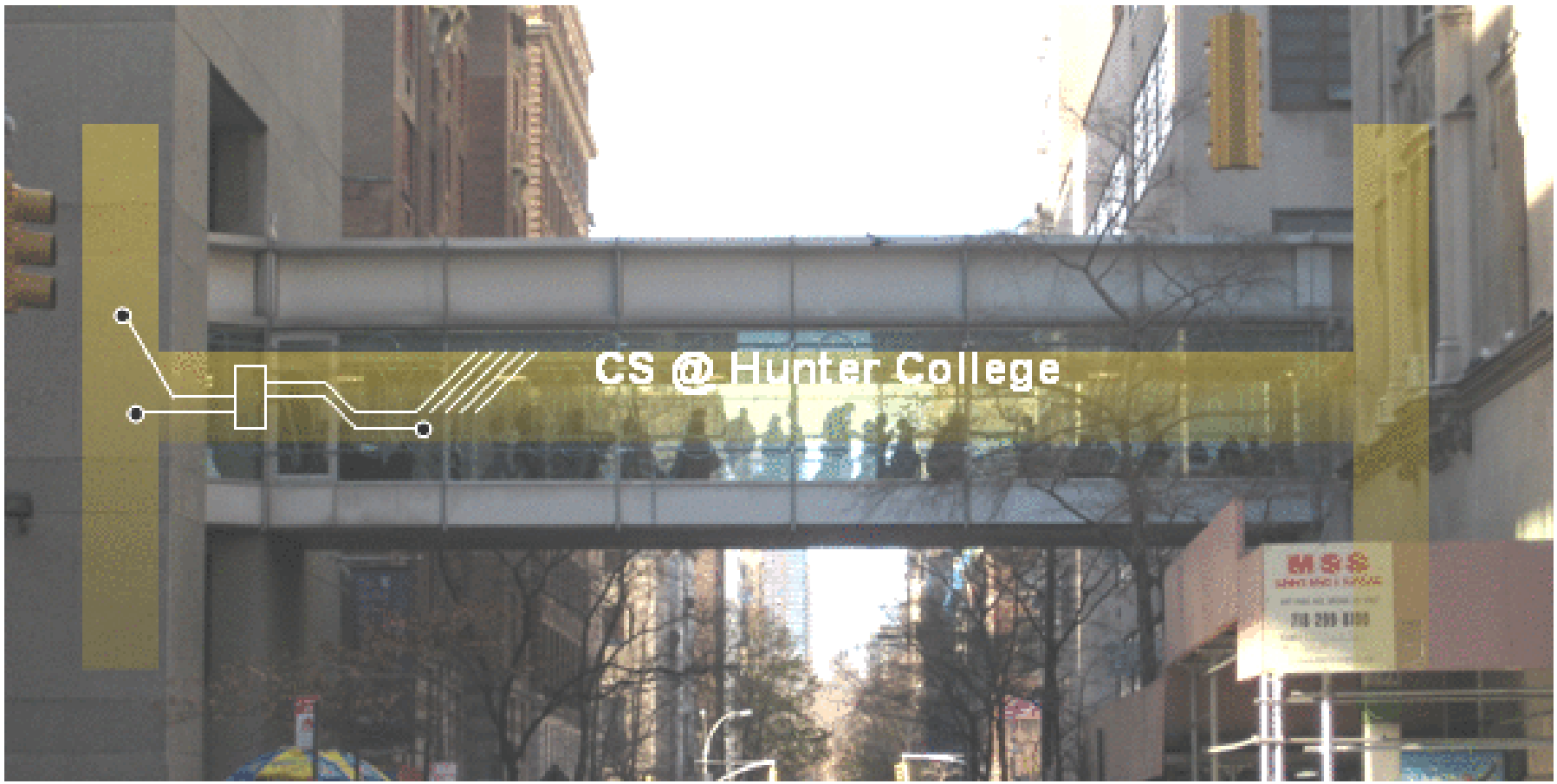
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

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- Have a great Thanksgiving!

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- Can we do more on design patterns?

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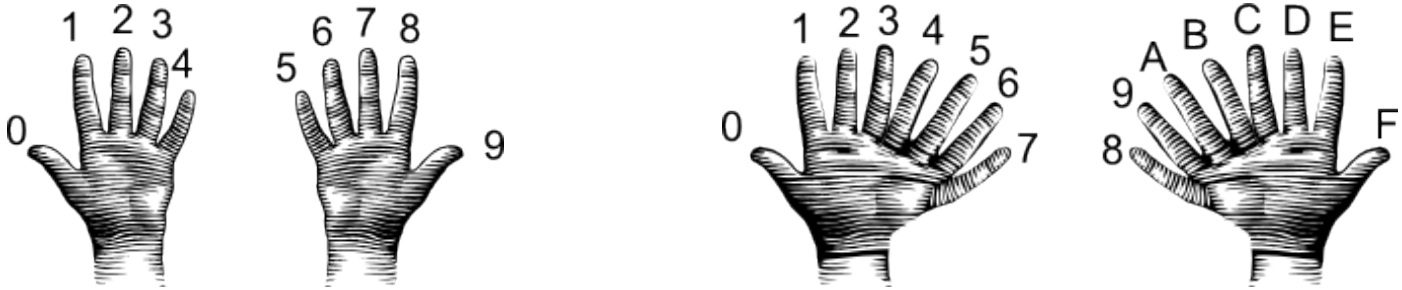
- Can we do more on design patterns?
  Yes, but we're going to transition to C++ after Thanksgiving.

Today's Topics

- Data Representation
- Machine Language: Jumps & Loops
- Recap of Python & Circuits
- Design Patterns: Sorting

Recap: Converting between bases



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- From decimal to hexadecimal:

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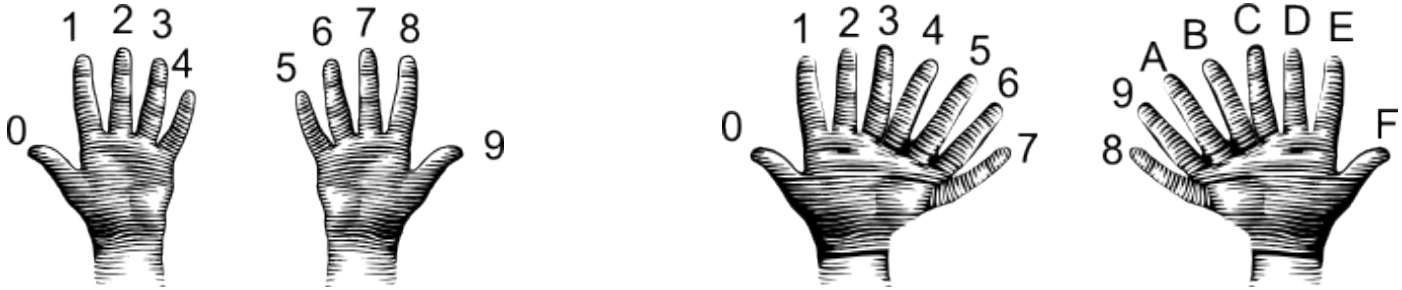

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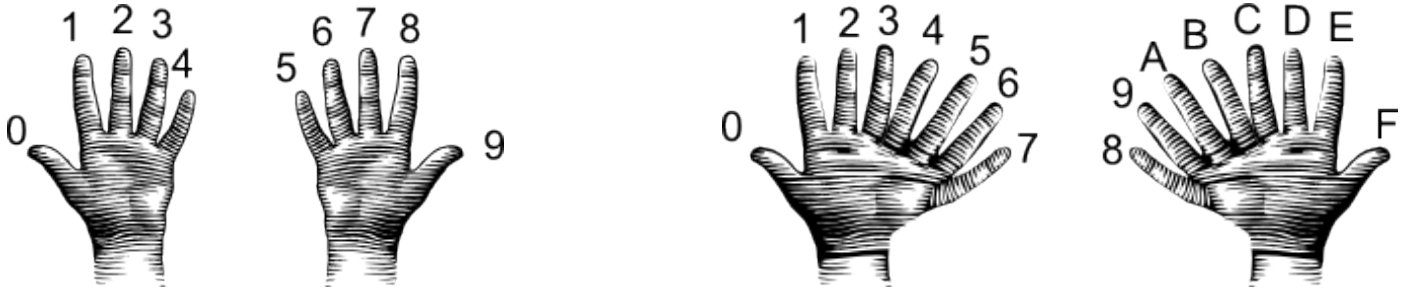

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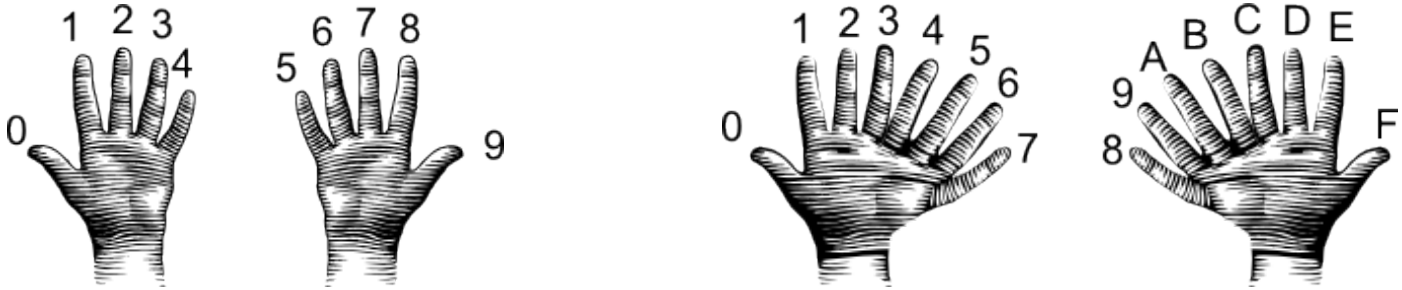

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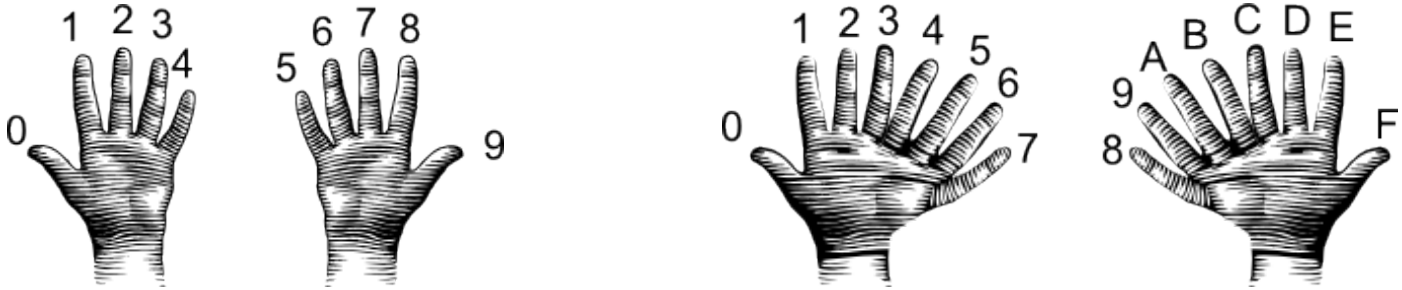

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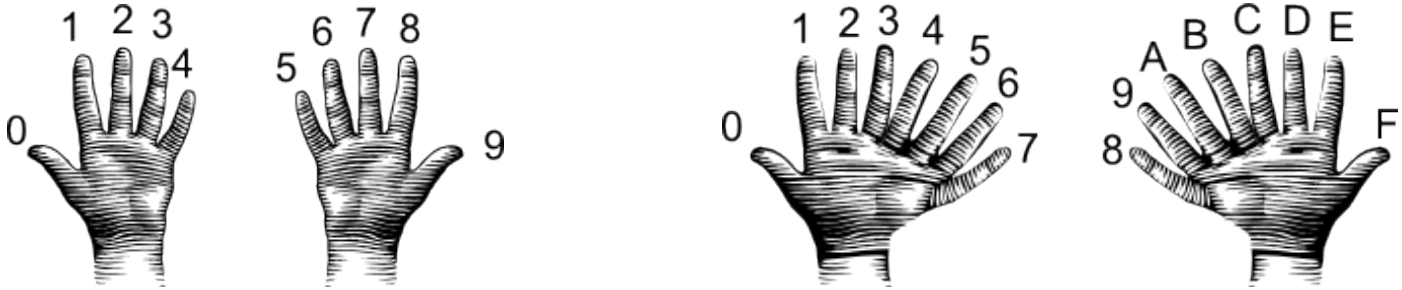

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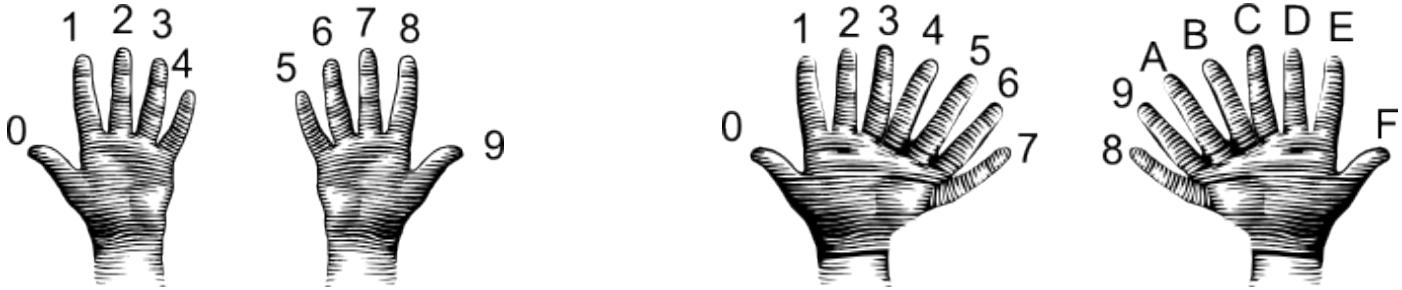

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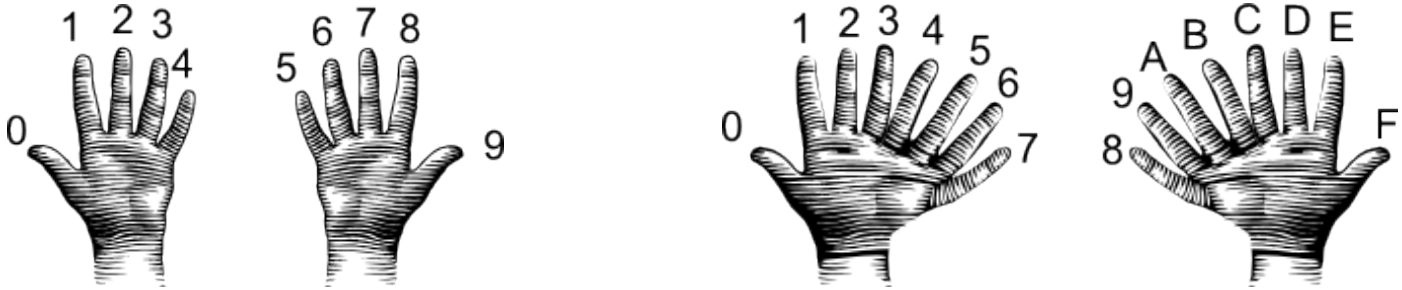

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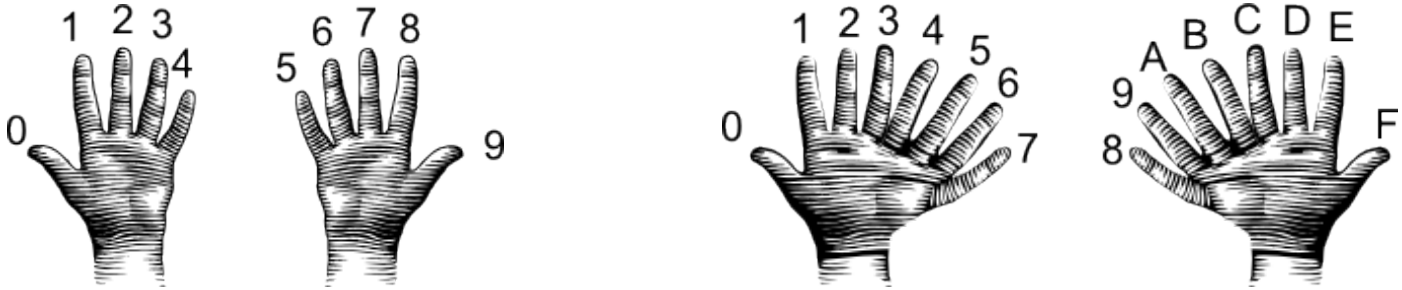

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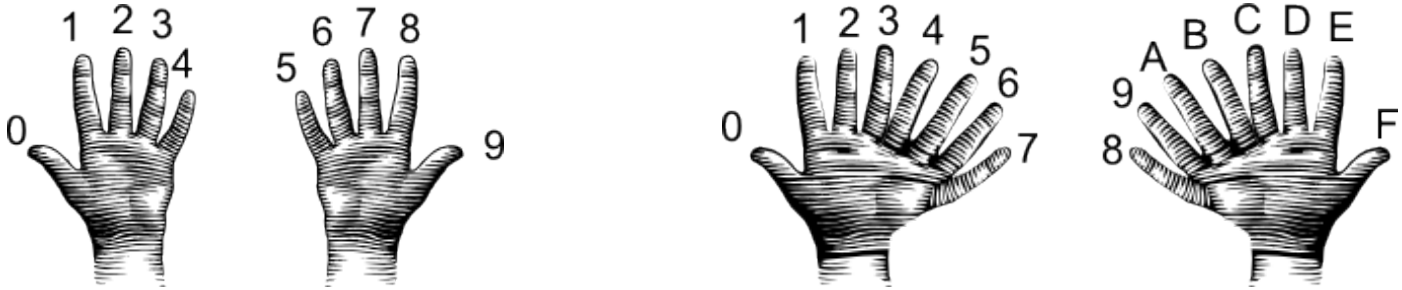

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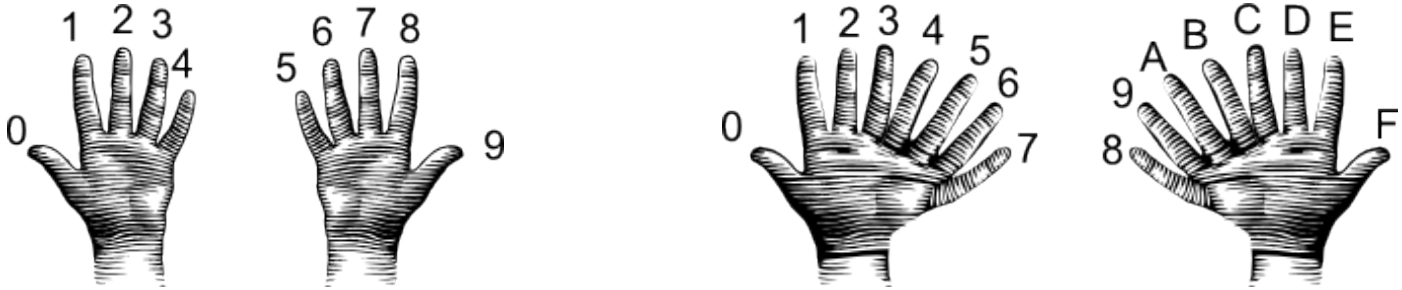

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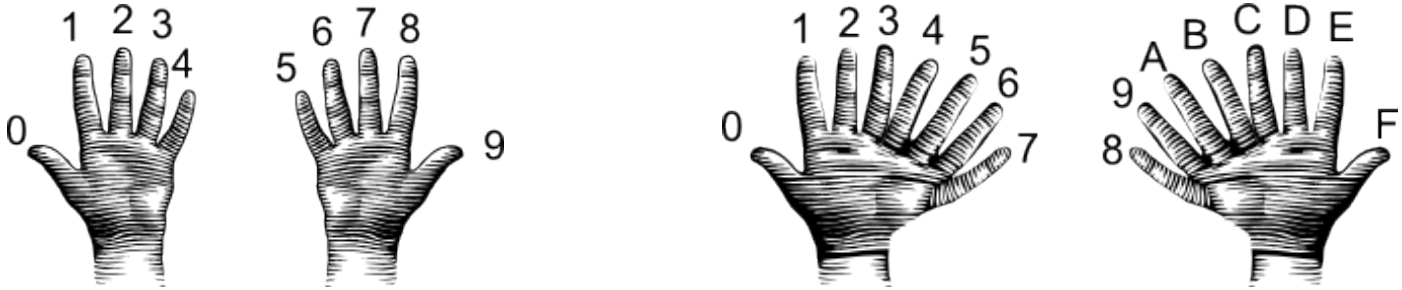

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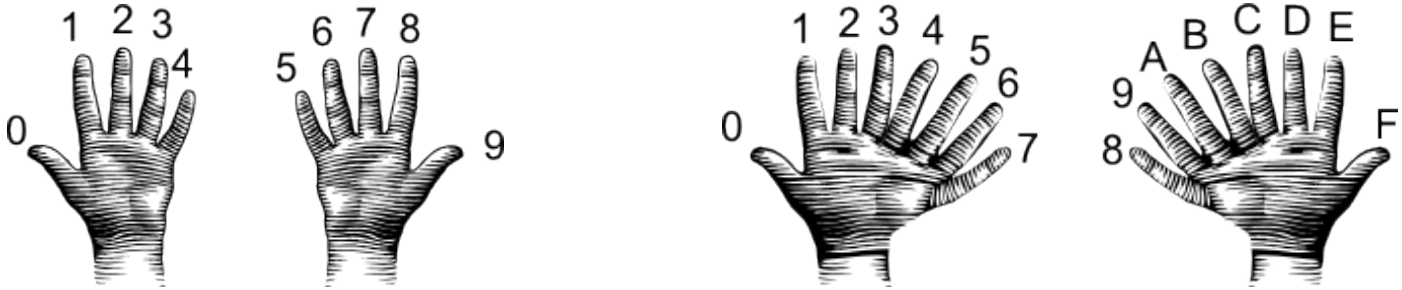

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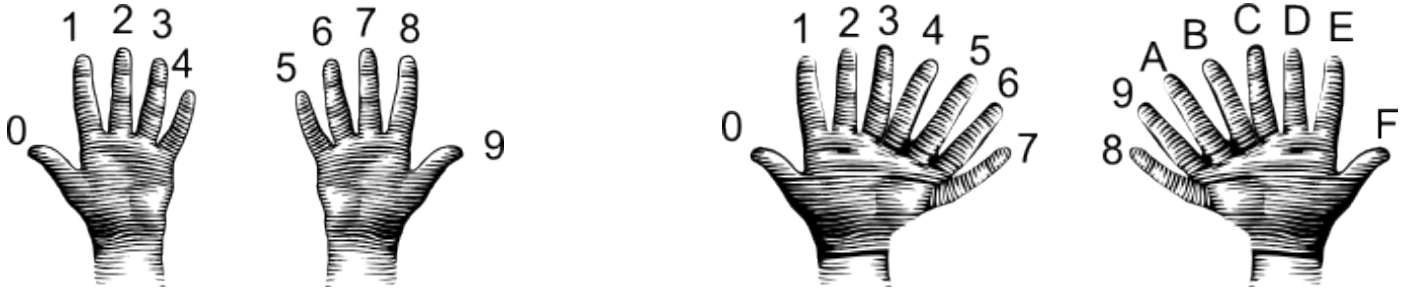

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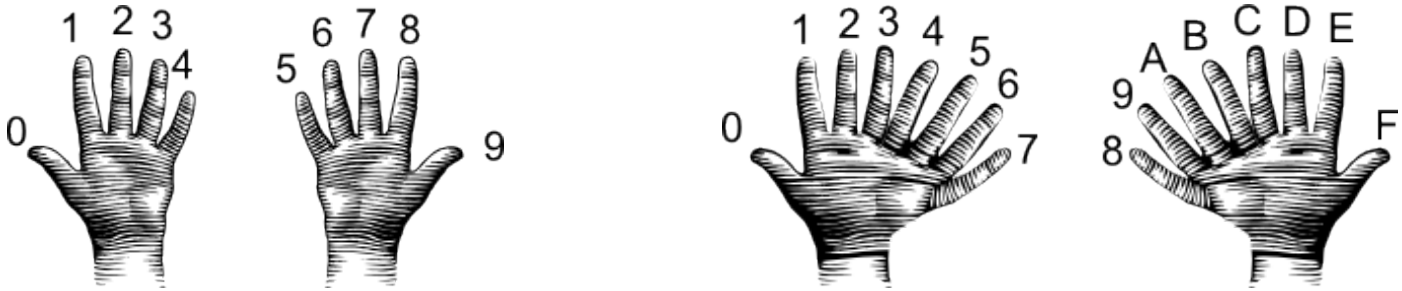

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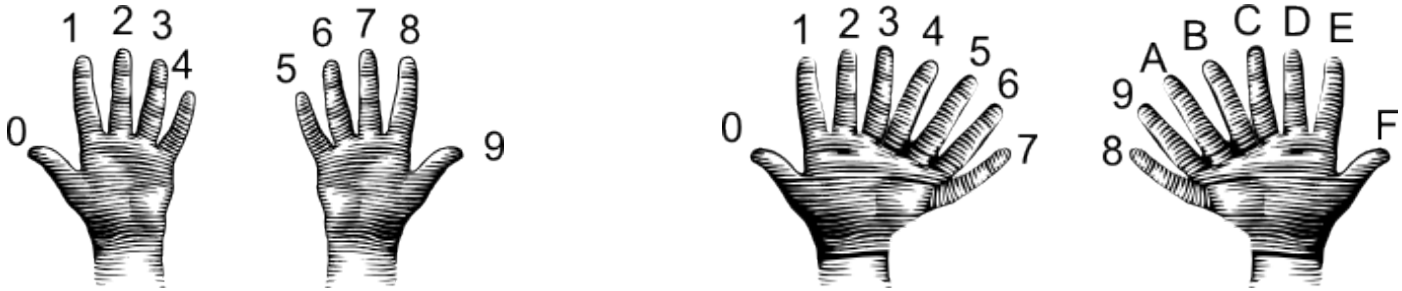

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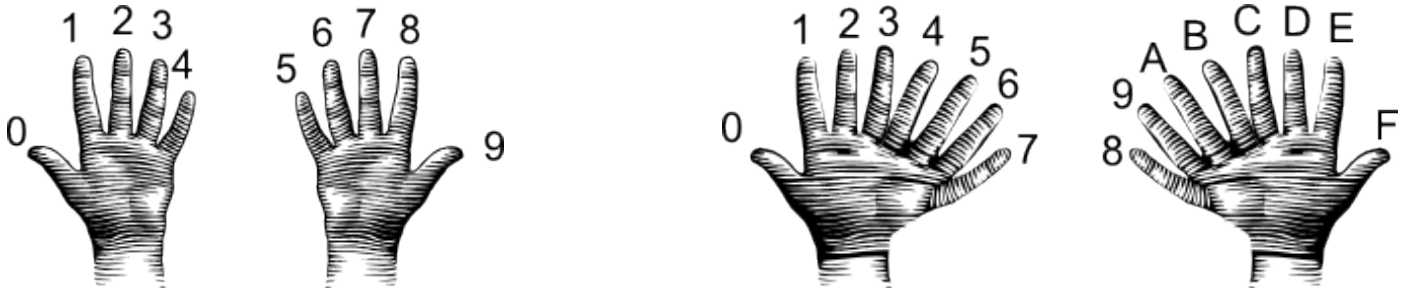

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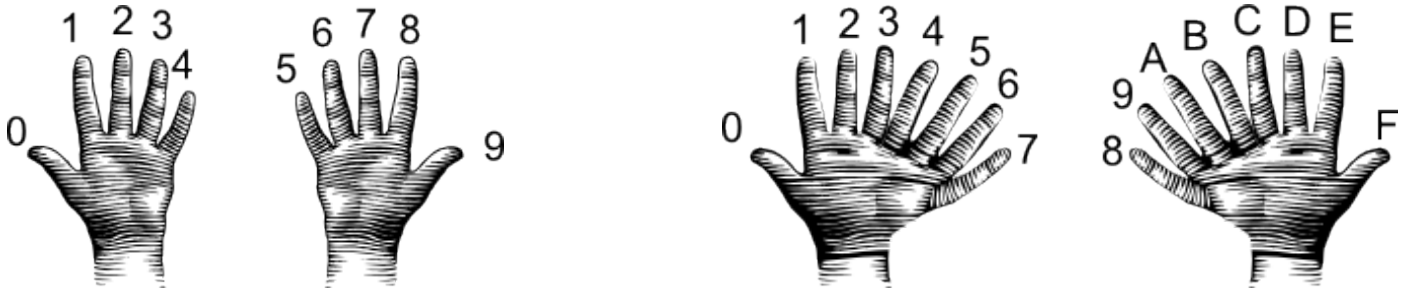

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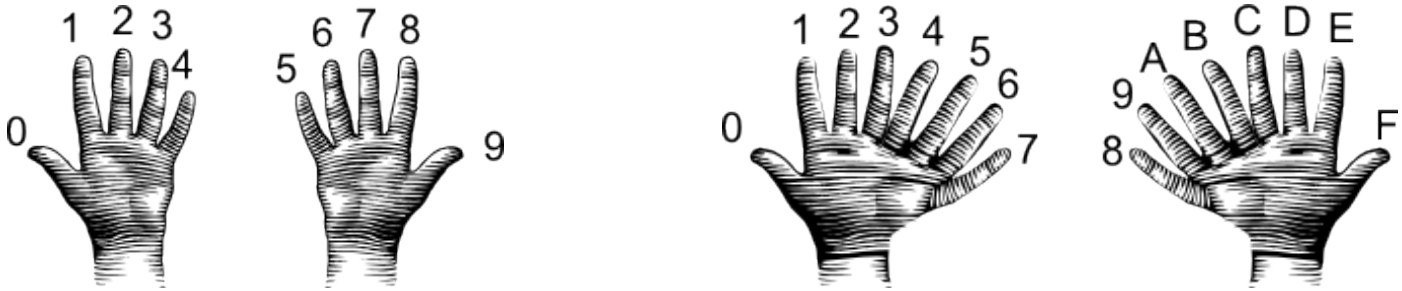

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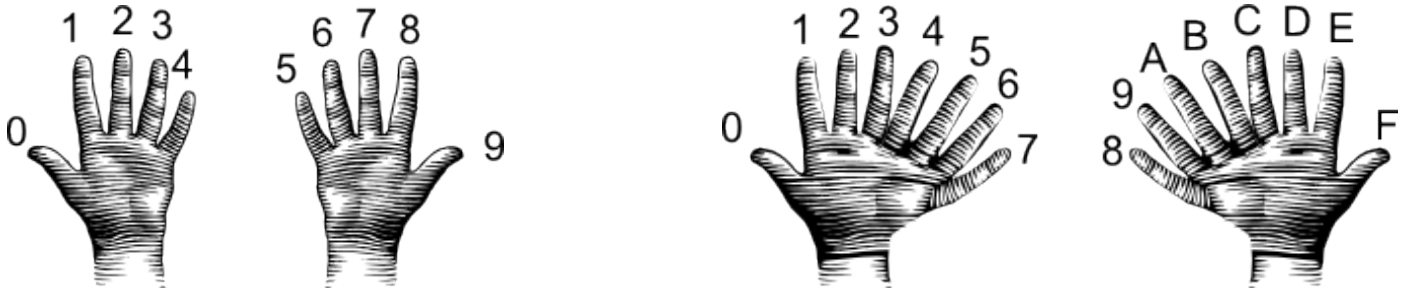

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    `A in decimal digits is 10.`

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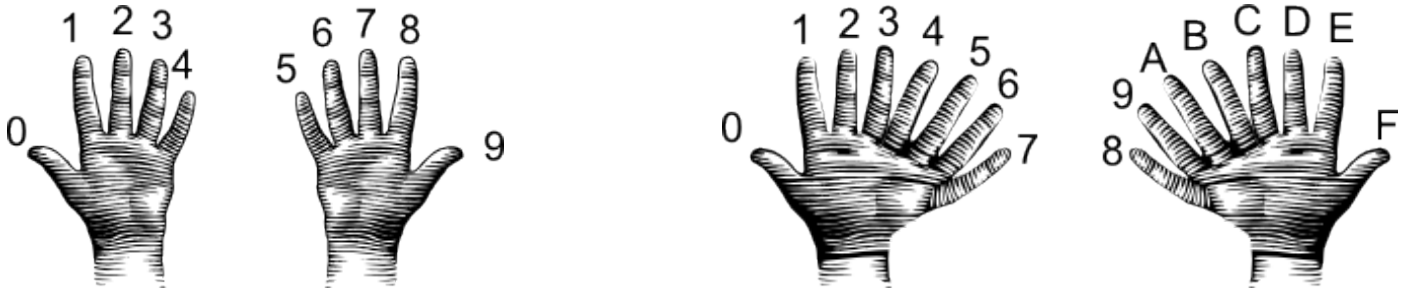

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    `32 + 10 is 42.`

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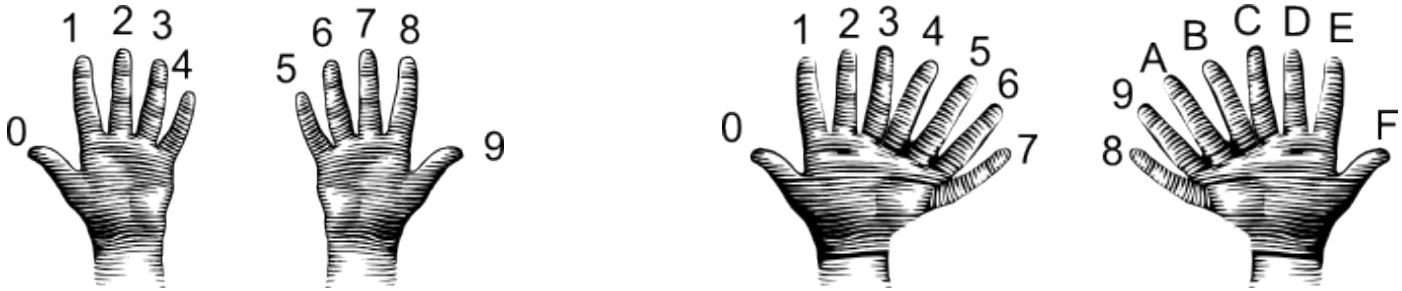

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    Answer is 42.
  - Example: what is 99 as a decimal number?

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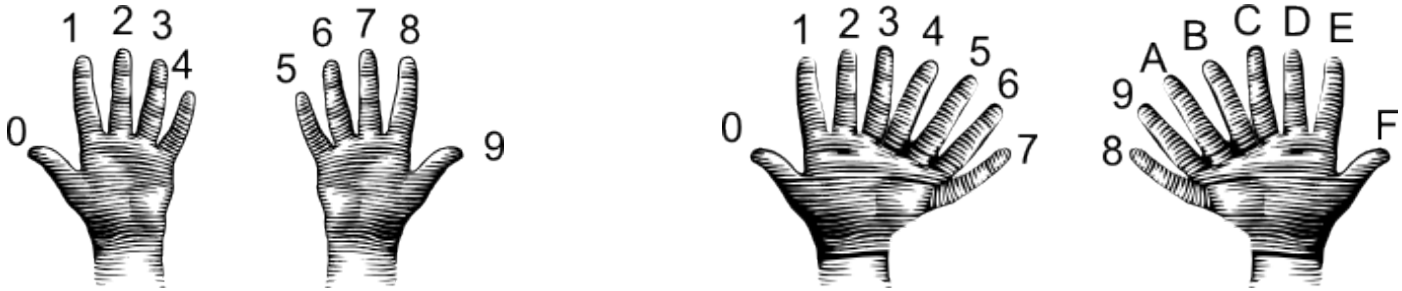

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    Answer is 42.
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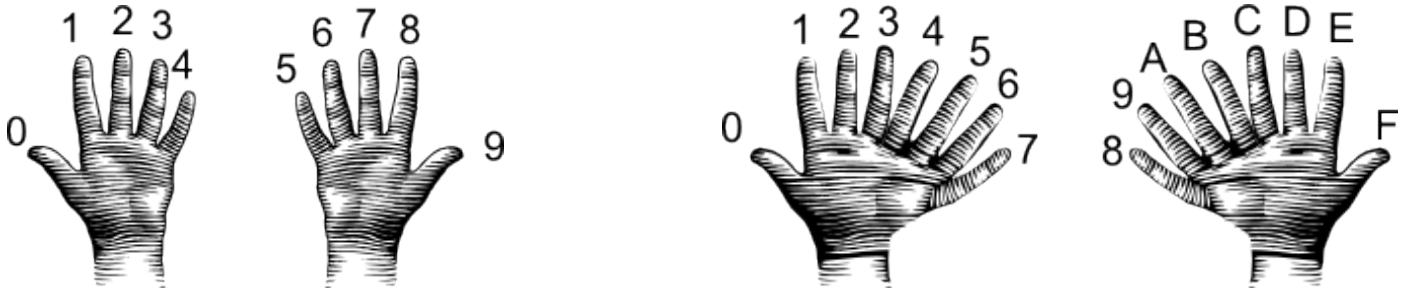
    `9 in decimal is 9.`

Recap: Converting Between Bases



(from i-programmer.info)

- From hexadecimal to decimal:
  - Convert first digit to decimal and multiple by 16.
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  - Example: what is 2A as a decimal number?

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

    `A in decimal digits is 10.`

    `32 + 10 is 42.`

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

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

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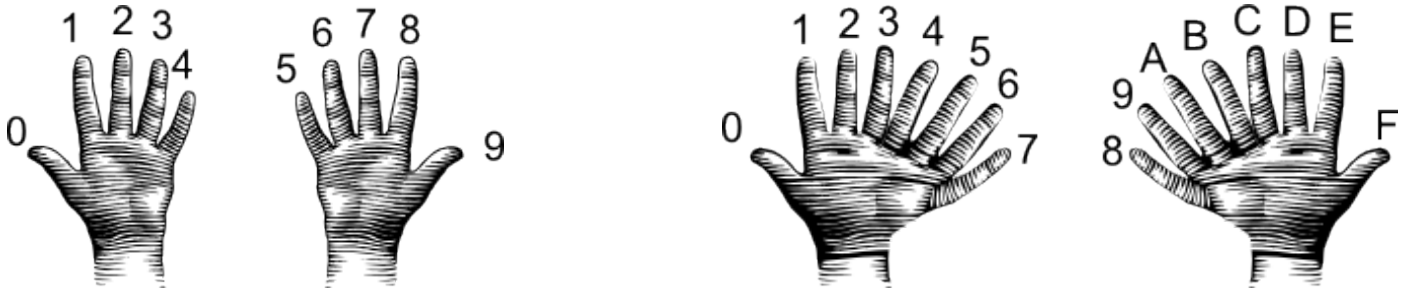

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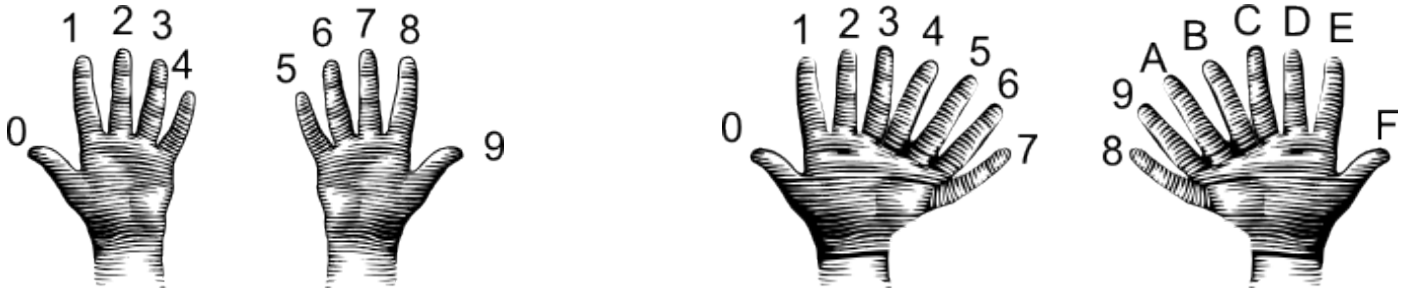

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    `144 + 9 is 153.`

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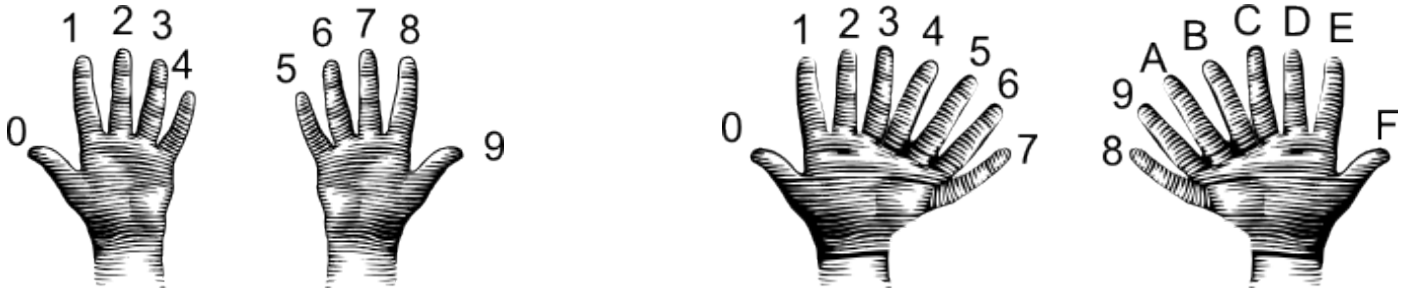

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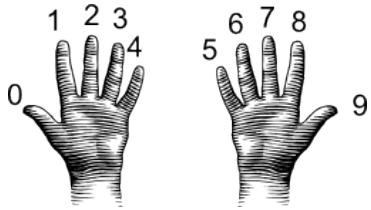

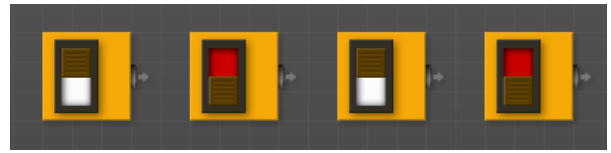

- From decimal to binary:
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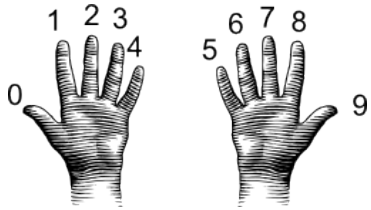

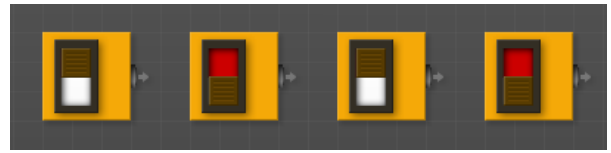

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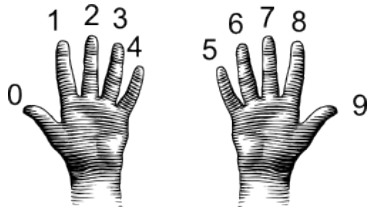

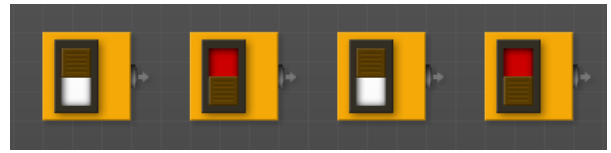

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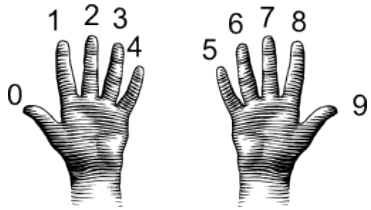

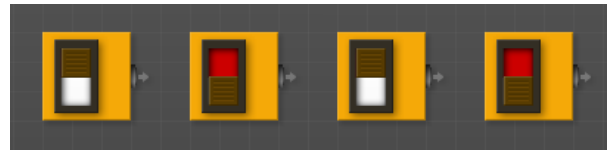

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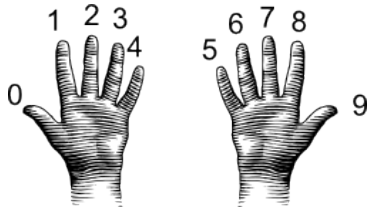

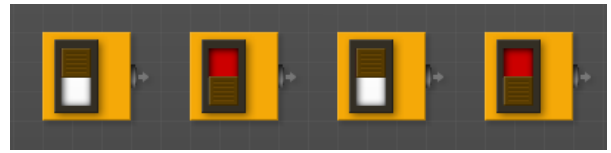

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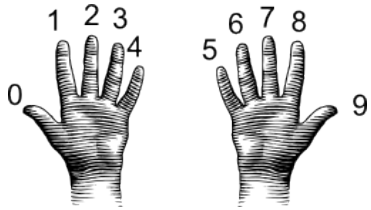

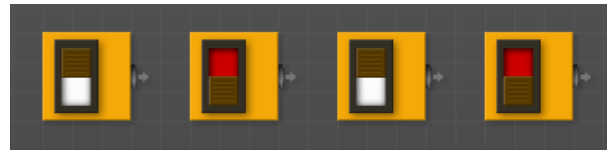

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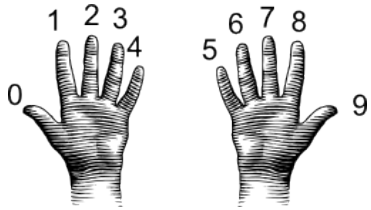

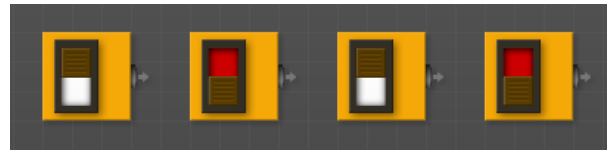

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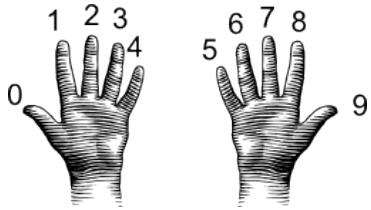

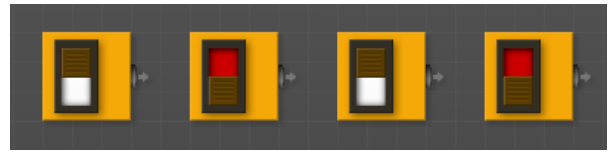

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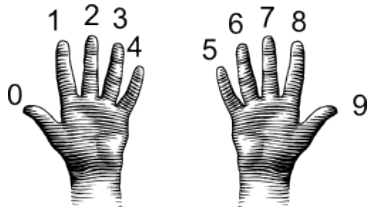

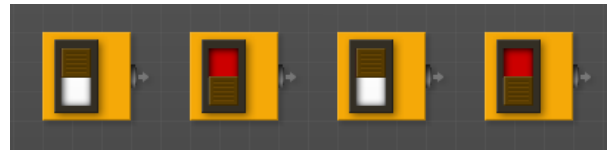

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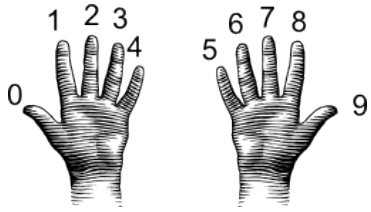

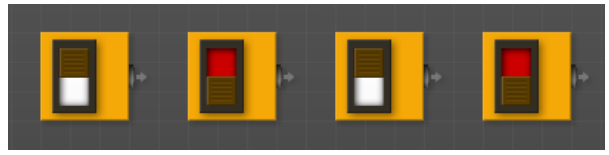

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    130/128 is 1 rem 2.
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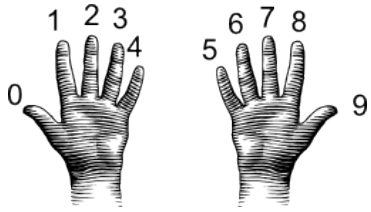

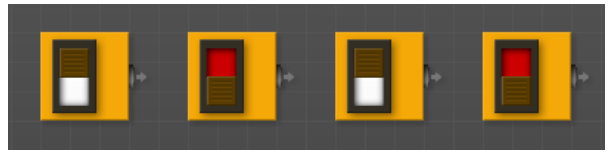

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  - Example: what is 130 in binary notation?

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

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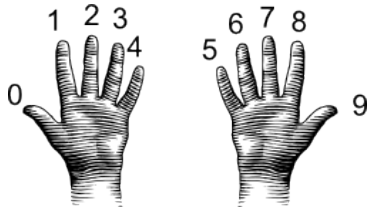

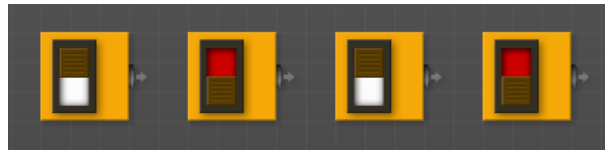

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130/128 is 1 rem 2. First digit is 1:   1...
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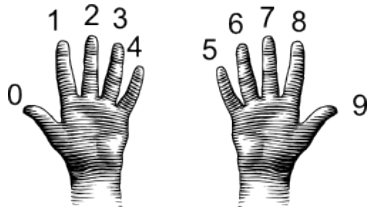

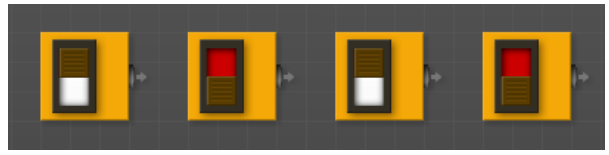

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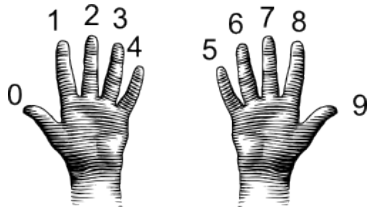

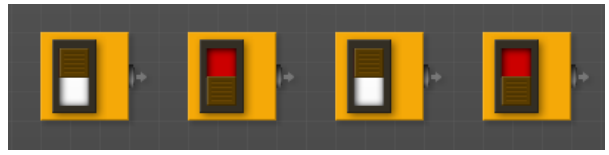

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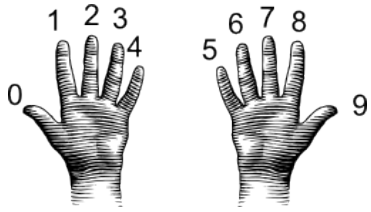

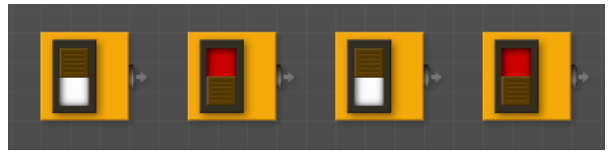

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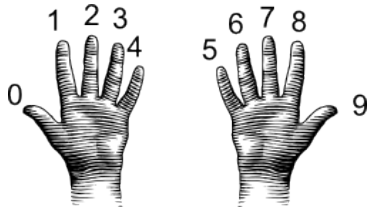

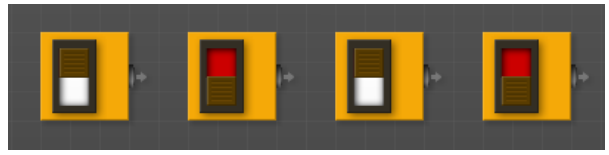

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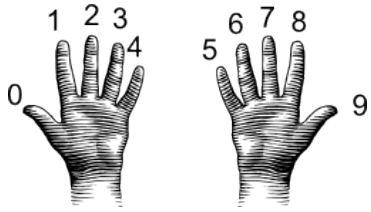
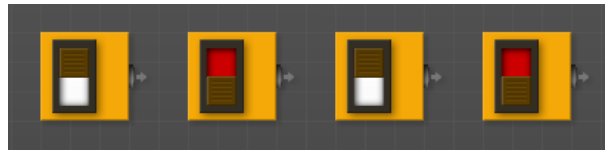
Recap: Converting Between Bases





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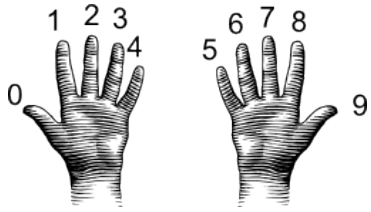

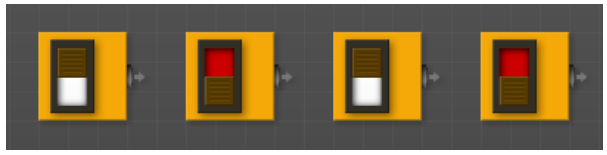

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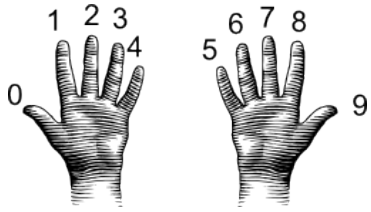

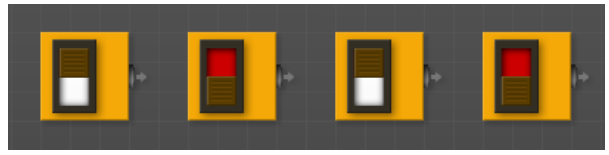

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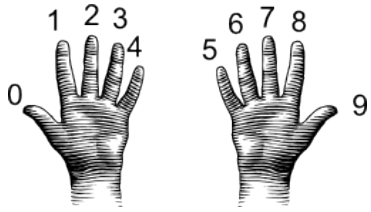

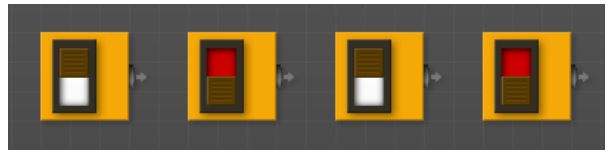

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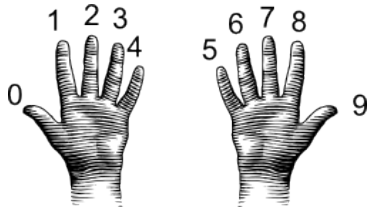

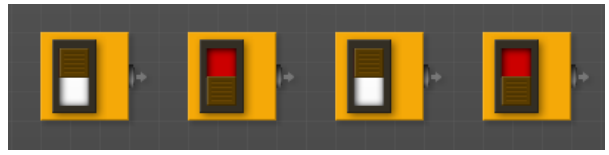

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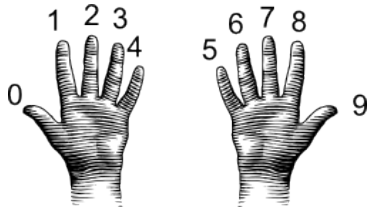

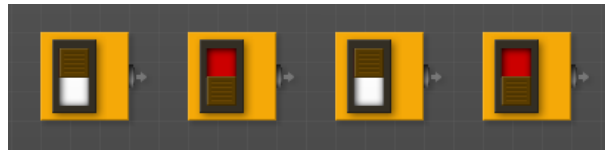

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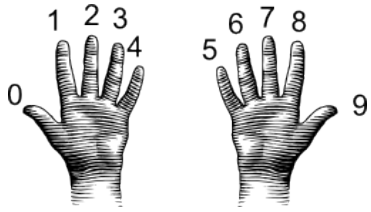

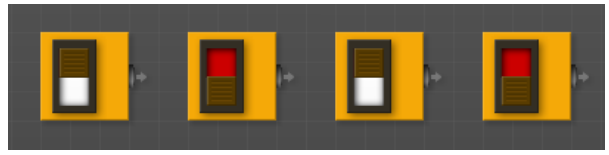

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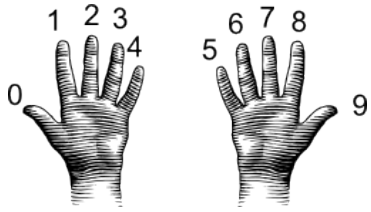

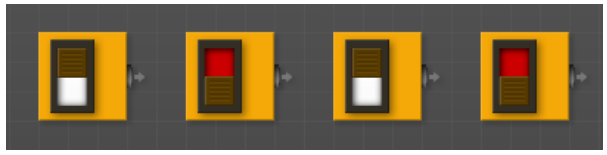

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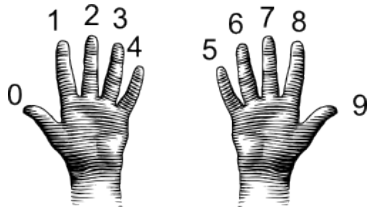

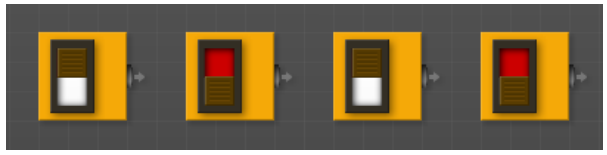

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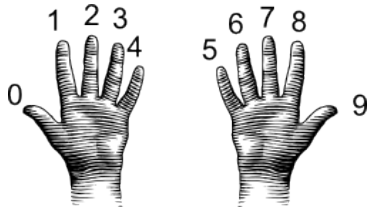

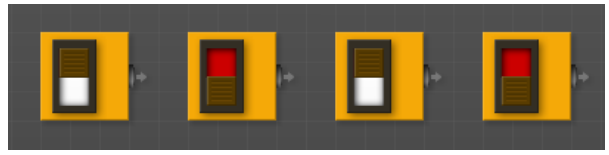

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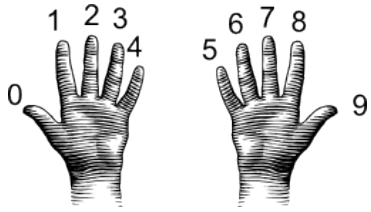

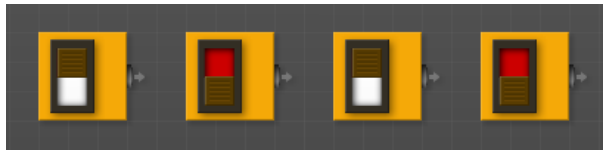

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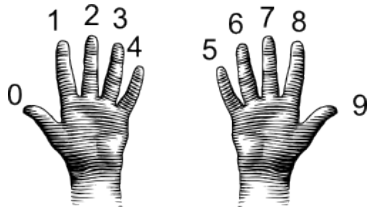

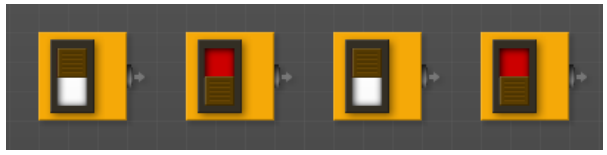

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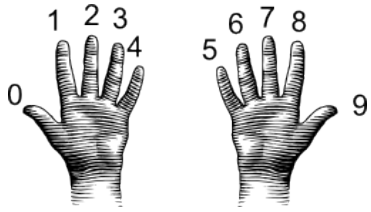

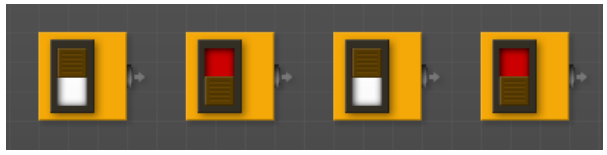

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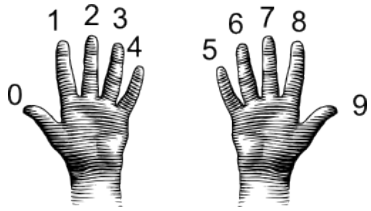

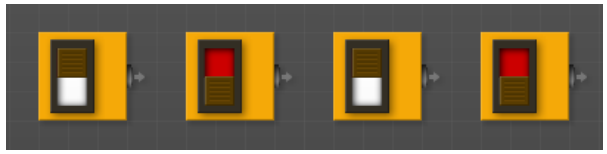

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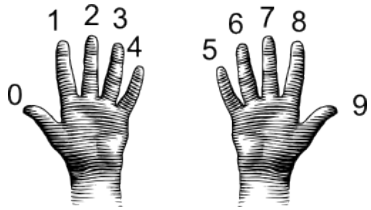
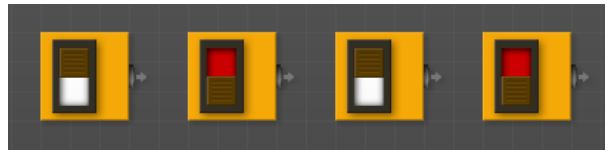
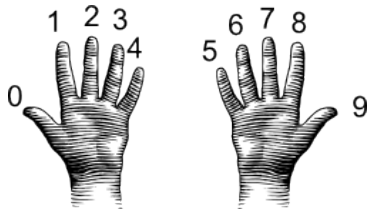


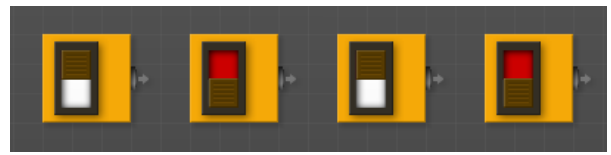


- From decimal to binary:
  - Divide by 128 ($= 2^7$). Quotient is the first digit.
  - Divide remainder by 64 ($= 2^6$). Quotient is the next digit.
  - Divide remainder by 32 ($= 2^5$). Quotient is the next digit.
  - Divide remainder by 16 ($= 2^4$). Quotient is the next digit.
  - Divide remainder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

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

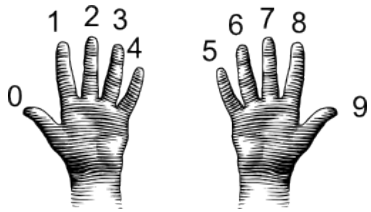
Recap: Converting Between Bases

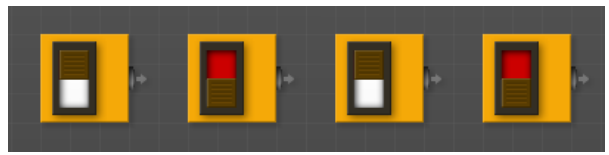




- Example: what is 99 in binary notation?

Recap: Converting Between Bases

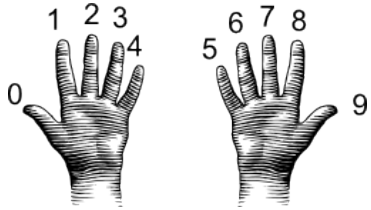


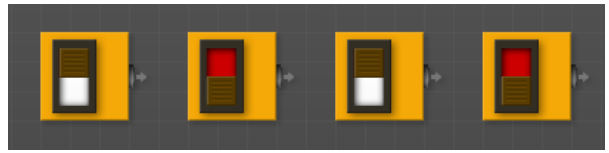


- Example: what is 99 in binary notation?

```
99/128 is 0 rem 99.
```

Recap: Converting Between Bases

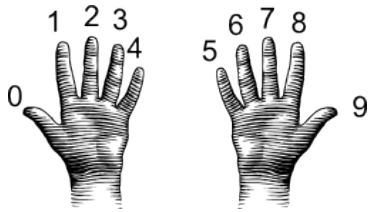


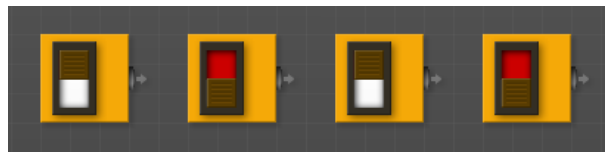


- Example: what is 99 in binary notation?

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

Recap: Converting Between Bases



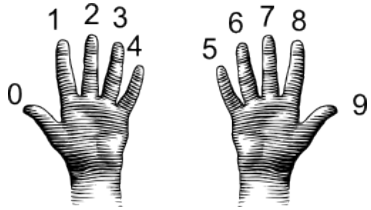


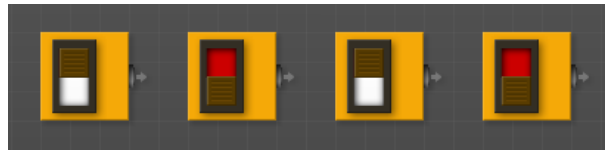
- Example: what is 99 in binary notation?

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

  `99/64 is 1 rem 35.`

Recap: Converting Between Bases





- Example: what is 99 in binary notation?

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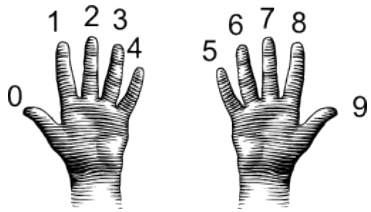
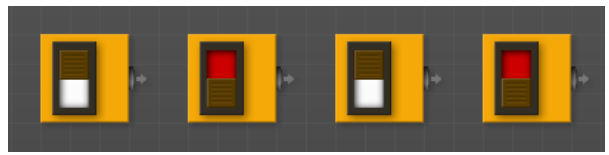
```

Recap: Converting Between Bases





- Example: what is 99 in binary notation?

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

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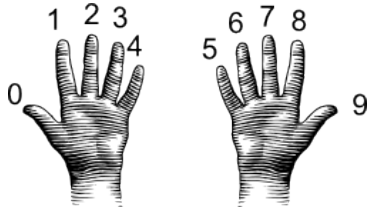

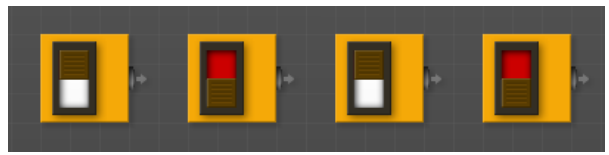

- Example: what is 99 in binary notation?

```
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.
```

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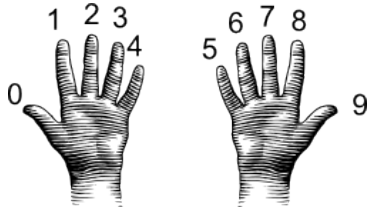

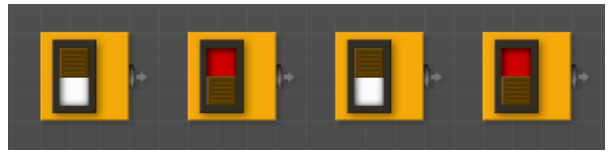

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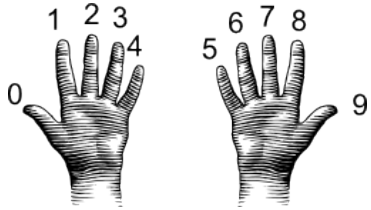

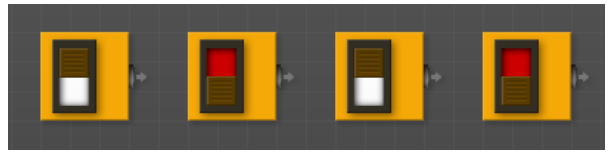

- Example: what is 99 in binary notation?

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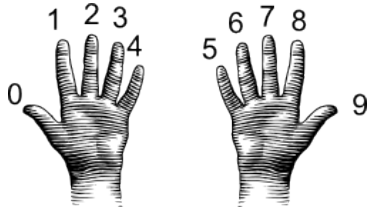

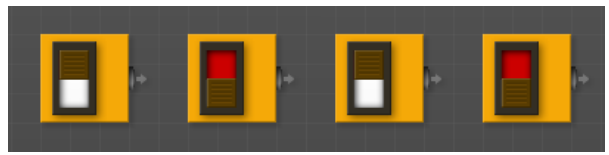

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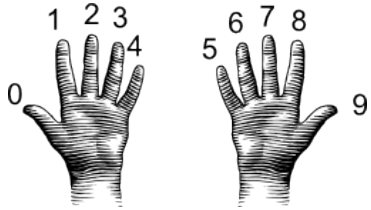

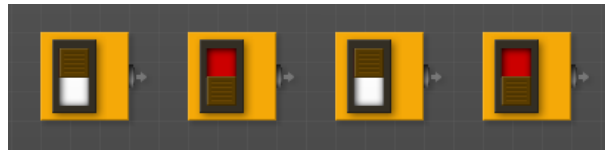

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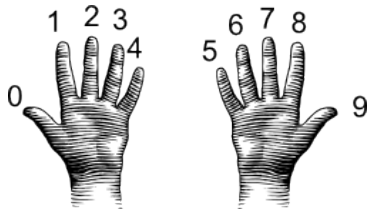

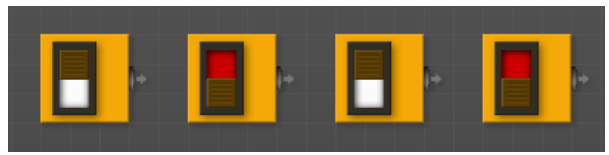

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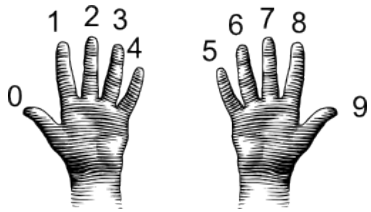

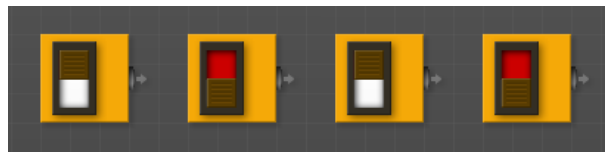

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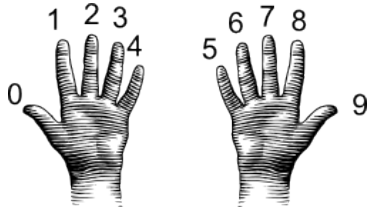

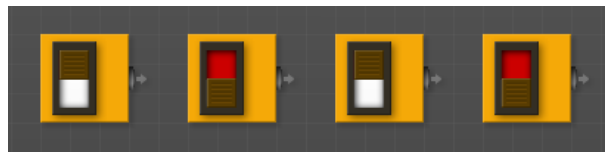

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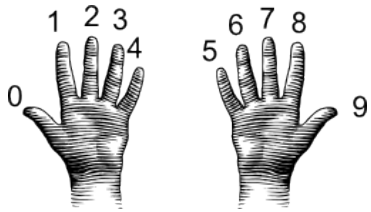

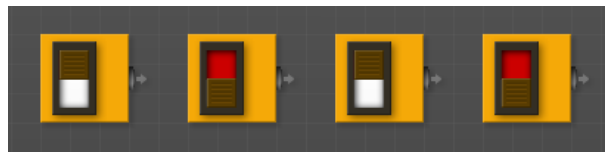

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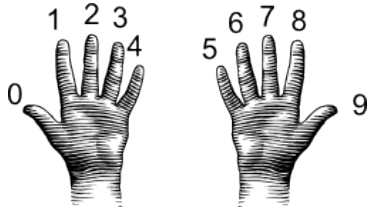

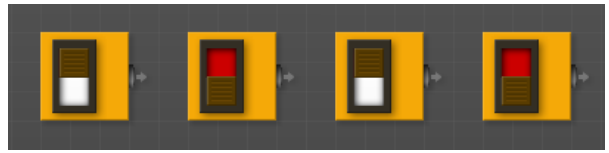

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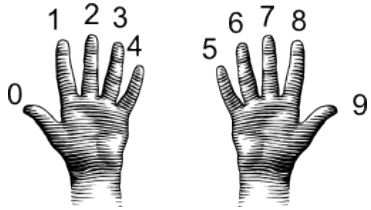

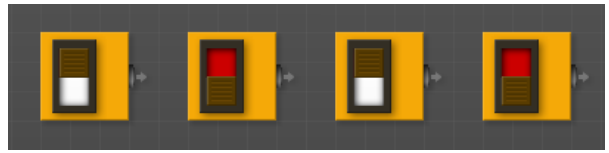

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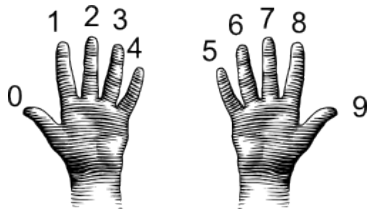

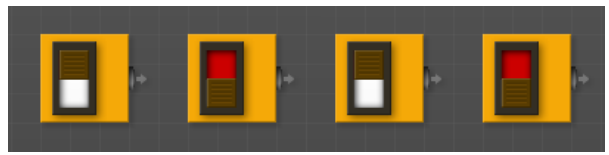

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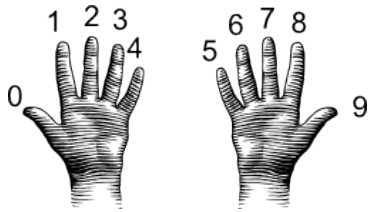

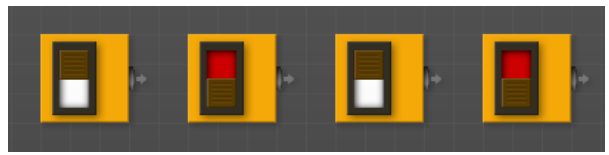

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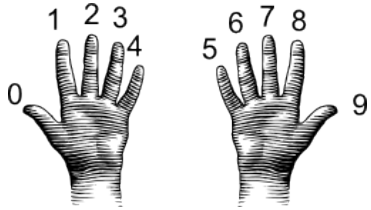

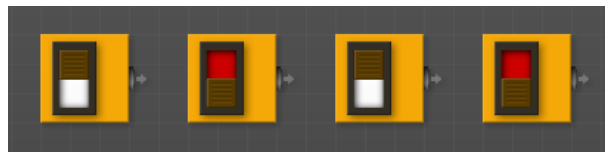

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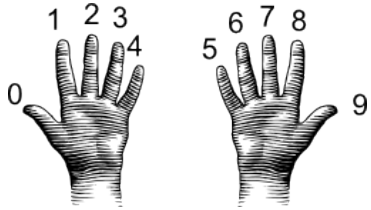

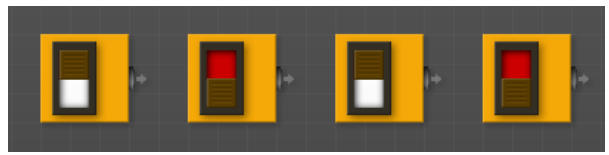

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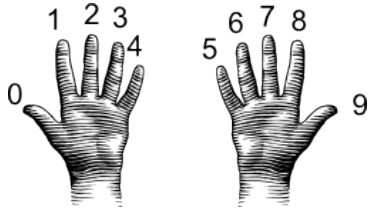
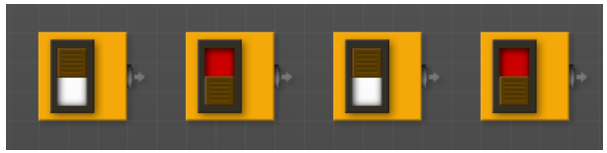
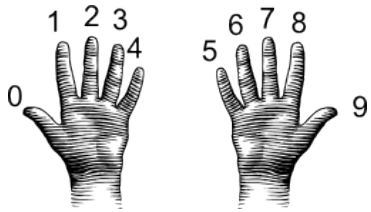


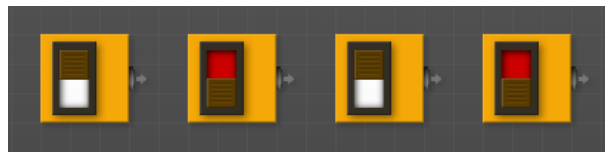


- Example: what is 99 in binary notation?

```
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
```

Recap: Converting Between Bases





- Example: what is 99 in binary notation?

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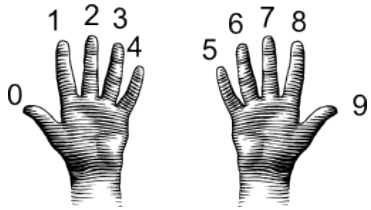
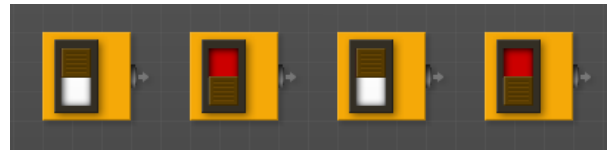
99/128 is 0 rem 99. First digit is 0:    0...
99/64 is 1 rem 35. Next digit is 1:      01...
35/32 is 1 rem 3. Next digit is 1:       011...
3/16 is 0 rem 3. Next digit is 0:        0110...
3/8 is 0 rem 3. Next digit is 0:         01100...
3/4 is 0 remainder 3. Next digit is 0:   011000...
3/2 is 1 rem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

Answer is 1100011.

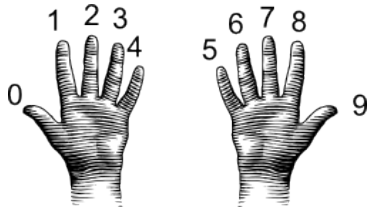
Recap: Converting Between Bases

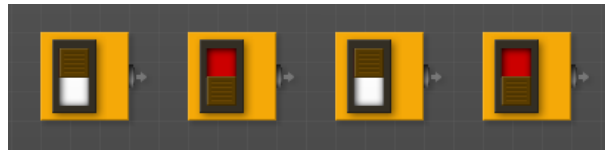




- From binary to decimal:
  - Set sum = last digit.

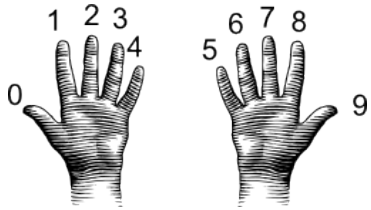
Recap: Converting Between Bases

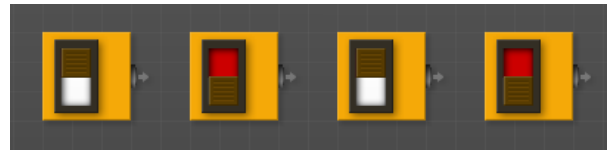




- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.

Recap: Converting Between Bases





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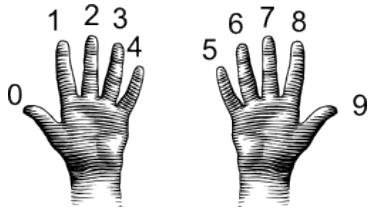
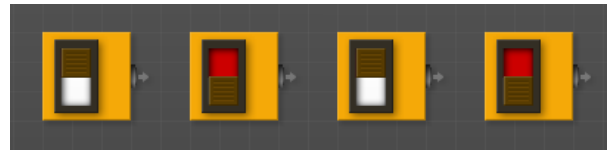
  - Multiply next digit by $4 = 2^2$. Add to sum.

Recap: Converting Between Bases





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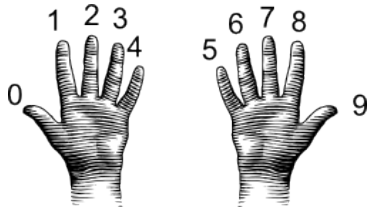
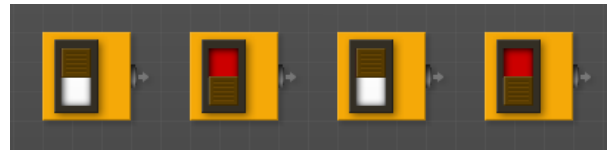
Recap: Converting Between Bases





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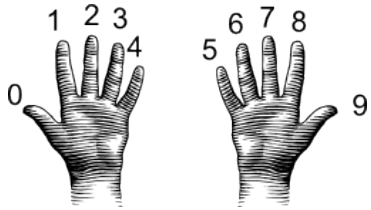
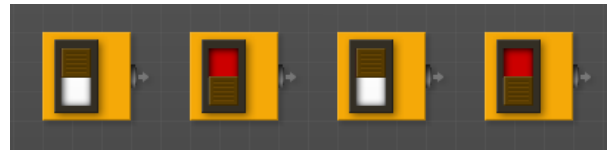
Recap: Converting Between Bases





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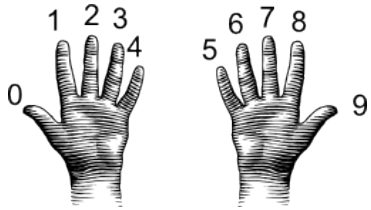
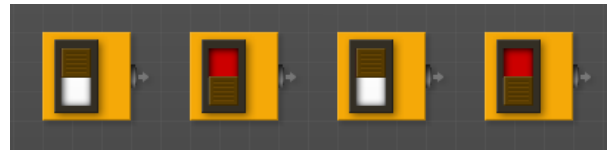
  - Multiply next digit by $32 = 2^5$. Add to sum.

Recap: Converting Between Bases





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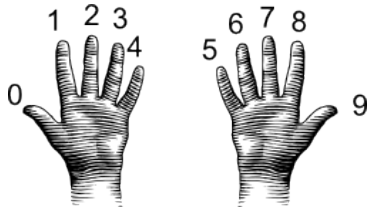
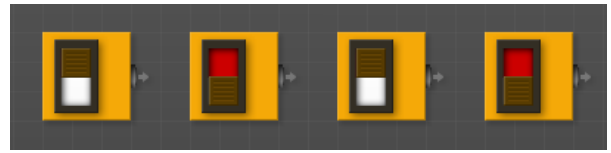
  - Multiply next digit by $64 = 2^6$. Add to sum.

Recap: Converting Between Bases





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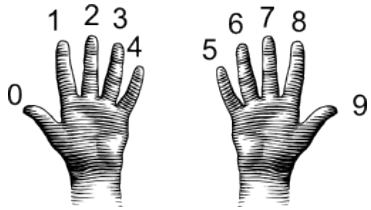
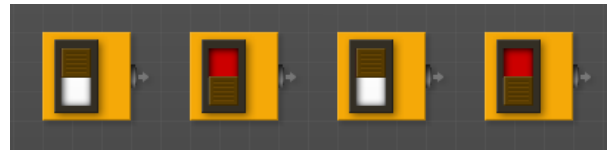
Recap: Converting Between Bases





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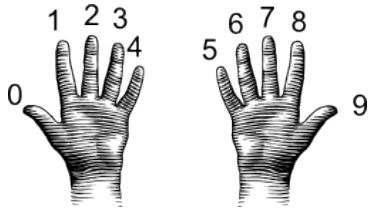
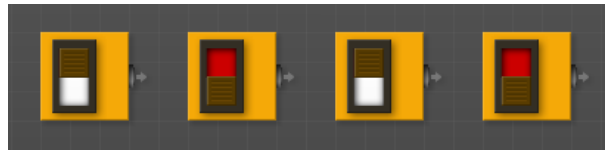
Recap: Converting Between Bases





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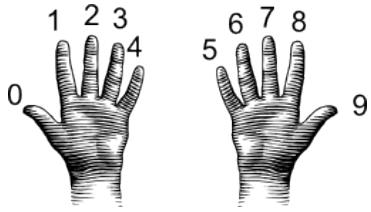
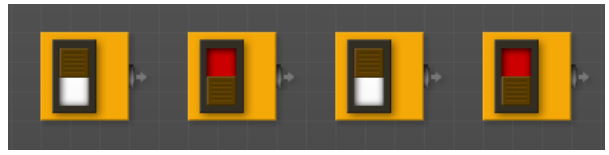
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

    `Sum starts with:`

Recap: Converting Between Bases





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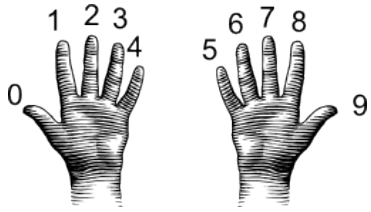
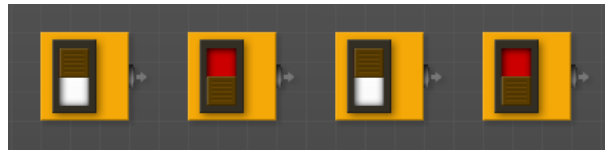
  - Example: What is 111101 in decimal?

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

Recap: Converting Between Bases





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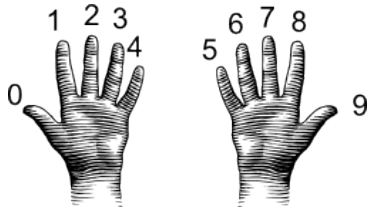
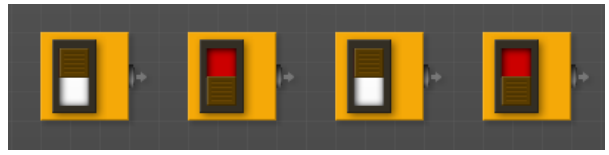
Recap: Converting Between Bases





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Sum starts with:              1
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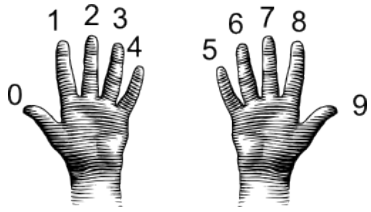
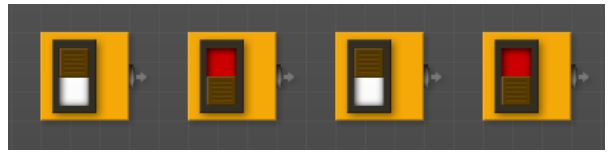
Recap: Converting Between Bases





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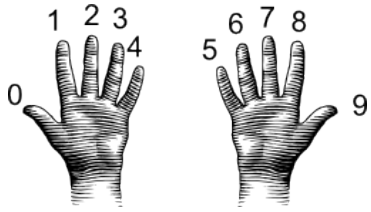
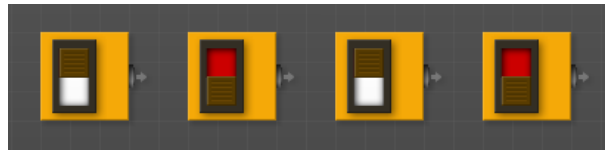
1*4 = 4.  Add 4 to sum:       5
```

Recap: Converting Between Bases





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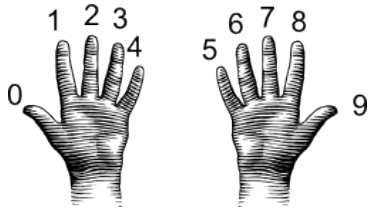
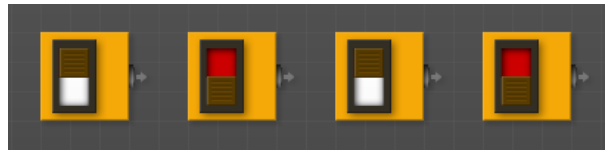
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Recap: Converting Between Bases





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  - Sum is the decimal number.
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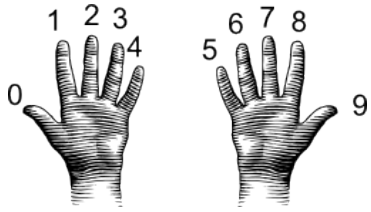
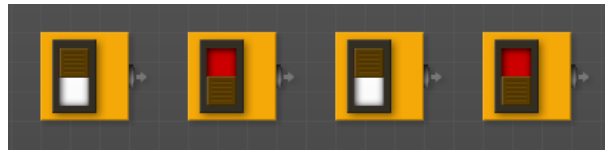
```
Sum starts with:              1
0*2 = 0.  Add 0 to sum:       1
1*4 = 4.  Add 4 to sum:       5
1*8 = 8.  Add 8 to sum:       13
```

Recap: Converting Between Bases





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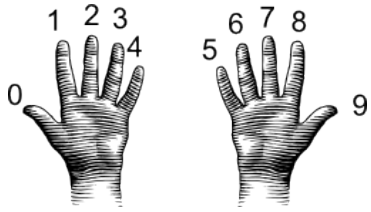
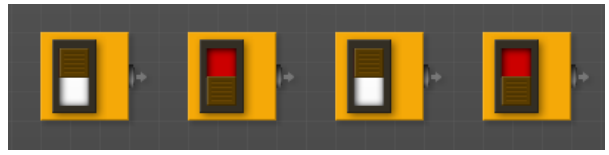
1*8 = 8.  Add 8 to sum:       13
1*16 = 16.  Add 16 to sum:
```

Recap: Converting Between Bases





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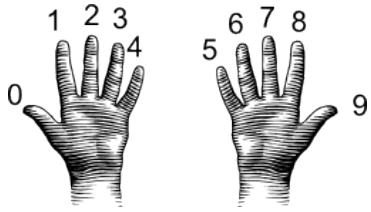
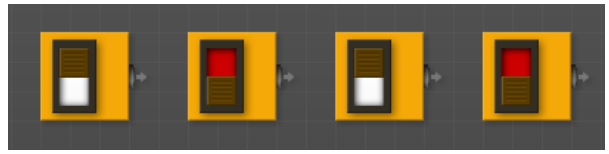
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What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

Recap: Converting Between Bases

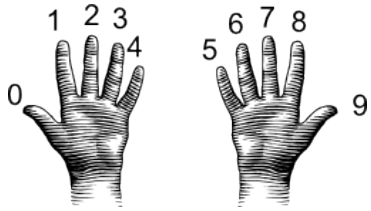


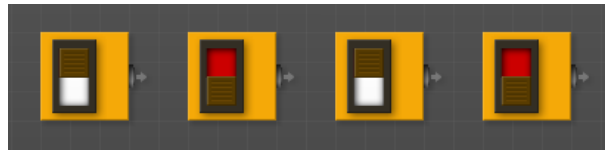


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Recap: Converting Between Bases

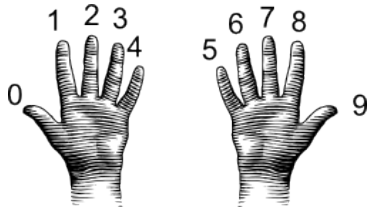


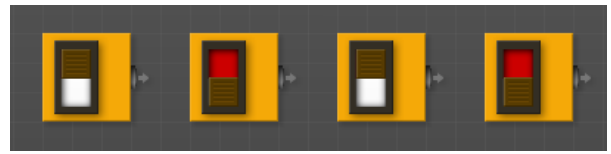


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

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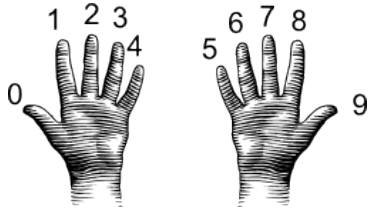
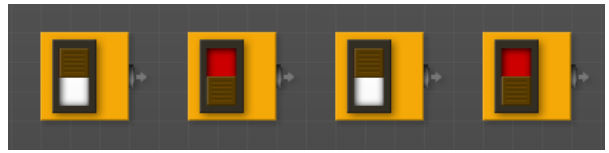
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

```
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
```

Recap: Converting Between Bases

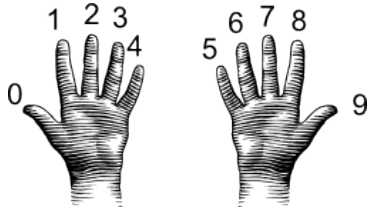


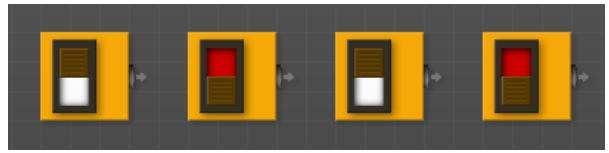


- Example: What is 10100100 in decimal?

  `Sum starts with:`

Recap: Converting Between Bases

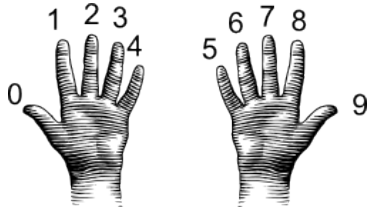


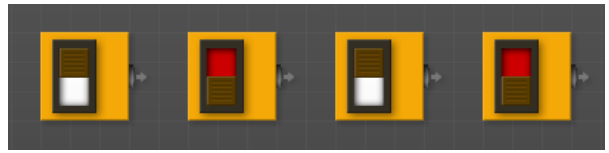


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

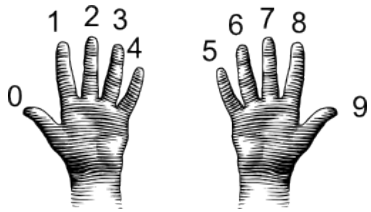


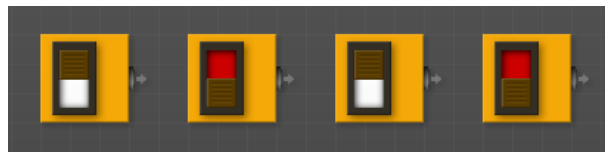


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

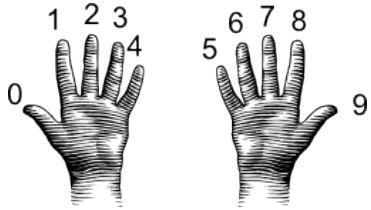


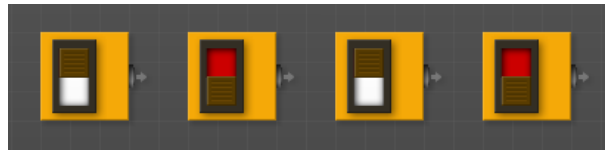


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

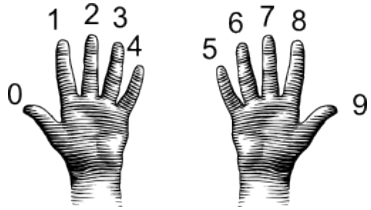


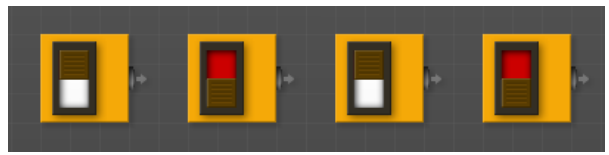


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

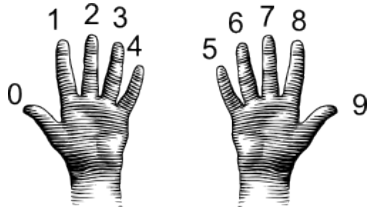


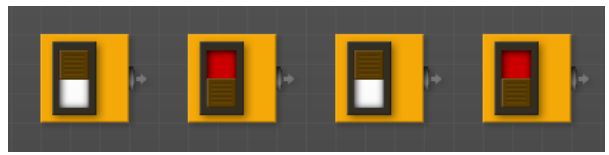


- Example: What is 10100100 in decimal?

```
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:
```

Recap: Converting Between Bases

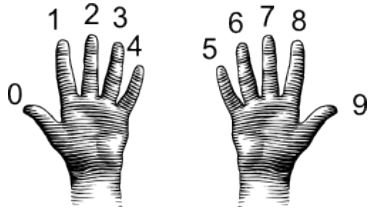


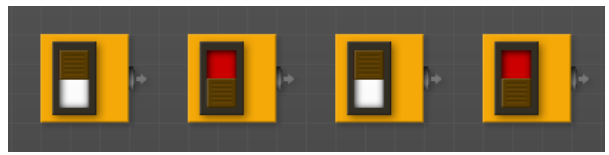


- Example: What is 10100100 in decimal?

```
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
```

Recap: Converting Between Bases

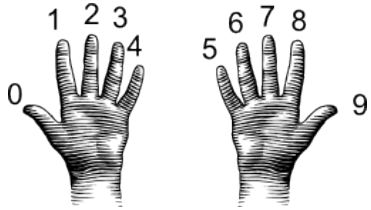


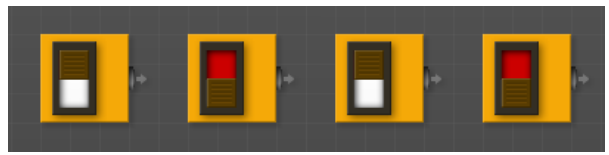


- Example: What is 10100100 in decimal?

```
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:
```

Recap: Converting Between Bases

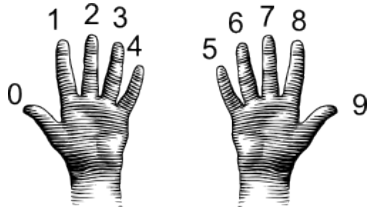


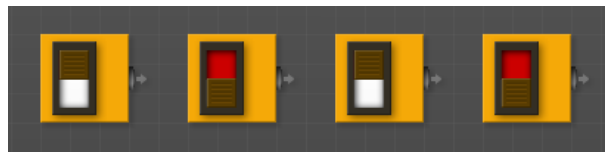


- Example: What is 10100100 in decimal?

```
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
```

Recap: Converting Between Bases

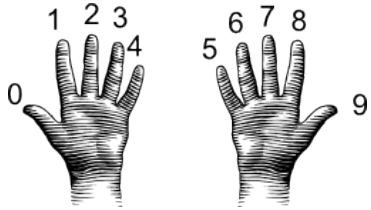


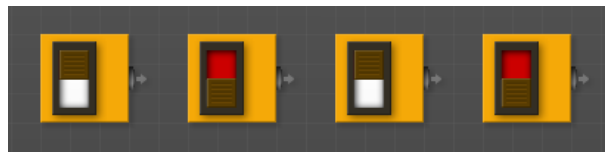


- Example: What is 10100100 in decimal?

```
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:
```

Recap: Converting Between Bases

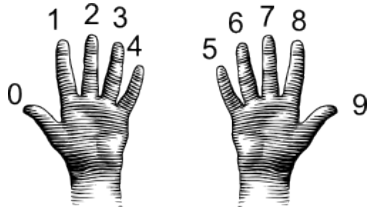


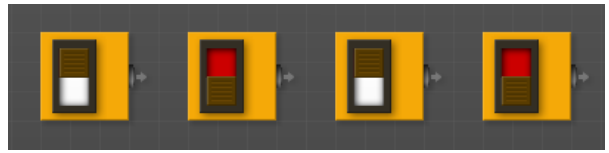


- Example: What is 10100100 in decimal?

```
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
```

Recap: Converting Between Bases

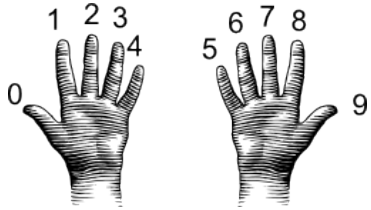


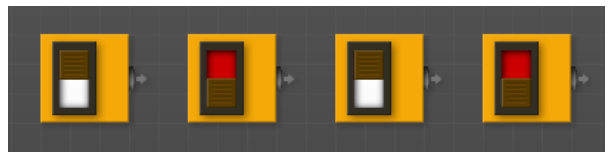


- Example: What is 10100100 in decimal?

```
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:
```

Recap: Converting Between Bases

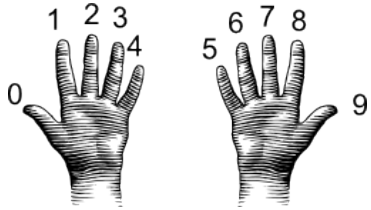


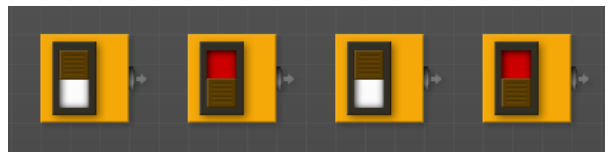


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

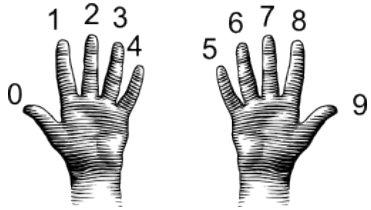


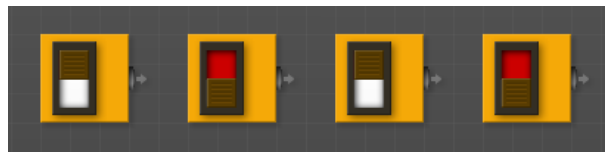


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases

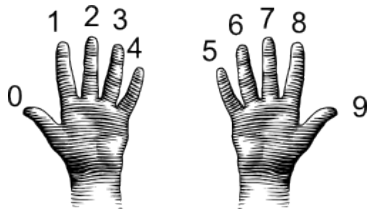


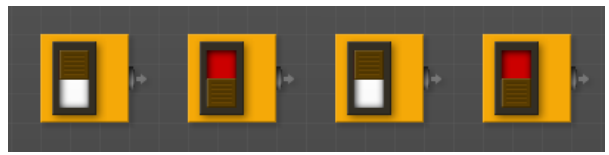


- Example: What is 10100100 in decimal?

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

Recap: Converting Between Bases





- Example: What is 10100100 in decimal?

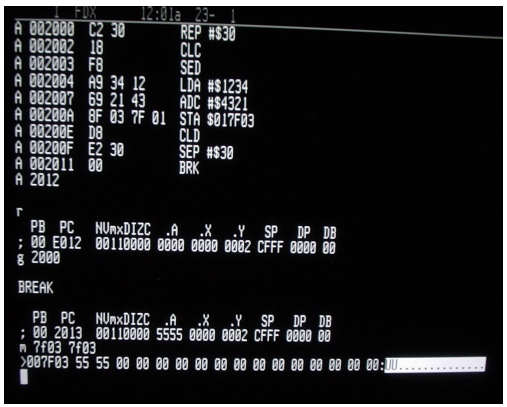
```
Sum starts with:                0
0*2 = 0.   Add 0 to sum:        0
1*4 = 4.   Add 4 to sum:        4
0*8 = 0.   Add 0 to sum:        4
0*16 = 0.   Add 0 to sum:       4
1*32 = 32.   Add 32 to sum:     36
0*64 = 0.   Add 0 to sum:       36
1*128 = 0.   Add 128 to sum:    164
```

The answer is 164.

Today's Topics

- Data Representation
- **Machine Language: Jumps & Loops**
- Recap of Python & Circuits
- Design Patterns: Sorting

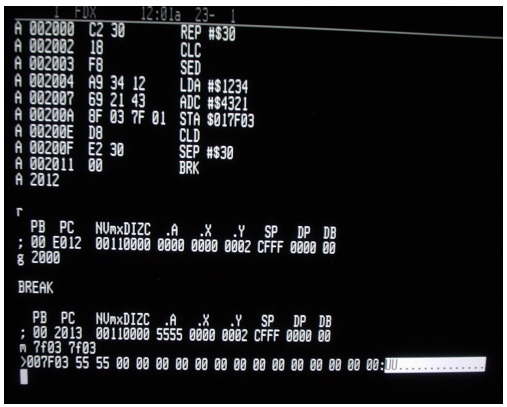
Recap: Machine Language



(wiki)

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

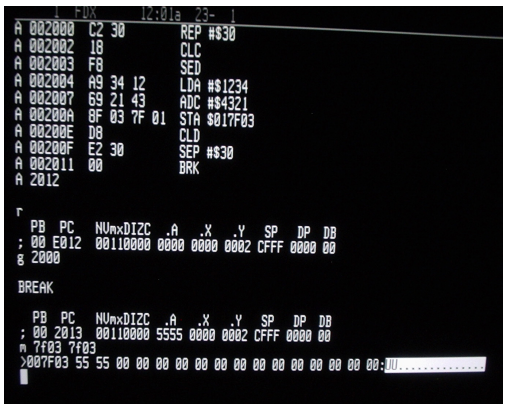
Recap: Machine Language



(wiki)

- We will be writing programs in a simplified machine language, WeMIPS.
- It is based on a reduced instruction set computer (RISC) design, originally developed by the MIPS Computer Systems.

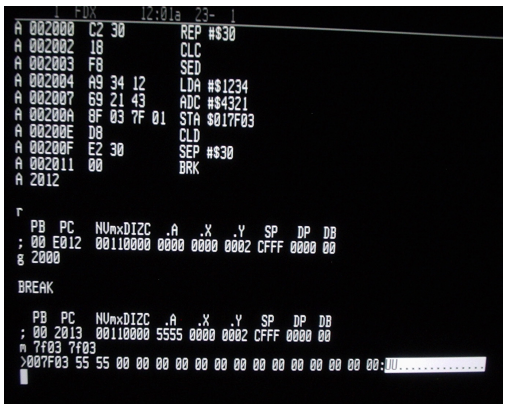
Recap: Machine Language



(wiki)

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

Recap: Machine Language



(wiki)

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

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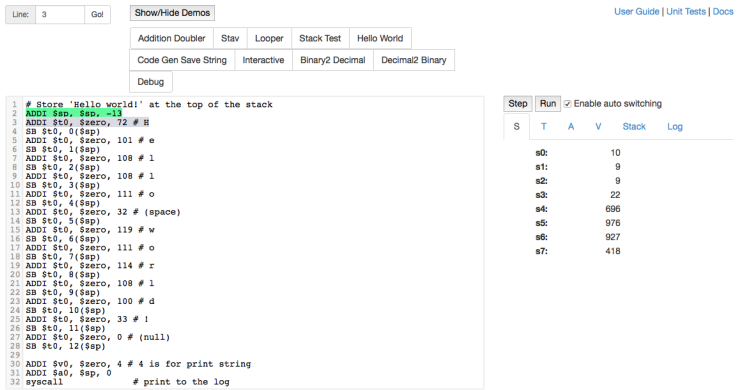

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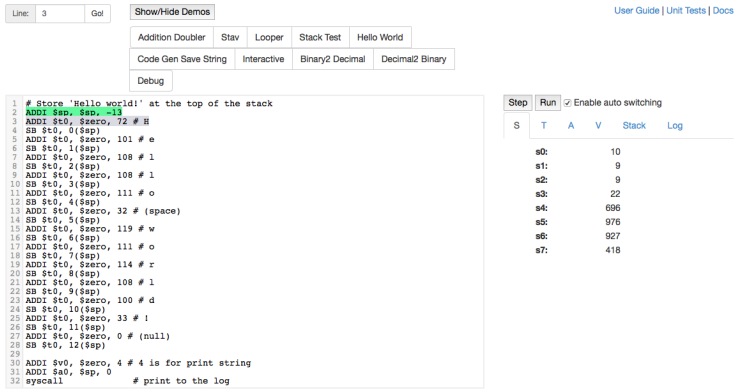

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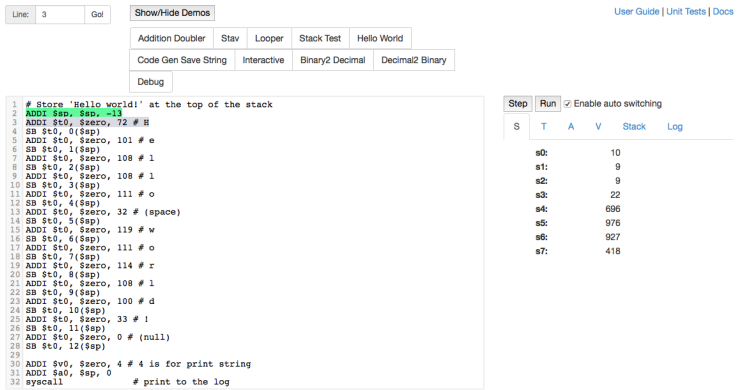

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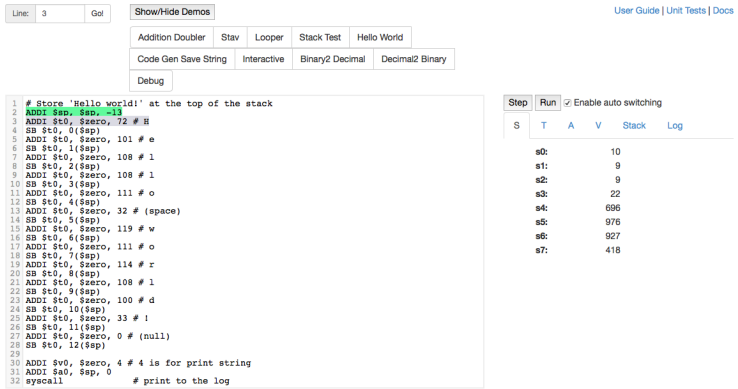

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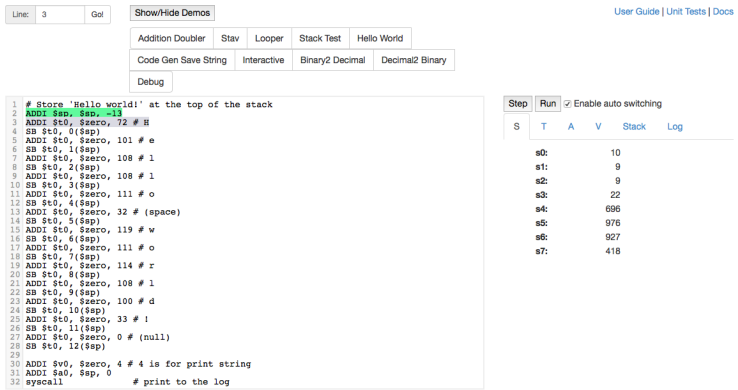

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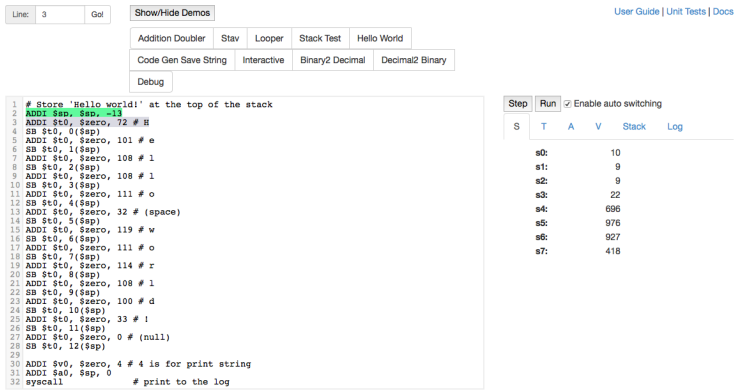

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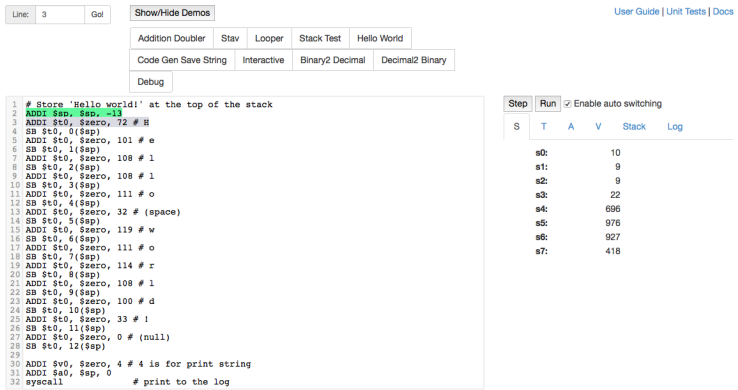

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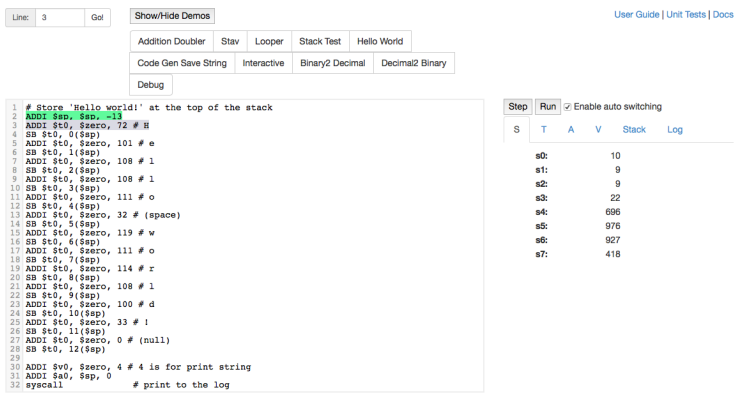

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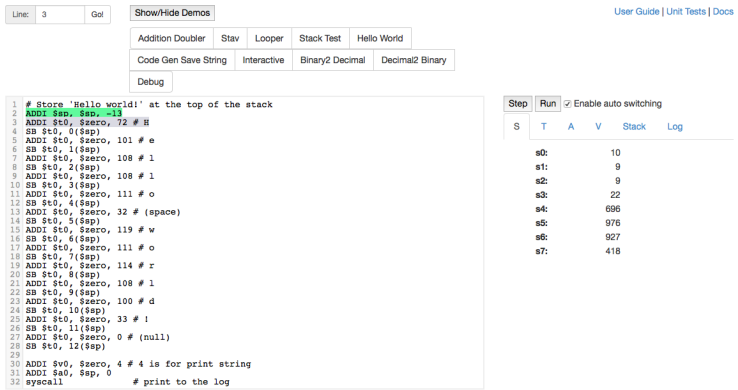

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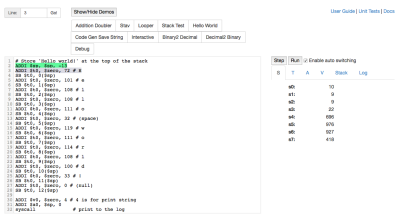

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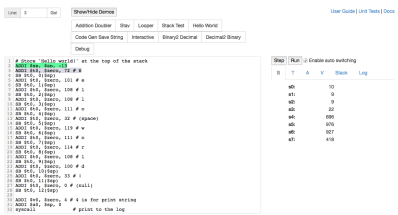

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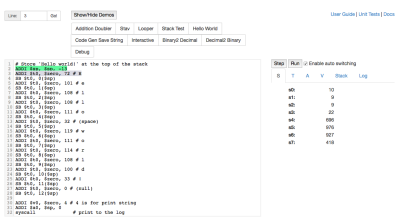

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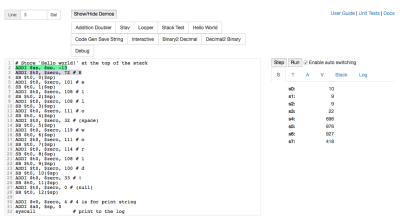

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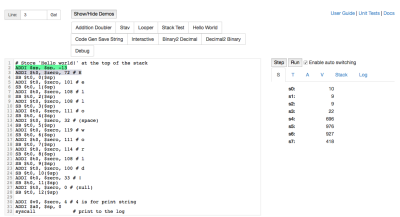

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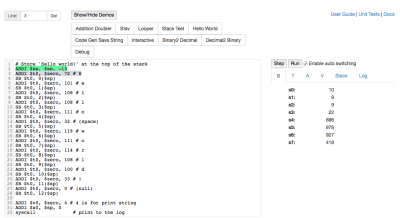

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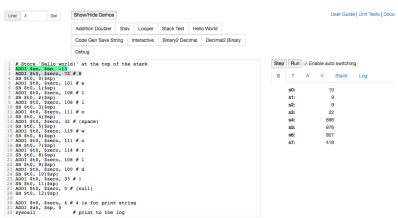

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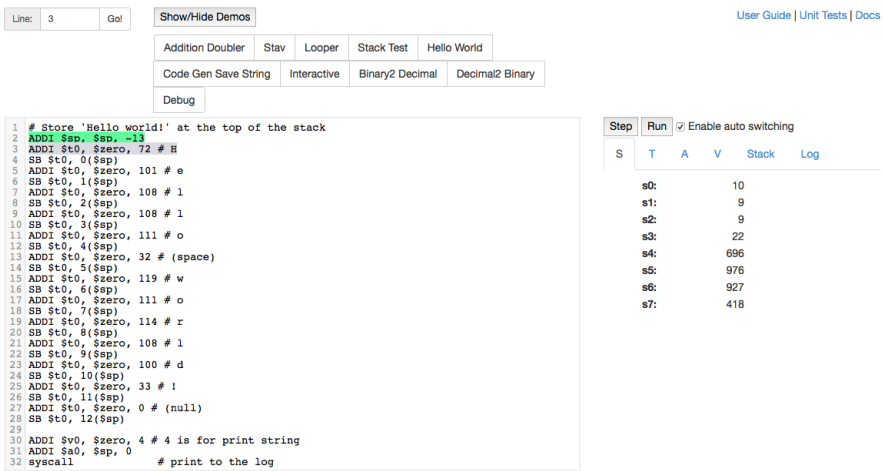
  - See reading for more variations.

WeMIPS



(Demo with WeMIPS)

Today's Topics

- Data Representation
- Machine Language: Jumps & Loops
- **Recap of Python & Circuits**
- Design Patterns: Sorting

Python & Circuits Review: 10 Weeks in 10 Minutes

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

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

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- Introduced comments & print():

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

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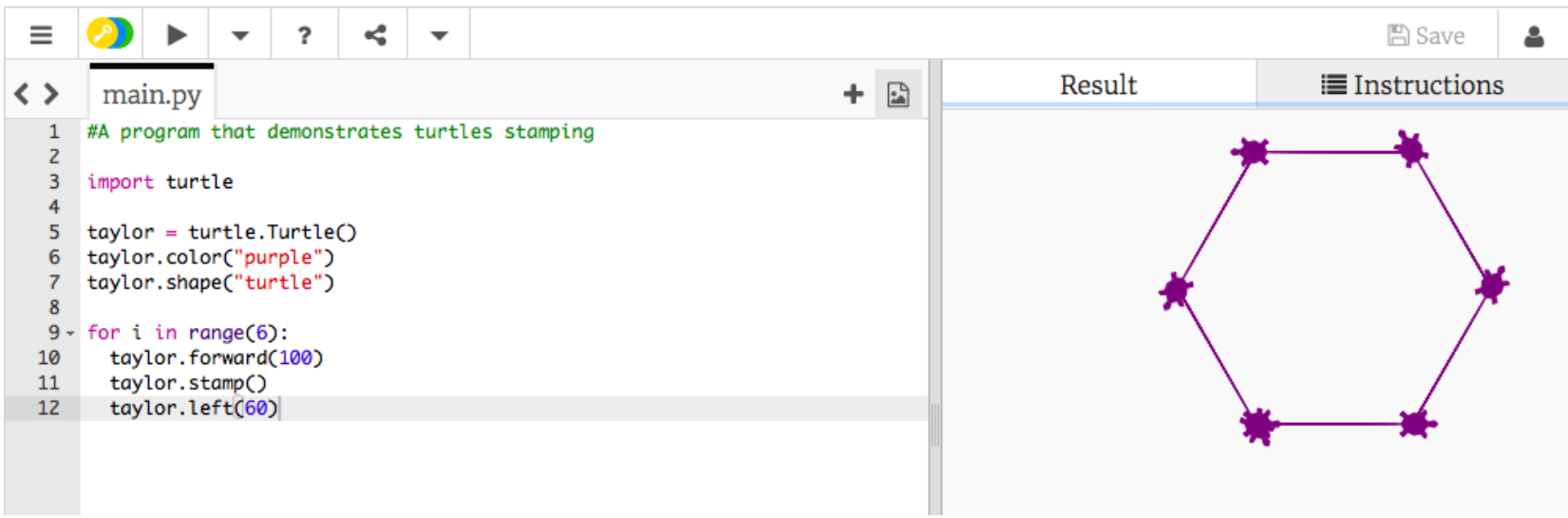
- As well as definite loops & the turtle package:



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- More on loops & ranges:

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

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

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Navy	#000080	
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MediumBlue	#0000CD	
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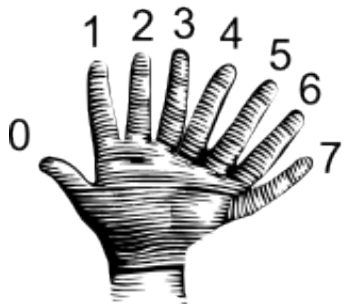

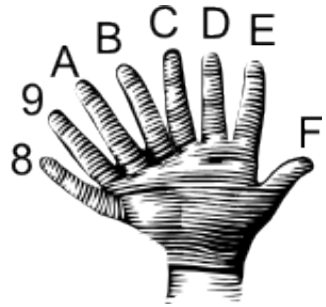

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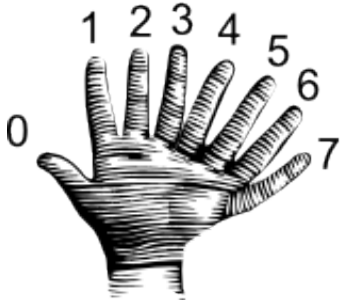

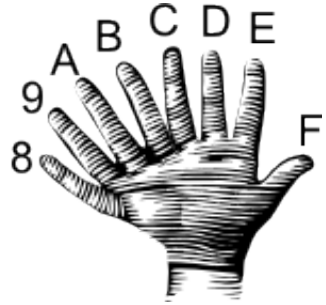

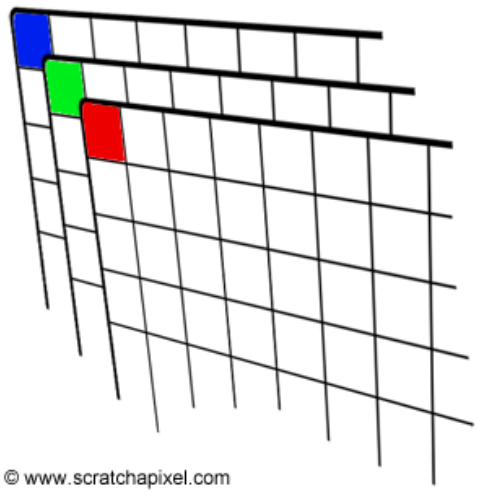

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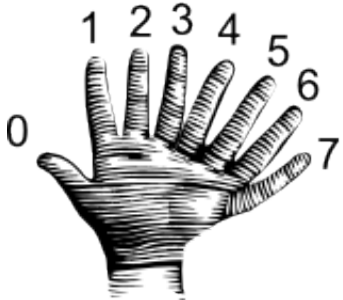
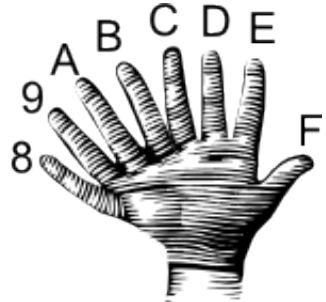
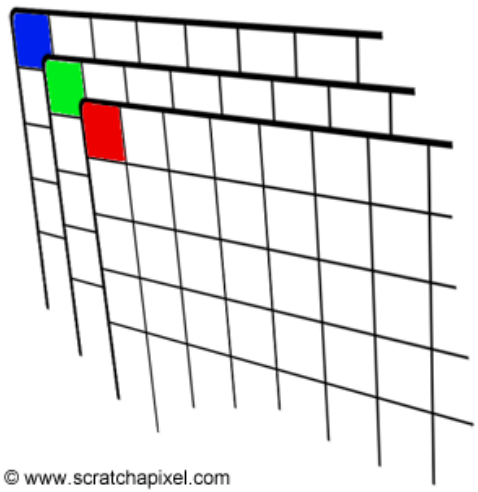







```
>>> a[0,3:5]
array([3,4])

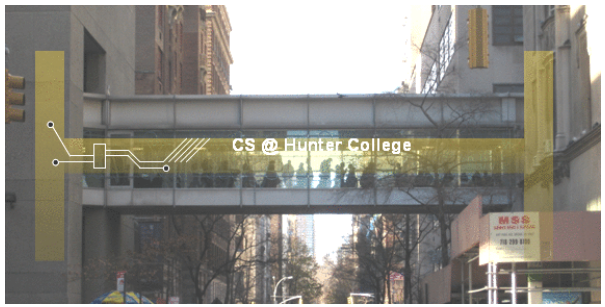
>>> a[4:,4:]
array([[44, 45],
       [54, 55]])

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

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

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

Week 4: design problem (cropping images) & decisions



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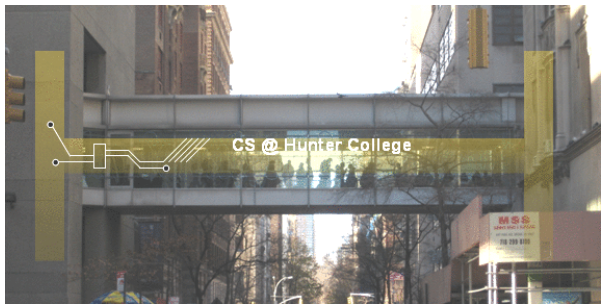

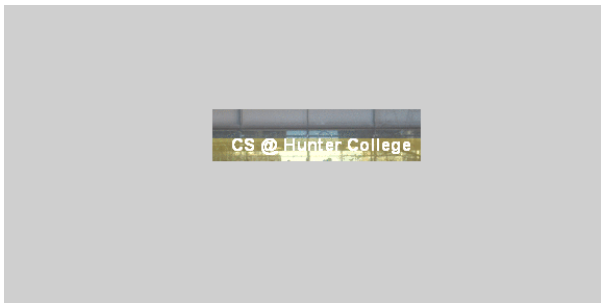

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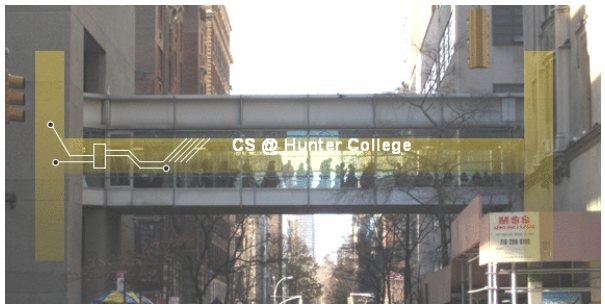

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- Next: write pseudocode.
  1. Import numpy and pyplot.
  2. Ask user for file names and dimensions for cropping.
  3. Save input file to an array.
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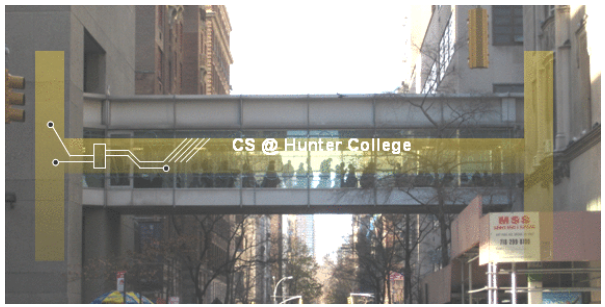

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- Next: translate to Python.

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

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

Week 5: logical operators, truth tables & logical circuits

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

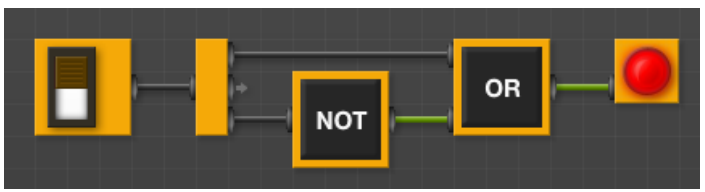
visibility = 0.2
winds = 40
conditions = "blowing snow"
if (winds > 35) and (visibility < 0.25) and \
      (conditions == "blowing snow" or conditions == "heavy snow"):
    print("Blizzard!")
```

Week 5: logical operators, truth tables & logical circuits

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

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

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



Week 6: structured data, pandas, & more design

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```

`nycHistPop.csv`

In Lab 6

Week 6: structured data, pandas, & more design

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import pandas as pd
```

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In Lab 6

Week 6: structured data, pandas, & more design

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import pandas as pd

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

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In Lab 6

Week 6: structured data, pandas, & more design

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In Lab 6

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pop.plot(x="Year")
plt.show()
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Week 6: structured data, pandas, & more design

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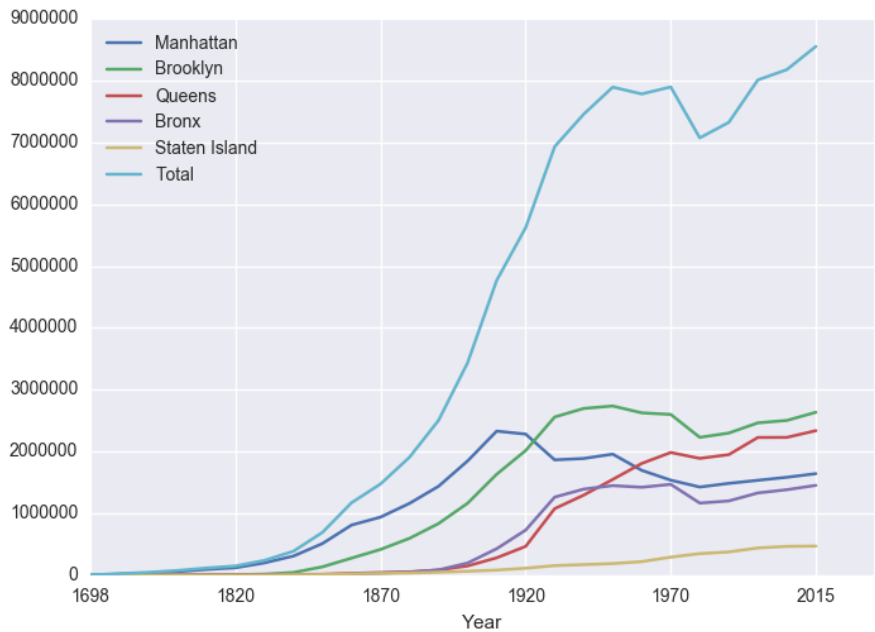
nycHistPop.csv

In Lab 6



Week 7: functions

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

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

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

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

Week 7: functions

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

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

Week 8: function parameters, github

- Functions can have **input parameters**.

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

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

dinner= float(input('Enter dinner total: '))
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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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- Functions can also **return values** to where it was called.

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Formal Parameters

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

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


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

Week 10: more on loops, searching data, random(), machine language

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

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

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

```
import turtle
import random

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

for i in range(100):
  trey.forward(10)
  a = random.randrange(0,360,90)
  trey.right(a)
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Week 10: more on loops, searching data, random(), machine language

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- Python's built-in random package has useful methods for generating random whole numbers and real numbers.

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- 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`.

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
- Simplified Machine Language

Today's Topics

- Data Representation
- Machine Language: Jumps & Loops
- Recap of Python & Circuits
- **Design Patterns: Sorting**

Sorting Demo

1. Let `num` be the number of items in the list.

Sorting Demo

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   - If the first in line is taller than the second, switch places.

Sorting Demo

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   - Repeat until you reach the end of the list.

Sorting Demo

Show sorting demo.

Lecture Slip: Design Patterns

In pairs or triples:

- Fill in the UTAs' name at the top of the sheet.
- What does the code do?

Recap: Python, Languages, & Design

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

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

if __name__ == "__main__":
     main()
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- On lecture slip, write down a topic you wish we had spent more time (and why).

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- Pass your lecture slips to the aisles for the UTAs to collect.

Final Overview: Top-Down Design & APIs

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

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

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

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```
def kg2lbs(kg):
    ...
    return(lbs)
```

Final Overview

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

- Write a function that takes a weight in kilograms and returns the weight in pounds.

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

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```
def sLength(str):
    ...
    return(length)
```

Final Overview

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

- Write a function that takes a string and returns its length.

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

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```
def getMin(df):
    ...
    return(min)
```

Final Overview

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

- Write a function that, given a DataFrame, returns the minimal value in the "Manhattan" column.

```
def getMin(df):
    min = df['Manhattan'].min()
    return(min)
```

Final Overview

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```
def num2bin(num):
    ...
    return(bin)
```

Final Overview

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

- Write a function that takes a whole number and returns the corresponding binary number as a string.

```
def num2bin(num):
    binStr = ""
    while (num > 0):
        #Divide by 2, and add the remainder to the string
        r = num %2
        binString = str(r) + binStr
        num = num / 2
    return(binStr)
```

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

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

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def computePayment(loan,rate,year):
    ....
    return(payment)
```

Final Overview

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

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

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