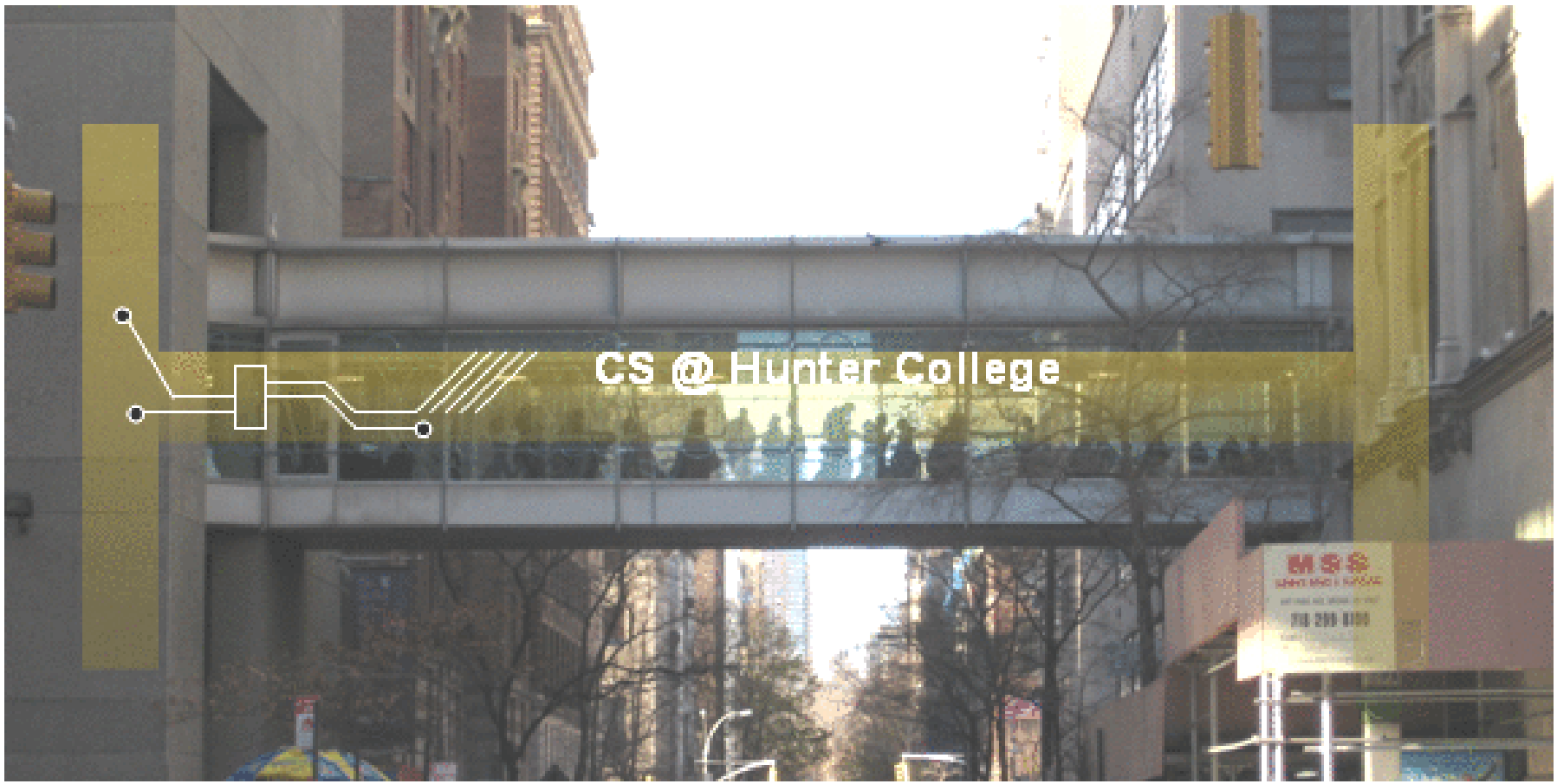
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

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  - See CUNYFirst for registration.

Today's Topics

- Recap of Python & Circuits
- High vs. Low-Level Programming
- A Simplified Machine Language
- Final Exam Overview

Python & Circuits Review: 10 Weeks in 10 Minutes

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

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

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- Introduced comments & print():

```
#Name:  Thomas Hunter                          ← These lines are comments
#Date:  September 1, 2017                      ← (for us, not computer to read)
#This program prints:  Hello, World!           ← (this one also)

print("Hello, World!")                         ← Prints the string "Hello, World!" to the screen
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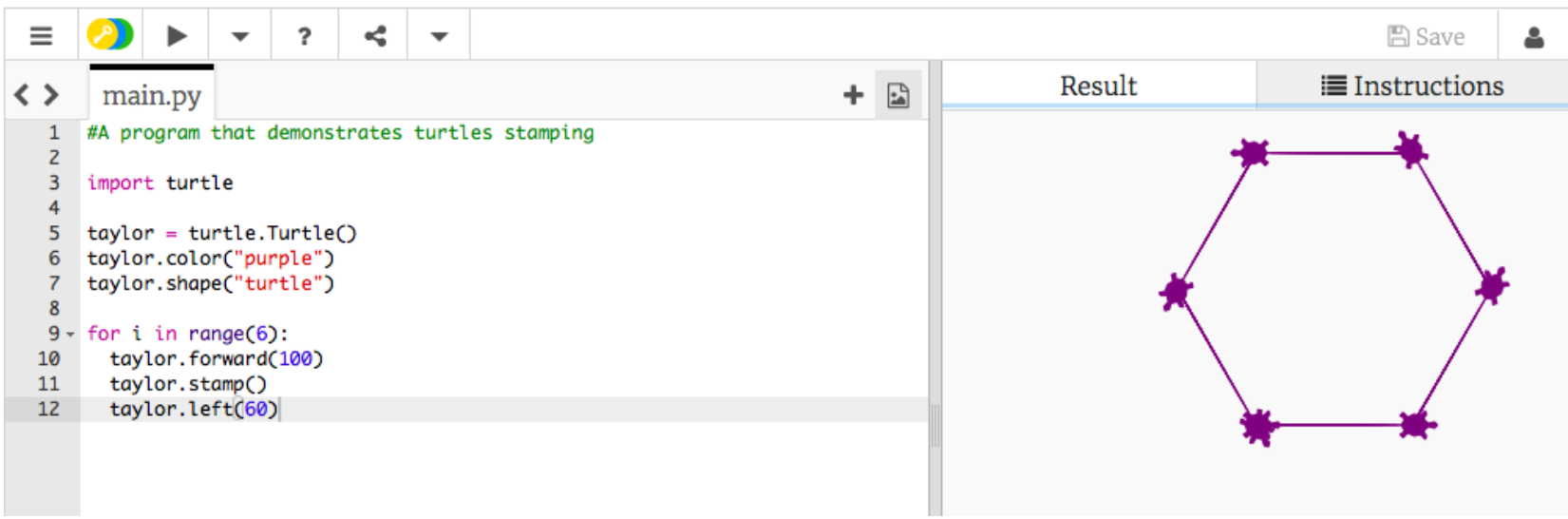
- As well as definite loops & the turtle package:



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- More on loops & ranges:

```
1  #Predict what will be printed:
2
3  for num in [2,4,6,8,10]:
4      print(num)
5
6  sum = 0
7  for x in range(0,12,2):
8      print(x)
9      sum = sum + x
10
11 print(x)
12
13 for c in "ABCD":
14     print(c)
```

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

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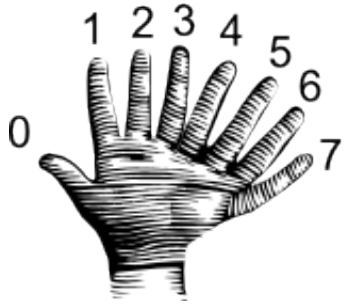

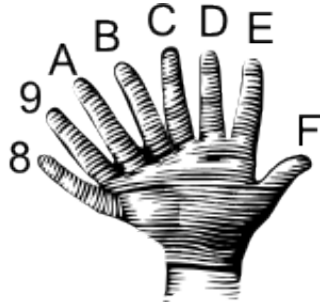

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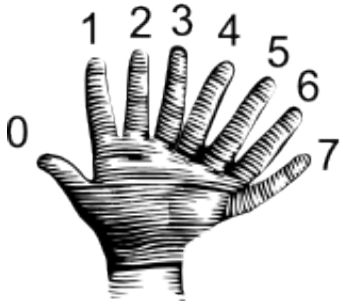

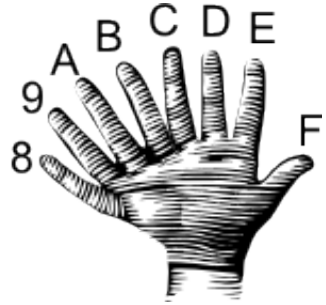

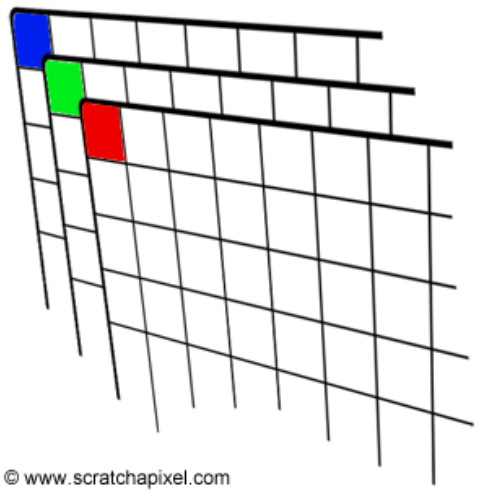

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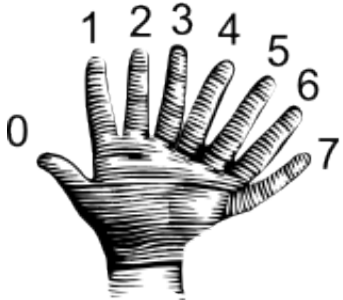
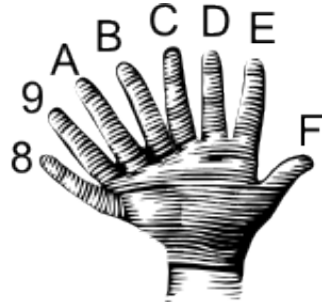
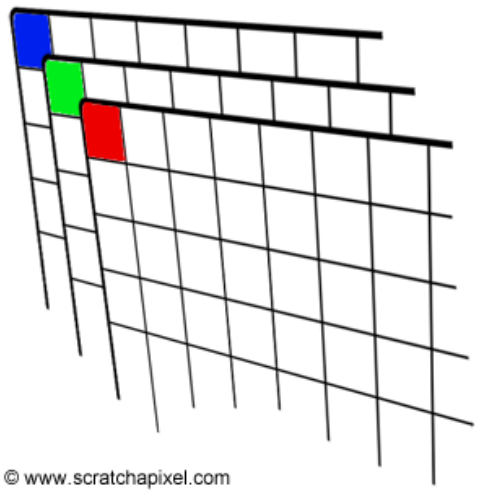







```
>>> a[0,3:5]
array([3,4])

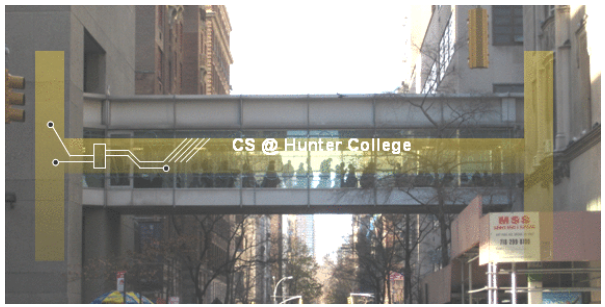
>>> a[4:,4:]
array([[44, 45],
       [54, 55]])

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

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

0	1	2	3	4	5
10	11	12	13	14	15
20	21	22	23	24	25
30	31	32	33	34	35
40	41	42	43	44	45
50	51	52	53	54	55

Week 4: design problem (cropping images) & decisions



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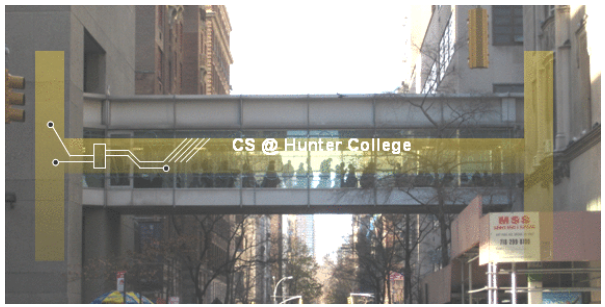

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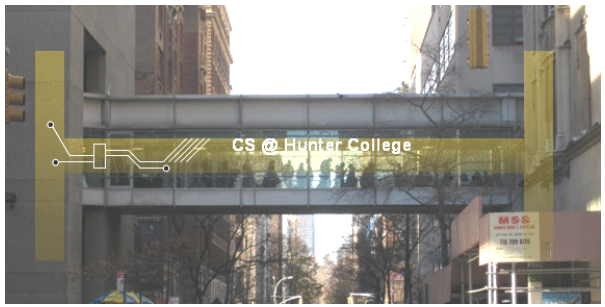

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- Next: write pseudocode.
  1. Import numpy and pyplot.
  2. Ask user for file names and dimensions for cropping.
  3. Save input file to an array.
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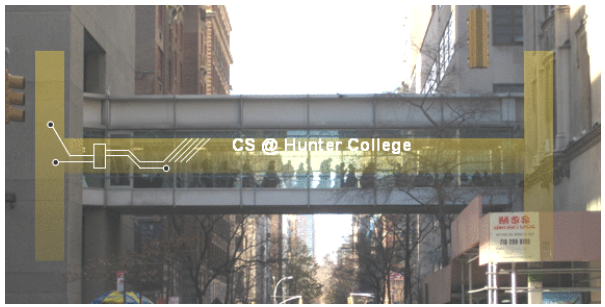

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- Next: translate to Python.

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```
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

```
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!")
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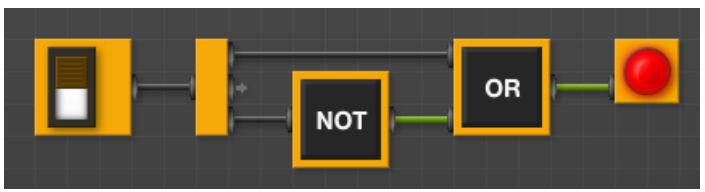
in1		in2	*returns:*
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True



Week 6: structured data, pandas, & more design

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1698,4937,2017,,,727,7681
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`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

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import pandas as pd
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Week 6: structured data, pandas, & more design

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import matplotlib.pyplot as plt
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pop = pd.read_csv('nycHistPop.csv',skiprows=5)
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In Lab 6

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import pandas as pd

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

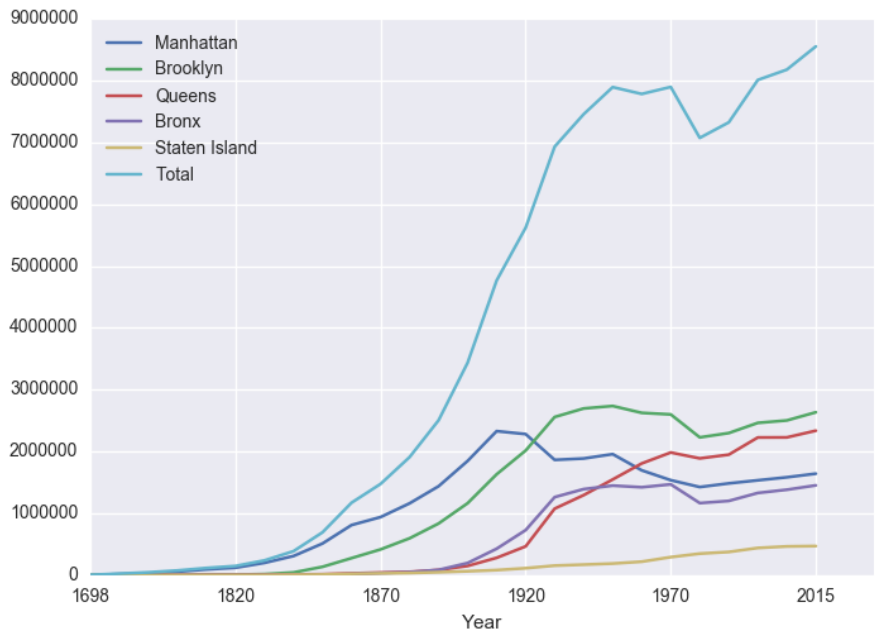
nycHistPop.csv

In Lab 6

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

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

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



Week 7: functions

```
#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()
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- Functions are a way to break code into pieces, that can be easily reused.

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- Can write, or **define** your own functions, which are stored, until invoked or called.

Week 8: function parameters, github

- Functions can have **input parameters**.

```
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: '))
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- The ones in the function call: **actual parameters**

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- Functions can also **return values** to where it was called.

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Formal Parameters

Actual Parameters

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- The ones in the function call: **actual parameters**.
- Functions can also **return values** to where it was called.

Week 9: top-down design, folium


```
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: indefinite loops, searching data, 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)
```

- Indefinite (while) loops allow you to repeat a block of code as long as a condition holds.

```
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)
```

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- 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`.

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trey.speed(10)

for i in range(100):
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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

Python & Circuits Review: 10 Weeks in 10 Minutes

A whirlwind tour with
10 (or so) challenges...

In Pairs or Triples: Week 1

Predict what the code will do:

```
1  #Predict what will be printed:
2
3  for i in range(4):
4      print('The world turned upside down')
5
6  for j in [0,1,2,3,4,5]:
7      print(j)
8
9  for count in range(6):
10     print(count)
11
12 for color in ['red', 'green', 'blue']:
13     print(color)
14
15 print()
16 print()
17
18 for i in range(2):
19     for j in range(2):
20         print('Look around,')
21     print('How lucky we are to be alive!')
```

In Pairs or Triples: Week 2

Predict what the code will do:

```
1  #Predict what will be printed:
2
3  for c in range(65,90):
4      print(chr(c))
5
6  message = "I love Python"
7  newMessage = ""
8  for c in message:
9      print(ord(c))   #Print the Unicode of each number
10     print(chr(ord(c)+1))    #Print the next character
11     newMessage = newMessage + chr(ord(c)+1) #add to the new message
12 print("The coded message is", newMessage)
13
14 word = "zebra"
15 codedWord = ""
16 for ch in word:
17     offset = ord(ch) - ord('a') + 1 #how many letters past 'a'
18     wrap = offset % 26  #if larger than 26, wrap back to 0
19     newChar = chr(ord('a') + wrap)  #compute the new letter
20     print(wrap, chr(ord('a') + wrap))    #print the wrap & new lett
21     codedWord = codedWord + newChar #add the newChar to the coded w
22
23 print("The coded word (with wrap) is", codedWord)
```

Decimal	Hex	Char	Decimal	Hex	Char
64	40	@	96	60	`
65	41	A	97	61	a
66	42	B	98	62	b
67	43	C	99	63	c
68	44	D	100	64	d
69	45	E	101	65	e
70	46	F	102	66	f
71	47	G	103	67	g
72	48	H	104	68	h
73	49	I	105	69	i
74	4A	J	106	6A	j
75	4B	K	107	6B	k
76	4C	L	108	6C	l
77	4D	M	109	6D	m
78	4E	N	110	6E	n
79	4F	O	111	6F	o
80	50	P	112	70	p
81	51	Q	113	71	q
82	52	R	114	72	r
83	53	S	115	73	s
84	54	T	116	74	t
85	55	U	117	75	u
86	56	V	118	76	v
87	57	W	119	77	w
88	58	X	120	78	x
89	59	Y	121	79	y
90	5A	Z	122	7A	z
91	5B	[	123	7B	{
92	5C	\	124	7C	|
93	5D	]	125	7D	}
94	5E	^	126	7E	~
95	5F		127	7F	[DEL]

In Pairs or Triples: Week 3

Predict what the code will do:

```
1  import turtle
2  teddy = turtle.Turtle()
3
4  names = ["violet", "purple", "indigo", "lavender"]
5  for c in names:
6    teddy.color(c)
7    teddy.left(60)
8    teddy.forward(40)
9    teddy.dot(10)
10
11 teddy.penup()
12 teddy.forward(100)
13 teddy.pendown()
14
15 hexNames = ["#FF00FF", "#990099", "#550055", "#111111"]
16 for c in hexNames:
17   teddy.color(c)
18   teddy.left(60)
19   teddy.forward(40)
20   teddy.dot(10)
```

In Pairs or Triples: Week 4

Extend this program to also allow drawing in purple & stamping:

```
import turtle

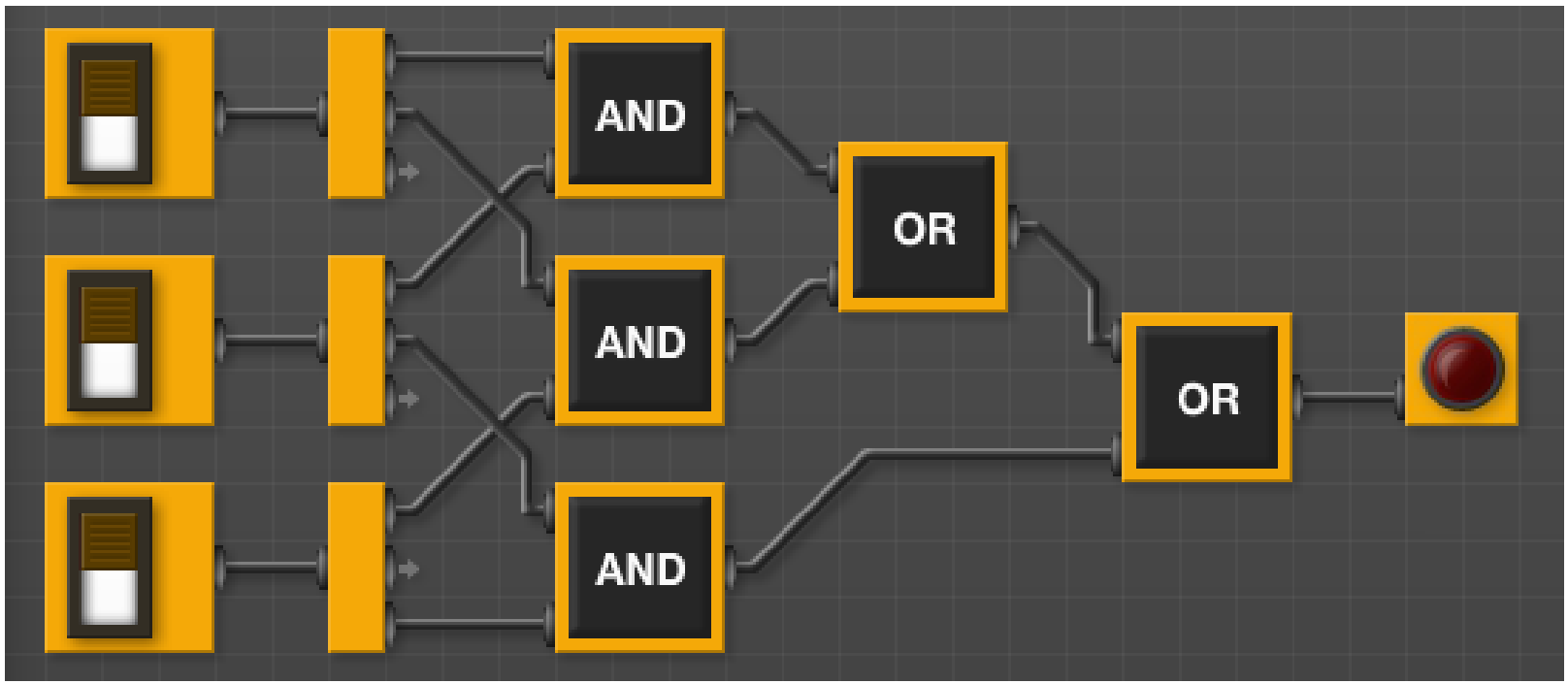
tess = turtle.Turtle()
myWin = turtle.Screen()     #The graphics window
commands = input("Please enter a command string: ")

for ch in commands:
    #perform action indicated by the character
    if ch == 'F':             #move forward
        tess.forward(50)
    elif ch == 'L':           #turn left
        tess.left(90)
    elif ch == 'R':           #turn right
        tess.right(90)
    elif ch == '^':           #lift pen
        tess.penup()
    elif ch == 'v':           #lower pen
        tess.pendown()
    elif ch == 'B':           #go backwards
        tess.backward(50)
    elif ch == 'r':           #turn red
        tess.color("red")
    elif ch == 'g':           #turn green
        tess.color("green")
    elif ch == 'b':           #turn blue
        tess.color("blue")
    else:                    #for any other character
        print("Error: do not know the command:", c)
```

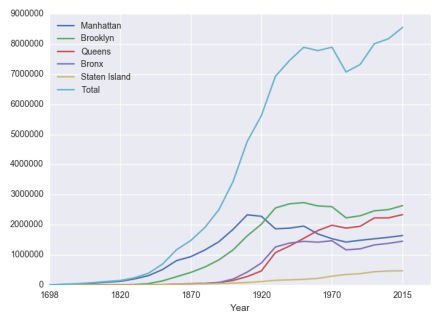
In Pairs or Triples: Week 5

When does this circuit yield true?

That is, what values for the inputs give an output value of true?



In Pairs or Triples: Week 6



Predict what the following will do:

- `print("Queens:", pop["Queens"].min())`
- `print("S I:", pop["Staten Island"].mean())`
- `print("S I:", pop["Staten Island"].std())`
- `pop.plot.bar(x="Year")`
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`

In Pairs or Triples: Week 7

Fill in the function body:

```
def monthString(monthNum):
    """
    Takes as input a number, monthNum, and
    returns the corresponding month name as a string.
    Example: monthString(1) returns "January".
    Assumes that input is an integer ranging from 1 to 12
    """

    monthString = ""

    ###################################
    ### FILL IN YOUR CODE HERE      ###
    ### Other than your name above, ###
    ### this is the only section    ###
    ### you change in this program. ###
    ###################################

    return(monthString)

def main():
    n = int(input('Enter the number of the month: '))
    mString = monthString(n)
    print('The month is', mString)
```

In Pairs or Triples: Week 8

```
def bar(n):
    if n <= 8:
        return 1
    else:
        return 0

def foo(l):
    n = bar(l[-1])
    return l[n]
```

- What are the formal parameters for the functions?
- What is the output of:

```
r = foo([1,2,3,4])
print("Return:  ", r)
```

- What is the output of:

```
r = foo([1024,512,256,128])
print("Return:  ", r)
```

In Pairs or Triples: Week 9

What does this code do?

```
import folium
import pandas as pd

cuny = pd.read_csv('cunyLocations.csv')
mapCUNY = folium.Map(location=[40.75, -74.125])

for index,row in cuny.iterrows():
    lat = row["Latitude"]
    lon = row["Longitude"]
    name = row["Campus"]
    if row["College or Institution Type"] == "Senior Colleges":
        collegeIcon = folium.Icon(color="purple")
    else:
        collegeIcon = folium.Icon(color="blue")
    newMarker = folium.Marker([lat, lon], popup=name, icon=collegeIcon)
    newMarker.add_to(mapCUNY)

mapCUNY.save(outfile='cunyLocationsSenior.html')
```

In Pairs or Triples: Week 10

- *Predict what the code will do:*

```
nums = [1,4,10,6,5,42,9,8,12]

maxNum = 0
for n in nums:
    if n > maxNum:
        maxNum = n
print('The max is', maxNum)
```

- Write a function that asks a user for number after 2000 but before 2018. The function should repeatedly ask the user for a number until they enter one within the range and return the number.

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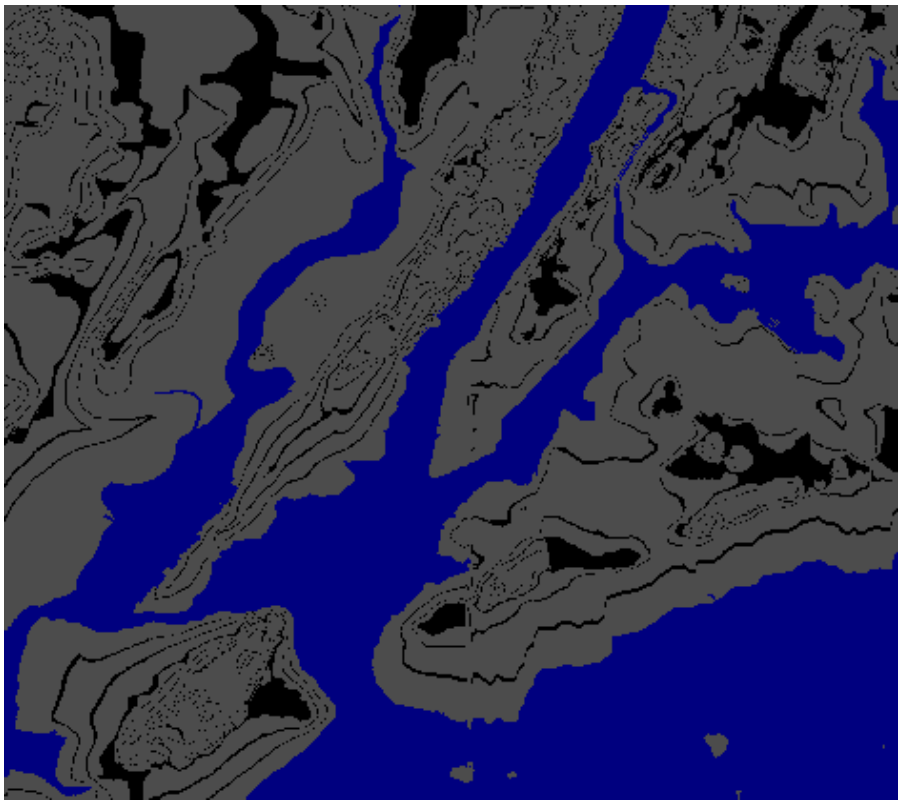
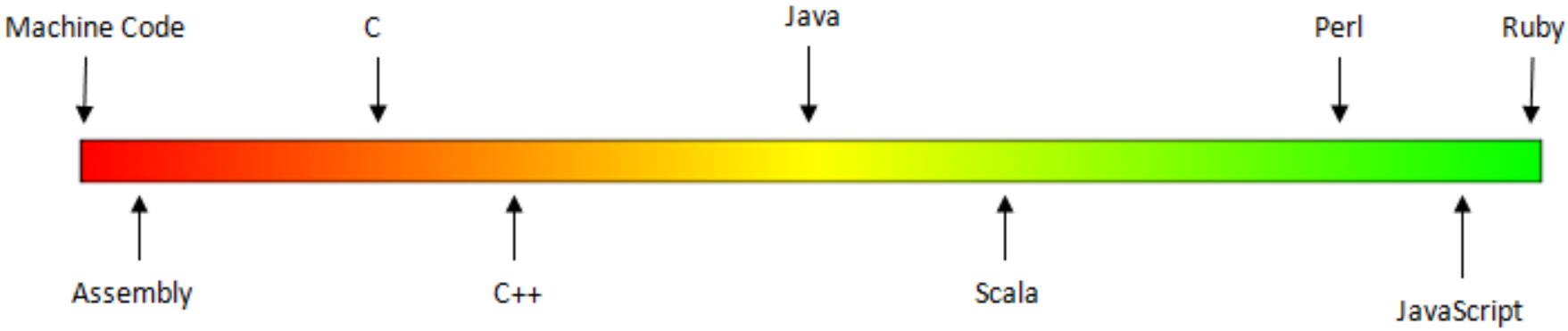
Lecture Slip: Commenting Code



In pairs or triples:

- What does the code do?
- Add comments to explain each line.

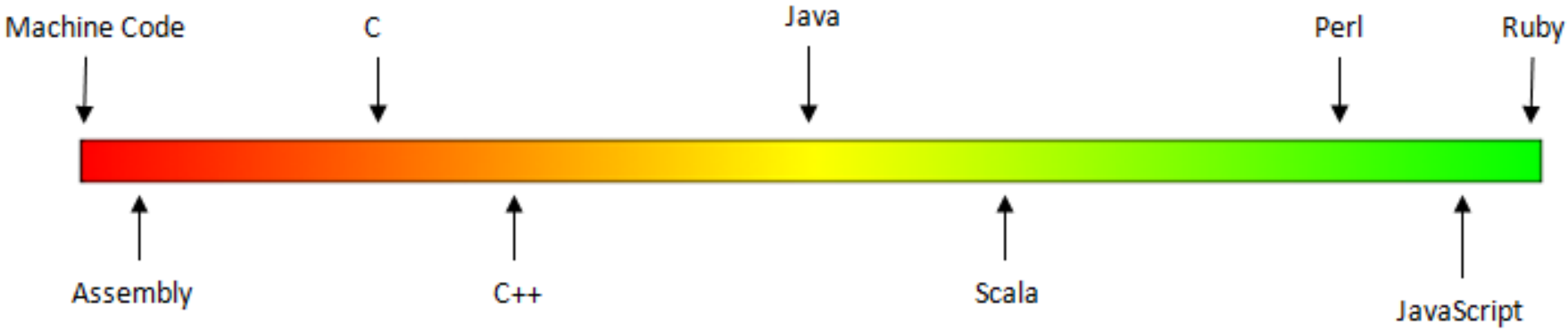
Low-Level vs. High-Level Languages



(codeCommit)

- Can view programming languages on a continuum.

Low-Level vs. High-Level Languages



(codeCommit)

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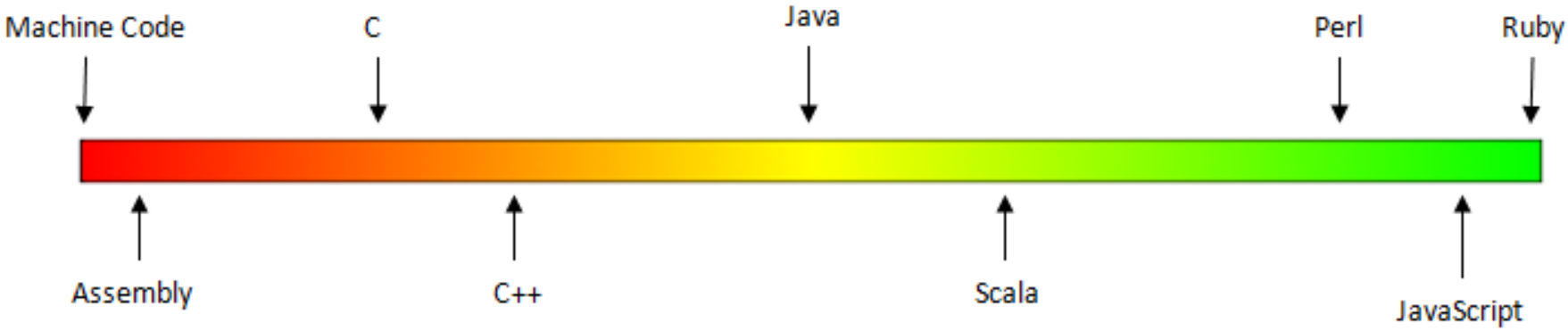
- Those that directly access machine instructions & memory and have little abstraction are **low-level languages**

Low-Level vs. High-Level Languages



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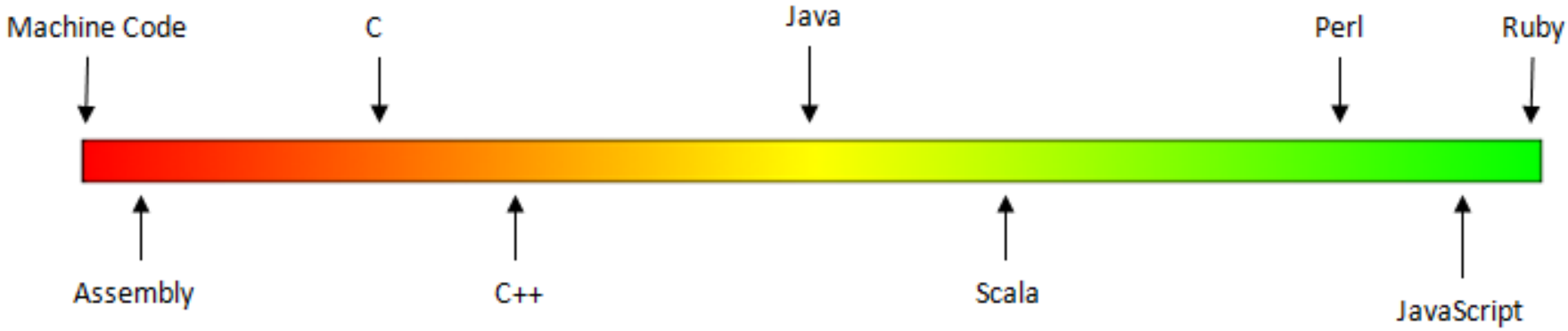
Low-Level vs. High-Level Languages



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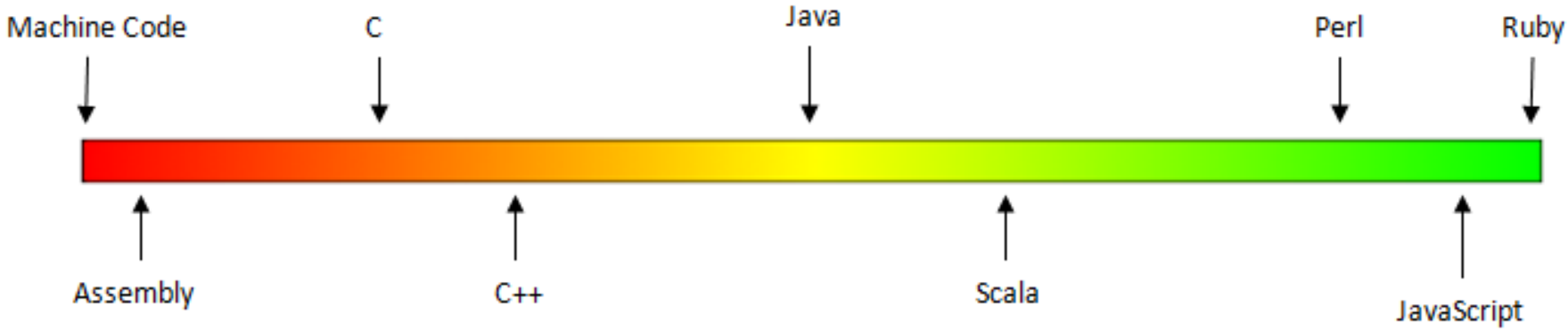
- Those that directly access machine instructions & memory and have little abstraction are **low-level languages** (e.g. machine language, assembly language).
- Those that have strong abstraction (allow programming paradigms independent of the machine details, such as complex variables, functions and looping that do not translate directly into machine code) are called **high-level languages**.

Low-Level vs. High-Level Languages



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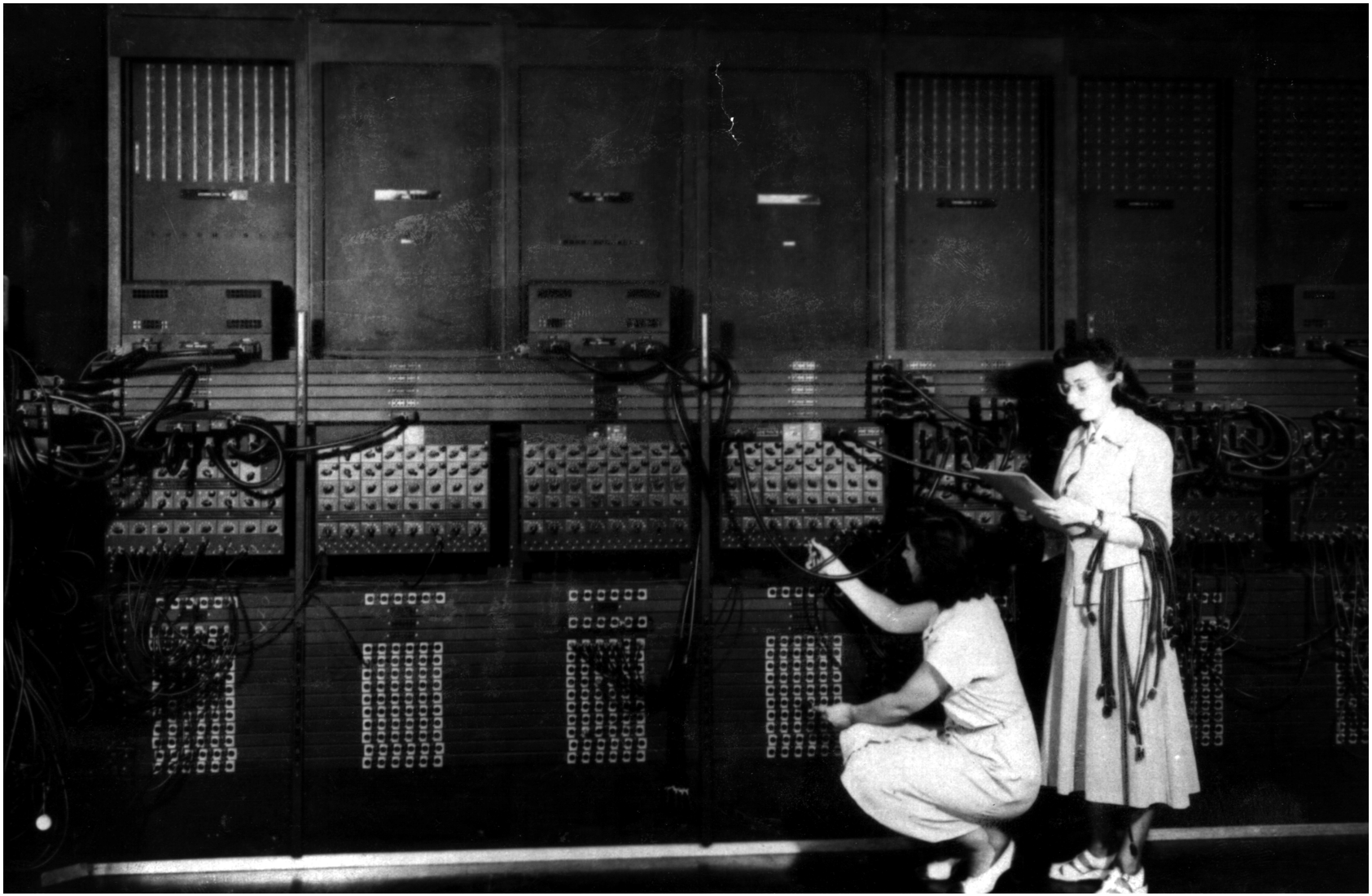
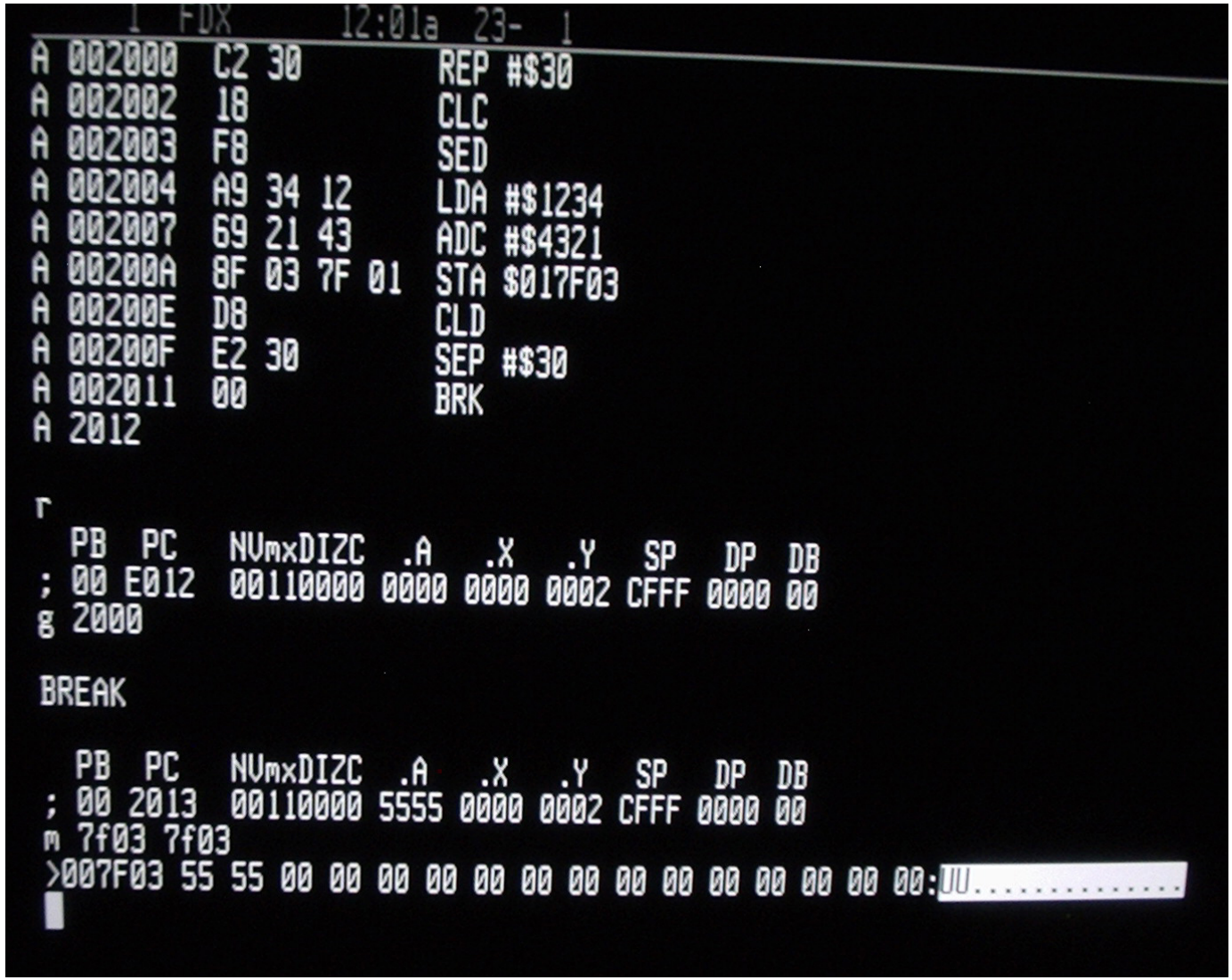
- Some languages, like C, are in between– allowing both low level access and high level data structures.

Machine Language



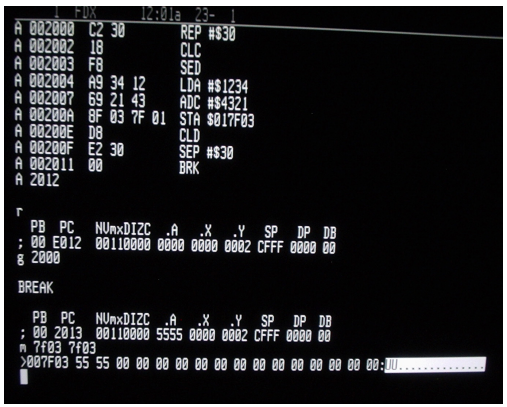
(Ruth Gordon & Ester Gerston programming the ENIAC, UPenn)

Machine Language



(wiki)

Machine Language



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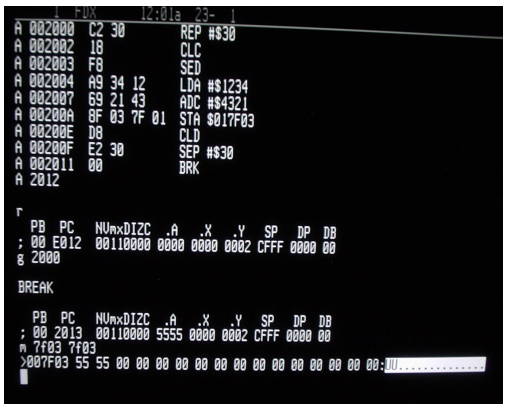
Machine Language



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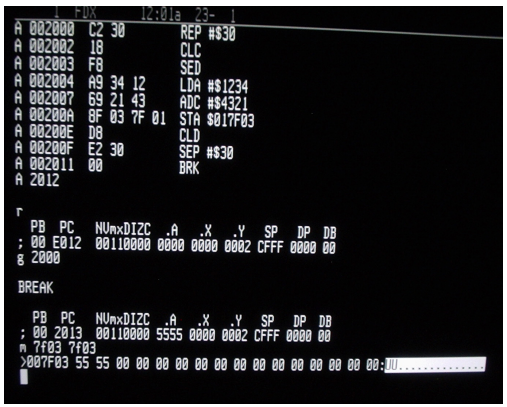

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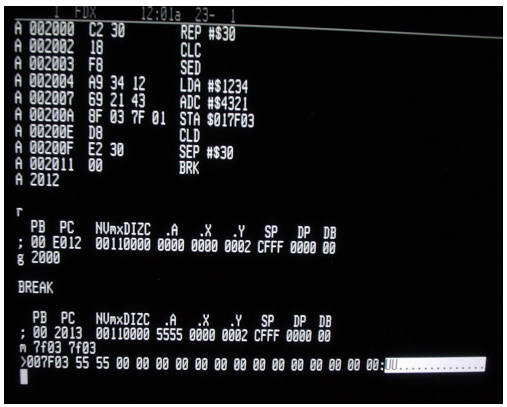
Machine Language



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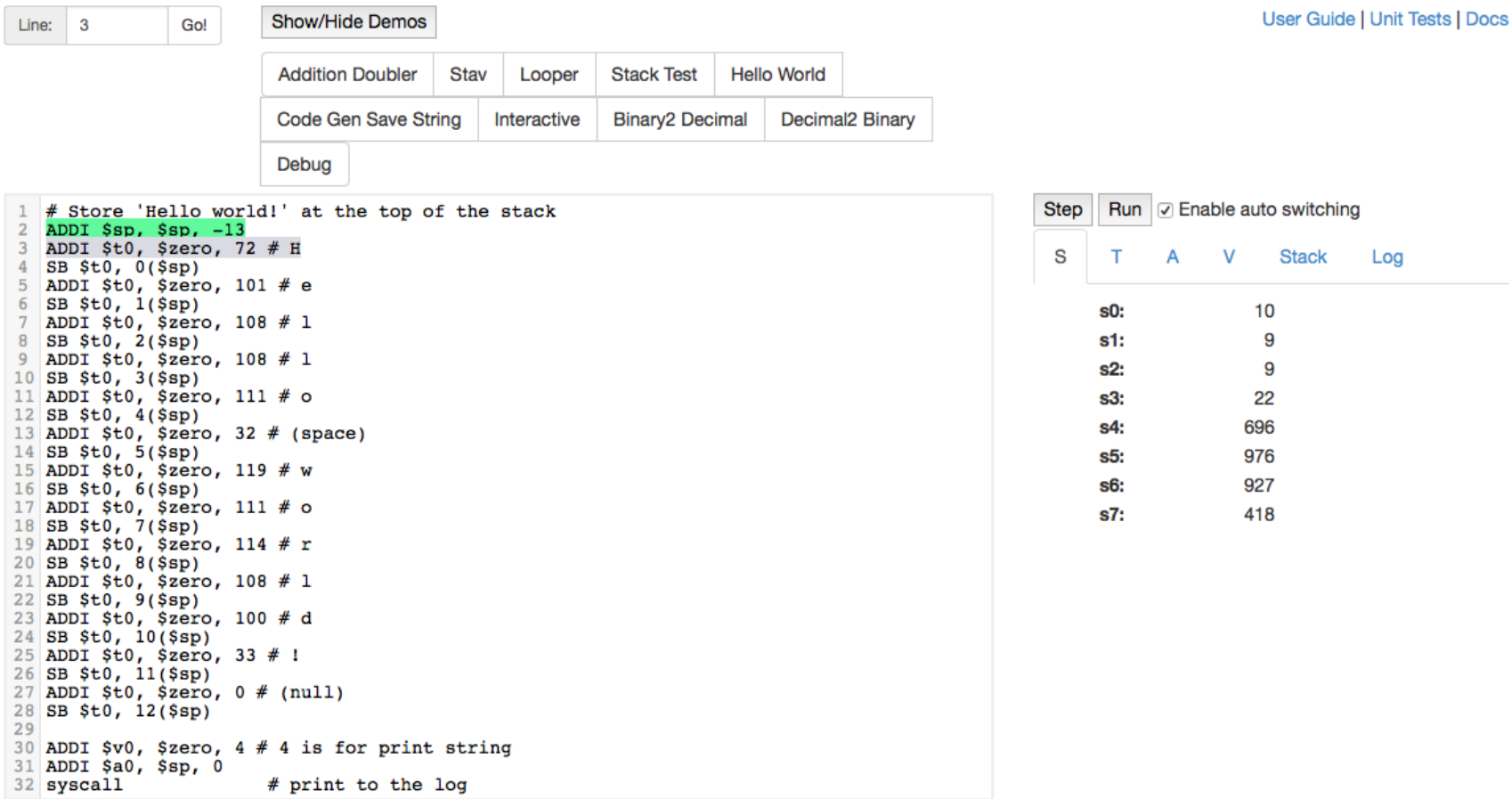
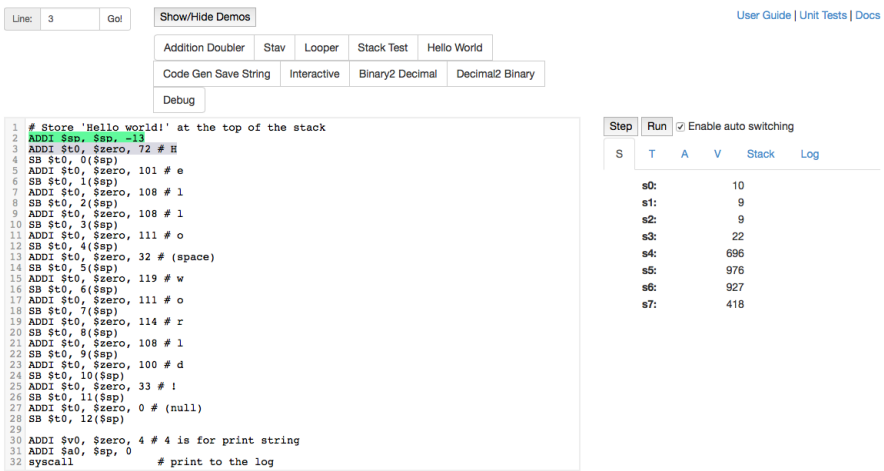
- More in future architecture classes....

"Hello World!" in Simplified Machine Language



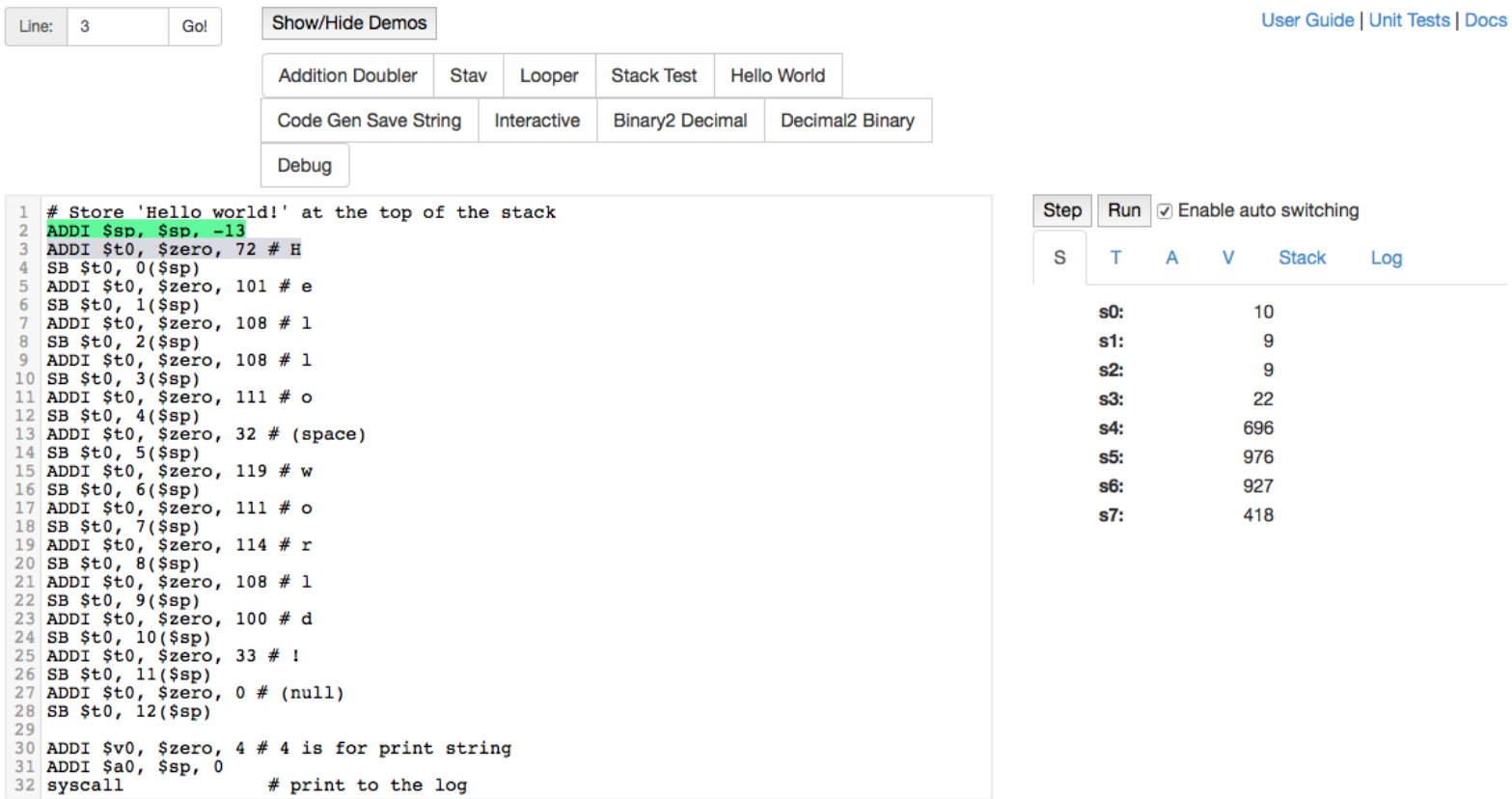
(WeMIPS)

WeMIPS



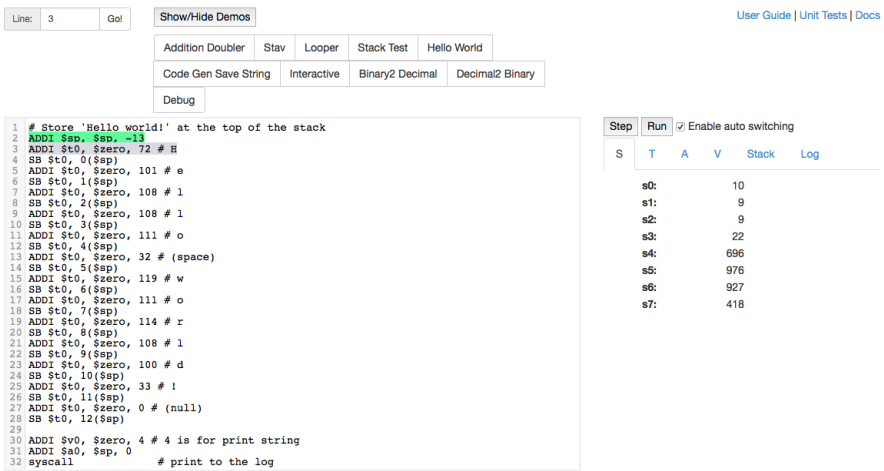
(Demo with WeMIPS)

In Pairs or Triples:



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

WeMIPS



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- Past exams available on webpage (includes answer keys).

Recap: Python, Languages, & Design

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#Name:  your name here
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#This program, uses functions,
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def main():
     print("Hello, World!")

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- Logical Circuits
- Simplified Machine Language
- Design: from written description ('specs') to function inputs & outputs ('APIs')

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- Write a function that takes a weight in kilograms and returns the weight in pounds.
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- Write a function that, given a DataFrame, returns the minimal value in the first column.
- Write a function that takes a whole number and returns the corresponding binary number as a string.
- Write a function that computes the total monthly payment when given the initial loan amount, annual interest rate, number of years of the loan.

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(Hint: highlight key words, make list of inputs, list of outputs, then put together.)

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def kg2lbs(kg):
    ...
    return(lbs)
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```
def kg2lbs(kg)
    lbs = kg * 2.2
    return(lbs)
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```

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```
def sLength(str):
    length = len(str)
    return(length)
```

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    return(min)
```

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For each question below, write the function header (name & inputs) and return values (often called the Application Programming Interface (API)):

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```
def getMin(df):
    mM = df['Manhattan'].min()
    return(mM)
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def num2bin(num):
    ...
    return(bin)
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```
def num2bin(num):
    binStr = ""
    while (num > 0):
        #Divide by 2, and add the remainder to the string
        r = num %2
        binString = str(r) + binStr
        num = num / 2
    return(binStr)
```

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- Write a function that computes the total monthly payment when given the initial loan amount, annual interest rate, number of years of the loan.

```
def computePayment(loan,rate,year):
    (Some formula for payment)
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