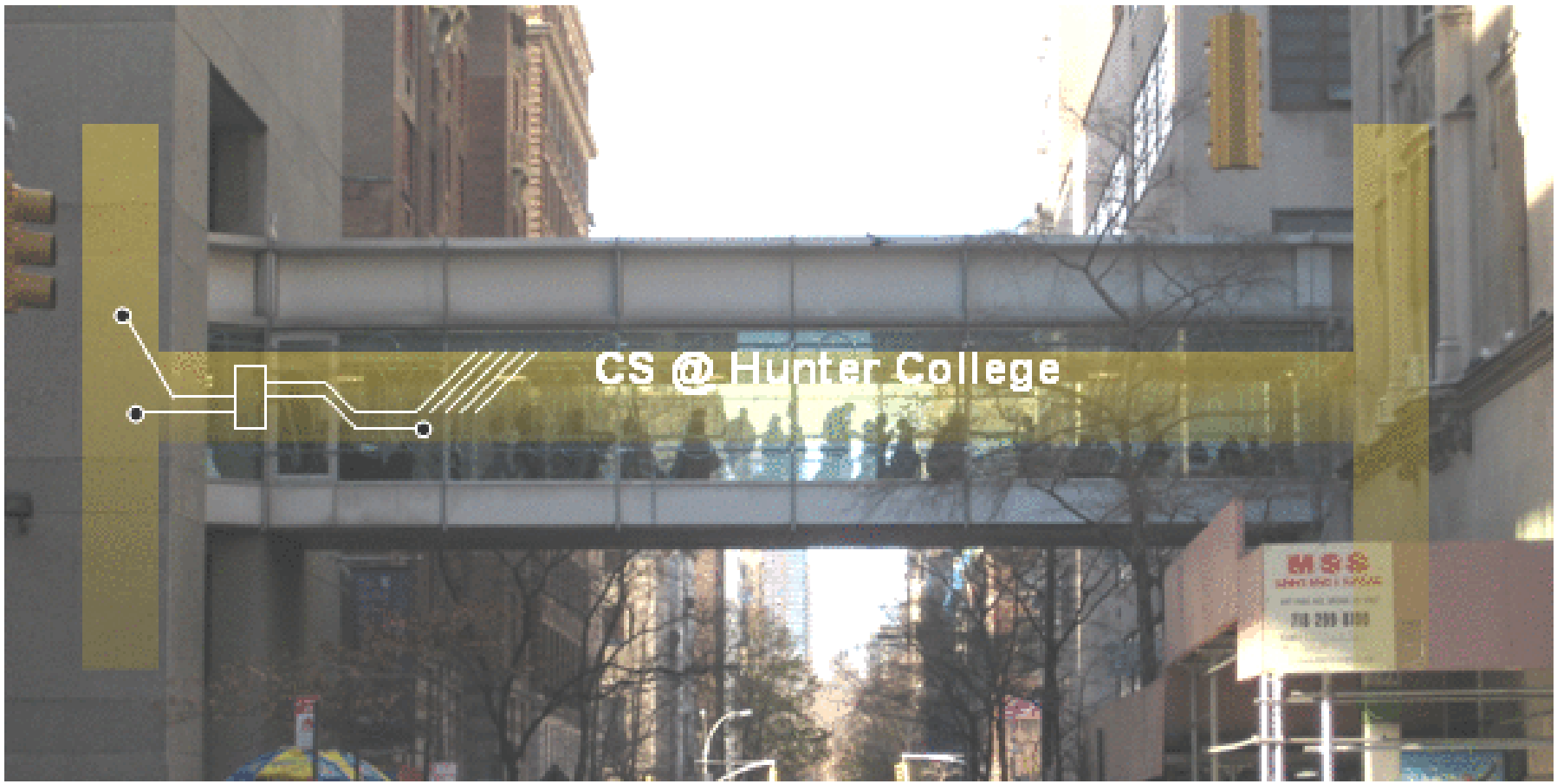
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Frequently Asked Questions

From email and tutoring.

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  - *All previous final exams (and answer keys) on the website.*
  - *UTAs in drop-in tutoring happy to review concepts and old exam questions.*
  - *There will be opportunity for practice during our last meeting on 17 May.*

Today's Topics

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

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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!')
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Python Tutor

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(Demo with `pythonTutor`)

Design Pattern: Linear Search

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- Look at each item, one-by-one.
- Stop when found, or the end of list is reached.

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

Python & Circuits Review: 10 Weeks in 10 Minutes

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

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

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- Introduced comments & print():

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

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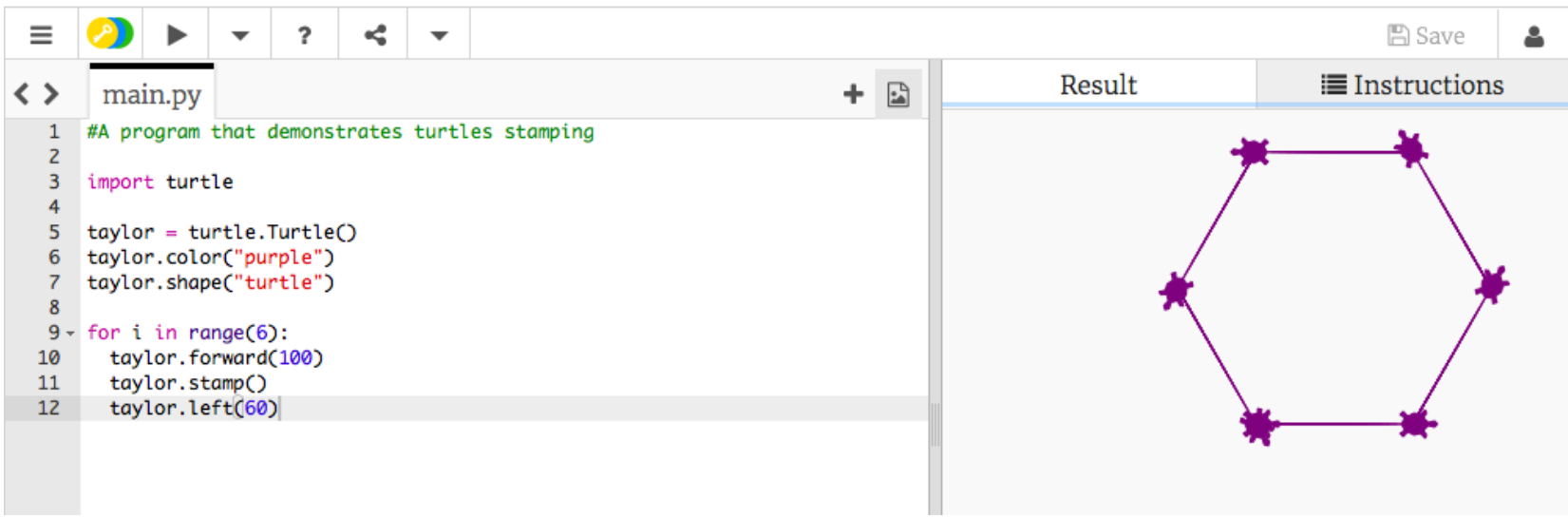
- As well as definite loops & the turtle package:



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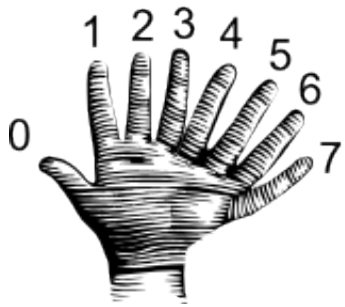
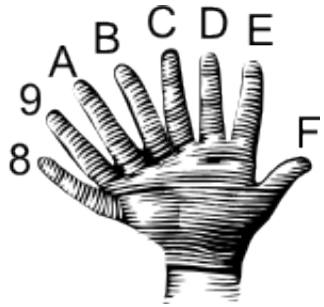
  - **class variables**: for complex objects, like turtles.
- More on loops & ranges:

```
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(sum)
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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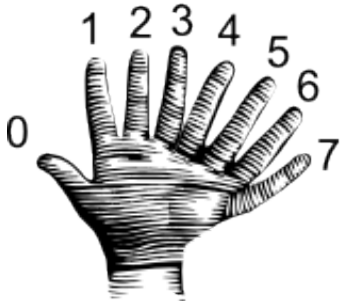

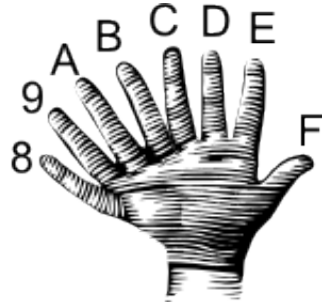

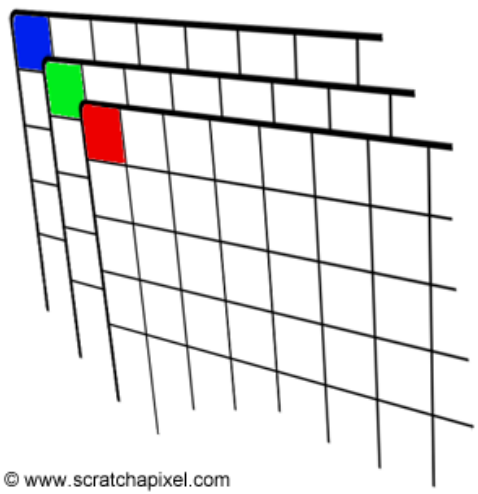

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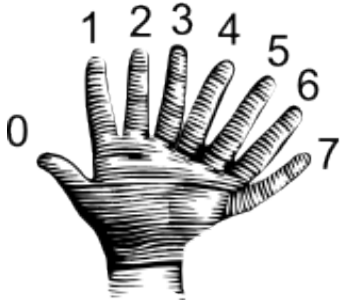
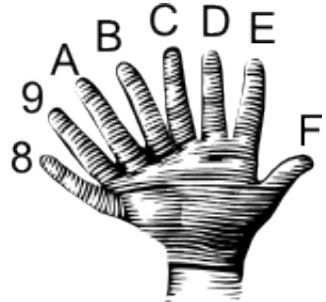
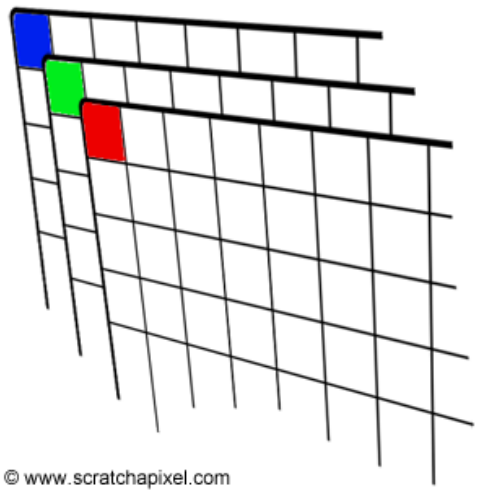
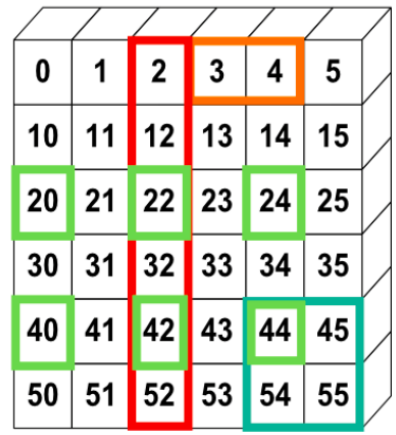


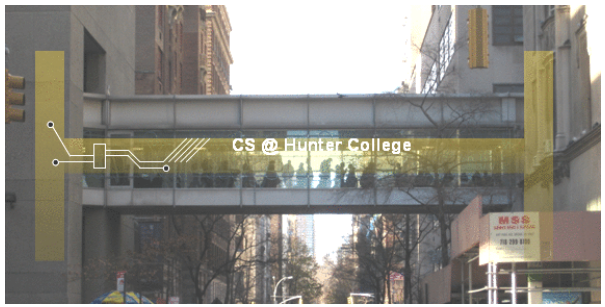


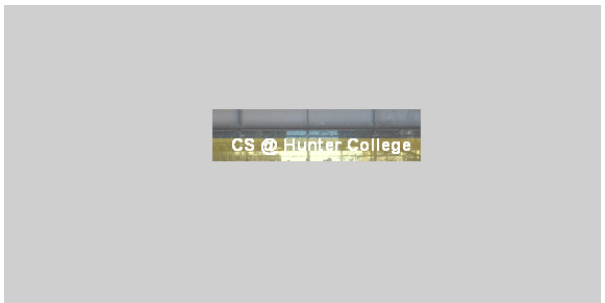



```
>>> a[0,3:5]
array([3,4])

>>> 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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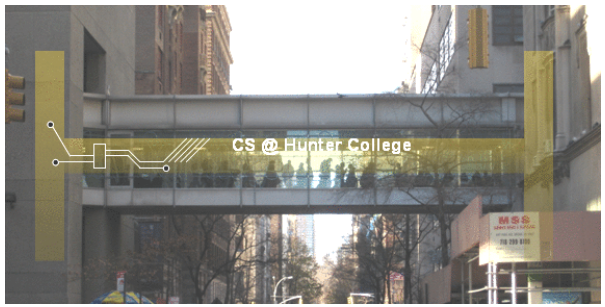

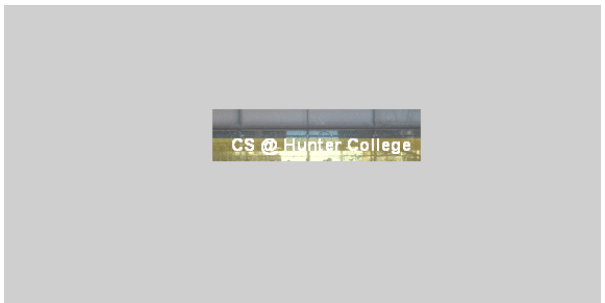

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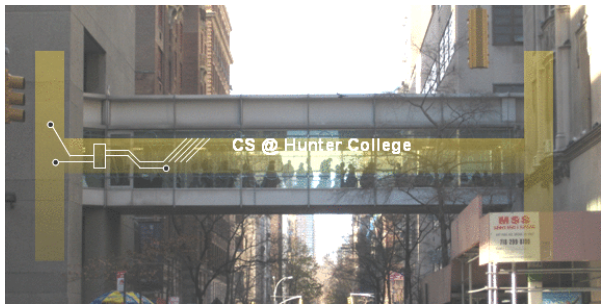

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- Next: write pseudocode.
  1. Import numpy and pyplot.
  2. Ask user for file names and dimensions for cropping.
  3. Save input file to an array.
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  5. Save the new array to the output file.

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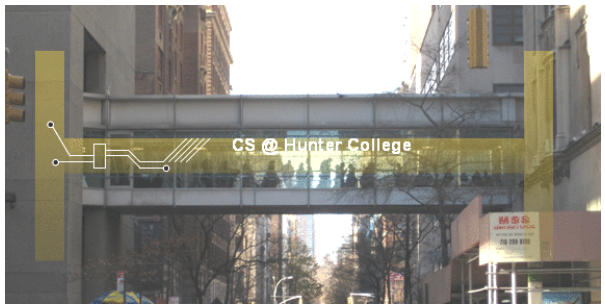

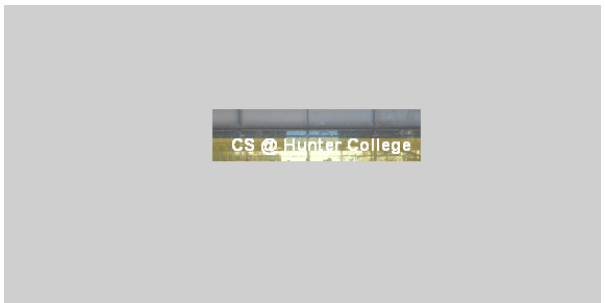

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- Next: translate to Python.

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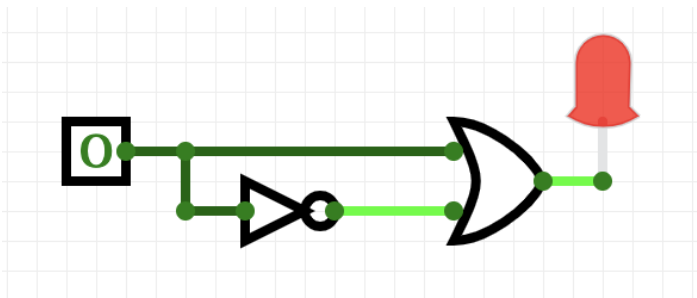
in1		in2	*returns:*
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True



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

`nycHistPop.csv`

In Lab 6

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

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All population figures are consistent with present-day boundaries.,,,,,,
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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
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1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,5346,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813669,279122,32903,23593,25492,1174779
1870,942292,419921,45468,37393,33029,1478103
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51693,2507414
1900,1850093,1166582,152999,200507,67021,3437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018356,469042,732016,116531,5620048
1930,1867312,2560401,1079129,1265258,158346,6930446
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1950,1960101,2738175,1550849,1451277,191555,7891957
1960,1698281,2627319,1809578,1424815,221991,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1891325,1168972,352121,7071639
1990,1487536,2300664,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1585873,2504700,2230722,1385108,468730,8175133
2015,1644518,2636735,2339150,1455444,474558,8550405
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`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

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

```
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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
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In Lab 6

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pop.plot(x="Year")
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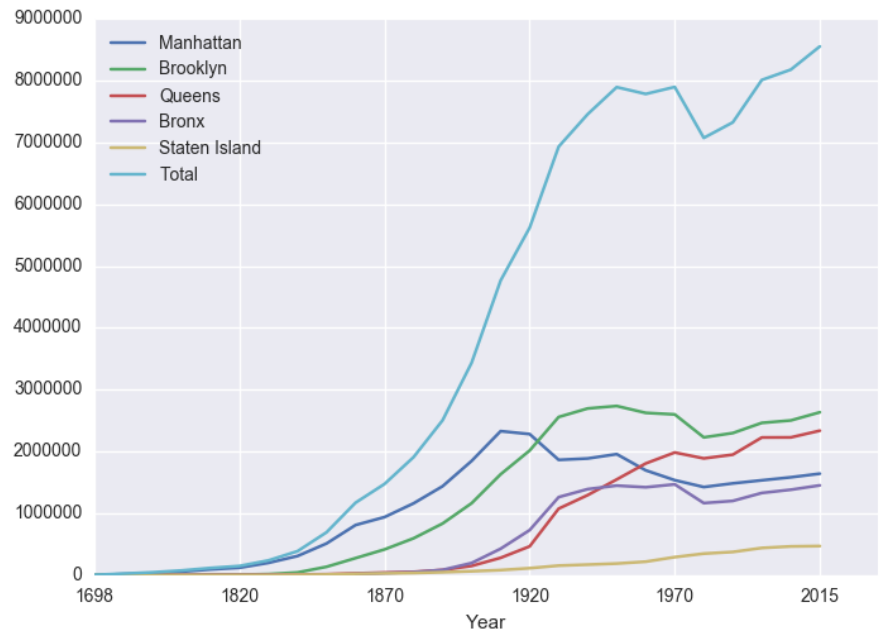

Week 7: functions

```
#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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- The opening function is often called `main()`
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis: Example: `print("Hello", "World")`
- Can write, or **define** your own functions, which are stored, until invoked or called.

Week 8: function parameters, github

- 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:' ))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

Week 8: function parameters, github

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- Surrounded by parenthesis, both in the function definition, and in the function call (invocation).

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- The "placeholders" in the function definition: **formal parameters**.

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- The "placeholders" in the function definition: **formal parameters**.
- 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)
  trey.right(a)
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- Python's built-in random package has useful methods for generating random whole numbers and real numbers.

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- Very useful for checking user input for correctness.
- Python's built-in random package has useful methods for generating random whole numbers and real numbers.
- To use, must include: `import random`.
- The max design pattern provides a template for finding maximum value from a list.

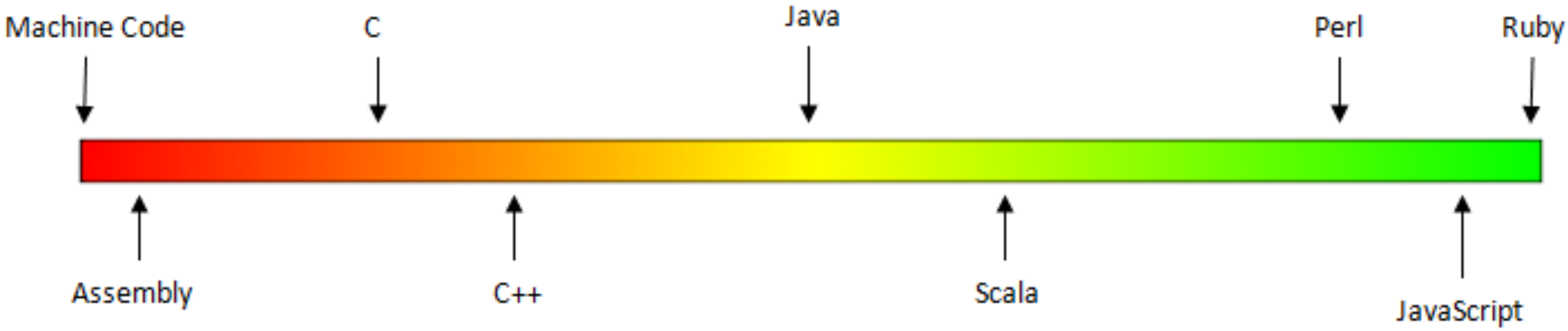
Python & Circuits Review: 10 Weeks in 10 Minutes

- 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

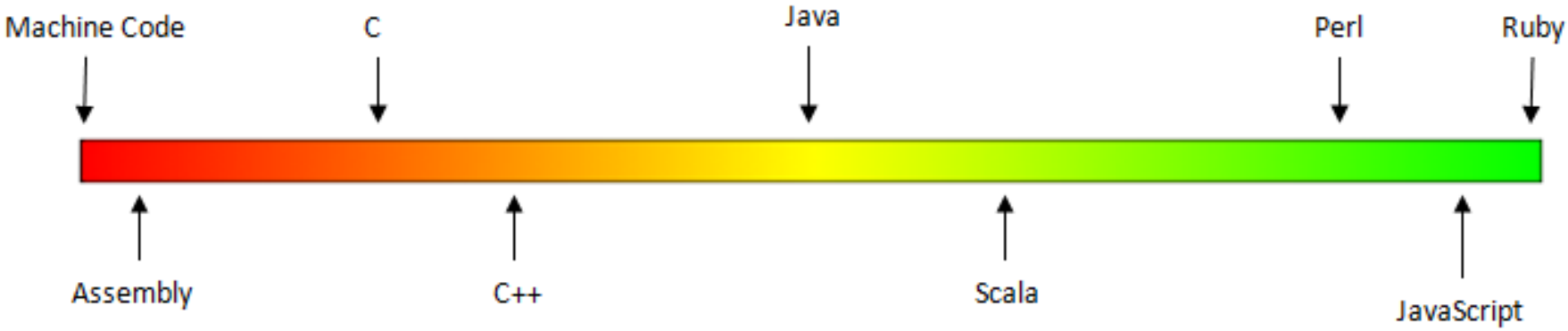
Low-Level vs. High-Level Languages



(codeCommit)

- Can view programming languages on a continuum.

Low-Level vs. High-Level Languages



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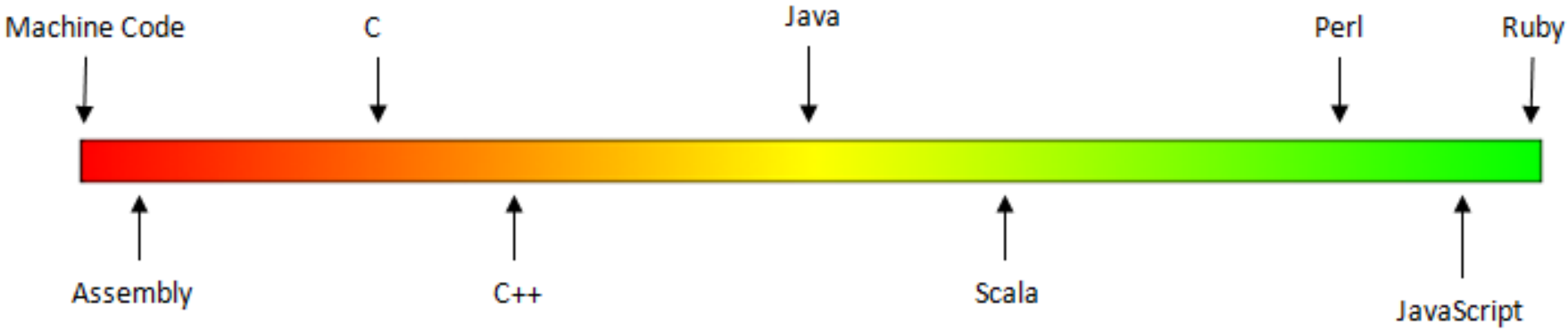

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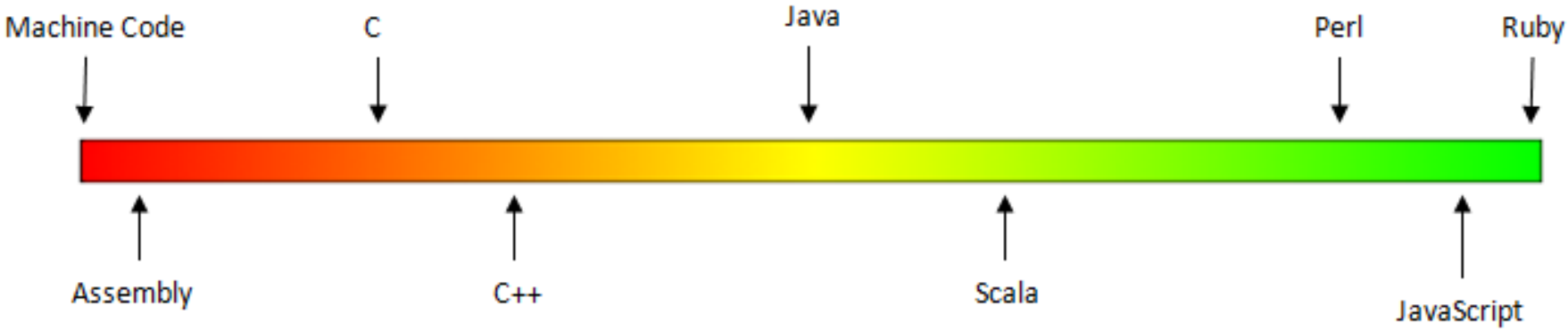

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- Those that have strong abstraction (allow programming paradigms independent of the machine details, such as complex variables, functions and looping that do not translate directly into machine code) are called **high-level languages**.

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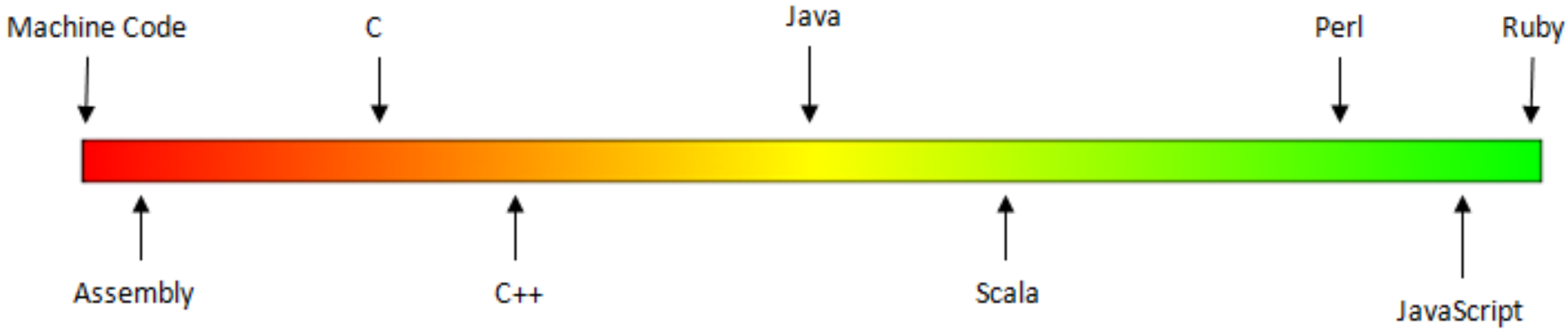

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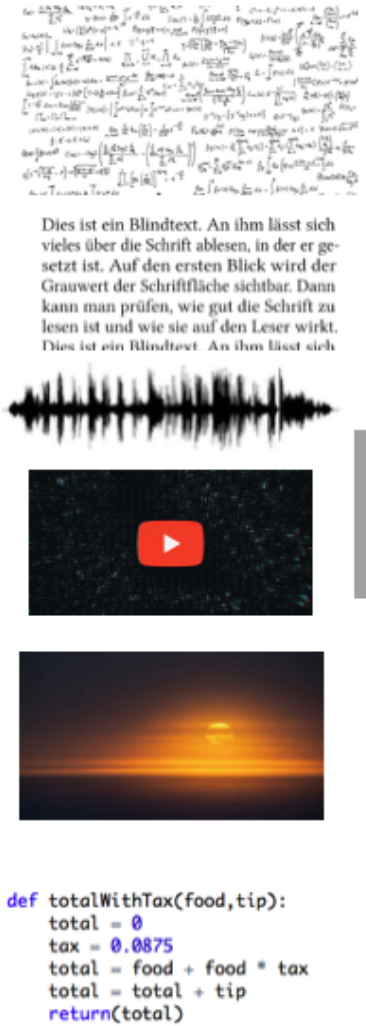
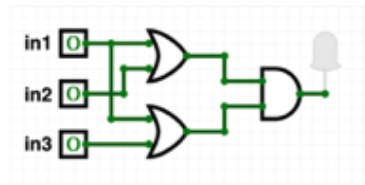
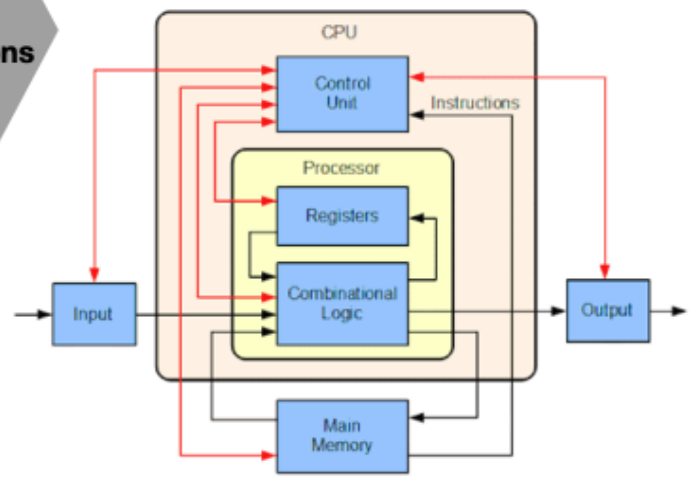
- Some languages, like C, are in between– allowing both low level access and high level data structures.

Processing

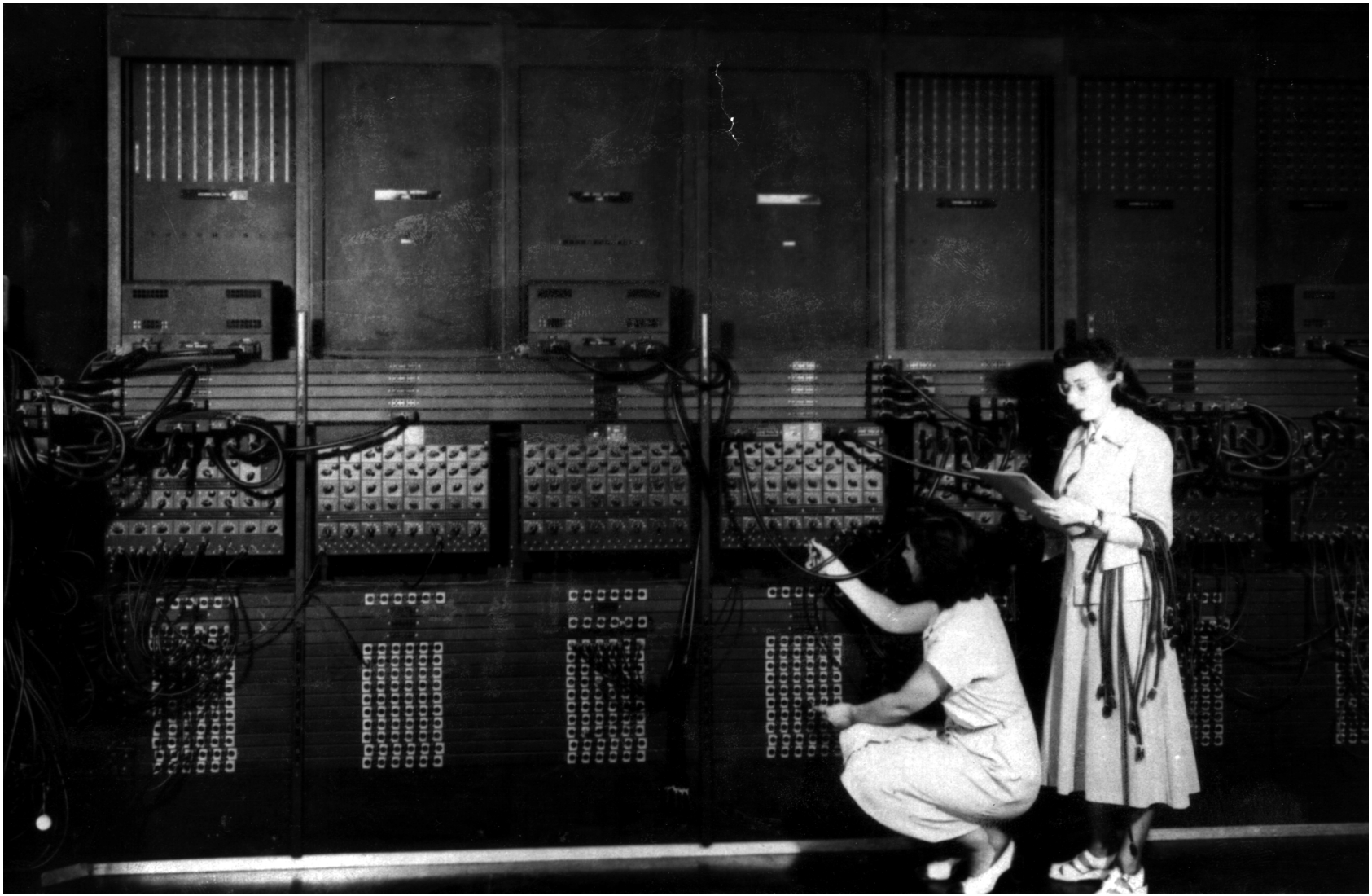




Circuits (switches)
On/Off 1/0 Logic
Billions of switches/bits

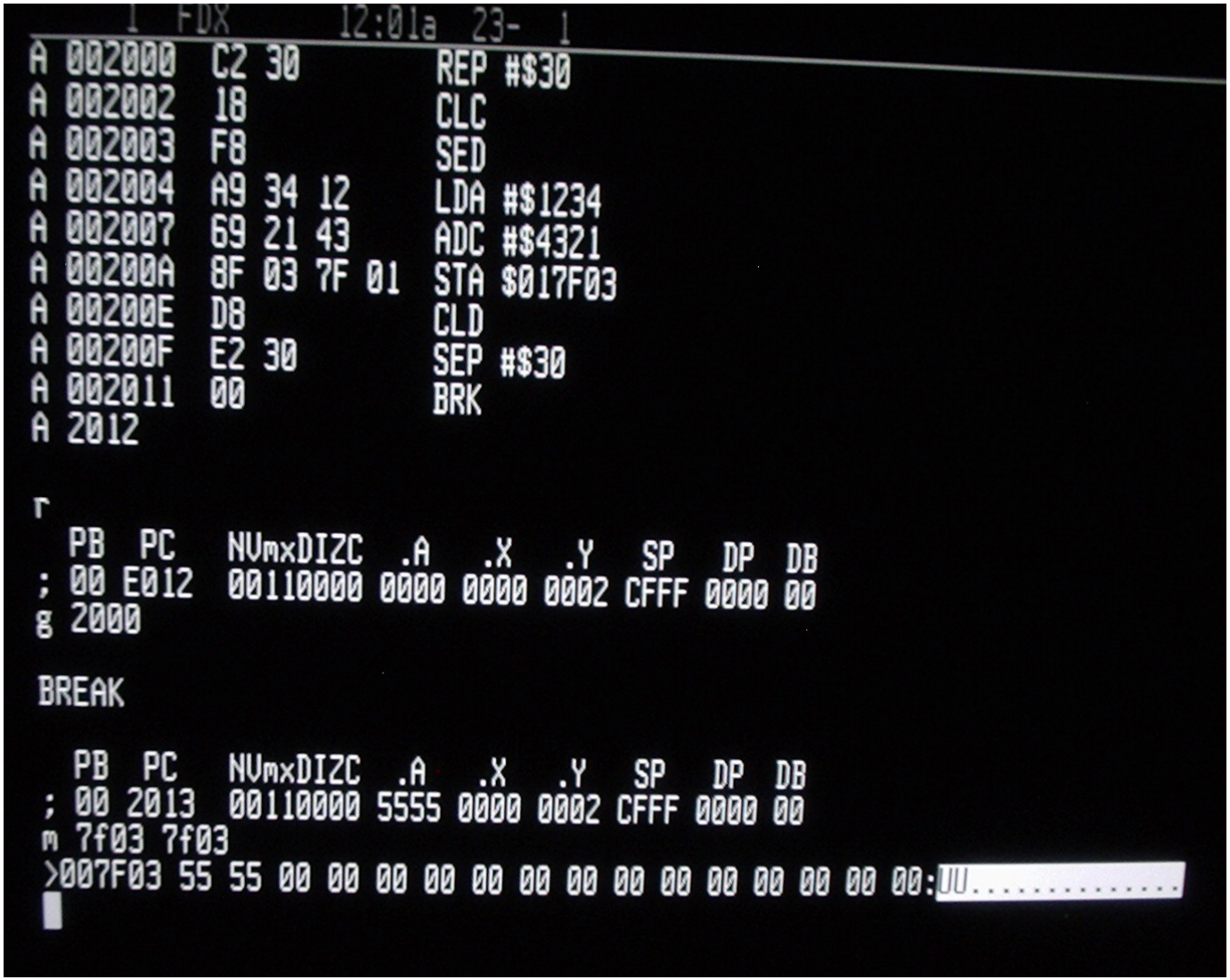


Machine Language



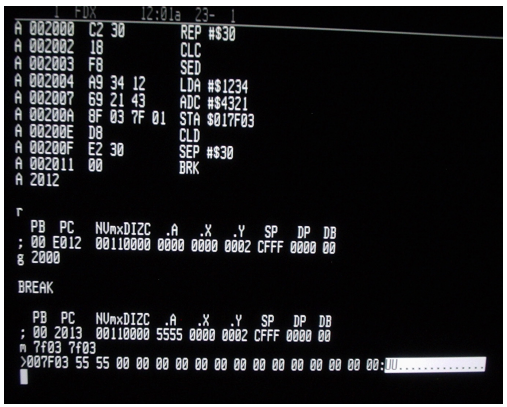
(Ruth Gordon & Ester Gerston programming the ENIAC, UPenn)

Machine Language



(wiki)

Machine Language



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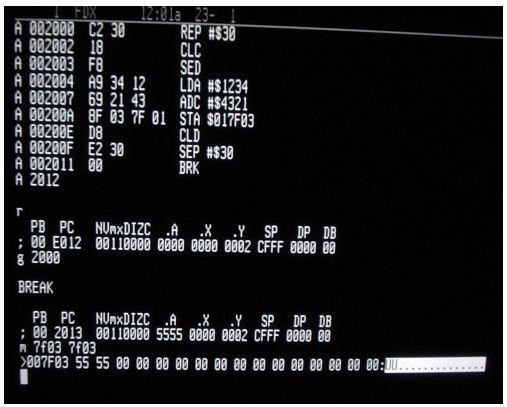
Machine Language



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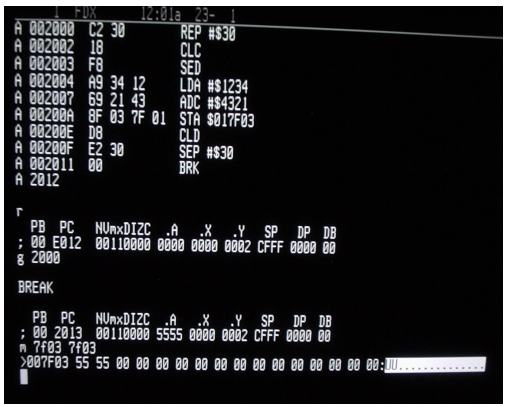
Machine Language



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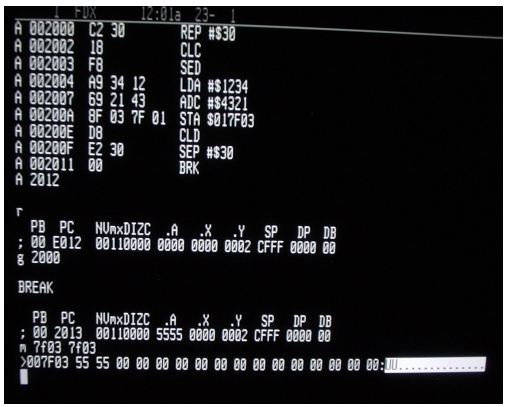
Machine Language



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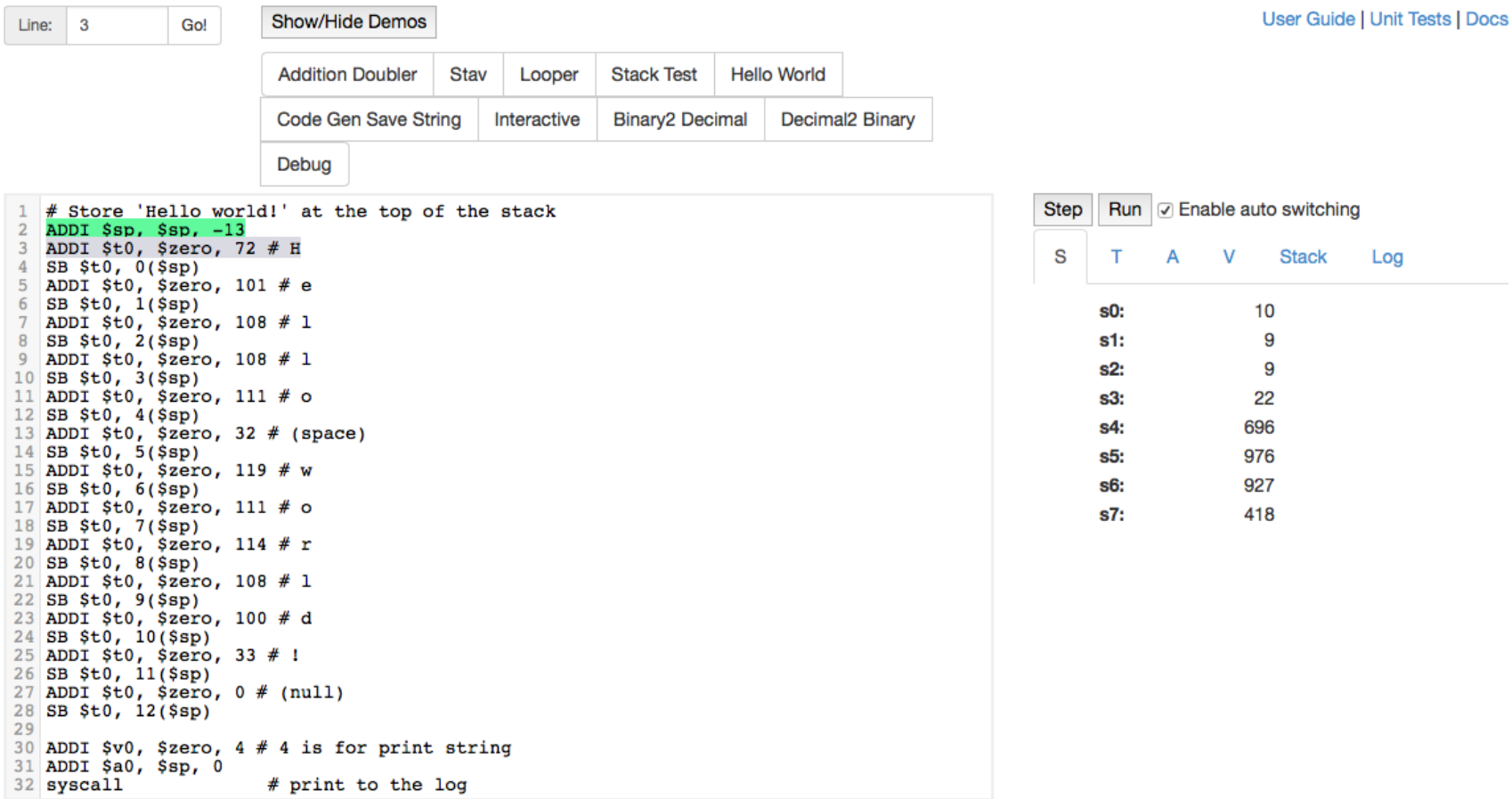
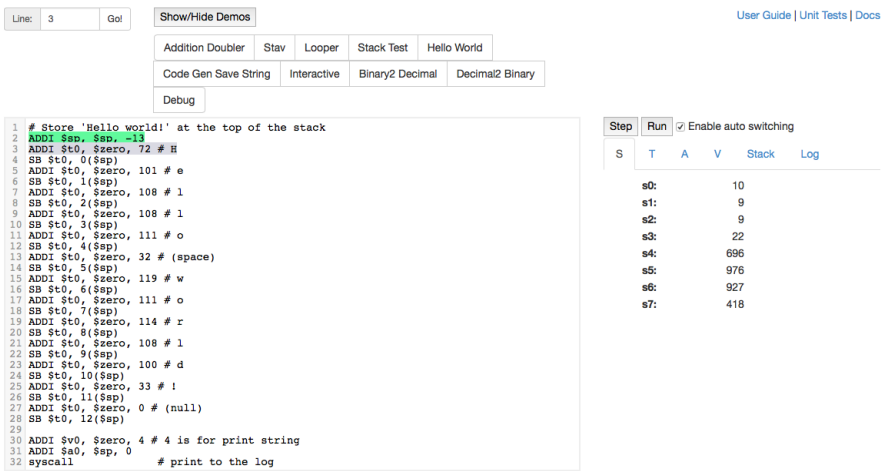
- More in future architecture classes....

“Hello World!” in Simplified Machine Language



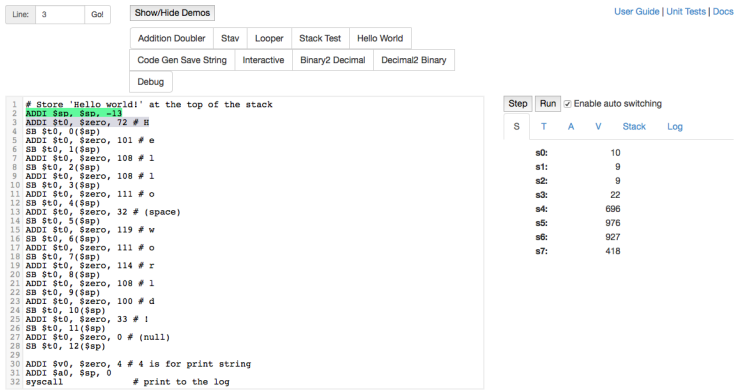
(WeMIPS)

WeMIPS



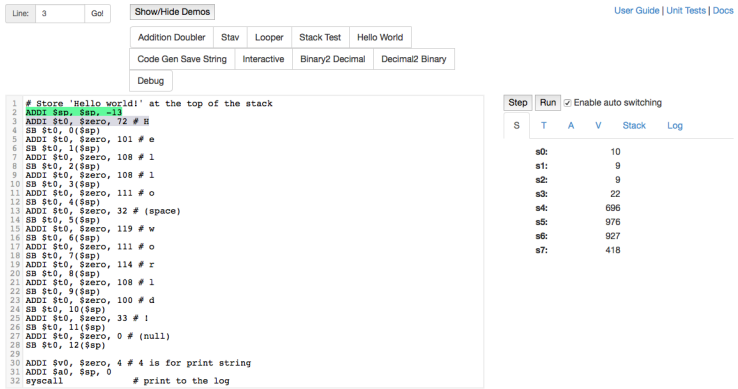
(Demo with WeMIPS)

MIPS Commands



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

MIPS Commands



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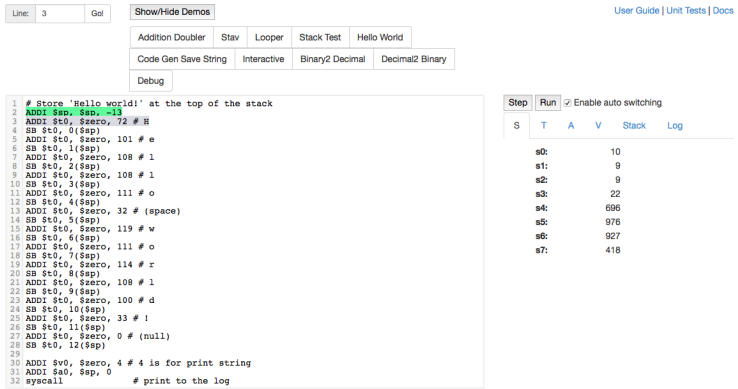
MIPS Commands



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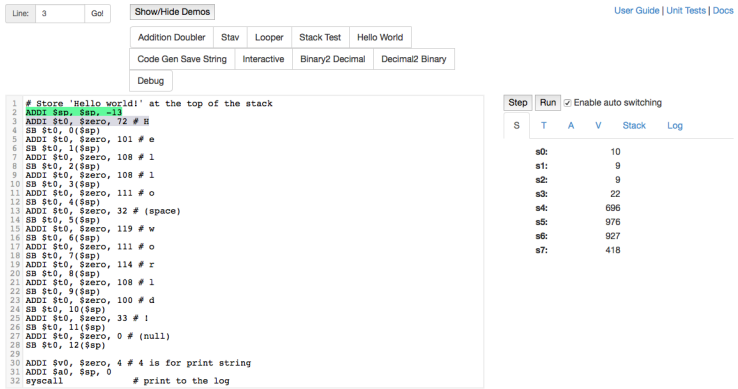
MIPS Commands



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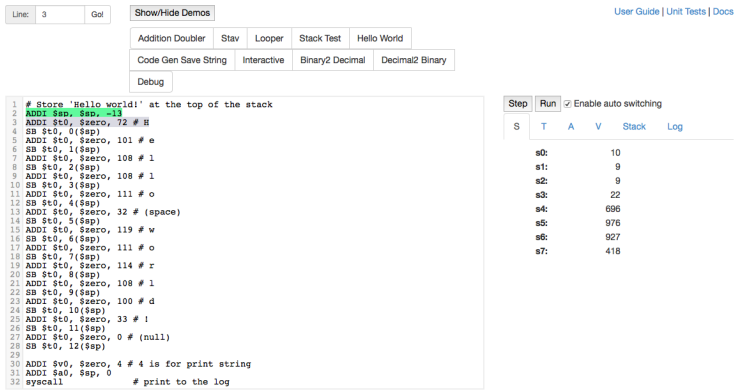

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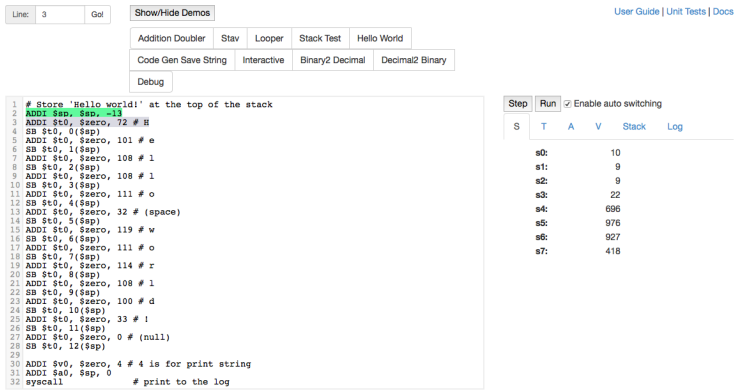

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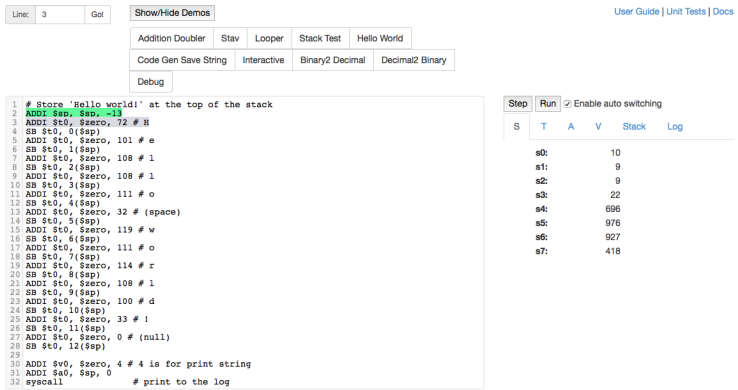
MIPS Commands



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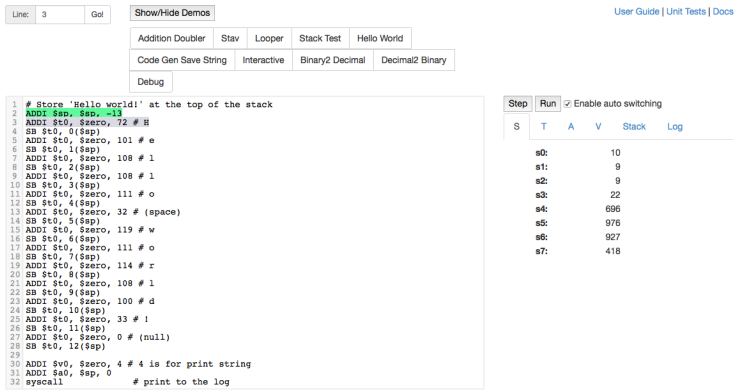

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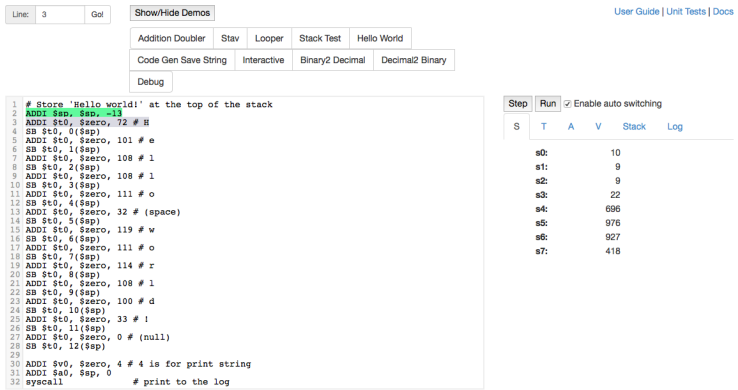

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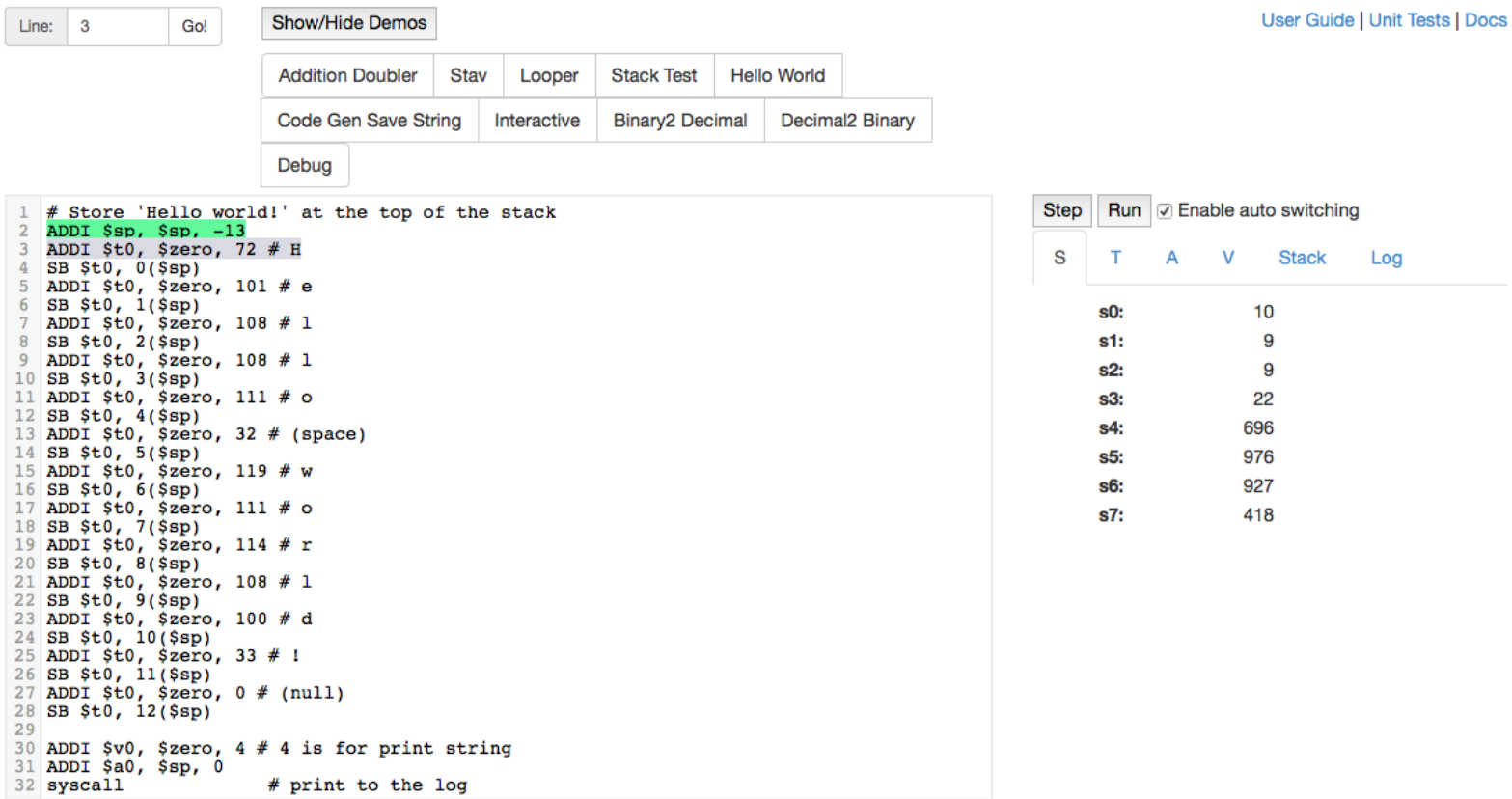
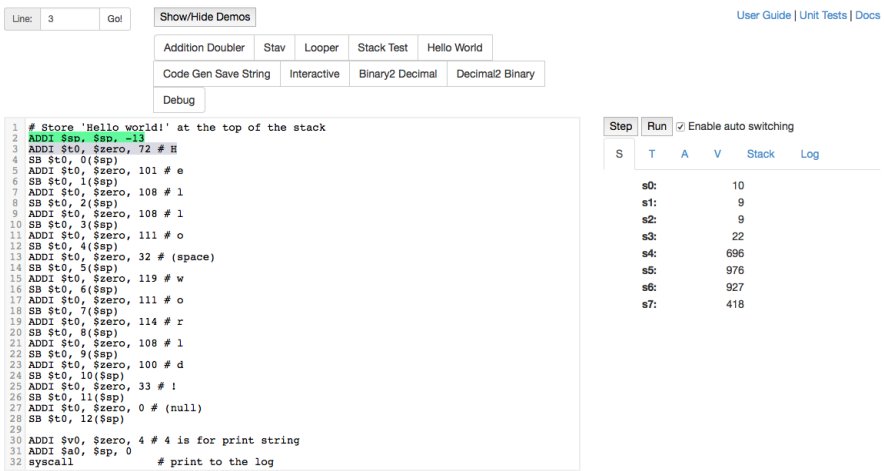
Challenge:



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

WeMIPS



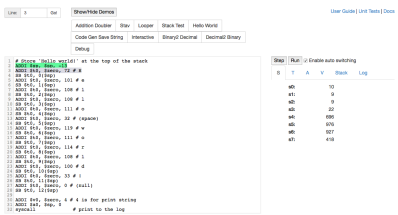
(Demo with WeMIPS)

Today's Topics

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

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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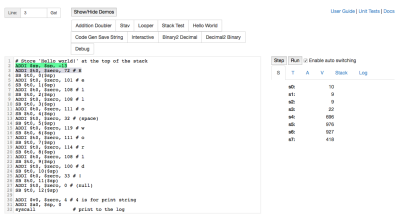
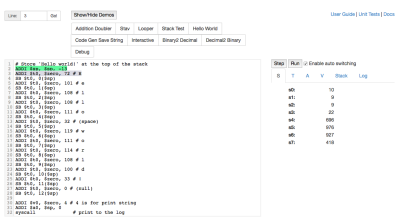


Loops & Jumps in Machine Language



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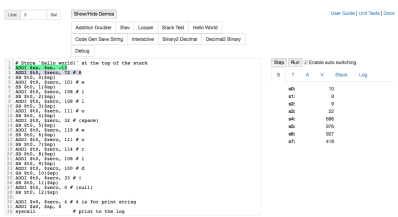

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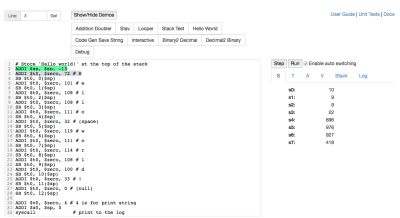

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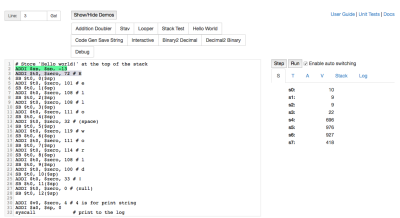
Loops & Jumps in Machine Language



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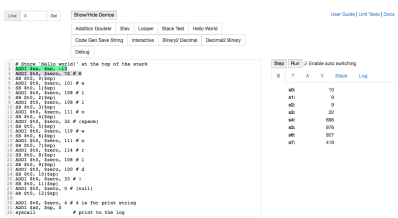
Loops & Jumps in Machine Language



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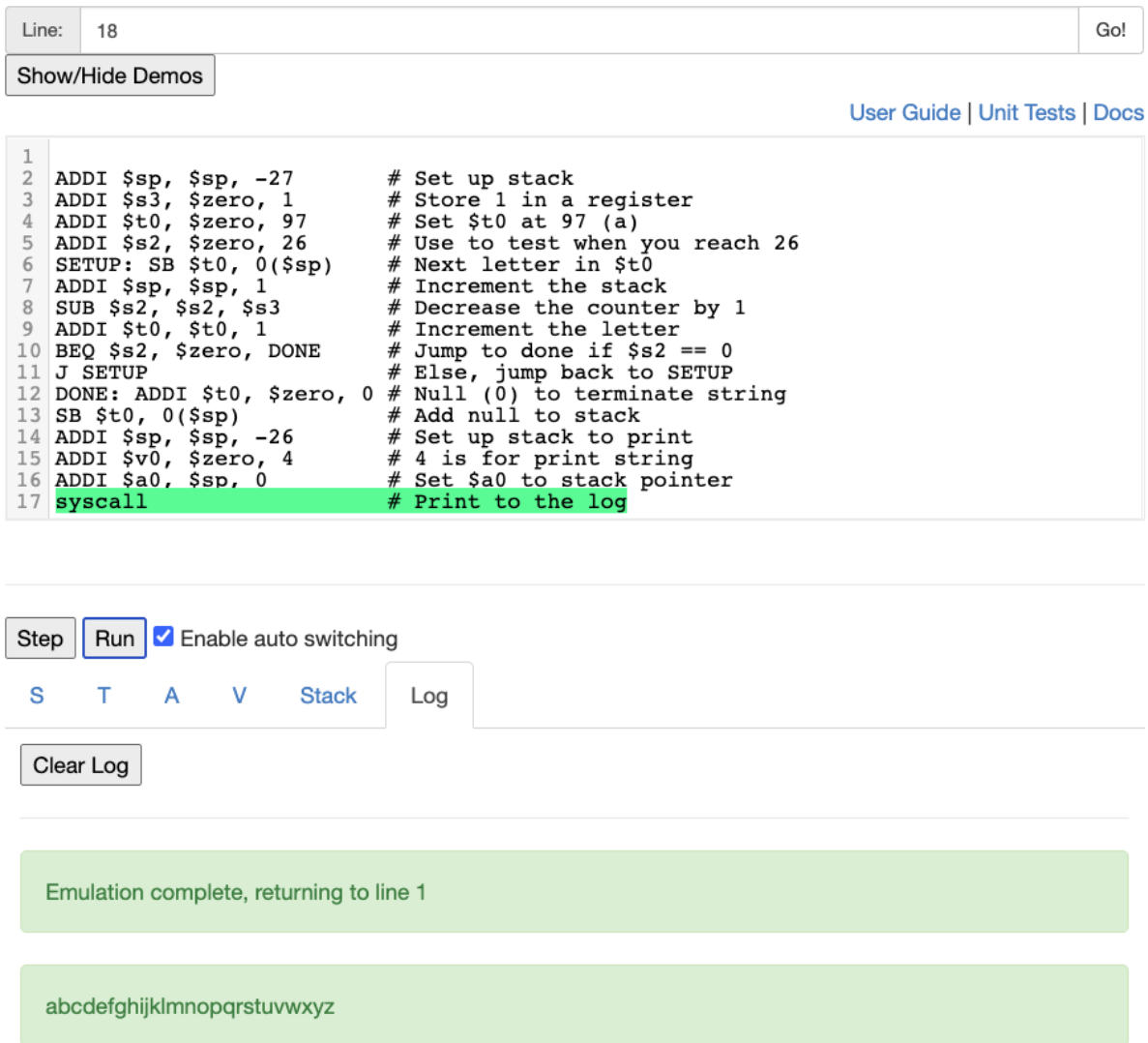
  - See reading for more variations.

Jump Demo



(Demo with `WeMIPS`)

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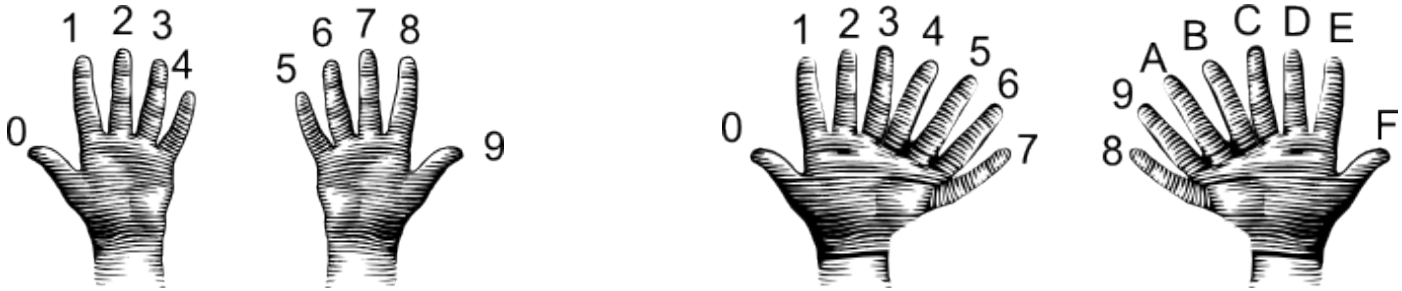
- Python Recap
- Machine Language
- Machine Language: Jumps & Loops
- **Binary & Hex Arithmetic**

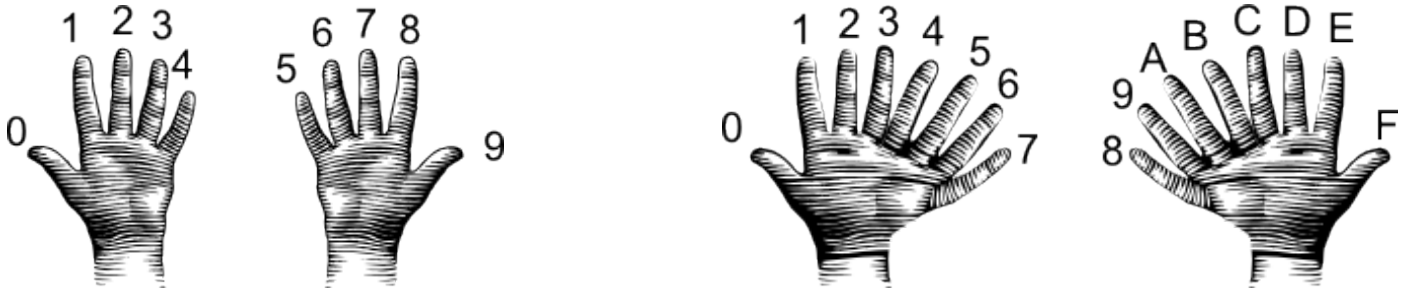
Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal (assuming two-digit numbers):
  - Convert first digit to decimal and multiple by 16.

Hexadecimal to Decimal: Converting Between Bases



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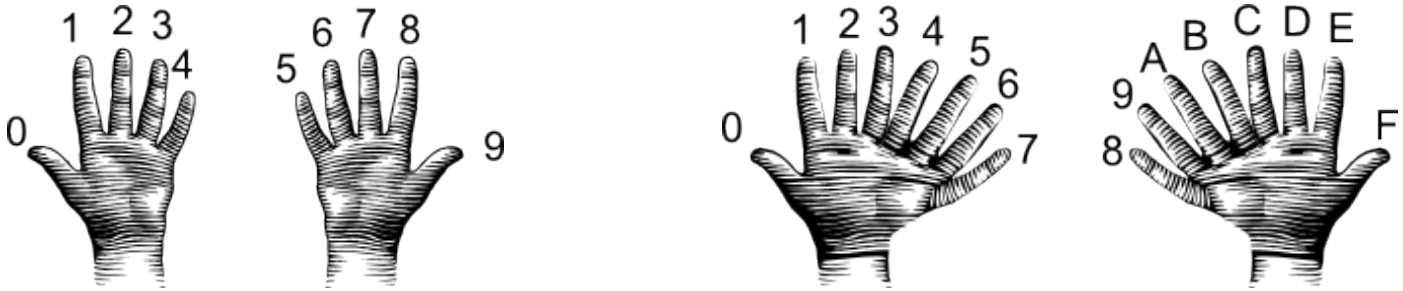

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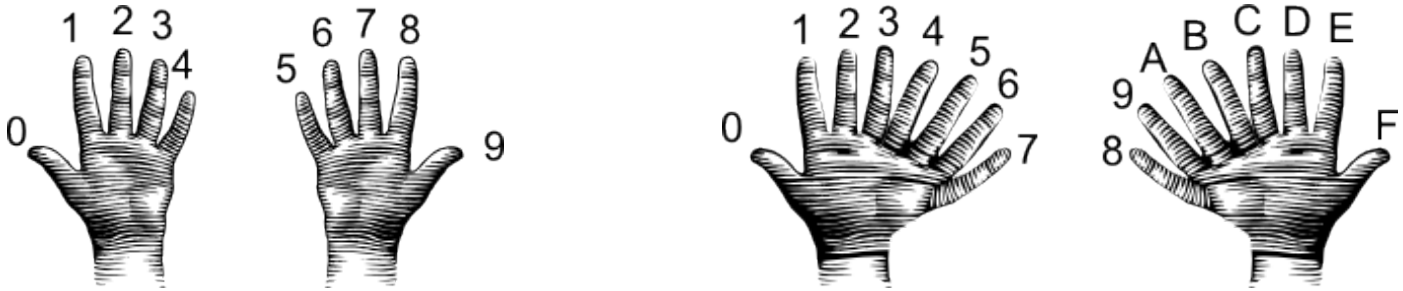

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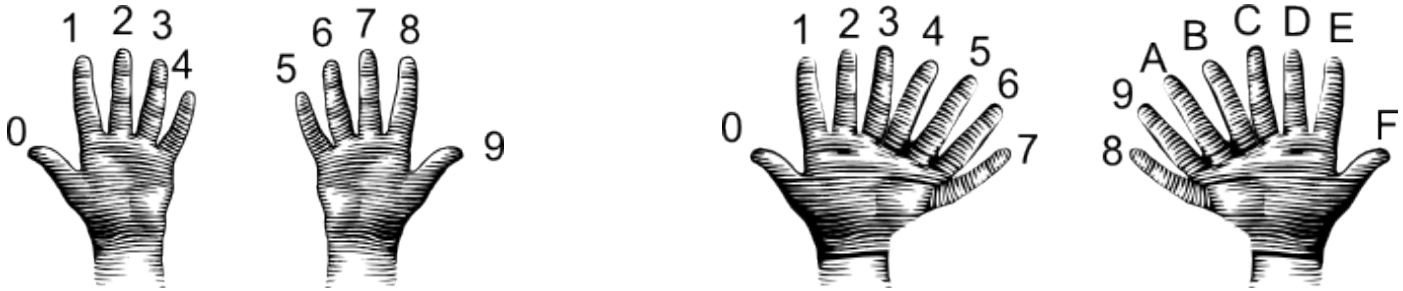

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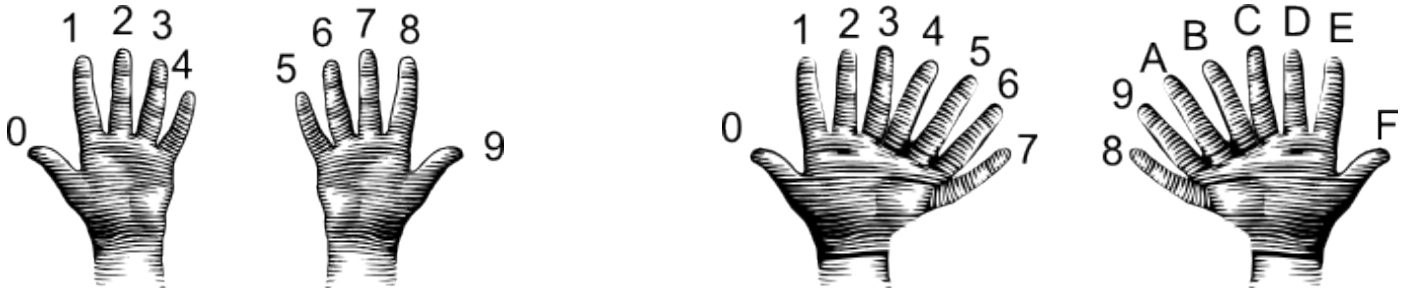

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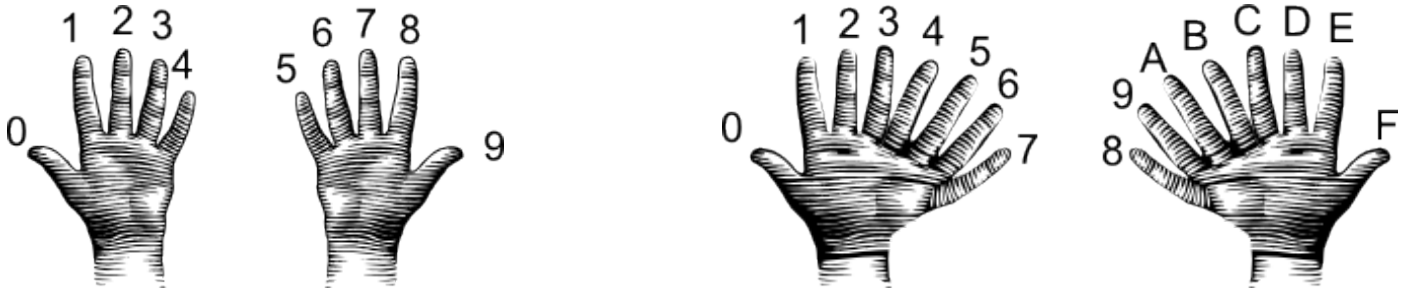
Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal (assuming two-digit numbers):
  - Convert first digit to decimal and multiple by 16.
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  - 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.
    ```

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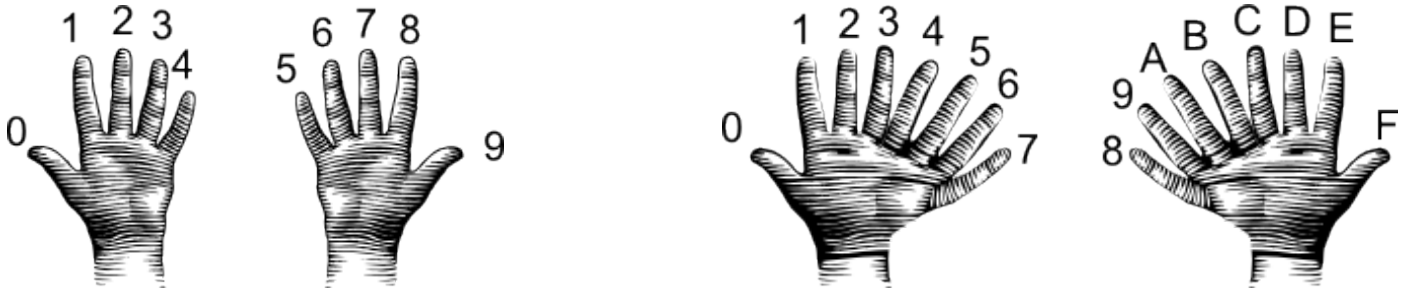

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    Answer is 42.
  - Example: what is 99 as a decimal number?

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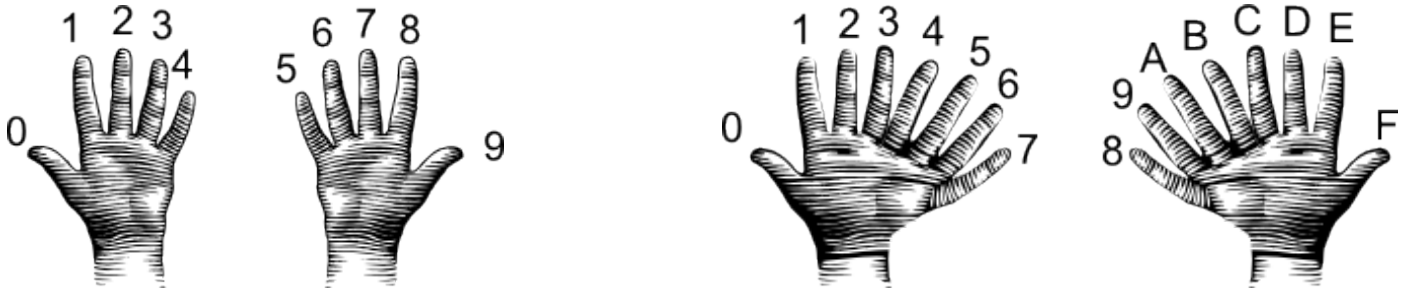

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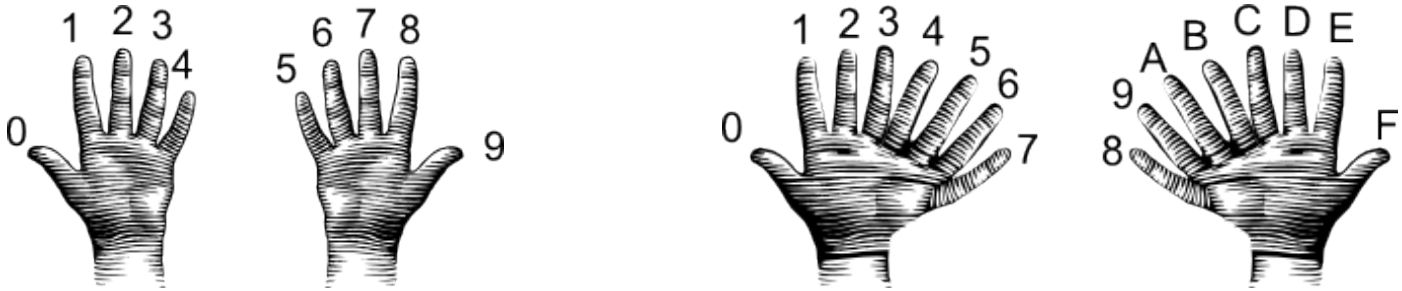

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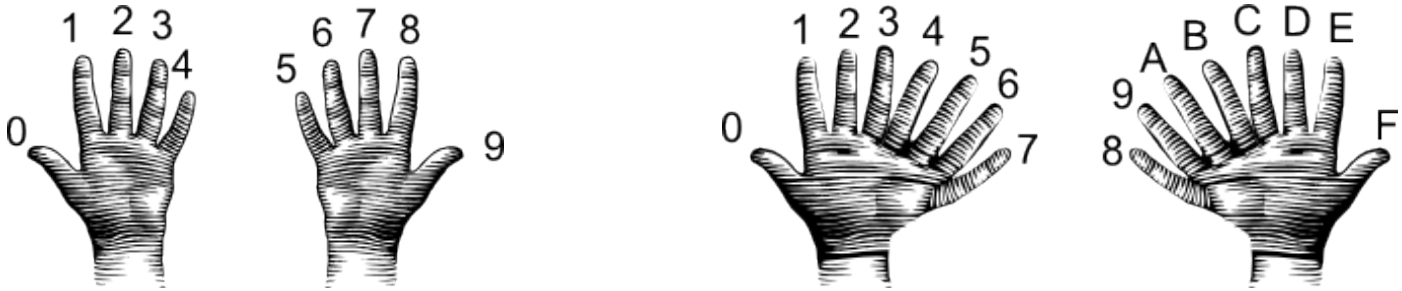
    `9 in decimal is 9. 9*16 is 144.`

Hexadecimal to Decimal: Converting Between Bases



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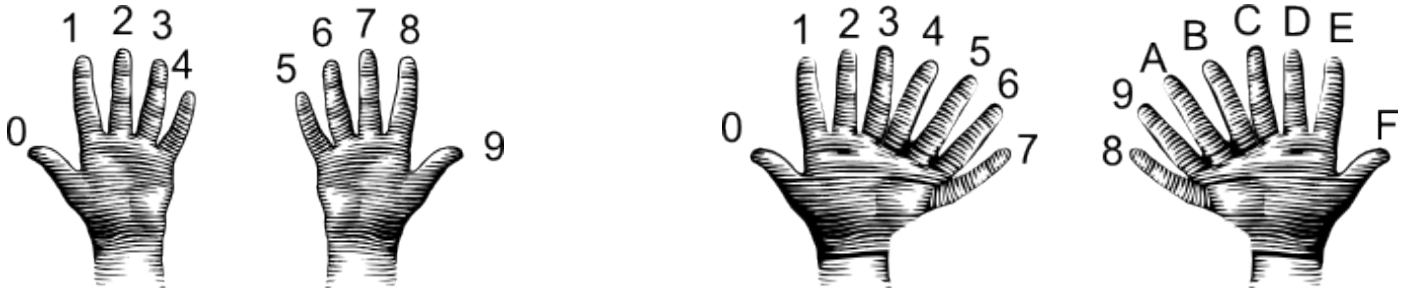
Hexadecimal to Decimal: Converting Between Bases



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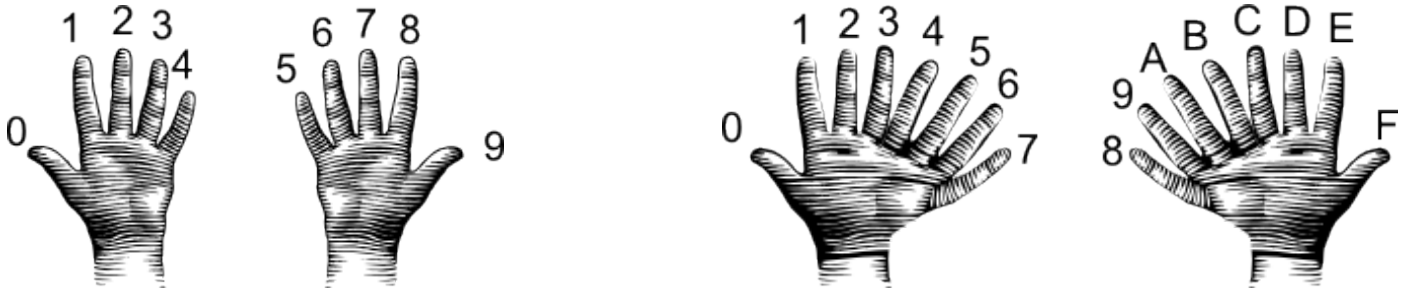

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    `9 in decimal is 9. 9*16 is 144.`

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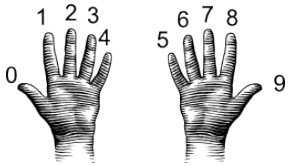
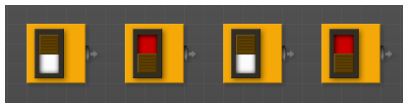
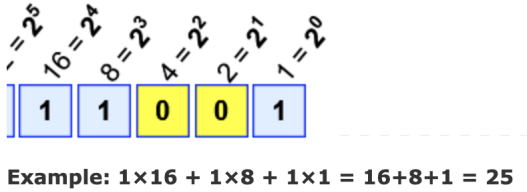
    Answer is 153.

Decimal to Binary: Converting Between Bases

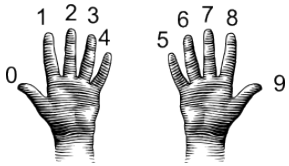


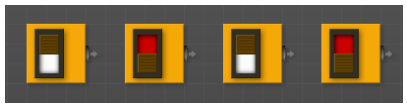


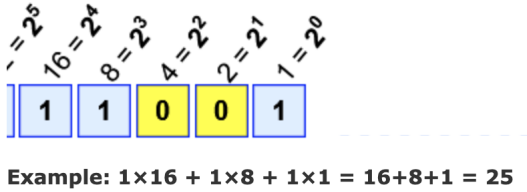


- From decimal to binary:
  - Divide by 128 ($= 2^7$). Quotient is the first digit.

Decimal to Binary: Converting Between Bases







- From decimal to binary:
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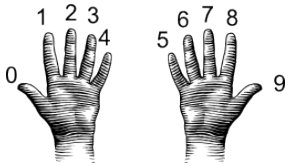
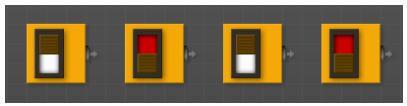
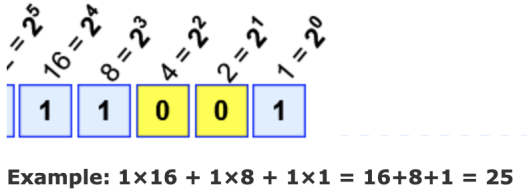
Decimal to Binary: Converting Between Bases







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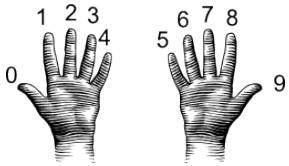

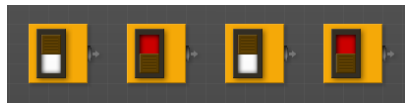

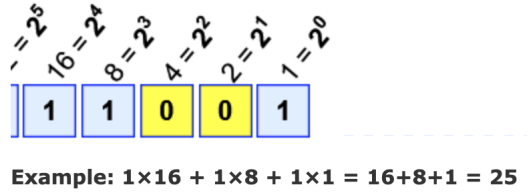

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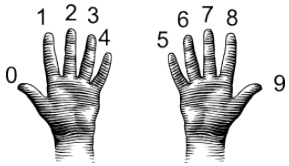
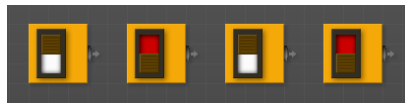
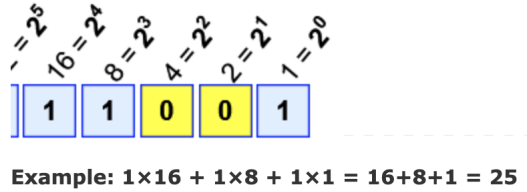
Decimal to Binary: Converting Between Bases







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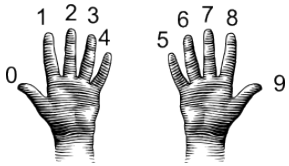

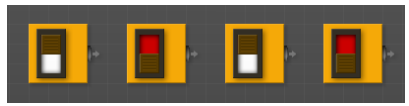

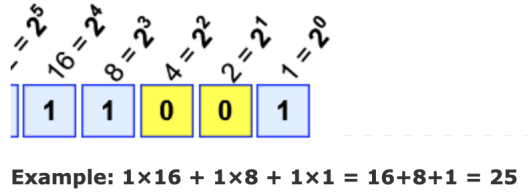

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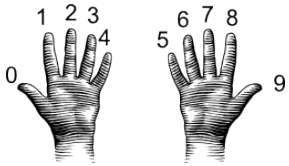

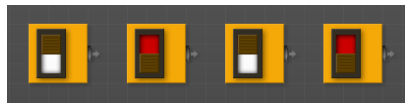

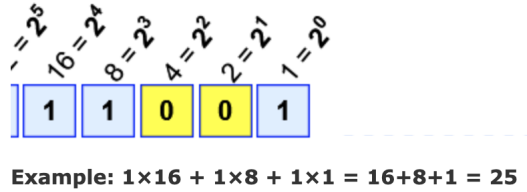

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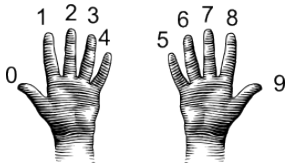

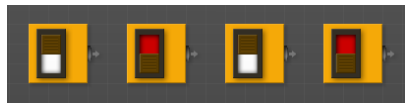

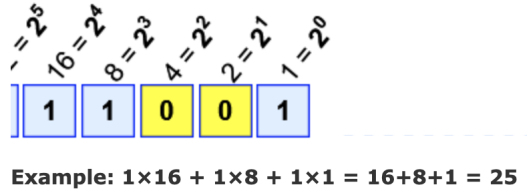

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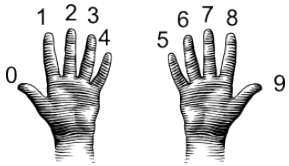
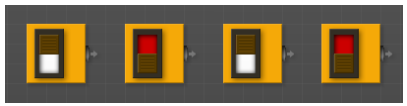
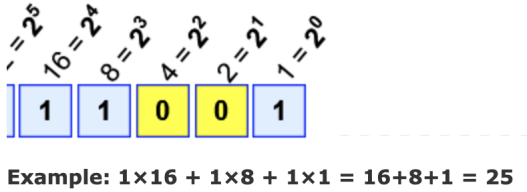
Decimal to Binary: Converting Between Bases







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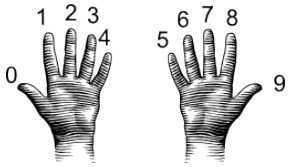
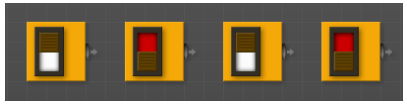
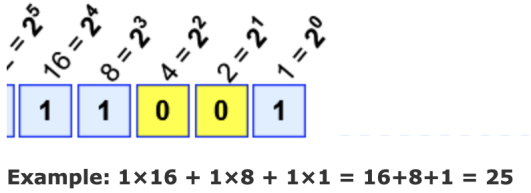
  - Example: what is 130 in binary notation?

Decimal to Binary: Converting Between Bases







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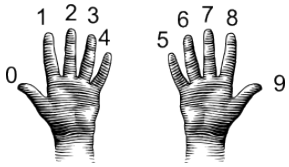
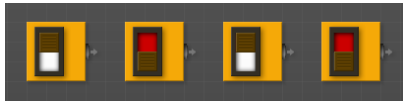
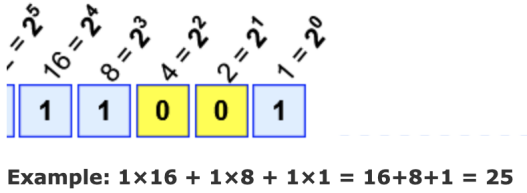
  - Divide remainder by 8 ($= 2^3$). Quotient is the next digit.
  - Divide remainder by 4 ($= 2^2$). Quotient is the next digit.
  - Divide remainder by 2 ($= 2^1$). Quotient is the next digit.
  - The last remainder is the last digit.
  - Example: what is 130 in binary notation?

    `130/128 is 1 rem 2.`

Decimal to Binary: Converting Between Bases







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

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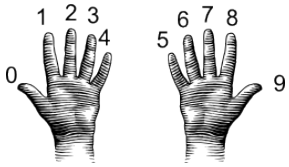

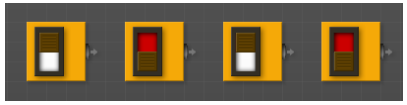

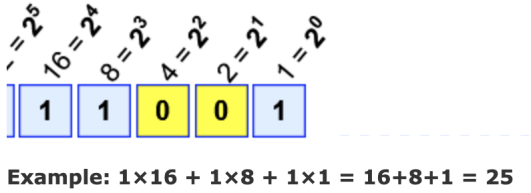

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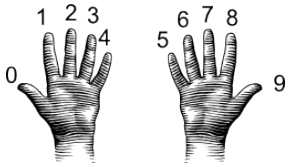

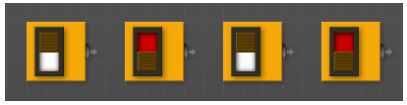

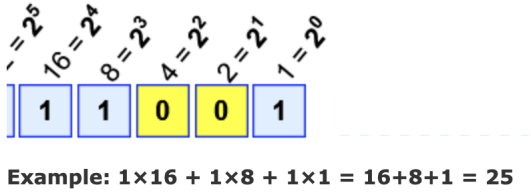

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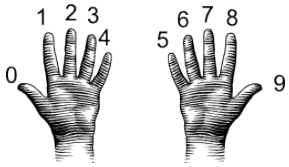

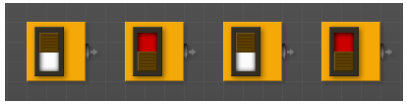

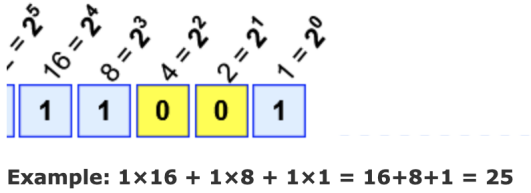

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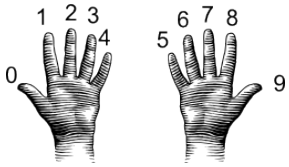

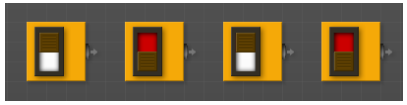

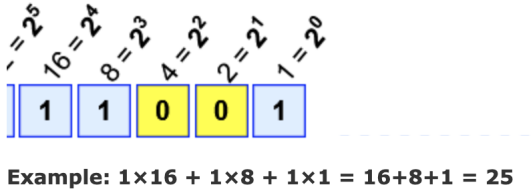

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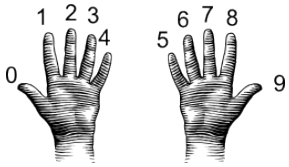

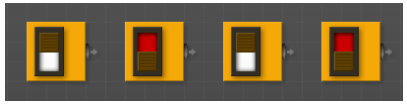

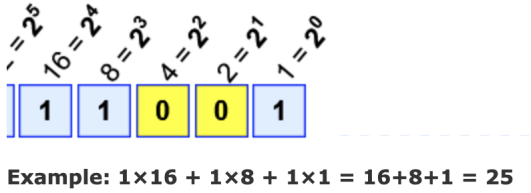

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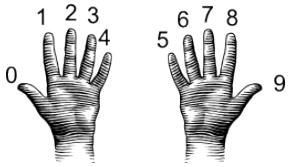

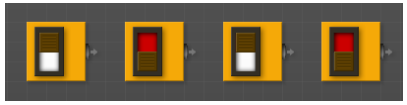

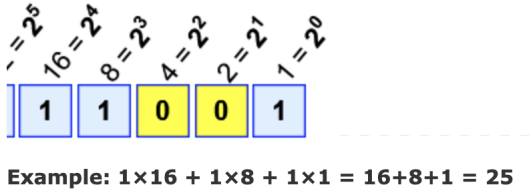

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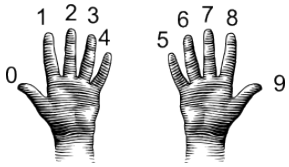

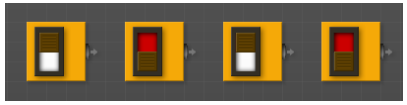

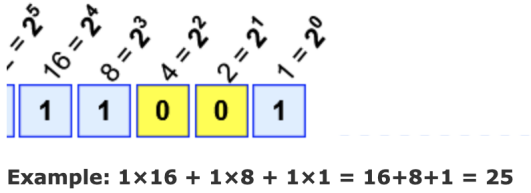

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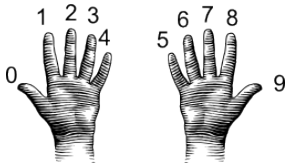

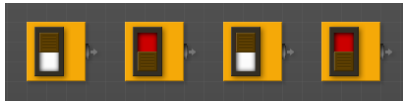

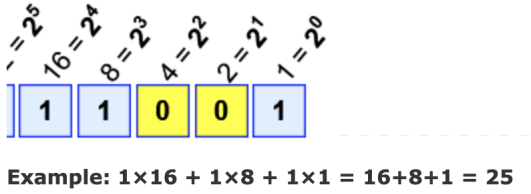

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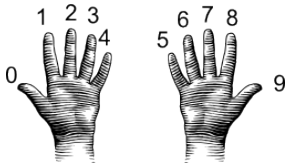

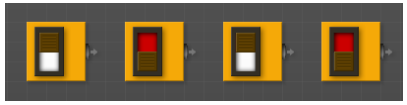

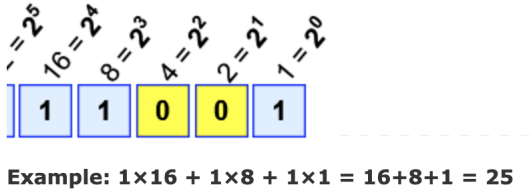

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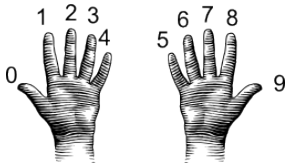

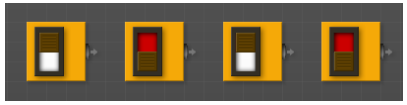

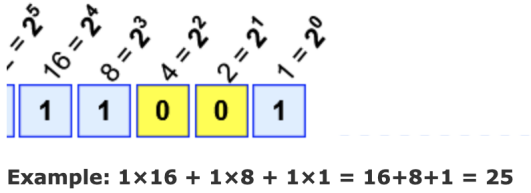

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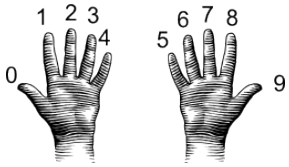

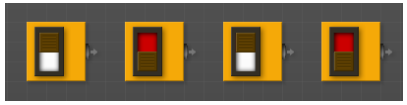

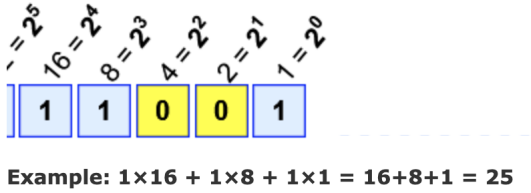

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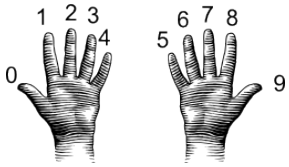
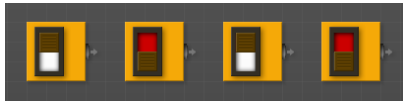
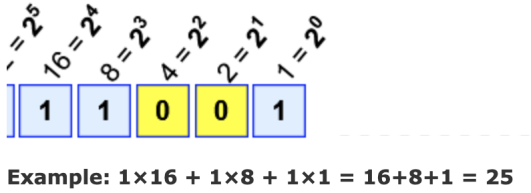
Decimal to Binary: Converting Between Bases







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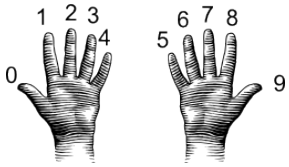

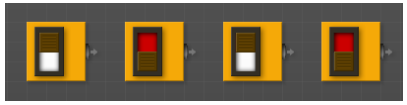

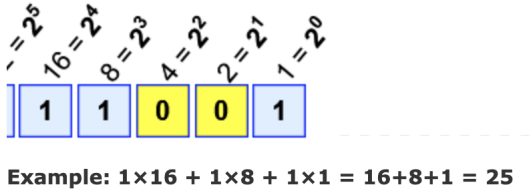

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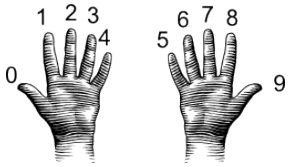

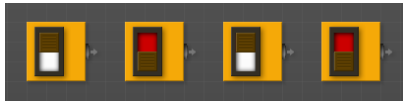

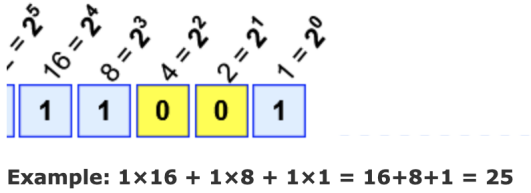

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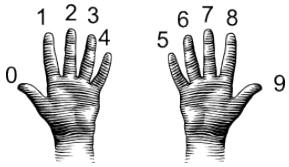

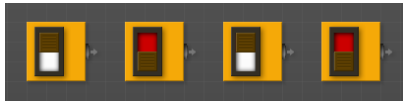

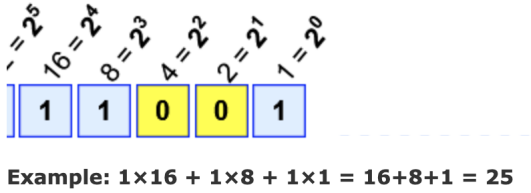

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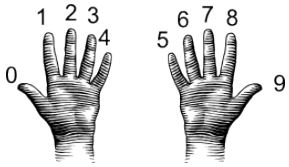

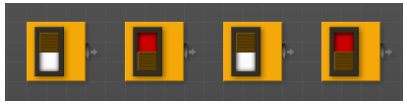

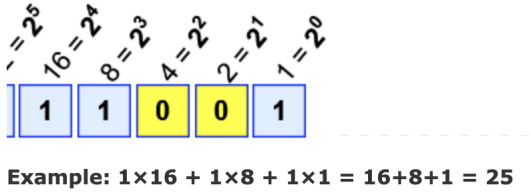

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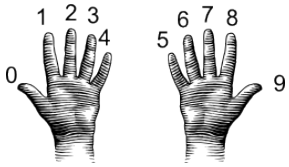

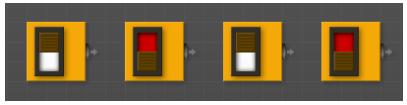

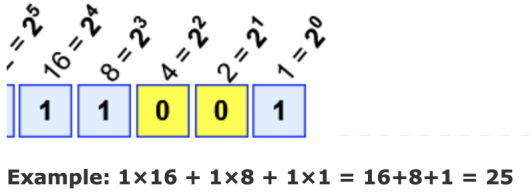

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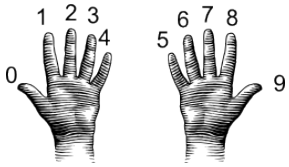

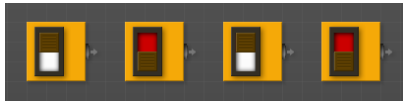

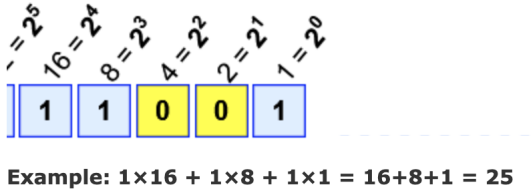

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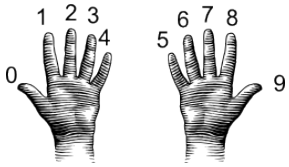

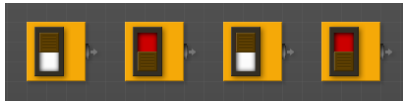

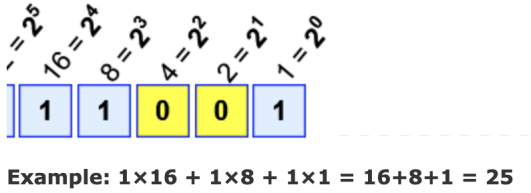

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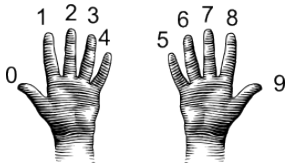

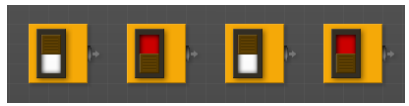

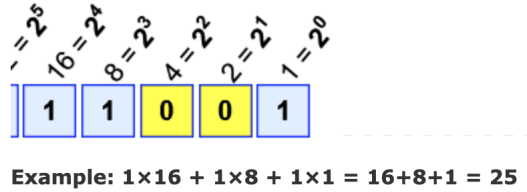

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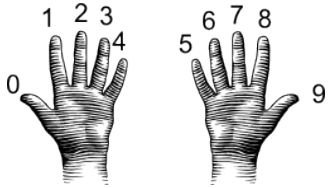

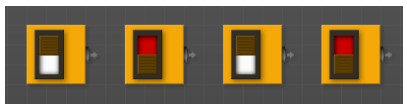

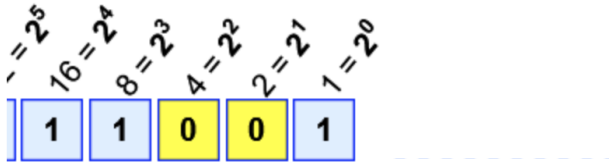

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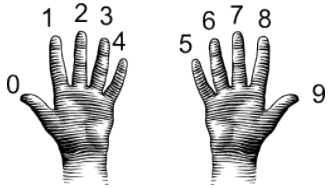
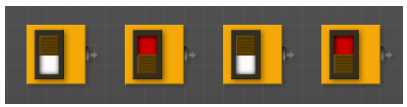
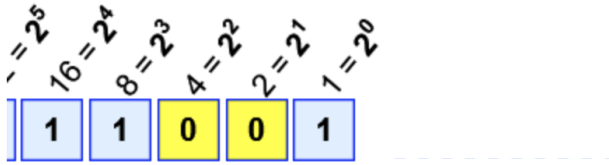
Decimal to Binary: Converting Between Bases







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  `99/128 is 0 rem 99.`

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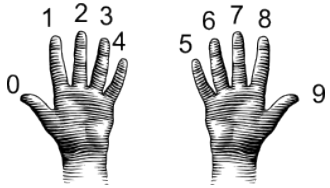

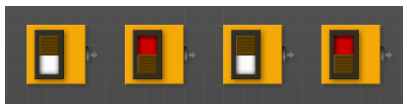

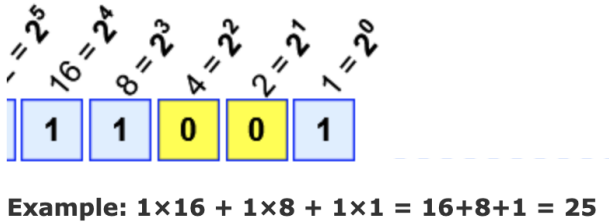

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  `99/128 is 0 rem 99. First digit is 0:`

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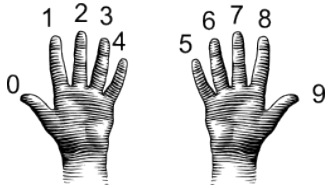

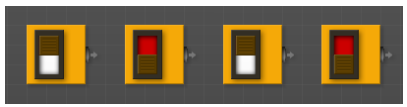

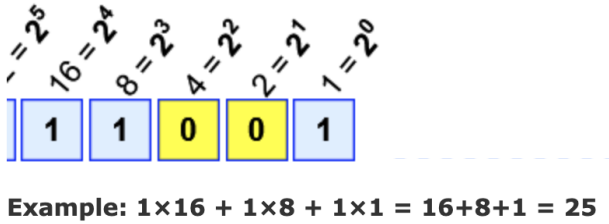

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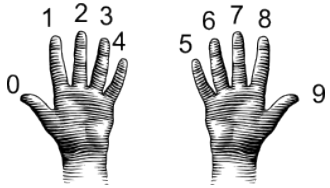

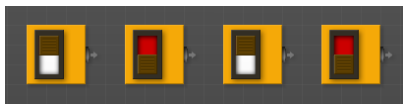

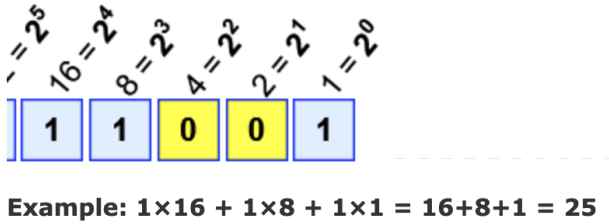

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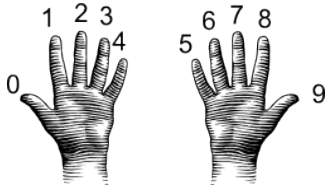
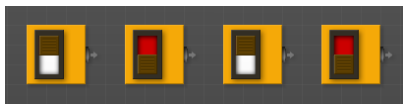
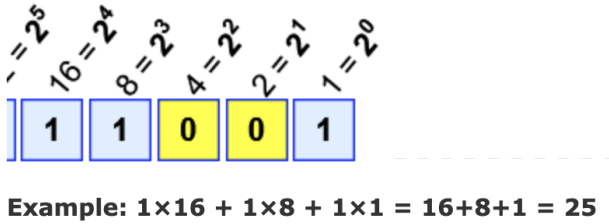
Decimal to Binary: Converting Between Bases







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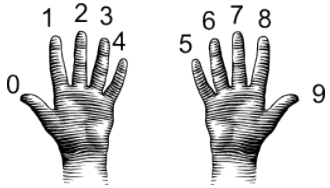

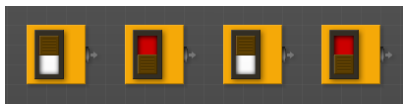

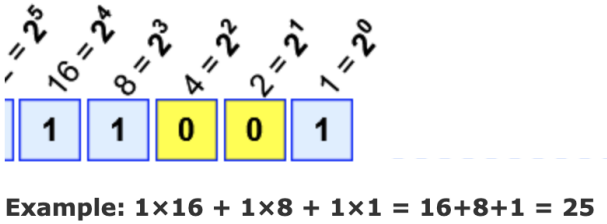

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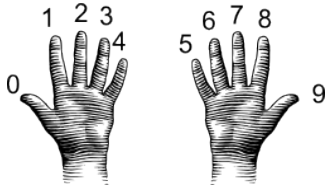

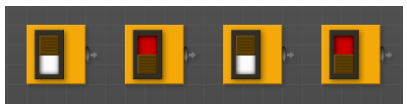

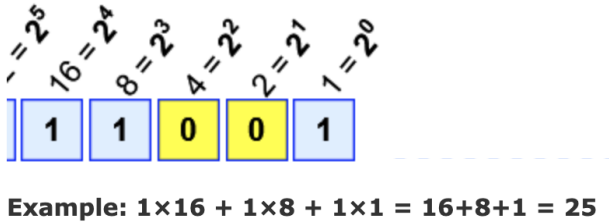

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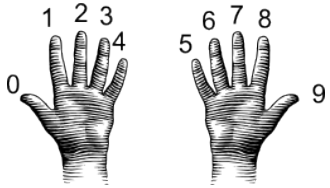

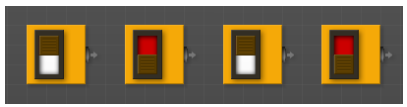

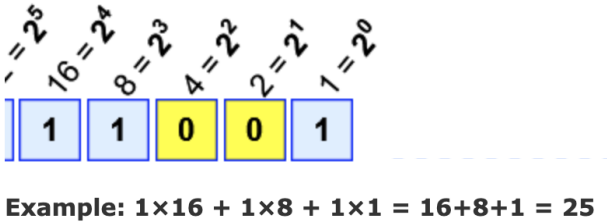

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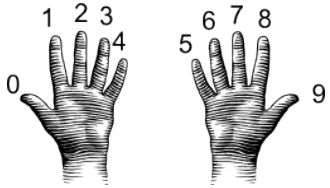

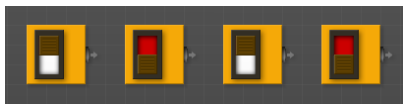

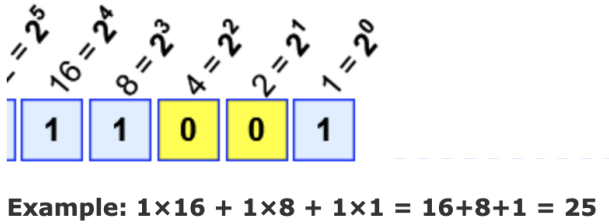

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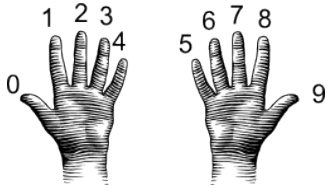

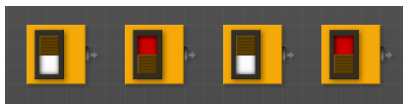

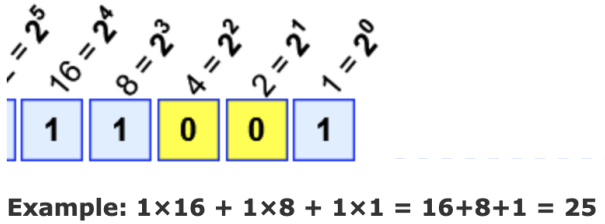

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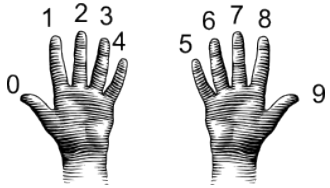

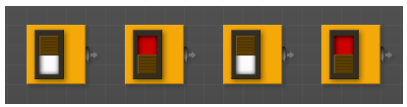

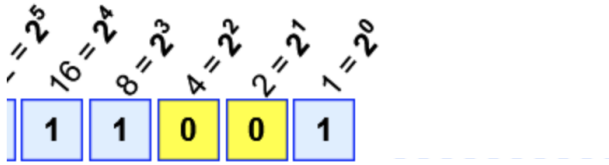

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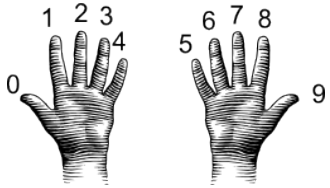

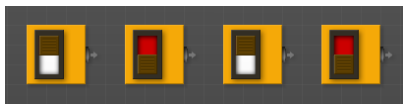

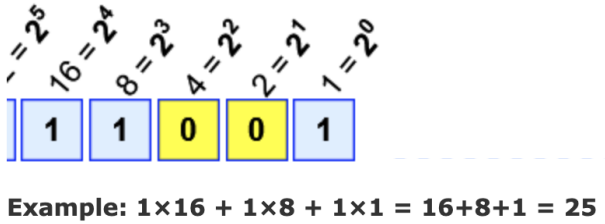

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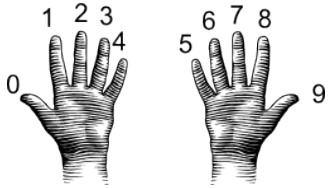

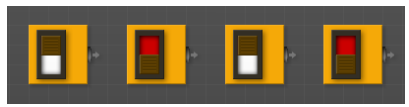

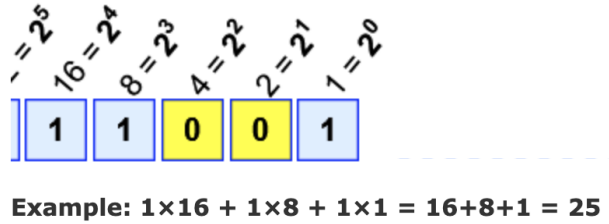

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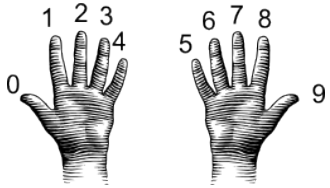

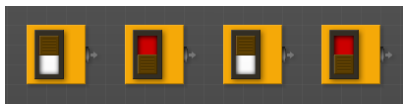

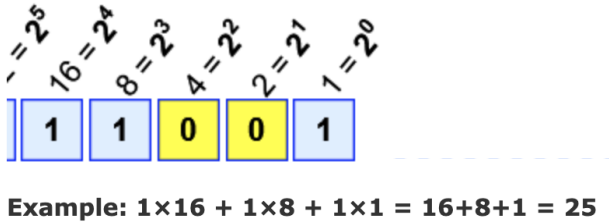

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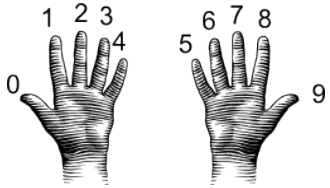

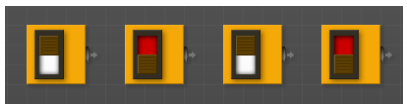

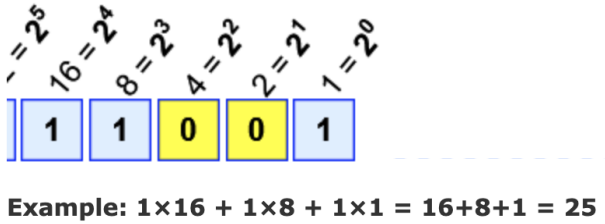

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99/128 is 0 rem 99. First digit is 0:     0...
99/64 is 1 rem 35. Next digit is 1:       01...
35/32 is 1 rem 3. Next digit is 1:        011...
3/16 is 0 rem 3. Next digit is 0:         0110...
3/8 is 0 rem 3. Next digit is 0:          01100...
3/4 is 0 remainder 3.
```
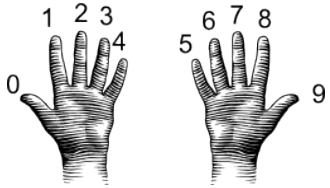
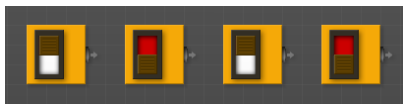
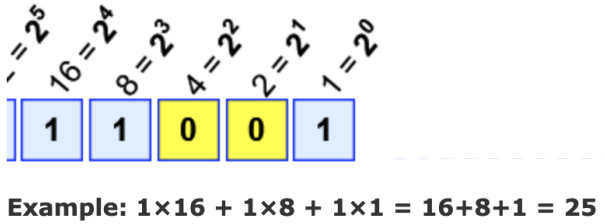

Decimal to Binary: Converting Between Bases







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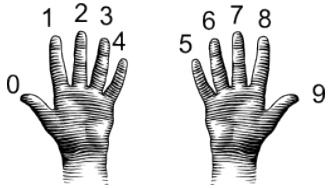

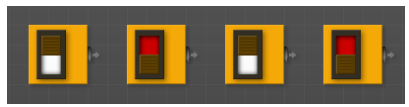

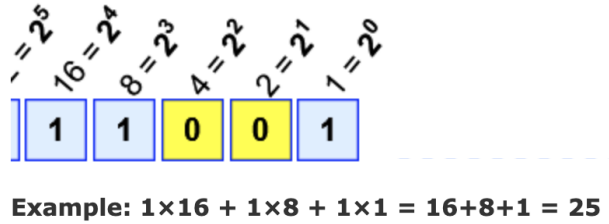

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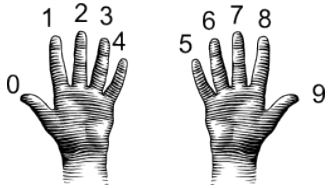
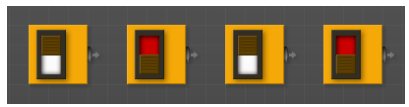
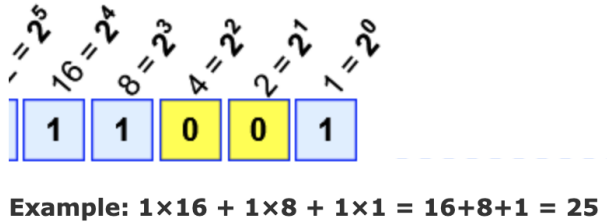
Decimal to Binary: Converting Between Bases







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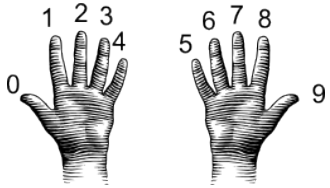
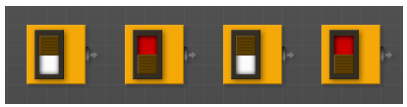
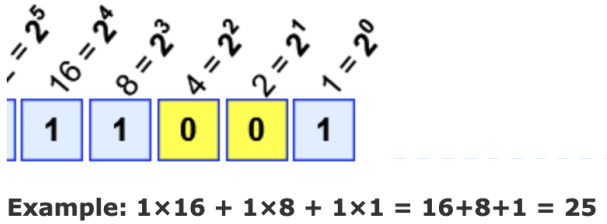
Decimal to Binary: Converting Between Bases







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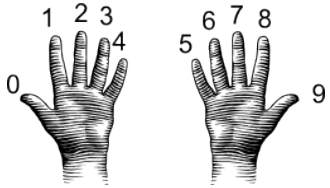
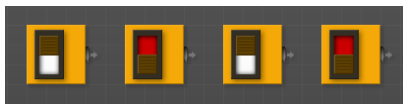
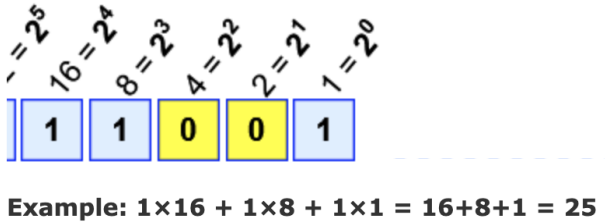
Decimal to Binary: Converting Between Bases







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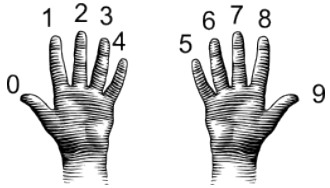
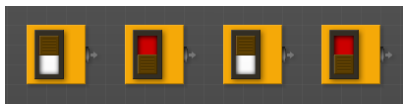
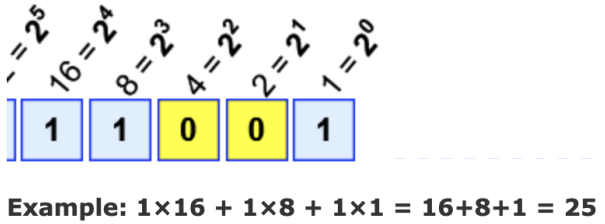
Decimal to Binary: Converting Between Bases







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3/2 is 1 rem 1. Next digit is 1:          0110001...
Adding the last remainder:                01100011
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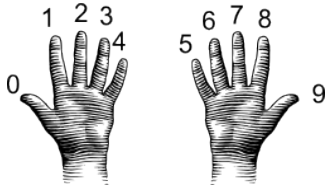
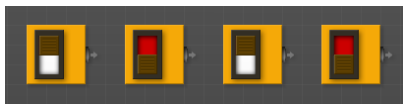
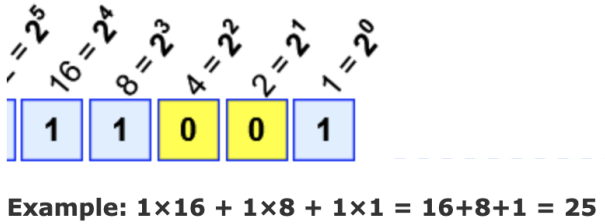
Decimal to Binary: Converting Between Bases







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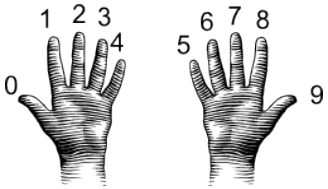
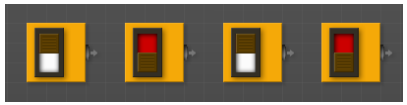
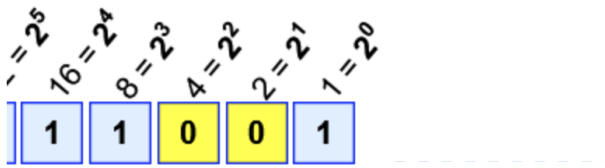
Answer is 1100011.

Binary to Decimal: Converting Between Bases



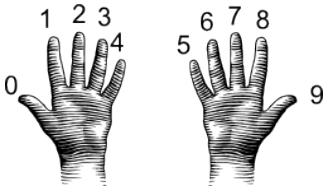


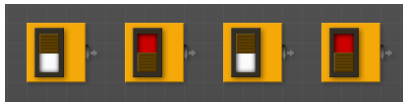


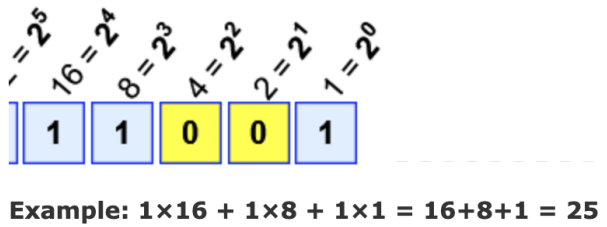
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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

Binary to Decimal: Converting Between Bases







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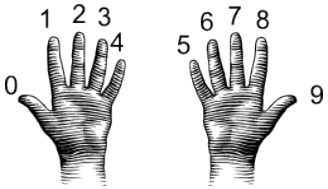
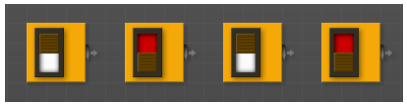
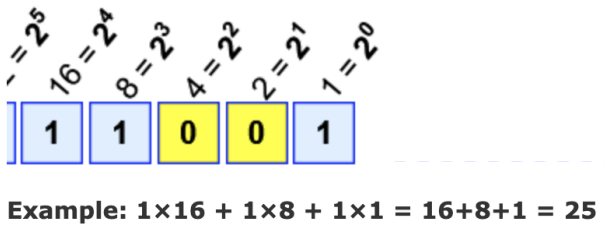
  - Multiply next digit by $2 = 2^1$. Add to sum.

Binary to Decimal: Converting Between Bases







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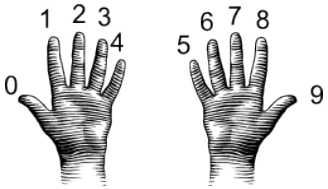
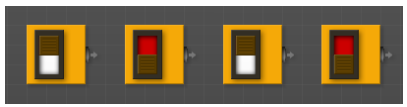
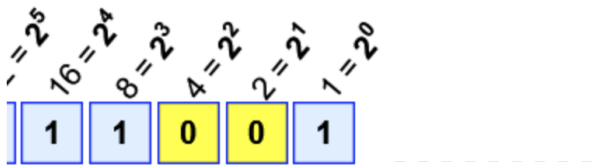
Binary to Decimal: Converting Between Bases







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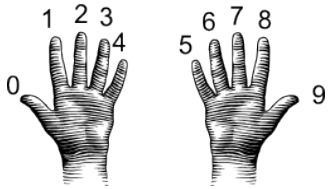
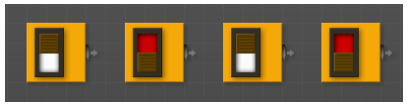
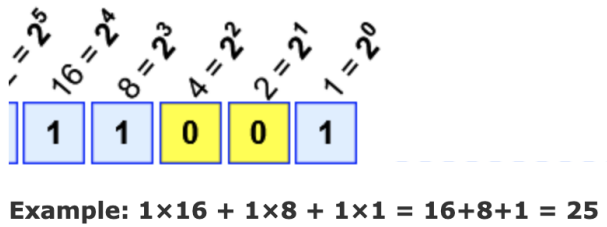
Binary to Decimal: Converting Between Bases







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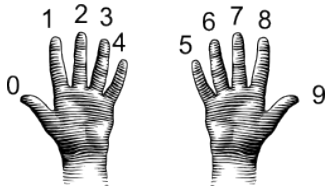
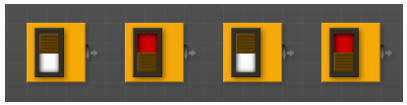
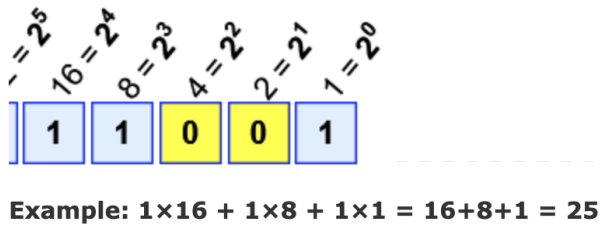
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.

Binary to Decimal: Converting Between Bases







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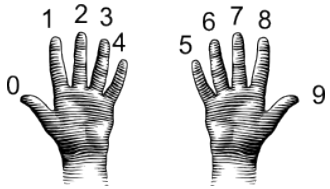
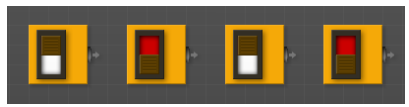
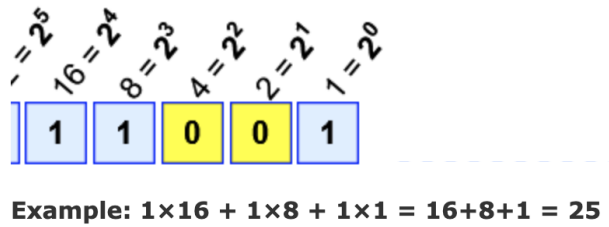
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.

Binary to Decimal: Converting Between Bases







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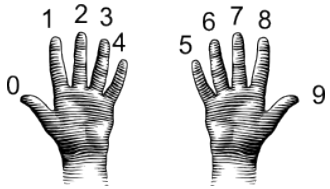
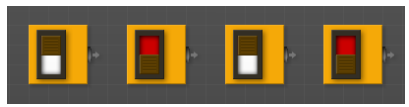
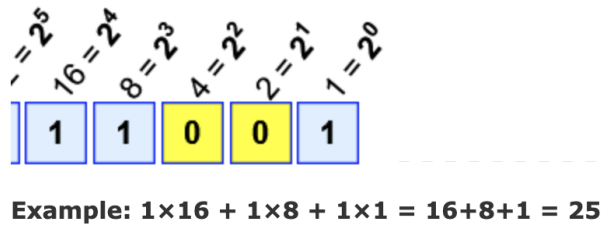
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.

Binary to Decimal: Converting Between Bases

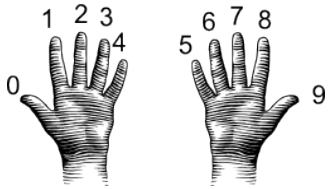


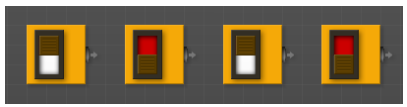


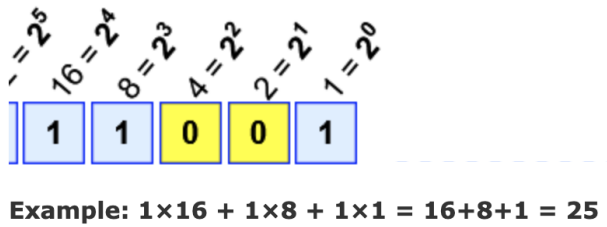


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.

Binary to Decimal: Converting Between Bases







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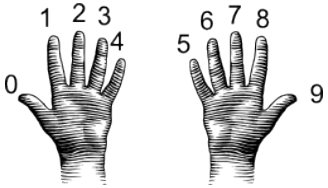
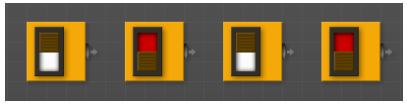
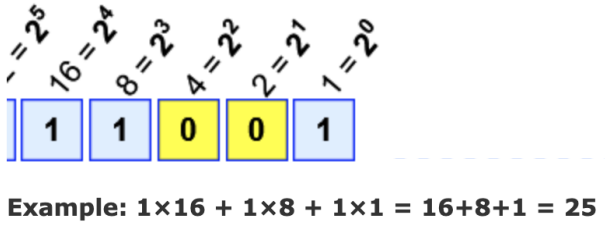
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.

Binary to Decimal: Converting Between Bases







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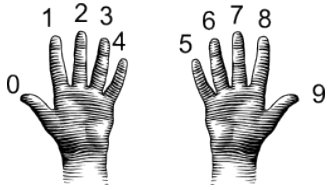
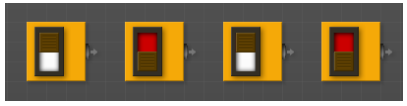
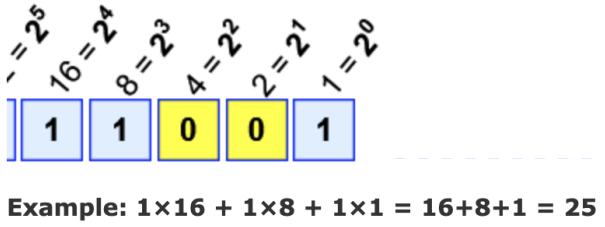
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

    `Sum starts with:`

Binary to Decimal: Converting Between Bases







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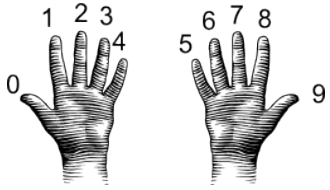
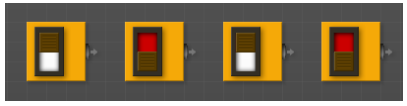
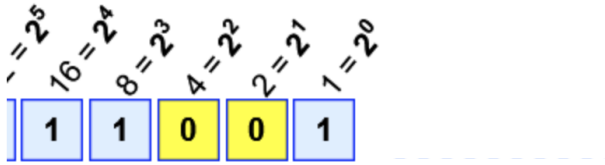
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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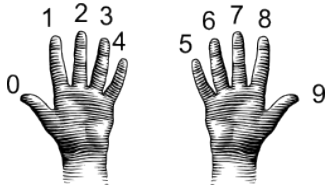
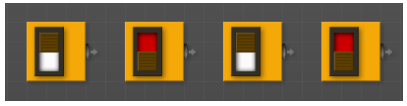
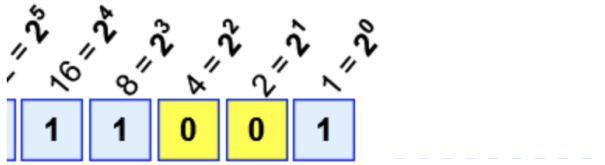
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What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

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

Binary to Decimal: Converting Between Bases







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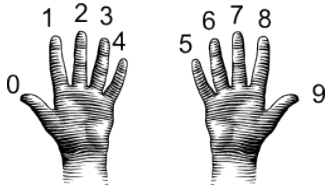
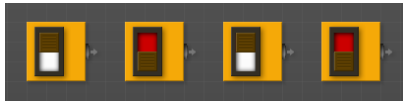
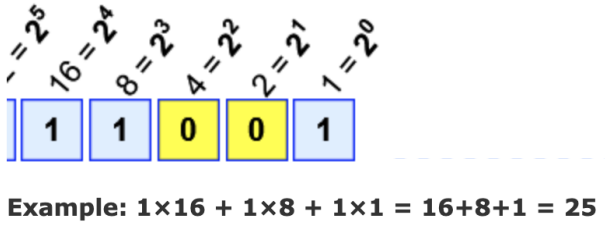
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What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



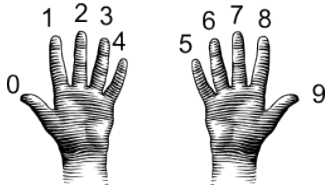


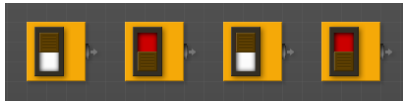


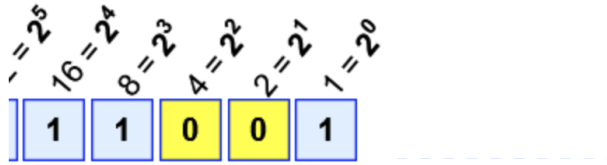
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Binary to Decimal: Converting Between Bases



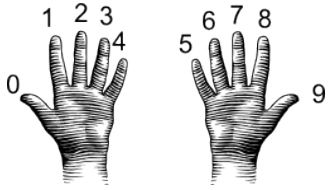


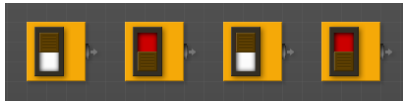


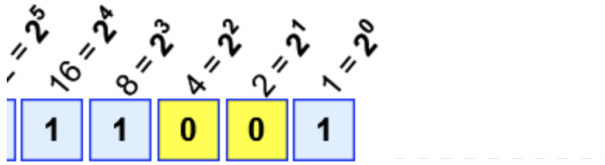
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Binary to Decimal: Converting Between Bases







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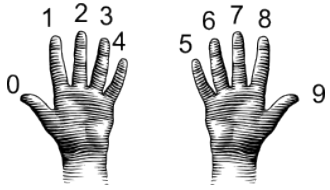
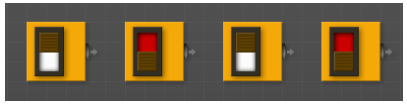
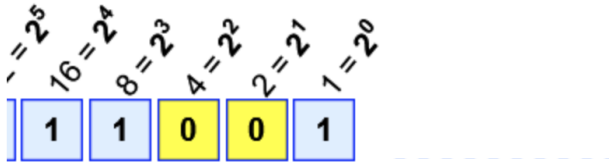
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What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

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

Binary to Decimal: Converting Between Bases







Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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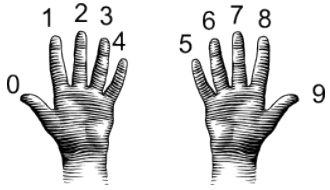
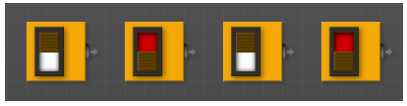
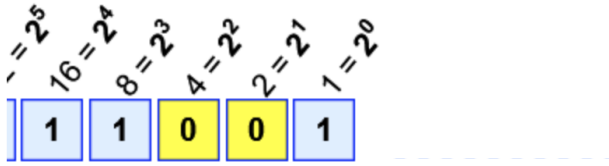
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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







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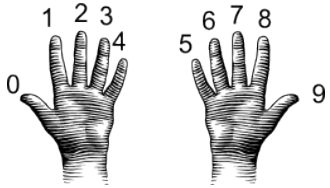
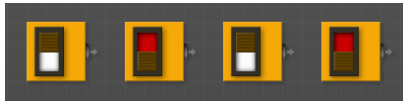
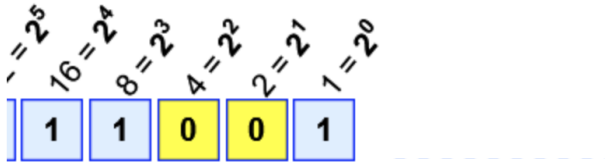
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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:    29
```

Binary to Decimal: Converting Between Bases







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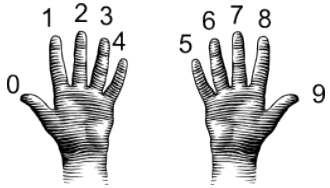
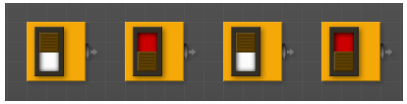
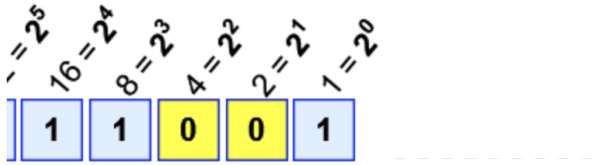
  - Example: What is 111101 in decimal?

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



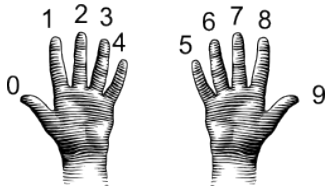


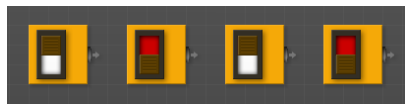


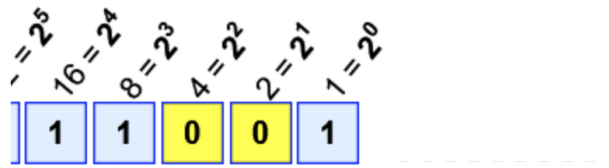
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Binary to Decimal: Converting Between Bases



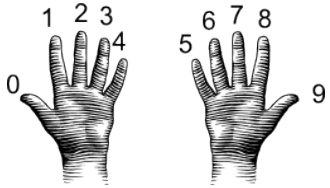


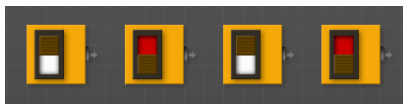


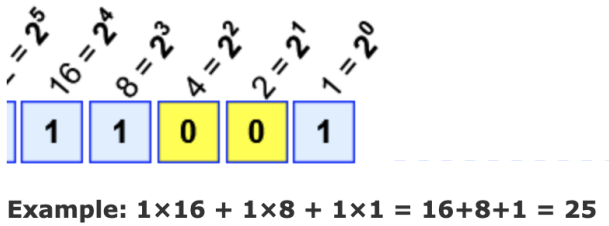
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Binary to Decimal: Converting Between Bases



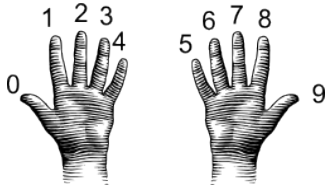


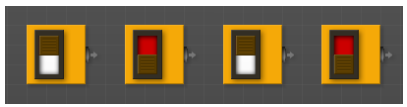


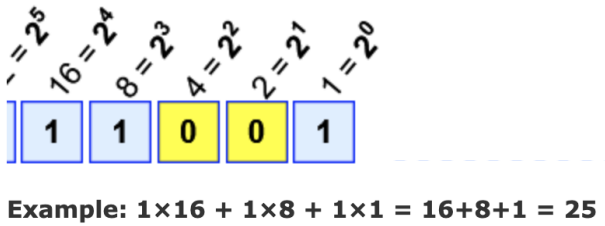
- Example: What is 10100100 in decimal?

  `Sum starts with:`

Binary to Decimal: Converting Between Bases



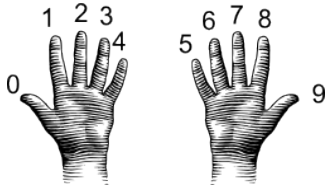


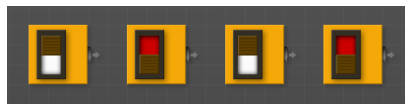


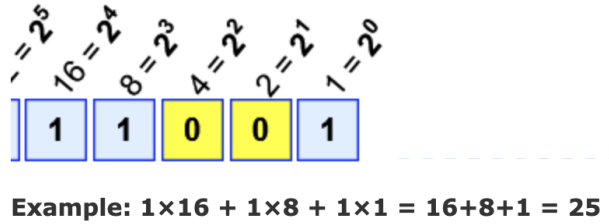
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



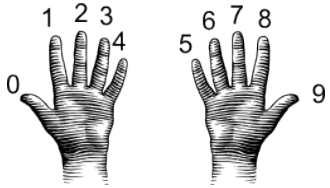


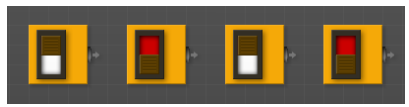


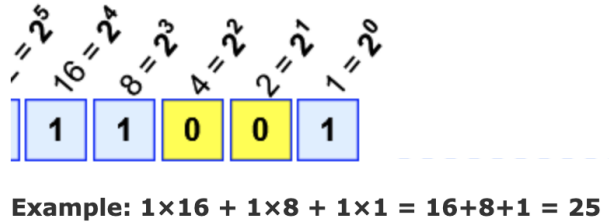
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



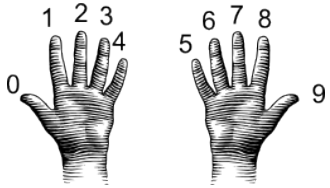


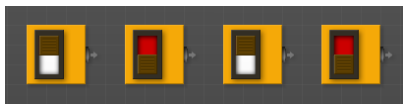


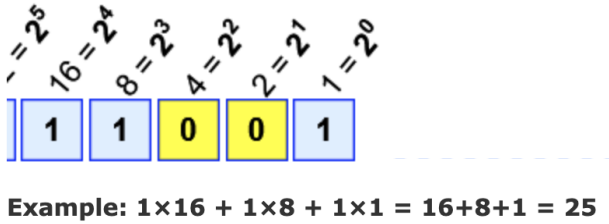
- Example: What is 10100100 in decimal?

```
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



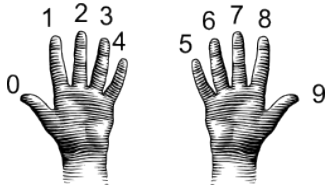


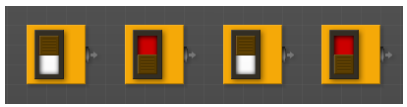


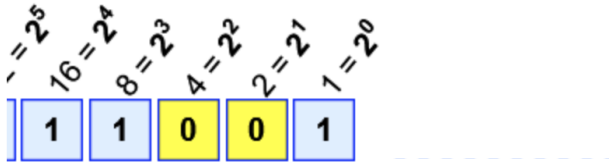
- Example: What is 10100100 in decimal?

```
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



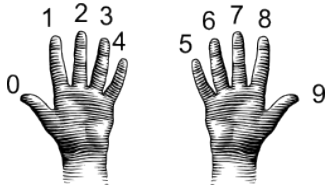


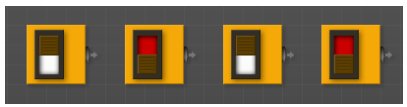


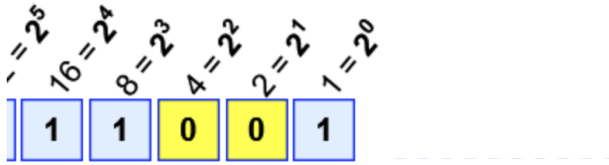
- Example: What is 10100100 in decimal?

```
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



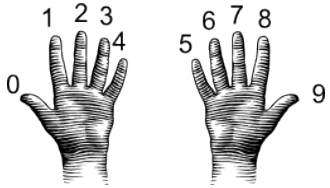


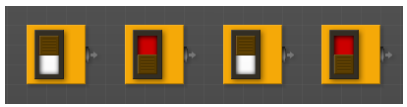


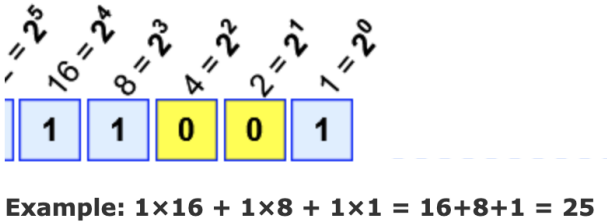
- Example: What is 10100100 in decimal?

```
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



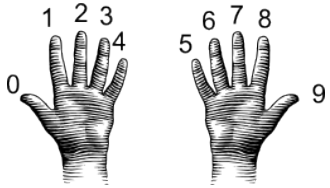


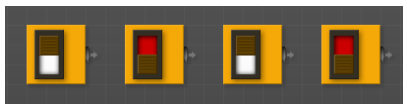


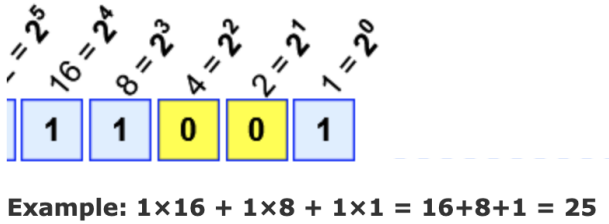
- Example: What is 10100100 in decimal?

```
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



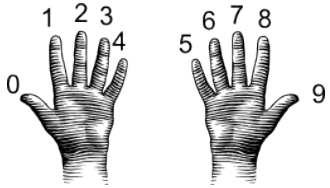


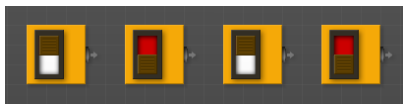


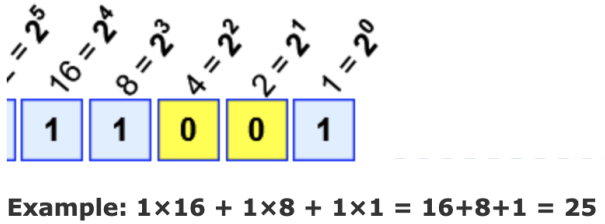
- Example: What is 10100100 in decimal?

```
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



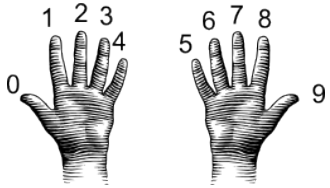


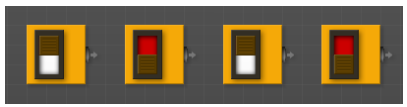


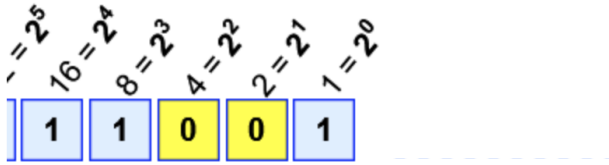
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



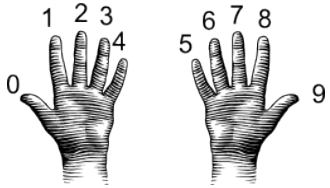


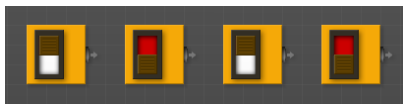


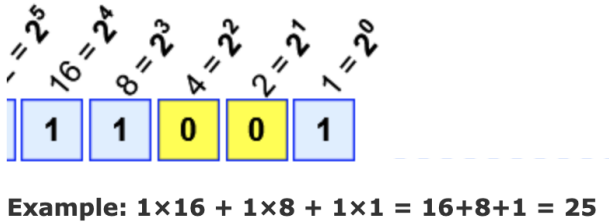
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



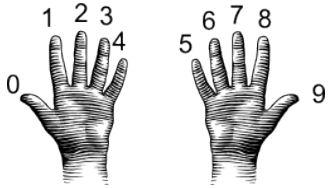


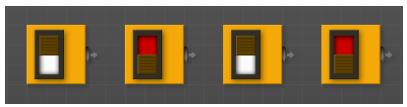


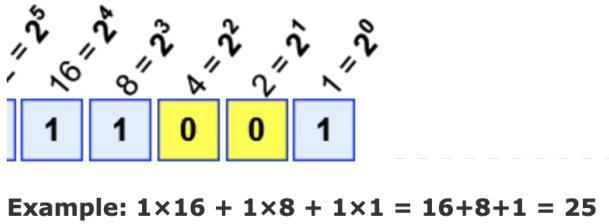
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases







- Example: What is 10100100 in decimal?

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

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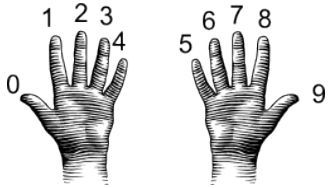

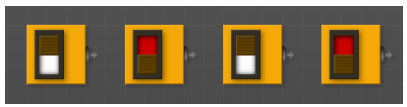

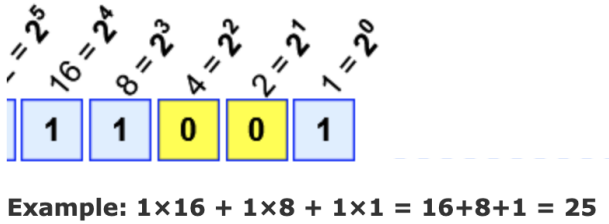

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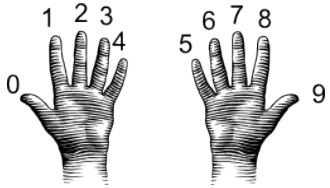

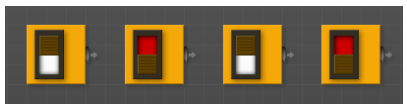

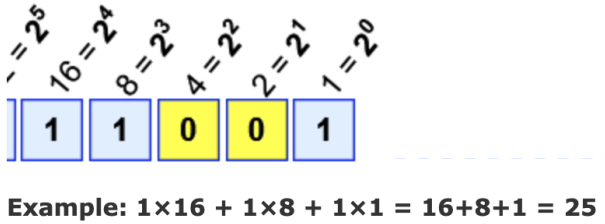

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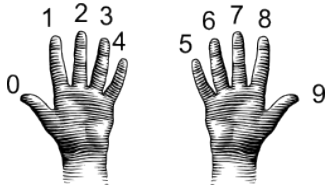

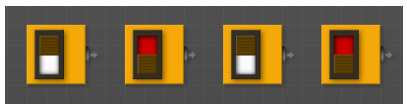

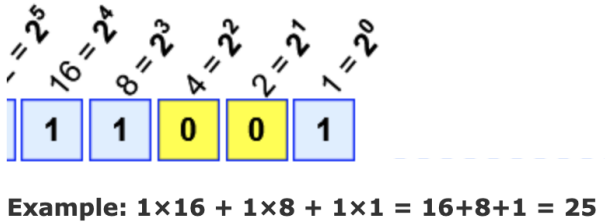

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```
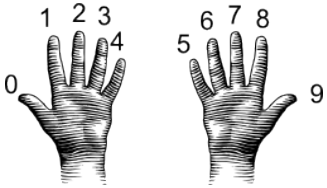
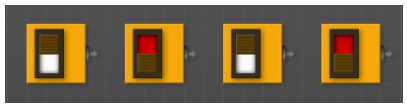
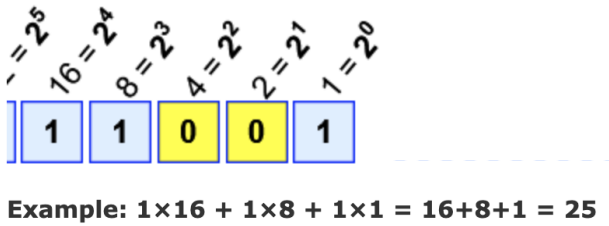

The answer is 164.

Design Challenge: Incrementers







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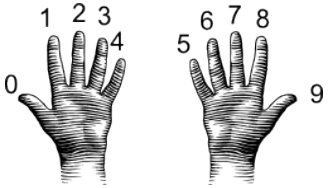

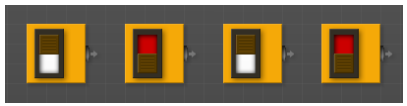

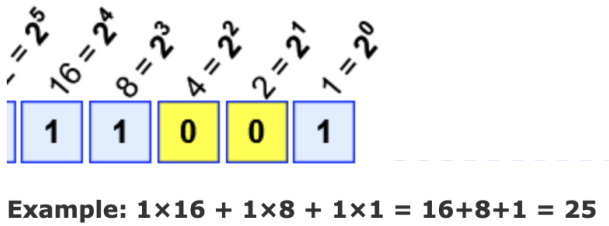

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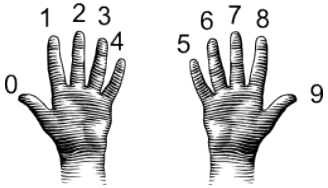

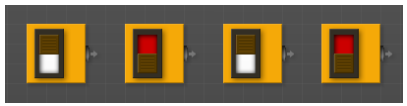

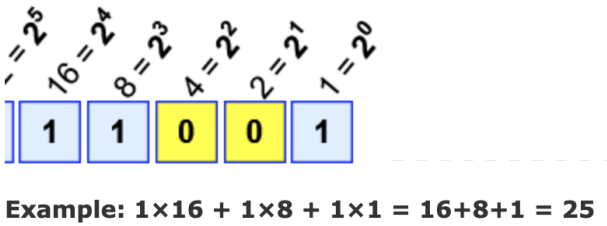

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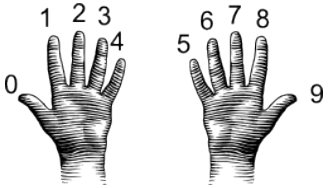

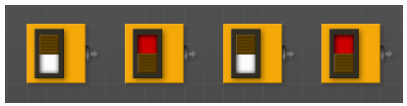

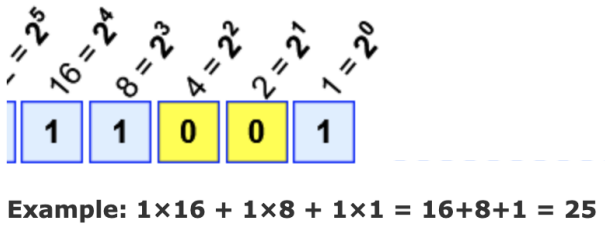

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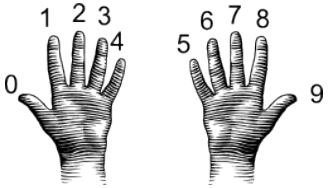

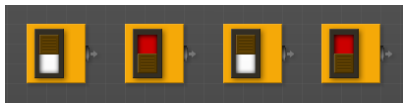

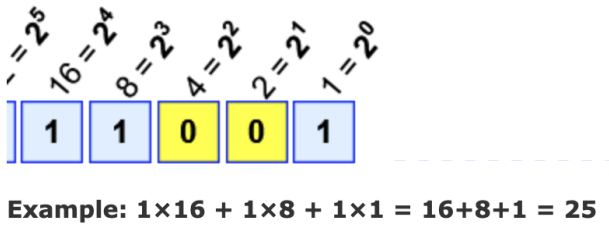

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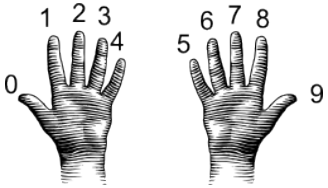

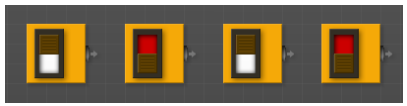

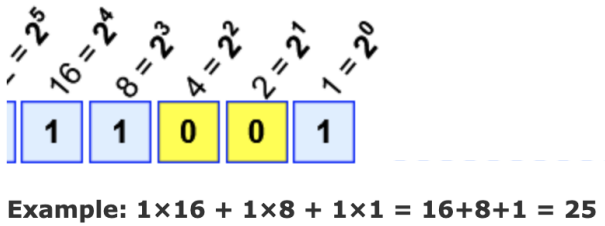

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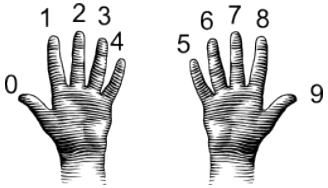

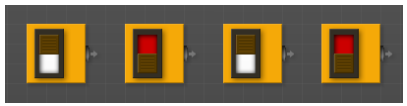

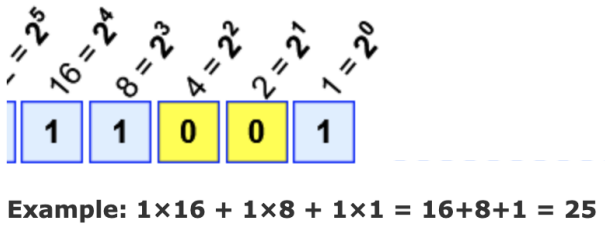

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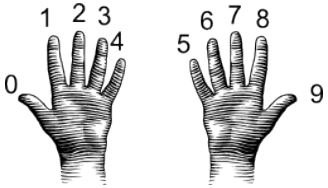

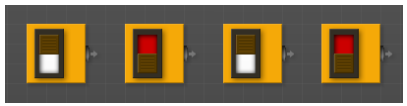

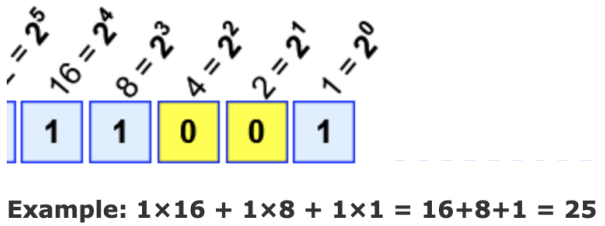

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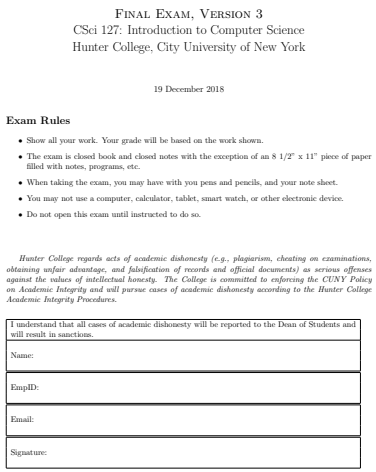
  - More on logistics next lecture.

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.
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Exam Options

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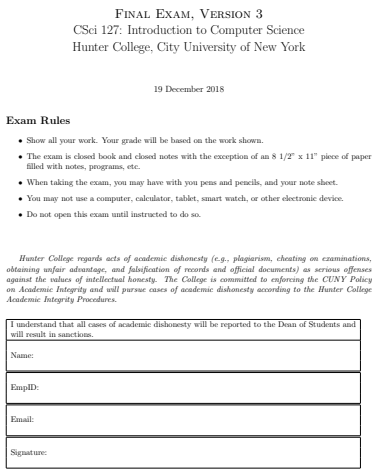

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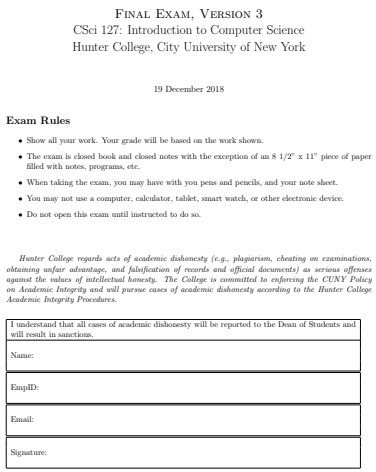

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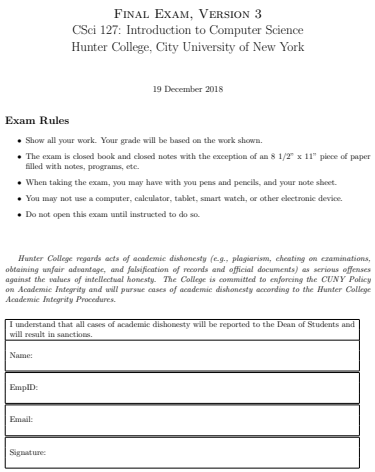

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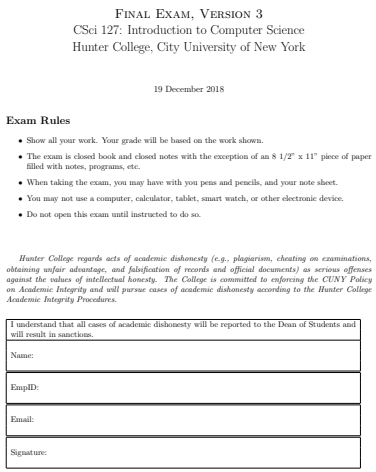

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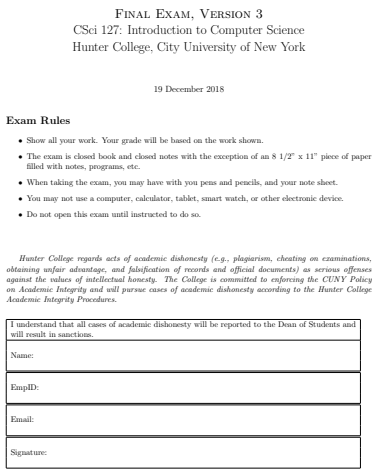

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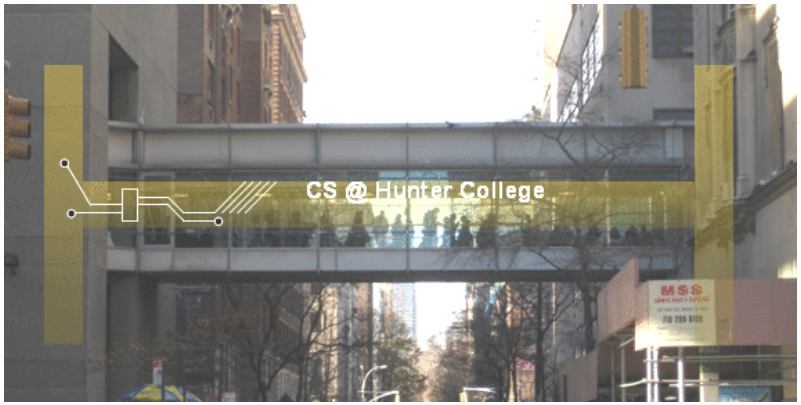
Weekly Reminders!



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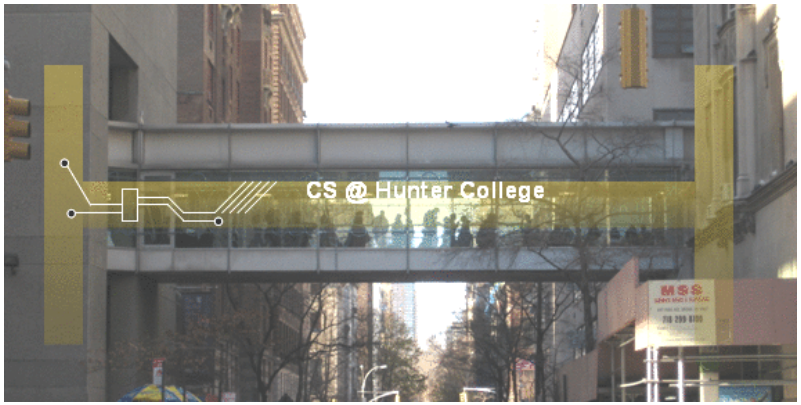

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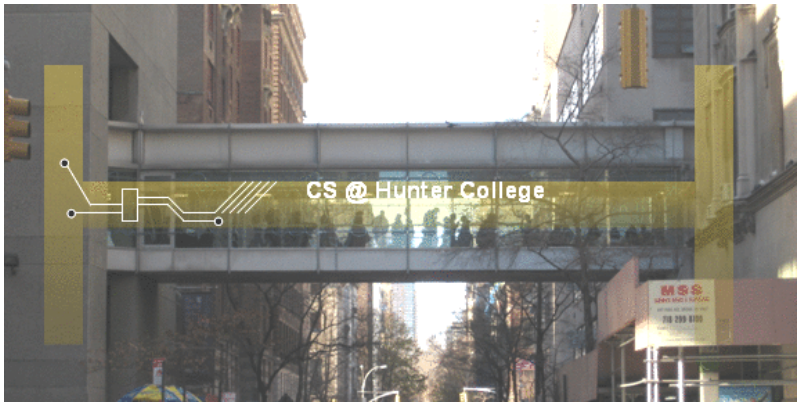

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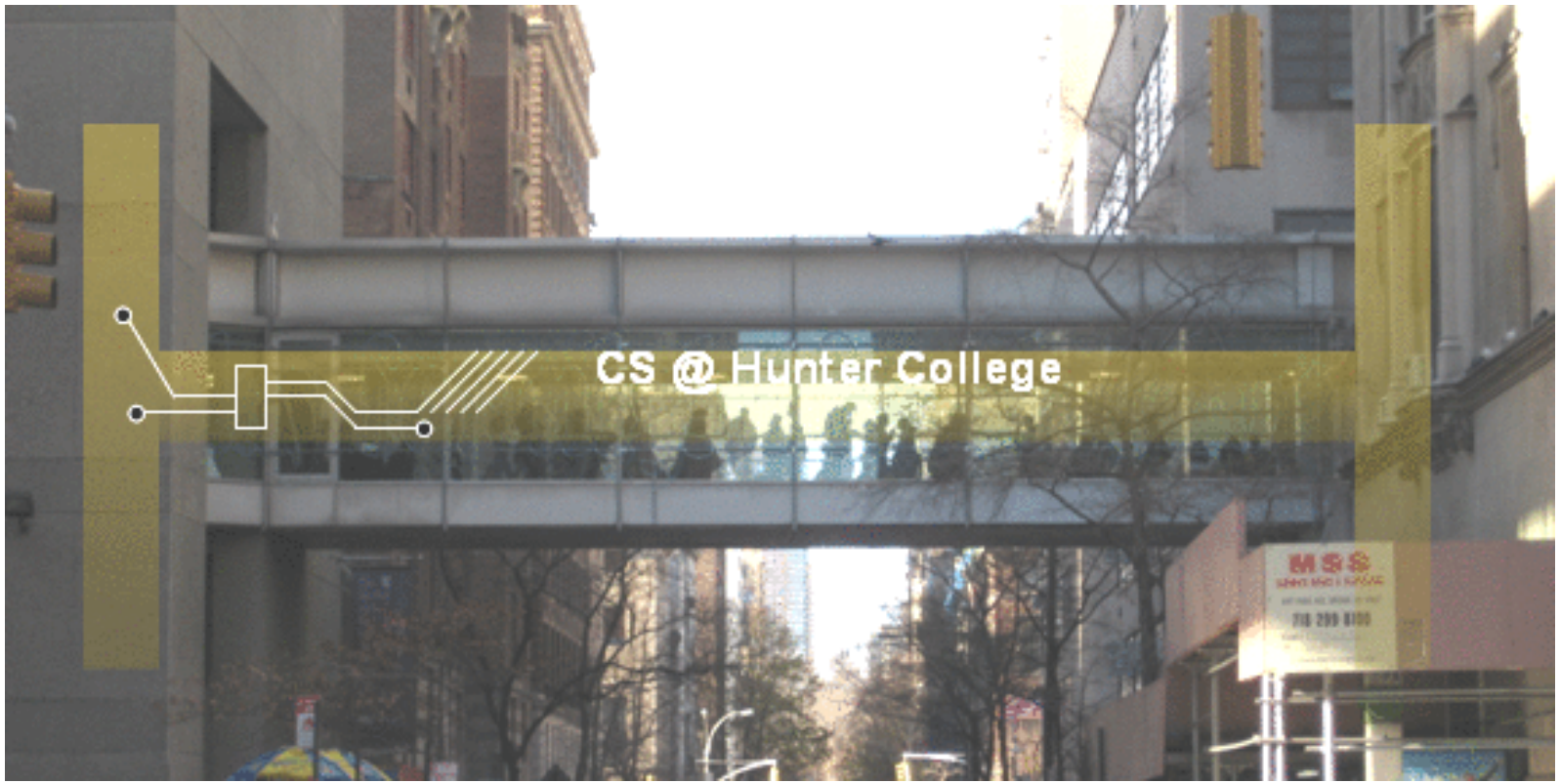
- Take the Lecture Preview on Blackboard on Monday (or no later than 10am on Tuesday)

Lecture Slips & Writing Boards



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