What is science?

According to the definition, *science* is understood as the provable and fact-based system of the objective relationships between *nature*, *society*, and *thinking*.

Science is not just a body of knowledge, but a process of discovery. *Science* aims to discover new information, facts, and answers about our world or the universe.

Science is distinguished from other historically established forms of social consciousness by the following characteristics:

Science has been highlighted because of the following criteria from our historically established social forms of consciousness:

- they possess high-reaching concepts or logical tools to formulate or express broad, general or universal **principles** or **laws**.
- they possess the required logical tools or methods that can help us to calculate or predict **results** in given circumstances
- they can describe the objective **conditions** under which these principles or laws will prevail.

Inductive Sciences

According to **law**, **conditions** (circumstances), and **results** (these three general aspects) we can categorize every scientific problem into the following problem groups.

Induction: the physical conditions are known, just like the results, and we are seeking for the general principle. this is the classical type of experimental physics problem.

flowchart TD E((Results)) F((Conditions)) T((Principles)) E-->T F-->T

Explanation: *Induction* is probably the most important logical method used by scientists to draft new *theories* or *principles*.

Induction is a generalizing method, which means that we seek a universal or general law from a given set of data with fixed conditions. A well-known example of this method is the Mendelian laws of inheritance.

The biggest problem with this method is whether we have (or have yet to) carry out sufficient observations to arrive at a general conclusion.

In natural sciences, we are always dealing with partial induction. The more experiments we do, the more confident we will become and the better our chances of understanding the connections.

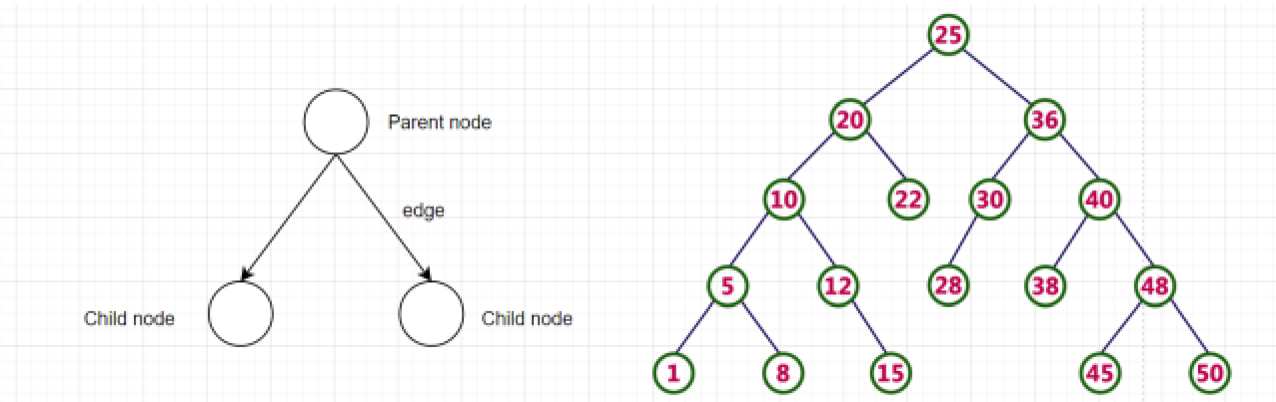
Our confidence is based on the premise that nature itself behaves consistently.

The so-called complete induction, which is used in mathematical problems, will bypass any kind of these problems.

Remark: Legislative processes are based on an inductive method that analyzes social problems and their causes and makes new laws as a conclusion.

Example: In **information technology**, mathematical induction can be applied to many areas, including algorithm analysis and data structures. One typical example is proving the correctness of algorithms or the properties of data structures like trees. Here's an example from **binary trees**:

Problem: Prove by induction that a **binary tree** with \(n\) nodes has exactly \(n-1\) edges. A *binary tree* is a hierarchical data structure where each node has at most two children (left and right). An *edge* is the connection between a *parent node* and a *child node*.



Steps for Mathematical Induction:

1. **Base Case** \((n = 1)\): For a binary tree with just one node (the root), there are no edges because there are no child nodes. Therefore, the number of edges is: $$ 0 = 1 - 1 $$
2. **Inductive Hypothesis**: Assume that for any binary tree with \(k\) nodes, the number of edges is \(k-1\).
3. **Inductive Step**: We must prove that if the statement holds for a binary tree with \(k\) nodes, then it also holds for a binary tree with \(k+1\) nodes.
   Suppose we add one more node to the binary tree, bringing the total number of nodes to \(k+1\). When we add this node, we also add exactly one edge connecting the new node to an existing node in the tree (either as a left or right child of a parent node).

   By the inductive hypothesis, the tree with \(k\) nodes has \((k - 1)\) edges. Adding one more node introduces one additional edge, so the number of edges in the tree with \((k + 1)\) nodes is: $$ (k-1) + 1 = k $$ This matches the formula for the number of edges in a tree with \((k + 1)\) nodes, which should be \((k-1) + 1 = k\).

Deductive Sciences

Deduction: the general principles and conditions are known and we seek several expected results. This is a typical example of theoretical physics.

Explanation:

Deduction must solve the initial, boundary or edge requirements of various differential equations.

This deductive method is the core of the so-called pure mathematics, where the theories are built from deductive results explicitly derived from axioms (just like in Euclidean geometry).

Then they take the results as principles if there a logically valid inference chain which has been derived from the axioms.

These deductive results will provide solid proofs that inductive methods can never achieve (assuming that the axioms are consistent).

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flowchart TD E((Results)) F((Conditions)) T((Principles)) T-->E F-->E

However, Deductive Logic cannot confirm whether a statement in the chain was true (or not).

Logic can only state that the results will be true if the premises are true (and consistent) and the arguments are logically correct.

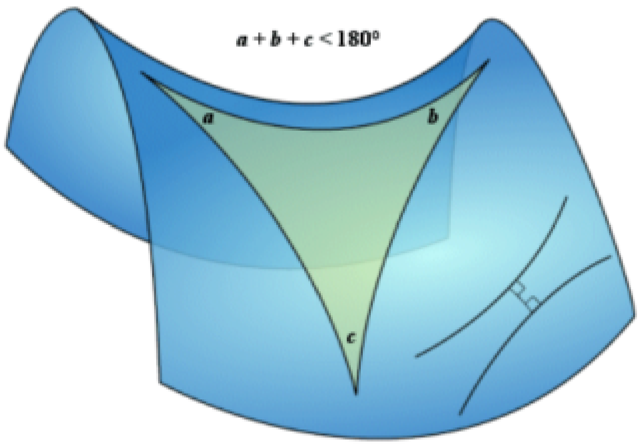
Bonus Content:

János Bólyai – a famous Hungarian mathematician – wrote this famous sentence to his father:

'*I have created a new and different world from scratch*.' He reached the conclusion that by changing the Fifth Axiom of the Euclidean principles, a new world could be created.

Fifth Axiom (Parallel Postulate): Given a straight line and a point not on the line, there is *exactly one straight line* that can be drawn through the point that is parallel to the given line.

People in his era were not really convinced by his theories, but today we have already known that our world is one of those which are based on different Euclidean geometrical principles.



Reductive Sciences

The main principles and the results are known and we are seeking the appropriate conditions which can realize our goals.

Explanation: these type of tasks are typical examples of technical sciences. However, sadly the solution cannot be inverted from the end results, therefore there can be an infinite number of terms which can get us to the known results. In this case we have to accept a few possibilities (or more usually only one). We usually get to this term in heuristic ways.

We can face another interpretation of reduction in the classification of elementary scientific problems (the so-called 'Trinity' of sciences).

In this case our main task is to reduce the number of possible solutions in a reasonable way.

flowchart TD E((Result)) F((Condition)) T((Principles)) T-->F E-->F