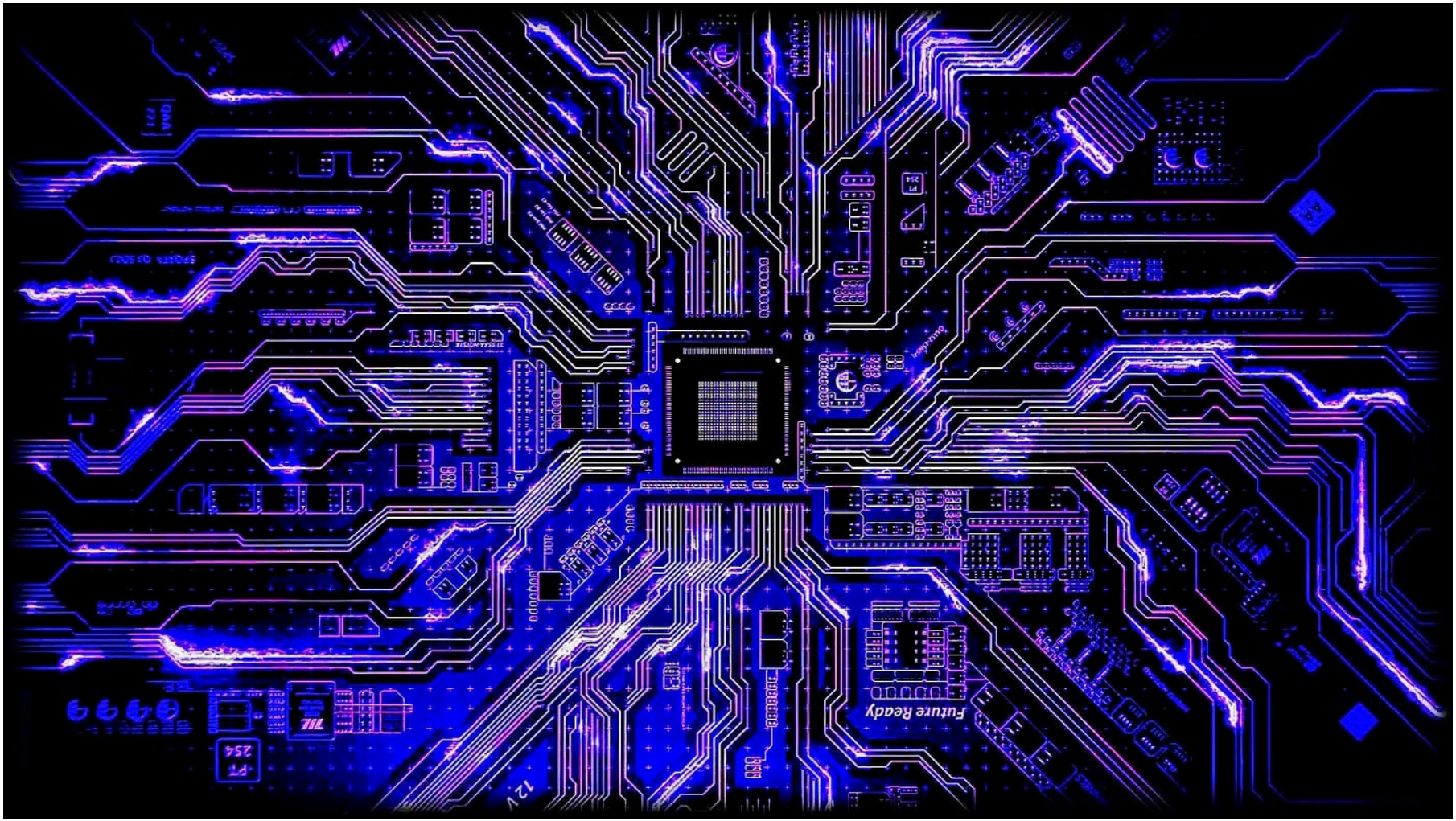
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

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  Types we have seen so far: `int`, `float`, `str` *and objects (e.g. turtles).*

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  Strings are surrounded by quotes (either single or double).
  Variables names (identifiers) for memory locations are not. Ex: `'num'` *vs.* `num`.

Today's Topics

- Recap: Decisions
- Logical Expressions
- Circuits
- Binary Numbers

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Challenge

Some challenges with types & decisions:

```
#What are the types:
y1 = 2017
y2 = "2018"
print(type(y1))
print(type("y1"))
print(type(2017))
print(type("2017"))
print(type(y2))
print(type(y1/4.0))

x = int(y2) - y1
if x < 0:
    print(y2)
else:
    print(y1)
```

```
cents = 432
dollars = cents // 100
change = cents % 100
if dollars > 0:
    print('$'+str(dollars))
if change > 0:
    quarters = change // 25
    pennies = change % 25
    print(quarters, "quarters")
    print("and", pennies, "pennies")
```

Python Tutor

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(Demo with pythonTutor)

Decisions

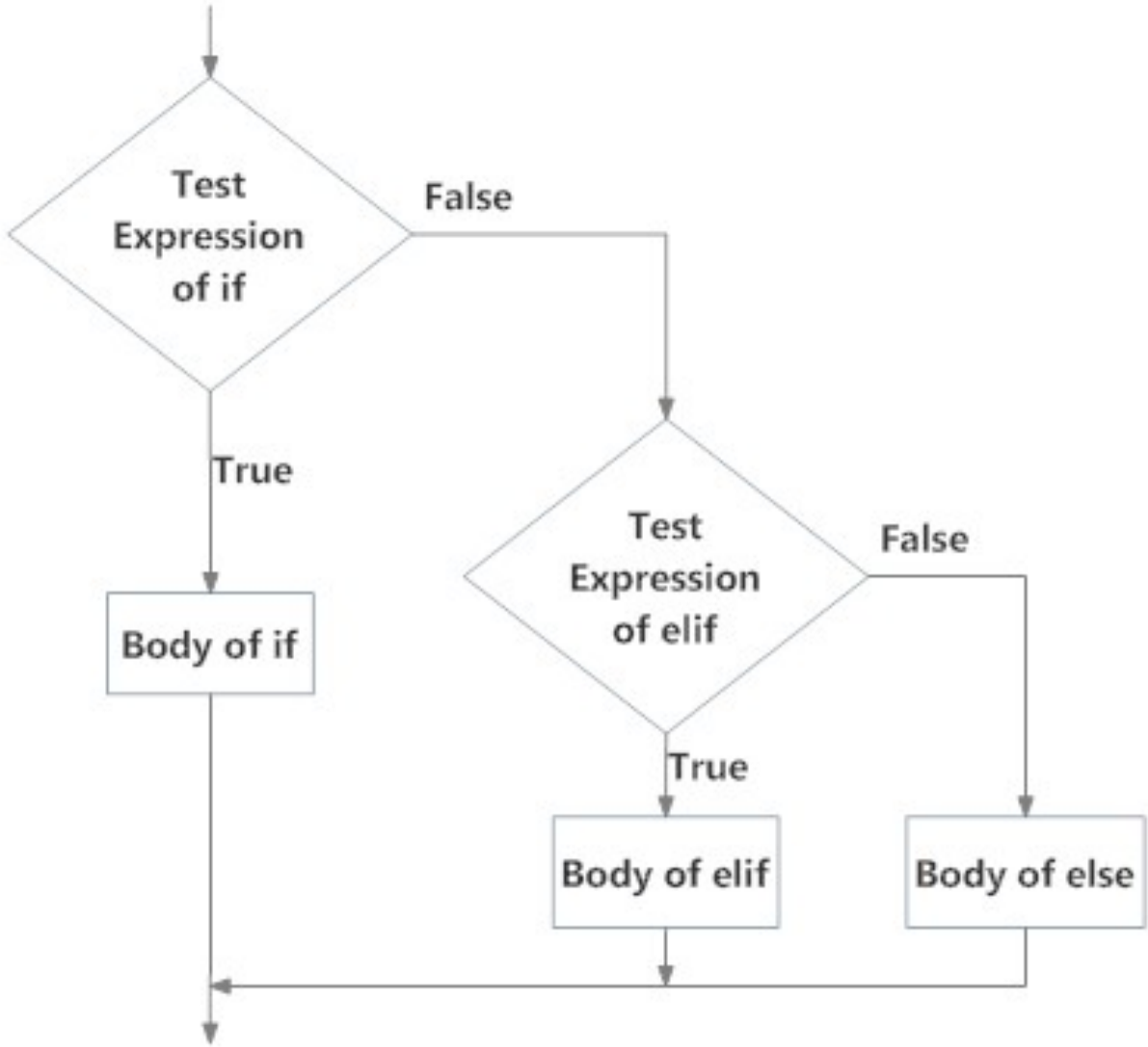
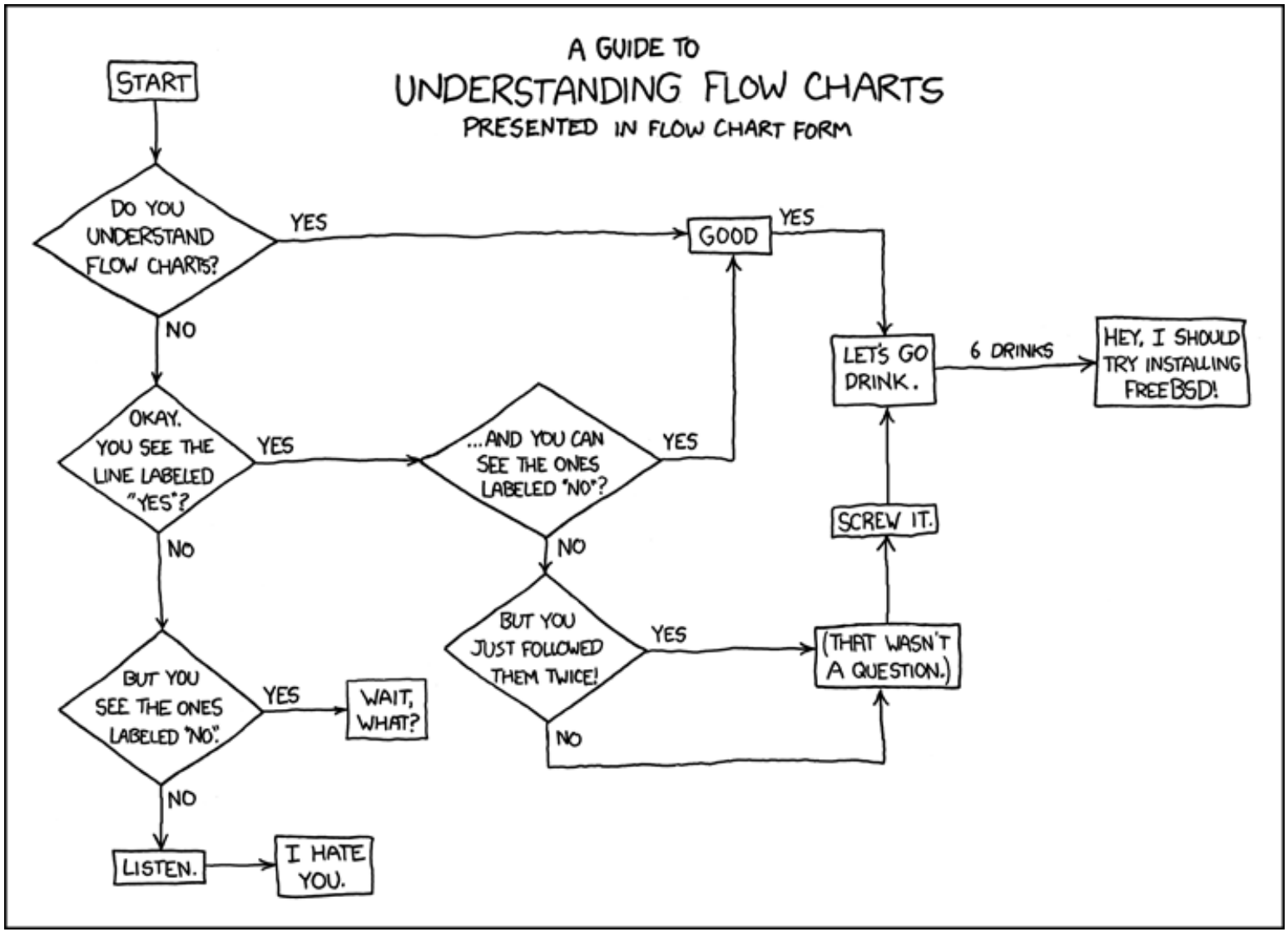


Fig: Operation of if...elif...else statement

(programiz)

Side Note: Reading Flow Charts



(xkcd/518)

Today's Topics

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- **Logical Expressions**
- Circuits
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Challenge

Predict what the code will do:

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

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

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(Demo with `pythonTutor`)

Logical Operators

and

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

not

	in1	*returns:*
`not`	`False`	`True`
`not`	`True`	`False`

Challenge

Predict what the code will do:

```
semHours = 18
reqHours = 120
if semHours >= 12:
     print('Full Time')
else:
     print('Part Time')

pace = reqHours // semHours
if reqHours % semHours != 0:
     pace = pace + 1
print('At this pace, you will graduate in', pace, 'semesters,')
yrs = pace / 2
print('(or', yrs, 'years).')


for i in range(1,20):
     if (i > 10) and (i % 2 == 1):
          print('oddly large')
     else:
          print(i)
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(Demo with pythonTutor)

Today's Topics

- Recap: Decisions
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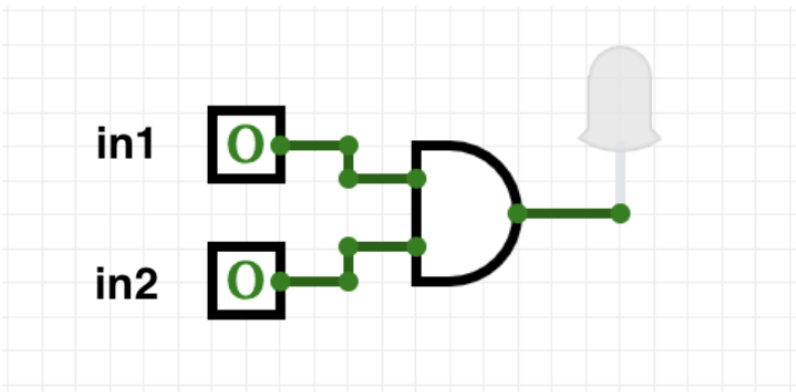
- **Circuits**
- Binary Numbers

Circuit Demo

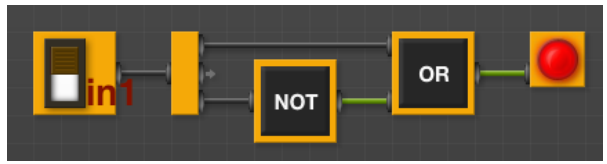


(Demo with `circuitverse`)

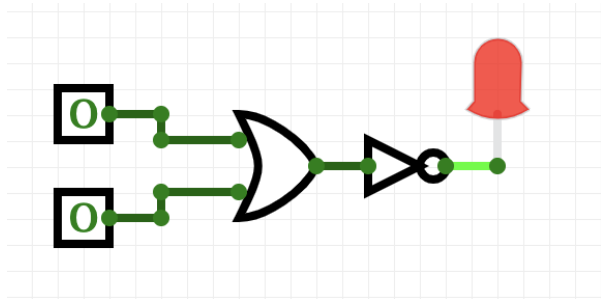
Challenge

Predict when these expressions are true:

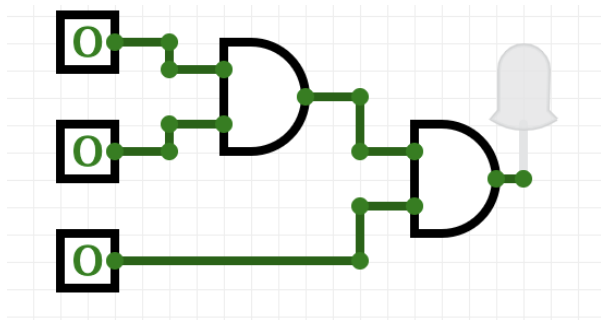
- `in1 or not in1`:



- `not(in1 or in2)`:



- `(in1 and in2) and in3`:



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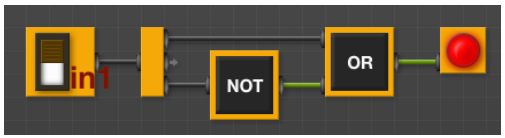
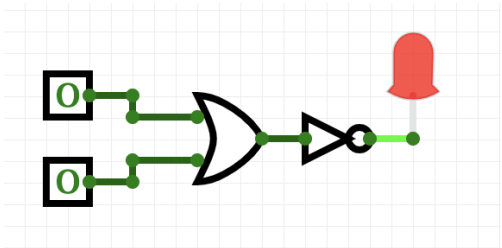
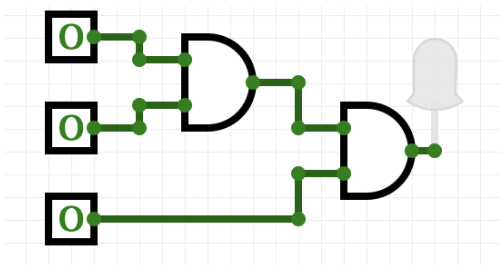
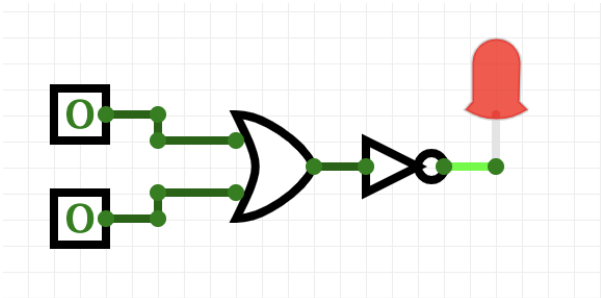






(Demo with `circuitverse`)

Challenge



Draw a circuit that corresponds to each logical expression:

- `in1 or in2`
- `(in1 or in2) and (in1 or in3)`
- `(not(in1 and not in2)) or (in1 and (in2 and in3))`

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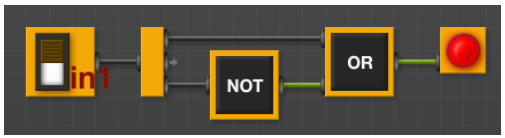

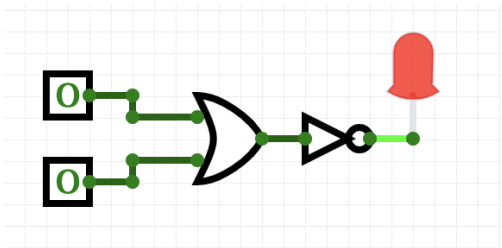

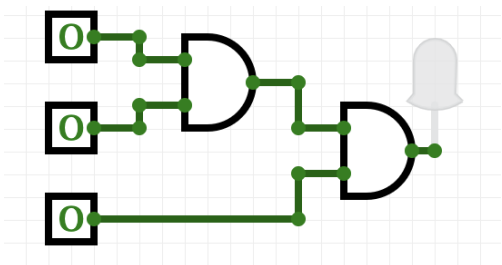

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- Circuits
- **Binary Numbers**

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- A **bit** (binary digit) being 1 (on) or 0 (off)

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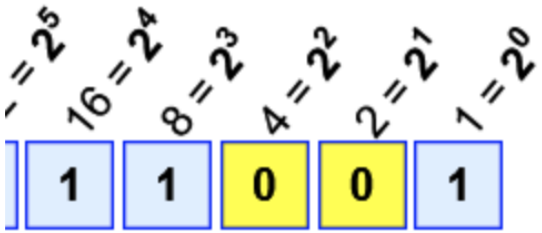

Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

- Two digits: **0** and **1**

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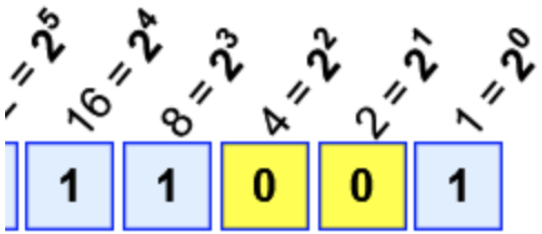

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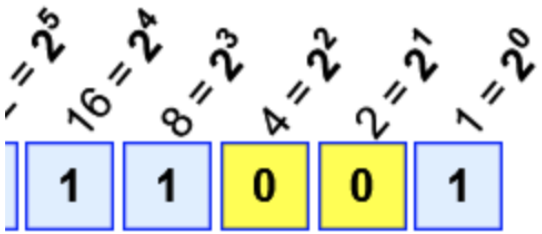

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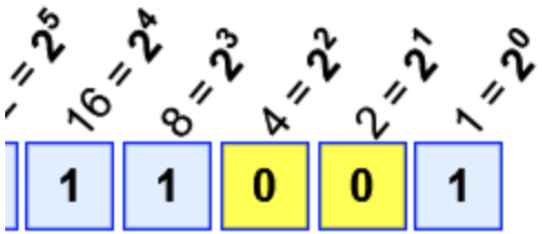

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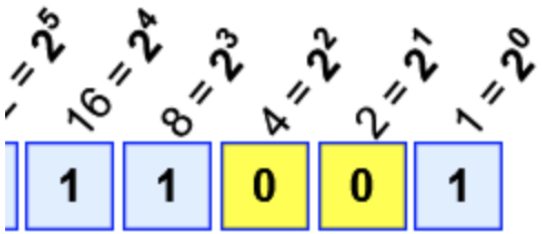

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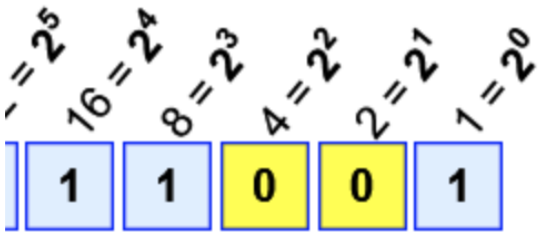

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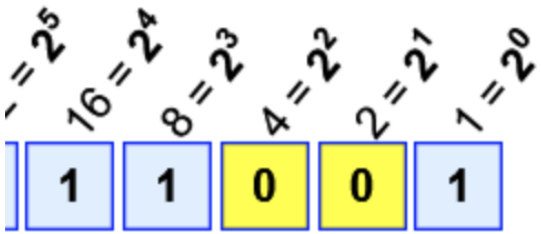

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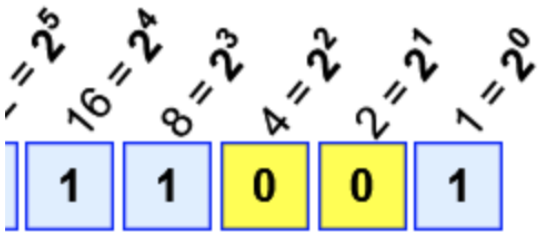

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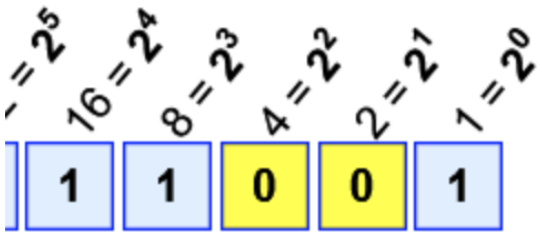

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- **Example:**

$$11001_{base2} = 16 + 8 + 1 = 25_{base10}$$

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.

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  1

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz
  4

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz
  4
  Buzz

Challenge: Tech Interview Classic

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  1
  2
  Fizz
  4
  Buzz
  Fizz

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- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- Write down the output to see the pattern:
  1
  2
  Fizz
  4
  Buzz
  Fizz
  7

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz
  4
  Buzz
  Fizz
  7
  ...
  14

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz
  4
  Buzz
  Fizz
  7
  ...
  14
  FizzBuzz

Challenge: Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- Write down the output to see the pattern:
  1
  2
  Fizz
  4
  Buzz
  Fizz
  7
  ...
  14
  FizzBuzz
- Write the **algorithm** then, if time, write the code.

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.

Tech Interview Classic

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- To Do List:

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List:
  - Create a loop that goes from 1 to 100.

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List:
  - Create a loop that goes from 1 to 100.
  - If the number is divisible by 3, print “Fizz”.

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List:
  - Create a loop that goes from 1 to 100.
  - If the number is divisible by 3, print “Fizz”.
  - If the number is divisible by 5, print “Buzz”.

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List:
  - Create a loop that goes from 1 to 100.
  - If the number is divisible by 3, print “Fizz”.
  - If the number is divisible by 5, print “Buzz”.
  - **If divisible by both, print “FizzBuzz”.**

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List:
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  - If the number is divisible by 3, print “Fizz”.
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  - **If divisible by both, print “FizzBuzz”.**
  - Otherwise print the number.

Tech Interview Classic

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- To Do List:
  - Create a loop that goes from 1 to 100.
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - **If divisible by both, print "FizzBuzz".**
  - Otherwise print the number.
    Order matters!!! To print FizzBuzz when i is divisible by both it should be checked first, otherwise it will never get to this case!

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print “Fizz” instead of the number and for the multiples of five print “Buzz”. For numbers which are multiples of both three and five print “FizzBuzz”.
- To Do List (**Reordered**):

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- To Do List (**Reordered**):
  - Create a loop that goes from 1 to 100.
  - **If divisible by both 3 and 5, print "FizzBuzz".**

Tech Interview Classic

- Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz".
- To Do List (**Reordered**):
  - Create a loop that goes from 1 to 100.
  - **If divisible by both 3 and 5, print "FizzBuzz".**
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print “FizzBuzz”.
  - If the number is divisible by 3, print “Fizz”.
  - If the number is divisible by 5, print “Buzz”.
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print "FizzBuzz".
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

```
for i in range(1,101):
```

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print "FizzBuzz".
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

```
for i in range(1,101):
    if i%3 == 0 and i%5 == 0:
        print("FizzBuzz")
```

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print "FizzBuzz".
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

```
for i in range(1,101):
    if i%3 == 0 and i%5 == 0:
        print("FizzBuzz")
    elif i%3 == 0:
        print("Fizz")
```

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print "FizzBuzz".
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

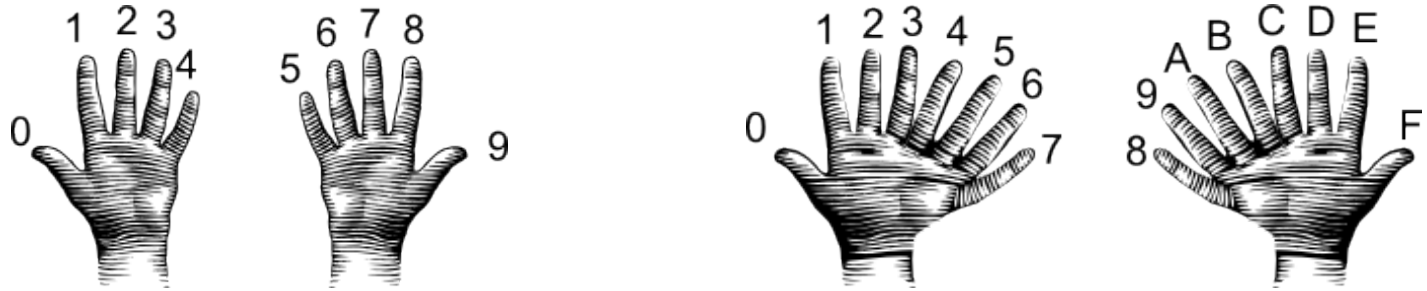
```
for i in range(1,101):
    if i%3 == 0 and i%5 == 0:
        print("FizzBuzz")
    elif i%3 == 0:
        print("Fizz")
    elif i%5 == 0:
        print("Buzz")
```

Tech Interview Classic

- To Do List:
  - Create a loop that goes from 1 to 100.
  - If divisible by both 3 and 5, print "FizzBuzz".
  - If the number is divisible by 3, print "Fizz".
  - If the number is divisible by 5, print "Buzz".
  - Otherwise print the number.
  - Also should print a new line (so each entry is on its own line).

```
for i in range(1,101):
    if i%3 == 0 and i%5 == 0:
        print("FizzBuzz")
    elif i%3 == 0:
        print("Fizz")
    elif i%5 == 0:
        print("Buzz")
    else:
        print(i)
```

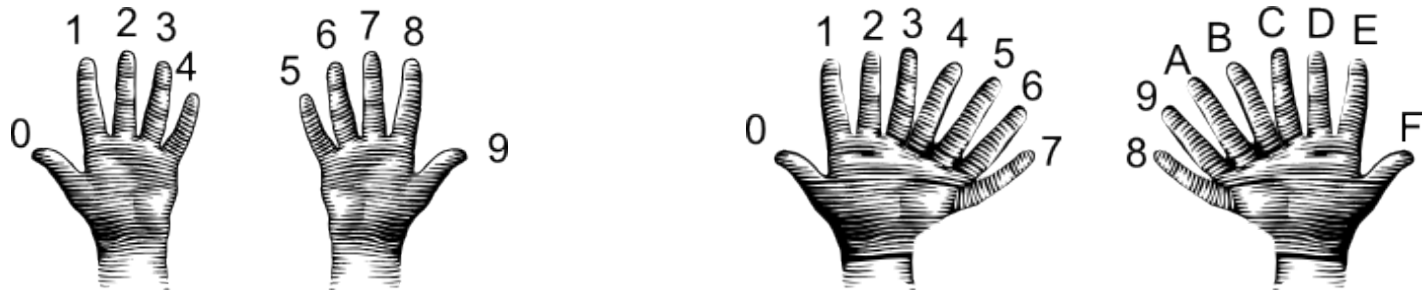
Hexadecimal to Decimal: Converting Between Bases



(from i-programmer.info)

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

Hexadecimal to Decimal: Converting Between Bases



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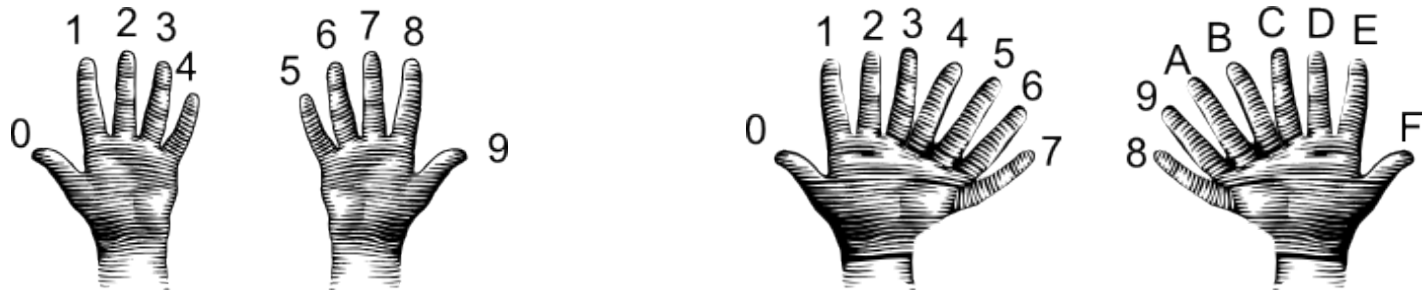
- From hexadecimal to decimal (assuming two-digit numbers):
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.

Hexadecimal to Decimal: Converting Between Bases



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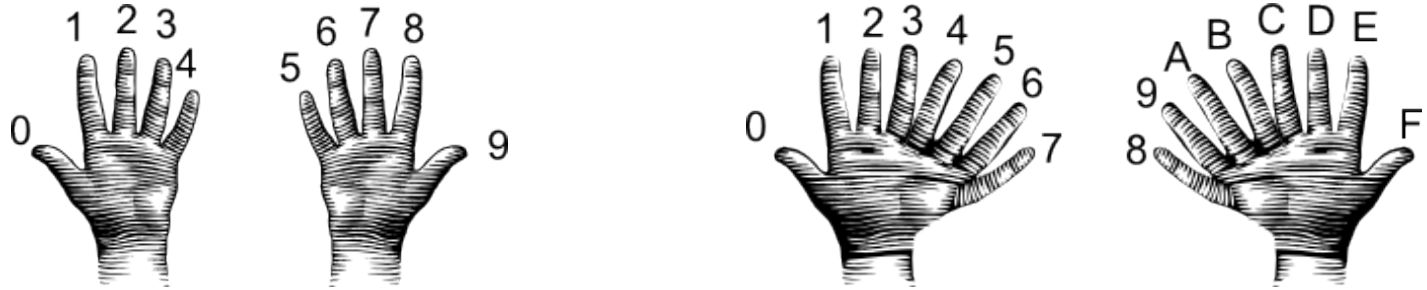
  - Example: what is 2A as a decimal number?

Hexadecimal to Decimal: Converting Between Bases



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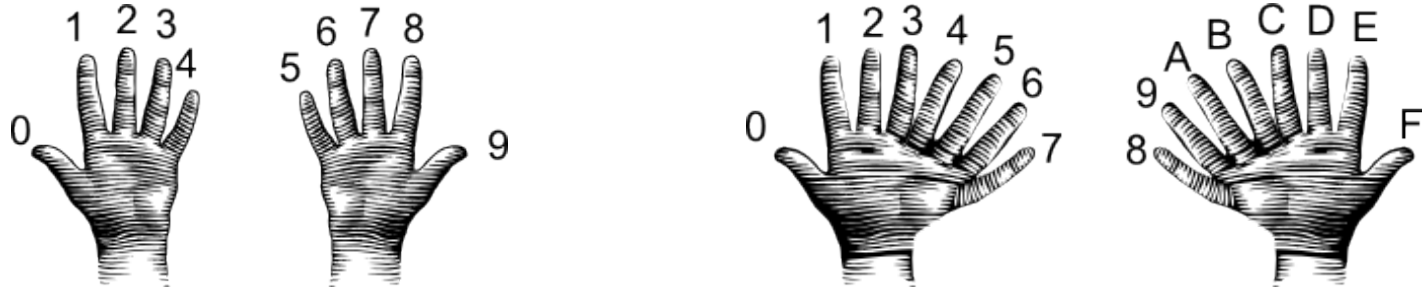
- From hexadecimal to decimal (assuming two-digit numbers):
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.
  - Example: what is 2A as a decimal number?
    `2 in decimal is 2.`

Hexadecimal to Decimal: Converting Between Bases



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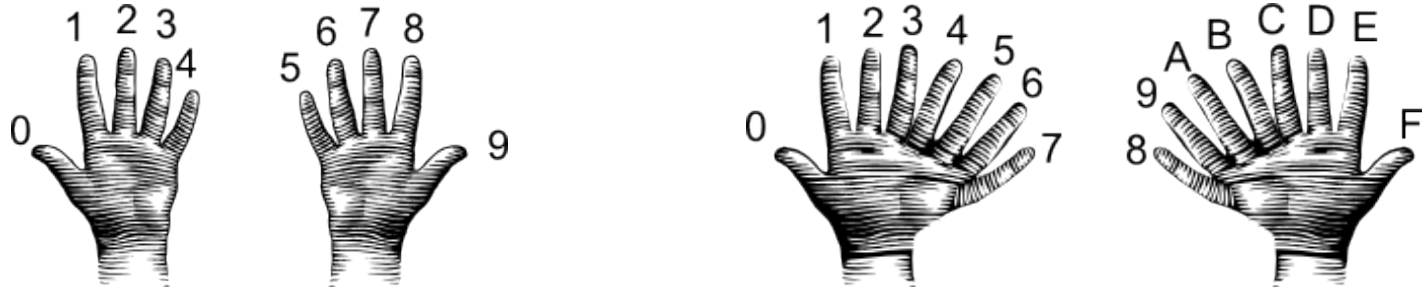
    `2 in decimal is 2. 2*16 is 32.`

Hexadecimal to Decimal: Converting Between Bases



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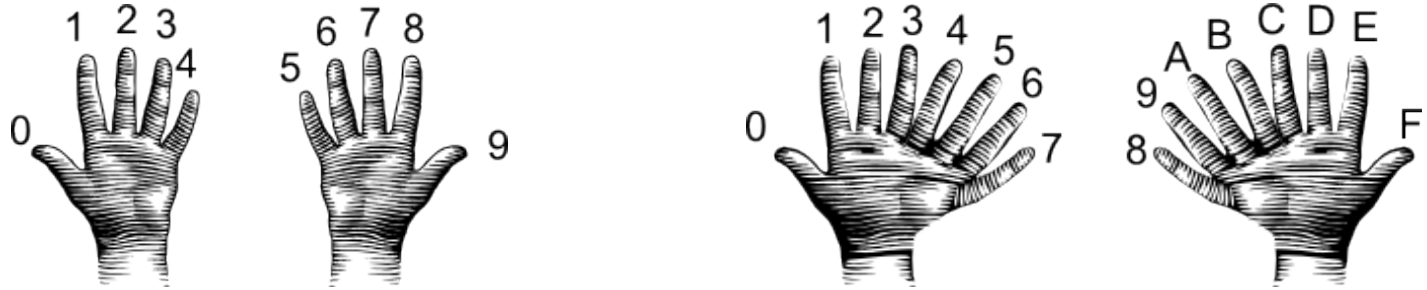
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.
  - Example: what is 2A as a decimal number?

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

    `A in decimal digits is 10.`

Hexadecimal to Decimal: Converting Between Bases



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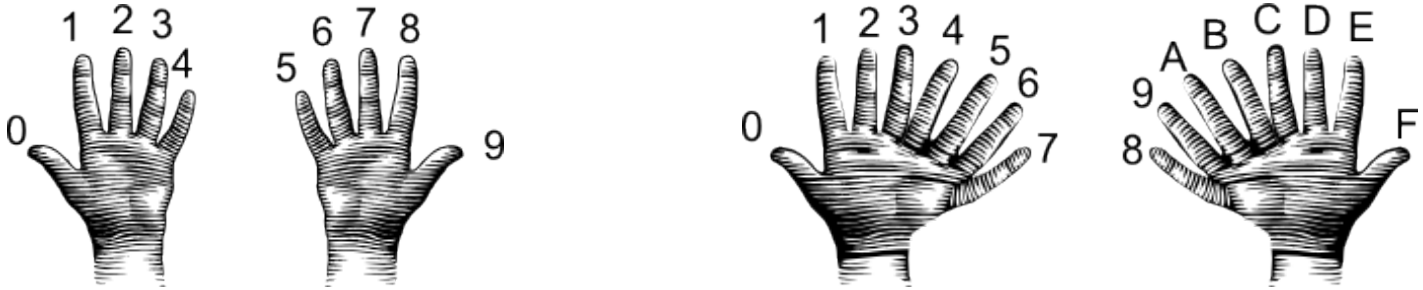
  - Convert first digit to decimal and multiple by 16.
  - Convert second digit to decimal and add to total.
  - Example: what is 2A as a decimal number?

    ```
    2 in decimal is 2. 2*16 is 32.
    A in decimal digits is 10.
    32 + 10 is 42.
    ```

Hexadecimal to Decimal: Converting Between Bases



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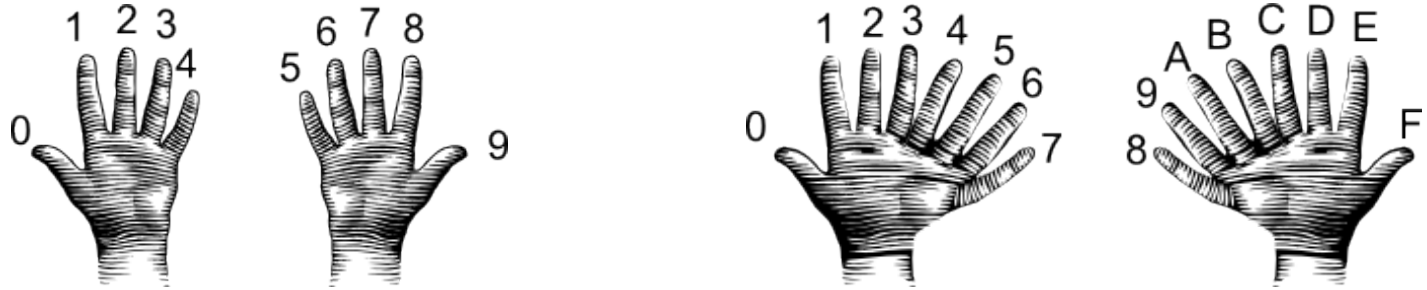
  - Example: what is 2A as a decimal number?

    ```
    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?

Hexadecimal to Decimal: Converting Between Bases



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  - Example: what is 2A as a decimal number?

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

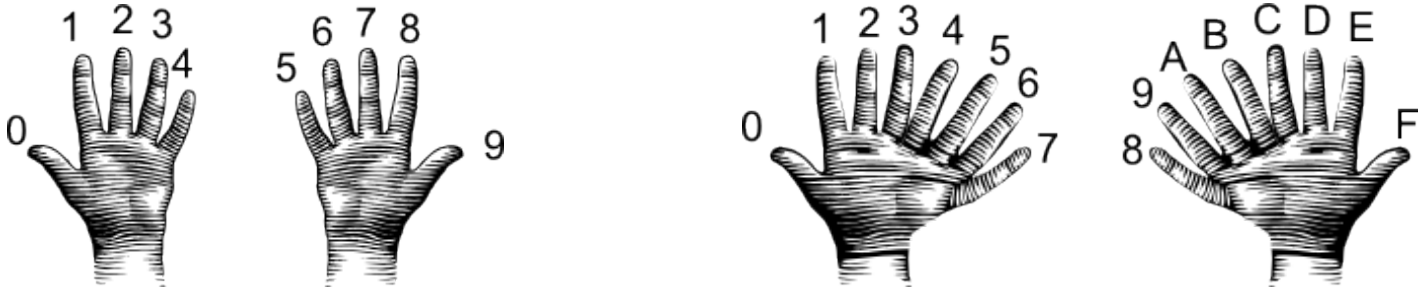
    `A in decimal digits is 10.`

    `32 + 10 is 42.`

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

    `9 in decimal is 9.`

Hexadecimal to Decimal: Converting Between Bases



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  - Example: what is 2A as a decimal number?

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

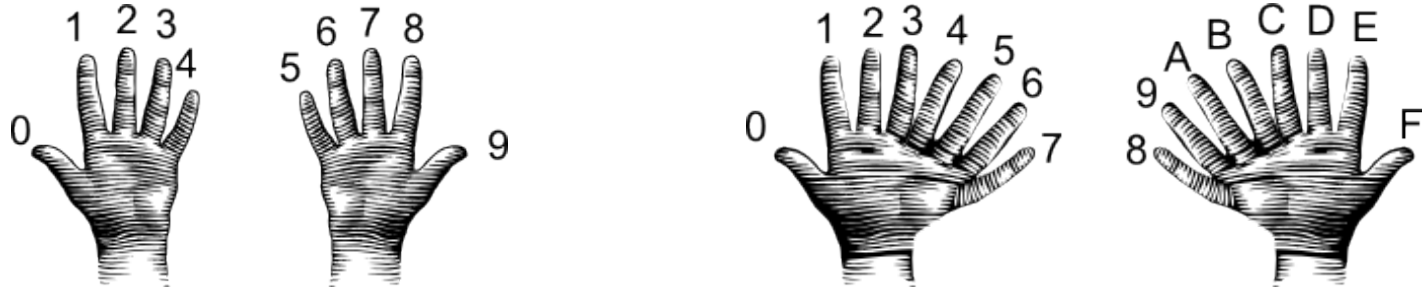
    `A in decimal digits is 10.`

    `32 + 10 is 42.`

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

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

Hexadecimal to Decimal: Converting Between Bases



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    `A in decimal digits is 10.`

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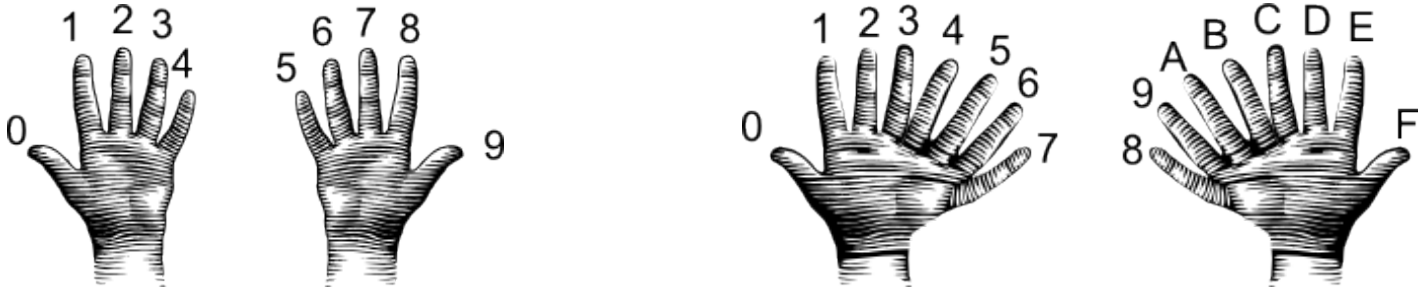
    `9 in decimal is 9. 9*16 is 144.`

    `9 in decimal digits is 9`

Hexadecimal to Decimal: Converting Between Bases



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

    `A in decimal digits is 10.`

    `32 + 10 is 42.`

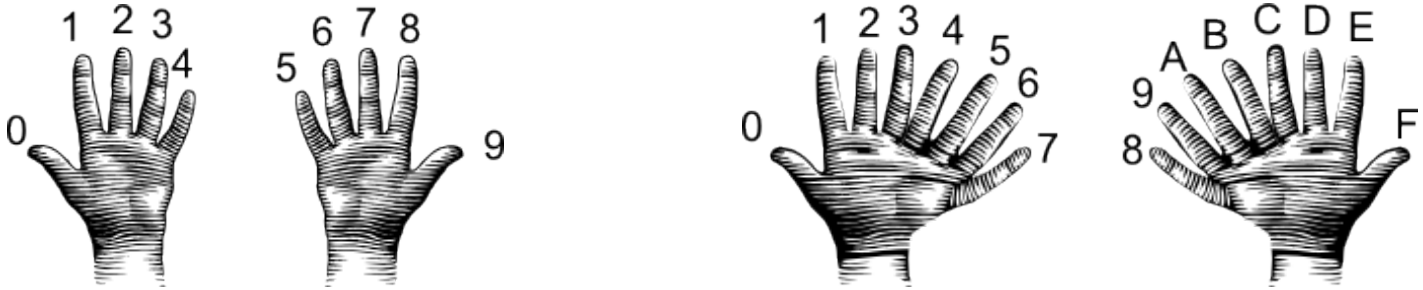
    Answer is 42.
  - Example: what is 99 as a decimal number?

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

    `9 in decimal digits is 9`

    `144 + 9 is 153.`

Hexadecimal to Decimal: Converting Between Bases



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  - Example: what is 2A as a decimal number?

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

    `A in decimal digits is 10.`

    `32 + 10 is 42.`

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

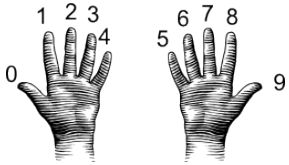
    `9 in decimal is 9. 9*16 is 144.`

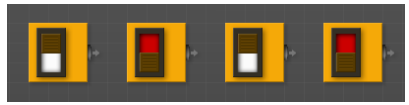
    `9 in decimal digits is 9`

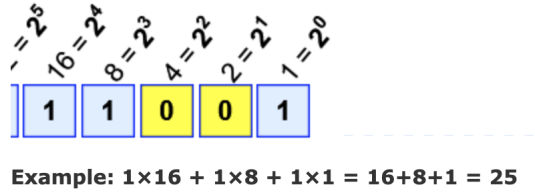
    `144 + 9 is 153.`

    Answer is 153.

Decimal to Binary: Converting Between Bases

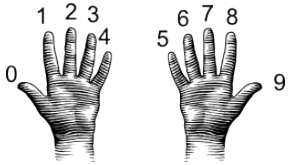


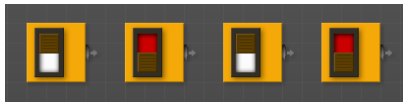


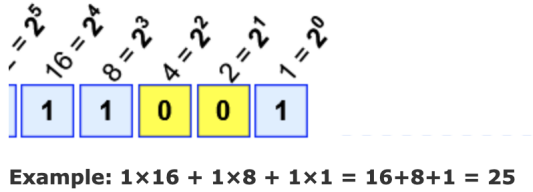


- From decimal to binary:
  - Divide by 128 ($= 2^7$). Quotient is the first digit.

Decimal to Binary: Converting Between Bases

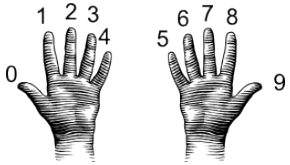


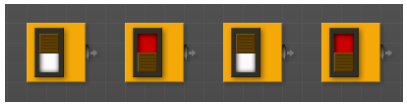


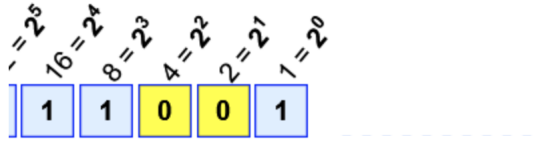


- From decimal to binary:
  - Divide by 128 $(= 2^7)$. Quotient is the first digit.
  - Divide remainder by 64 $(= 2^6)$. Quotient is the next digit.

Decimal to Binary: Converting Between Bases







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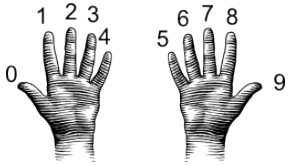

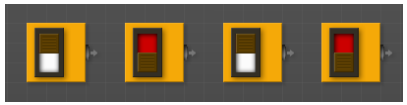

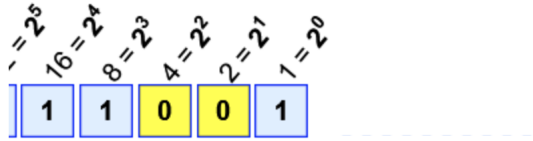

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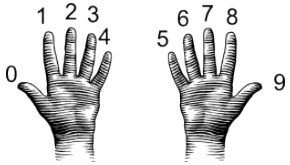

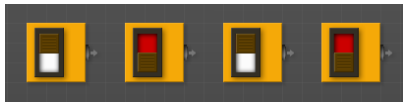

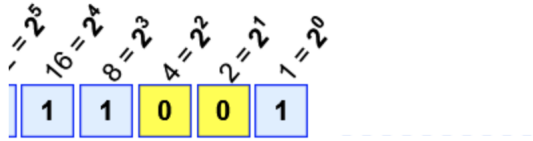

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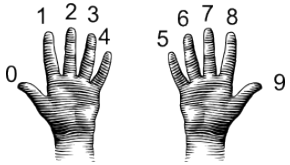

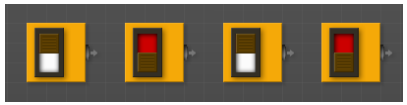

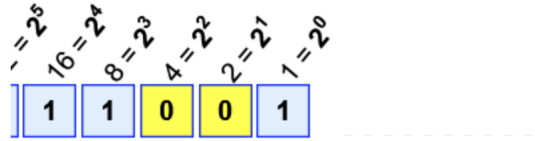

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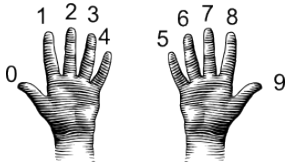

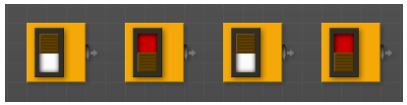

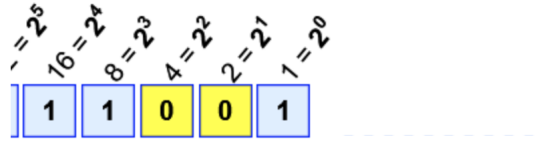

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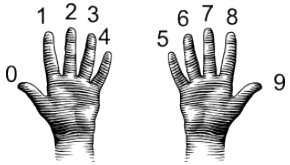

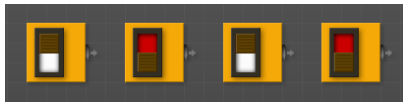

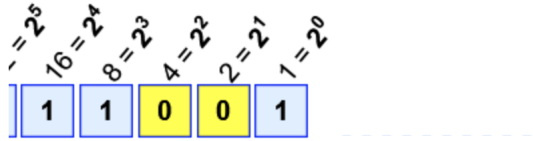

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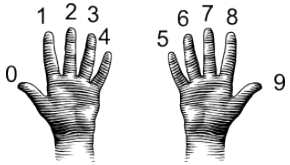

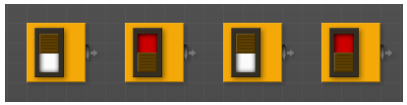

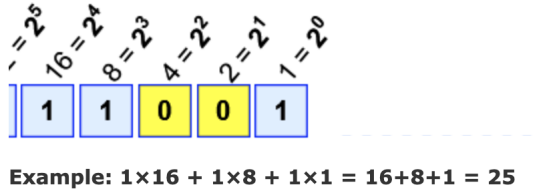

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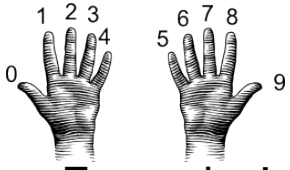

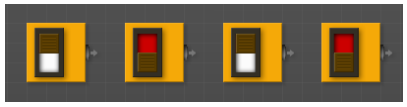

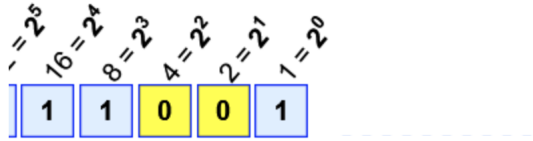

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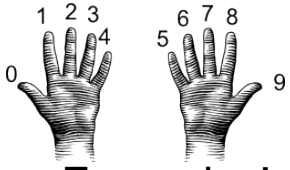

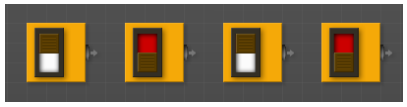

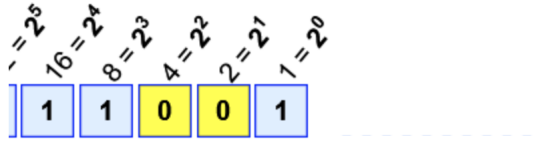

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    `130/128 is 1 rem 2. First digit is 1:`

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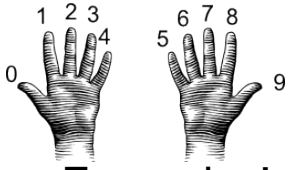

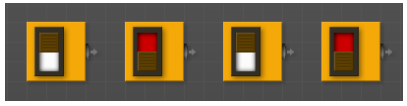

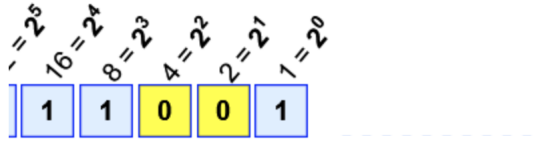

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    `2/64 is 0 rem 2.`

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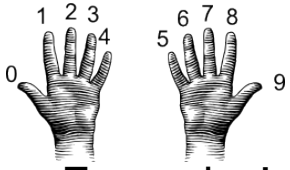

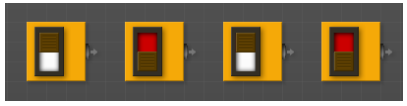

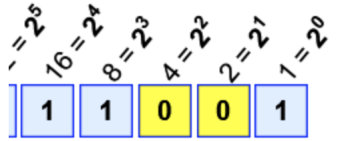

Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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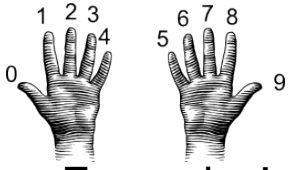

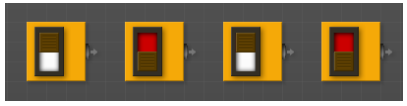

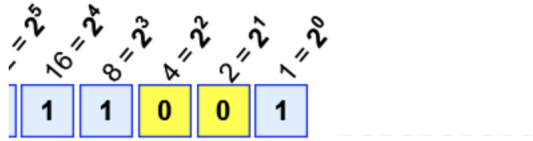

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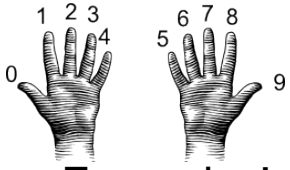

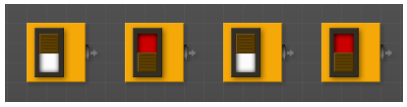

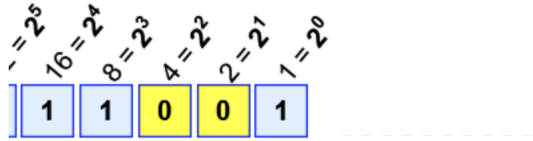

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  - Divide remainder by 8 ($= 2^3$). Quotient is the next digit.
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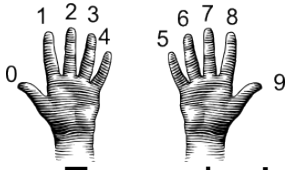
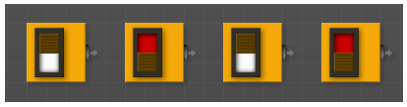
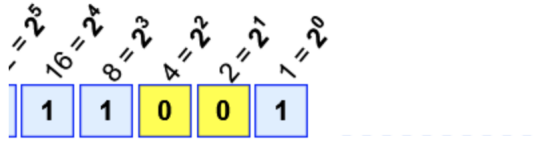
  - The last remainder is the last digit.
  - Example: what is 130 in binary notation?

```
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.
```

Decimal to Binary: Converting Between Bases







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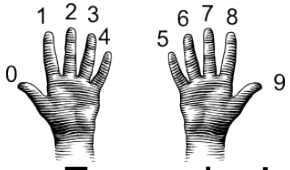

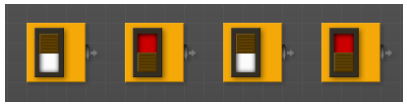

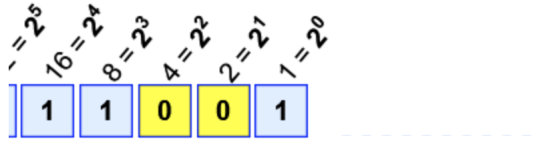

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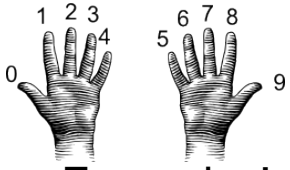

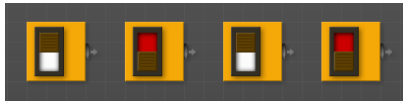

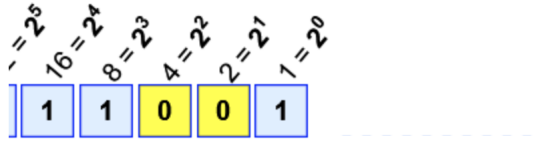

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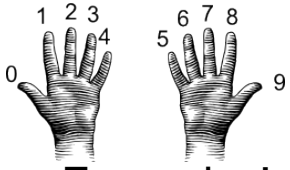

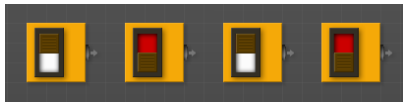

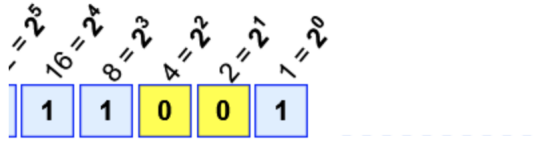

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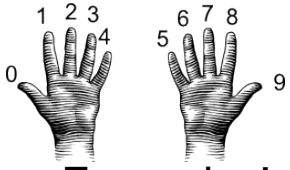

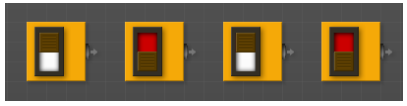

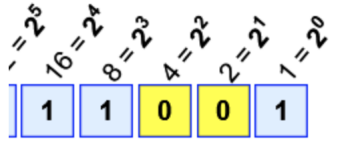

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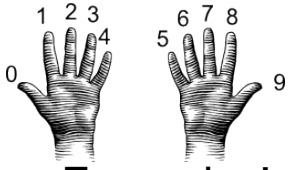
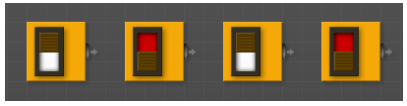
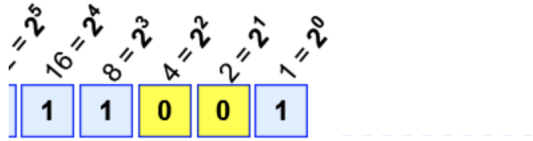
Decimal to Binary: Converting Between Bases







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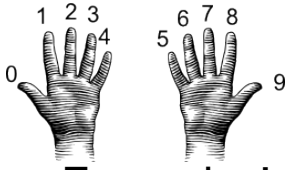

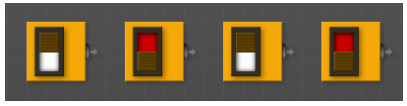

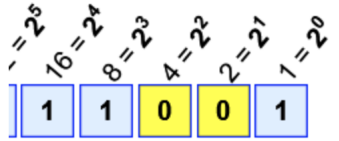

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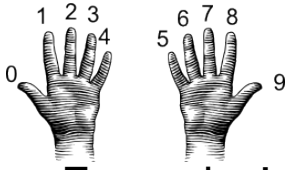

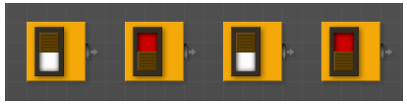

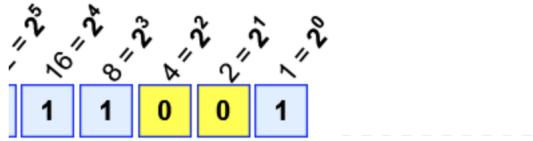

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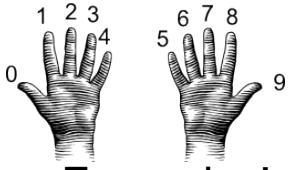

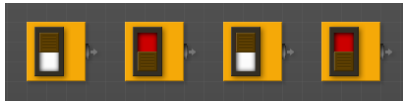

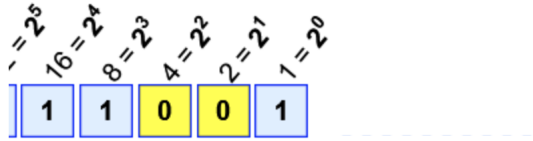

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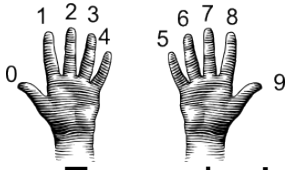

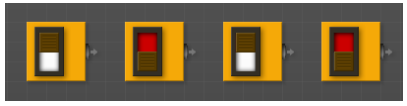

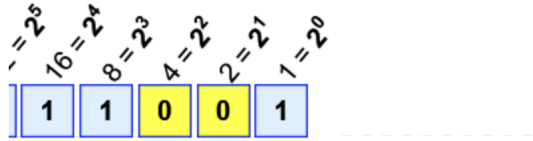

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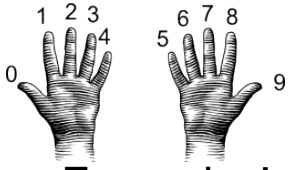

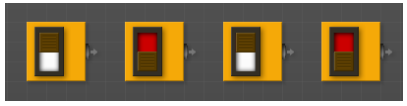

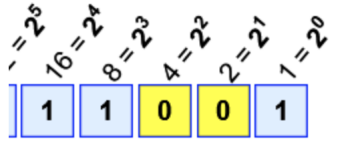

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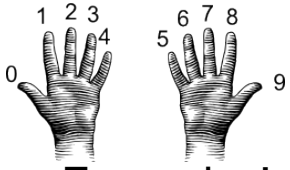
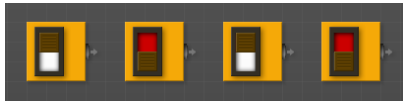
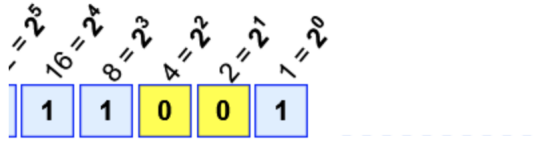
  - Divide remainder by 8 ($= 2^3$). Quotient is the next digit.
  - Divide remainder by 4 ($= 2^2$). Quotient is the next digit.
  - Divide remainder by 2 ($= 2^1$). Quotient is the next digit.
  - The last remainder is the last digit.
  - Example: what is 130 in binary notation?

```
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...
```

Decimal to Binary: Converting Between Bases







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

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  - Divide by 128 ($= 2^7$). Quotient is the first digit.
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```
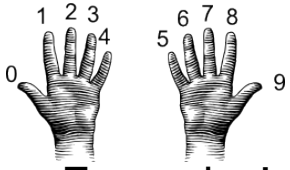
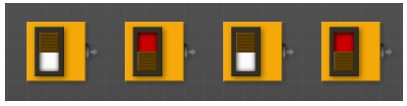
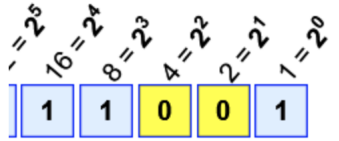

Decimal to Binary: Converting Between Bases







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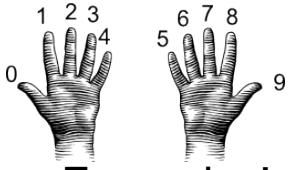
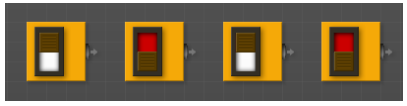
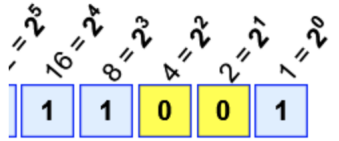
2/2 is 1 rem 0. Next digit is 1:
```

Decimal to Binary: Converting Between Bases







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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...
```
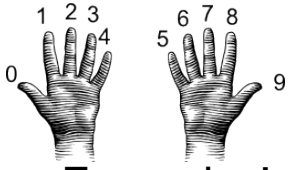
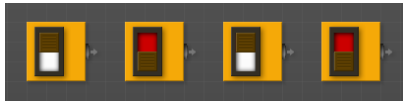
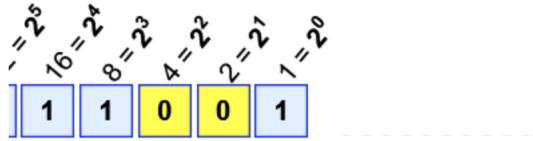

Decimal to Binary: Converting Between Bases







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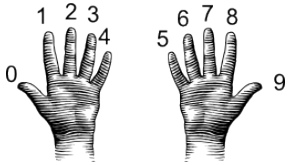
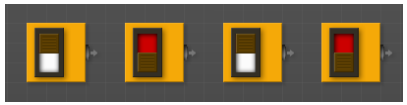
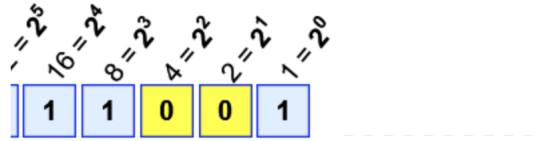
2/8 is 0 rem 2. Next digit is 0:         10000...
2/4 is 0 remainder 2. Next digit is 0:   100000...
2/2 is 1 rem 0. Next digit is 1:         1000001...
Adding the last remainder:               10000010
```

Decimal to Binary: Converting Between Bases







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Adding the last remainder:               10000010
```
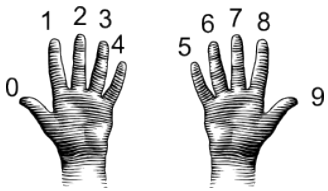
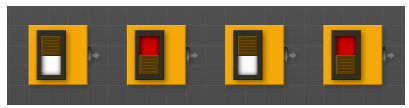
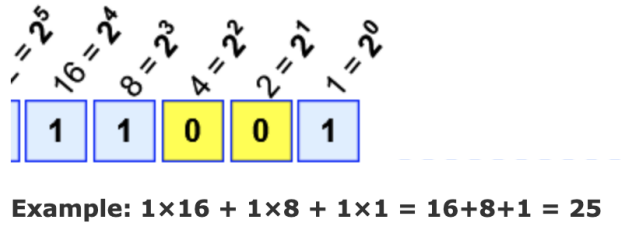

Decimal to Binary: Converting Between Bases

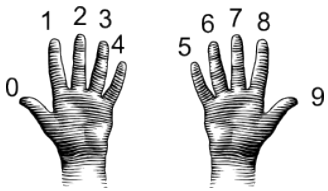


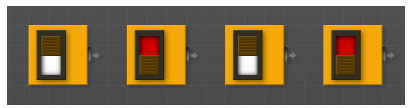


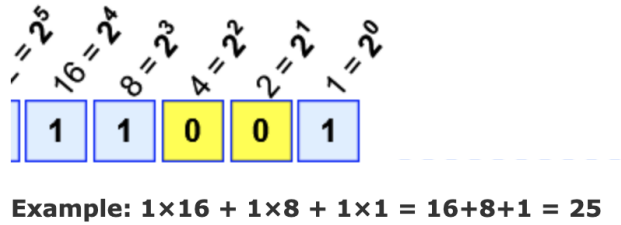


- Example: what is 99 in binary notation?

Decimal to Binary: Converting Between Bases



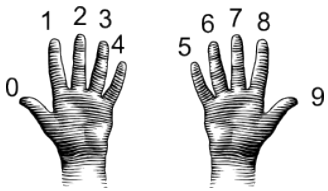


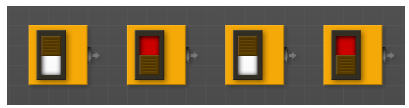


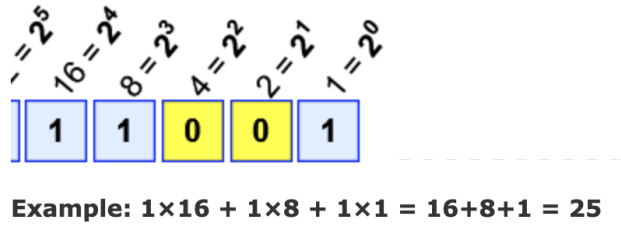
- Example: what is 99 in binary notation?

  `99/128 is 0 rem 99.`

Decimal to Binary: Converting Between Bases



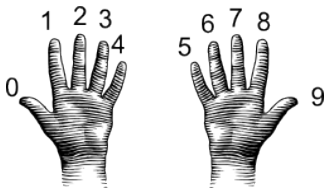


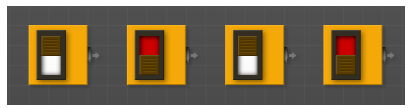


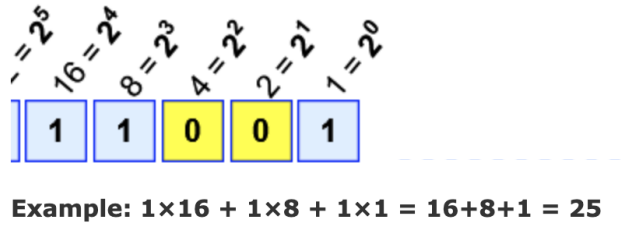
- Example: what is 99 in binary notation?

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

Decimal to Binary: Converting Between Bases





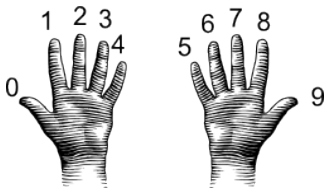


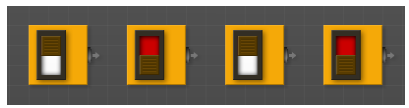
- Example: what is 99 in binary notation?

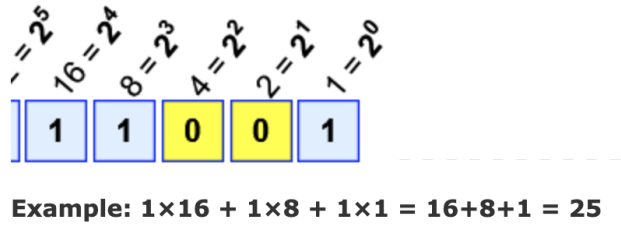
  `99/128 is 0 rem 99. First digit is 0:` `0...`

  `99/64 is 1 rem 35.`

Decimal to Binary: Converting Between Bases







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

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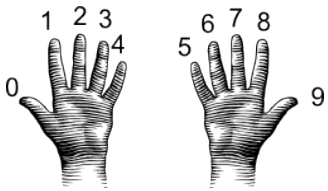
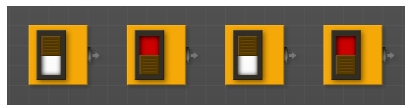
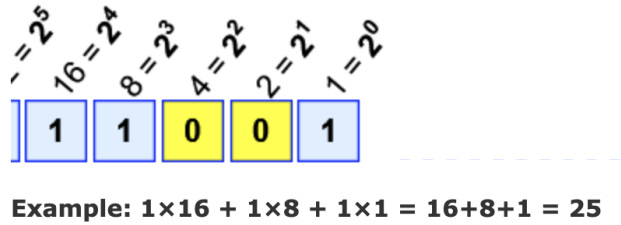
Decimal to Binary: Converting Between Bases







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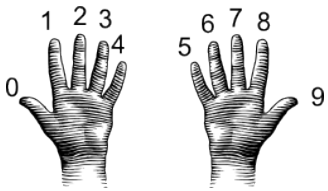
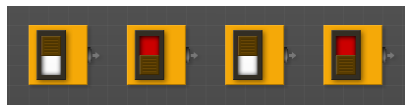
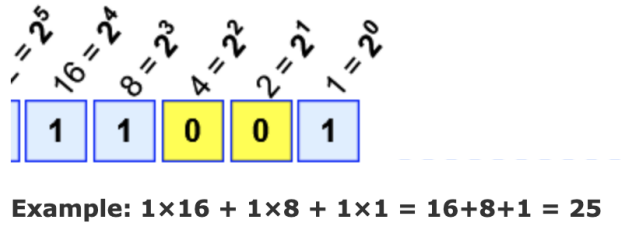


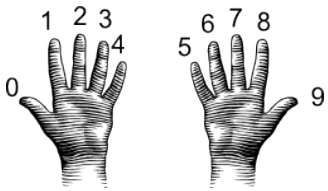


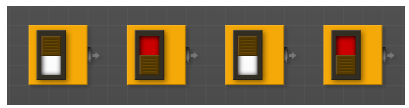


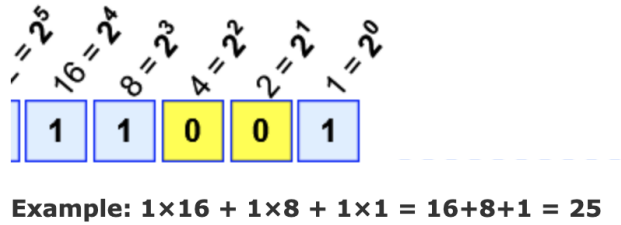
- Example: what is 99 in binary notation?

```
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.
```

Decimal to Binary: Converting Between Bases







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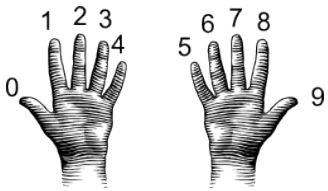
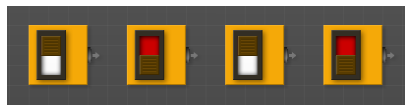
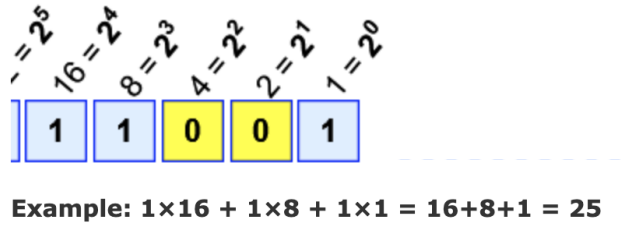
Decimal to Binary: Converting Between Bases







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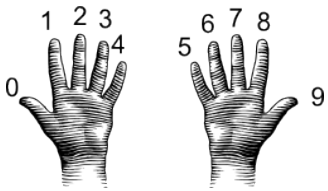

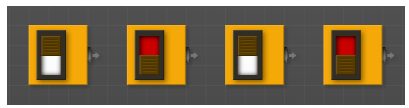

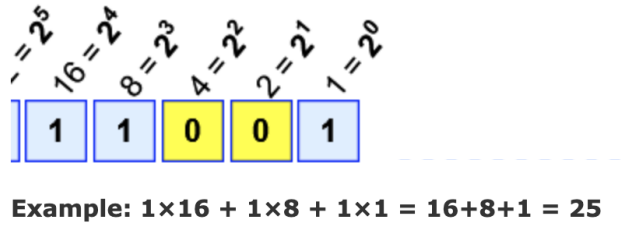

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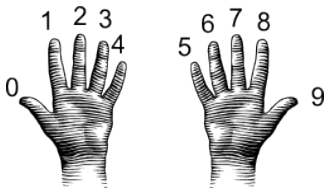

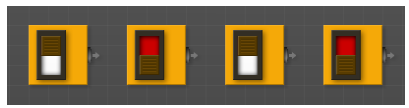

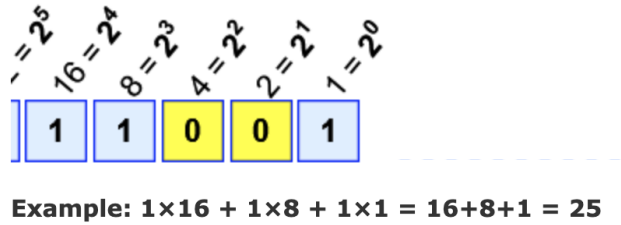

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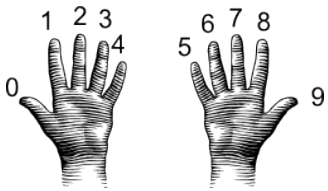

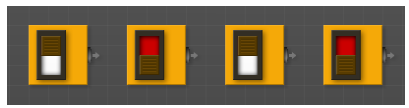

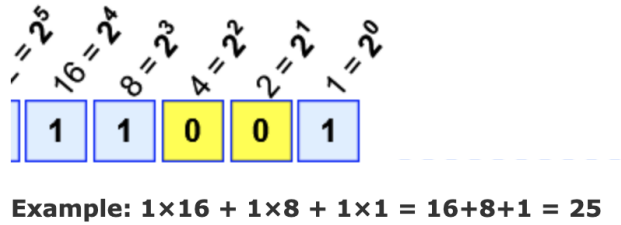

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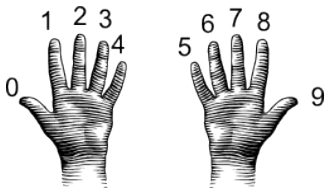

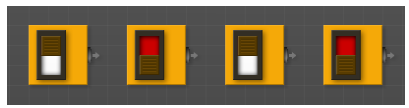

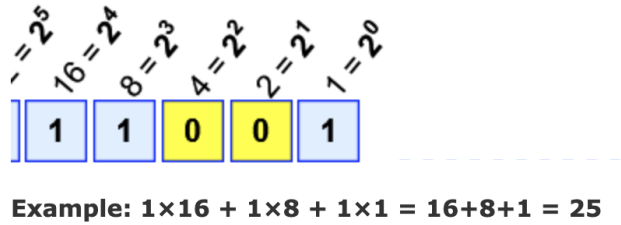

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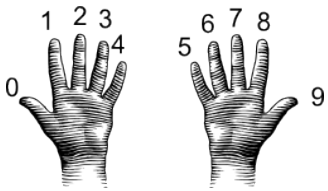

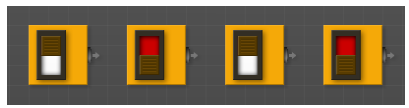

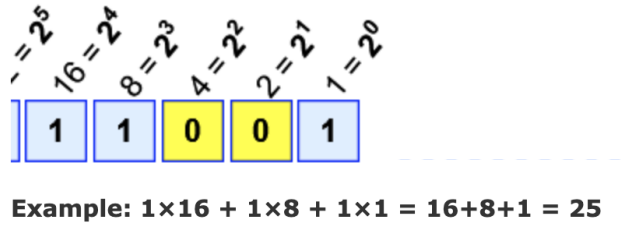

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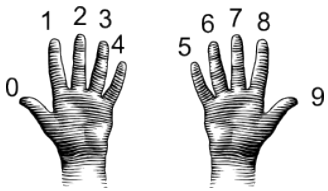

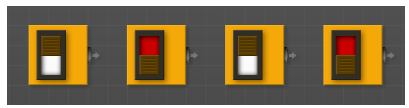

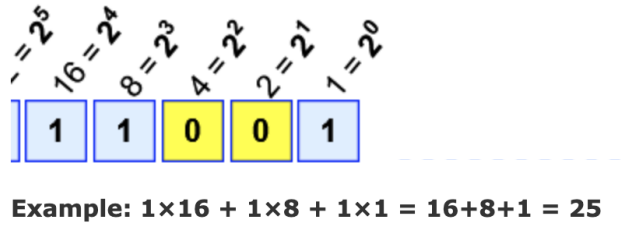

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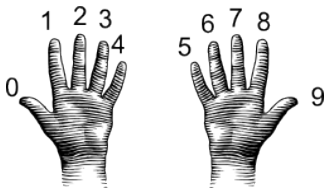

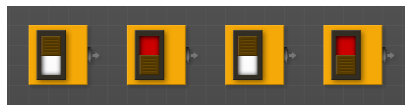

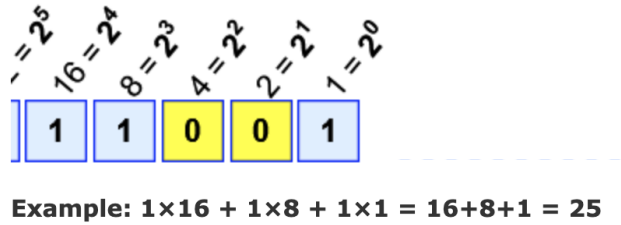

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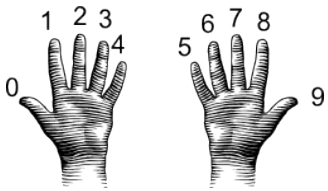

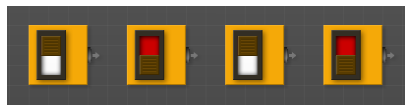

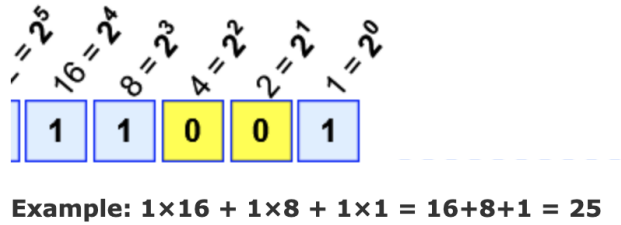

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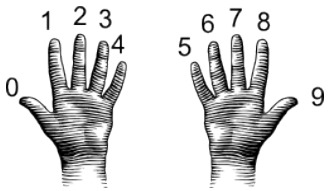

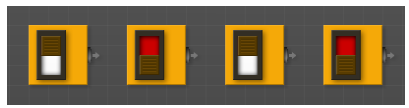

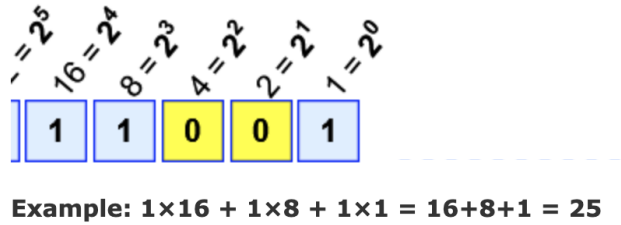

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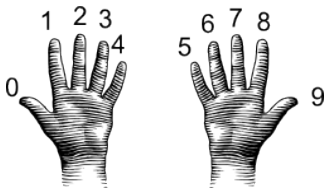

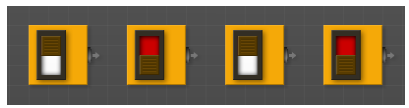

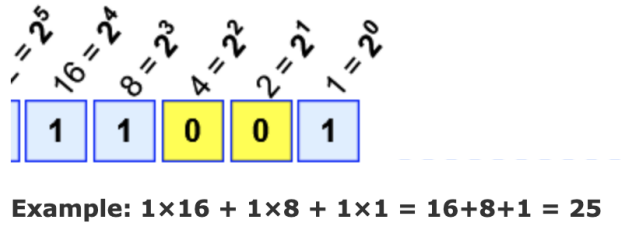

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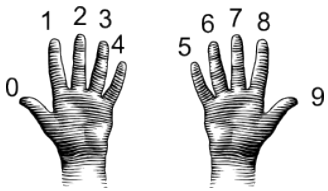

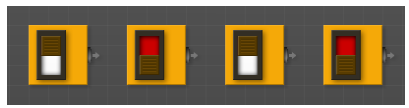

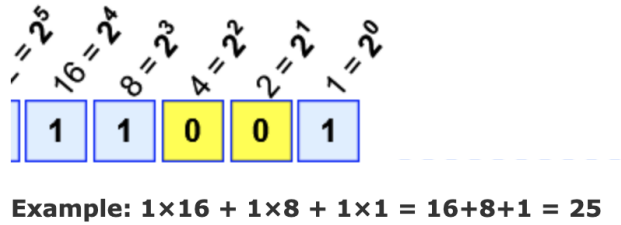

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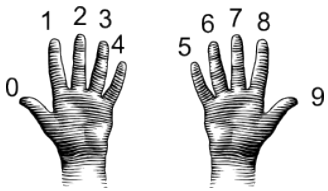

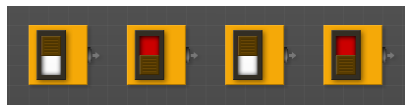

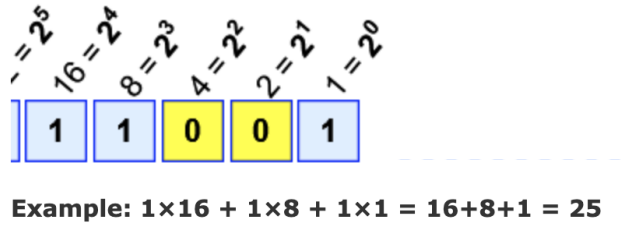

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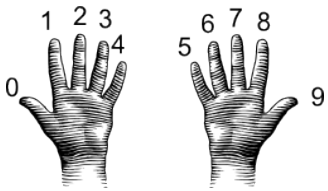
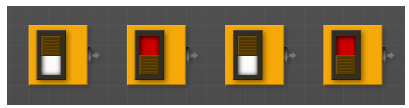
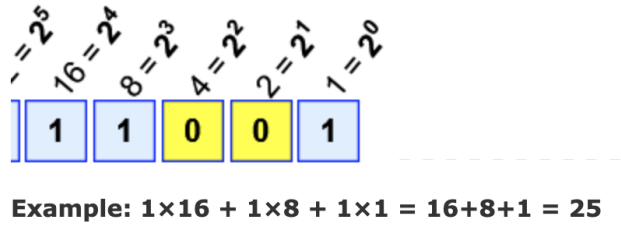
Decimal to Binary: Converting Between Bases



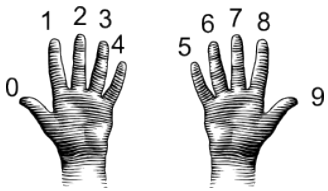


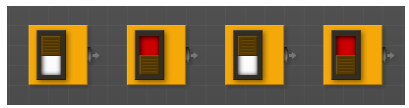


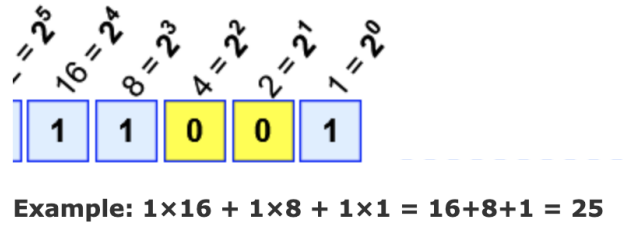
- Example: what is 99 in binary notation?

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

Decimal to Binary: Converting Between Bases







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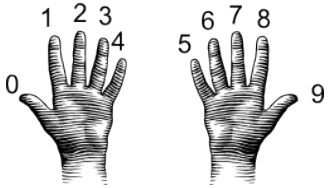
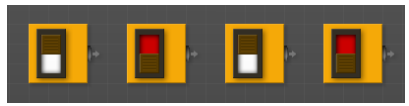
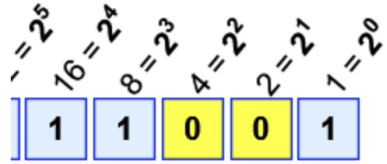
35/32 is 1 rem 3. Next digit is 1:        011...
3/16 is 0 rem 3. Next digit is 0:         0110...
3/8 is 0 rem 3. Next digit is 0:          01100...
3/4 is 0 remainder 3. Next digit is 0:    011000...
3/2 is 1 rem 1. Next digit is 1:          0110001...
Adding the last remainder:                01100011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

Answer is 1100011.

Binary to Decimal: Converting Between Bases



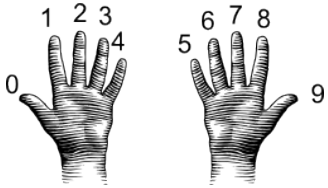


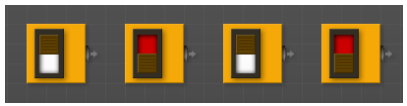


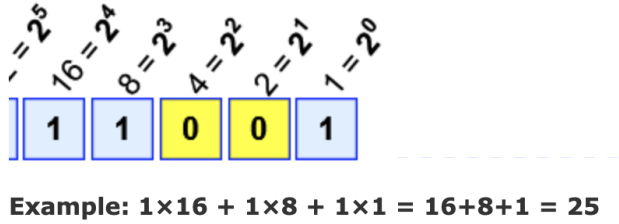
Example: 1×16 + 1×8 + 1×1 = 16+8+1 = 25

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

Binary to Decimal: Converting Between Bases

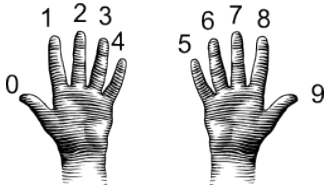


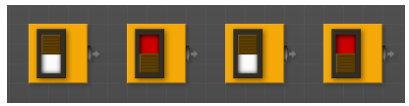


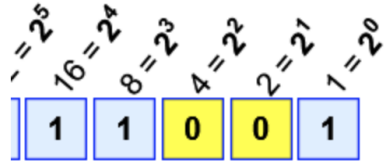


- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.

Binary to Decimal: Converting Between Bases







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

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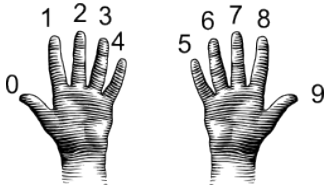
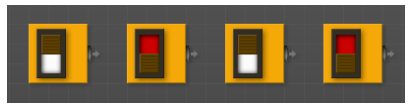
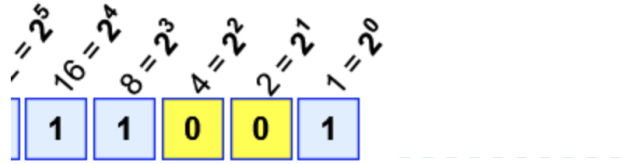
Binary to Decimal: Converting Between Bases







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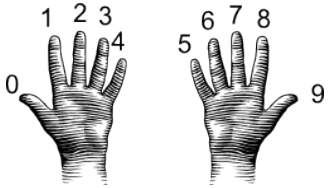
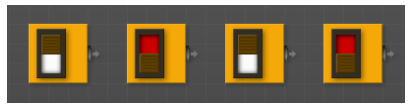
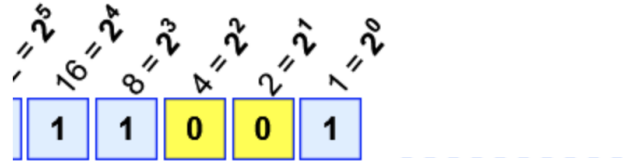
Binary to Decimal: Converting Between Bases







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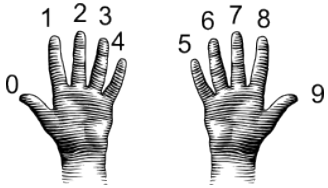
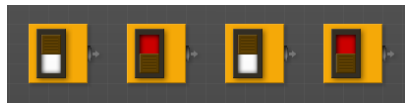
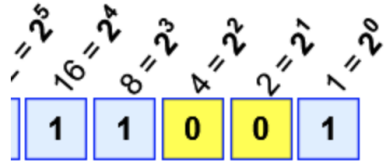
  - Multiply next digit by $16 = 2^4$. Add to sum.

Binary to Decimal: Converting Between Bases







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

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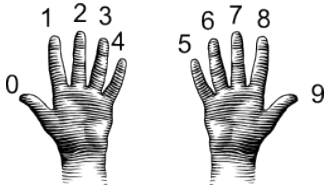
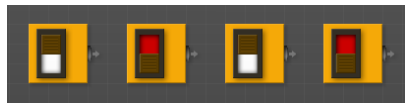
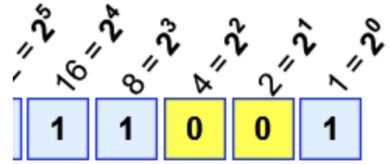
Binary to Decimal: Converting Between Bases







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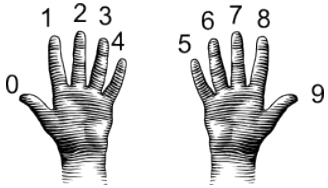
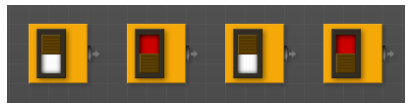
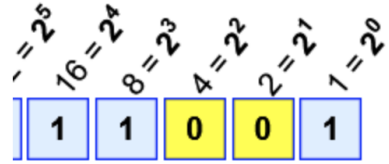
  - Multiply next digit by $64 = 2^6$. Add to sum.

Binary to Decimal: Converting Between Bases







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  - Multiply next digit by $64 = 2^6$. Add to sum.
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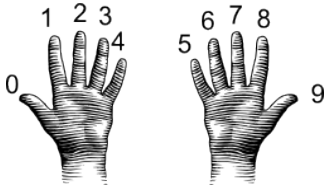
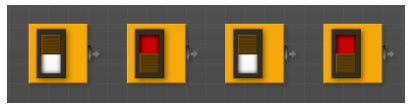
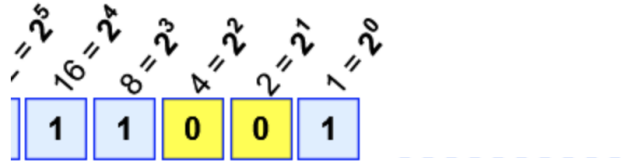
Binary to Decimal: Converting Between Bases







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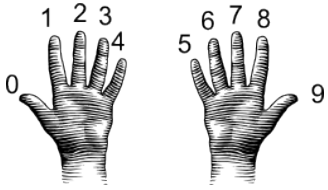
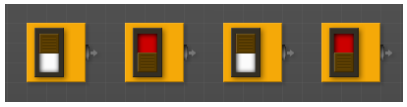
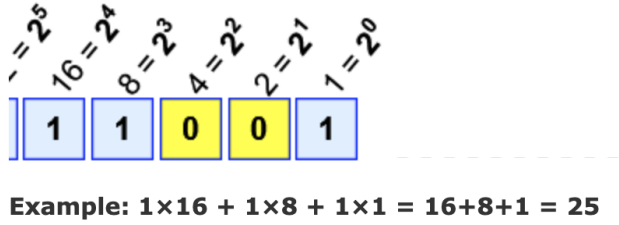
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.

Binary to Decimal: Converting Between Bases







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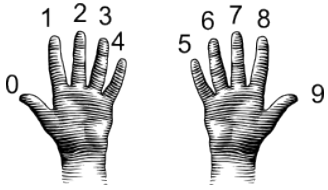
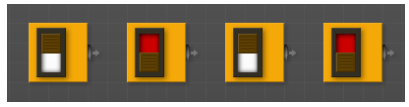
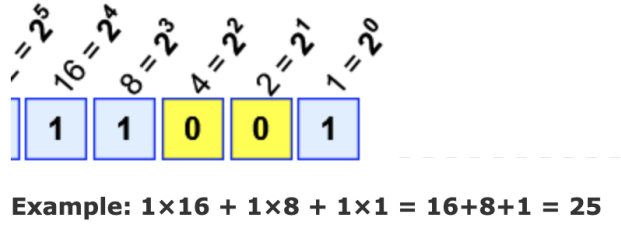
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

    `Sum starts with:`

Binary to Decimal: Converting Between Bases







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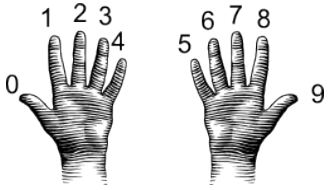
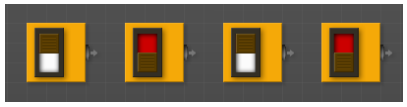
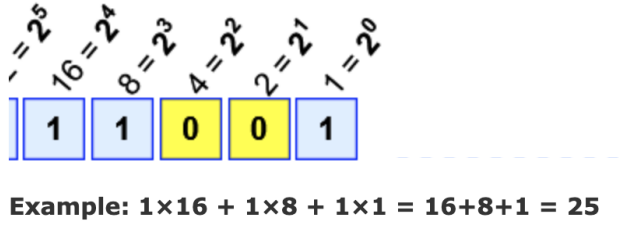
  - Multiply next digit by $64 = 2^6$. Add to sum.
  - Multiply next digit by $128 = 2^7$. Add to sum.
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases



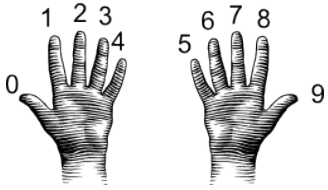


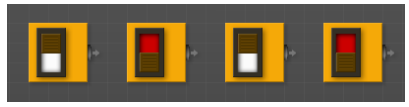


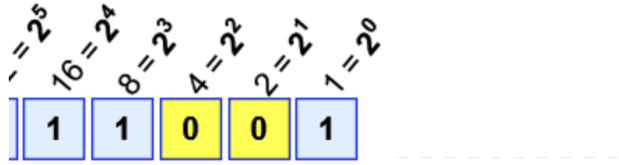
- From binary to decimal:
  - Set sum = last digit.
  - Multiply next digit by $2 = 2^1$. Add to sum.
  - Multiply next digit by $4 = 2^2$. Add to sum.
  - Multiply next digit by $8 = 2^3$. Add to sum.
  - Multiply next digit by $16 = 2^4$. Add to sum.
  - Multiply next digit by $32 = 2^5$. Add to sum.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

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

Binary to Decimal: Converting Between Bases







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

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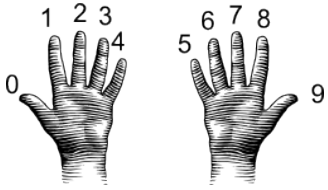
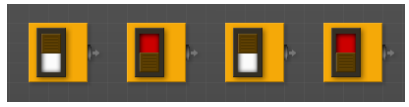
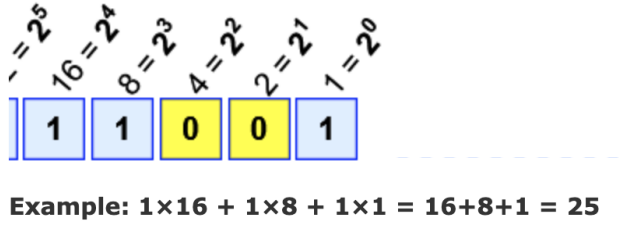
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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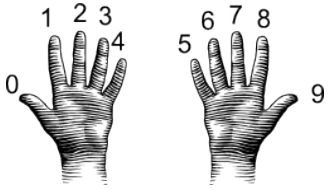
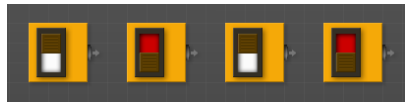
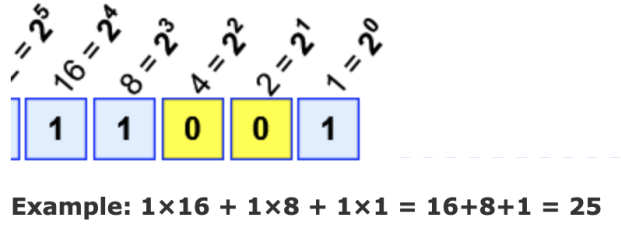
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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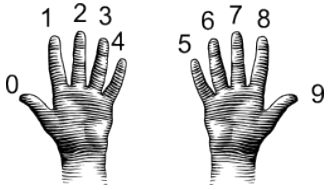
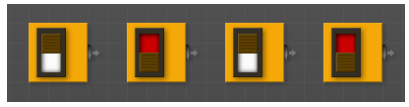
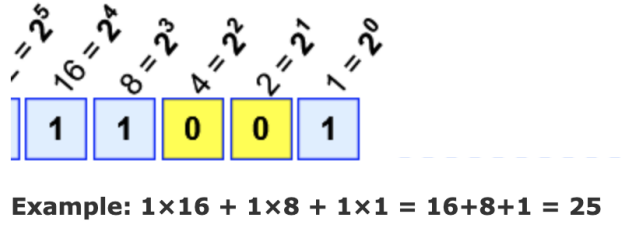
1*4 = 4.  Add 4 to sum:       5
1*8 = 8.  Add 8 to sum:
```

Binary to Decimal: Converting Between Bases







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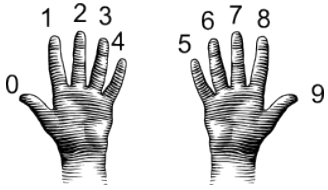
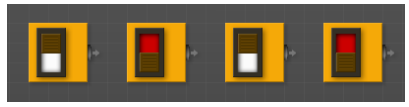
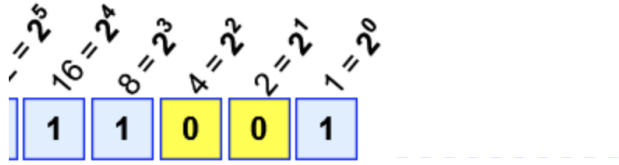
1*4 = 4.  Add 4 to sum:       5
1*8 = 8.  Add 8 to sum:       13
```

Binary to Decimal: Converting Between Bases







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

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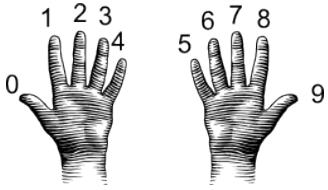
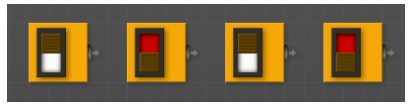
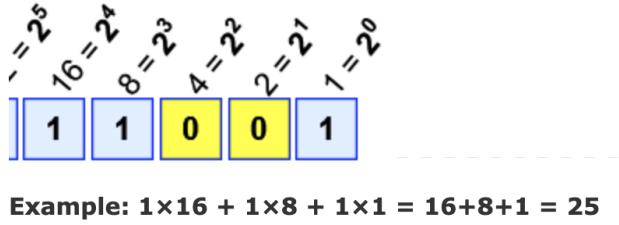
  - Sum is the decimal number.
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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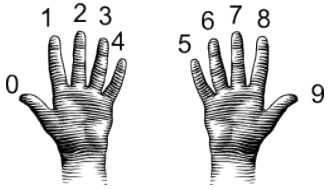
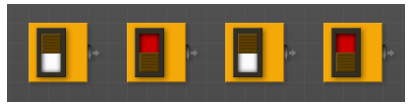
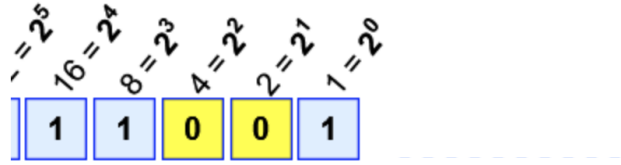
  - Example: What is 111101 in decimal?

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

Binary to Decimal: Converting Between Bases







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

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Sum starts with:              1
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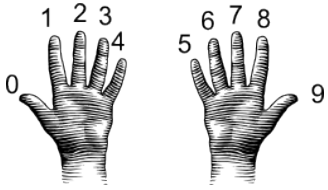
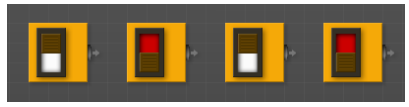
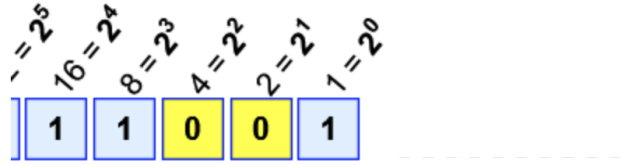
Binary to Decimal: Converting Between Bases







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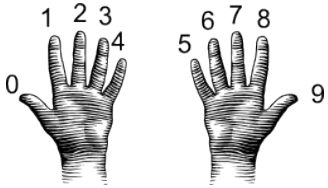
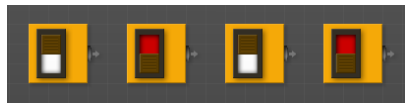
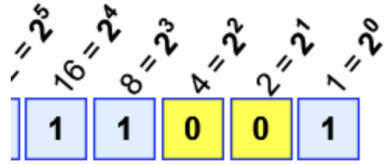

Binary to Decimal: Converting Between Bases







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```
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
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```
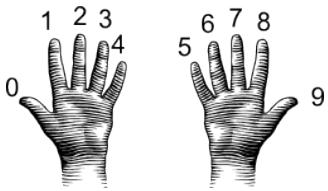
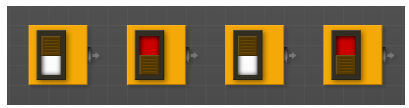
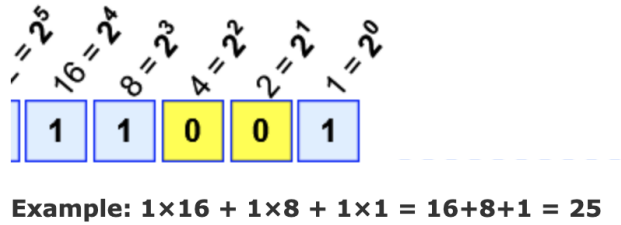

Binary to Decimal: Converting Between Bases



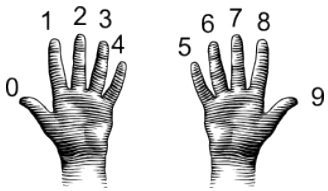


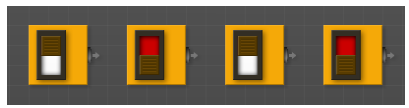


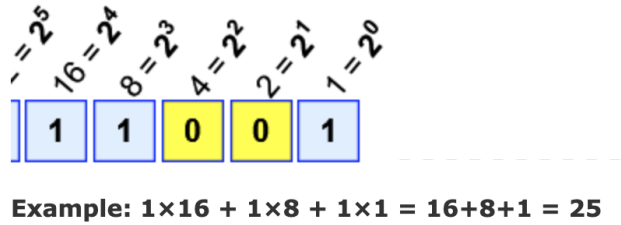
- Example: What is 10100100 in decimal?

  `Sum starts with:`

Binary to Decimal: Converting Between Bases



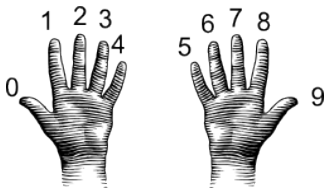


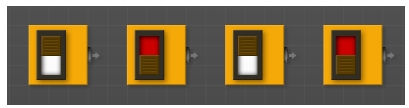


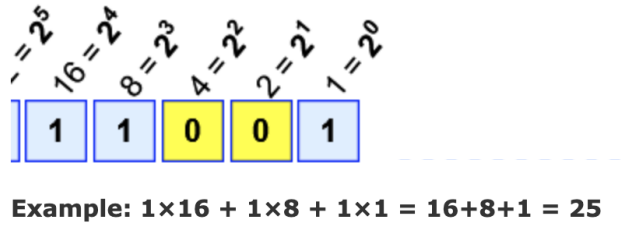
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases







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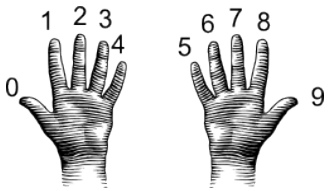
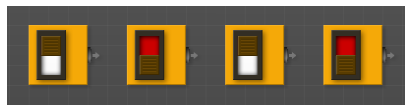
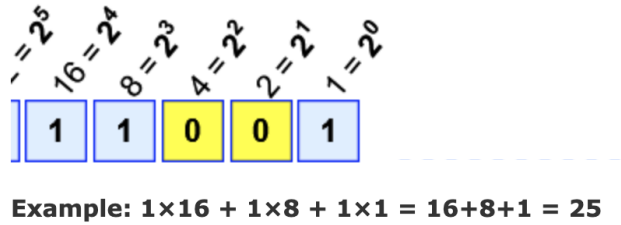
Binary to Decimal: Converting Between Bases



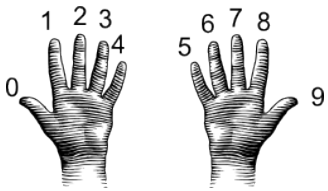


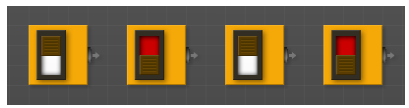


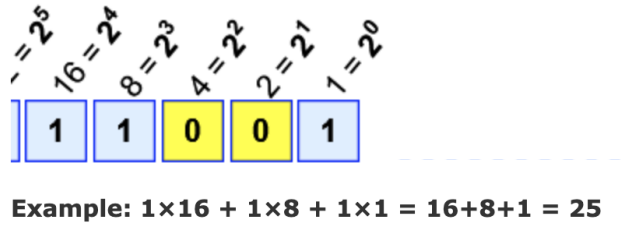
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



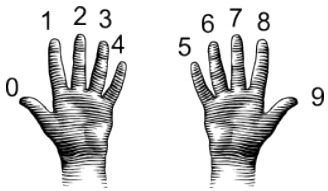


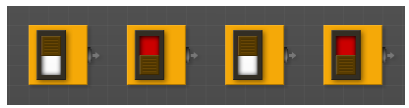


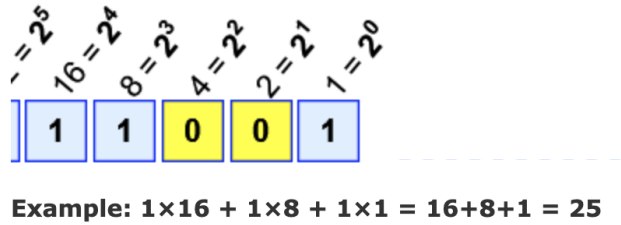
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



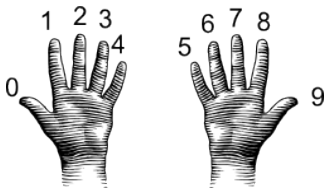


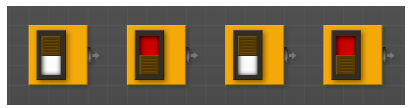


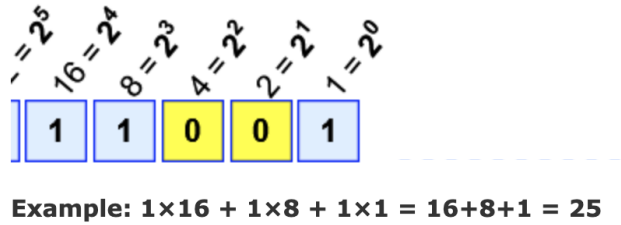
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



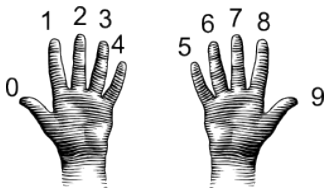


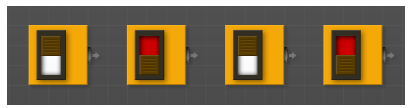


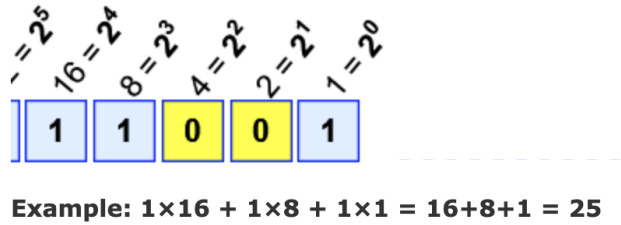
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



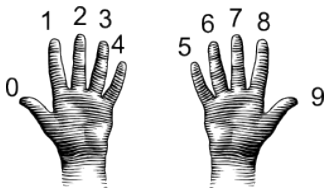


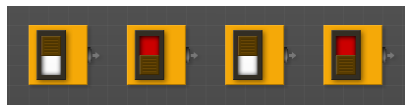


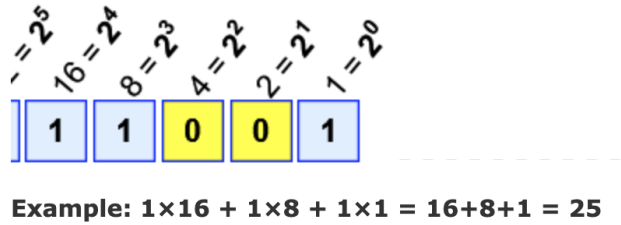
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



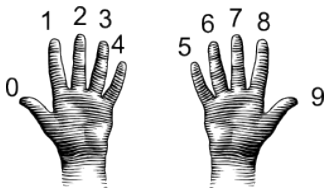


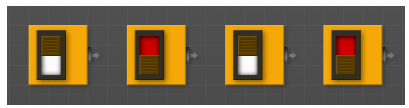


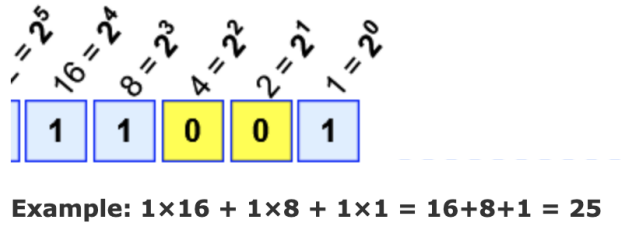
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



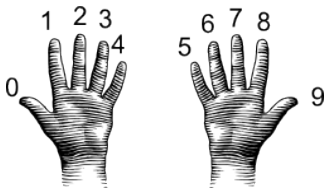


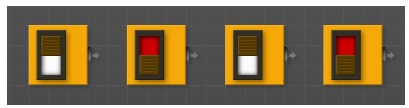


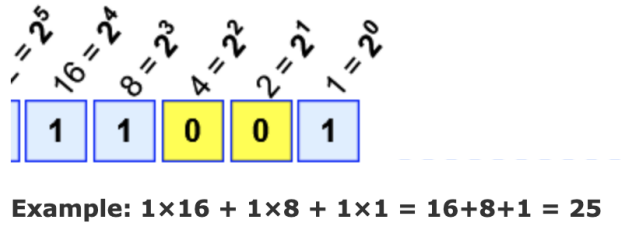
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



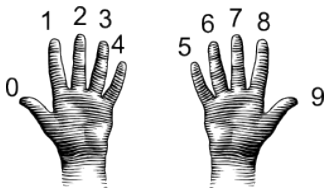


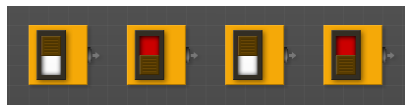


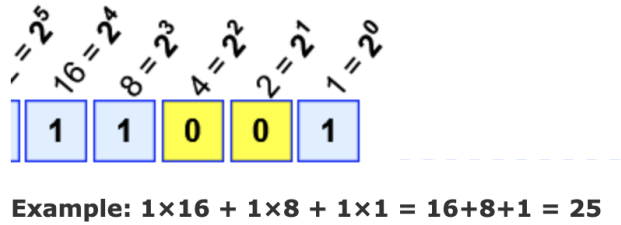
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



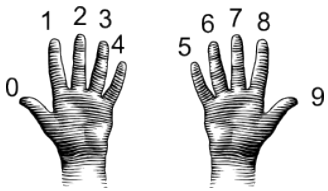


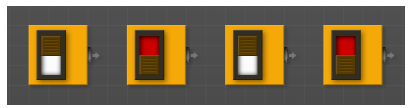


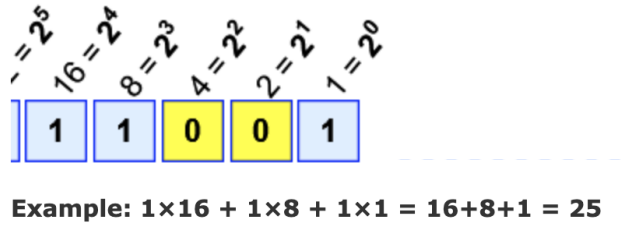
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



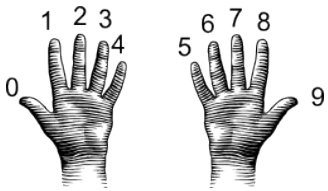


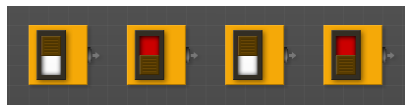


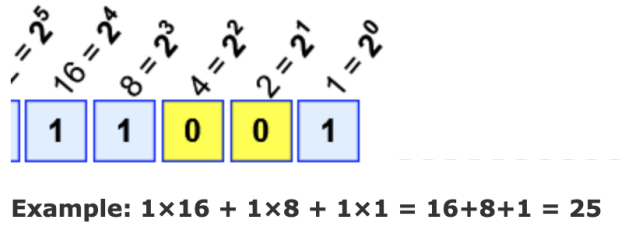
- Example: What is 10100100 in decimal?

```
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
```

Binary to Decimal: Converting Between Bases



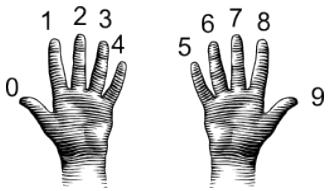


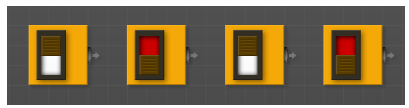


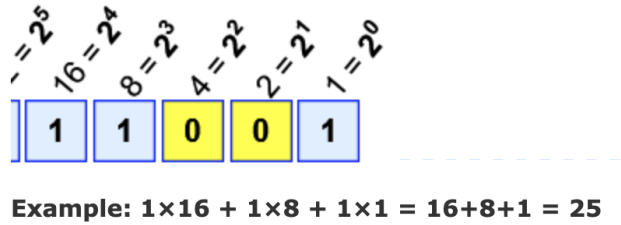
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases



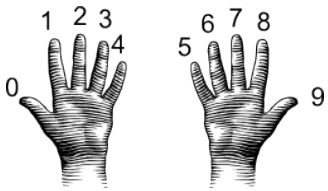


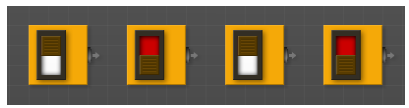


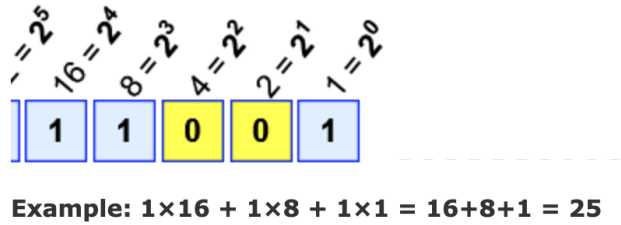
- Example: What is 10100100 in decimal?

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

Binary to Decimal: Converting Between Bases







- Example: What is 10100100 in decimal?

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

The answer is 164.

Recap

- In Python, we introduced:

Recap

- In Python, we introduced:
  - Decisions
  - Logical Expressions
  - Circuits
  - Binary Numbers

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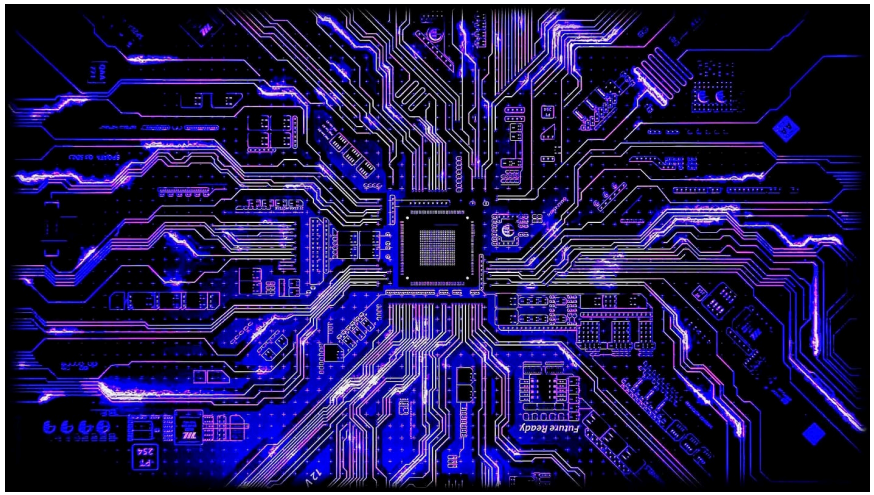
Weekly Reminders!



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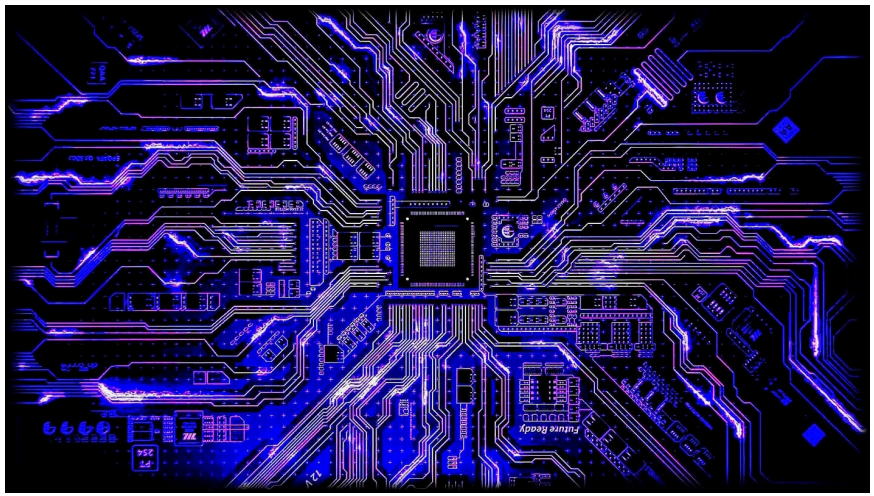

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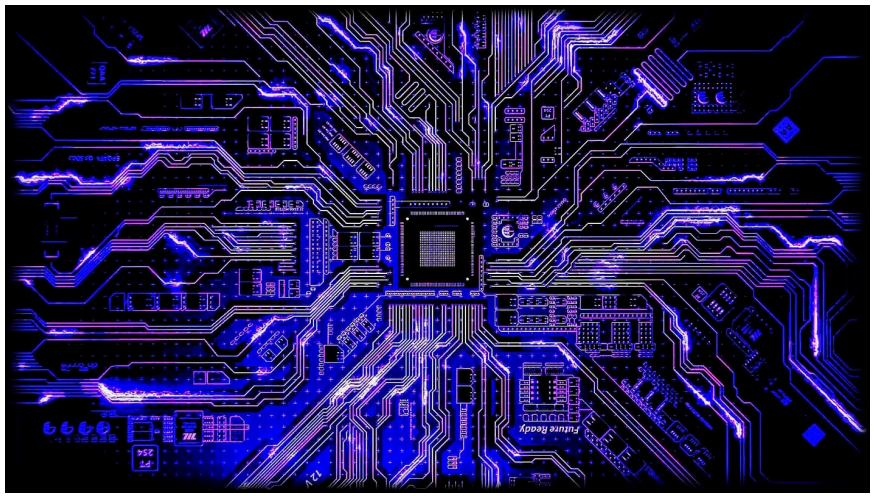

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