Chapter Digitized

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ABOUT CALCULUS

Calculus is that branch of mathematics that deals with instantaneous rates of change of quantities (differentiation) and with the accumulation of quantities (integration). It grew out of a desire to understand various physical phenomena, such as the orbits of planets and the effects of gravity. The immediate success of calculus in formulating physical laws and predicting their consequences led to development of a new division in mathematics called analysis, of which calculus remains a large part.

- Calculus was invented, more or less simultaneously, by <u>Isaac Newton</u> (1642–1727) and Gottfried Leibniz (1646–1716).

- Calculus divides naturally into two parts, differential calculus and integral calculus.

- Differential calculus is concerned with finding the instantaneous rate at which one quantity changes with respect to another, called the derivative of the first quantity with respect to the second.

- Integral calculus deals with the inverse of the derivative, namely, finding a function when its rate of change is known.

How about getting a real case scenario? -

- Alex: "Hey Sam! How fast are we going now?"

- Sam: "Wait a minute …"

  - "Well in the last minute we went 1.2 km, so we are going:"

  - 1.2 km per minute x 60 minutes in an hour = 72 km/h

- Alex: "No, Sam! Not our average for the last minute, or even the last second, I want to know our speed RIGHT NOW."

- Sam: "OK, let us measure it up here … at this road sign… NOW!"

  - "OK, we were AT the sign for zero seconds, and the distance was … zero meters!"

  - The speed is 0m / 0s = 0/0 = I Don't Know!

"I can't calculate it Sam! I need to know some distance over some time, and you are saying the time should be zero? Can't be done."

That is amazing … you'd think it is easy to work out the speed of a car at any point in time, but it isn't.

Even the speedometer of a car just shows us an average of how fast we were going for the last (very short) amount of time.
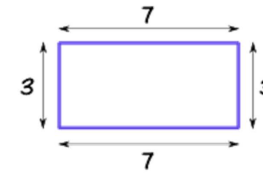
ABOUT PERIMETER

A perimeter is a path that encompasses/surrounds a two-dimensional shape. The term may be used either for the path, or its length—in one dimension. It can be thought of as the length of the outline of a shape. The perimeter of a circle or ellipse is called its circumference.

- Calculating the perimeter has several practical applications.

- A calculated perimeter is the length of fence required to surround a yard or garden.

- The perimeter of a wheel/circle (its circumference) describes how far it will roll in one revolution. Similarly, the amount of string wound around a spool is related to the spool's perimeter; if the length of the string was exact, it would equal the perimeter.

Example: the perimeter of this rectangle is 7+3+7+3 = 20

Example: the perimeter of this regular <u>pentagon</u> is: 3+3+3+3+3 = 5×3 = 15
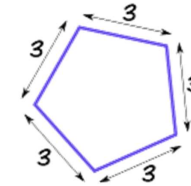
ABOUT PYTHAGOREAN THEOREM

The Pythagorean theorem, also known as Pythagoras' theorem, is a fundamental relation in Euclidean geometry among the three sides of a right triangle. It states that the area of the square whose side is the hypotenuse (the side opposite the right angle) is equal to the sum of the areas of the squares on the other two sides. This theorem can be written as an equation relating the lengths of the sides a, b and c, often called the "Pythagorean equation".

$$a^2 + b^2 = c^2$$

where c represents the length of the hypotenuse and a and b the lengths of the triangle's other two sides.
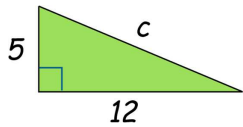
Example: A "3,4,5" triangle has a right angle in it.
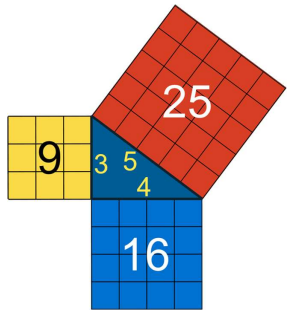
Let's check if the areas **are** the same: $3^2 + 4^2 = 5^2$

Calculating this becomes: $9 + 16 = 25$

Example: Solve this triangle

Start with:	$a^2 + b^2 = c^2$	
Substitute	$5^2 + 12^2 = c^2$	
Calculate squares:	$25 + 144 = c^2$	
	$25+144=169:169 = c^2$	
Swap sides:	$c^2 = 169$	
Square root of both sides	$c = \sqrt{169}$	
Calculate:	**c = 13**	

ABOUT TRIGONOMETRY

Trigonometry (from Greek trigōnon, "triangle" and metron, "measure") is a branch of mathematics that studies relationships between side lengths and angles of triangles.

- The Greeks focused on the calculation of chords, while mathematicians in India created the earliest-known tables of values for trigonometric ratios (also called trigonometric functions) such as sine.

- Trigonometry has been applied in areas such as geodesy, surveying, celestial mechanics, and navigation.

- Trigonometry is known for its many identities, which are equations used for rewriting trigonometrical expressions to solve equations, to find a more useful expression, or to discover new relationships

- Trigonometric ratios are the ratios between edges of a right triangle. These ratios are given by the following **trigonometric functions** of the known angle A, where a, b and c refer to the lengths of the sides.

Sine function (sin), defined as the ratio of the side opposite the angle to the hypotenuse.

$$\sin A = \text{opposite} / \text{hypotenuse} = a / c$$

Cosine function (cos), defined as the ratio of the adjacent leg (the side of the triangle joining the angle to the right angle) to the hypotenuse.

$$\cos A = \text{adjacent} / \text{hypotenuse} = b / c$$

Tangent function (tan), defined as the ratio of the opposite leg to the adjacent leg.

$$\tan A = \text{opposite} / \text{adjacent} = a / b = a/c / b / c = \sin A / \cos A$$

The hypotenuse is the side opposite to the 90-degree angle in a right triangle; it is the longest side of the triangle and one of the two sides adjacent to angle A. The adjacent leg is the other side that is adjacent to angle A. The opposite side is the side that is opposite to angle A. The terms perpendicular and base are sometimes used for the opposite and adjacent sides respectively.

ABOUT SCIENCE AND TECHNOLOGY

Science is a systematic process to gain knowledge through observation and experiments, and the practical application of science gives rise to technology. Technology is used to design products that improve the quality of human life.

- **Meaning of Science:** Science is a systematic way of acquiring knowledge about a field of study. Science helps us to gain knowledge, through an organized system of observation and experimentation. This system is used to describe different natural phenomena. The description is that of pure science, and biology, chemistry, physics and Earth science are the basic fields of pure science.

  Science has been applied to all aspects of everyday life, from transportation to even the increase in genetically modified organism foods, affecting everything that people eat as well as the ecosystem. It has changed the fields of medicine and introduced new materials like plastics, which are widely used in hundreds of applications.

- **Meaning of Technology:** Technology can be defined as the products, tools and processes used to accomplish tasks in daily life. Technology is the application of science to solve a problem. Technology involves the application of engineering and applied sciences to solve the practical problems of human lives.

  Technology is basically human knowledge that is used to create products and artifacts with the help of innovative tools, systems and materials. Technology is used for communication, manufacturing, learning, securing data and transportation.

- **Positive Impact of Science and Technology:** The impact of science and technology on humankind has been transformative on many levels. In particular, the birth of the Internet and its use by society has changed the way people communicate, learn and understand the world. Alongside the consumer aspect of technology, the advances in science and technology have also made great changes in the medical fields.

- **Negative Impact of Science and Technology:** While most advancements are seen in a positive light, there have been negative consequences to science and technology on society. There are new types of technological crimes that were not possible before, and some argue that it homogenizes communities and cultures. Also, people are developing a dependence on technology and devices, which have been likened to heroin-like addictive behaviors.
- The Future of Science and Technology

More and more, smart devices, appliances and homes are replacing the traditional, nontechnological counterparts. There is a move towards advancing Smart Cities, which are believed to be the way of the future.

One of the most talked about topic surrounding science and technology is the subject of artificial intelligence (AI). The world of AI and robotics is exploding while people are still considering its implications and ethical considerations. With the introduction of robotic police and increasingly intensified surveillance procedures, some people question the direction of science and technology, and whether it is good or bad for the future of humanity.

ABOUT DATA SCIENCE

Data Science is a detailed study of the flow of information from the colossal amounts of data present in an organization's repository. It involves obtaining meaningful insights from raw and unstructured data which is processed through analytical, programming, and business skills.

- In digital space, organizations deal with zettabytes and yottabytes of structured and unstructured data every day. Evolving technologies have enabled cost savings and smarter storage spaces to store critical data.

There is a huge growth in the field of Internet of Things (IoT), due to which 90 percent of the data has been generated in the current world. Every day, 2.5 quintillion bytes of data are generated, and it is more accelerated with the growth of IoT.

This data comes from all possible sources such as:

- Sensors used in shopping malls to gather shoppers' information
- Posts on social media platforms
- Digital pictures and videos captured in our phones
- Purchase transactions made through e-commerce

This data is known as big data.

Companies are flooded with colossal amounts of data. Thus, it is very important to know what to do with this exploding data and how to utilize it.
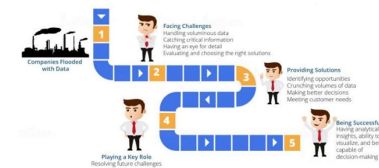
- Reduce costs
- Get into new markets
- Tap on different demographics
- Gauge the effectiveness of a marketing campaign
- Launch a new product or service

The concept of Data Science comes into the picture. Data Science brings together a lot of skills like statistics, mathematics, and business domain knowledge.