1.1 Number systems

Number systems

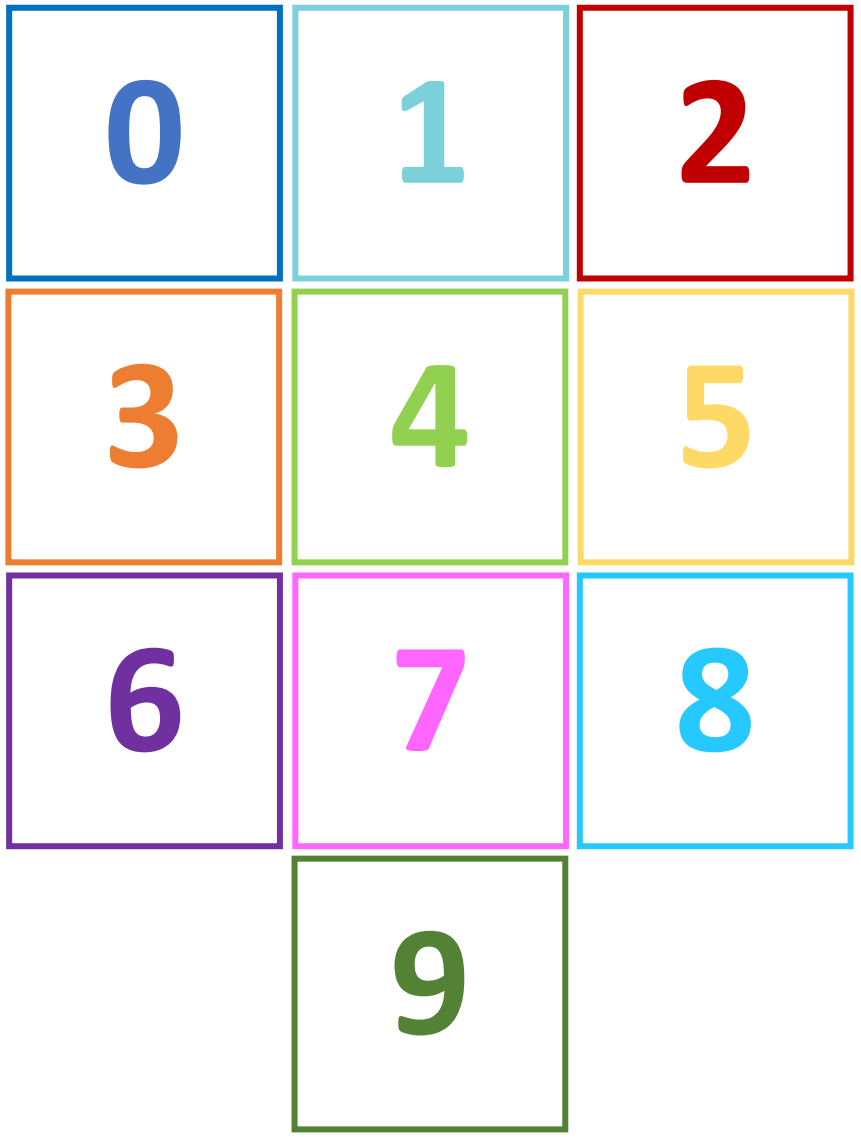
Number bases: Denary (base 10)

This is the number system you are most familiar with.

You have been using it ever since you first started to count.

It contains ten unique digits from 0-9.

Why do you think our number system evolved this way?



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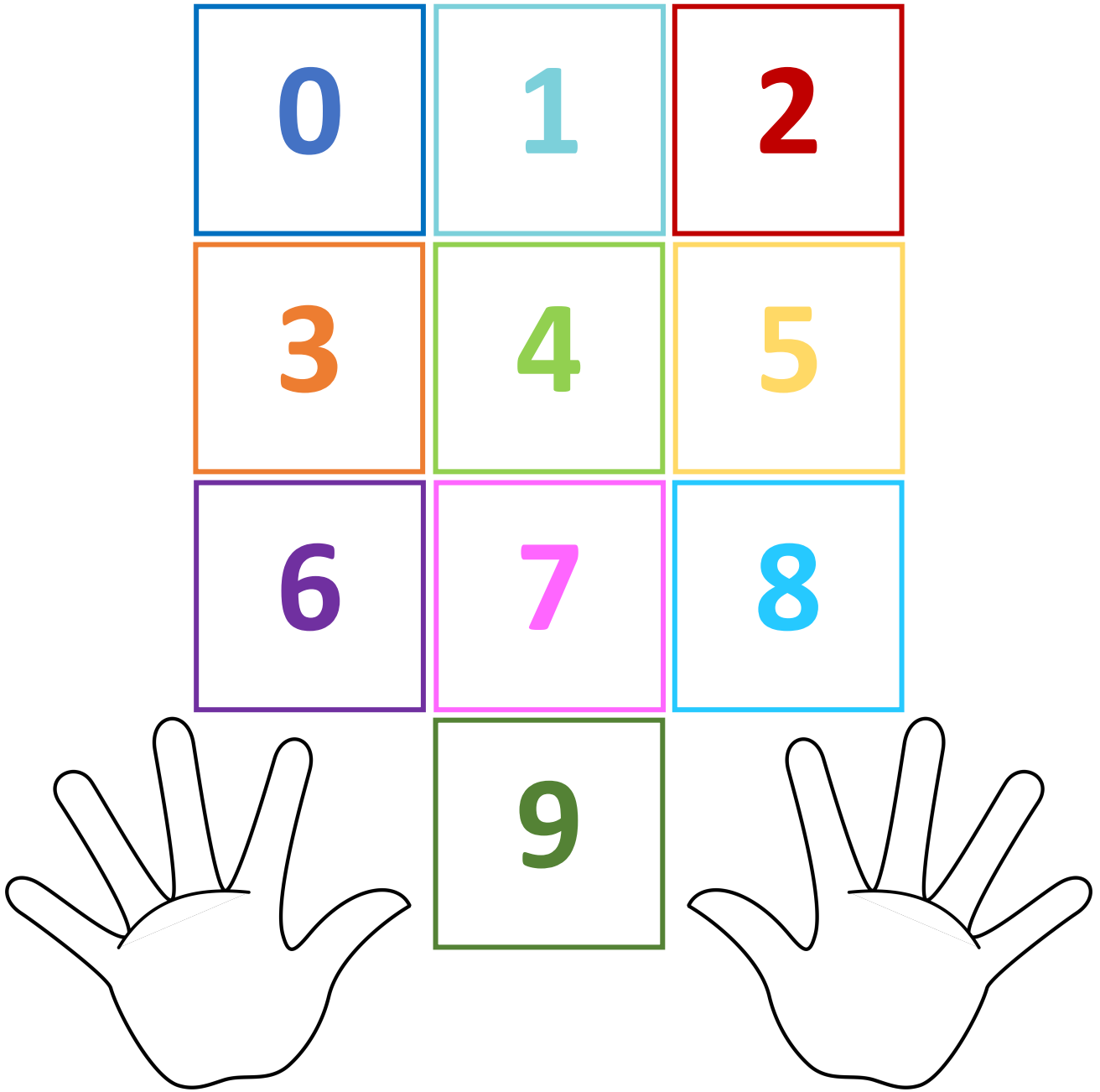

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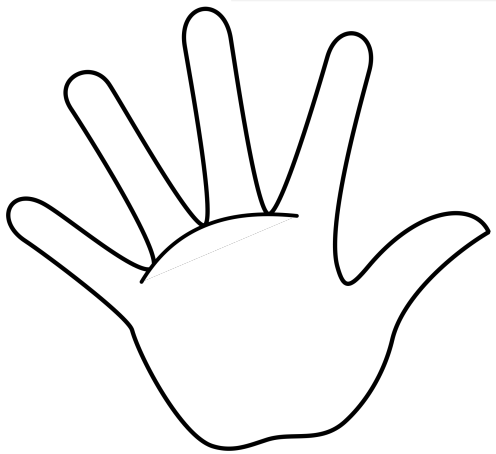
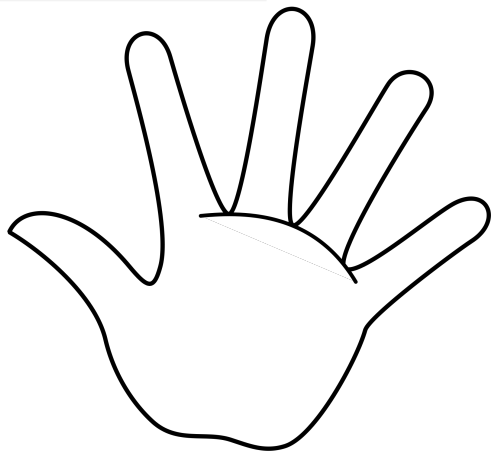
With the denary system, we have no unique digit for the number ten. We have to put a one and zero together.

1 0 = ten





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Let’s look at how that actually works with larger numbers.

1000s	100s	10s	1s
0	0	1	0

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1000s	100s	10s	1s
0	0	1	0
0 x 1000 +	0 x 100 +	1 x 10 +	0 x 1 = 10

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1000s	100s	10s	1s
4	2	7	3

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Let's look at how that actually works with larger numbers.

1000s	100s	10s	1s
4	2	7	3
4 x 1000 +	2 x 100 +	7 x 10 +	3 x 1

= 4,273

Notice how the column headings are increasing by a factor of ten every time we move to the left.

This is because **denary** is a **base-10** number system.

Number bases: Binary (base 2)

The base-2 binary number system only has two unique digits – 0 and 1.

All other numbers in binary must be made up of a combination of these two digits.

8s	4s	2s	1s
0	0	1	1

Number bases: Binary (base 2)

The base-2 binary number system only has two unique digits – 0 and 1.

All other numbers in binary must be made up of a combination of these two digits.

8s	4s	2s	1s
0	0	1	1
0 x 8 +	0 x 4 +	1 x 2 +	1 x 1 = 3

Number bases: Binary (base 2)

The base-2 binary number system only has two unique digits – 0 and 1.

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8s	4s	2s	1s
1	0	1	1

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The base-2 binary number system only has two unique digits – 0 and 1.

All other numbers in binary must be made up of a combination of these two digits.

8s	4s	2s	1s
1	0	1	1
1 x 8 +	0 x 4 +	1 x 2 +	1 x 1 = 11

Notice how the column headings are increasing by a factor of two every time we move to the left.

This is because **binary** is a **base-2** number system.

Number bases: Binary (base 2)

The base-2 binary number system only has two unique digits – 0 and 1.

All other numbers in binary must be made up of a combination of these two digits.

Notice how the column headings are increasing by a factor of two every time we move to the left.

This is because **binary** is a **base-2** number system.

32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2	1	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	= 0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	= 65,535

Number bases: Hexadecimal (base 16)

The base-16 hexadecimal number system has sixteen unique digits.

This presents us with a unique problem.

What do we use to represent the hex digits 10-15?

We can’t use the numbers 10 to 15, as these are two digits stuck together!

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

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What do we use to represent the hex digits 10-15?

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0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Instead, we use the first six letters of the alphabet.

So, in hexadecimal, A = 10

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	10

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	A	1010

Number bases

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Number bases

Computers use different base number systems.

Binary

- Base 2
- 0, 1
- Easy to represent two states – on/off, yes/no, etc.

Denary

- Base 10
- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Our number system – the one we are most familiar with

Hexadecimal

- Base 16
- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- Can be expressed more compactly than binary

Denary (base 10)	Hex (base 16)	Binary (base 2)
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111