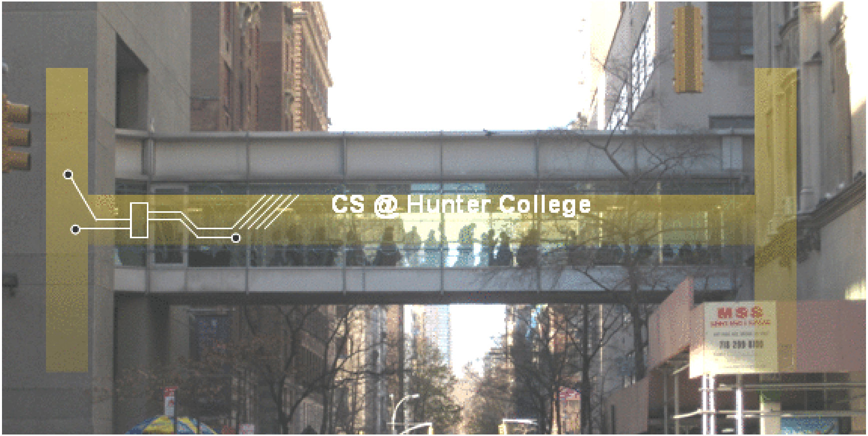
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

- This lecture will be recorded

Announcements

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  - Be very comfortable with our labs and programming assignments
  - Be able to describe a successful tutoring experience (go to tutoring!!!)
  - Previous tutoring experience helpful but not expected

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 some practice during our last meeting on 11 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!')
else:
    print('Did not find 6 in the list.')
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Python Tutor

```python
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(Demo with `pythonTutor`)

Design Pattern: Linear Search

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

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- **Python Recap**
- Machine Language
- Machine Language: Jumps & Loops
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- Final Exam: Format

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():

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

print("Hello, World!")
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← *These lines are comments*
← *(for us, not computer to read)*
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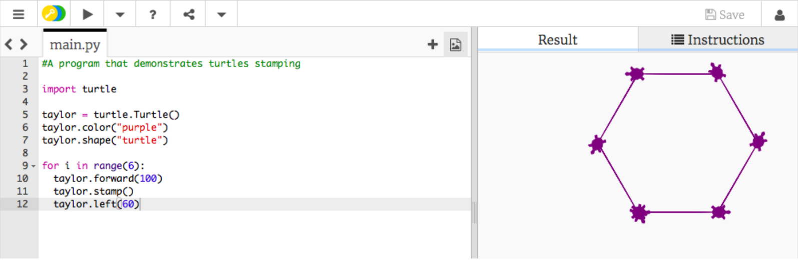
- As well as definite loops & the turtle package:



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

```
#Predict what will be printed:

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

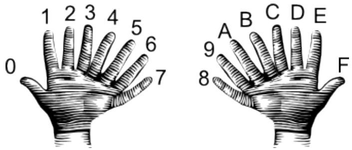
sum = 0
for x in range(0,12,2):
    print(x)
    sum = sum + x

print(sum)

for c in "ABCD":
    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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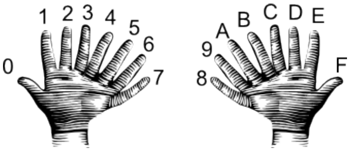

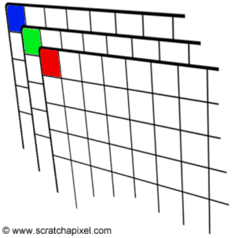

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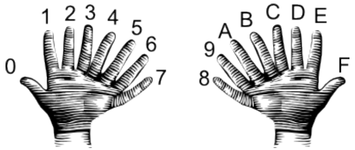
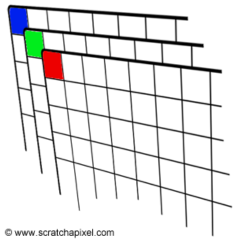


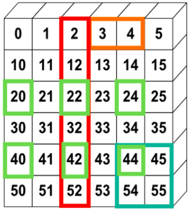



```
>>> a[0,3:5]
array([3,4])

>>> 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]])
```



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  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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- Next: translate to Python.

Week 4: design problem (cropping images) & decisions

```python
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

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

visibility = 0.2
winds = 40
conditions = "blowing snow"
if (winds > 35) and (visibility < 0.25) and \
      (conditions == "blowing snow" or conditions == "heavy snow"):
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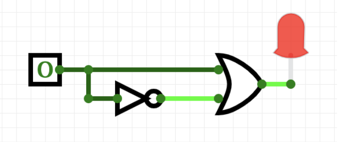
in1		in2	*returns:*
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True



Week 6: structured data, pandas, & more design

```
Source:  https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,,
All population figures are consistent with present-day boundaries.,,,,,,
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Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island,Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
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1810,96373,8303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
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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
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1990,1487536,2300664,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
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```

`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

```
import matplotlib.pyplot as plt
import pandas as pd
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In Lab 6

Week 6: structured data, pandas, & more design

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

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

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

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

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

nycHistPop.csv

In Lab 6

Week 6: structured data, pandas, & more design

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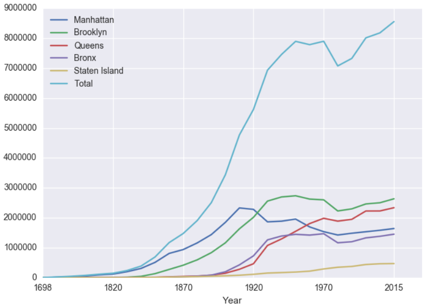
nycHistPop.csv

In Lab 6



Week 7: functions

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

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

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

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

Week 7: functions

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

Week 7: functions

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

Week 8: function parameters, github

- Functions can have **input parameters**.

```python
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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- 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**

Week 8: function parameters, github

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

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Formal Parameters

Actual Parameters

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

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


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

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

```python
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.

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

Python & Circuits Review: 10 Weeks in 10 Minutes

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

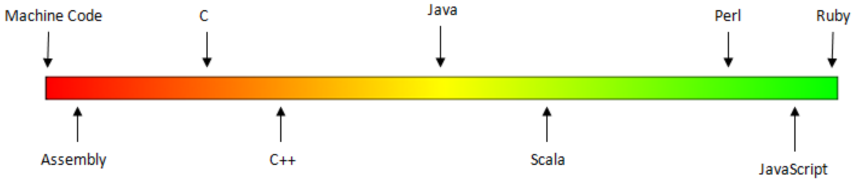
Lecture Quiz

- Log-in to Gradescope
- Find LECTURE 11 Quiz
- Take the quiz
- **You have 3 minutes**

Today's Topics

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

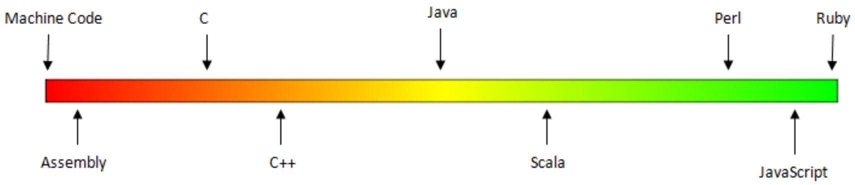
Low-Level vs. High-Level Languages



(codeCommit)

- Can view programming languages on a continuum.

Low-Level vs. High-Level Languages



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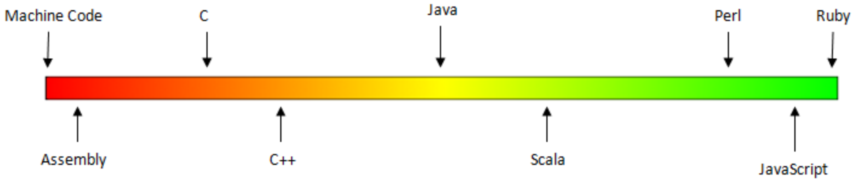
- Those that directly access machine instructions & memory and have little abstraction are **low-level languages**

Low-Level vs. High-Level Languages



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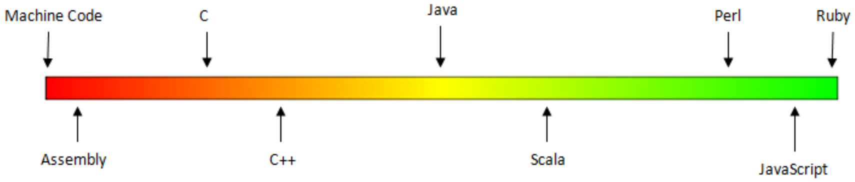

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- Those that have strong abstraction (allow programming paradigms independent of the machine details, such as complex variables, functions and looping that do not translate directly into machine code) are called **high-level languages**.

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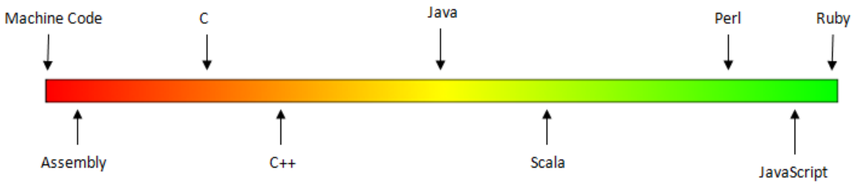

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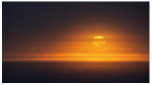
- Some languages, like C, are in between– allowing both low level access and high level data structures.

Processing



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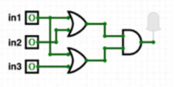
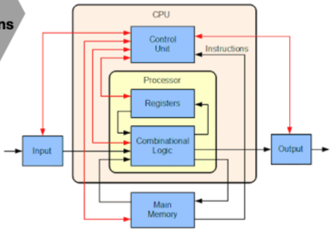
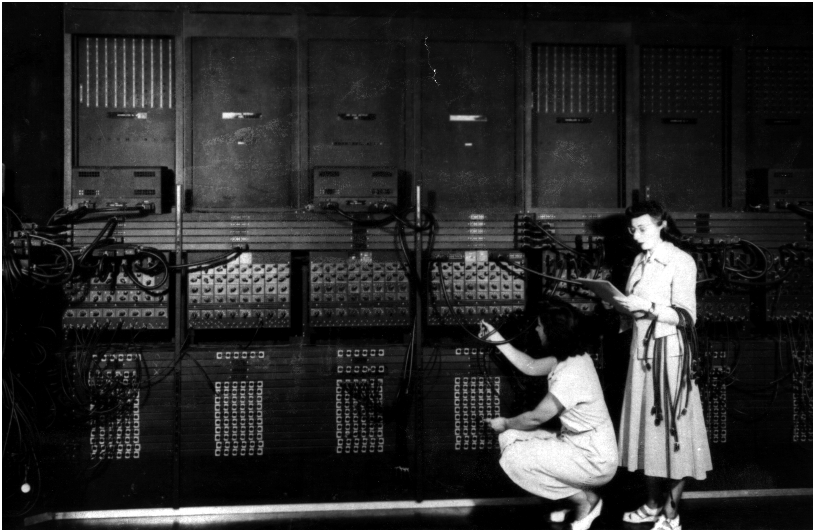


Circuits (switches)
On/Off 1/0 Logic
Billions of switches/bits

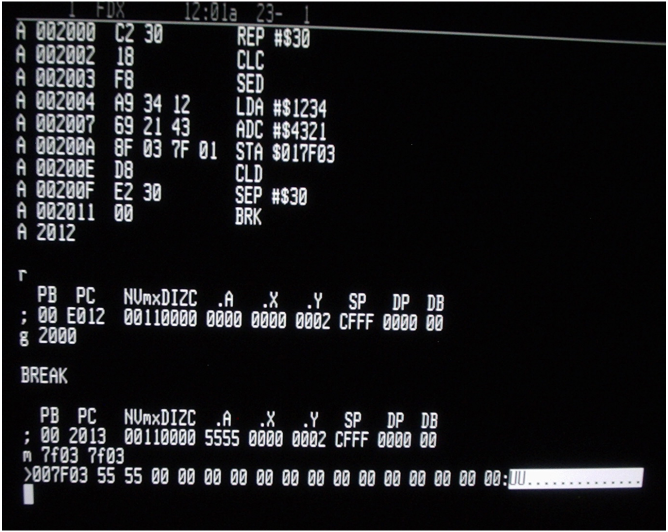


Machine Language



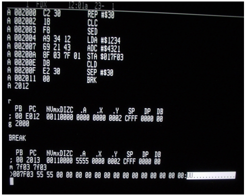
(Ruth Gordon & Ester Gerston programming the ENIAC, UPenn)

Machine Language



(wiki)

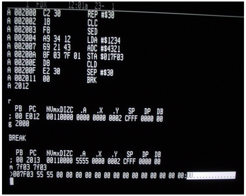
Machine Language



(wiki)

- We will be writing programs in a simplified machine language, WeMIPS.

Machine Language



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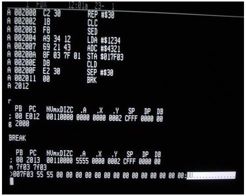
Machine Language



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- Due to its small set of commands, processors can be designed to run those commands very efficiently.

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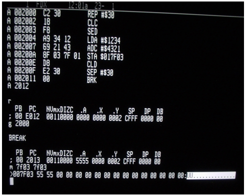

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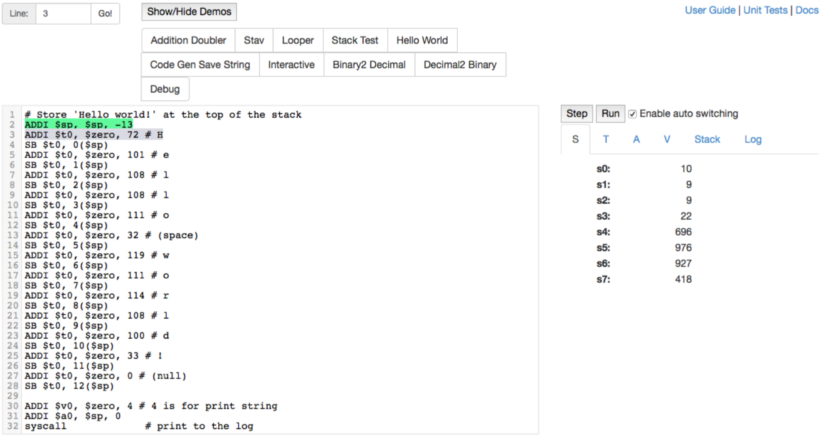
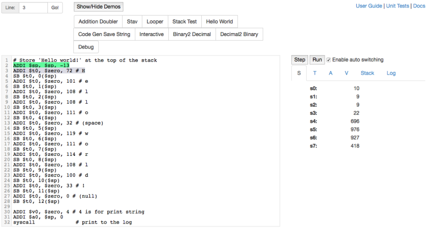
- More in future architecture classes....

“Hello World!” in Simplified Machine Language



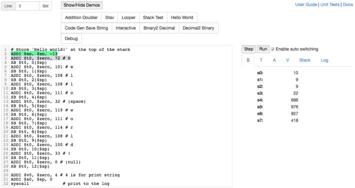
(WeMIPS)

WeMIPS



(Demo with `WeMIPS`)

MIPS Commands



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

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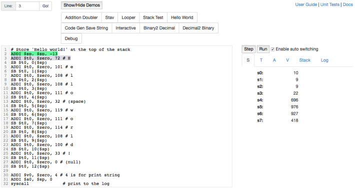

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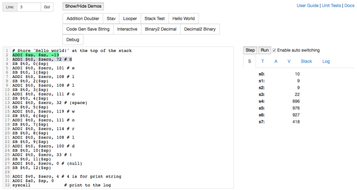

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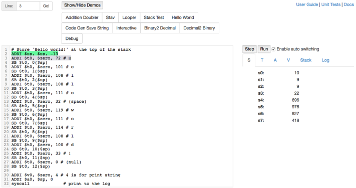

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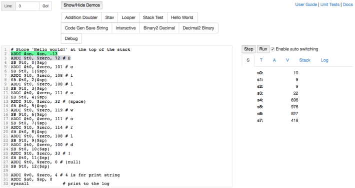

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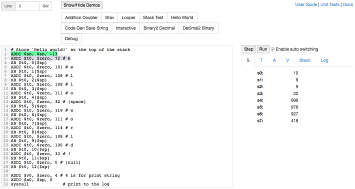

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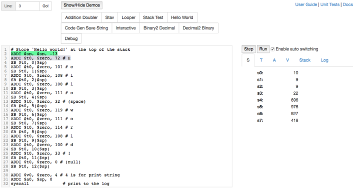

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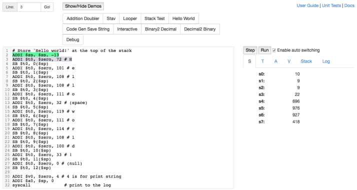

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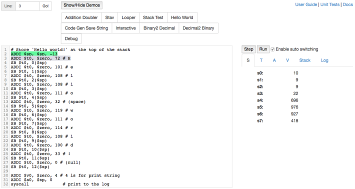

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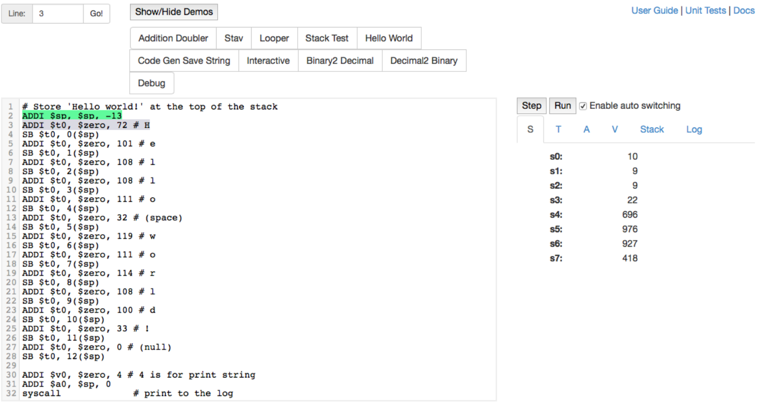
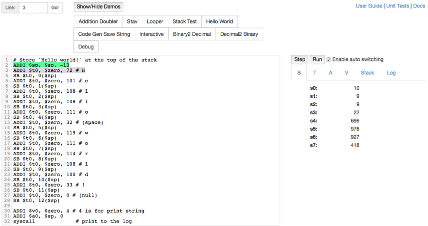
  `j done` (Basic form: `OP label`)

Challenge:



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

WeMIPS

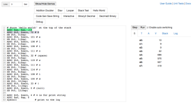


(Demo with `WeMIPS`)

Today's Topics

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

Loops & Jumps in Machine Language



- Instead of built-in looping structures like `for` and `while`, you create your own loops by "jumping" to the location in the program.

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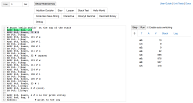

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- Can indicate locations by writing **labels** at the beginning of a line.

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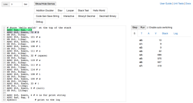

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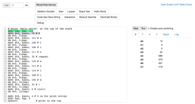

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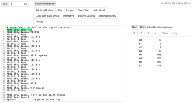

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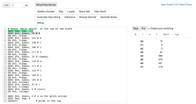

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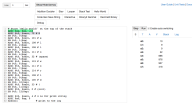
Loops & Jumps in Machine Language



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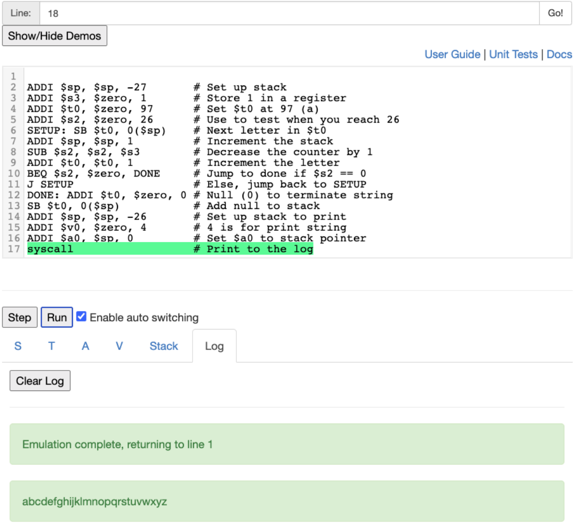
  - See reading for more variations.

Jump Demo



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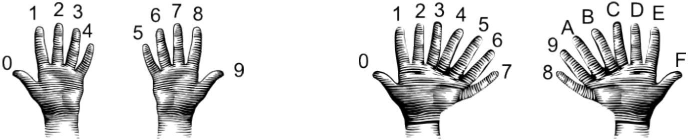
Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

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

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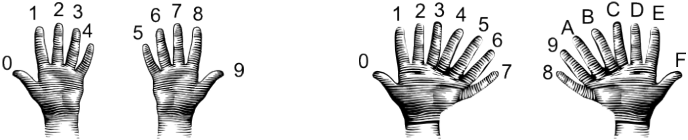

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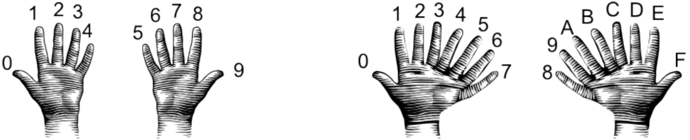

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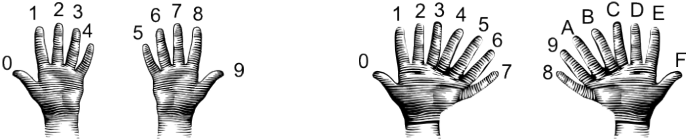

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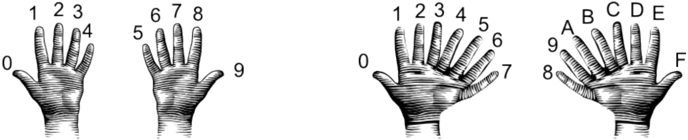

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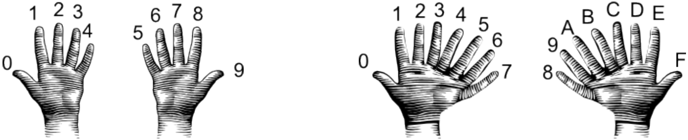

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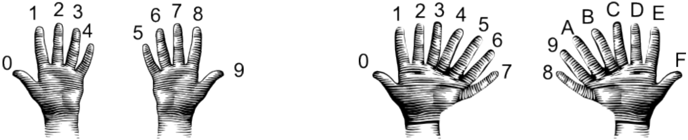

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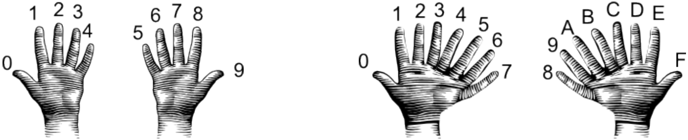

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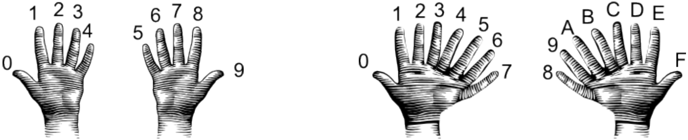

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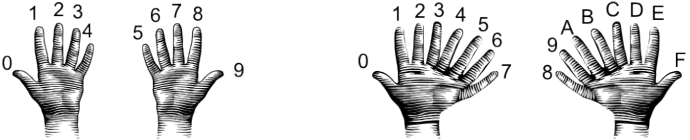

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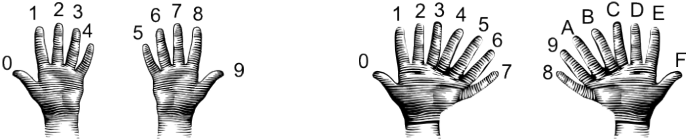

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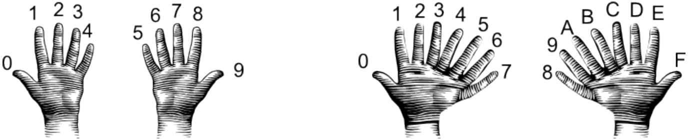

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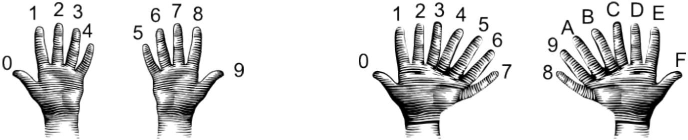

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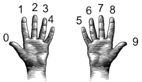
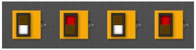
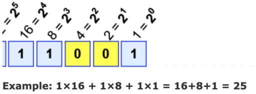
Decimal to Binary: Converting Between Bases







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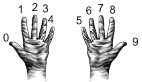
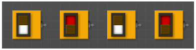
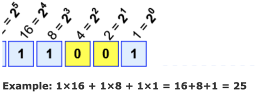
Decimal to Binary: Converting Between Bases







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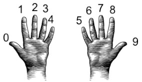

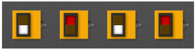

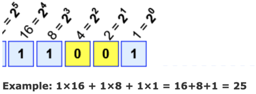

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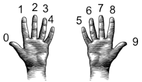

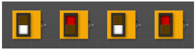

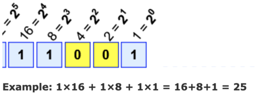

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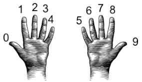
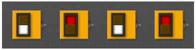
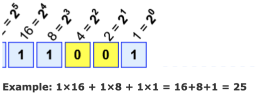
Decimal to Binary: Converting Between Bases







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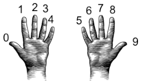

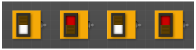

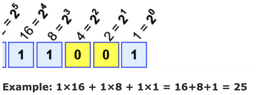

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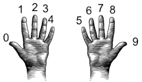

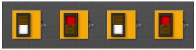

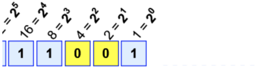

Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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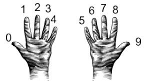

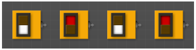

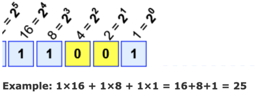

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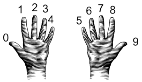

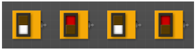

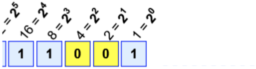

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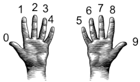

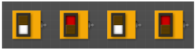

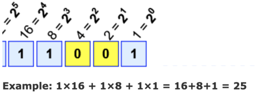

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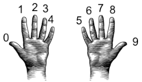
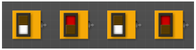
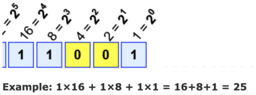
    `130/128 is 1 rem 2.`

Decimal to Binary: Converting Between Bases







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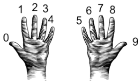
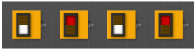
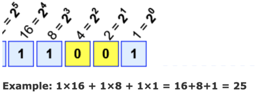
```
130/128 is 1 rem 2. First digit is 1:
```

Decimal to Binary: Converting Between Bases







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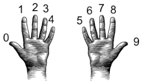

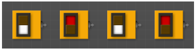

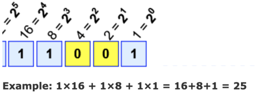

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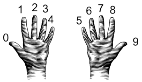

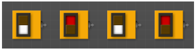

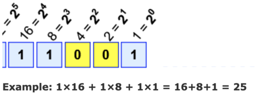

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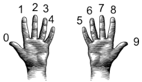

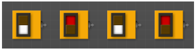

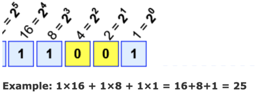

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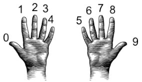

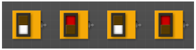

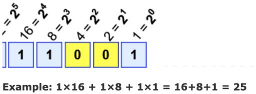

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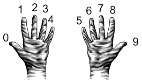

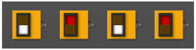

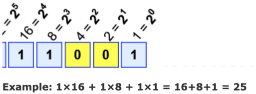

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2/32 is 0 rem 2. Next digit is 0:        100...
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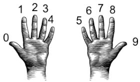

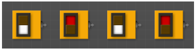

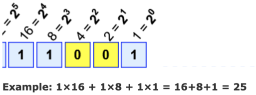

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2/16 is 0 rem 2.
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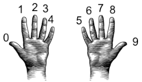

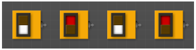

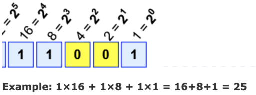

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  - Example: what is 130 in binary notation?

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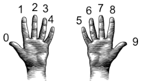
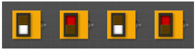
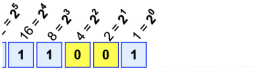
130/128 is 1 rem 2. First digit is 1:   1...
2/64 is 0 rem 2. Next digit is 0:       10...
2/32 is 0 rem 2. Next digit is 0:       100...
2/16 is 0 rem 2. Next digit is 0:
```

Decimal to Binary: Converting Between Bases







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

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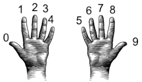

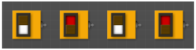

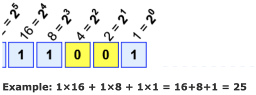

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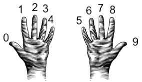
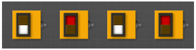
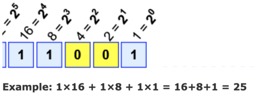
Decimal to Binary: Converting Between Bases







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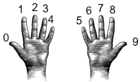
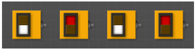
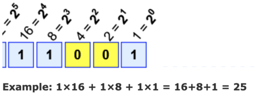
Decimal to Binary: Converting Between Bases







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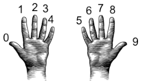

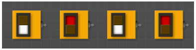

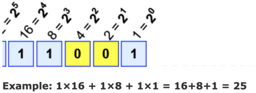

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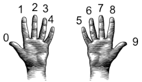

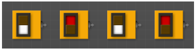

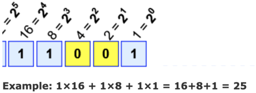

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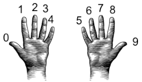

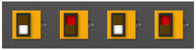

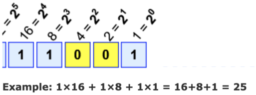

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```
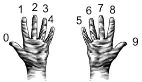
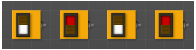
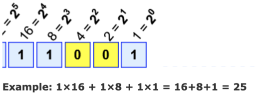

Decimal to Binary: Converting Between Bases







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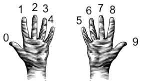

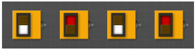

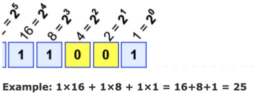

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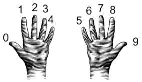

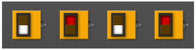

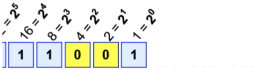

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2/2 is 1 rem 0. Next digit is 1:         1000001...
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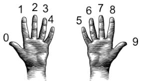

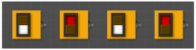

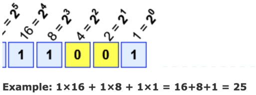

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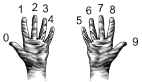
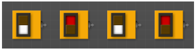
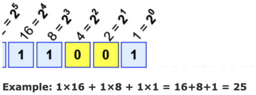
2/8 is 0 rem 2. Next digit is 0:         10000...
2/4 is 0 remainder 2. Next digit is 0:   100000...
2/2 is 1 rem 0. Next digit is 1:         1000001...
Adding the last remainder:               10000010
```

Decimal to Binary: Converting Between Bases







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2/8 is 0 rem 2. Next digit is 0:          10000...
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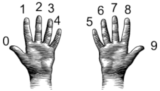
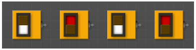
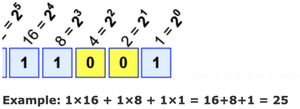
Decimal to Binary: Converting Between Bases

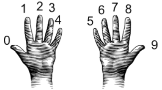


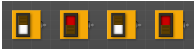


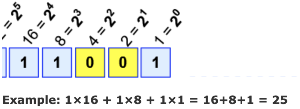


- Example: what is 99 in binary notation?

Decimal to Binary: Converting Between Bases







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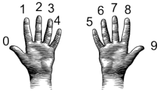
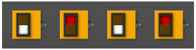
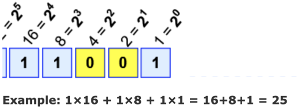
  `99/128 is 0 rem 99.`

Decimal to Binary: Converting Between Bases



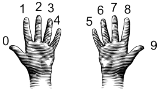


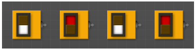


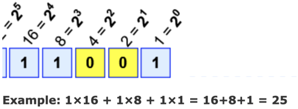
- Example: what is 99 in binary notation?

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

Decimal to Binary: Converting Between Bases







- Example: what is 99 in binary notation?

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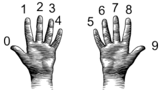
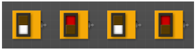
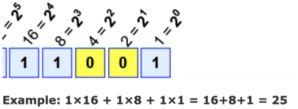
Decimal to Binary: Converting Between Bases







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```
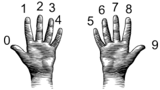
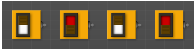
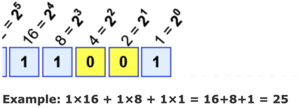

Decimal to Binary: Converting Between Bases







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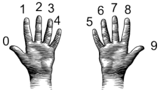

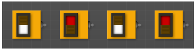

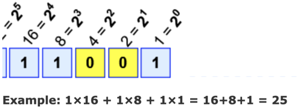

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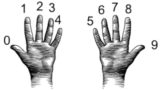

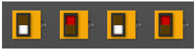

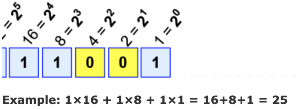

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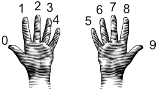

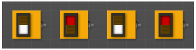

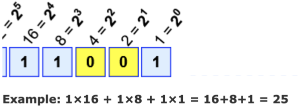

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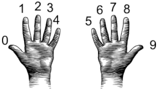

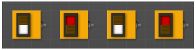

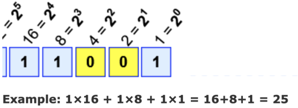

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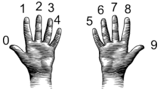

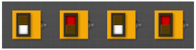

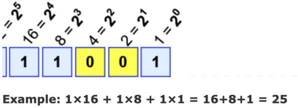

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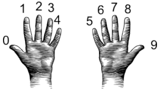

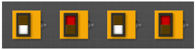

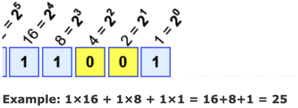

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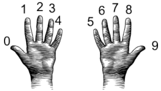

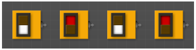

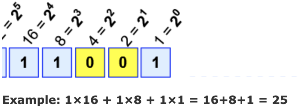

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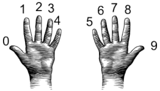

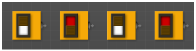

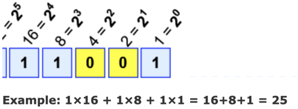

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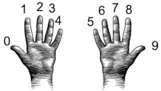

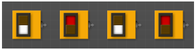

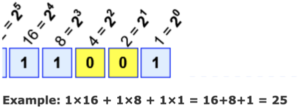

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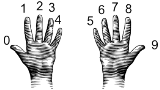

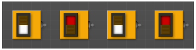

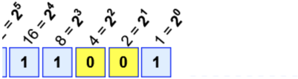

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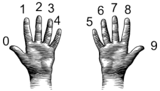

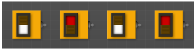

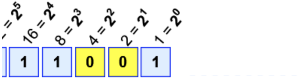

Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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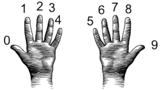
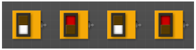
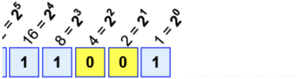
Decimal to Binary: Converting Between Bases







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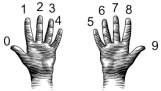

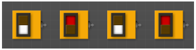

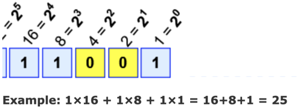

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3/4 is 0 remainder 3. Next digit is 0:    011000...
3/2 is 1 rem 1.
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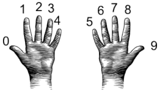

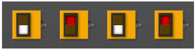

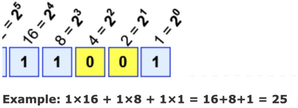

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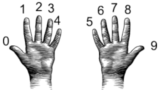

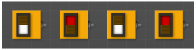

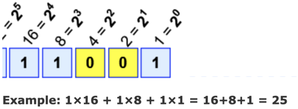

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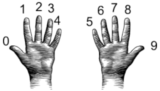
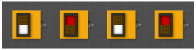
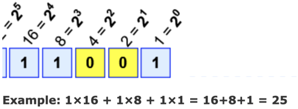
`99/128 is 0 rem 99. First digit is 0:`	0...
`99/64 is 1 rem 35. Next digit is 1:`	01...
`35/32 is 1 rem 3. Next digit is 1:`	011...
`3/16 is 0 rem 3. Next digit is 0:`	0110...
`3/8 is 0 rem 3. Next digit is 0:`	01100...
`3/4 is 0 remainder 3. Next digit is 0:`	011000...
`3/2 is 1 rem 1. Next digit is 1:`	0110001...

Decimal to Binary: Converting Between Bases



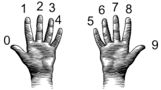


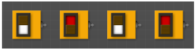


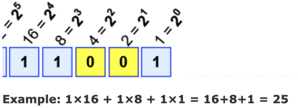
- Example: what is 99 in binary notation?

`99/128 is 0 rem 99. First digit is 0:`	0 . . .
`99/64 is 1 rem 35. Next digit is 1:`	01 . . .
`35/32 is 1 rem 3. Next digit is 1:`	011 . . .
`3/16 is 0 rem 3. Next digit is 0:`	0110 . . .
`3/8 is 0 rem 3. Next digit is 0:`	01100 . . .
`3/4 is 0 remainder 3. Next digit is 0:`	011000 . . .
`3/2 is 1 rem 1. Next digit is 1:`	0110001 . . .
`Adding the last remainder:`	01100011

Decimal to Binary: Converting Between Bases





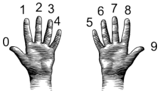


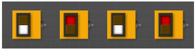
- Example: what is 99 in binary notation?

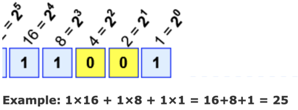
`99/128 is 0 rem 99. First digit is 0:`	0 . . .
`99/64 is 1 rem 35. Next digit is 1:`	01 . . .
`35/32 is 1 rem 3. Next digit is 1:`	011 . . .
`3/16 is 0 rem 3. Next digit is 0:`	0110 . . .
`3/8 is 0 rem 3. Next digit is 0:`	01100 . . .
`3/4 is 0 remainder 3. Next digit is 0:`	011000 . . .
`3/2 is 1 rem 1. Next digit is 1:`	0110001 . . .
`Adding the last remainder:`	01100011

Answer is 1100011.

Binary to Decimal: Converting Between Bases

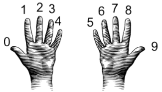


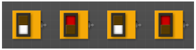


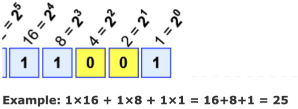


- From binary to decimal:
  - Set sum = last digit.

Binary to Decimal: Converting Between Bases

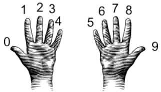


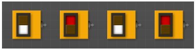


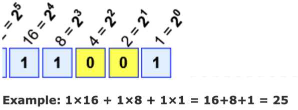


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.

Binary to Decimal: Converting Between Bases

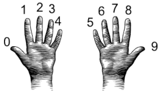


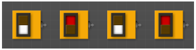


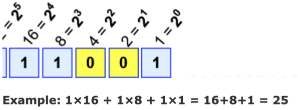


- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.

Binary to Decimal: Converting Between Bases

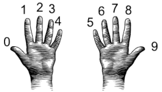


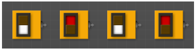


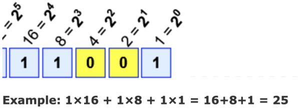


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.

Binary to Decimal: Converting Between Bases

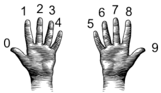


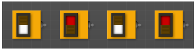


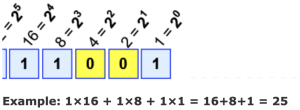


- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.

Binary to Decimal: Converting Between Bases

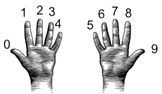


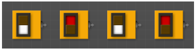


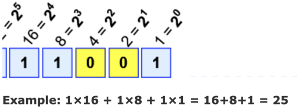


- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to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

Binary to Decimal: Converting Between Bases







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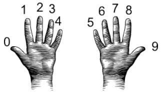
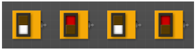
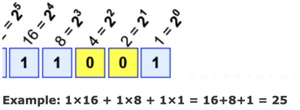
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by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

Binary to Decimal: Converting Between Bases







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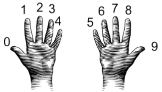
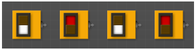
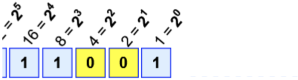
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.

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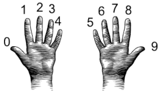
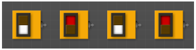
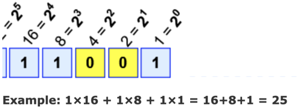
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.

Binary to Decimal: Converting Between Bases







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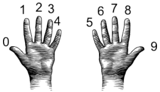
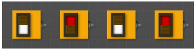
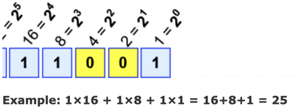
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

    `Sum starts with:`

Binary to Decimal: Converting Between Bases







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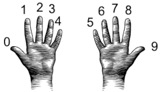
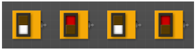
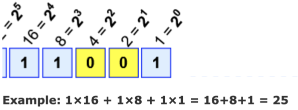
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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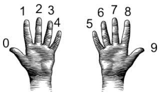
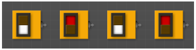
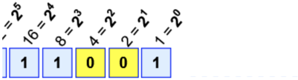
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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

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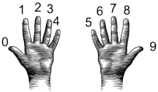
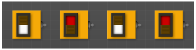
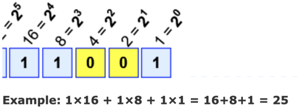
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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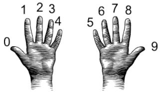
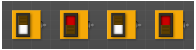
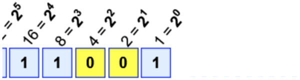
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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

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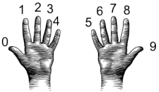
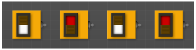
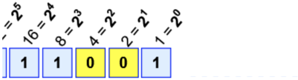
```
Sum starts with:           1
0*2 = 0.  Add 0 to sum:    1
1*4 = 4.  Add 4 to sum:    5
1*8 = 8.  Add 8 to sum:
```

Binary to Decimal: Converting Between Bases



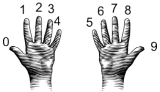


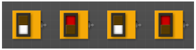


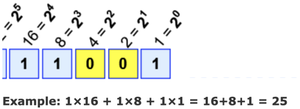
- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to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

Binary to Decimal: Converting Between Bases



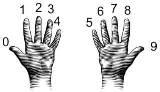


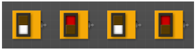


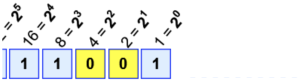
- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to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

Binary to Decimal: Converting Between Bases





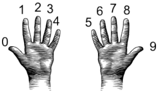


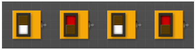
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

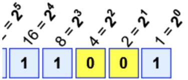
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

Binary to Decimal: Converting Between Bases





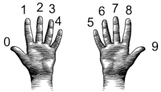


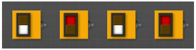
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

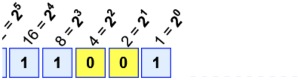
- From binary to decimal:
  - Set sum $=$ last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to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

Binary to Decimal: Converting Between Bases





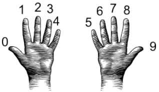


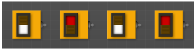
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

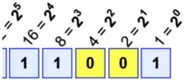
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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





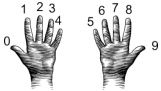


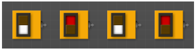
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

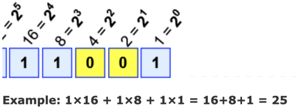
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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



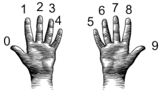


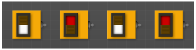


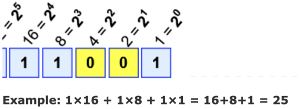
- Example: What is 10100100 in decimal?

  `Sum starts with:`

Binary to Decimal: Converting Between Bases



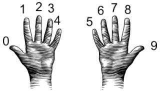


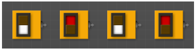


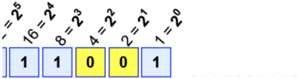
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



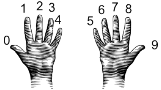


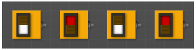


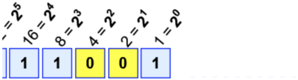
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



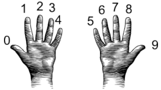


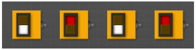


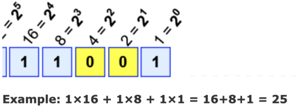
- Example: What is 10100100 in decimal?

```
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



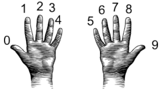


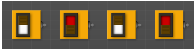


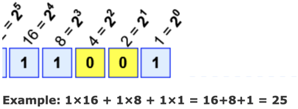
- Example: What is 10100100 in decimal?

```
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



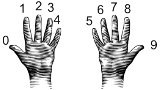


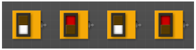


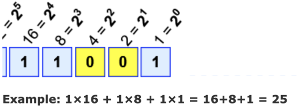
- Example: What is 10100100 in decimal?

```
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



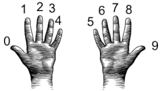


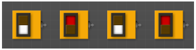


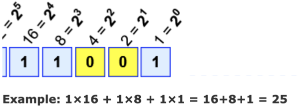
- Example: What is 10100100 in decimal?

```
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



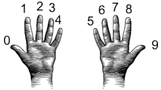


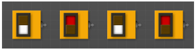


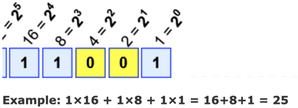
- Example: What is 10100100 in decimal?

```
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



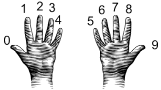


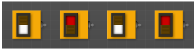


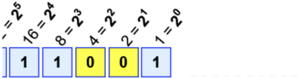
- Example: What is 10100100 in decimal?

```
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





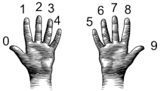


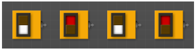
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

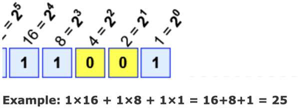
- Example: What is 10100100 in decimal?

```
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



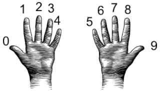


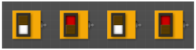


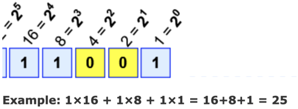
- Example: What is 10100100 in decimal?

```
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:
```

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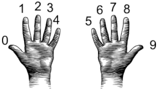

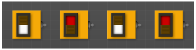

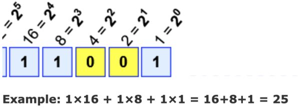

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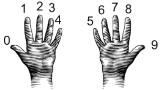

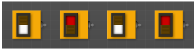

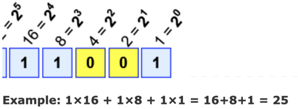

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1*128 = 0.   Add 128 to sum:
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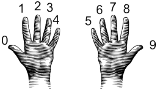

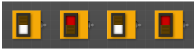

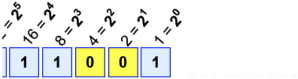

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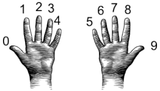
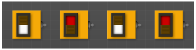
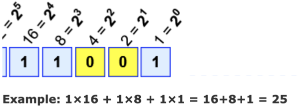
1*128 = 0.  Add 128 to sum:    164
```

Binary to Decimal: Converting Between Bases







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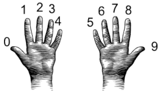
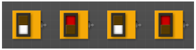
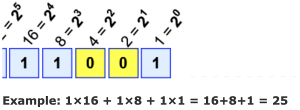

The answer is 164.

Design Challenge: Incrementers







- Simplest arithmetic: add one ("increment") a variable.

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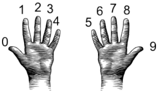

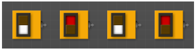

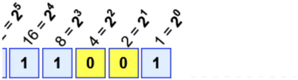

Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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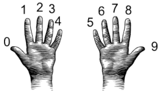
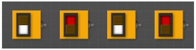
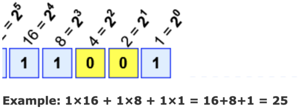
Design Challenge: Incrementers







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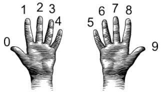

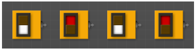

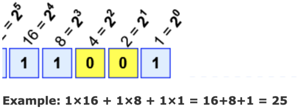

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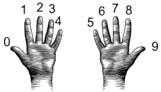

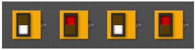

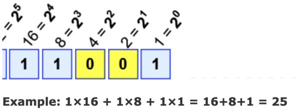

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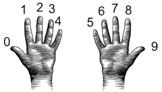

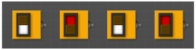

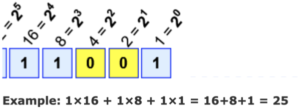

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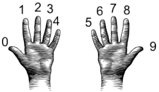

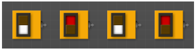

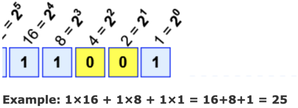

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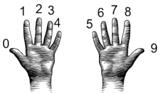

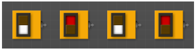

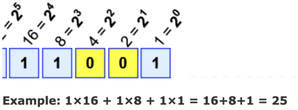

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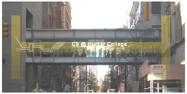
- Challenge: Write an algorithm for incrementing binary numbers.

  Example: `"1001"` → `"1010"`

Recap



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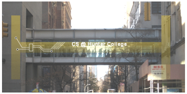
Recap



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

Today's Topics

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

Final Overview: Administration

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- The only assignment in that course will be your final exam.
- The morning of the exam: log into Gradescope, find the **CSci 127 Final Exam** course and open the assignment.

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

Exam Options

Exam Times:

FINAL EXAM, VERSION 3
CSci 127: Introduction to Computer Science
Hunter College, City University of New York

19 December 2018

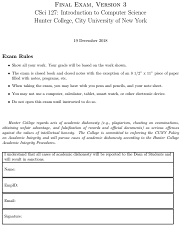
Exam Rules

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

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

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

Exam Options



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Exam Times:

- Default Regular Time: Monday, 24 May, 9-11am.

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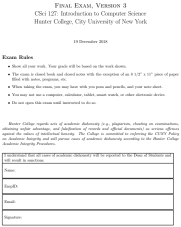

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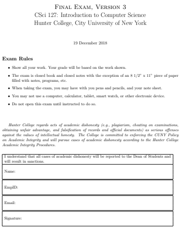
FINAL EXAM, VERSION 3
CSci 127: Introduction to Computer Science
Hunter College, City University of New York

19 December 2018

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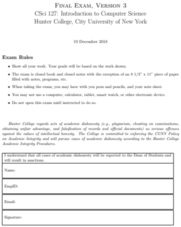

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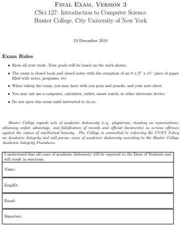

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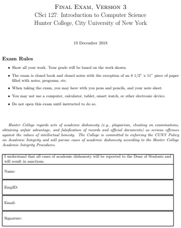
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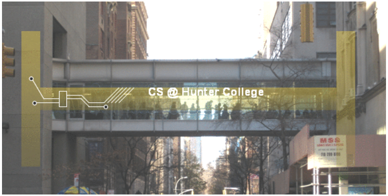

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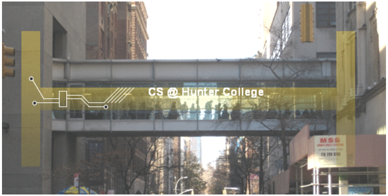

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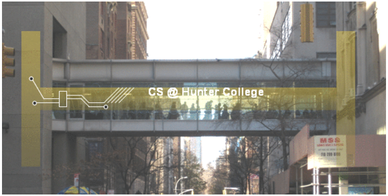

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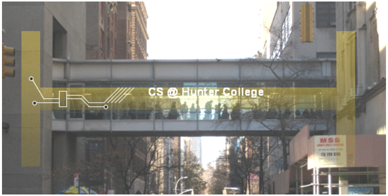

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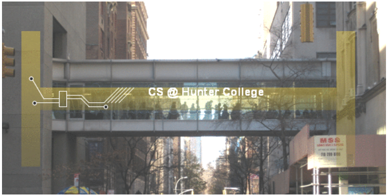

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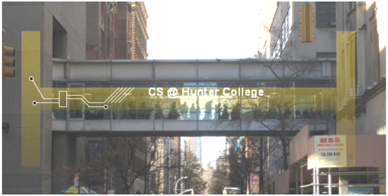

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