# AI/ML Introduction

Intelligence, Models, Learning

## Intelligence - *what is it?*

What is intelligence? How do you test or claim if someone you just met is intelligent or not?

Suppose, I referred a person to you, who I have known for years that he is intelligent. Now, before you hire him for a specific job, you need to know (or test) if he is really intelligent as I claim. Let's say, you came up with a plan to test him. Now, we realize the person (call him 'A') has these disabilities:

a. He can't *listen*
b. He can't *speak*
c. He can't *see* or *read*, nor can he *write*.

Can you now make a plan on 'how would you know if such a person is intelligent or not'?

Assuming you decided not to hire him for other reasons (beyond the disabilities listed above). I referred to another intelligent person (call her 'B'), who does not have the above disabilities. In fact she can read, write three-times faster than an average person. But she has this problem – "*she can't remember anything beyond three minutes*". What would be your plan to test her intelligence?

## Models - what are those?

We saw this problem - of guessing the next number, and the formulation of T(n) which represent the $n^{th}$ number in the sequence:

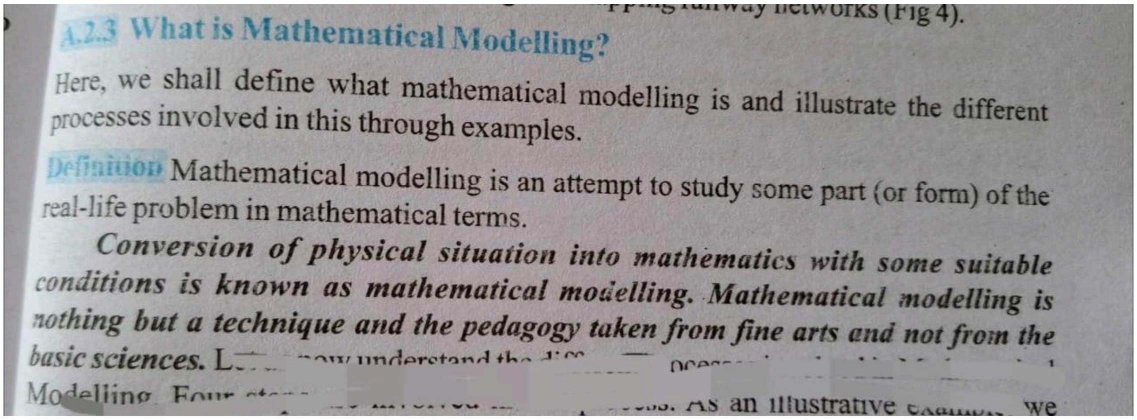
| | **1st** | **2nd** | **3rd** | **4th** | **5th** | **T(n)** |
|---|---|---|---|---|---|---|
| **Ex1** | 1 | 3 | 5 | 7 | ? | ? |
| **Ex2** | 1 | 4 | 9 | 16 | ? | ? |
| **Ex3** | 2 | 7 | 14 | 23 | ? | ? |

What's the advantage of having T(n) formulation? Say, I ask you to find the 100th number in each of those sequences, who would likely do it faster:

a. the one who knows T(n), OR,
b. the one who would build it up one-by-one going through each term, and building the next term subsequently?

What would you refer to such a *formulation*? And what does it take to build such a formulation for *every* real life problem we see?

Let's see some excerpts taken randomly from some of the books (sources mentioned).



...railway networks (Fig 4).

### A.2.3 What is Mathematical Modelling?

Here, we shall define what mathematical modelling is and illustrate the different processes involved in this through examples.

**Definition** Mathematical modelling is an attempt to study some part (or form) of the real-life problem in mathematical terms.

***Conversion of physical situation into mathematics with some suitable conditions is known as mathematical modelling. Mathematical modelling is nothing but a technique and the pedagogy taken from fine arts and not from the basic sciences.*** L... now understand the ... Modelling. Four ... As an illustrative ... we

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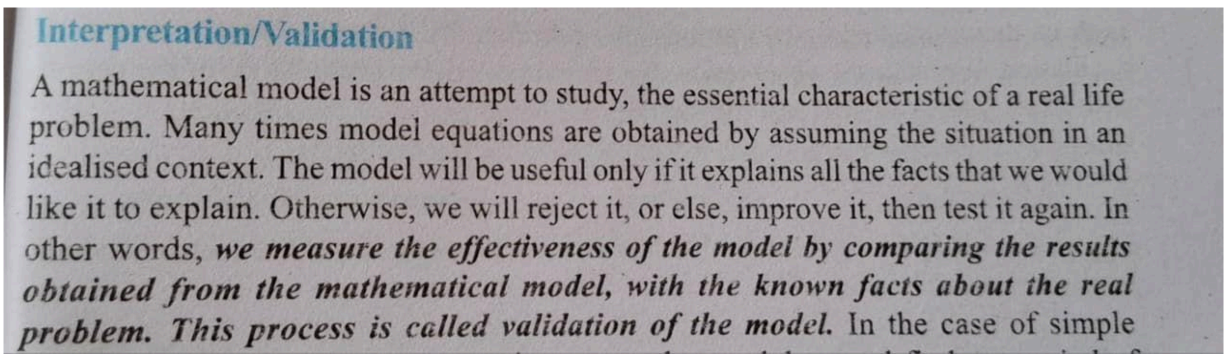

### Interpretation/Validation

A mathematical model is an attempt to study, the essential characteristic of a real life problem. Many times model equations are obtained by assuming the situation in an idealised context. The model will be useful only if it explains all the facts that we would like it to explain. Otherwise, we will reject it, or else, improve it, then test it again. In other words, ***we measure the effectiveness of the model by comparing the results obtained from the mathematical model, with the known facts about the real problem. This process is called validation of the model.*** In the case of simple

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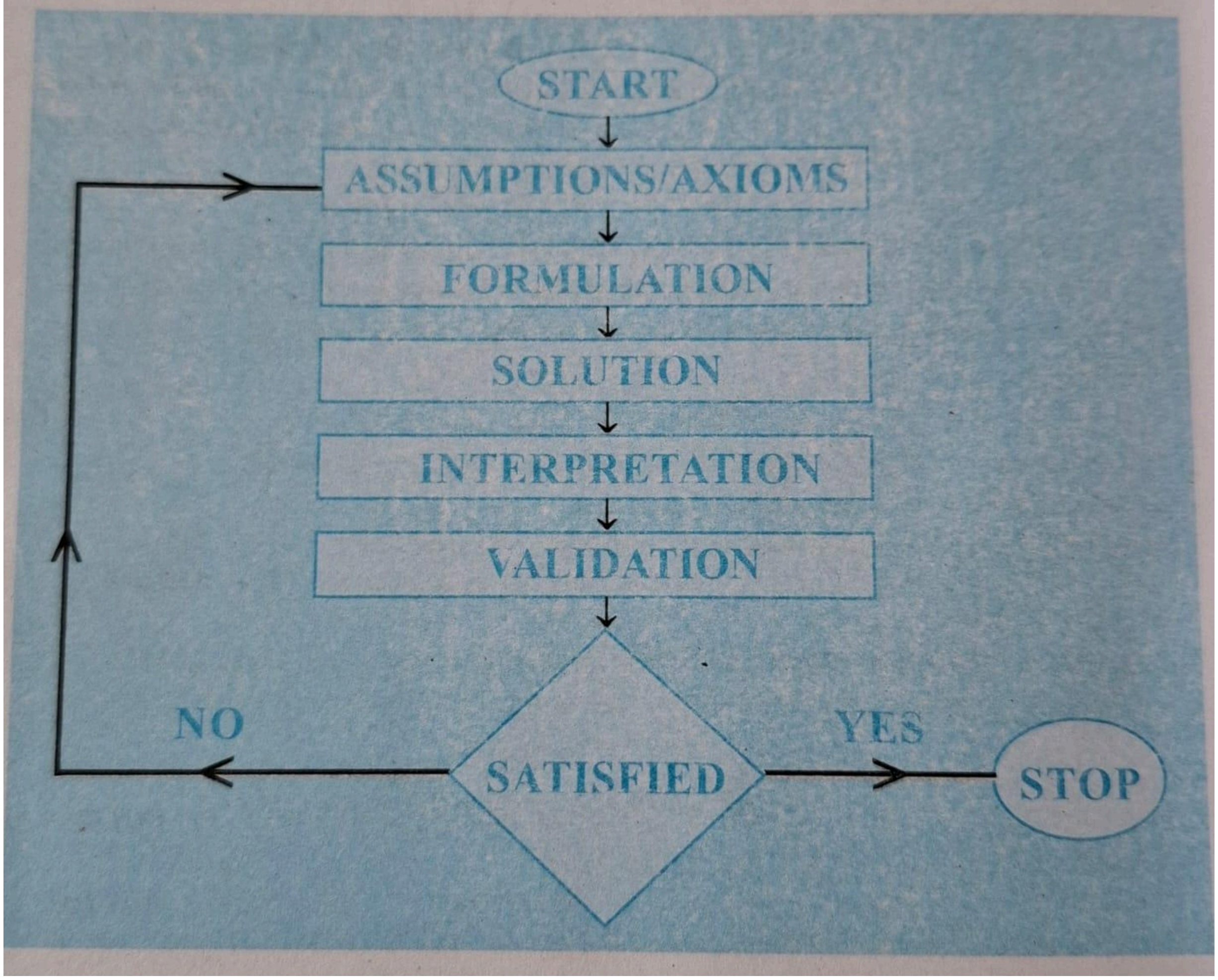
Since a mathematical model is a simplified representation of a real problem, by its very nature, has built-in assumptions and approximations. Obviously, the most important question is to decide whether our model is a good one or not i.e., when the obtained results are interpreted physically whether or not the model gives reasonable answers. If a model is not accurate enough, we try to identify the sources of the shortcomings. It may happen that we need a new formulation, new mathematical manipulation and hence a new evaluation. Thus mathematical modelling can be a cycle of the modelling process as shown in the flowchart given below:

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This section summarizes the fundamental concepts of logical representation and reasoning. These beautiful ideas are independent of any of logic's particular forms. We therefore postpone the technical details of those forms until the next section, using instead the familiar example of ordinary arithmetic.

SYNTAX

In Section 7.1, we said that knowledge bases consist of sentences. These sentences are expressed according to the **syntax** of the representation language, which specifies all the sentences that are well formed. The notion of syntax is clear enough in ordinary arithmetic: "$x + y = 4$" is a well-formed sentence, whereas "$x4y+ =$" is not.

SEMANTICS
TRUTH
POSSIBLE WORLD

A logic must also define the **semantics** or meaning of sentences. The semantics defines the **truth** of each sentence with respect to each **possible world**. For example, the semantics for arithmetic specifies that the sentence "$x + y = 4$" is true in a world where $x$ is 2 and $y$ is 2, but false in a world where $x$ is 1 and $y$ is 1. In standard logics, every sentence must be either true or false in each possible world—there is no "in between."[1]

MODEL

When we need to be precise, we use the term **model** in place of "possible world." Whereas possible worlds might be thought of as (potentially) real environments that the agent might or might not be in, models are mathematical abstractions, each of which simply fixes the truth or falsehood of every relevant sentence. Informally, we may think of a possible world as, for example, having $x$ men and $y$ women sitting at a table playing bridge, and the sentence $x + y = 4$ is true when there are four people in total. Formally, the possible models are just all possible assignments of real numbers to the variables $x$ and $y$. Each such assignment fixes the truth of any sentence of arithmetic whose variables are $x$ and $y$. If a sentence $\alpha$ is true in model $m$, we say that $m$ **satisfies** $\alpha$ or sometimes $m$ **is a model of** $\alpha$. We use the notation $M(\alpha)$ to mean the set of all models of $\alpha$.

SATISFACTION

ENTAILMENT

Now that we have a notion of truth, we are ready to talk about logical reasoning. This involves the relation of logical **entailment** between sentences—the idea that a sentence *follows logically* from another sentence. In mathematical notation, we write

$$\alpha \models \beta$$

The book "Artificial Intelligence" by Stuart J. Russel and Peter Norvig

Gather your thoughts around why models are important in Artificial Intelligence (*short*: AI)? What are we trying to model in AI?

## Learning

Find out various texts/books/articles on what's commonly understood as *Learning*. Here is another excerpt from a book (source mentioned):

LEARNING

An agent is **learning** if it improves its performance on future tasks after making observations about the world. Learning can range from the trivial, as exhibited by jotting down a phone number, to the profound, as exhibited by Albert Einstein, who inferred a new theory of the universe. In this chapter we will concentrate on one class of learning problem, which seems restricted but actually has vast applicability: from a collection of input–output pairs, learn a function that predicts the output for new inputs.

Why would we want an agent to learn? If the design of the agent can be improved, why wouldn't the designers just program in that improvement to begin with? There are three main reasons. First, the designers cannot anticipate all possible situations that the agent might find itself in. For example, a robot designed to navigate mazes must learn the layout of each new maze it encounters. Second, the designers cannot anticipate all changes over time; a program designed to predict tomorrow's stock market prices must learn to adapt when conditions change from boom to bust. Third, sometimes human programmers have no idea how to program a solution themselves. For example, most people are good at recognizing the faces of family members, but even the best programmers are unable to program a computer to accomplish that task, except by using learning algorithms. This chapter first gives an overview of the various forms of learning, then describes one popular approach, decision-tree learning, in Section 18.3, followed by a theoretical analysis of learning in Sections 18.4 and 18.5. We look at various learning systems used in practice: linear models, nonlinear models (in particular, neural networks), nonparametric models, and support vector machines. Finally we show how ensembles of models can outperform a single model.

The book "Artificial Intelligence" by Stuart J. Russel and Peter Norvig

What did you *learn* from the above excerpt? Look for the *terms* and *phrases* in the excerpt that you do not know or understand – what steps will you take to *learn* those?