) ; 3
```

  - String, number

```
;; string <-> number
(string-to-number "3")
(number-to-string 3)
```

- Variables
  - Global variables -- `setq`

```
;; global variables, no declaration needed
(setq x 1) ; assign 1 to x
(setq a 3 b 2 c 7) ; multiple assignment
```

  - Local variables -- `let`
    - Define a local scope where variables works in
    - `(let (var1 var2 …) body)`
    - `(let (var1 val1) (var2 val2) (…) …) body)`
    - `body`: one or more lisp expressions; the body's last expression value is returned

```
;; local variables eg1
(let (a b)
 (setq a 3)
 (setq b 4)
 (+ a b)
 ) ;  7
```

```
;; local variables eg2
(let ((a 3) (b 4))
 (+ a b)
 ) ;  7
```

1. Lisp -- Arithmetic

- Basic calculations
  - `+`, `-`, `*`
  - `/`
    - Integer
    - Float
    - single digit decimal number such as `2`. needs a zero after the dot, like this: `2.0`. For example, `(/ 7 2.)` returns `3`, not `3.5`.
  - Mod: `%`
  - Power: `expt`

```
(+ 4 5 1)   ; 10
(- 9 2)     ; 7
(- 9 2 3)   ; 4
(* 2 3)     ; 6
(* 2 3 2)   ; 12

;; integer part of quotient
(/ 7 2)     ; 3

;; division
(/ 7 2.0)   ; 3.5

;; mod, remainder
(% 7 4)     ; 3

;; power; exponential
  (expt 2 3) ; 8
```

1. Lisp -- If Conditions

- True, False (No boolean datatype)

```
;; symbol nil is false
;; nil is equivalent to empty list ()

;; symbol t is true
```

- Boolean Functions
  - and, or, not

```
; and, or
(and t nil) ;  nil
(or t nil) ;  t
;; can take multiple args
(and t nil t t t t) ;  nil

; not
(not (= 3 4)) ;  t
(/= 3 4) ;  t. "/=" is for comparing numbers only
(not (equal 3 4)) ;t. General way to test inequality.
```

- Boolean Functions
  - Compare: numbers, strings

```
;; compare numbers
(< 3 5) ; less than ⇒ t
(> 3 5) ; greater than ⇒ nil
(<= 3 5) ; less or equal to ⇒ t
(>= 3 5) ; greater or equal to ⇒ nil
(= 3 3)  ; equal ⇒ t
(= 3 3.0)  ; equal ⇒ t
(/= 3 4) ; not equal ⇒ t

;; compare string
(equal "abc" "abc") ; t
;; dedicated function for comparing string
(string-equal "abc" "abc") ; t
(string-equal "abc" "Abc") ; nil. Case matters
```

  - Compare: `equal` v.s. `=` v.s. `eq`
    - `equal`: test if two values have the same **data type** and **value**
    - `=`: test if two **values** are the same
    - `eq`: test if two args are the same **Lisp object**

```
(= 3 3.0)       ; t
(equal 3 3)     ; t
(equal 3 3.0)   ; nil. Because datatype doesn't match
(equal "e" "e") ; t
(eq "e" "e")    ; nil. Because not the same object
```

1. Lisp -- If Conditions

- If Then Else
  - `(if test body)`
  - `(if test true_body false_body)`
  - `(when test expr1 expr2 …)`
    - `(if test (prong expr1 expr2 …))`

```
(if (< 3 2) 7 8 ) ; 8

;; no false expression, return nil
(if (< 3 2) (message "yes") ) ; nil
(when (< 3 2) (message "yes") ) ;

;; if with blocks of expressions
(if something
    (progn ; true
    …
    )
    (progn ; else
    …
    )
 )
```

- Block of Expressions
  - Group several expressions together as one single expression
  - `(prong …)`
  - Return the last expression in its body
  - Similar to a block of code `{ … }` in C-like languages

```
(progn (message "a") (message "b"))
;; is equivalent to
(message "a") (message "b")
;; return the last expression
(progn 3 4 ) ; 4
```

1. Lisp -- Loop

- Most basic loop
  - `(while test body)`
  - `body`: one or more lisp expressions

```
(setq x 0)

(while (< x 4)
  (message "number is %d" x)
  (setq x (1+ x)))
```

1. Lisp -- Functions

- Define a Function
  - `(defun function_name (param1 param2 …) “doc_string” body)`
  - `body`: one or more lisp expressions

```
(defun myFunction ()
  "Testing"
  (message "Yay!"))

;; return number*8 where number is a input parameter
(defun multiply-by-eight (number)
  (* 8 number))

;; call a function
(multiply-by-seven 6) ; = 48
```

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2. Python -- Why?

- Python was conceived in the late 1980s by Guido van Rossum in the Netherlands.
- Python 2.0 was released in Oct 2000; Python 3.0 was released in Dec 2008.

- Why Python?
  - Popular!!!
    - Large and active community
    - Many powerful libraries and tools
    - Open-source resources
  - Design philosophy emphasizes code readability with notable use of significant whitespace
  - Language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects

input/output: https://docs.python.org/3/tutorial/inputoutput.html

2. Python -- Printing

- Print something
  - print() function

```
# starts a comment
# printing a string
print("hi")
# printing variable values
print("Her age is: ", 16)                    # Her age is 16
age = 16      # define a variable age with its value assigned as 16
print("Her age is: ", age)                   # Her age is 16
# formatted output
print(f"Her age is: {age}")                  # Her age is 16

import math
print(f"The value of pi is approximately {math.pi:.3f}." )
              # The value of pi is approximately 3.142.
```

2. Python -- Variables and Data Types

- Data Types
  - int, float

```
# int to float
int(4.5) # 4
float(4) # 4.0
```

  - string, number

```
# string <-> number
str(457)        # '457'
int('356')      # 356
float('341.53') # 341.53

int('341.53')
# error: invalid literal for int() with base 10
```

  - bool

```
# True
# False
```

  - tuple: used to group data; immutable

```
year_born = ("Paris Hilton", 1981)
julia = ("Julia", "Roberts", 1967, "Duplicity", 2009, "Actress",
"Atlanta, Georgia")
print(julia[2])   # 1967
Julia[0] = "AnotherName"
# TypeError: 'tuple' object does not support item assignment
```

  - list: store multiple items in a single variable

```
this_list = ["apple", "banana", "cherry"]
another_list = [1, 2, 3]
print(len(this_list))   # 3 (element number)
another_list[2] = 4     # access the list items
print(another_list)   # [1, 2, 4]
```

  - dic: store data values in *key:value* pairs

```
this_dic = {"apple": 3, "banana": 1, "cherry": 5}
print(this_dic["apple"])     # 3, access the list items
this_dic["orange"] = 3       # insert items
print(this_dic)   # {"apple": 3, "banana": 1, "cherry": 5, "orange": 3}
```

  - set: item collection, unordered and unindexed, no repeats

```
this_set = {1, 2, 3, 3, 1, 2}
print(this_set)     # {1, 2, 3}
this_set.add(4)
This_set[2] # TypeError: 'set' object does not support indexing
```

2. Python -- If Conditions

- Boolean Functions
  - compare: `>`, `>=`, `<`, `<=`, `==`, `!=`
  - `and`, `or`, `not`
- if , elif, else
  - `if` (if the conditions are true, then execute the following)
  - `elif` (if the previous conditions were not true, then try this condition)
  - `else` (catches anything which isn't caught by the preceding conditions)
- Indentation and whitespace
  - Each block needs to be indented to be grouped together
  - Indicate scope (try to only use tabs or spaces; a mixture of both can mess up the grouping)

```
# example 1
a = 200
b = 33
if b > a:
  print("b is greater than a")
elif a == b:
  print("a and b are equal")
else:
  print("a is greater than b")

# example 2
a = 200
b = 33
c = 500
if a > b and c > a:
  print("Both conditions are True")

# short-hand if
if a > b: print("a is greater than b")

# short-hand if-else
a = 2
b = 330
print("A") if a > b else print("B")
```

2. Python -- Loop

- While Loop
  - `while`
  - `else` (optional, run a block of code once when the condition no longer is true)
- For Loop
  - `for .. in ..`
    - List, dic, set, string, range(..)
  - `range()` function
    - `range(5)` (values 0 to 4, 5 is not included)
    - `range(2, 30)` (start, end)
    - `range(2, 30, 3)` (start, end, increment)
  - `else` (optional)

```
# example - while
i = 1
while i < 6:
  print(i)
  i += 1

# example - while-else
i = 1
while i < 6:
  print(i)
  i += 1
else:
  print("i is no longer less than 6")

# example - for in (string)
for x in "banana":
  print(x)

# example - for in (list)
fruits = ["apple", "banana", "cherry"]
for x in fruits:
  print(x)

# example - for in (range)
for x in range(2, 30, 3):
  print(x)
else:
  print("Finally finished!")
```

2. Python -- Loop

- While Loop
  - `while`
  - `else` (optional, run a block of code once when the condition no longer is true)
- For Loop
  - `for .. in ..`
    - List, dic, set, string, range(..)
  - `range()` function
    - `range(5)` (values 0 to 4, 5 is not included)
    - `range(2, 30)` (start, end)
    - `range(2, 30, 3)` (start, end, increment)
  - `else` (optional)
- Break and Continue
  - `break` (stops the loop even if the while condition is true)
  - `continue` (stop the current iteration and continue to the next)

```
# example - continue
# 1, 2, 4, 5, 6
i = 0
while i < 6:
  i += 1
  if i == 3:
    continue
  print(i)

# example - break
# 1, 2, 3
i = 1
while i < 6:
  print(i)
  if i == 3:
    break
  i += 1
```

2. Python -- Functions

- Create a function
  - Keyword: `def`
- Call a function
  - Function name + parenthesis

```
# example - def a function
def my_function():
  print("Hello from a function")

# example - call a function
my_function()

# example - def a function with arguments
def my_function2(fname):
  print(fname + " Refsnes")

# example - def a function with arguments
def my_function3(dirname, fname):
  print(dirname + fname + " Refsnes")

# example - call a function with arguments
my_function2("Emil")
my_function2("Tobias")
my_function2("Linus")

my_function3("dirname", "filename")
```

2. Python -- Modules

- Consider a module to be
  - a code library.
  - a file containing a set of functions you want to include in your application
- Use a module
  - Keywords:
    - `import …`
    - `from … import …`

```python
# save this code in a file named module.py
def greeting(name):
  print("Hello, " + name)

person1 = {
  "name": "Somename",
  "age": 18,
  "country": "Someplace"
}
```

```python
# another file to run, let's say test.py
import module

module.greeting("Yuxing")

a = module.person1["age"]
print(a) # 18
```

```python
# another way to implement test.py
from module import greeting, person1

greeting("Yuxing")

a = person1["age"]
print(a) # 18
```