Calculus

Numbers

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Numbers

Outline of Numbers

- 1. Real Numbers
- 2. Imaginary Numbers
- 3. Rational Numbers
- 4. Irrational Numbers
- 5. Natural Numbers
- 6. Whole Numbers
- 7. Integers

What are the types of numbers?

There are two main branches of numbers:





Numbers

Real Numbers

What is a real number?

Any number can be find on the Number line is a real number, possibly any number you have ever seen up to now is a real number. Including all (Positive, negative, zero, and fractional numbers).





Numbers

Examples:

(Positive, negative, zero, and fractional numbers).

- 1, 2, 33, 52, 107, 209, 567, 100000, etc.
- -1, -10, -17, -200, -1000, -732, -99, -1000000, etc.
- 0
- 0.3, 0.5, 0.7, 0.91, 0.72, -0.1, -0.8, etc.

$$\frac{2}{4}$$
, $\frac{5}{7}$, $\frac{23}{72}$, $\frac{94}{6}$, etc



Numbers

Real Numbers are divided to two parts:

- **1. Rational Numbers**
- 2. Irrational Numbers

<u>NOTE</u>: to make it easier to distinguish between rational and irrational numbers, irrational numbers are explained first.



Numbers

Irrational Numbers

Numbers that cannot become a simple fraction are called irrational numbers. Any real number can be irrational number if and only if the following two conditions are satisfied:



Numbers

Irrational Numbers

- Fractional numbers with unlimited and never ending decimals. In other words any fraction number must have infinity number of decimals.
- Note: If this condition is satisfied, then check the second condition. Otherwise, <u>NO NEED</u> to check the second condition.
- Second condition, decimal numbers must not be repeated or to be similar to each other.



Numbers

Examples:

- $\sqrt{2} = 1.41421356237 \dots$
- $\sqrt{3} = 1.7320508075 \dots$
- $\sqrt{5} = 2.2360679774 \dots$
- $\pi = 3.14159265358 \dots$

As you can see

- Number of decimals are unlimited and
- They are not similar to each other.
 Therefore, they are irrational number.



Numbers

Rational Numbers

- If a real number is not Irrational number then its for sure is a Rational number.
- Rational numbers must satisfy this mathematical expression

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Where, a and b are integers and $b \neq 0$.



Numbers

Examples:

• $-1, -2, -3, \dots -\infty$ are **Rational Numbers**.

As long as we can write it as

 $-\frac{1}{1}, -\frac{2}{1}, -\frac{3}{1}$



Numbers

Examples:

• 1, 2, 3 $\cdots \cdots + \infty$ are **Rational No**.

as long as we can write it as

$$\frac{1}{1}, \frac{2}{1}, \frac{3}{1}$$



Numbers

Examples:

• 0 is Rational Number.

as long as we can write it as

$$\frac{0}{1} = 0$$

$$-\frac{1}{2}, -\frac{1}{3}, -\frac{2}{3}, 0r, \frac{1}{2}, \frac{1}{3}, \frac{2}{3}$$



Numbers

Examples:

Simple fractions are

1.2 - 1.2

1.25 - 1.25

1.3 – 1.3

1.5 - 1.5



Numbers

Examples:

Numbers with unlimited, never-ending decimals, but

repeated or similar decimals such as;

• $\frac{1}{11} = 0.090909090909$



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Examples:

• $\frac{1}{22} = 0,045454545454545$

• $\frac{3}{7} = 0.428571$, 428571, 428571

• $\frac{3}{21} = 0.142857, 142857, 142857$



Numbers

There are three types of Rational Numbers:

- **1. Natural Numbers**
- 2. Whole Numbers
- 3. Integers



Numbers

Natural Numbers:

- All counting numbers Any number we can count it using our fingers is a Natural Number.
- Negative numbers and 0 are not natural numbers, because we cannot count them by our fingers.
- So, Natural Numbers start from 1 to $+\infty$



Numbers

Examples:

Natural Numbers are

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, ... + ∞

- $\frac{8}{2}$ Is a Natural Number, because its simple fraction
 - $\frac{8}{2} = 4$ and 4 can be counted using our gingers.



Numbers

Examples:

- NO negative numbers
- NO Fractions (points)

• $\frac{3}{2}$ Is not a Natural Number, because $\frac{3}{2} = 1.5$ is a Fractional number and we can't count it using our fingers.



Numbers

Examples:

- O cannot be counted by fingers, so O is not Natural Number.
- -1 or -2 or -3 cannot be counted by fingers, so -1, -2,
 -3 are not Natural Numbers.
- 0.3, 0.8, 0.5 cannot be counted by fingers, so they are not Natural Numbers.



Numbers

Whole Numbers

- Whole numbers are consisting of Natural numbers and 0.
- So, Whole Number start from 0 to $+\infty$
- NO negative numbers
- NO Fractions (points)



Numbers

Examples:

- **0**, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, +∞
- $\frac{4}{2}$ Is a Natural Number, because $\frac{4}{2} = 2$ and 2 can be counted using our gingers.
- Natural Numbers is also a Whole Number



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Examples:

• $\frac{5}{2}$ Is not a Natural Number because $\frac{5}{2} = 2.5$ is a Fractional number and we can't count it using our fingers. So, its neither Natural Number nor Whole

Number

-1 or -2 or -3 cannot be counted so -1, -2, -3 are not
 Natural Number. So, its not Whole Number



Numbers

Integers

- Integers are whole numbers and their opposites.
- Opposite Means $a \xrightarrow{\text{Opposite}} a$
- So, the Itegers start from $-\infty$ to $+\infty$
- NO Fractions (points)



Numbers

Examples:

- 1 \longleftrightarrow 1
- 2 <----- 2
- $\{-\infty, \cdots, -3, -2, -1, \mathbf{0}, 1, 2, 3, \cdots, +\infty\}$





Numbers

Imaginary Numbers:

An imaginary number¹ is a complex number that can be written as a real number multiplied by the imaginary unit i, which is defined by its property $i^2 =$ -1. The square of an imaginary number bi is $-b^2$. For example, 5i is an imaginary number, and its square is -25.

Examples: