Digital Information

What is Digital Information?

Computers are not capable of understanding things like pictures, video, or even simple text!

The only thing that computers understand is **numbers**.

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The only thing that computers understand is **numbers**.

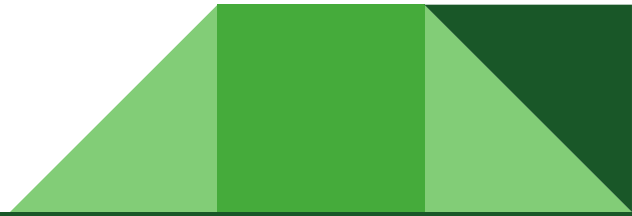
> They don't even understand numbers as we do - they **only** know *Binary*!

In order to store information in our computers, we need to store information as numerical digits.

Digital Information

In order to store and manipulate information with computers, we need to **encode** information into numbers. We talked about encoding way back at the beginning of our class!

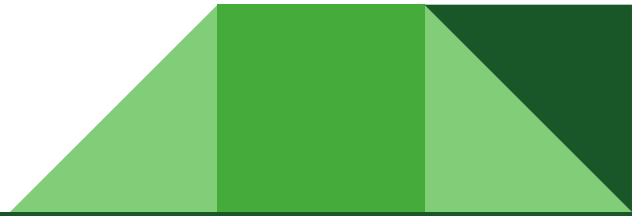
We need to attach meaning to simple sequences of digits.



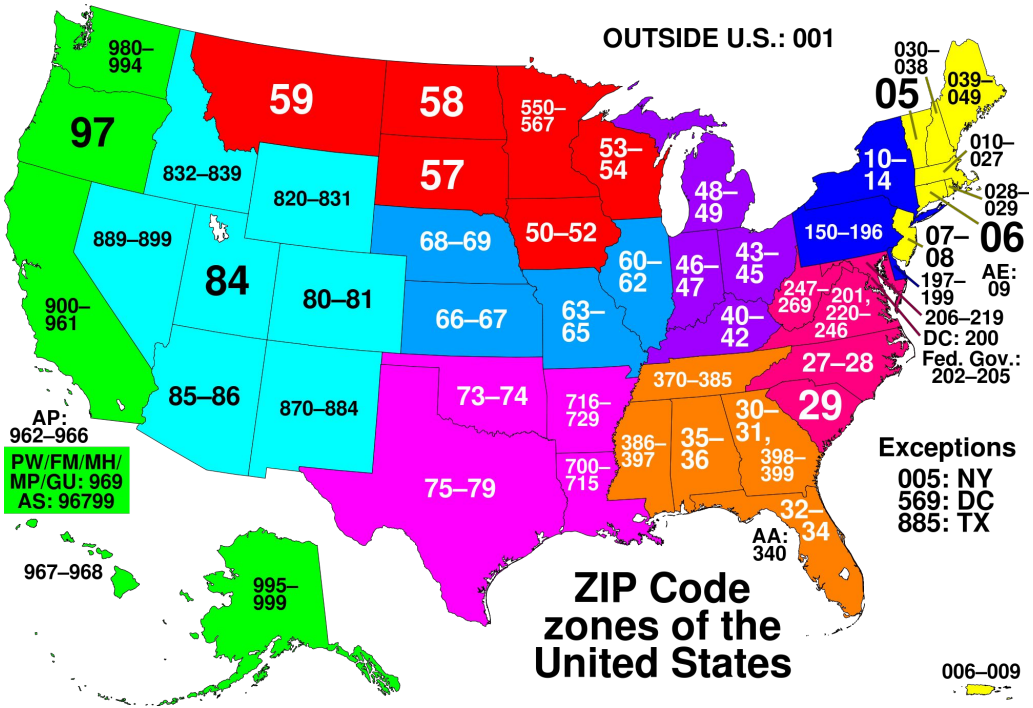
Encoding Information

Fast Food menus are one example of encoding information!

1 - Burger
2 - Cheeseburger
3 - French Fries
4 - Chicken Fingers
etc.

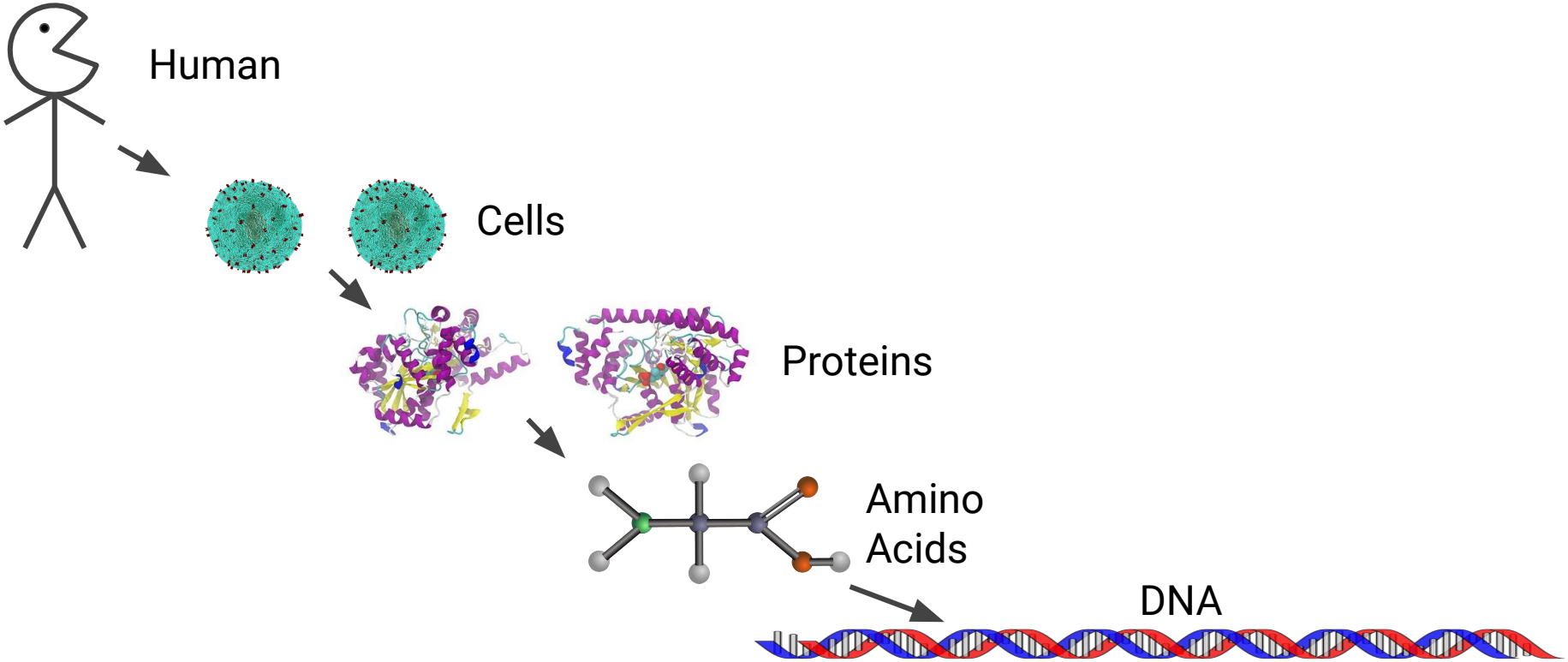


Encoding Information



Zip Codes encode a location as a number!

Even WE Are Encoded!



Data Abstraction

Abstraction is the process of simplifying complicated data into manageable chunks.

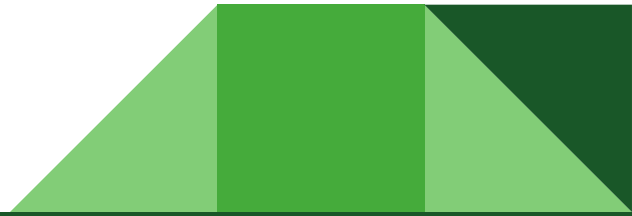
There are different levels to abstraction, as we go from human-readable information to computer-readable information!

Data Abstraction

Word HI

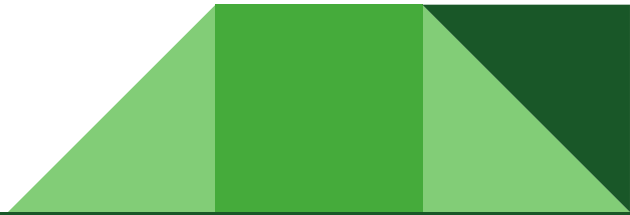
Data Abstraction

Word		HI
Characters	H	I



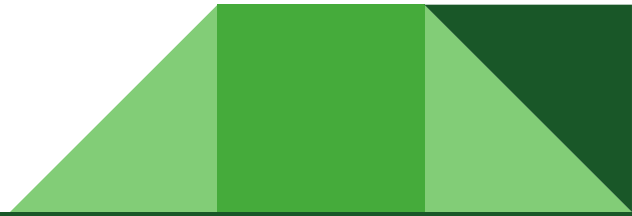
Data Abstraction

Word		HI	
Characters	H		I
ASCII Value	72		73



Data Abstraction

Word	HI	
Characters	H	I
ASCII Value	72	73
Binary	01001000	01001001



Data Abstraction

Word	HI	
Characters	H	I
ASCII Value	72	73
Binary	01001000	01001001
Hardware		

Data Abstraction

Word	HI	
Characters	H	I
ASCII Value	72	73
Binary	01001000	01001001
Hardware		

Data Abstraction

Word	HI	
Characters	H	I
ASCII Value	72	73
Binary	01001000	01001001
Hardware		

Processing Digital Information

Once information is brought into a computer, we can easily manipulate it in a variety of different ways!

We can easily examine and filter digital information to gain more knowledge!

Processing Digital Information

Information can be often be stored much more compactly in digital form than in physical form. A webcomic artist drew a visualization of what it might look like if all digital data were to be stored as punch cards:

Source: https://what-if.xkcd.com/63/ xkcd.com Randall Munroe

Processing Digital Information

Digital information is also much more easily transmitted than physical information, since we can transmit it over radio waves rather than having to move a physical object!

Getting to Digital Data

Number Systems

In order to understand how computers store information, we need to know how they think about numbers. This means we need to have an understanding of how Binary works!

Number Systems

Before we talk about Binary specifically, let's discuss **Number Systems**. A **Number System** determines how a number is represented - which digits are used, and what each position within a number means.

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Decimal (a.k.a. the **Number System** we're familiar with) has **10 digits**.

```
0 1 2 3 4 5 6 7 8 9
```

Number Systems

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Decimal (a.k.a. the **Number System** we're familiar with) has **10 digits**.

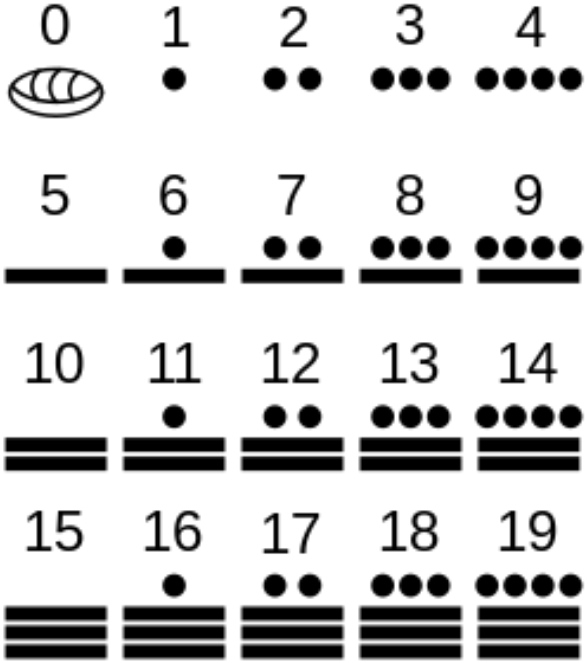
```
0 1 2 3 4 5 6 7 8 9
```

Binary (a.k.a. the **Number System** computers think with) has only **2 digits**.

```
0 1
```

Alternative Number Systems

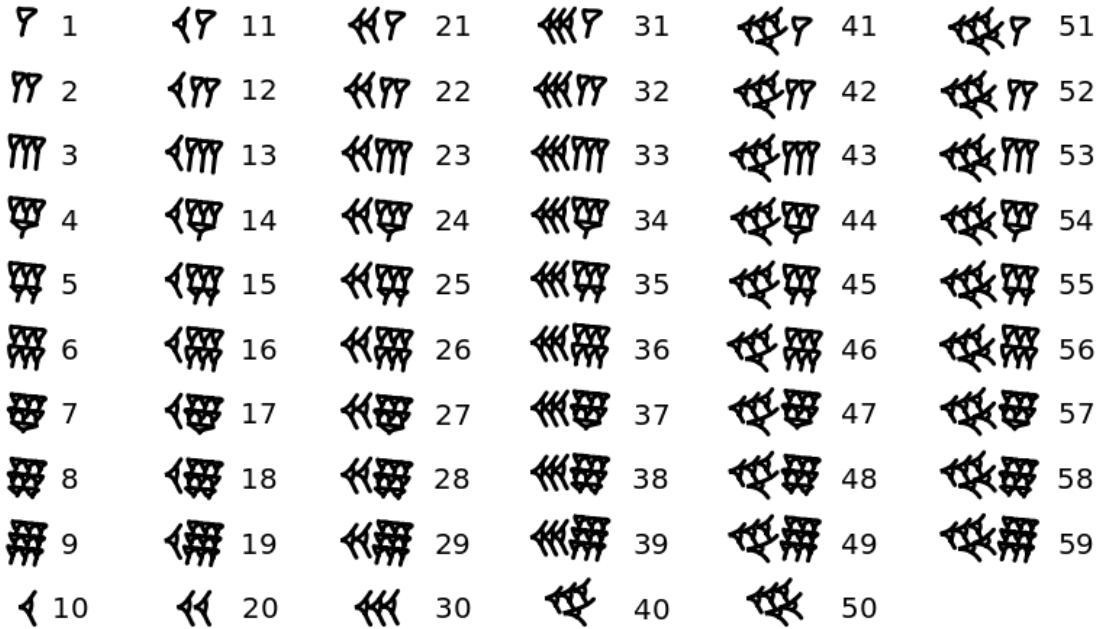
The Mayan **Number System** has **20 digits**!



Source: https://en.wikipedia.org/wiki/Maya_numerals#/media/File:Maya.svg Bryan Derksen

Alternative Number Systems

The Babylonian **Number System** uses **60 digits**!



Source: https://en.wikipedia.org/wiki/File:Babylonian_numerals.svg Josell7

Number Systems

All **Number Systems** work, fundamentally, in the same way as one another. Each one has its own *Number Base*, which is used to determine the places!

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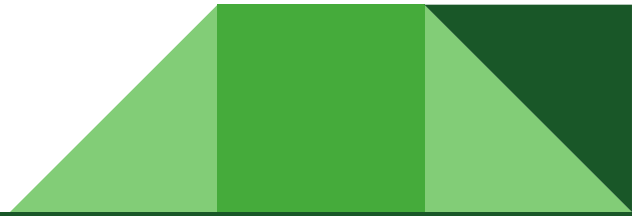
Decimal
Base: `10`
Number of Digits: `10`
Digits: `0 1 2 3 4 5 6 7 8 9`



Number Systems

All **Number Systems** work, fundamentally, in the same way as one another. Each one has its own *Number Base*, which is used to determine the places!

Decimal
Base: `10`
Number of Digits: `10`
Digits: `0 1 2 3 4 5 6 7 8 9`

Binary
Base: `2`
Number of Digits: `2`
Digits: `0 1`

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

0

How Does Decimal Work?

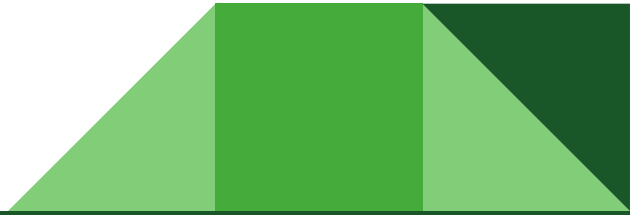
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

1



How Does Decimal Work?

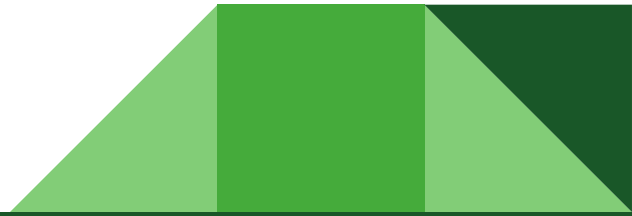
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

2



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

3

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

4

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

5

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

6

How Does Decimal Work?

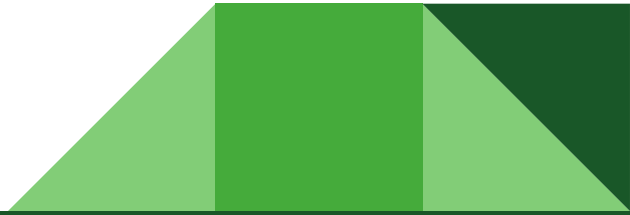
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

7



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

8

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

9

How Does Decimal Work?

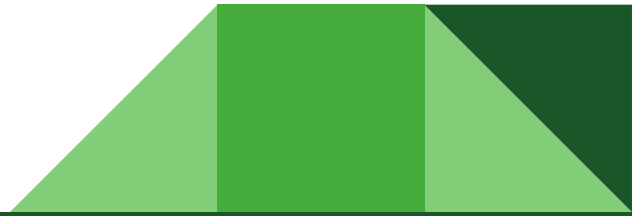
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

0000009



How Does Decimal Work?

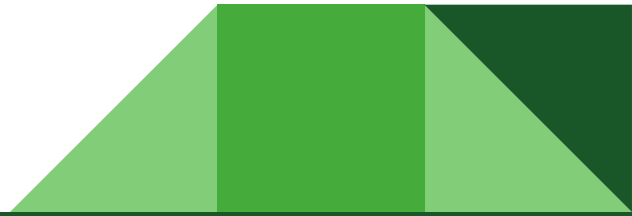
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

10



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

11

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

12

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

19

How Does Decimal Work?

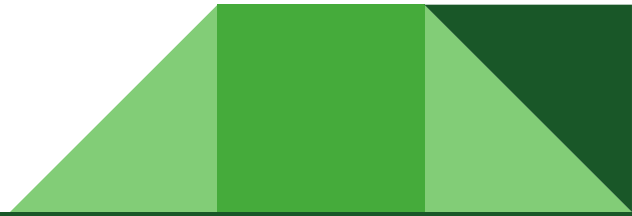
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

20



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

99

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

099

How Does Decimal Work?

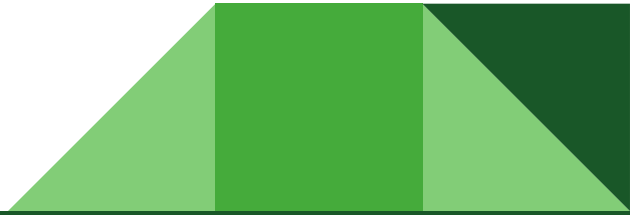
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

100



How Does Decimal Work?

Decimal

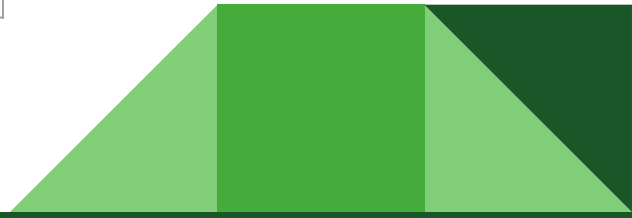
Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825

7	8	2	5



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825

7	8	2	5
1000s	100s	10s	1s

How Does Decimal Work?

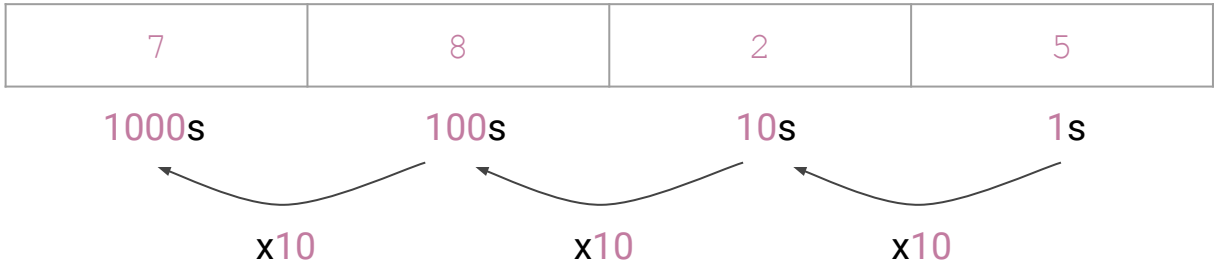
Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825



How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10 x 10 x 10	10 x 10	10	1

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

How Does Decimal Work?

Decimal

Base: 10

Number of Digits: 10

Digits: 0 1 2 3 4 5 6 7 8 9

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

```
7 * (1000)
```

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

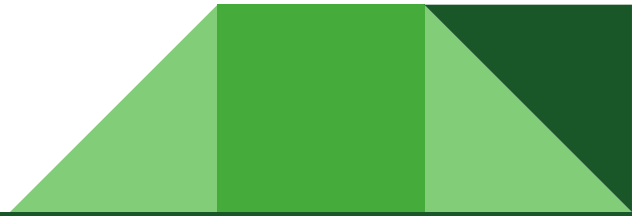
```
7 * (1000) + 8 * (100)
```

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

```
7 * (1000) + 8 * (100) + 2 * (10)
```



How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

```
7 * (1000) + 8 * (100) + 2 * (10) + 5 * (1)
```

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

7000 + 800 + 20 + 5

How Does Decimal Work?

Example: 7825

7	8	2	5
1000s	100s	10s	1s
10^3	10^2	10^1	10^0

$$7000 + 800 + 20 + 5 = 7825_{10}$$

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

0

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

1

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

0001

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

10

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

11

How does Binary Work?

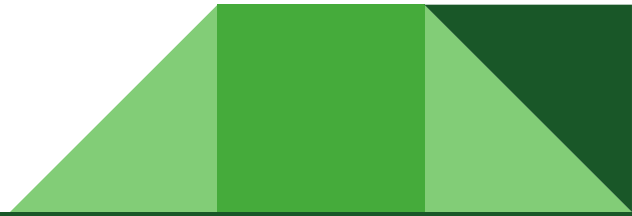
Binary

Base: 2

Number of Digits: 2

Digits: 0 1

0011



How does Binary Work?

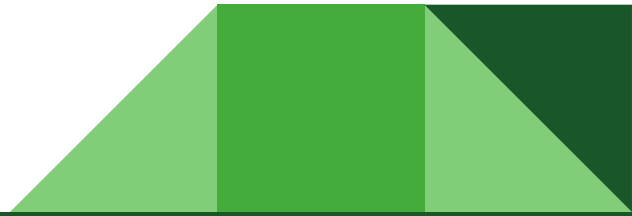
Binary

Base: 2

Number of Digits: 2

Digits: 0 1

100



How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0

1s

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0

How does Binary Work?

Binary

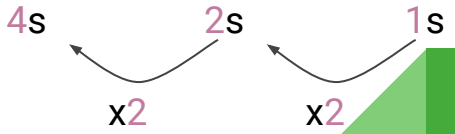
Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0



How does Binary Work?

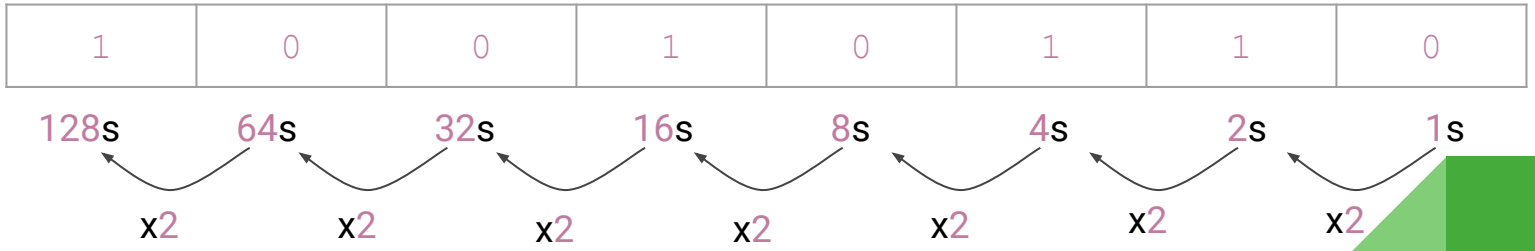
Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110



How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16 + 0 * 8

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16 + 0 * 8 + 1 * 4

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16 + 0 * 8 + 1 * 4 + 1 * 2

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16 + 0 * 8 + 1 * 4 + 1 * 2 + 0 * 1

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 0 * 64 + 0 * 32 + 1 * 16 + 0 * 8 + 1 * 4 + 1 * 2 + 0 * 1

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

1 * 128 + 1 * 16 + 1 * 4 + 1 * 2

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

128 + 16 + 4 + 2

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

$128 + 16 + 4 + 2 = 150_{10}$

How does Binary Work?

Binary

Base: 2

Number of Digits: 2

Digits: 0 1

Example: 10010110

1	0	0	1	0	1	1	0
128s	64s	32s	16s	8s	4s	2s	1s
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

$128 + 16 + 4 + 2 = 150_{10}$

$10010110_2 = 150_{10}$