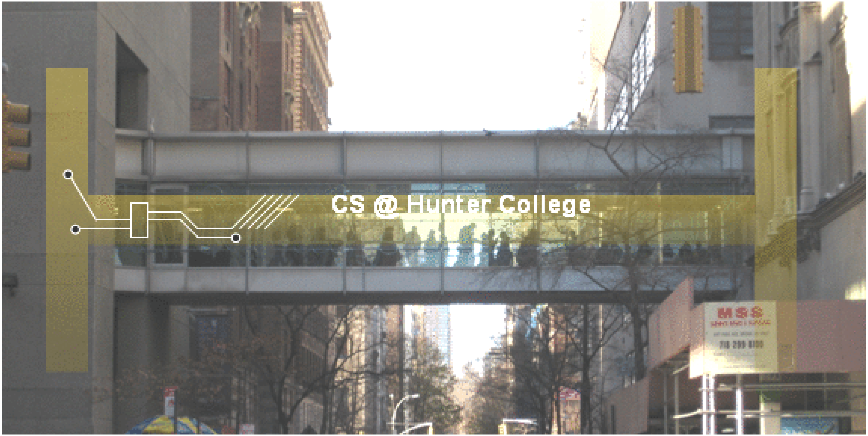
CSCI 127: Introduction to Computer Science



hunter.cuny.edu/csci

Today's Topics

- Design Patterns: Searching
- Python Recap
- Machine Language
- Machine Language: Jumps & Loops
- Binary & Hex Arithmetic
- Final Exam: Format

Today's Topics

- **Design Patterns: Searching**
- Python Recap
- Machine Language
- Machine Language: Jumps & Loops
- Binary & Hex Arithmetic
- Final Exam: Format

Predict what the code will do:

```
def search(nums, locate):
    found = False
    i = 0
    while not found and i < len(nums):
        print(nums[i])
        if locate == nums[i]:
            found = True
        else:
            i = i+1
    return(found)

nums= [1,4,10,6,5,42,9,8,12]
if search(nums,6):
    print('Found it! 6 is in the list!')
else:
    print('Did not find 6 in the list.')
```

Python Tutor

```
def search(nums, locate):
    found = False
    i = 0
    while not found and i < len(nums):
        print(nums[i])
        if locate == nums[i]:
            found = True
        else:
            i = i+1
    return(found)

nums= [1,4,10,6,5,42,9,8,12]
if search(nums,6):
    print('Found it! 6 is in the list!')
else:
    print('Did not find 6 in the list.')
```

(Demo with `pythonTutor`)

Design Pattern: Linear Search

```
def search(nums, locate):
    found = False
    i = 0
    while not found and i < len(nums):
        print(nums[i])
        if locate == nums[i]:
            found = True
        else:
            i = i+1
    return(found)

nums= [1,4,10,6,5,42,9,8,12]
if search(nums,6):
    print('Found it! 6 is in the list!')
else:
    print('Did not find 6 in the list.')
```

- Example of **linear search**.
- Start at the beginning of the list.
- Look at each item, one-by-one.
- Stop when found, or the end of list is reached.

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- Design Patterns: Searching
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- Machine Language
- Machine Language: Jumps & Loops
- Binary & Hex Arithmetic

Python & Circuits Review: 10 Weeks in 10 Minutes

A whirlwind tour of the semester, so far...

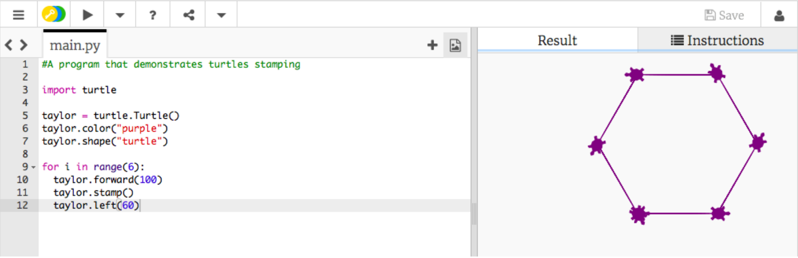
Week 1: print(), loops, comments, & turtles

- Introduced comments & print():

```
#Name:  Thomas Hunter
#Date:  September 1, 2017
#This program prints:  Hello, World!

print("Hello, World!")
```

← These lines are comments
← (for us, not computer to read)
← (this one also)
← Prints the string "Hello, World!" to the screen

- As well as definite loops & the turtle package:



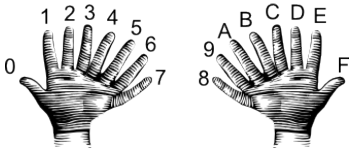
Week 2: variables, data types, more on loops & range()

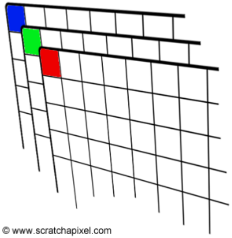
- A **variable** is a reserved memory location for storing a value.
- Different kinds, or **types**, of values need different amounts of space:
  - **int**: integer or whole numbers
  - **float**: floating point or real numbers
  - **string**: sequence of characters
  - **list**: a sequence of items
    e.g. `[3, 1, 4, 5, 9]` or `['violet','purple','indigo']`
  - **class variables**: for complex objects, like turtles.
- More on loops & ranges:

```
#Predict what will be printed:

for num in [2,4,6,8,10]:
    print(num)

sum = 0
for x in range(0,12,2):
    print(x)
    sum = sum + x

print(sum)

for c in "ABCD":
```

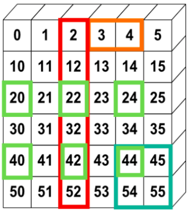
Week 3: colors, hex, slices, numpy & images

Color Name	HEX	Color
Black	#000000	
Navy	#000080	
DarkBlue	#00008B	
MediumBlue	#0000CD	
Blue	#0000FF	






```
>>> a[0,3:5]
array([3,4])

>>> a[4:,4:]
array([[44, 45],
       [54, 55]])

>>> a[:,2]
array([2,12,22,32,42,52])

>>> a[2::2,::2]
array([[20,22,24]
       [40,42,44]])
```



Week 4: design problem (cropping images) & decisions

- First: specify inputs/outputs. *Input file name, output file name, upper, lower, left, right ("bounding box")*
- Next: write pseudocode.
  1. Import numpy and pyplot.
  2. Ask user for file names and dimensions for cropping.
  3. Save input file to an array.
  4. Copy the cropped portion to a new array.
  5. Save the new array to the output file.
- Next: translate to Python.

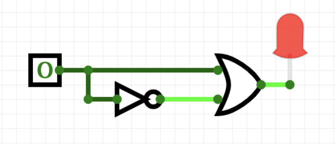
Week 4: design problem (cropping images) & decisions

```
yearBorn = int(input('Enter year born: '))
if yearBorn < 1946:
    print("Greatest Generation")
elif yearBorn <= 1964:
    print("Baby Boomer")
elif yearBorn <= 1984:
    print("Generation X")
elif yearBorn <= 2004:
    print("Millennial")
else:
    print("TBD")

x = int(input('Enter number: '))
if x % 2 == 0:
    print('Even number')
else:
    print('Odd number')
```

Week 5: logical operators, truth tables & logical circuits

in1		in2	*returns:*
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True

```python
origin = "Indian Ocean"
winds = 100
if (winds > 74):
    print("Major storm, called a ", end="")
    if origin == "Indian Ocean" or origin == "South Pacific":
        print("cyclone.")
    elif origin == "North Pacific":
        print("typhoon.")
    else:
        print("hurricane.")

visibility = 0.2
winds = 40
conditions = "blowing snow"
if (winds > 35) and (visibility < 0.25) and \
      (conditions == "blowing snow" or conditions == "heavy snow"):
    print("Blizzard!")
```



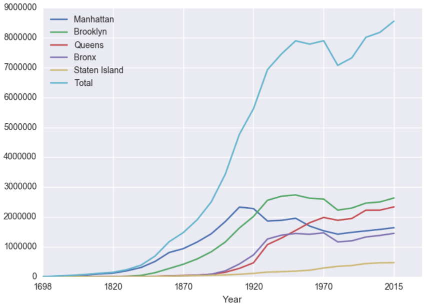
Week 6: structured data, pandas, & more design

```
import matplotlib.pyplot as plt
import pandas as pd

pop = pd.read_csv('nycHistPop.csv',skiprows=5)

pop.plot(x="Year")
plt.show()
```

```
Source:  https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,,
All population figures are consistent with present-day boundaries.,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,,
,,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island,Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,4549,6159,1781,3827,49447
1800,60515,5740,6642,1755,4563,79215
1810,96373,8303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,5346,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813669,279122,32903,23593,25492,1174779
1870,942292,419921,45468,37393,33029,1478103
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51693,2507414
1900,1850093,1166582,152999,200507,67021,3437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018356,469042,732016,116531,5620048
1930,1867312,2560401,1079129,1265258,158346,6930446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1960101,2738175,1550849,1451277,191555,7891957
1960,1698281,2627319,1809578,1424815,221991,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1891325,1168972,352121,7071639
1990,1487536,2300664,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1585873,2504700,2230722,1385108,468730,8175133
2015,1644518,2636735,2339150,1455444,474558,8550405
```

nycHistPop.csv

In Lab 6



Week 7: functions

```python
#Name:  your name here
#Date:  October 2017
#This program, uses functions,
#     says hello to the world!

def main():
     print("Hello, World!")

if __name__ == "__main__":
     main()
```

- Functions are a way to break code into pieces, that can be easily reused.
- Many languages require that all code must be organized with functions.
- The opening function is often called `main()`
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis: Example: `print("Hello", "World")`
- Can write, or **define** your own functions, which are stored, until invoked or called.

Week 8: function parameters, github

```
def totalWithTax(food,tip):
    total = 0
    tax = 0.0875
    total = food + food * tax
    total = total + tip
    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip:' ))
lTotal = totalWithTax(lunch, lTip)
print('Lunch total is', lTotal)

dinner= float(input('Enter dinner total: '))
dTip = float(input('Enter dinner tip:' ))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

- Functions can have **input parameters**.
- Surrounded by parenthesis, both in the function definition, and in the function call (invocation).
- The "placeholders" in the function definition: **formal parameters**.
- The ones in the function call: **actual parameters**
- Functions can also **return values** to where it was called.

Week 8: function parameters, github

```
def totalWithTax(food,tip):
    total = 0
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```

Formal Parameters

Actual Parameters

- Functions can have **input parameters**.
- Surrounded by parenthesis, both in the function definition, and in the function call (invocation).
- The "placeholders" in the function definition: **formal parameters**.
- The ones in the function call: **actual parameters**.
- Functions can also **return values** to where it was called.

Week 9: top-down design, folium, loops, and random()


```python
def main():
    dataF = getData()
    latColName, lonColName = getColumnNames()
    lat, lon = getLocale()
    cityMap = folium.Map(location = [lat,lon], tiles = 'cartodbpositron',zoom_start=11)
    dotAllPoints(cityMap,dataF,latColName,lonColName)
    markAndFindClosest(cityMap,dataF,latColName,lonColName,lat,lon)
    writeMap(cityMap)
```

Week 10: more on loops, max design pattern, random()

```
dist = int(input('Enter distance: '))
while dist < 0:
    print('Distances cannot be negative.')
    dist = int(input('Enter distance: '))

print('The distance entered is', dist)
```

```
import turtle
import random

trey = turtle.Turtle()
trey.speed(10)

for i in range(100):
  trey.forward(10)
  a = random.randrange(0,360,90)
  trey.right(a)
```

- Indefinite (while) loops allow you to repeat a block of code as long as a condition holds.
- Very useful for checking user input for correctness.
- Python's built-in random package has useful methods for generating random whole numbers and real numbers.
- To use, must include: `import random`.
- The max design pattern provides a template for finding maximum value from a list.

Python & Circuits Review: 10 Weeks in 10 Minutes

- Input/Output (I/O): `input()` and `print()`; pandas for CSV files
- Types:
  - Primitive: int, float, bool, string;
  - Container: lists (but not dictionaries/hashes or tuples)
- Objects: turtles (used but did not design our own)
- Loops: definite & indefinite
- Conditionals: if-elif-else
- Logical Expressions & Circuits
- Functions: parameters & returns
- Packages:
  - Built-in: turtle, math, random
  - Popular: numpy, matplotlib, pandas, folium

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- **Machine Language**
- Machine Language: Jumps & Loops
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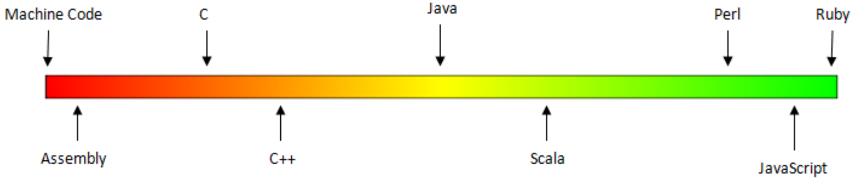
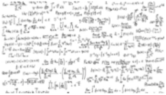
Low-Level vs. High-Level Languages

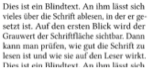


(codeCommit)

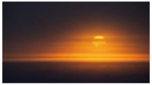
- Can view programming languages on a continuum.
- Those that directly access machine instructions & memory and have little abstraction are **low-level languages** (e.g. machine language, assembly language).
- Those that have strong abstraction (allow programming paradigms independent of the machine details, such as complex variables, functions and looping that do not translate directly into machine code) are called **high-level languages**.
- Some languages, like C, are in between– allowing both low level access and high level data structures.

Processing





Dies ist ein Blindtext. An ihm lässt sich vieles über die Schrift ablesen, in der er gesetzt ist. Auf den ersten Blick wird der Grauwert der Schriftfläche sichtbar. Dann kann man prüfen, wie gut die Schrift zu lesen ist und wie sie auf den Leser wirkt. Dies ist ein Blindtext. An ihm lässt sich



```python
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    tax = 0.0875
    total = food + food * tax
    total = total + tip
    return(total)
```
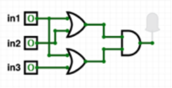
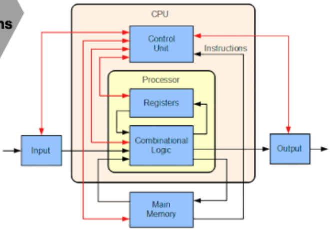
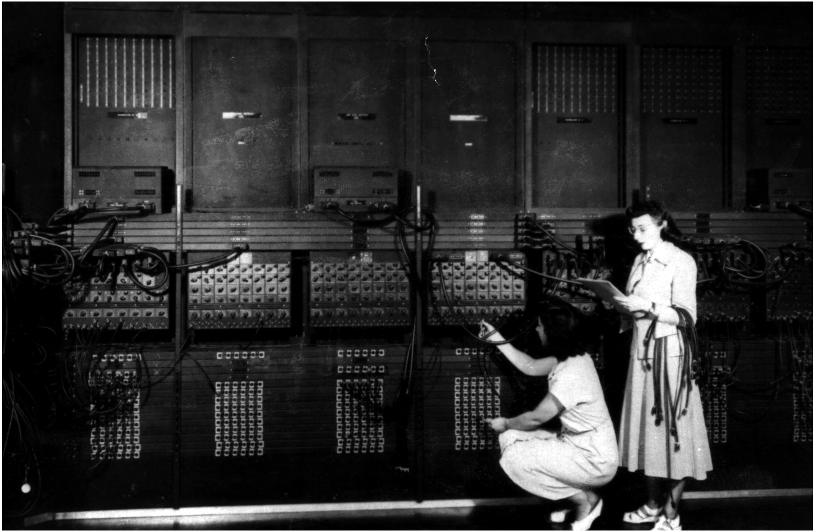



Circuits (switches)
On/Off 1/0 Logic
Billions of switches/bits

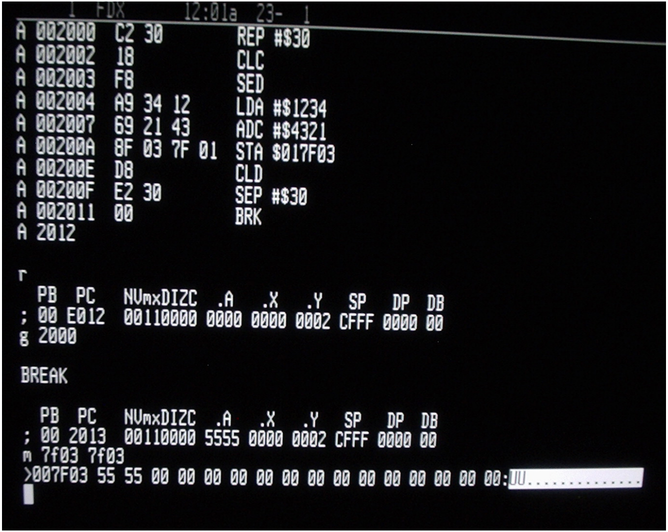


Machine Language



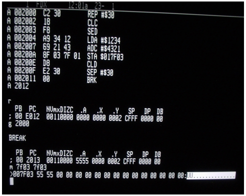
(Ruth Gordon & Ester Gerston programming the ENIAC, UPenn)

Machine Language



(wiki)

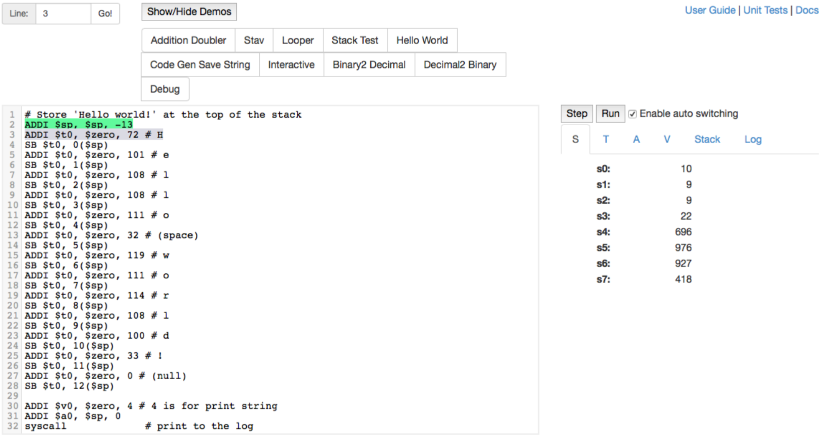
Machine Language



(wiki)

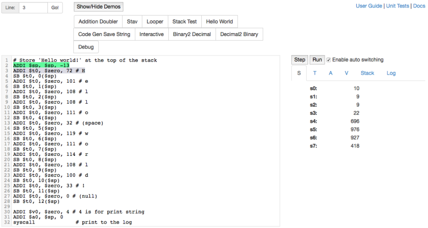
- We will be writing programs in a simplified machine language, WeMIPS.
- It is based on a reduced instruction set computer (RISC) design, originally developed by the MIPS Computer Systems.
- Due to its small set of commands, processors can be designed to run those commands very efficiently.
- More in future architecture classes....

“Hello World!” in Simplified Machine Language



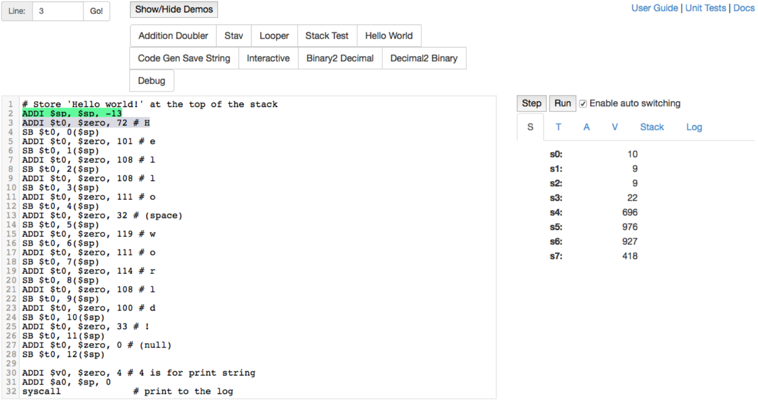
(WeMIPS)

WeMIPS



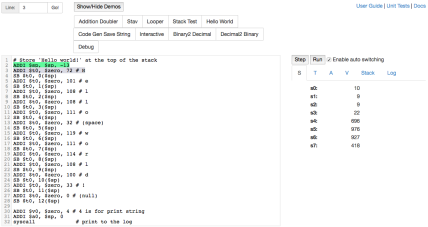
(Demo with `WeMIPS`)

Challenge:



Write a program that prints out the alphabet: `a b c d ... x y z`

WeMIPS



(Demo with WeMIPS)

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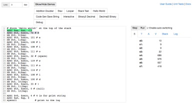
- **Machine Language: Jumps & Loops**
- Binary & Hex Arithmetic

Loops & Jumps in Machine Language



- Instead of built-in looping structures like `for` and `while`, you create your own loops by "jumping" to the location in the program.
- Can indicate locations by writing **labels** at the beginning of a line.
- Then give a command to jump to that location.
- Different kinds of jumps:
  - **Unconditional:** `j Done` will jump to the address with label `Done`.
  - **Branch if Equal:** `beq $s0 $s1 DoAgain` will jump to the address with label `DoAgain` if the registers \$s0 and \$s1 contain the same value.
  - See reading for more variations.

Jump Demo

Line: 18 Go!

Show/Hide Demos

User Guide | Unit Tests | Docs

```
ADDI $sp, $sp, -27       # Set up stack
ADDI $s3, $zero, 1       # Store 1 in a register
ADDI $t0, $zero, 97      # Set $t0 at 97 (a)
ADDI $s2, $zero, 26      # Use to test when you reach 26
SETUP: SB $t0, 0($sp)    # Next letter in $t0
ADDI $sp, $sp, 1         # Increment the stack
SUB $s2, $s2, $s3        # Decrease the counter by 1
ADDI $t0, $t0, 1         # Increment the letter
BEQ $s2, $zero, DONE     # Jump to done if $s2 == 0
J SETUP                  # Else, jump back to SETUP
DONE: ADDI $t0, $zero, 0 # Null (0) to terminate string
SB $t0, 0($sp)           # Add null to stack
ADDI $sp, $sp, -26       # Set up stack to print
ADDI $v0, $zero, 4       # 4 is for print string
ADDI $a0, $sp, 0         # Set $a0 to stack pointer
syscall                  # Print to the log
```

Step Run Enable auto switching

S T A V Stack Log

Clear Log

Emulation complete, returning to line 1

abcdefghijklmnopqrstuvwxyz

(Demo with WeMIPS)

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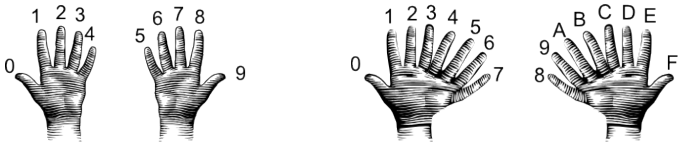
- **Binary & Hex Arithmetic**

Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal (assuming two-digit numbers):
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.
  - Example: what is 2A as a decimal number?

    `2 in decimal is 2. 2*16 is 32.`

    `A in decimal digits is 10.`

    `32 + 10 is 42.`

    Answer is 42.
  - Example: what is 99 as a decimal number?

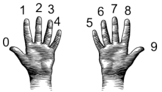
    `9 in decimal is 9. 9*16 is 144.`

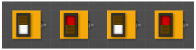
    `9 in decimal digits is 9`

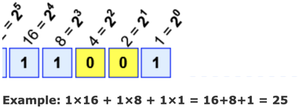
    `144 + 9 is 153.`

    Answer is 153.

Binary to Decimal: Converting Between Bases



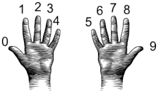


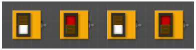


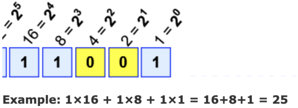
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
Sum starts with:             1
0*2 = 0.  Add 0 to sum:      1
 1*4 = 4.  Add 4 to sum:     5
 1*8 = 8.  Add 8 to sum:     13
 1*16 = 16.  Add 16 to sum:  29
 1*32 = 32.  Add 32 to sum:  61
```

Binary to Decimal: Converting Between Bases





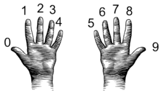


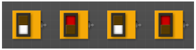
- Example: What is 10100100 in decimal?

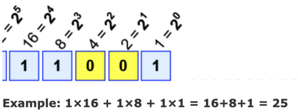
```
Sum starts with:              0
0*2 = 0.   Add 0 to sum:      0
 1*4 = 4.   Add 4 to sum:     4
 0*8 = 0.   Add 0 to sum:     4
 0*16 = 0.   Add 0 to sum:    4
 1*32 = 32.   Add 32 to sum:  36
 0*64 = 0.   Add 0 to sum:    36
 1*128 = 0.   Add 128 to sum: 164
```

The answer is 164.

Design Challenge: Incrementers







- Simplest arithmetic: add one ("increment") a variable.
- Example: Increment a decimal number:

```
def addOne(n):
    m = n+1
    return(m)
```

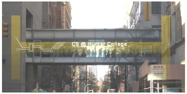
- Challenge: Write an algorithm for incrementing numbers expressed as words.
  Example: `"forty one"` → `"forty two"`

  Hint: Convert to numbers, increment, and convert back to strings.

- Challenge: Write an algorithm for incrementing binary numbers.

  Example: `"1001"` → `"1010"`

Recap

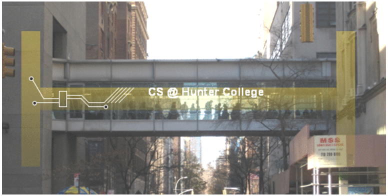


- Searching through data is a common task– built-in functions and standard design patterns for this.
- Programming languages can be classified by the level of abstraction and direct access to data.
- WeMIPS simplified machine language
- Converting between Bases

Final Overview: Format

- The exam is 2 hours long.
- It is on paper. No use of computers, phones, etc. allowed.
- You may have 1 piece of **8.5" x 11"** piece of paper.
  - With notes, examples, programs: what will help you on the exam.
  - Do not fold the paper; it's distracting to others taking the exam.
  - Best if you design/write your own as it's an excellent way to study.
- The exam format:
  - 10 questions, each worth 10 points.
  - Questions correspond to the course topics, and are variations on the programming assignments, lab exercises, and lecture design challenges.
  - Style of questions: what does the code do? short answer, write functions, top-down design, & write complete programs.
  - More on logistics next lecture.
- Past exams available on the webpage (includes answer keys).

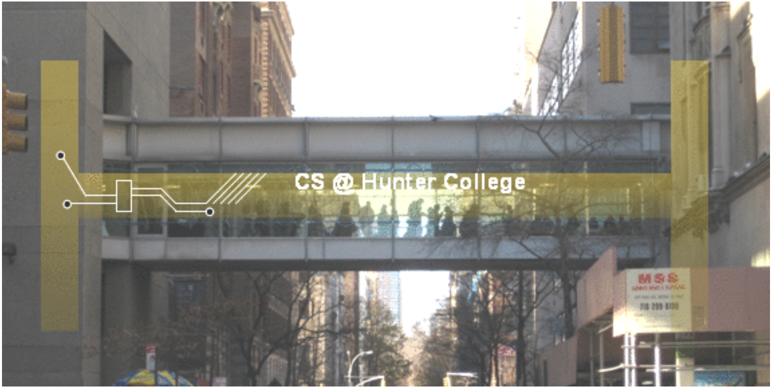
Weekly Reminders!



Before the next lecture, don't forget to:

- Work on this week's Online Lab
- Schedule an appointment to take the Quiz
- Schedule an appointment to take the Code Review
- Submit this week's programming assignments
- If you need help, schedule an appointment for Tutoring
- Take the Lecture Preview on Blackboard

Lecture Slips & Writing Boards



- Hand your lecture slip to a UTA.
- Return writing boards as you leave.