ARTIFICIAL INTELLIGENCE EPISODE 2 - THE IMITATION GAME AND BUSINESS

TECH

MAY 2019 | 20 MINUTE READ

Christophe Leclerc
Partner

Gil-Arnaud Coche
Manager

Take care of the pennies and the pounds will take care of themselves
Popular British saying

You insist that there is something a machine cannot do. If you will tell me precisely what it is that a machine cannot do, then I can always make a machine which will do just that!
John Von Neumann (1948)

Companies' operations are complex and costly. They have entire teams dedicated to making sure that penny leaks (which can be substantial) are contained and dealt with. These teams receive assistance from elaborate systems that gather, store and analyse data.

These elaborate systems are composed of multiple ***Artificial Intelligence*** (AI) bricks[1], which significantly increase the accuracy of performance assessment and decision-making, whether it be on compliance issues, investment strategies or operations management.

In this article, we will ask what is artificial intelligence and examine how it can be applied to business.

[1] *As discussed in the third section, an AI system is made of multiple bricks. These AI bricks, within their decision perimeter, are AIs themselves. Once incorporated in bigger systems, the term AI brick becomes more appropriate as they become a part of some higher intelligence system.*

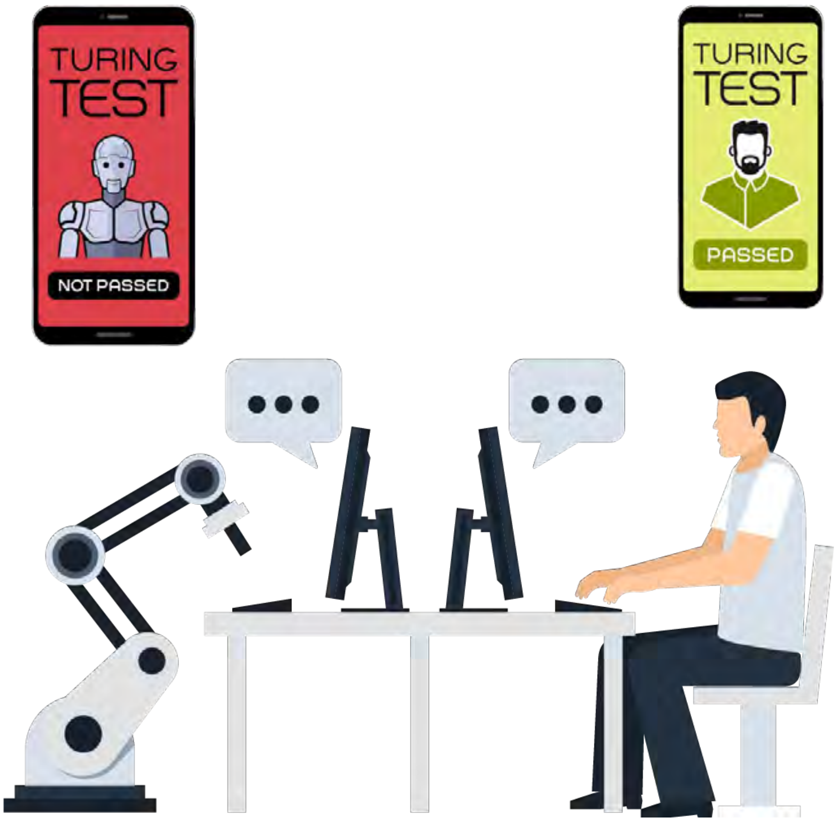
1. THE IMITATION GAME: A RULE-BASED GAME

We cannot talk about AI without mentioning this philosophical cornerstone. The ***Imitation Game*** first appeared for the first time in an article by the English mathematician Alan Turing[2], the instigator of modern AI. He argued very early on that machines would one day be able to perform any task better than humans could. In his 1950 discourse in the scientific journal 'Mind', he felt uneasy with the question:

'Can machines think?'

He considered that defining the terms would be tricky and, instead, chose to introduce a question and answer (Q&A) game played by a human, a machine and a judge. In it, the judge could ask any questions that he or she wanted. At the end of the game, the judge had to decide whether one of the players was a machine, and if so, identify which one it was. According to Turing, if the judge was unable to distinguish between the human player and the robotic one, then the machine would pass the ***Turing Test***.

Figure – Turing Test



Turing considered that any machine able to fool the human judge would be an ***Artificial Intelligence***.

He based the Imitation Game on questions and answers, feeling that it would be the best way to focus on all the particularities of the human mind without favouring either the machine or the human player.

---

[2] *TURING, A M, Computing Machinery and Intelligence, 1950.*

However, the essence of this test is not in the form of the game itself (here a very broad Q&A) but rather on the idea that ***for a given game, a machine can achieve human-like skills so that an external observer cannot distinguish it from a human player.*** We may therefore say that, within the context of a game of some sort, any form of AI automatically imitates a human player. Such an approach enlarges the realm of AI, with the rules of the game becoming essential to determine what qualifies as imitation.[3]
This philosophical twist might seem like a convenient intellectual argument to label certain algorithms – which would otherwise not be – as AI, but this is not the intent.

Instead, the intent is to circumvent disputes around the scope of AI.[4] One of the most evident sources of dispute comes from the ***AI effect***: as soon as AI solves a problem, the problem is no longer part of AI.[5] The AI effect constantly requires the redefinition of AI unnecessarily. To settle matters, we have turned to historical figures of philosophy, mathematics and computer science, like George Boole and Alan Turing (and many others[6]), to guide our definition process.

Figure – George Boole (1815–1864) and Alan Turing (1912–1954)

Concisely, intelligence is a combinatorial and Boolean matter. Any situation requiring intelligent decision-making can be modelled with a decision tree. To take into account what would be a better decision, this model attributes utility weights to each of the leaf nodes. The intelligent decision is the one given by the leaf node with the highest utility value. The tree exists within a set of rules defined by what we can call a 'game'. If a machine plays the game and imitates humans to the point of fooling them, it is an AI.

Of course, this assertion raises the question of whether humans constantly evolve in a finite or infinite decision tree. For the sake of this argumentation, we will put this question aside and assume that it is, in any case, so vast that tree size no longer matters.

Ultimately, the race for AI will be won when a machine is developed that can browse the immensity of the human decision tree. With appropriate reward–penalty reinforcement learning, it will be possible to teach such a machine human ways and customs. The challenges to achieve this ultimate AI are numerous, yet history shows that this should not prevent us from expecting the existence of such a machine in a humanly conceivable time span.

[3] *Naturally, an AI that imitates human behaviour well in a given game may not do as well in another type of game.*

[4] *See Wikipedia – second paragraph of the introduction*

[5] *See Wikipedia – first paragraph of first section*

[6] *See Wikipedia for an overview*

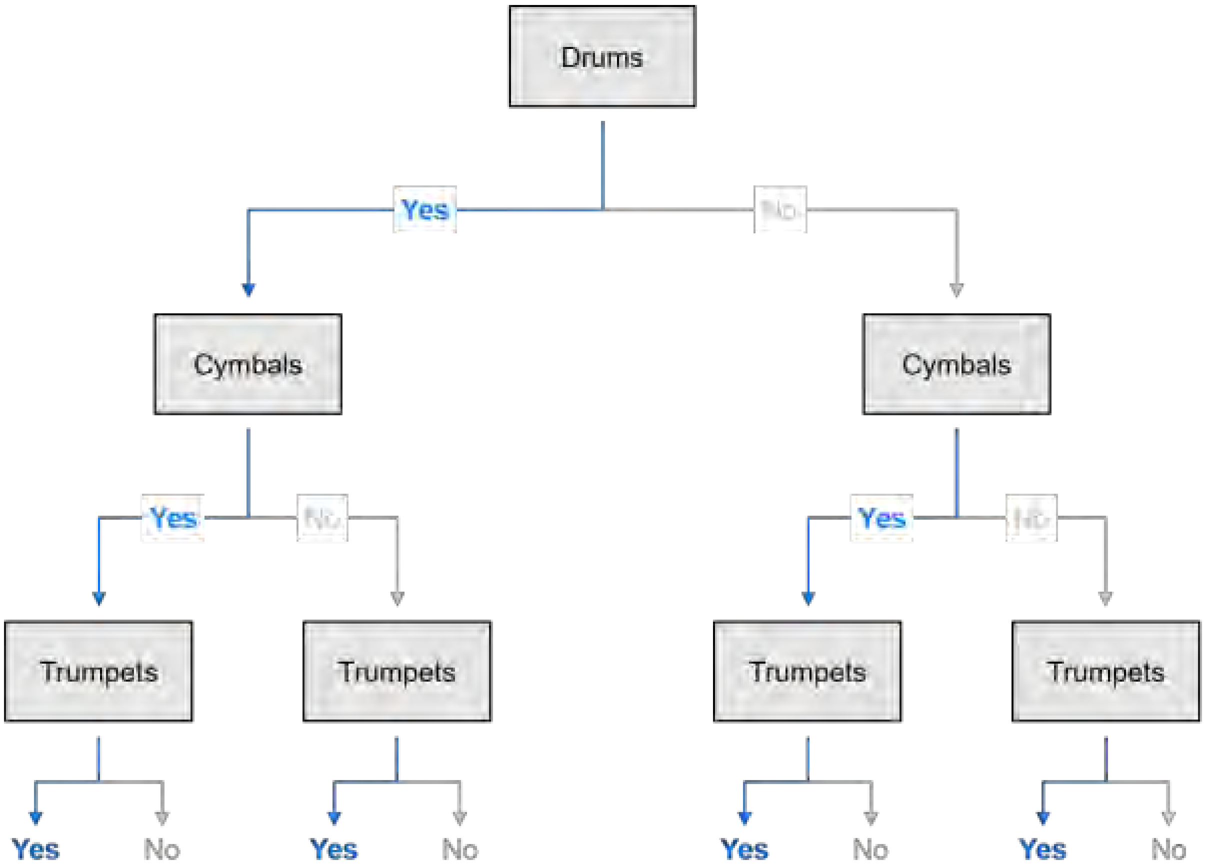
2. THE IMITATION GAME: IT'S ALL RELATIVE

Let's look at the example of music. Automation occurred long ago in Cizre, Turkey. The ingenious inventor Ismail Al-Jazari created, circa 1206[7], a programmable orchestra that mimicked humans playing music.

More recently, Sony has claimed on multiple occasions that it has invented AIs capable of learning and reproducing music. These AIs are called Flow Machines and reproduce any given type of music. One such Flow Machine, ***DeepBach***, is able to generate Bach-type harmonies, which cannot be distinguished from the original. Another, the ***Continuator***[8], was able to copy a Jazz pianist, and Jazz critics could not differentiate between the two.

From Al-Jazari's automaton to the DeepBach Flow Machine, the complexity of the decision tree has grown exponentially. We present below the decision tree of Al-Jazari's automaton at each note of the melody.

Figure – Decision tree of Al-Jazari's automaton at each note of the melody



The automaton had three different instruments and most probably only one note for the trumpets. The number of leaf nodes in its decision tree is quite straightforward and amounts to

$$2^{\text{Number of instruments}} = 8.$$

[7] *The Book of Knowledge of Ingenious Mechanical Devices, Ibn Al-Razzaz al-Jazari*
[8] *See the Youtube video*

Now considering the full score played by the automaton, we would have to reproduce the tree at each leaf node for as many times as there are notes. This would lead to a much greater tree whose size would equal

$$2^{\text{Number of instruments}\times\text{Score length}} = 8^{\text{Score length}}.$$

DeepBach goes further as it can play as many instruments as desired and any note. Its tree is much more complex, equalling

$$2^{\text{Number of instruments}\times\text{Number of notes}\times\text{Score length}}.$$

To learn the ways of Bach, it allocates degrees of importance to each leaf node.

The question is this: are both systems AI? None of these technologies would pass the Imitation Game as defined by Turing, but they do pass the test within their own set of rules.

To illustrate the issue at hand, let's put AI aside for a moment and consider life instead. Prions, for example, are not considered as living beings, whilst bacteria are. This may be elementary for those with a Biology background, but even experienced biologists would find it difficult to correctly classify what happens in between these two extremes. There, we find viruses, which still fuel debate on whether or not they constitute living beings.

It's the same story here!

Consider that you are a passer-by in Al-Jazari's time, and you hear music coming from his automated fountain. You think to yourself, 'What a marvellous machine, Al-Jazari is a genius'. To your surprise, you realise that several human players have taken the place of the mechanical players. Had you not looked closely, you would not have been able to tell the difference.

Could we not therefore say that the automaton passes a form of Turing Test based on a simpler Imitation Game?

Answering this question sparked lively debate among Accuracy's expert community. With such a definition of AI, we could say that Al-Jazari's automaton is, indeed, an AI. Compared with DeepBach, however, Al-Jazari's automaton seems rather simple. And yet even DeepBach is not technically an AI, since it cannot play Turing's original Imitation Game.

If we say that a machine that passes the Turing Test is to AI as bacteria are to life, and automatons (such as Al-Jazari's machine) are to AI as prions are to life, then algorithms like DeepBach, Watson or even Google Duplex occupy that same in-between space as viruses. A line has to be drawn to establish a normative limit.

At Accuracy, we believe that the Imitation Game is valuable depending on the rules of the game. For the purpose of recreating a human-like AI, these rules should incorporate a certain level of interaction with humans, as well as certain learning capabilities.

The recent exponential growth of AI applications is the result of major technological advances in computer power, data management (from generation to storage via communication) and algorithms (neural networks in particular). These advances now make it possible to create an AI that could play 'corporate games', at least with regard to corporate operations.

3. AI FOR BUSINESS

Taking Von Neumann at his word, no intelligent task is beyond the reach of machine intelligence.

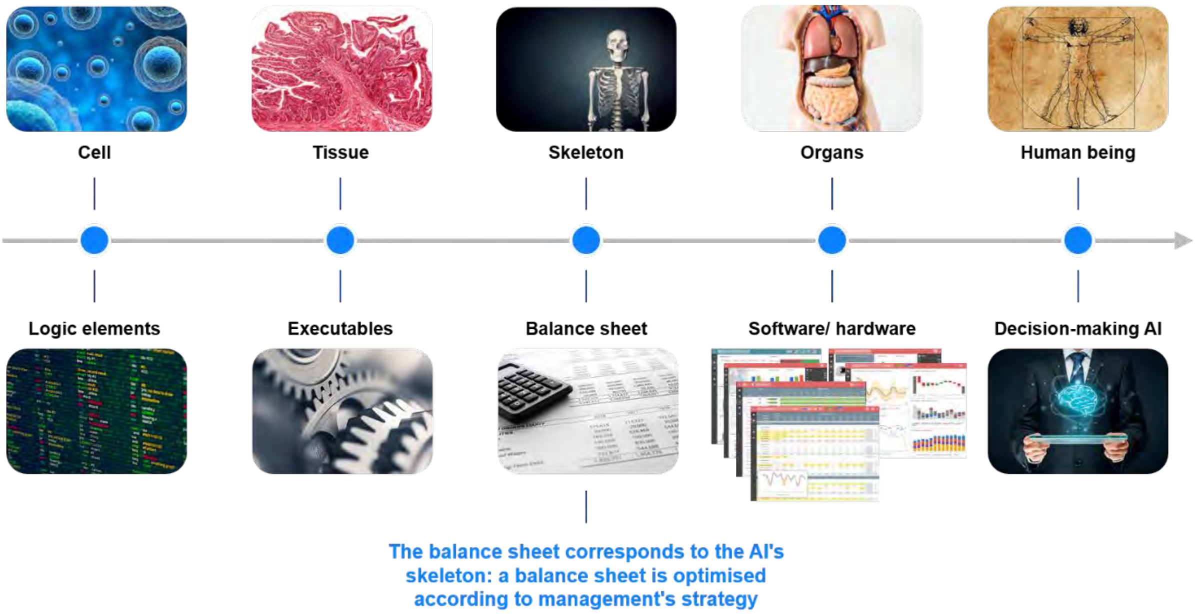
Business is no exception to this rule.

All businesses operate with a single purpose: offering their services or products to customers in exchange for money. With this money, they maintain their operations, paying creditors, shareholders and taxes, and investing to broaden their activities. Year after year, the accounts keep a thorough record of all these cash flows. When the time comes to make important decisions, C-level management rely entirely on these records to correctly assess the state of the business. From the numbers in the books, management decide on the best future course of action (often by valuing the different strategical options). They then implement that course and monitor the implemented activities.

The accounts are therefore the quantitative bedrock of corporate management.

As mentioned in the introduction, a fully functional business AI would be made of multiple bricks, each controlling a specific operational branch (e.g. a marketing AI brick, or set of bricks, would have control over marketing operations). The AI bricks are analogous to organs in the human body (see figure below). Just as the skeleton provides the frame for the human body and its organs, ***finance and accounting provide the framework*** for the business AI, ***ensuring its operational coherence*** and avoiding dis-synergies between branches.

Figure - Comparison of business AI with human life



Typical AI bricks are usually ***hardware and software pieces***, and sometimes both. In terms of hardware, the most essential task of all is to generate, transmit and maintain data. Obvious hardware components include sensors, cables and relay servers. They also contain database servers, as well as robotic installations, which can handle packages in warehouses, production sites, etc. In terms of software, the principal task is to choose the appropriate path within a decision tree, either deterministically (rule-based methods) or statistically (machine or deep learning). Software AI bricks can thus be optimisers, simulators (e.g. Monte Carlo simulation software), machine or deep learning algorithms and so on.

Table – Examples of AI bricks and their applications

Function	Technology	Applications
Speech recogniser	Machine or Deep learning	Dealing with customers in phone centres
Image recognition	Machine or Deep learning	Customer identification, web crawling, security, etc.
Route optimiser	Linear or Constraint programming	Deliveries, depot location, electronic circuits, etc.
Planning systems	Constraint programming	Budget planning, operational management, etc.
Time series analysers	Machine or Deep learning	Budget planning, activity monitoring, etc.
Smart sensors	Sensors with embedded software intelligence	Operation monitoring, security, etc.
…	…	…

To this day, developments within companies are very heterogeneous. When companies implement AI, it is usually for a specific branch of operations, using several AI bricks. Often, these different AI systems handle their branch of operations independently.

To obtain a fully functioning business AI, there are two main axes of improvements (see figure below):

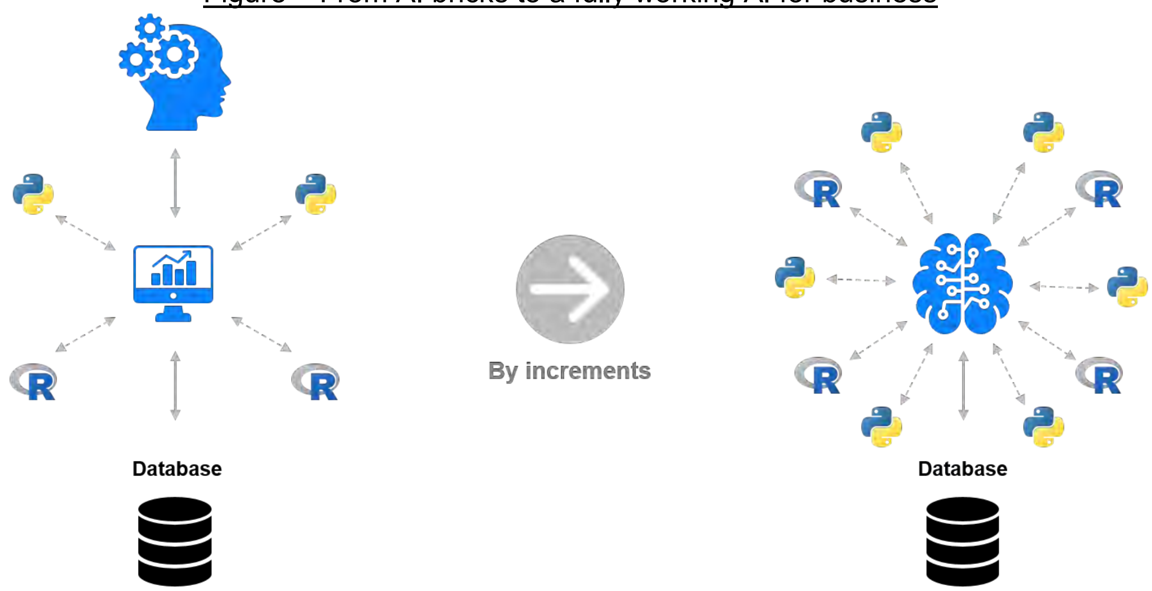
(i) Multiplying AI bricks in the different operating branches and connecting them to a single human–machine interface

(ii) Slowly replacing the human–machine interface with an artificial brain that would assess the different strategies available to C-level management and choose the best course of action.

These developments should occur whilst respecting the value chain in its entirety, as the implemented AI bricks would be coordinated around the accounts.

Moreover, innovation changes towards AI must occur at the right pace and with the right entropy shift. The right entropy shift would give enough time to developers and data scientists to fully seize and implement the company's ethos and processes in its systems. It would also give flexibility to executive management to reallocate resources, re-establish updated processes and retrain employees for other tasks when necessary.

Figure – From AI bricks to a fully working AI for business



Business exists, in its very essence, only when two human parties can help each other. In this view, one fulfils the needs of the other by means of a transaction, based on a swap or monetary exchange. As long as humans exist, business transactions will be undertaken. Embedding a business AI in a company ensures the safe, thorough and precise execution of all the laborious aspects of its operations.

That said, when it comes to the creation of value, maintaining strong client relationships, providing a healthy working environment to employees, etc., the only trustworthy 'machines' to execute these tasks will remain human.

4. AI at Accuracy

As with its other areas of expertise, Accuracy brings together various skillsets to consider the full implications of AI. With its wide range of financial expertise on any aspect of corporate mechanics, technical expertise on the latest data science modelling paradigms, and unique knowledge and access to innovation hubs, Accuracy is well placed to face the challenges surrounding AI for business.

i. Expert reports to choose the correct algorithms and their appropriate implementations for any sort of operational activity with full respect of the value chain integrity
ii. Implementation of AI bricks with an in-house implementation or in the form of Software-As-a-Solution using enhanced security
iii. Access and interface with innovative start-ups from the AI world whenever additional knowhow is required (e.g. installation of robotics, specific hardware, etc.).