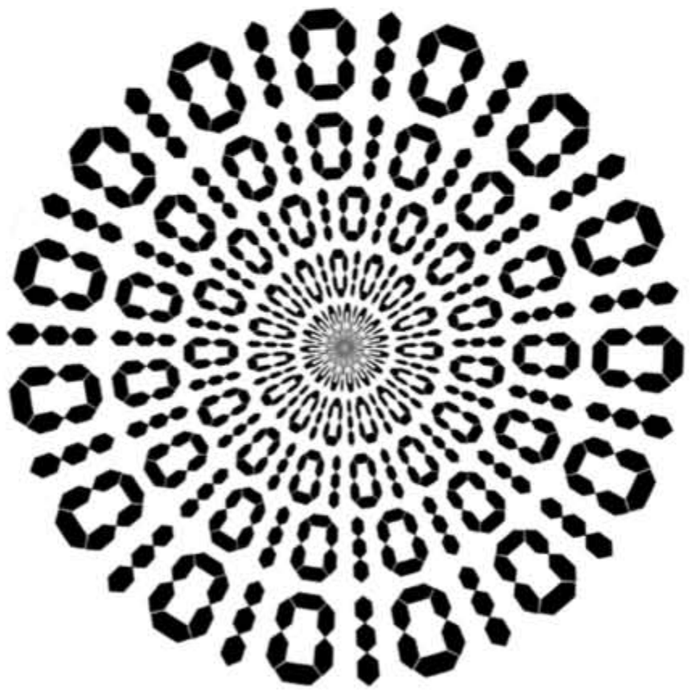
Number Representation



Denary

The denary number system (also known as decimal) uses 10 symbols (0–9) to represent numbers. It is a base-10 number system.

Humans use it because we have 10 fingers.

Binary

Computers don't have fingers, they have circuits. These circuits can be in one of two states: on or off. So, they use a base-2 number system.

On = 1

Off = 0

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 1

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 2

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 3

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 4

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 5

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 6

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 7

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Counting in Binary

Each place in a binary number has a value.
These go up in multiples of 2.

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

= 8

To convert a binary number to decimal we add up the place values of the columns with a 1 in.

Denary to Binary

Start by writing out the place values.

	128	64	32	16	8	4	2	1
10 =					1		1	

Then write a 1 underneath the place values that add up to the denary number.

Denary to Binary

Start by writing out the place values.

10 =

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

Then write a 1 underneath the place values that add up to the denary number.

Finally, fill in the remaining spaces with 0s.

16-bit Example

255 is the highest value that can be stored in 8-bit binary.

By increasing the number of bits to 16 we can store a maximum value of 65,535.

32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2	1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

32,768 + 2 = 32,770

Hexadecimal

Hexadecimal is often used as a shorthand for binary as it is quicker for humans to write.

Hexadecimal is a base-16 number system, which means it uses 16 symbols.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

It starts by using the symbols 0–9 and then switches the letters A–F. This is so that only single digits are used.

F = 15

Hexadecimal to Binary

Hexadecimal numbers usually consist of pairs of digits as this is equivalent to 1 byte (8 bits).

Converting between hexadecimal and binary is simple. You just take each character and convert it into the equivalent binary number.

Hex	D				A			
Decimal	13				10			
Binary	1	1	0	1	1	0	1	0

Finally, you join the two binary numbers together.

DA = 11011010

Binary to Hexadecimal

To convert from binary to hexadecimal we simply reverse the process.

Binary	1	1	0	1	1	0	1	0
Decimal	13				10			
Hex	D				A			

The easiest way to convert a hexadecimal number to denary is to convert it to binary first and then from binary into denary.

16-bit Example

Here is an example of the conversion of a 16-bit binary number.

Binary	1	1	0	1	1	0	0	1	1	0	1	0	0	0	0	1
Decimal	13				9				10				1			
Hex	D				9				A				1			

A 16-bit binary number becomes a 4 digit hexadecimal number.

D9A1