

Lecture 3

Algorithms, Computer Programs and Machine Learning

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Machine Learning: The New Science

Part I

What is this New Science of Machine Learning?

Putting Machine Learning in the context of Artificial Intelligence (AI)

 Introduction, Lecture 0

Part II

Foundational Concepts of Machine Learning

 Lectures 1 – 12.

Part III

Solving Real Life Problems with Machine Learning

 Lectures 13 – 25.

Part IV

Machine Learning: The Changing Landscape of Knowledge

(Near and the Not So Distant Future)

 Lectures 26, 27.

We have talked about algorithms in the previous two chapters. It seems we simply cannot talk of anything else 😊. We need to talk about it some more. And then we'll keep talking about it in the forthcoming lectures till the end of this course!

As we have said, an algorithm is a set of instructions, given in a sequential order to a computer telling it what to do and how to execute a task. But the way the algorithm is fed into the computer is via what we call a computer program. A computer program is somewhat like a natural language – English, Spanish, Bengali, Swahili – that humans speak with a certain grammar and syntax. A

big difference is that it is not natural but man-made; computer programs are devised by human beings to talk to computers. Computers understand algorithms, the instructions given by human beings, in a certain specific way. That way is the computer program.

A computer program is a very specific manner in which the algorithm is expressed, written for the benefit of the computer. It is a language that is needed to communicate with the computer. Just as there are numerous natural languages, such as English, Bengali, Cantonese, etc. there are also numerous computer programming languages such as Java, Visual Basic, C++ and many others. Just as natural languages are independent of the content and knowledge (a “tree” in any natural language is a tree) computer programming languages are also independent of content and knowledge. You can ask a computer to solve a difficult math problem by writing the math algorithm in any of the programming languages such as Java, C++ or Visual Basic and the result will remain the same.

This is how conventional computer programming looks like.

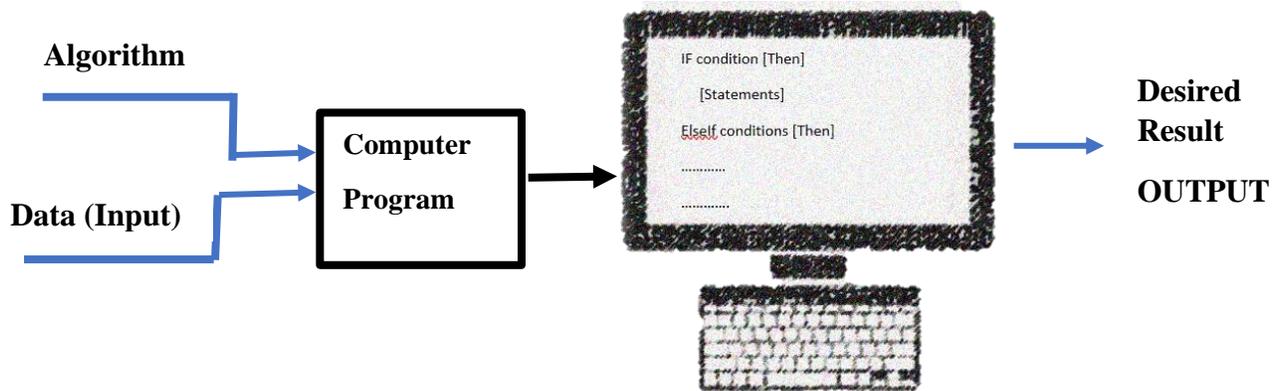


Figure 3.1 The conventional computer programming

Machine Learning Paradigm

Machine Learning turns conventional computer programming upside down. In the world of machine learning there is no need for any computer programming (and, computer programmers). We do not need to hard code any problem. The computer learns on its own from the data that we

present to the computer along with the output (the desired result) that is given in advance. So, then what does machine learning do? It generates the algorithm that is embedded in the data.

The very algorithms that we have devised using the knowledge – in every domain from physics to physiology to biology – that we have acquired over centuries and millennia of collective human learning, our prized possession, our secret weapon against the machines (to keep them dumb forever), the fruit of our brains’ struggles over time, those very algorithms are learnt and generated by the machine. In machine learning we solve the inverse problem. In conventional computer science (in this phrase, I have deliberately used the word “conventional” to delineate the distinction between computer science and machine learning and yet implying that the latter is a sub-field of the former even though I subscribe to the general understanding that machine learning is a whole new discipline and a brand new science totally separate from computer science) the inputs to the computer are the data and the algorithm and the output is the desired result. In machine learning, on the other hand, the inputs are the data and the desired result and the output is the algorithm.

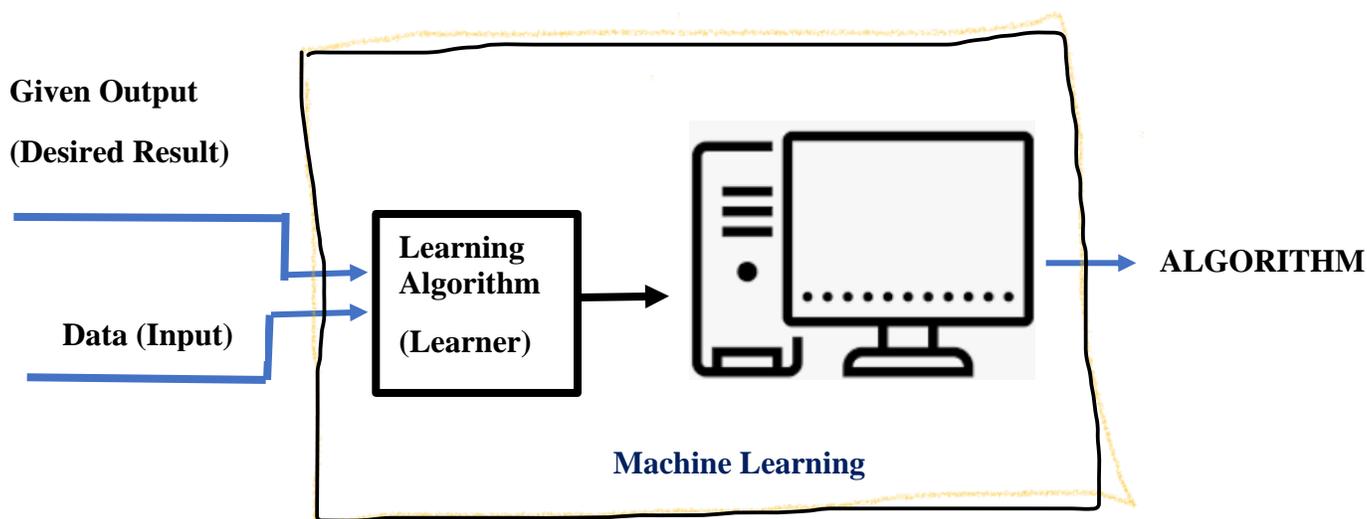


Figure 3.2 The machine learning paradigm

In the above picture, notice that the computer is shown without a key board. I perceive that in the near future there will be minimal or perhaps, even no use of a keyboard as computers will be writing their own programs and giving instructions to themselves internally.

Of course, we need to bear in mind that a “Learning Algorithm” – of which, we will talk more about in the coming lectures – is very different from the algorithms that we have talked so far. So far, we have talked about how algorithms are within the domain of human knowledge and in the field of conventional computer science; the algorithms that run our lives, the algorithms that are used to solve problems in physics, engineering, medical science and that run on our cellular phones and all other gadgets that have become a constant fixture of our lives. The algorithms that we have talked about so far have been synthesized inside a human brain and fed into the computer via a program.

But **learning algorithms** are special kinds of algorithms that let computers learn from data. We talk a great deal about them in the forthcoming lectures. They are the algorithms that generate all the other conventional algorithms (that we have talked about so far and that govern our lives at home and workplace) inside a computer. A learning algorithm like a computer’s brain.

We’ll talk more about learning algorithms in the next lecture.

References:

- Domingos, Pedro, *The Master Algorithm*, Basic Books, 2015
- Khanna, Rahul, Mariette Awad, *Efficient Learning Machines, Theories, Concepts, and Applications for Engineers and System Designers*, Apress Open, 2015
- Russell, Stuart, Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd edition, Pearson, 2014

Machine Learning: The New Science is an **online course** developed by Risk Latte AI to increase awareness and a very basic understanding of the field of Machine Learning, the new science that is taking our world by storm. In the next ten years, the world that we see around us would have changed completely, thanks to machine learning. In the next 20 to 30 years at most we, the human beings, would be in a totally uncharted territory, once again thanks to machine learning and the much bigger and related discipline of artificial intelligence (AI). In more ways than one, machine learning is the stepping stone to understanding artificial intelligence. Machine learning is a very important sub-field of artificial intelligence.

This online course prepares a person to start off with a more formal **Machine Learning 101** course. This course contains very easy to understand lectures and simple tutorials implemented in Microsoft Excel™ to illustrate real life problem solving using machine learning algorithms.

- This course is primarily targeted towards high school, college and university students and middle to senior level working professionals and executives around the world who have a very basic knowledge of mathematics and a very limited or even **no knowledge** of computer programming.
- For certain segments of our target audience, such as certain specific groups of high school, college and university students in India and other developing countries this online course costs only US\$8.00 (USD Eight only).
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