Artificial Intelligence Basics

A Non-Technical Introduction

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Introduction

On the face of it, the Uber app is simple. With just a couple clicks, you can hail a driver within a few minutes.

But behind the scenes, there is an advanced technology platform, which relies heavily on artificial intelligence (AI). Here are just some of the capabilities:

- A Natural Language Processing (NLP) system that can understand conversations, allowing for a streamlined experience
- Computer vision software that verifies millions of images and documents like drivers' licenses and restaurant menus
- Sensor processing algorithms that help improve the accuracy in dense urban areas, including automatic crash detection by sensing unexpected movement from the phone of a driver or passenger
- Sophisticated machine learning algorithms that predict driver supply, rider demand, and ETAs

Such technologies are definitely amazing, but they are also required. There is no way that Uber could have scaled its growth—which has involved handling over 10 billion trips—without AI. In light of this, it should be no surprise that the company spends hundreds of millions on the technology and has a large group of AI experts on staff.[1]

But AI is not just for fast-charging startups. The technology is also proving a critical priority for traditional companies. Just look at McDonald's. In 2019, the company shelled out $300 million to acquire a tech startup, Dynamic Yield. It was the company's largest deal since it purchased Boston Market in 1999.[2]

Dynamic Yield, which was founded in 2011, is a pioneer in leveraging AI for creating personalized customer interactions across the Web, apps, and email. Some of its customers include the Hallmark Channel, IKEA, and Sephora.

As for McDonald's, it has been undergoing a digital transformation—and AI is a key part of the strategy. With Dynamic Yield, the company plans to use the technology to reimagine its Drive Thru, which accounts for a majority of its revenues. By analyzing data, such as the weather, traffic, and time of day, the digital menus will be dynamically changed to enhance the revenue opportunities. It also looks like McDonald's will use geofencing and even image recognition of license plates to enhance the targeting.

But this will just be the start. McDonald's expects to use AI for in-store kiosks and signage as well as the supply chain.

The company realizes that the future is both promising and dangerous. If companies are not proactive with new technologies, they may ultimately fail. Just look at how Kodak was slow to adapt to digital cameras. Or consider how the taxi industry did not change when faced with the onslaught of Uber and Lyft.

On the other hand, new technologies can be almost an elixir for a company. But there needs to be a solid strategy, a good understanding of what's possible, and a willingness to take risks. So in this book, I'll provide tools to help with all this.

OK then, how big will AI get? According to a study from PWC, it will add a staggering $15.7 trillion to the global GDP by 2030, which is more than the combined output of China and India. The authors of the report note: "AI touches almost every aspect of our lives. And it's only just getting started."[3]

True, when it comes to predicting trends, there can be a good deal of hype. However, AI may be different because it has the potential for turning into a general-purpose technology. A parallel to this is what happened in the nineteenth century with the emergence of electricity, which had a transformative impact across the world.

As a sign of the strategic importance of AI, tech companies like Google, Microsoft, Amazon.com, Apple, and Facebook have made substantial investments in this industry. For example, Google calls itself an "AI-first" company and has spent billions buying companies in the space as well as hiring thousands of data scientists.

As for this book, the goal is to provide actionable advice that can make a big difference in your organization and career. Now you will not find deeply technical explanations, code snippets, or equations. Instead, *Artificial Intelligence Basics* is about answering the top-of-mind questions that managers have: Where does AI make sense? What are the gotchas? How do you evaluate the technology? What about starting an AI pilot?

This book also takes a real-world view of the technology. A big advantage I have as a writer for Forbes.com and an advisor in the tech world is that I get to talk to many talented people in the AI field—and this helps me to identify what is really important in the industry. I also get to learn about case studies and examples of what works.

This book is organized in a way to cover the main topics in AI—and you do not have to read each chapter in order. *Artificial Intelligence Basics* is meant to be a handbook.

Here are brief descriptions of the chapters:

- *Chapter 1—AI Foundations*: This is an overview of the rich history of AI, which goes back to the 1950s. You will learn about brilliant researchers and computer scientists like Alan Turing, John McCarthy, Marvin Minsky, and Geoffrey Hinton. There will also be coverage of key concepts like the Turing Test, which gauges if a machine has achieved true AI.
- *Chapter 2—Data*: Data is the lifeblood of AI. It's how algorithms can find patterns and correlations to provide insights. But there are landmines with data, such as quality and bias. This chapter provides a framework to work with data in an AI project.
- *Chapter 3—Machine Learning*: This is a subset of AI and involves traditional statistical techniques like regressions. But in this chapter, we'll also cover the advanced algorithms, such as k-Nearest Neighbor (k-NN) and the Naive Bayes Classifier. Besides this, there will be a look at how to put together a machine learning model.
- *Chapter 4—Deep Learning*: This is another subset of AI and is clearly the one that has seen much of the innovation during the past decade. Deep learning is about using neural networks to find patterns that mimic the brain. In the chapter, we'll take a look at the main algorithms like recurrent neural networks (RNNs), convolutional neural networks (CNNs), and generative adversarial networks (GANs). There will also be explanations of key concepts like backpropagation.

- *Chapter 5—Robotic Process Automation:* This uses systems to automate repetitive processes, such as inputting data in a Customer Relationship Management (CRM) system. Robotic Process Automation (RPA) has seen tremendous growth during the past few years because of the high ROI (Return on Investment). The technology has also been an introductory way for companies to implement AI.
- *Chapter 6—Natural Language Processing (NLP)*: This form of AI, which involves understanding conversations, is the most ubiquitous as seen with Siri, Cortana, and Alexa. But NLP systems, such as chatbots, have also become critical in the corporate world. This chapter will show ways to use this technology effectively and how to avoid the tricky issues.
- *Chapter 7—Physical Robots*: AI is starting to have a major impact on this industry. With deep learning, it is getting easier for robots to understand their environments. In this chapter, we'll take a look at both consumer and industrial robots, such as with a myriad of use cases.
- *Chapter 8—Implementation of AI*: We'll take a step-by-step approach to putting together an AI project, from the initial concept to the deployment. This chapter will also cover the various tools like Python, TensorFlow, and PyTorch.
- *Chapter 9—The Future of AI:* This chapter will cover some of the biggest trends in AI like autonomous driving, weaponization of AI, technological unemployment, drug discovery, and regulation.

At the back of the book, you'll also find an appendix of resources for further study and a glossary of common terms related to AI.

interested in; our banking apps provide us with reminders; and on and on. This personalized content creation almost seems magical but is quickly becoming normal in our everyday lives.

To understand AI, it's important to have a grounding in its rich history. You'll see how the development of this industry has been full of breakthroughs and setbacks. There is also a cast of brilliant researchers and academics, like Alan Turing, John McCarthy, Marvin Minsky, and Geoffrey Hinton, who pushed the boundaries of the technology. But through it all, there was constant progress.

Let's get started.

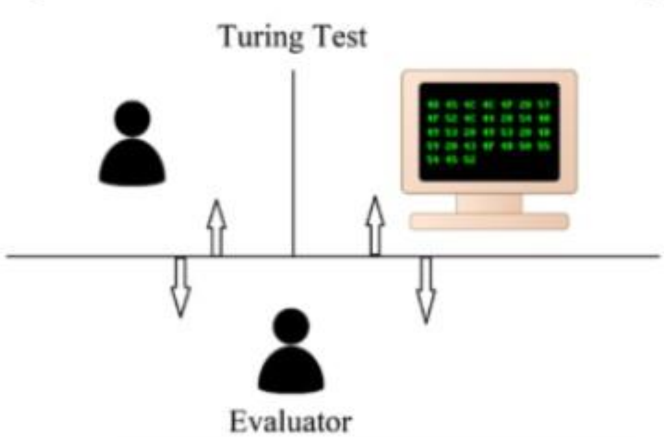
Alan Turing and the Turing Test

Alan Turing is a towering figure in computer science and AI. He is often called the "father of AI."

In 1936, he wrote a paper called "On Computable Numbers." In it, he set forth the core concepts of a computer, which became known as the Turing machine. Keep in mind that real computers would not be developed until more than a decade later.

Yet it was his paper, called "Computing Machinery and Intelligence," that would become historic for AI. He focused on the concept of a machine that was intelligent. But in order to do this, there had to be a way to measure it. What is intelligence—at least for a machine?

This is where he came up with the famous "Turing Test." It is essentially a game with three players: two that are human and one that is a computer. The evaluator, a human, asks open-ended questions of the other two (one human, one computer) with the goal of determining which one is the human. If the evaluator cannot make a determination, then it is presumed that the computer is intelligent. Figure 1-1 shows the basic workflow of the Turing Test.



The genius of this concept is that there is no need to see if the machine actually knows something, is self-aware, or even if it is correct. Rather, the Turing Test indicates that a machine can process large amounts of information, interpret speech, and communicate with humans.

Turing believed that it would actually not be until about the turn of the century that a machine would pass his test. Yes, this was one of many predictions of AI that would come up short.

So how has the Turing Test held up over the years? Well, it has proven to be difficult to crack. Keep in mind that there are contests, such as the Loebner Prize and the Turing Test Competition, to encourage people to create intelligent software systems.

In 2014, there was a case where it did look like the Turing Test was passed. It involved a computer that said it was 13 years old.[2] Interestingly enough, the human judges likely were fooled because some of the answers had errors.

Then in May 2018 at Google's I/O conference, CEO Sundar Pichai gave a standout demo of Google Assistant.[3] Before a live audience, he used the device to call a local hairdresser to make an appointment. The person on the other end of the line acted as if she was talking to a person!

Amazing, right? Definitely. Yet it still probably did not pass the Turing Test. The reason is that the conversation was focused on one topic—not open ended.

As should be no surprise, there has been ongoing controversy with the Turing Test, as some people think it can be manipulated. In 1980, philosopher John Searle wrote a famous paper, entitled "Minds, Brains, and Programs," where he set up his own thought experiment, called the "Chinese room argument" to highlight the flaws.

Here's how it worked: Let's say John is in a room and does not understand the Chinese language. However, he does have manuals that provide easy-to-use rules to translate it. Outside the room is Jan, who does understand the language and submits characters to John. After some time, she will then get an accurate translation from John. As such, it's reasonable to assume that Jan believes that John can speak Chinese.

Searle's conclusion:

> The point of the argument is this: if the man in the room does not understand Chinese on the basis of implementing the appropriate program for understanding Chinese then neither does any other digital computer solely on that basis because no computer, qua computer, has anything the man does not have.[4]

It was a pretty good argument—and has been a hot topic of debate in AI circles since.

Searle also believed there were two forms of AI:

- *Strong AI*: This is when a machine truly understands what is happening. There may even be emotions and creativity. For the most part, it is what we see in science fiction movies. This type of AI is also known as Artificial General Intelligence (AGI). Note that there are only a handful of companies that focus on this category, such as Google's DeepMind.
- *Weak AI*: With this, a machine is pattern matching and usually focused on narrow tasks. Examples of this include Apple's Siri and Amazon's Alexa.

The reality is that AI is in the early phases of weak AI. Reaching the point of strong AI could easily take decades. Some researchers think it may never happen.

Given the limitations to the Turing Test, there have emerged alternatives, such as the following:

- *Kurzweil-Kapor Test*: This is from futurologist Ray Kurzweil and tech entrepreneur Mitch Kapor. Their test requires that a computer carry on a conversation for two hours and that two of three judges believe it is a human talking. As for Kapor, he does not believe this will be achieved until 2029.
- *Coffee Test*: This is from Apple co-founder Steve Wozniak. According to the coffee test, a robot must be able to go into a stranger's home, locate the kitchen, and brew a cup of coffee.

The Origin Story

John McCarthy's interest in computers was spurred in 1948, when he attended a seminar, called "Cerebral Mechanisms in Behavior," which covered the topic of how machines would eventually be able to think. Some of the participants included the leading pioneers in the field such as John von Neumann, Alan Turing, and Claude Shannon.

McCarthy continued to immerse himself in the emerging computer industry—including a stint at Bell Labs—and in 1956, he organized a ten-week research project at Dartmouth University. He called it a "study of artificial intelligence." It was the first time the term had been used.

The attendees included academics like Marvin Minsky, Nathaniel Rochester, Allen Newell, O. G. Selfridge, Raymond Solomonoff, and Claude Shannon. All of them would go on to become major players in AI.

The goals for the study were definitely ambitious:

> The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.[5]

At the conference, Allen Newell, Cliff Shaw, and Herbert Simon demoed a computer program called the Logic Theorist, which they developed at the Research and Development (RAND) Corporation. The main inspiration came from Simon (who would win the Nobel Prize in Economics in 1978). When he saw how computers printed out words on a map for air defense systems, he realized that these machines could be more than just about processing numbers. It could also help with images, characters, and symbols—all of which could lead to a thinking machine.

Regarding Logic Theorist, the focus was on solving various math theorems from *Principia Mathematica*. One of the solutions from the software turned out to be more elegant—and the co-author of the book, Bertrand Russell, was delighted.

Next, there was Frank Rosenblatt, who believed that AI needed to use systems similar to the brain like neural networks (this field was also known as connectionism). But instead of calling the inner workings neurons, he referred to them as perceptrons. A system would be able to learn as it ingested data over time.

In 1957, Rosenblatt created the first computer program for this, called the Mark I Perceptron. It included cameras to help to differentiate between two images (they had 20 × 20 pixels). The Mark I Perceptron would use data that had random weightings and then go through the following process:

1. Take in an input and come up with the perceptron output.
2. If there is not a match, then
    a. If the output should have been 0 but was 1, then the weight for 1 will be decreased.
    b. If the output should have been 1 but was 0, then the weight for 1 will be increased.
3. Repeat steps #1 and #2 until the results are accurate.

This was definitely pathbreaking for AI. The *New York Times* even had a write-up for Rosenblatt, extolling "The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence."[7]

But there were still nagging issues with the perceptron. One was that the neural network had only one layer (primarily because of the lack of computation power at the time). Next, brain research was still in the nascent stages and did not offer much in terms of understanding cognitive ability.

Minsky would co-write a book, along with Seymour Papert, called *Perceptrons* (1969). The authors were relentless in attacking Rosenblatt's approach, and it quickly faded away. Note that in the early 1950s Minsky developed a crude neural net machine, such as by using hundreds of vacuum tubes and spare parts from a B-24 bomber. But he saw that the technology was nowhere at a point to be workable.

Rosenblatt tried to fight back, but it was too late. The AI community quickly turned sour on neural networks. Rosenblatt would then die a couple years later in a boating accident. He was 43 years old.

Yet by the 1980s, his ideas would be revived—which would lead to a revolution in AI, primarily with the development of deep learning.