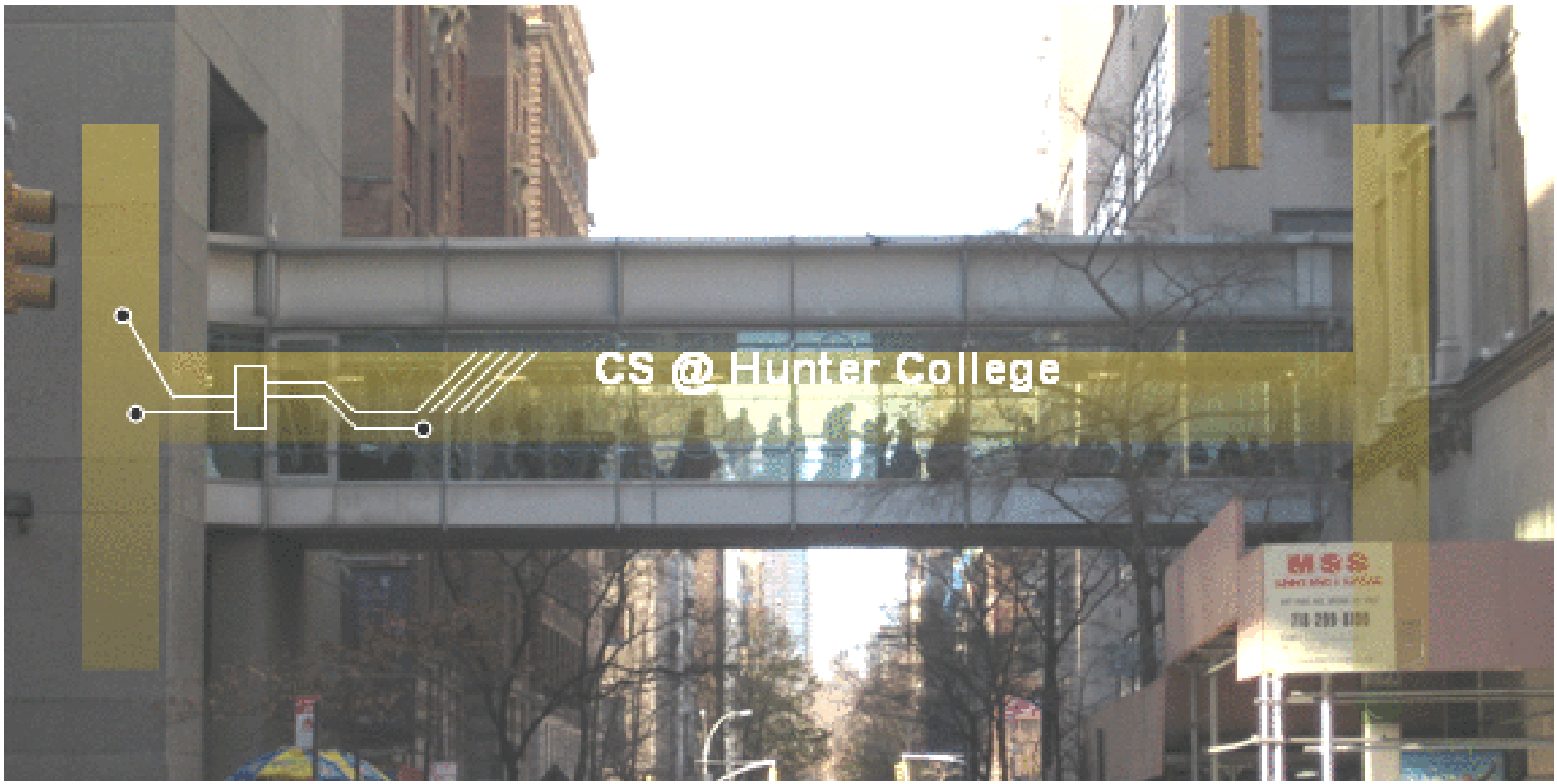
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

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  Thursday-Saturday, 28-31 November.

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- In response to wrap-up requests, additional challenges today with while loops and binary & hexadecimal numbers.

Today's Topics

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

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- **Design Patterns: Searching**
- Python Recap
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- Final Exam: Format

In Pairs or Triples:

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

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(Demo with `pythonTutor`)

Design Pattern: Linear Search

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

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- Design Patterns: Searching
- **Python Recap**
- Machine Language
- Machine Language: Jumps & Loops
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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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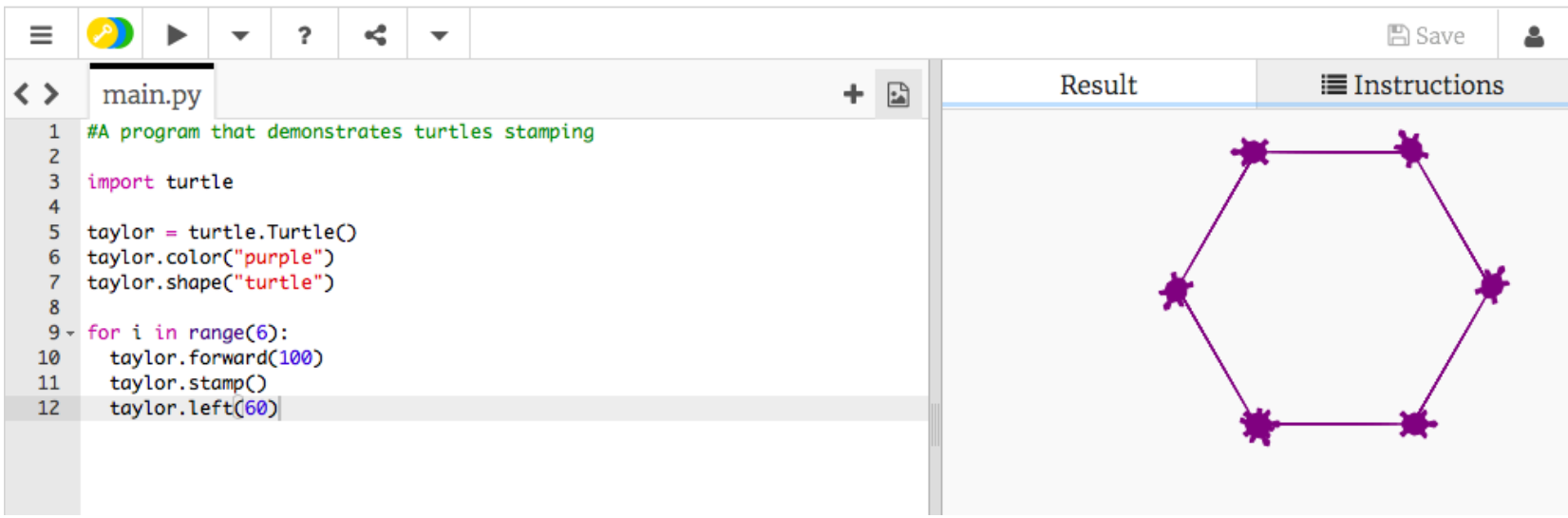
- As well as definite loops & the turtle package:



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

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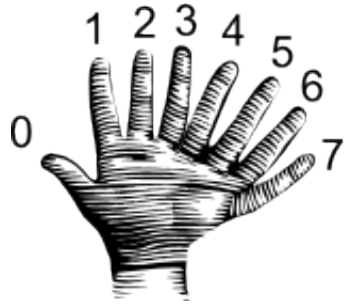
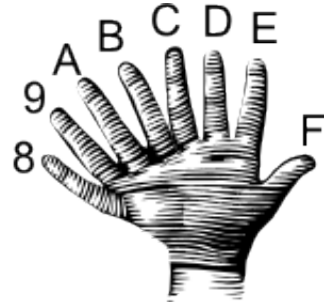
  - **class variables**: for complex objects, like turtles.
- More on loops & ranges:

```
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

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





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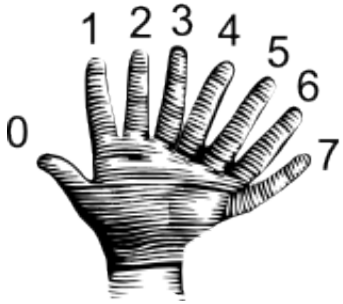

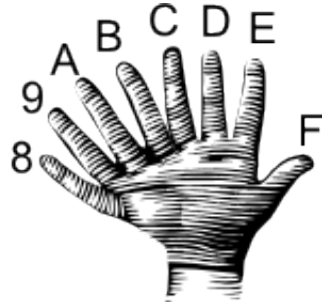

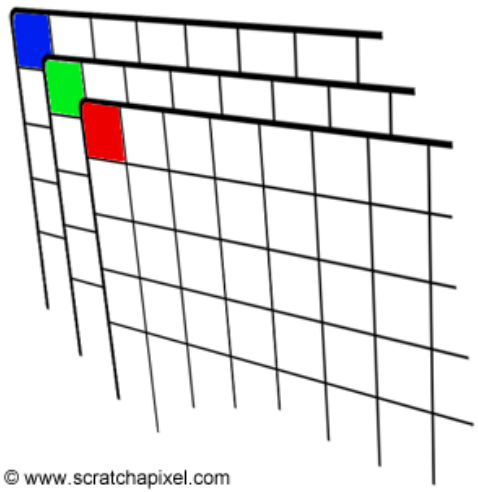

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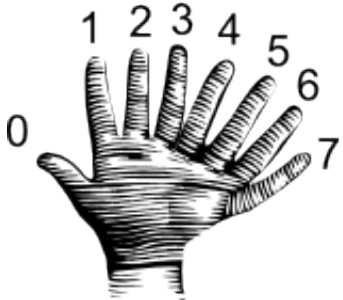
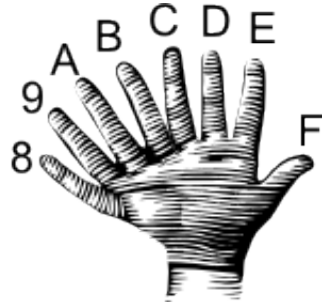
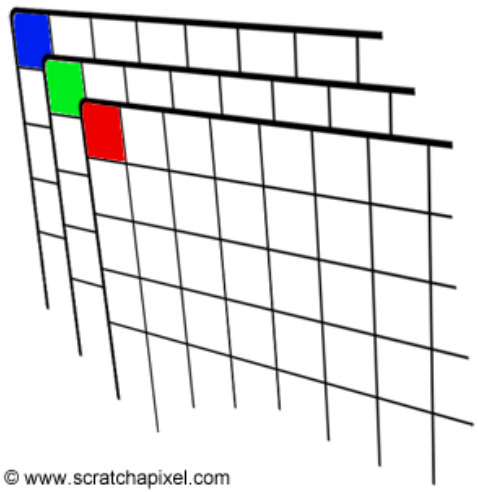




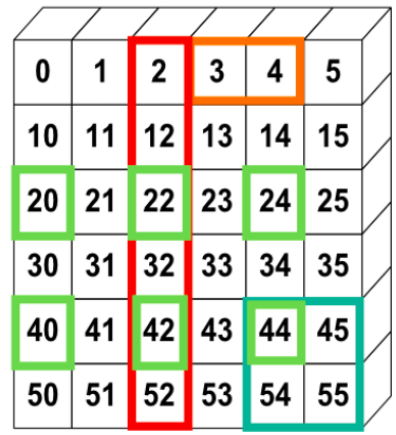



```
>>> a[0,3:5]
array([3,4])

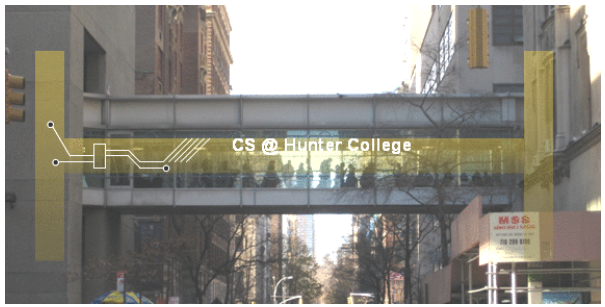
>>> a[4:,4:]
array([[44, 45],
       [54, 55]])

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

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



Week 4: design problem (cropping images) & decisions



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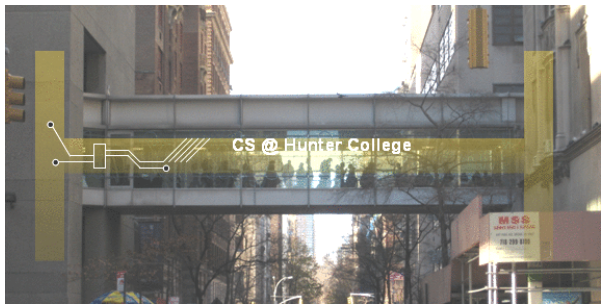

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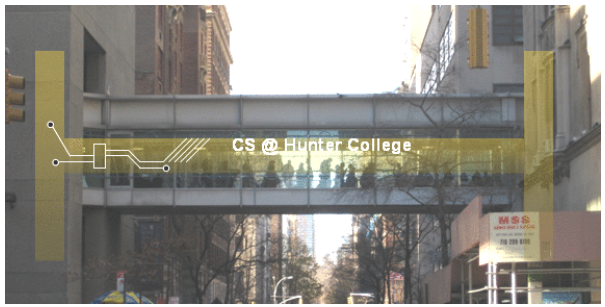

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- Next: write pseudocode.
  1. Import numpy and pyplot.
  2. Ask user for file names and dimensions for cropping.
  3. Save input file to an array.
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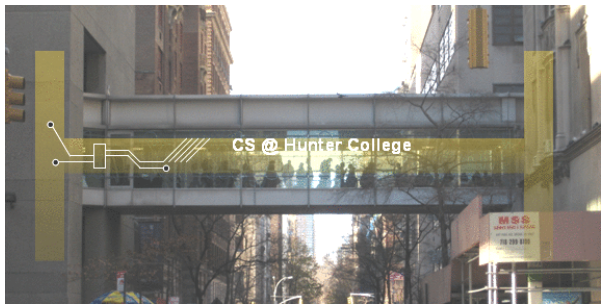

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- Next: translate to Python.

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

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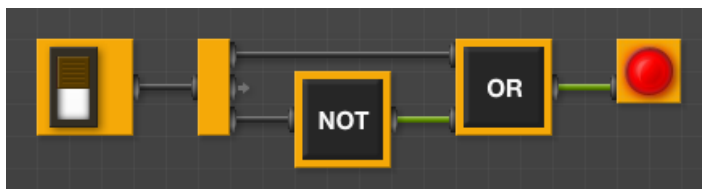
in1		in2	*returns:*
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True



Week 6: structured data, pandas, & more design

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Source:  https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,,
All population figures are consistent with present-day boundaries.,,,,,,
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,,,,,,
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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
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1860,813669,279122,32903,23593,25492,1174779
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1890,1441216,838547,87050,88908,51693,2507414
1900,1850093,1166582,152999,200507,67021,3437202
1910,2331542,1634351,284041,430980,85969,4766883
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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
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2015,1644518,2636735,2339150,1455444,474558,8550405
```

`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

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

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`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

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

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

```
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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
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```

`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

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Source:  https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,,
All population figures are consistent with present-day boundaries.,,,,,,
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,,,,,,
,,,,,,
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
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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()
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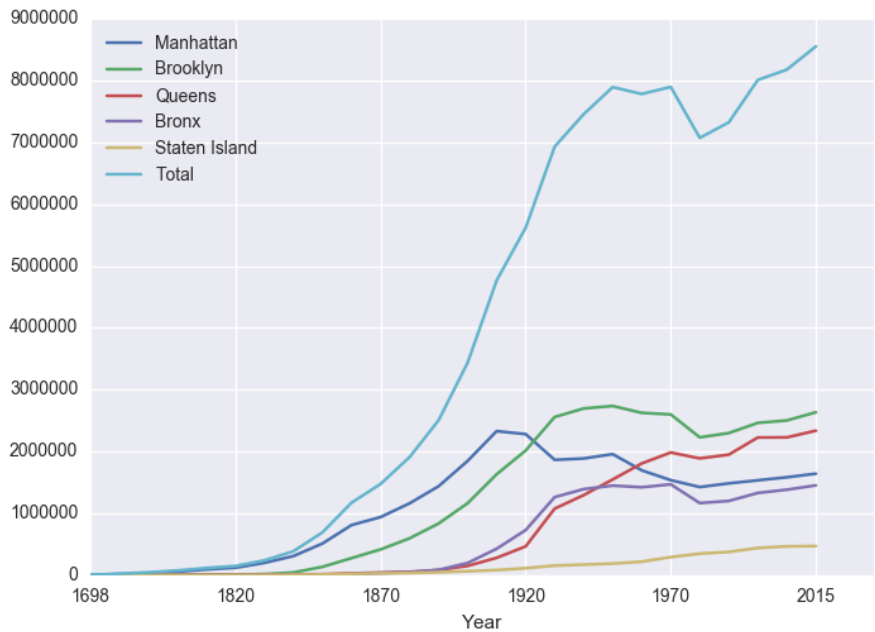

Week 7: functions

```
#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()
```

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

Week 7: functions

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- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:

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- 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

- 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: '))
dTip = float(input('Enter dinner tip:' ))
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```

Week 8: function parameters, github

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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

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


```
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)
```

- 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)
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```

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- 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.

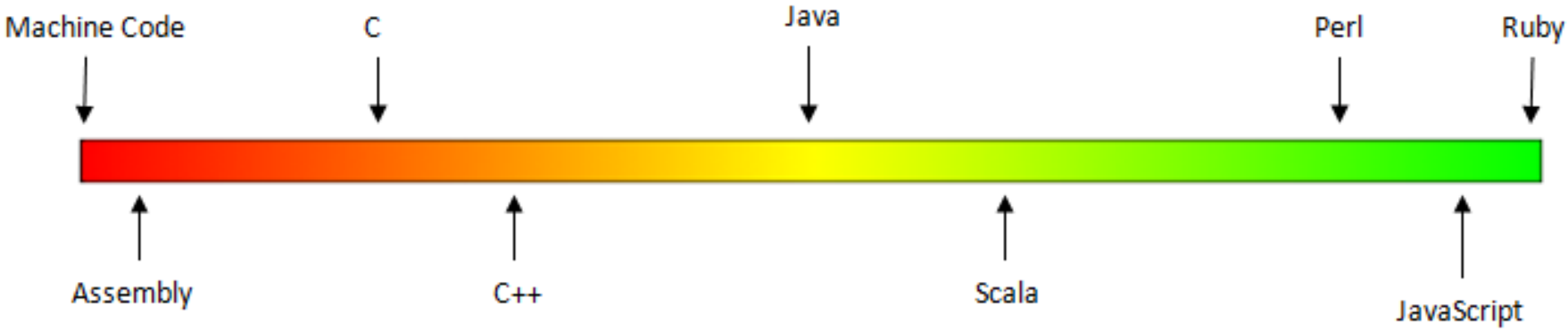
Python & Circuits Review: 10 Weeks in 10 Minutes

- 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

Today's Topics

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

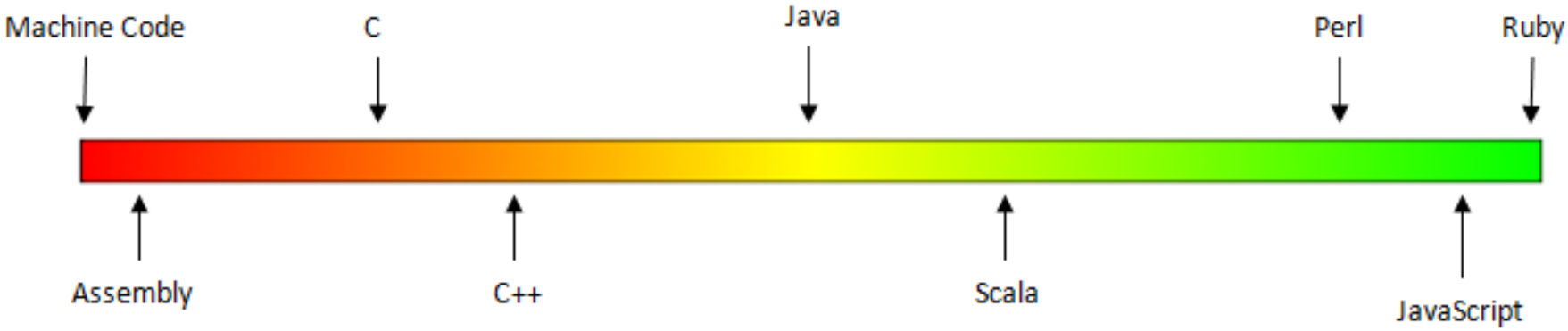
Low-Level vs. High-Level Languages



(codeCommit)

- Can view programming languages on a continuum.

Low-Level vs. High-Level Languages



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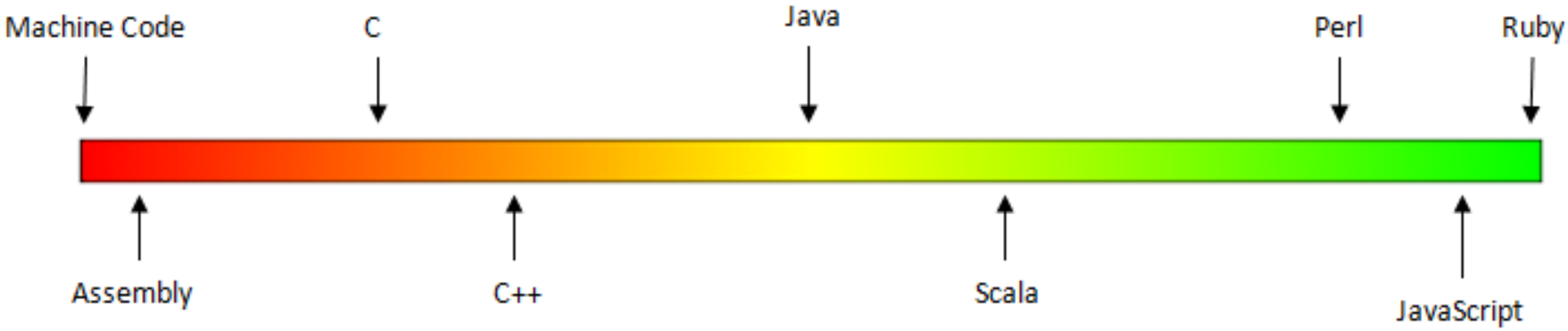

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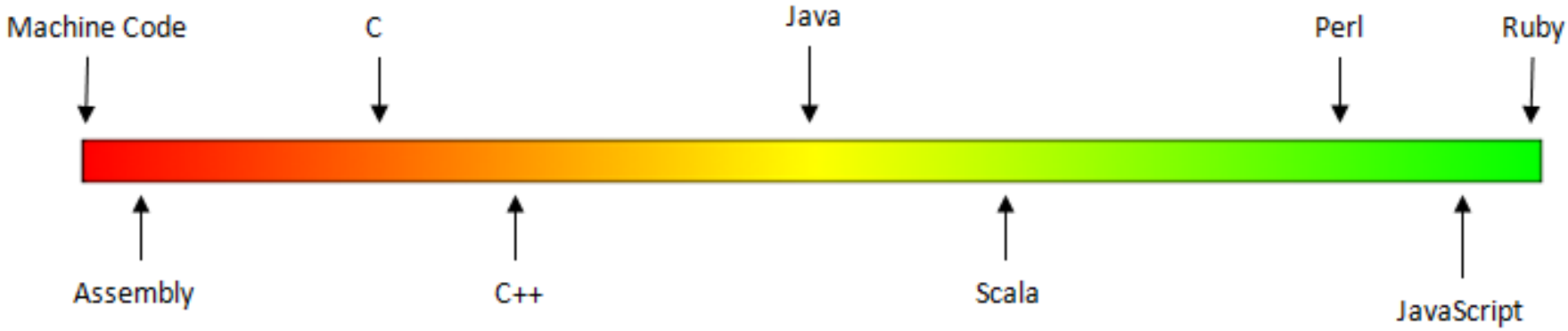

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- Those that have strong abstraction (allow programming paradigms independent of the machine details, such as complex variables, functions and looping that do not translate directly into machine code) are called **high-level languages**.

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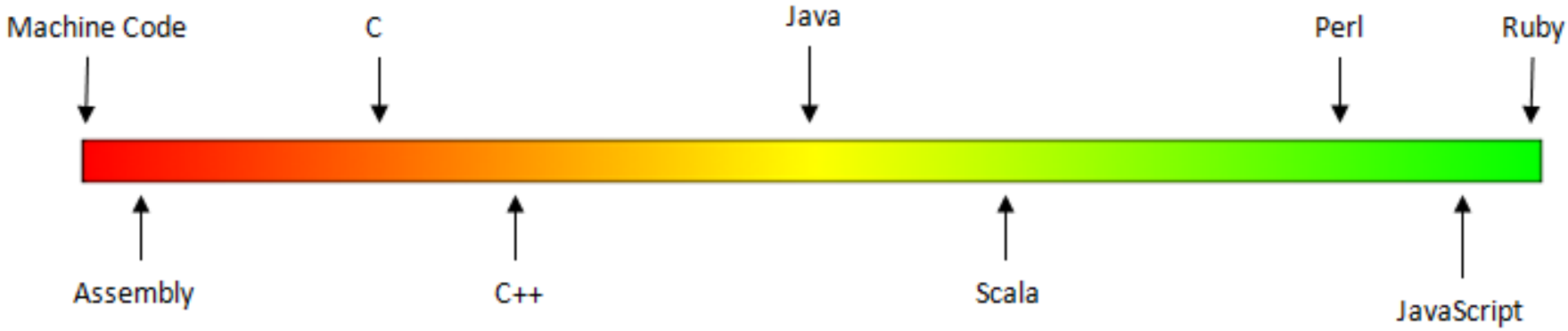

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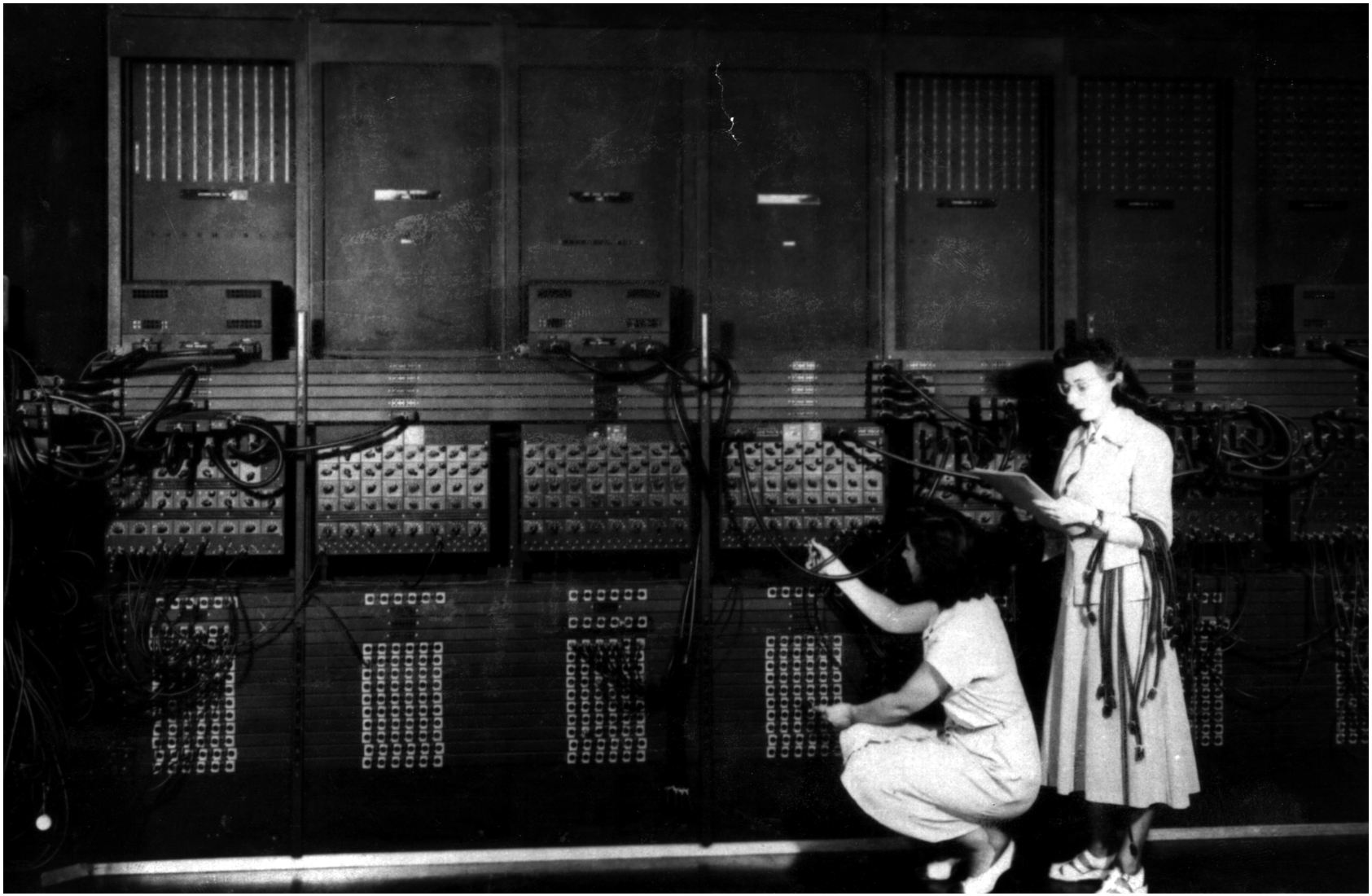
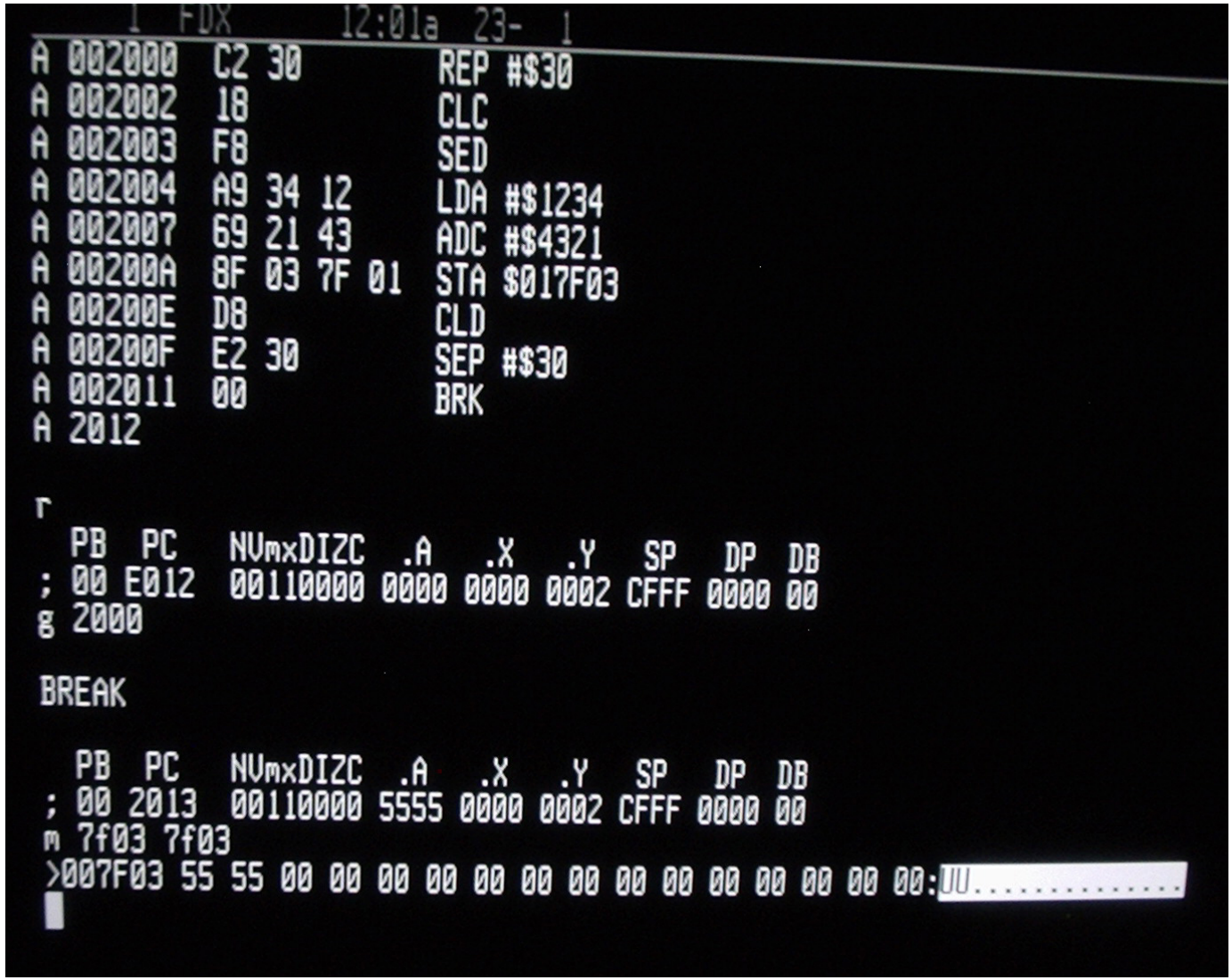
- Some languages, like C, are in between– allowing both low level access and high level data structures.

Machine Language



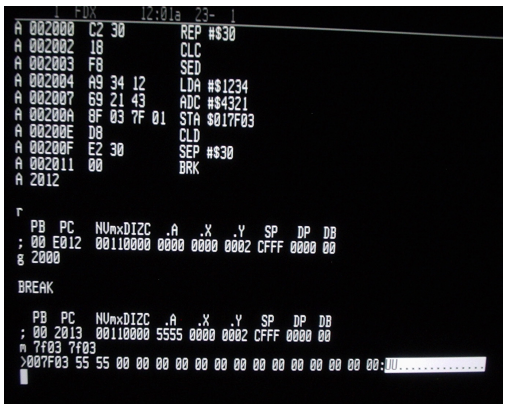
(Ruth Gordon & Ester Gerston programming the ENIAC, UPenn)

Machine Language



(wiki)

Machine Language



(wiki)

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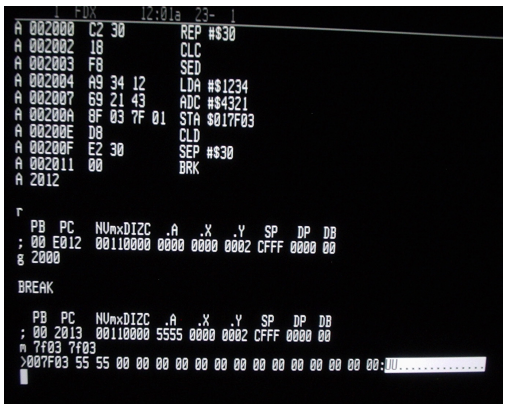
Machine Language



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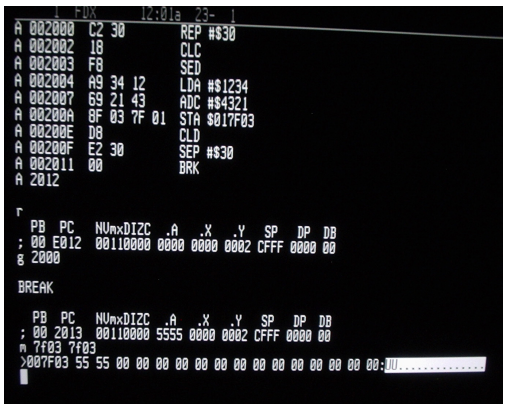
Machine Language



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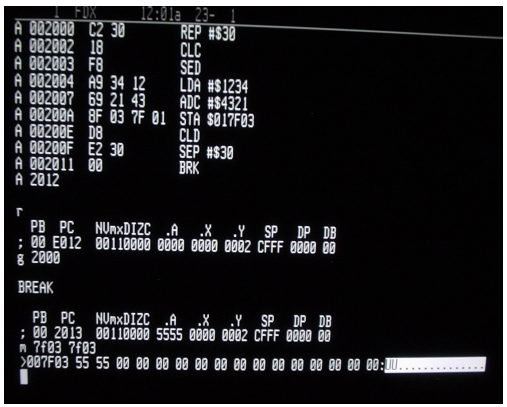
- It is based on a reduced instruction set computer (RISC) design, originally developed by the MIPS Computer Systems.
- Due to its small set of commands, processors can be designed to run those commands very efficiently.

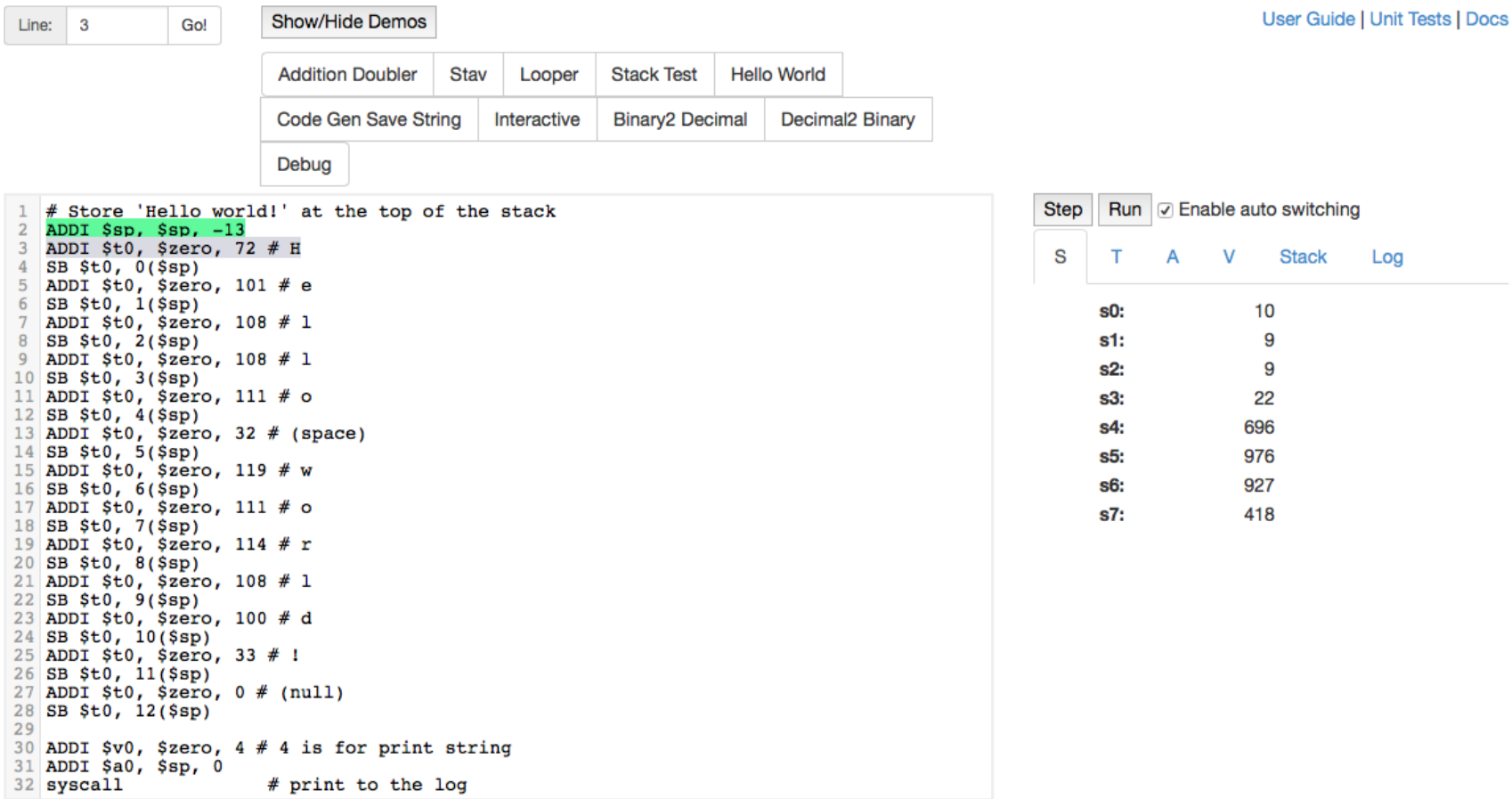
Machine Language



(wiki)

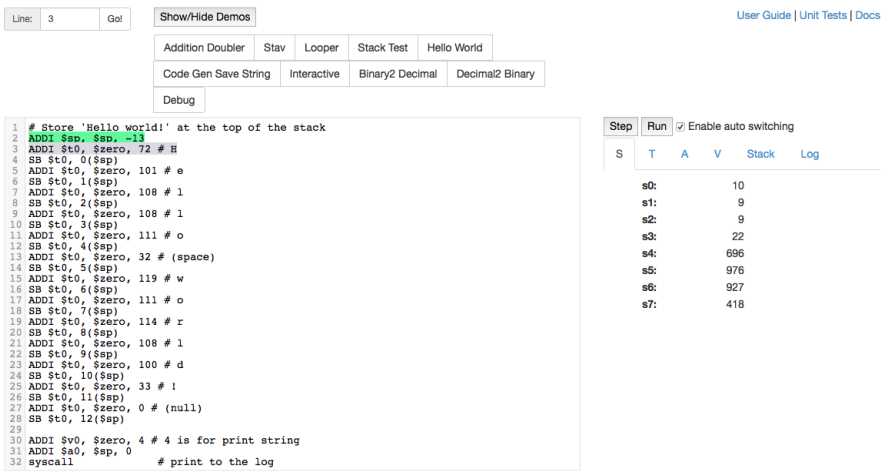
- We will be writing programs in a simplified machine language, WeMIPS.
- It is based on a reduced instruction set computer (RISC) design, originally developed by the MIPS Computer Systems.
- Due to its small set of commands, processors can be designed to run those commands very efficiently.
- More in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

"Hello World!" in Simplified Machine Language



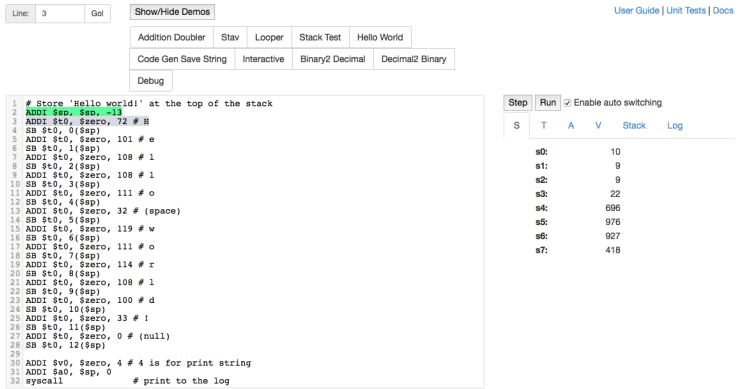
(WeMIPS)

WeMIPS



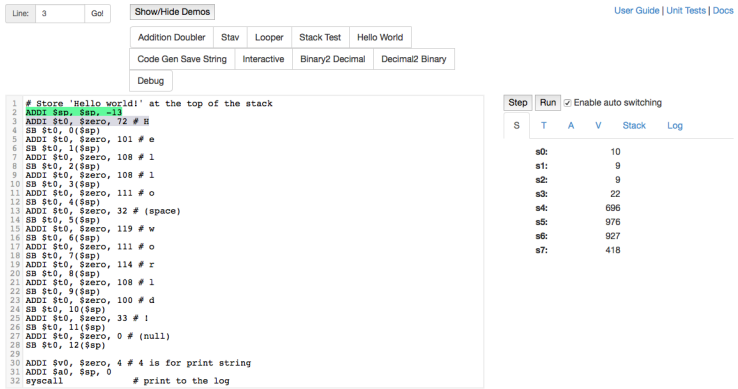
(Demo with `WeMIPS`)

MIPS Commands



- **Registers:** locations for storing information that can be quickly accessed.

MIPS Commands



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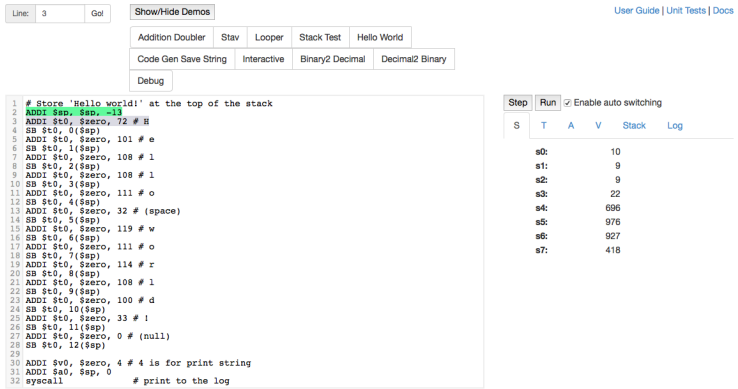

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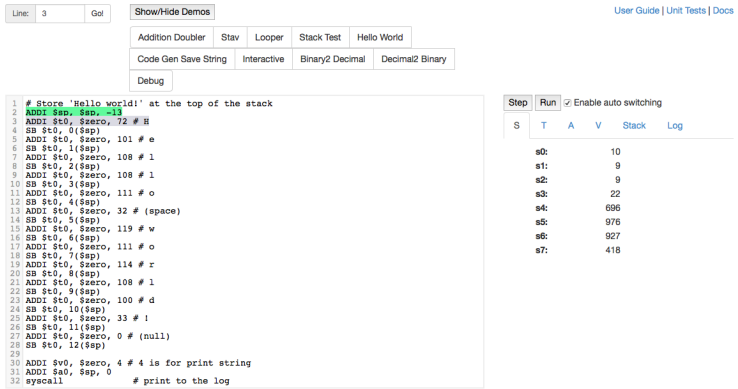

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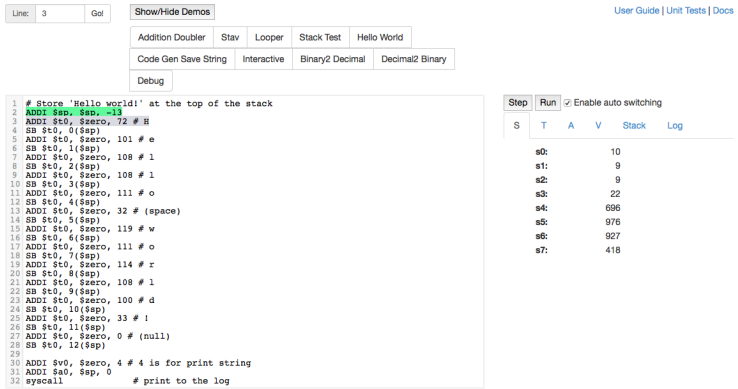

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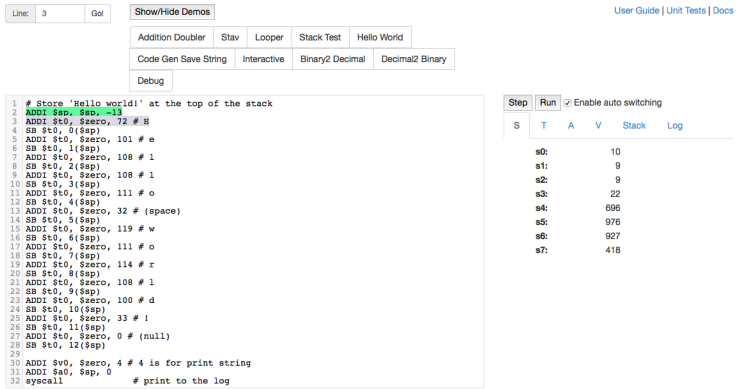

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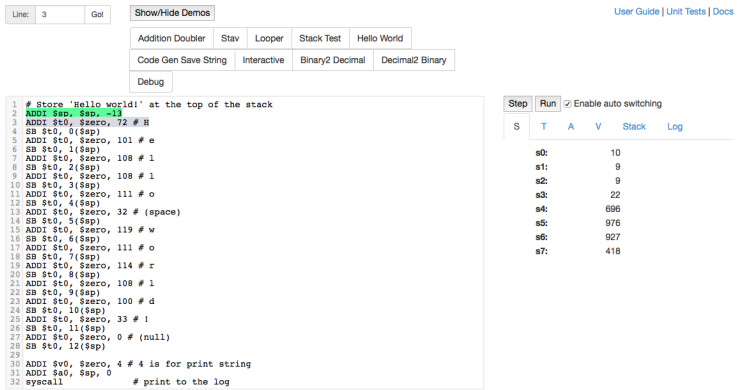

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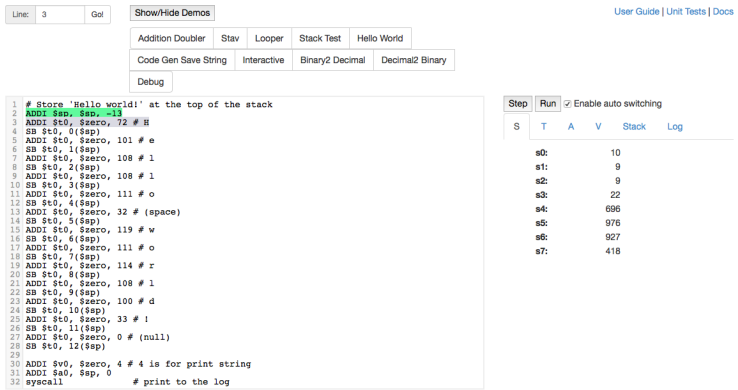

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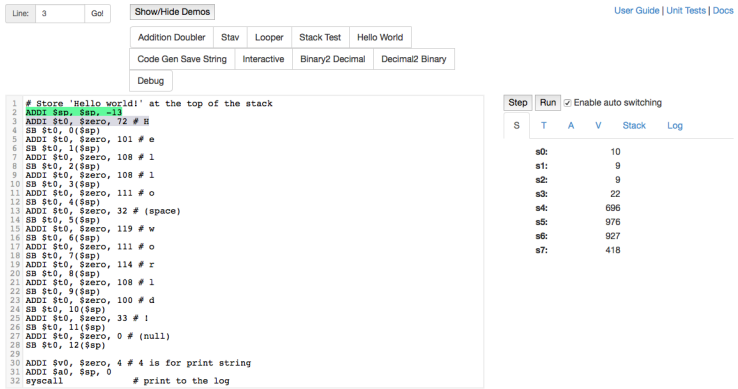

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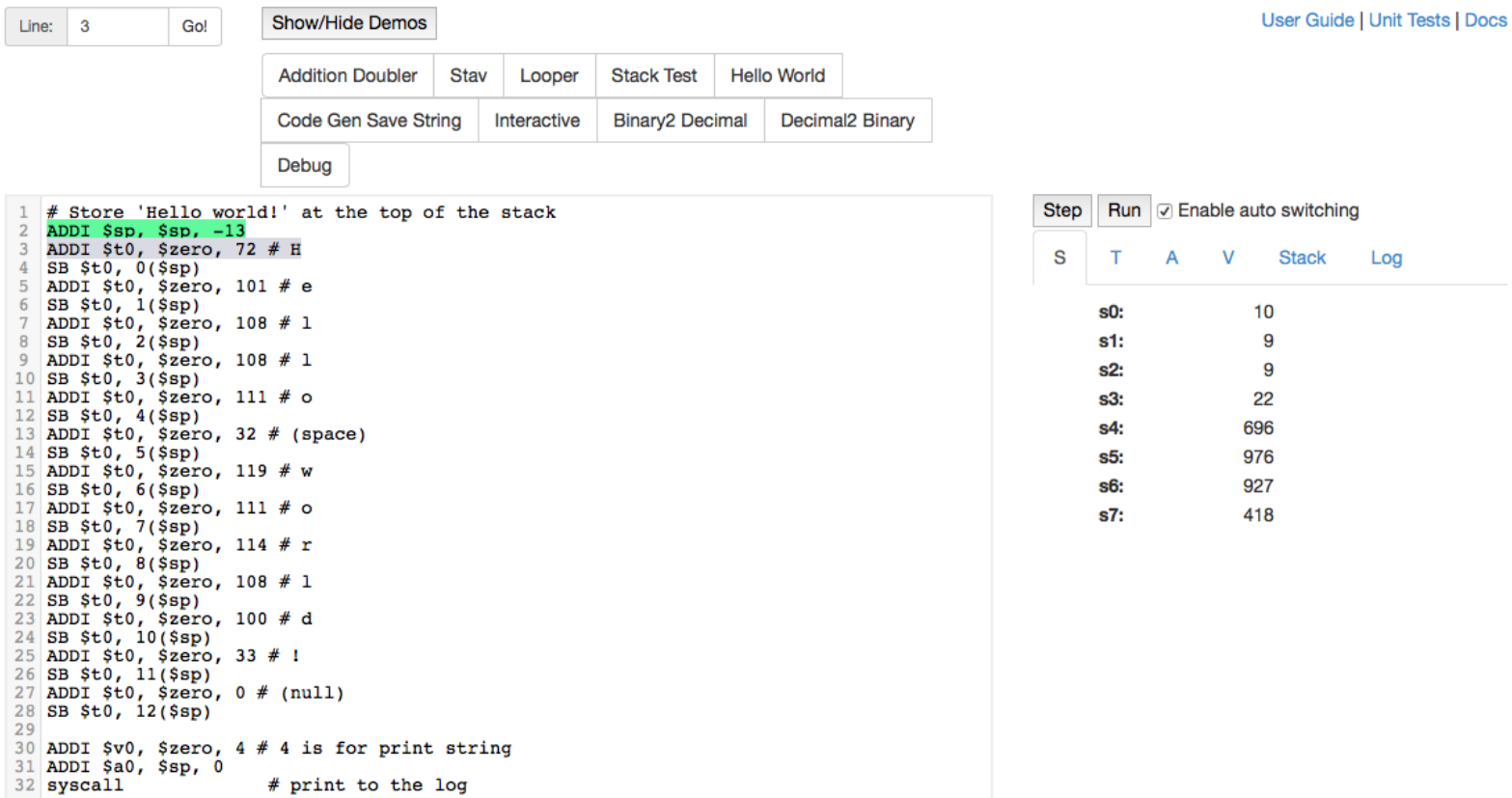
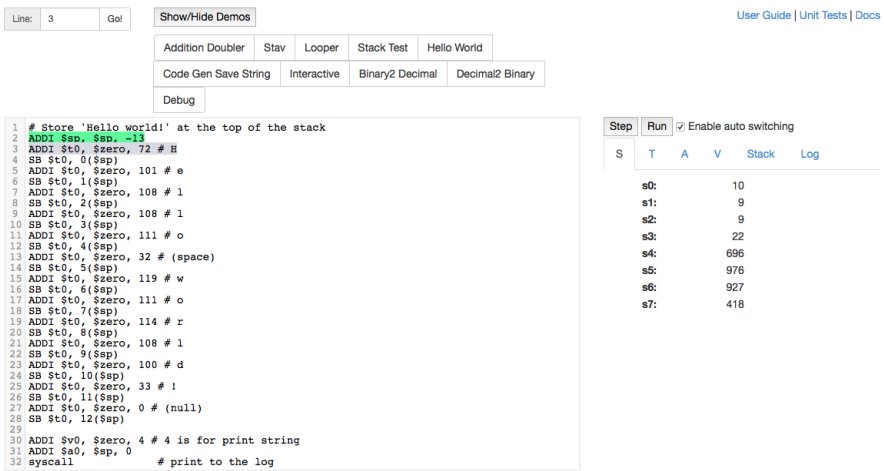
In Pairs or Triples:



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

WeMIPS



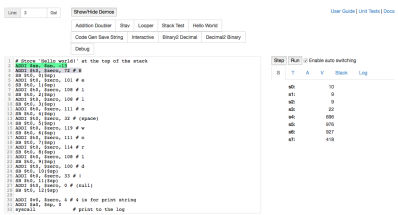
(Demo with `WeMIPS`)

Today's Topics

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

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.



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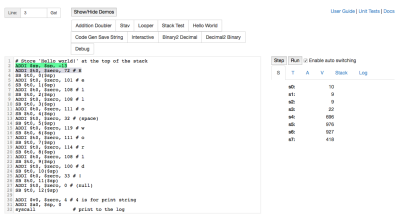

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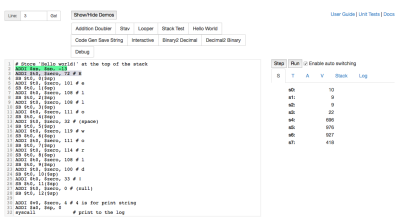

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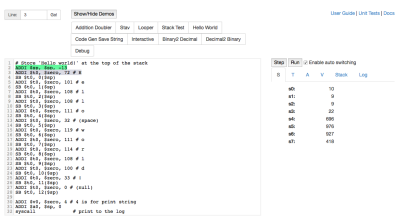

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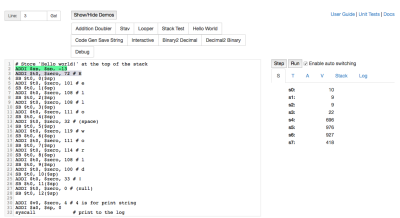

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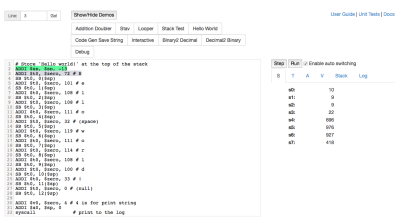

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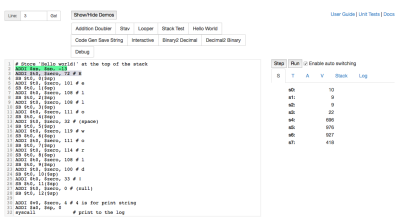
Loops & Jumps in Machine Language



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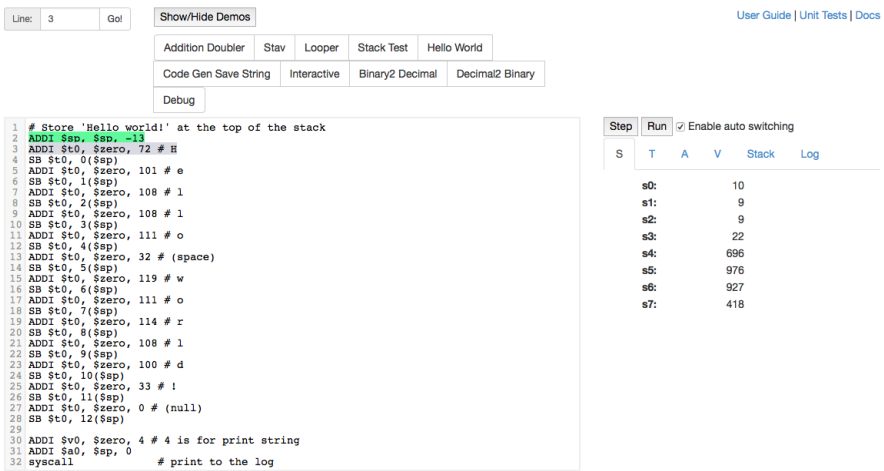
  - See reading for more variations.

Jump Demo



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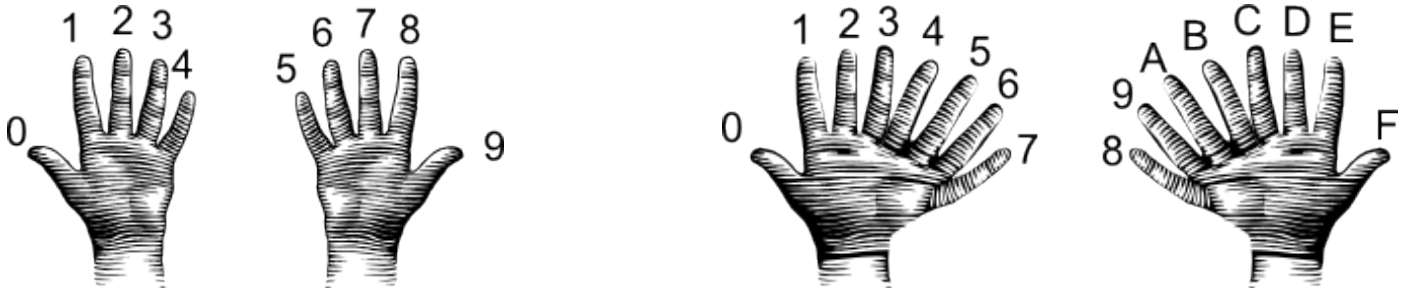
Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal:
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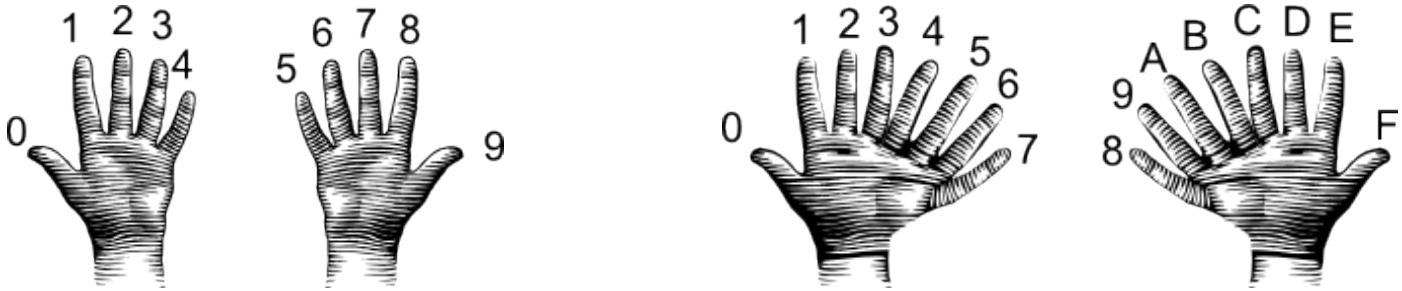

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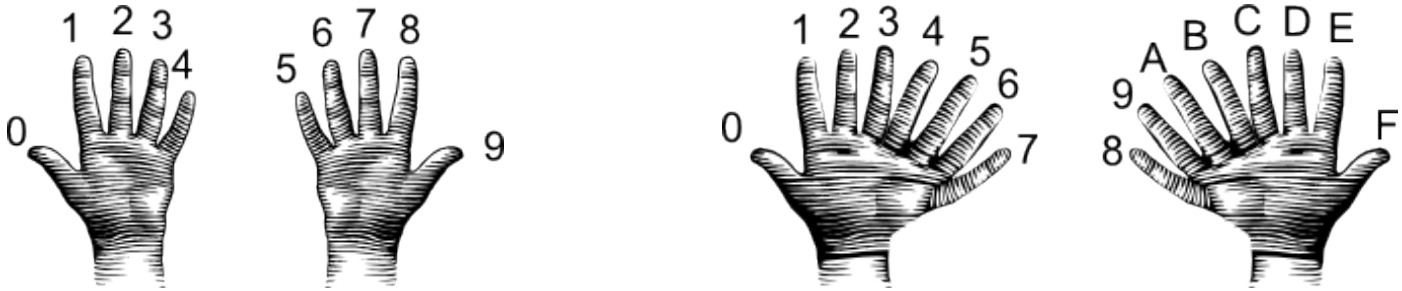

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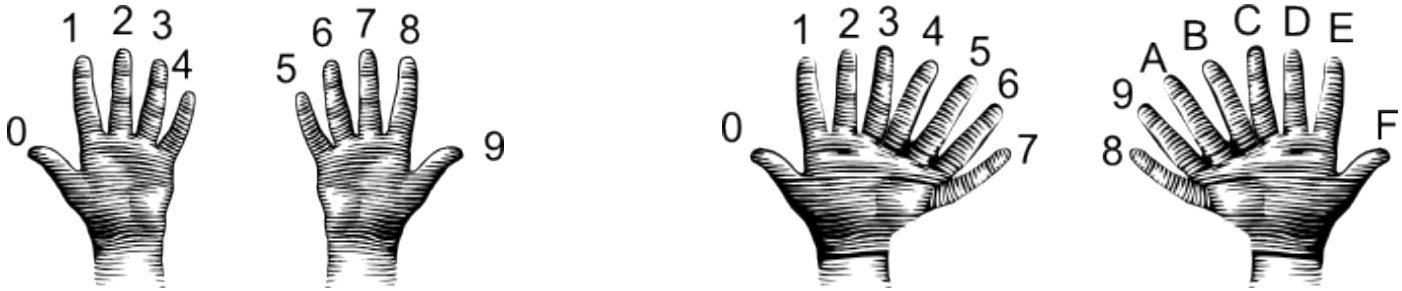

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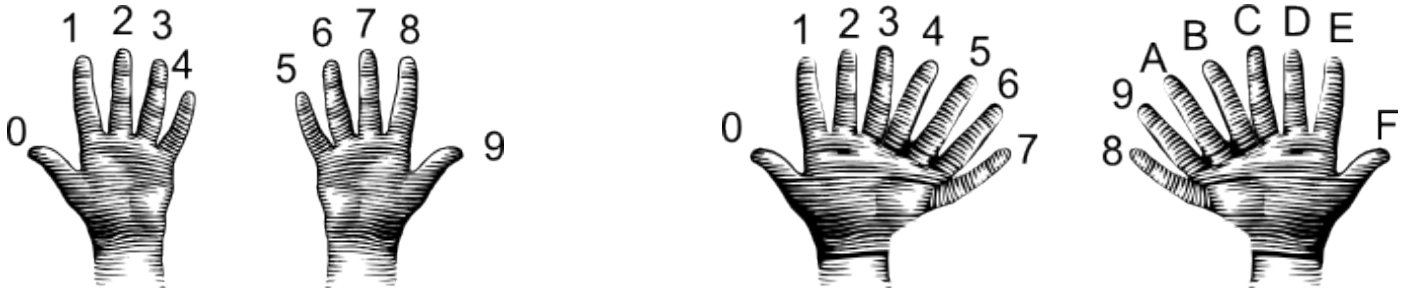

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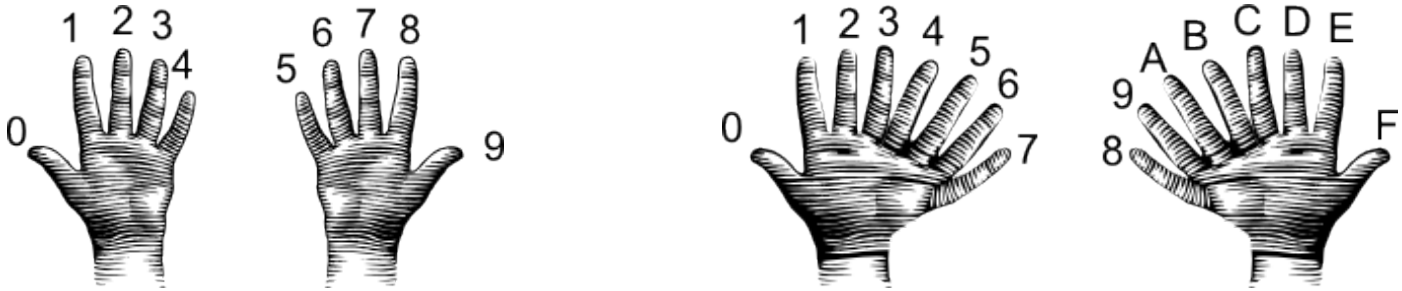

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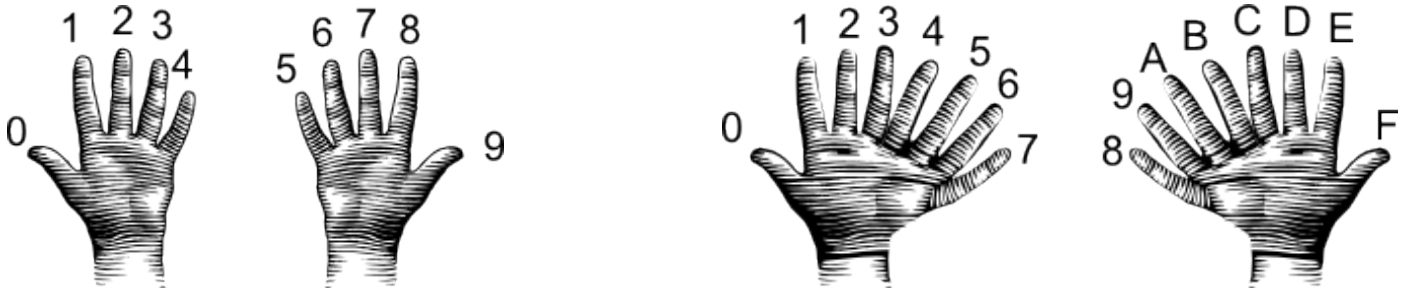

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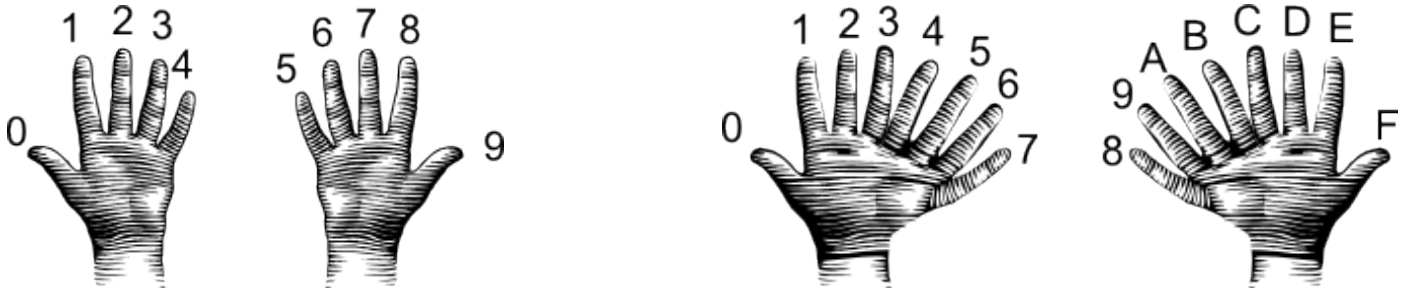

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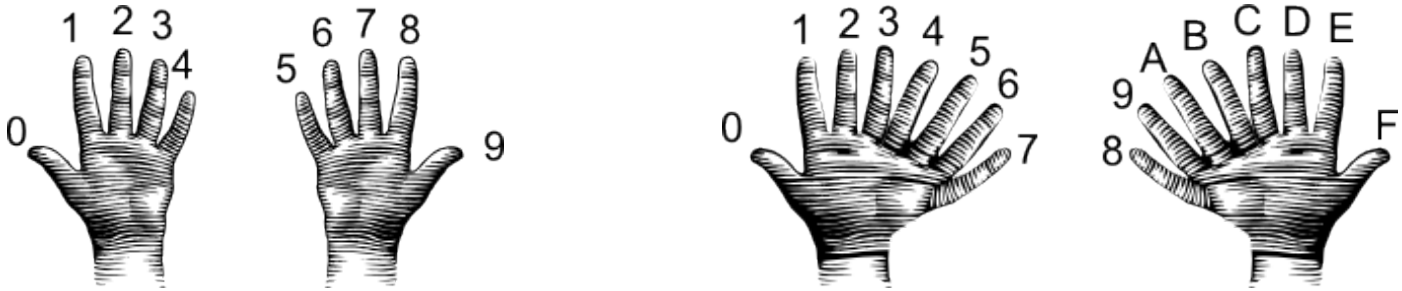

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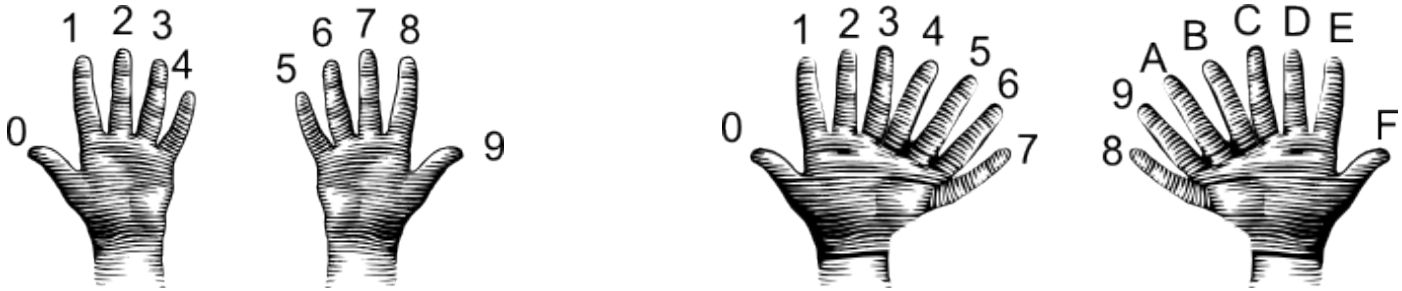

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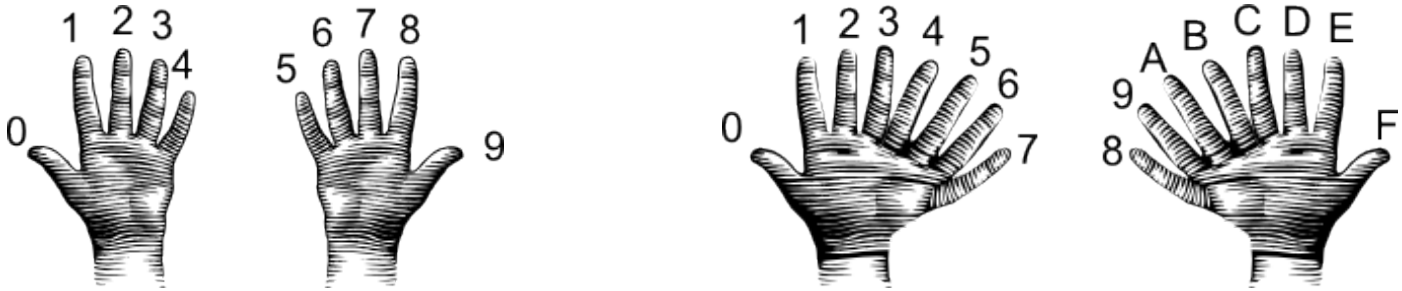

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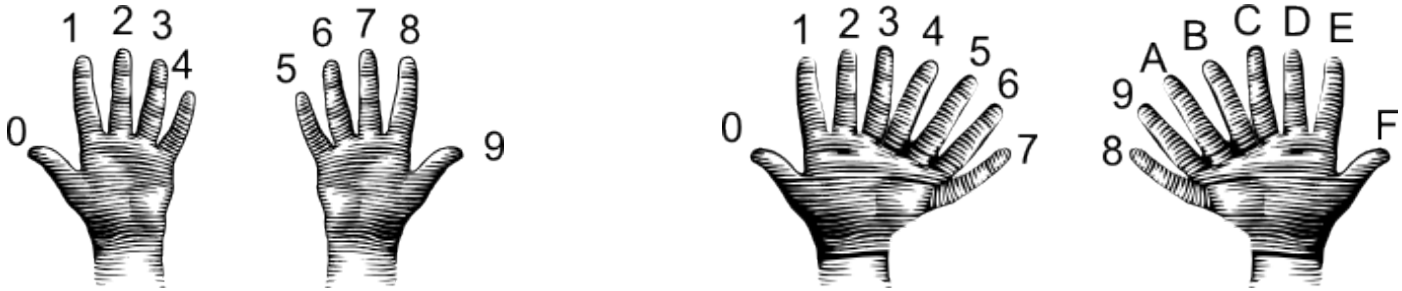
    `9 in decimal digits is 9`

Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal:
  - 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.`

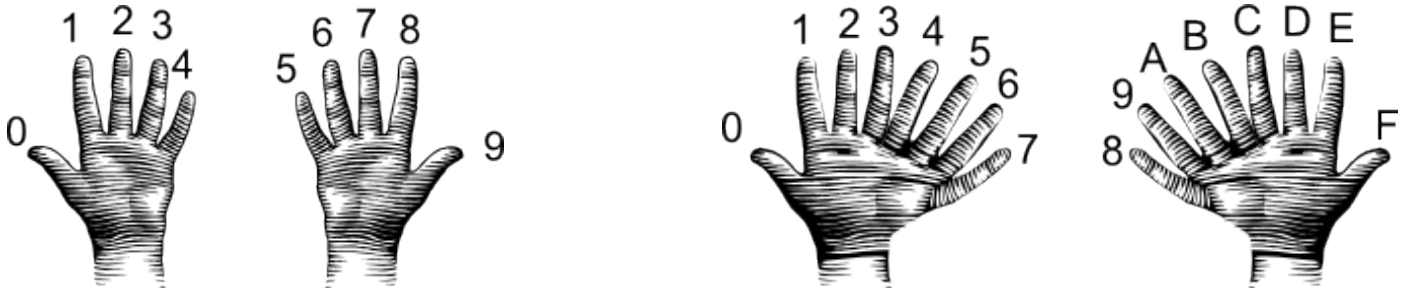
    Answer is 42.
  - Example: what is 99 as a decimal number?

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

    `9 in decimal digits is 9`

    `144 + 9 is 153.`

Hexadecimal to Decimal: Converting Between Bases



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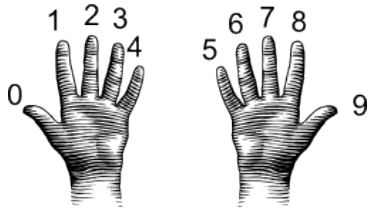
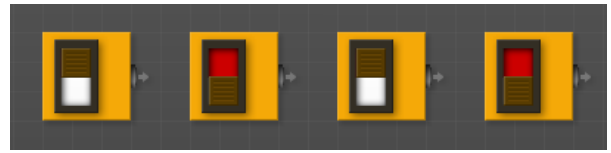
- From hexadecimal to decimal:
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.
  - Example: what is 2A as a decimal number?
    `2 in decimal is 2. 2*16 is 32.`
    `A in decimal digits is 10.`
    `32 + 10 is 42.`
    Answer is 42.
  - Example: 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.

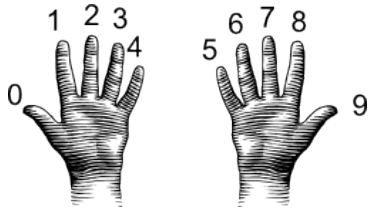
Decimal to Binary: Converting Between Bases

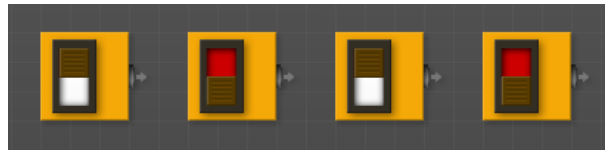




- From decimal to binary:
  - Divide by 128 ($= 2^7$). Quotient is the first digit.

Decimal to Binary: Converting Between Bases





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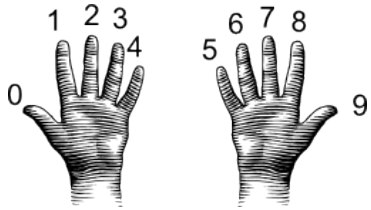

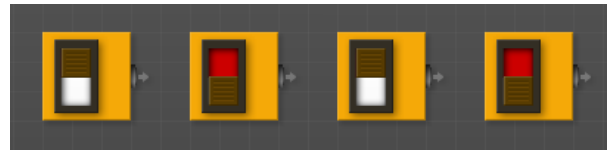

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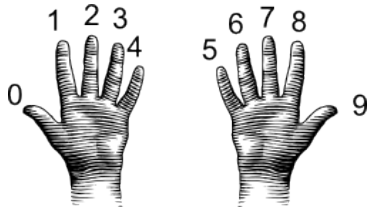

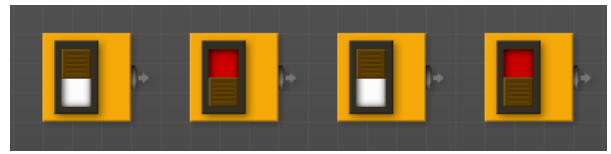

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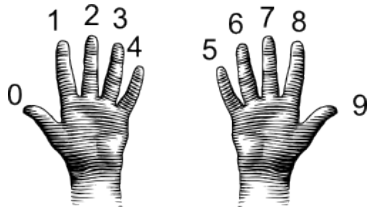

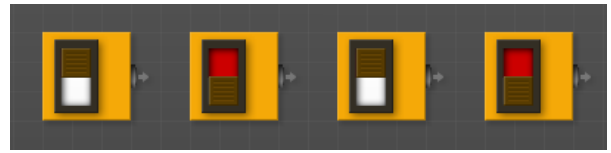

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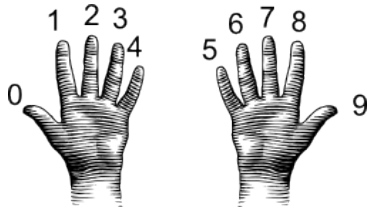

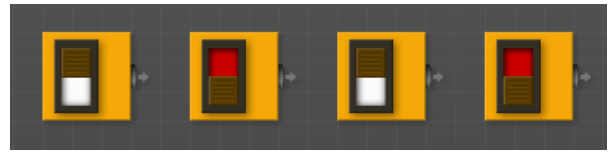

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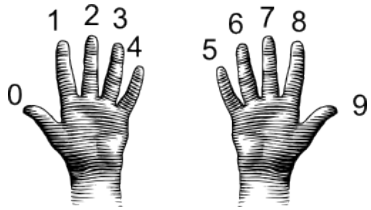

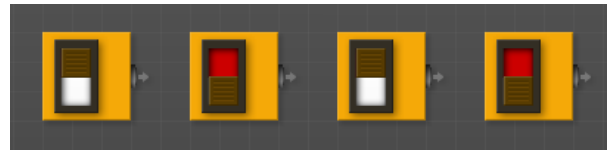

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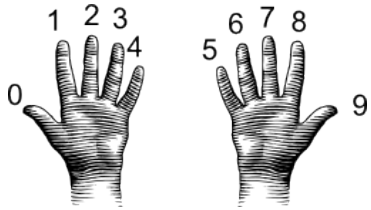

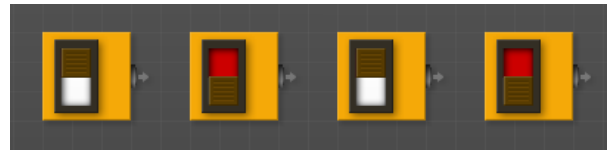

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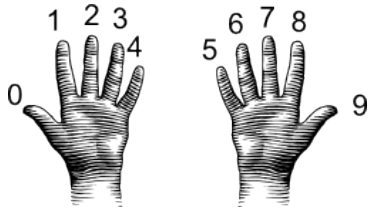

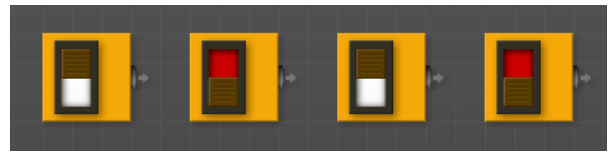

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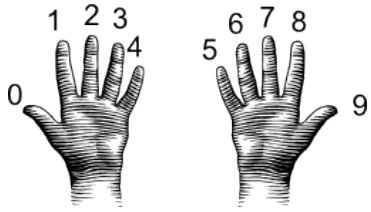
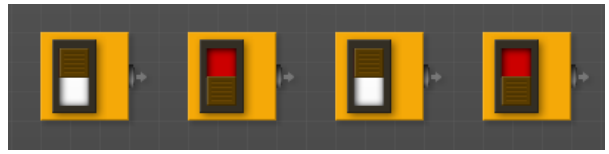
  - Example: what is 130 in binary notation?

Decimal to Binary: Converting Between Bases





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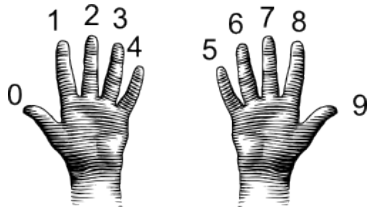
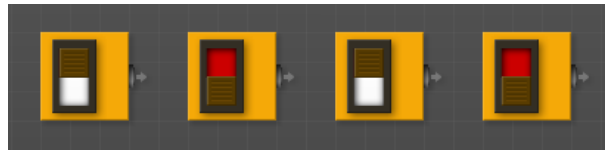
    ```
    130/128 is 1 rem 2.
    ```

Decimal to Binary: Converting Between Bases





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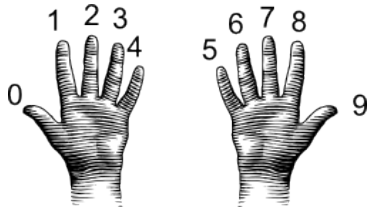
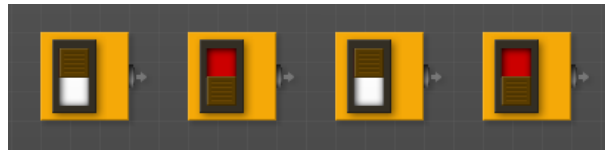
  - Example: what is 130 in binary notation?

    `130/128 is 1 rem 2. First digit is 1:`

Decimal to Binary: Converting Between Bases





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    130/128 is 1 rem 2. First digit is 1:   1...
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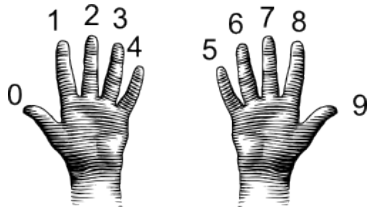

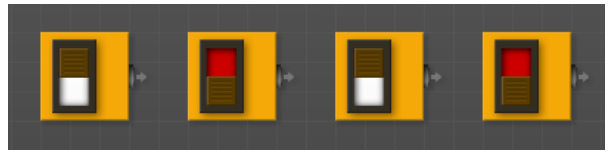

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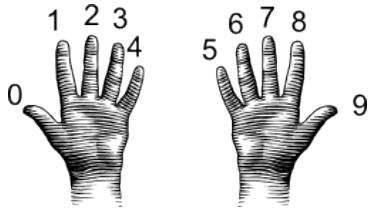

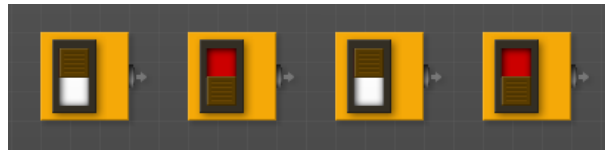

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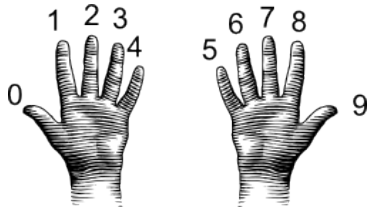

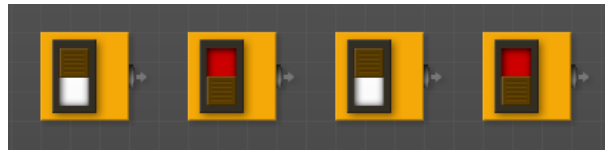

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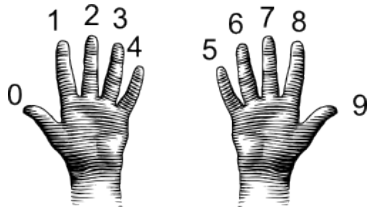

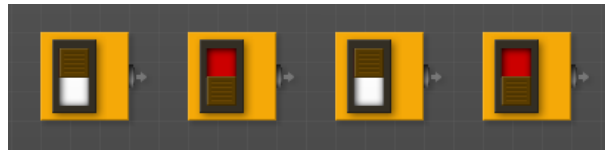

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  - Example: what is 130 in binary notation?

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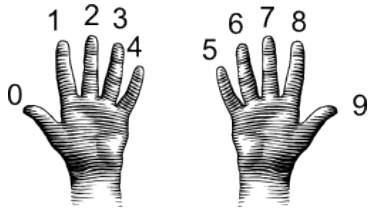
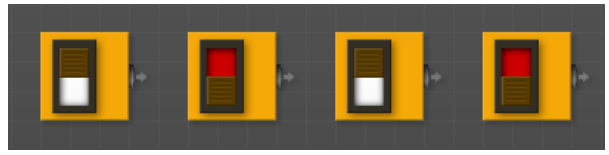
130/128 is 1 rem 2. First digit is 1:    1...
2/64 is 0 rem 2. Next digit is 0:        10...
2/32 is 0 rem 2. Next digit is 0:
```

Decimal to Binary: Converting Between Bases





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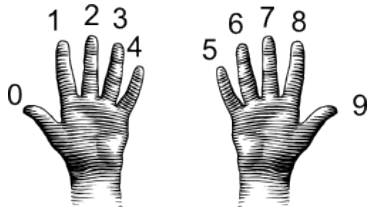

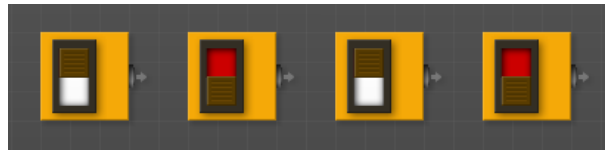

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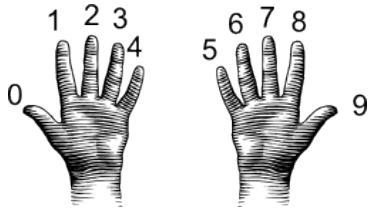

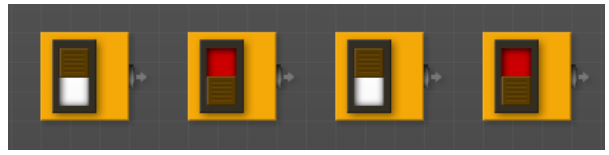

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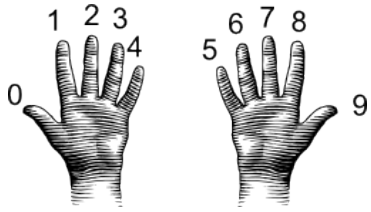

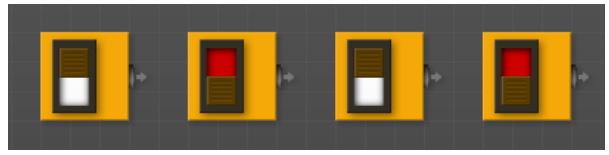

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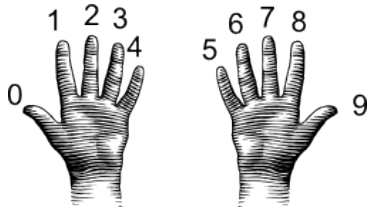

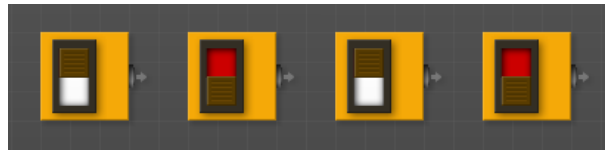

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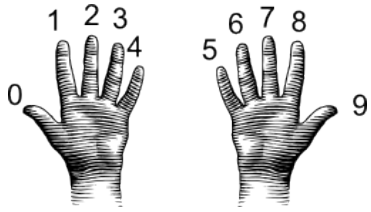

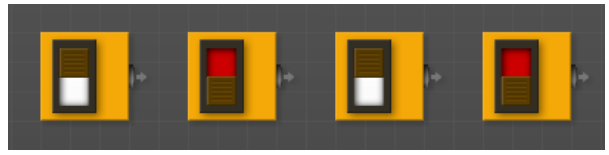

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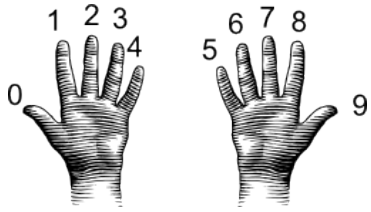

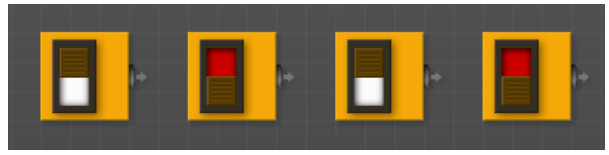

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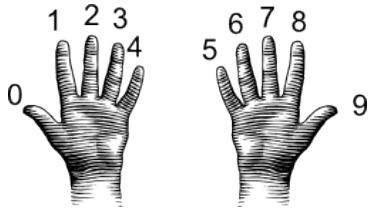

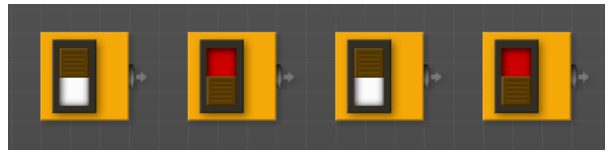

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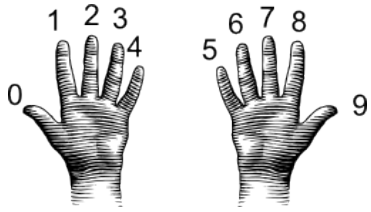

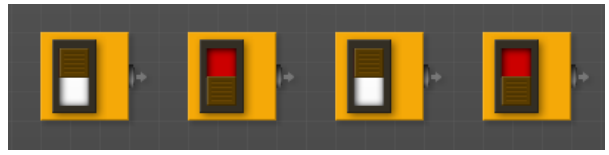

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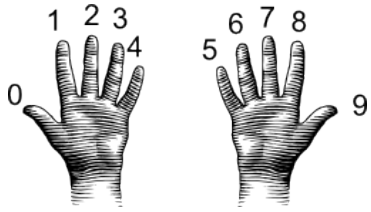

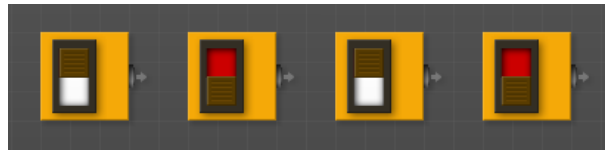

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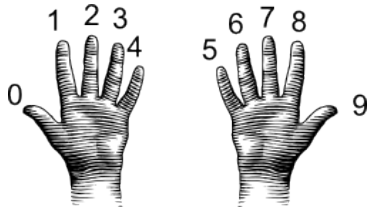

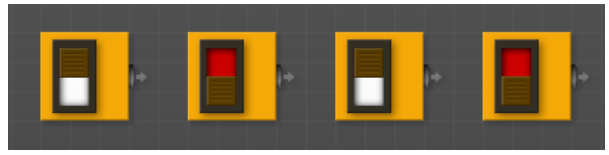

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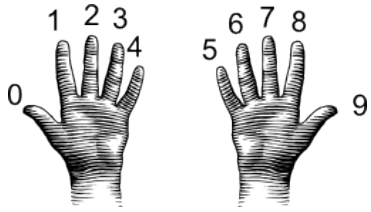

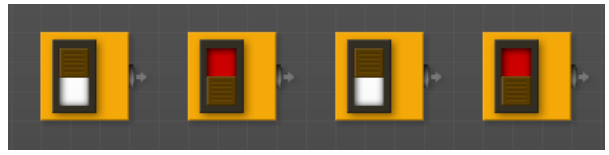

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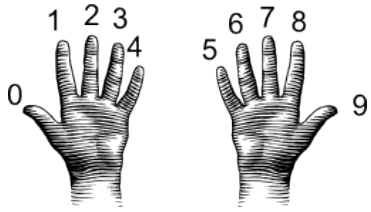

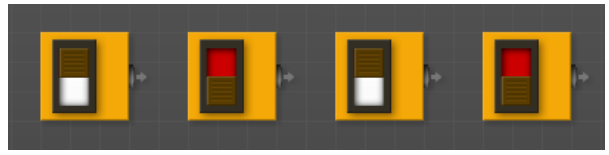

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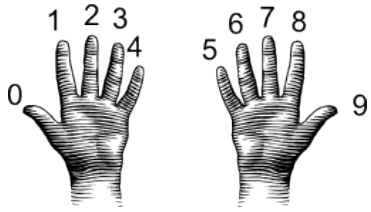
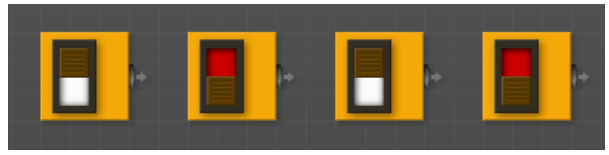
```

Decimal to Binary: Converting Between Bases

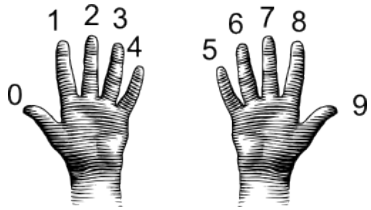


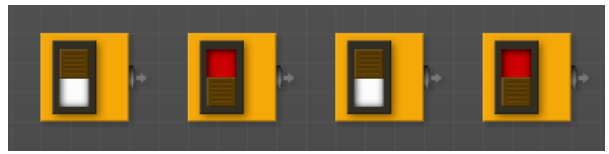


- From decimal to binary:
  - Divide by 128 ($= 2^7$). Quotient is the first digit.
  - Divide remainder by 64 ($= 2^6$). Quotient is the next digit.
  - Divide remainder by 32 ($= 2^5$). Quotient is the next digit.
  - Divide remainder by 16 ($= 2^4$). Quotient is the next digit.
  - Divide remainder by 8 ($= 2^3$). Quotient is the next digit.
  - Divide remainder by 4 ($= 2^2$). Quotient is the next digit.
  - Divide remainder by 2 ($= 2^1$). Quotient is the next digit.
  - The last remainder is the last digit.
  - Example: what is 130 in binary notation?

```
130/128 is 1 rem 2. First digit is 1:    1...
2/64 is 0 rem 2. Next digit is 0:        10...
2/32 is 0 rem 2. Next digit is 0:        100...
2/16 is 0 rem 2. Next digit is 0:        1000...
2/8 is 0 rem 2. Next digit is 0:         10000...
2/4 is 0 remainder 2. Next digit is 0:   100000...
2/2 is 1 rem 0. Next digit is 1:         1000001...
Adding the last remainder:               10000010
```

Decimal to Binary: Converting Between Bases





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Adding the last remainder:               10000010
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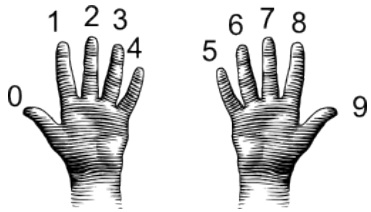
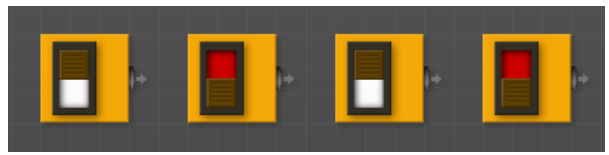
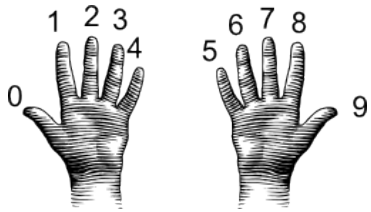
Decimal to Binary: Converting Between Bases

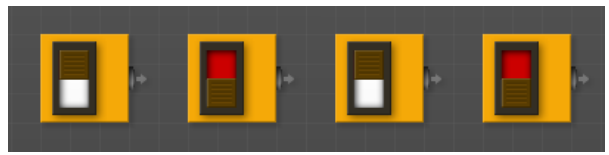




- Example: what is 99 in binary notation?

Decimal to Binary: Converting Between Bases

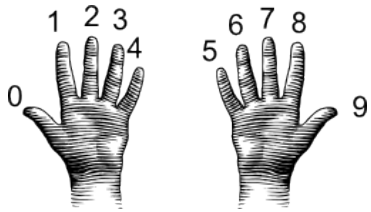


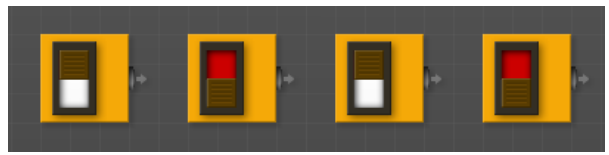


- Example: what is 99 in binary notation?

  `99/128 is 0 rem 99.`

Decimal to Binary: Converting Between Bases

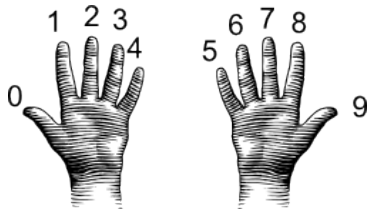


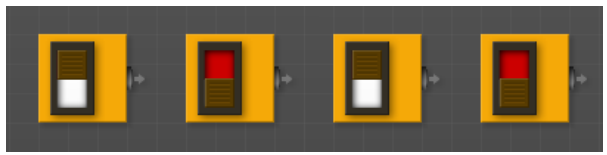


- Example: what is 99 in binary notation?

  `99/128 is 0 rem 99. First digit is 0:`

Decimal to Binary: Converting Between Bases

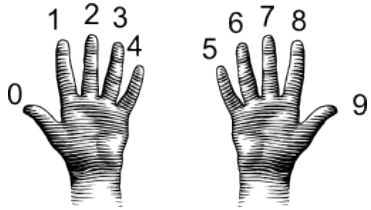


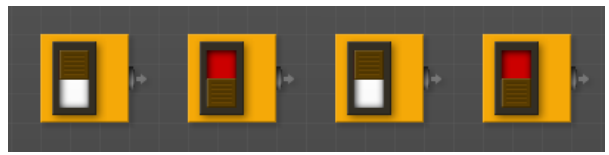


- Example: what is 99 in binary notation?

```
99/128 is 0 rem 99. First digit is 0:    0...
99/64 is 1 rem 35.
```

Decimal to Binary: Converting Between Bases





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99/128 is 0 rem 99. First digit is 0:    0...
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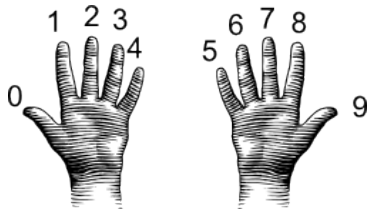
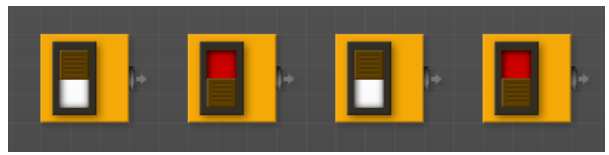
```

Decimal to Binary: Converting Between Bases





- Example: what is 99 in binary notation?

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99/128 is 0 rem 99. First digit is 0:    0...
99/64 is 1 rem 35. Next digit is 1:      01...
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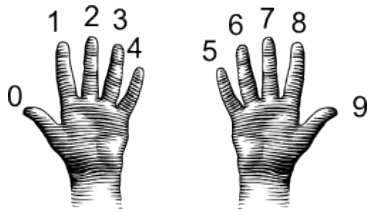
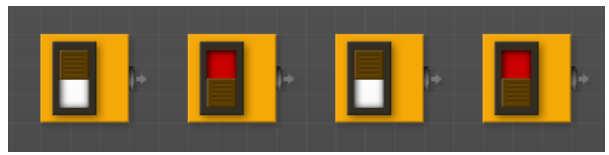
Decimal to Binary: Converting Between Bases





- Example: what is 99 in binary notation?

```
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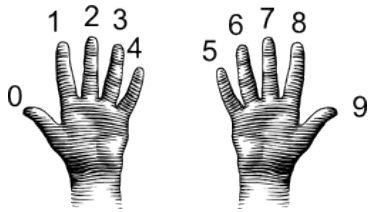
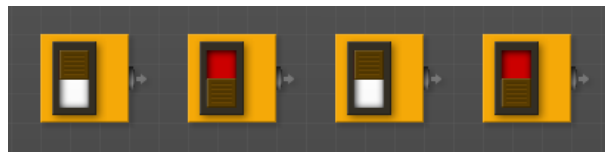
35/32 is 1 rem 3.
```

Decimal to Binary: Converting Between Bases





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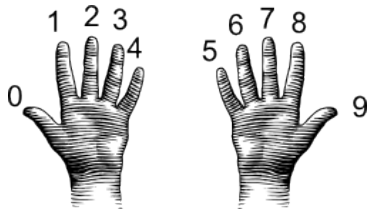

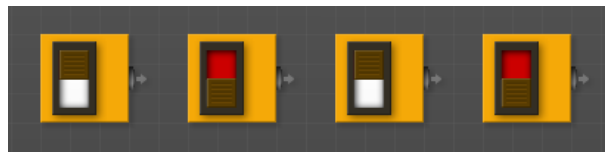

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35/32 is 1 rem 3. Next digit is 1:       011...
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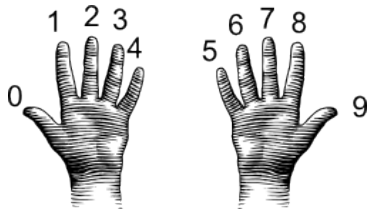

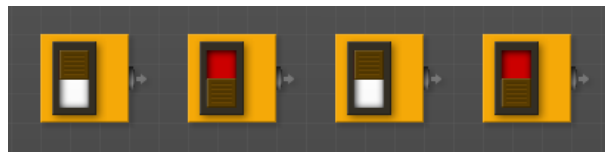

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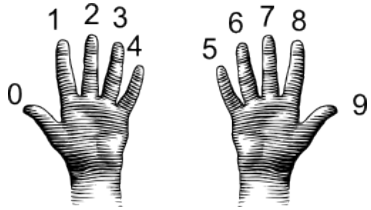

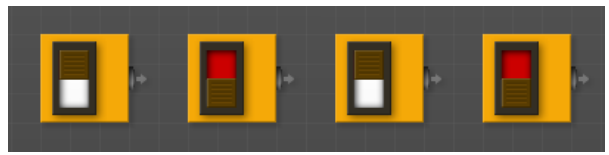

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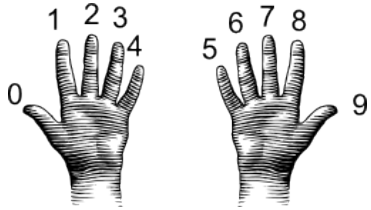

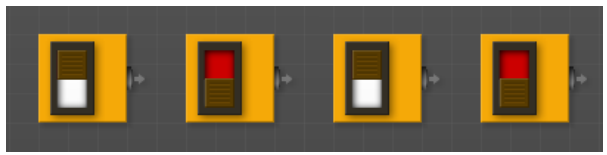

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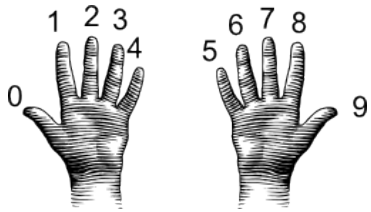

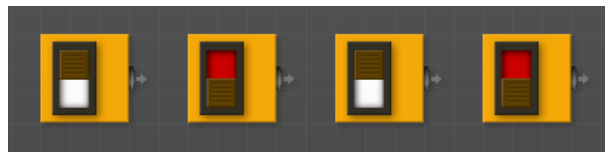

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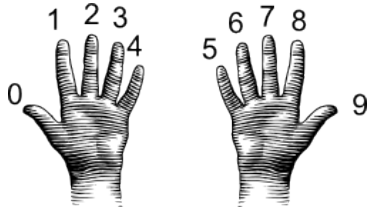

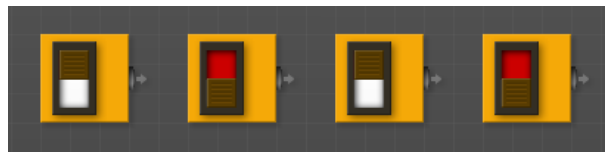

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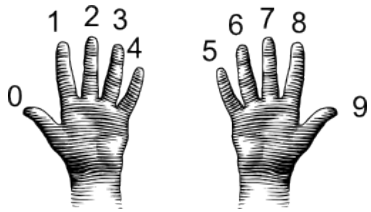

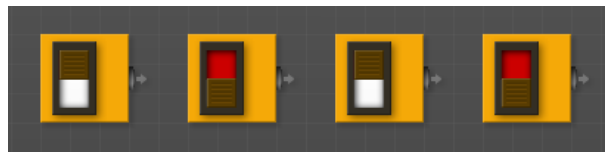

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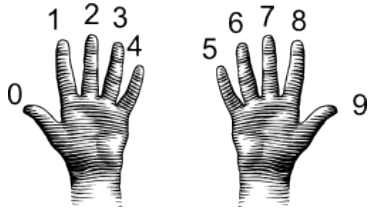

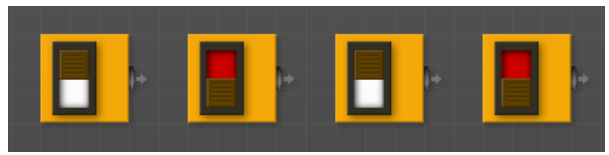

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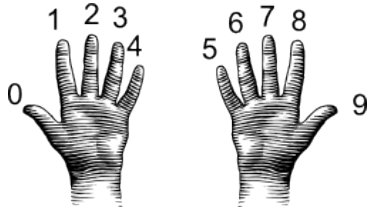

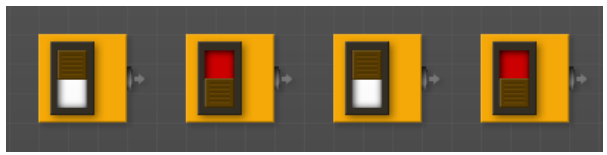

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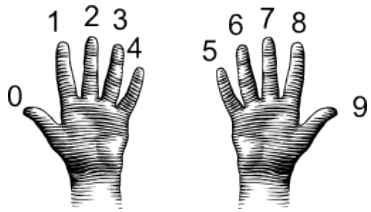
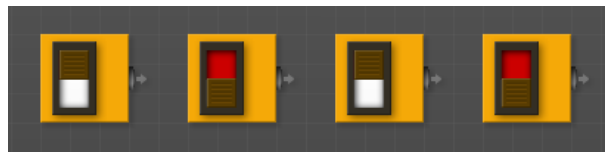
Decimal to Binary: Converting Between Bases





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```
99/128 is 0 rem 99. First digit is 0:    0...
99/64 is 1 rem 35. Next digit is 1:      01...
35/32 is 1 rem 3. Next digit is 1:       011...
3/16 is 0 rem 3. Next digit is 0:        0110...
3/8 is 0 rem 3. Next digit is 0:         01100...
3/4 is 0 remainder 3. Next digit is 0:   011000...
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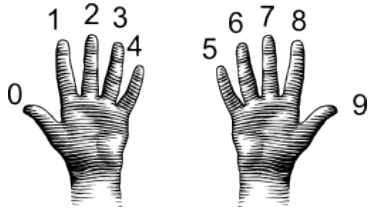
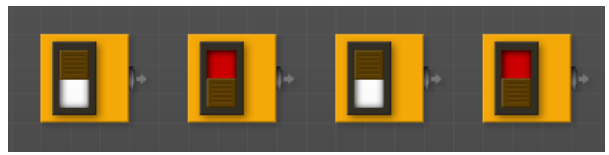
Decimal to Binary: Converting Between Bases





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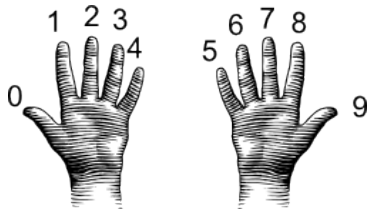

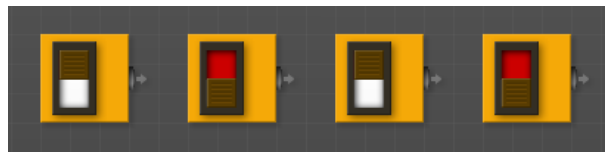

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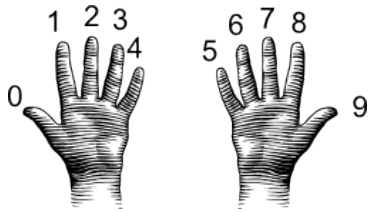

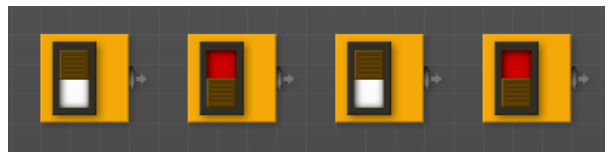

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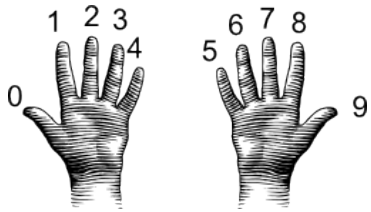
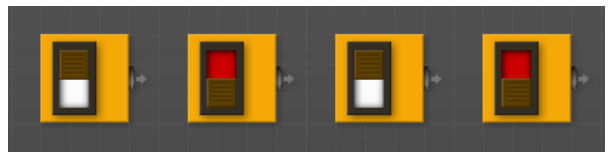
```

Decimal to Binary: Converting Between Bases





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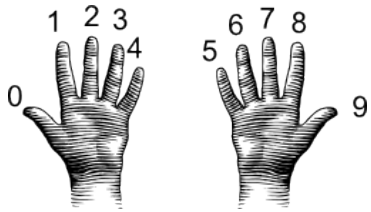
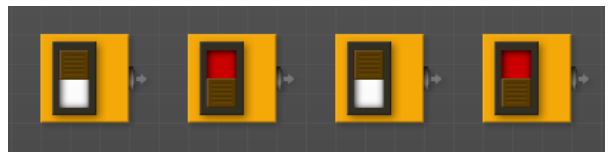
Adding the last remainder:               01100011
```

Decimal to Binary: Converting Between Bases





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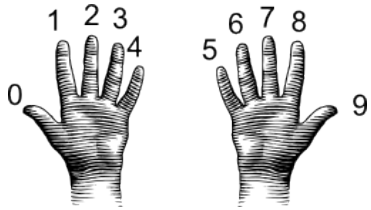
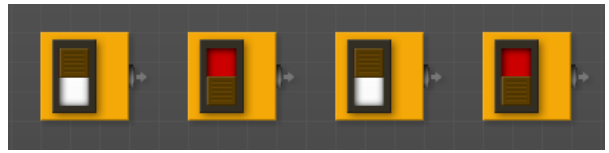
Adding the last remainder:               01100011
```

Answer is 1100011.

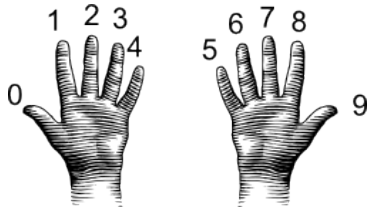
Binary to Decimal: Converting Between Bases

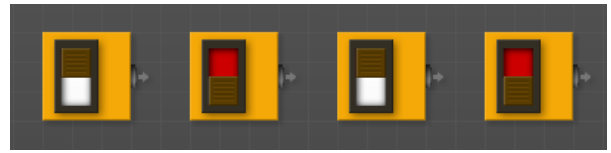




- From binary to decimal:
  - Set sum = last digit.

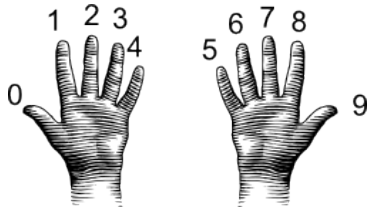
Binary to Decimal: Converting Between Bases

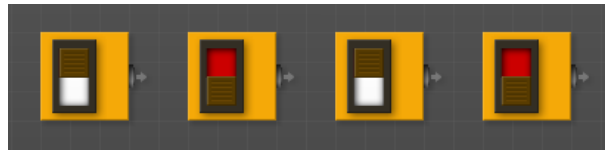




- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.

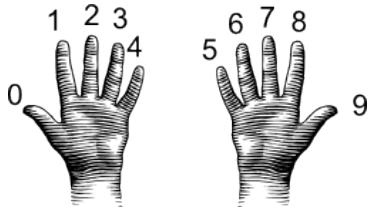
Binary to Decimal: Converting Between Bases

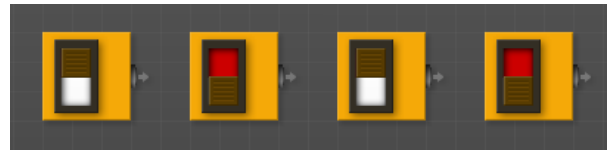




- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.

Binary to Decimal: Converting Between Bases





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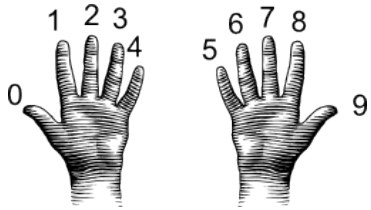
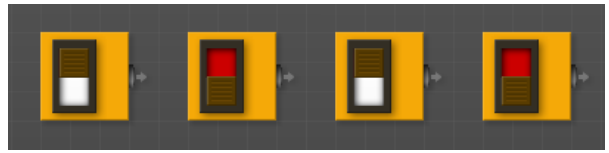
Binary to Decimal: Converting Between Bases





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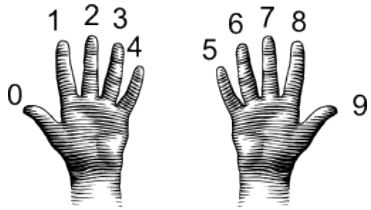
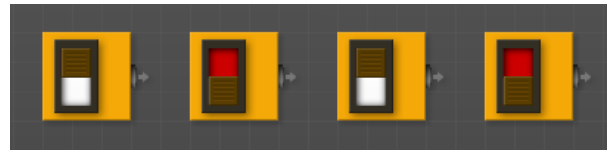
  - Multiply next digit by $16 = 2^4$. Add to sum.

Binary to Decimal: Converting Between Bases





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  - Multiply next digit by $32 = 2^5$. Add to sum.

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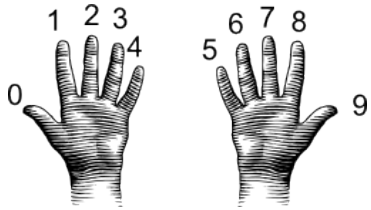

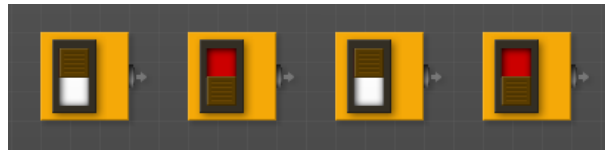

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  - Multiply next digit by $64 = 2^6$. Add to sum.

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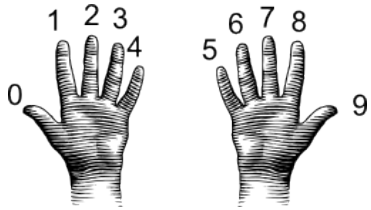

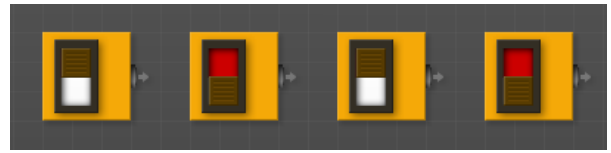

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  - Multiply next digit by $32 = 2^5$. Add to sum.
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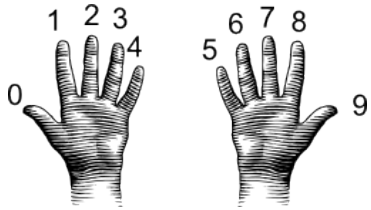
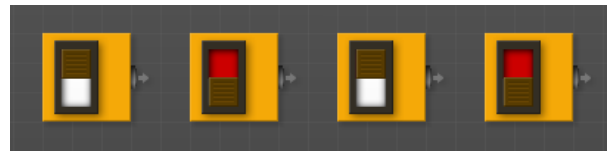
  - Multiply next digit by $128 = 2^7$. Add to sum.

Binary to Decimal: Converting Between Bases





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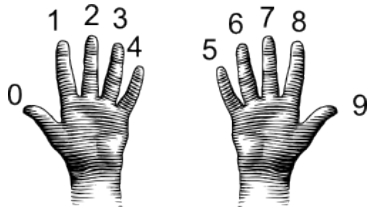
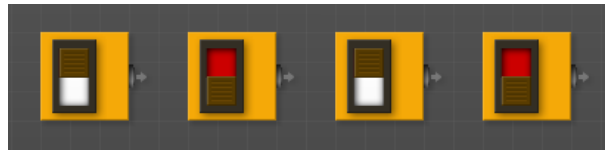
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.

Binary to Decimal: Converting Between Bases





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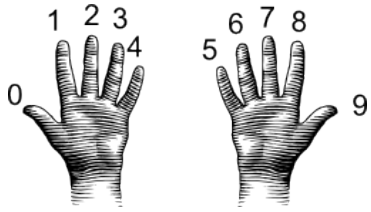
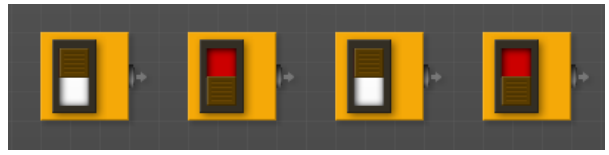
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

    `Sum starts with:`

Binary to Decimal: Converting Between Bases





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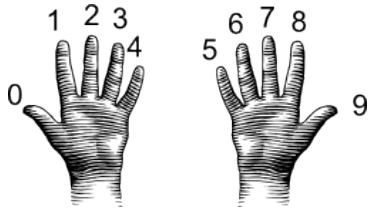
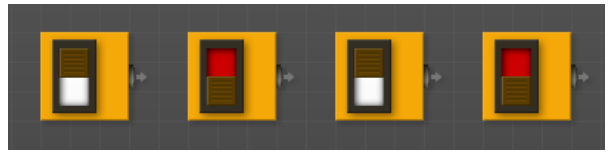
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
Sum starts with:                1
0*2 = 0.  Add 0 to sum:
```

Binary to Decimal: Converting Between Bases





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  - Example: What is 111101 in decimal?

```
Sum starts with:              1
0*2 = 0.  Add 0 to sum:       1
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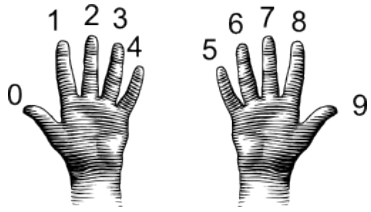
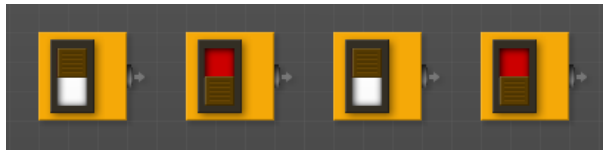
Binary to Decimal: Converting Between Bases





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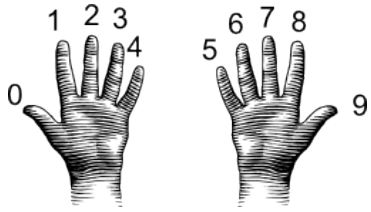
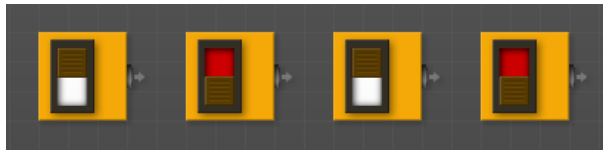
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. 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:
```

Binary to Decimal: Converting Between Bases





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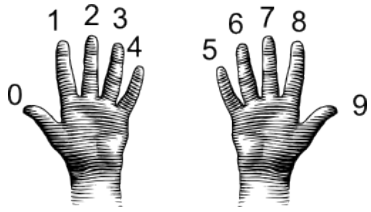
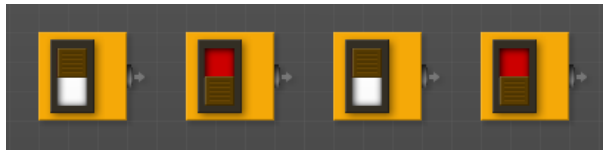
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
Sum starts with:              1
0*2 = 0.  Add 0 to sum:       1
1*4 = 4.  Add 4 to sum:       5
```

Binary to Decimal: Converting Between Bases





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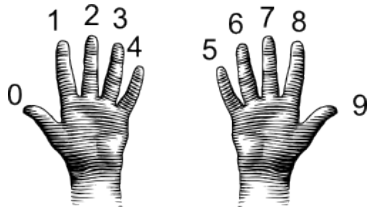
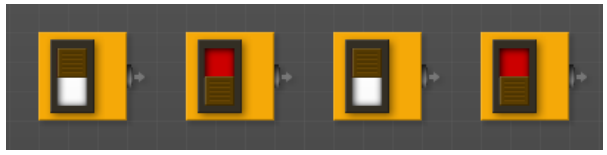
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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:
```

Binary to Decimal: Converting Between Bases





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  - Multiply next digit by $16 = 2^4$. Add to sum.
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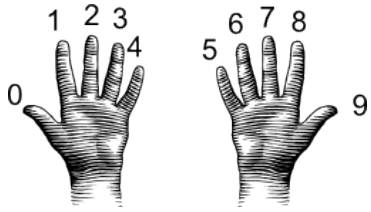
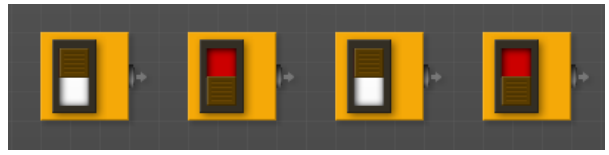
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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
```

Binary to Decimal: Converting Between Bases





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  - Multiply next digit by $64 = 2^6$. Add to sum.
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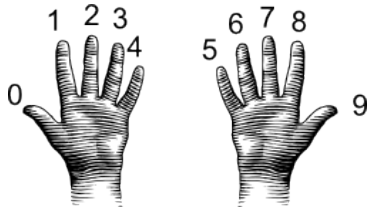
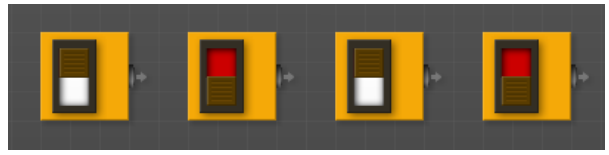
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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:
```

Binary to Decimal: Converting Between Bases





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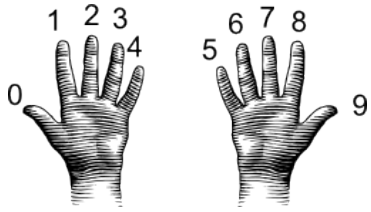
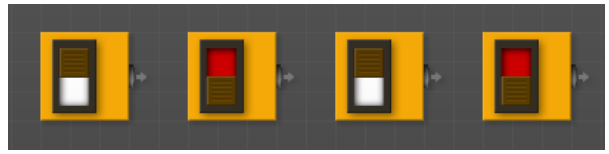
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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
```

Binary to Decimal: Converting Between Bases





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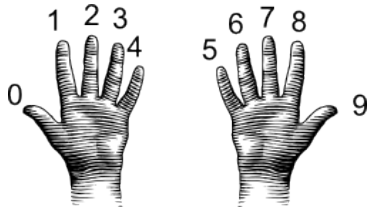
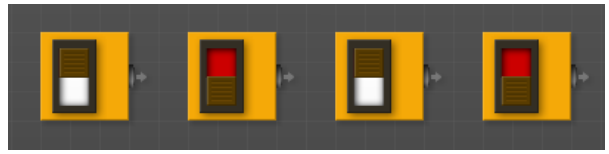
Sum starts with:              1
0*2 = 0.  Add 0 to sum:       1
1*4 = 4.  Add 4 to sum:       5
1*8 = 8.  Add 8 to sum:       13
1*16 = 16.  Add 16 to sum:    29
1*32 = 32.  Add 32 to sum:
```

Binary to Decimal: Converting Between Bases





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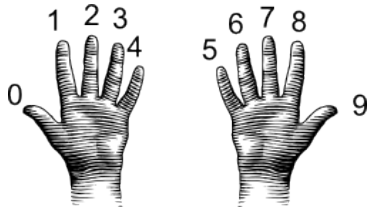
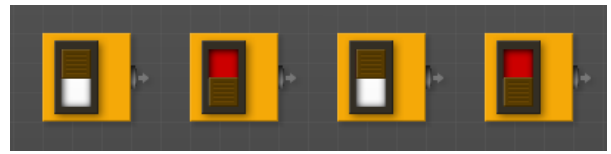
```
Sum starts with:              1
0*2 = 0.  Add 0 to sum:       1
1*4 = 4.  Add 4 to sum:       5
1*8 = 8.  Add 8 to sum:       13
1*16 = 16.  Add 16 to sum:    29
1*32 = 32.  Add 32 to sum:    61
```

Binary to Decimal: Converting Between Bases





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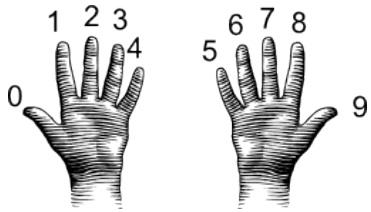
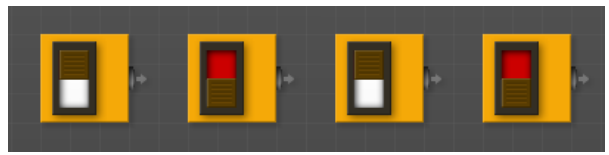
Binary to Decimal: Converting Between Bases

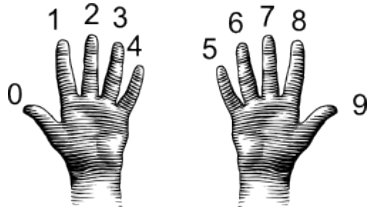


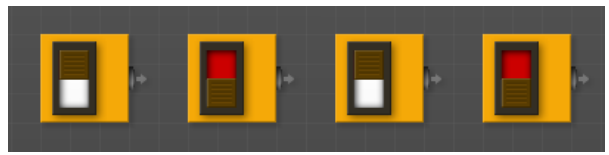


- Example: What is 10100100 in decimal?

  `Sum starts with:`

Binary to Decimal: Converting Between Bases

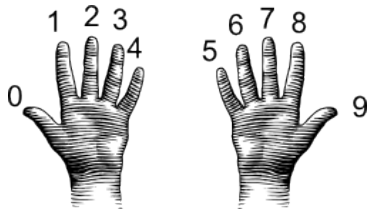


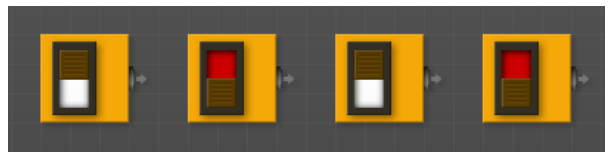


- Example: What is 10100100 in decimal?

```
Sum starts with:                    0
0*2 = 0.  Add 0 to sum:
```

Binary to Decimal: Converting Between Bases

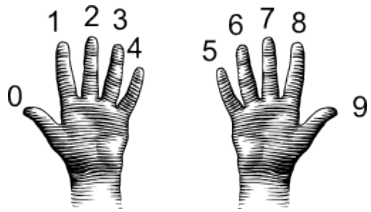


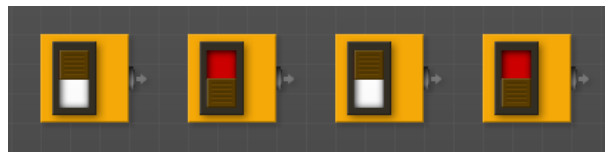


- Example: What is 10100100 in decimal?

```
Sum starts with:                0
0*2 = 0.  Add 0 to sum:         0
```

Binary to Decimal: Converting Between Bases

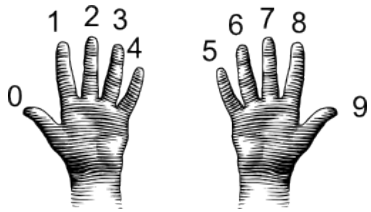


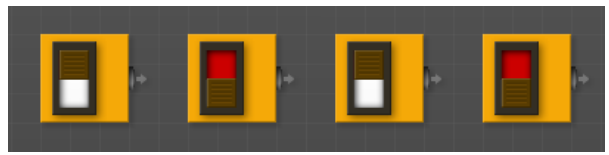


- Example: What is 10100100 in decimal?

```
Sum starts with:                0
0*2 = 0.  Add 0 to sum:         0
1*4 = 4.  Add 4 to sum:
```

Binary to Decimal: Converting Between Bases

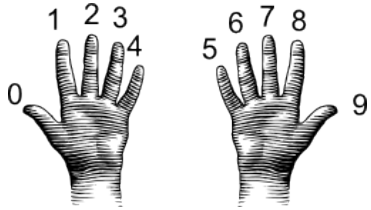


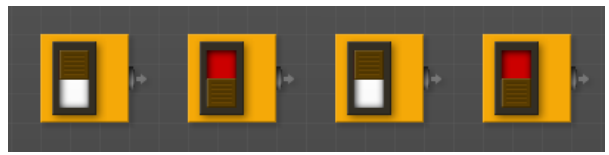


- Example: What is 10100100 in decimal?

```
Sum starts with:                0
0*2 = 0.  Add 0 to sum:         0
1*4 = 4.  Add 4 to sum:         4
```

Binary to Decimal: Converting Between Bases

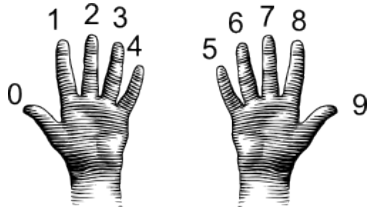


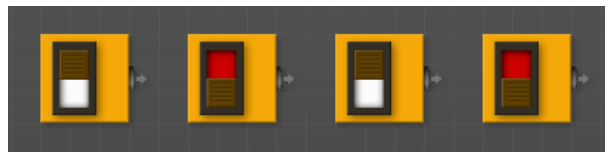


- Example: What is 10100100 in decimal?

```
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:
```

Binary to Decimal: Converting Between Bases

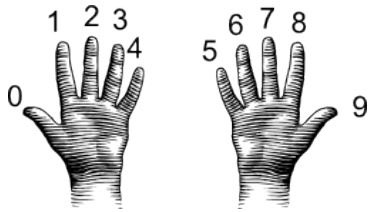


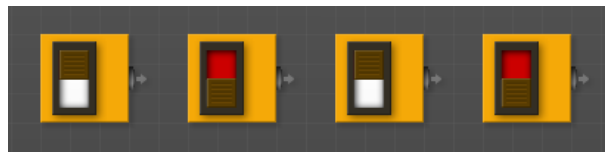


- Example: What is 10100100 in decimal?

```
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
```

Binary to Decimal: Converting Between Bases

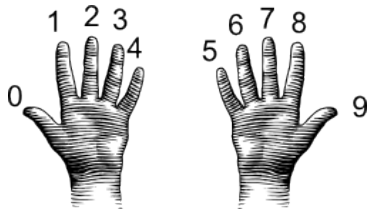


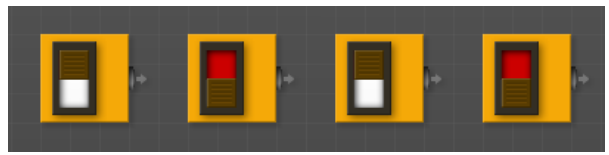


- Example: What is 10100100 in decimal?

```
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:
```

Binary to Decimal: Converting Between Bases

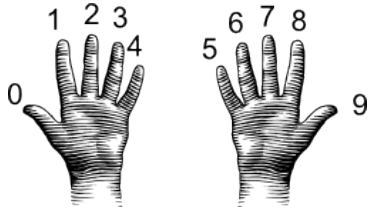


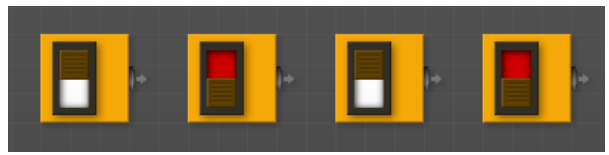


- Example: What is 10100100 in decimal?

```
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
```

Binary to Decimal: Converting Between Bases





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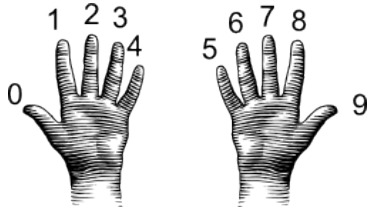

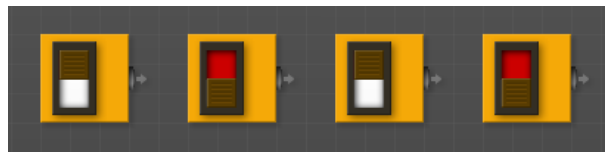

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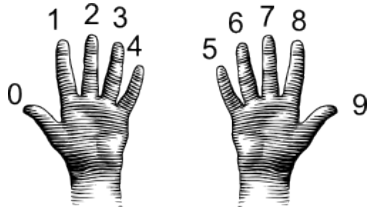

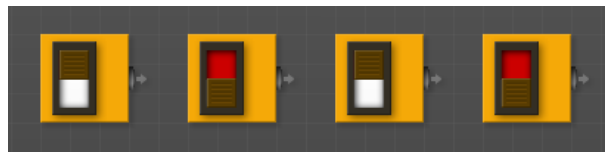

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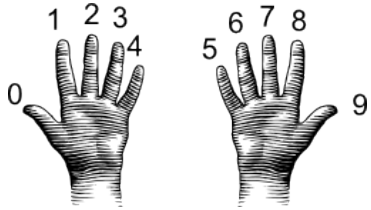

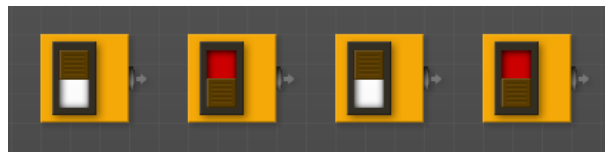

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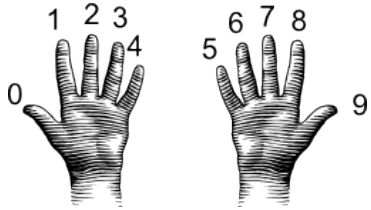

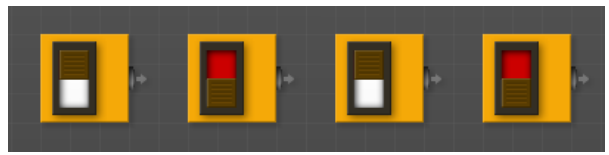

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1*128 = 0.   Add 128 to sum:
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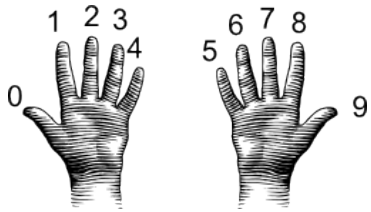
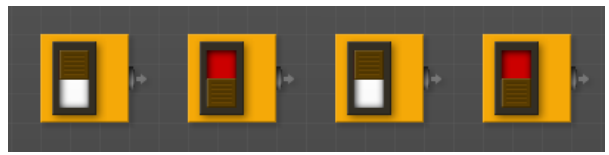
Binary to Decimal: Converting Between Bases





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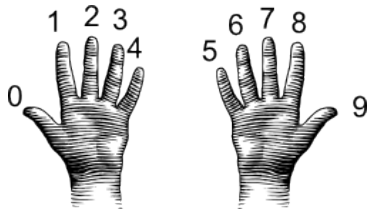
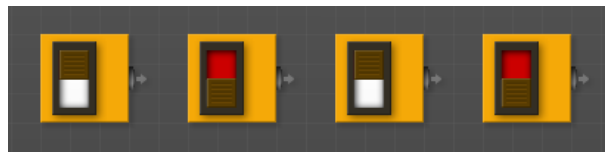
0*64 = 0.   Add 0 to sum:       36
1*128 = 0.   Add 128 to sum:    164
```

Binary to Decimal: Converting Between Bases





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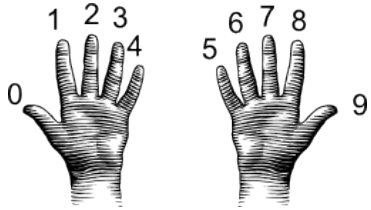
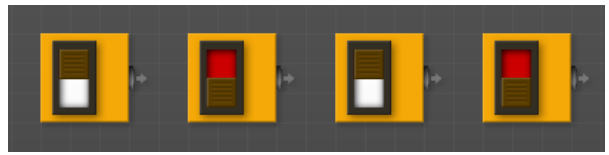
0*64 = 0.   Add 0 to sum:       36
1*128 = 0.   Add 128 to sum:    164
```

The answer is 164.

Design Challenge: Incrementers





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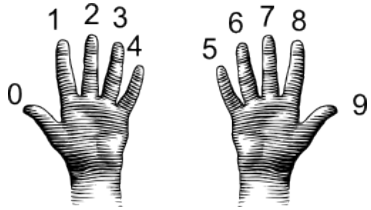

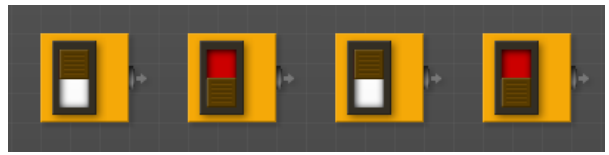

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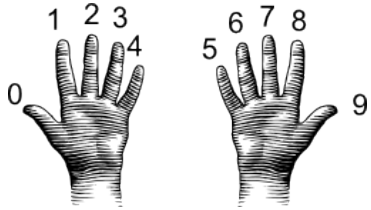

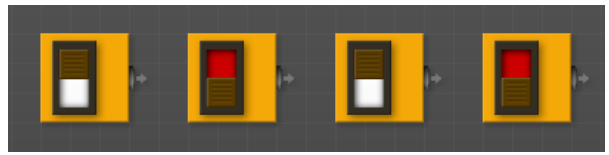

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    m = n+1
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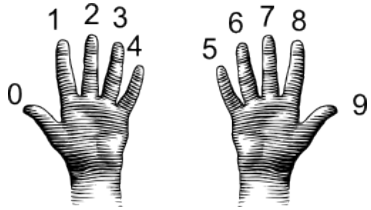

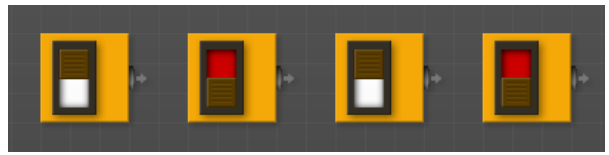

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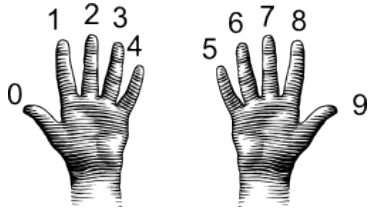

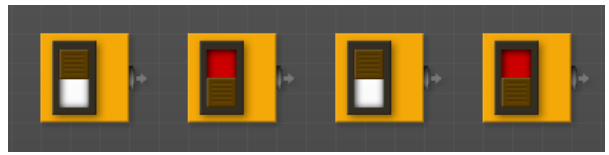

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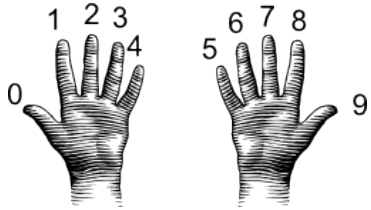

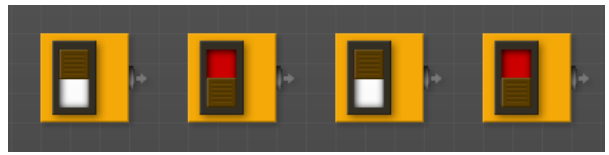

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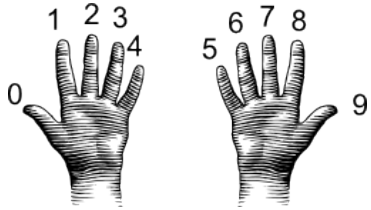

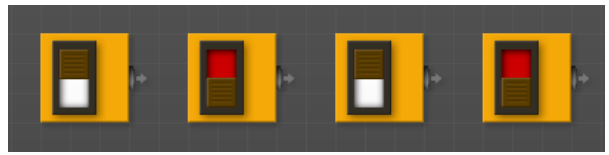

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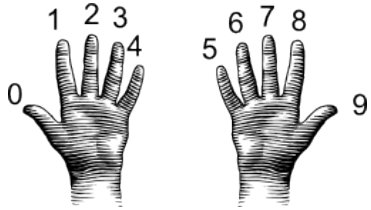

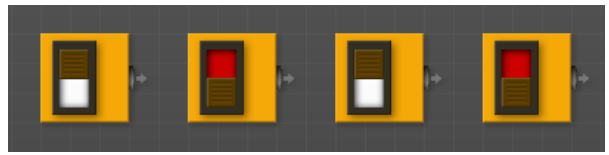

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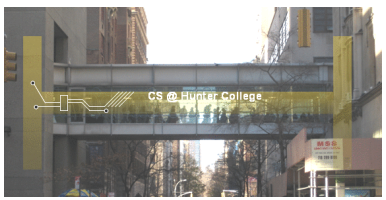
  Example: `"1001"` → `"1010"`

Recap

- On lecture slip, write down a topic you wish we had spent more time (and why).



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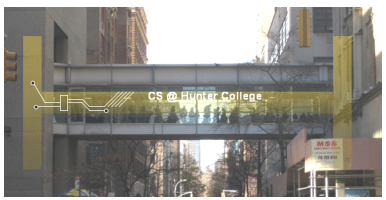

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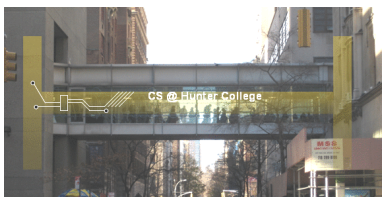

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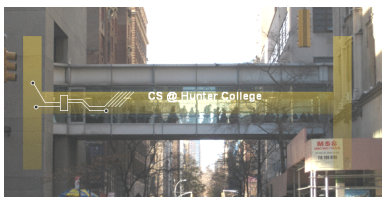

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Today's Topics

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

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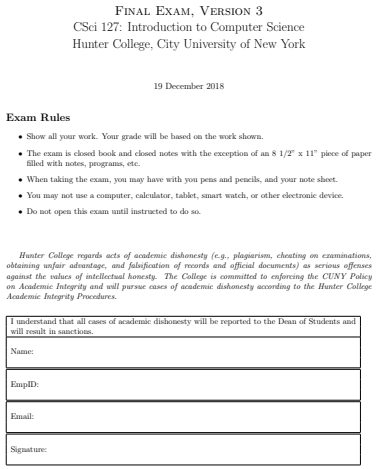
  - Style of questions: what does the code do? short answer, write functions, top down design, & write complete programs.
  - More on logistics next lecture.

Final Overview: Format

- The exam is 2 hours long.
- There are 4 different versions to discourage copying.
- 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.
  - No origami– it's distracting to others taking the exam.
  - Best if you design/write yours since 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 webpage (includes answer keys).

Exam Options

Exam Times:



Final Exam, Version 3
CSci 127: Introduction to Computer Science
Hunter College, City University of New York

19 December 2018

Exam Rules

- Show all your work. Your grade will be based on the work shown.
- The exam is closed book and closed notes with the exception of an 8 1/2" x 11" piece of paper filled with notes, programs, etc.
- When taking the exam, you may have with you pens and pencils, and your note sheet.
- You may not use a computer, calculator, tablet, smart watch, or other electronic device.
- Do not open this exam until instructed to do so.

Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The College is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

I understand that all cases of academic dishonesty will be reported to the Dean of Students and will result in sanctions.
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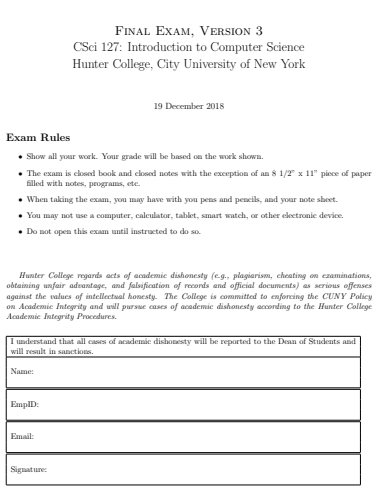
Signature:

Exam Options



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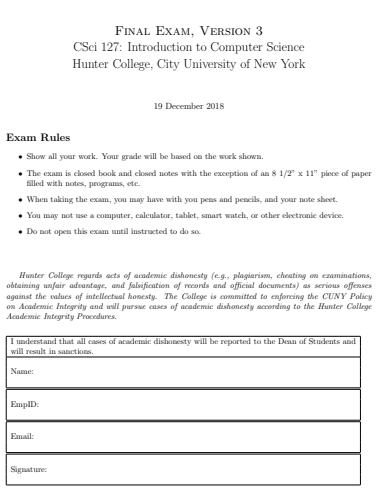
Exam Times:

- Default: Regular Time: Monday, 16 December, 9-11am.
- Alternate Time: Reading Day, Friday, 13 December, 8:30am-10:30am.
- Accessibility Testing Center: Paperwork required. Must be completed on 13 December.

Exam Options



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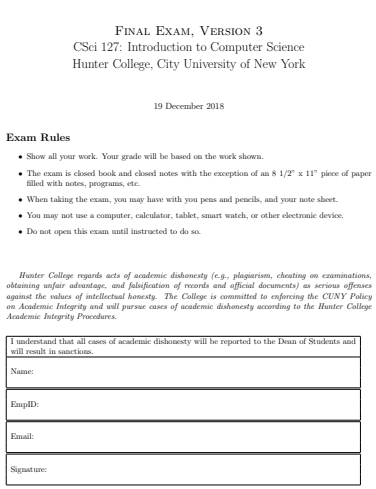

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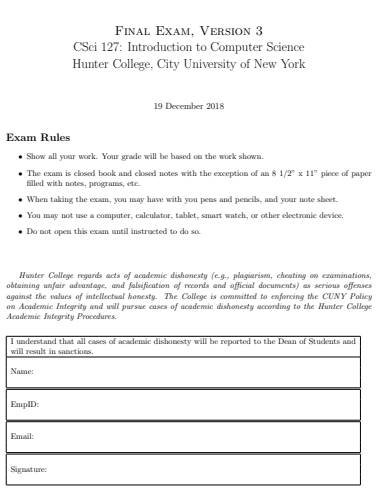
Grading Options:

- Default: Letter Grade.
- Credit/NoCredit grade– availability depends on major and academic standing.

Exam Options



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Grading Options:

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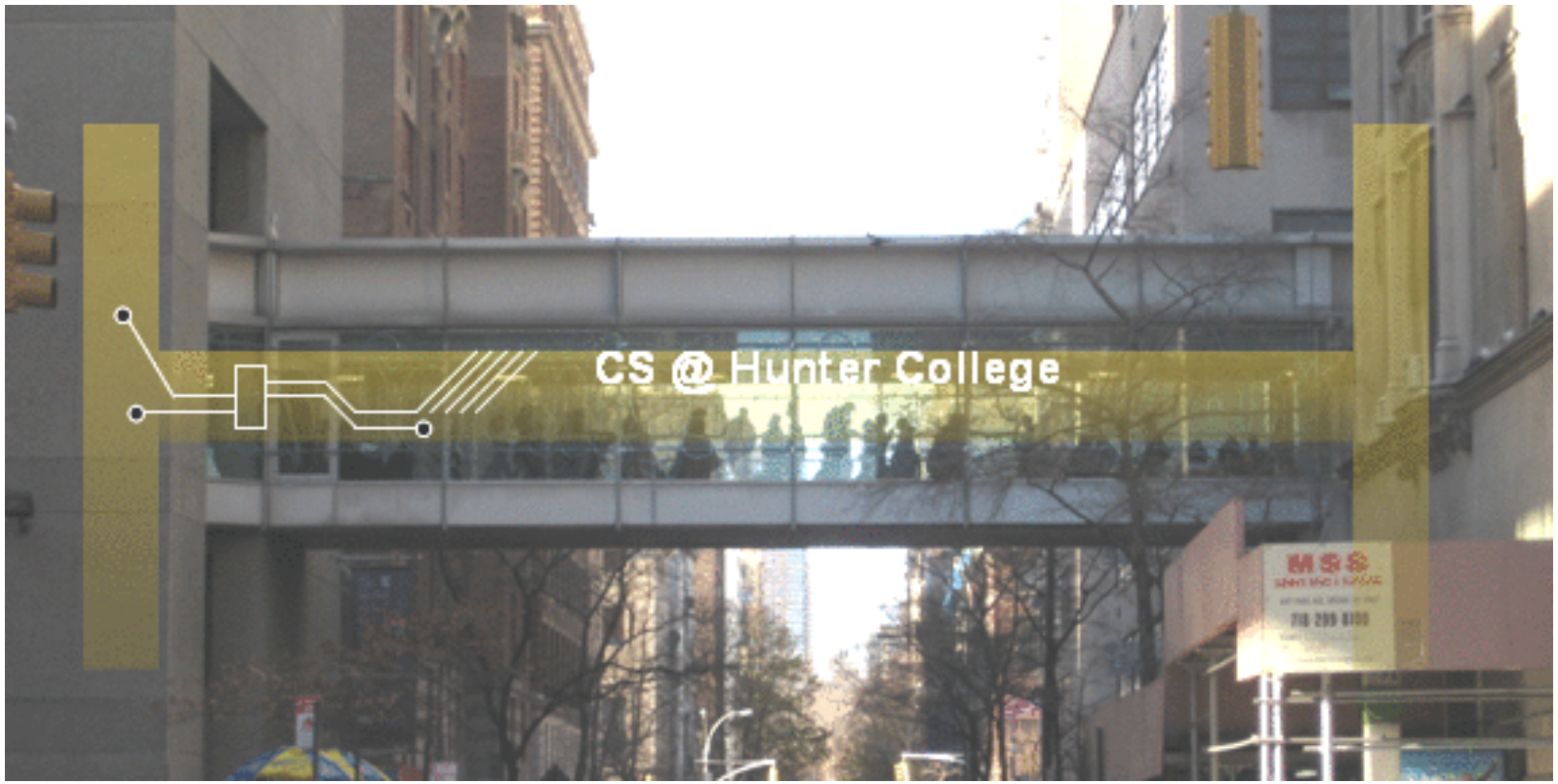
Forms for your choices ("pink slips") available next lecture.

Writing Boards



- Return writing boards as you leave...