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What is Intelligence?

Before we start discussing Business Intelligence (BI) and Artificial Intelligence (AI), let us begin by reviewing what we mean by "intelligence" (in a non-philosophical context).

1.1. Intelligence

ETYMOLOGY.– The word "intelligence" comes from the Latin *intelligentia* meaning "faculty of perception", "comprehension". It is derived from intellĕgĕre ("discern", "grasp", "understand"), which is composed of the prefix *inter-* ("between") and the verb lĕgĕre ("pick", "choose", "read"). Etymologically speaking, intelligence consists of making a choice, a selection.

We could therefore say that intelligence is defined as the set of mental faculties that make it possible to understand things and facts, and to discover the relationships between them in order to arrive at a rational understanding (knowledge) (as opposed to intuition). It makes it possible to understand and adapt to new situations and can therefore also be defined as adaptability. Intelligence can be seen as the ability to process information to achieve an objective. In this book, we are particularly interested in the latter definition: projecting intelligence in the digital world of the

Internet where information travels at the speed of light. Our digitalized world continuously generates information (the Internet never sleeps) and does so in various forms (transactions, texts, images, sounds, etc.), which is what we call "Big Data[1]". Since the dawn of time, "man seeks to know how to act" and he has used all the information at his disposal, learning from past experiences and using it to project himself into a more or less immediate future. The challenge for companies is to make this information "intelligent": intelligible, diffusible and understandable by those who will have to transform it into an action plan ("know how to act"), which is the fundamental principle of BI (see section 1.2 for more details).

1.2. Business Intelligence

BI could be defined as a data principle that is "augmented" by a certain amount of computer tools (database, dashboards, etc.) and know-how (data management, analytical processes, etc.). Its objective is to help "decision-makers" (both strategic and operational) in their decision-making and/or management of their activities. One of the most important principles of this is that operational decisions must be made as closely as possible to their implementation based on indicators that are directly linked to the operational processes they control. Their aim is to make the right decision at the right time (timing has become a key word in BI) in order to limit the risks of deceleration between the operational situation and the

1 Big Data are datasets that are so large they become difficult to process using traditional "classic" database management tools. The quantitative explosion and multiple formats of digital data (image, sound, transaction, text, etc.) require new ways of seeing and analyzing this digitized world. Big Data are characterized by Volume, Variety of format, Velocity (the Internet never sleeps) and Value (for those who know how to exploit them).

indicators that reflect it. BI platforms have had to adapt to this new situation. In the mid-2000s, this led to the creation of a new architecture called Operational BI[2]. This was aimed more at "field" players, in other words operational staff who managed their activities in near-real time, although BI had historically been more of a decision-making tool aimed at analysts and strategic decision makers (who are not at all or not very well "connected" to the field). On a technical level, BI consists of acquiring data from various sources (varied both in terms of content and form), processing it (cleaning, classifying, formatting, storing, etc.), analyzing it and then learning from it (scores, behavioral models, etc.). This will then feed into the management, decision-making and action processes within companies. It requires data management platforms (continued use of IT tools for processing and publishing data) and also an organization (BI competence center) that will be in charge of transforming these data into information and then into knowledge. These Business Intelligence Competency Centers (BICCs[3]) produce analyses, reports and business activity monitoring tables to inform decision makers, regardless of whether they are strategic or operational.

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2 Operational BI differs from Business Intelligence due to two structural elements: (1) time taken (velocity) to update indicators (aligned with the time frame of the operational processes it controls), and (2) the granularity of implemented data (only those needed to feed operational management indicators), so in short, less but more frequent data.

3 A Business Intelligence Competence Center (BICC) is a multifunctional organizational team that has defined tasks, roles, responsibilities and processes to support and promote the effective use of Business Intelligence (BI) within an organization. A BICC coordinates activities and resources to ensure that an evidence-based approach is systematically considered throughout the organization. It is responsible for the governance structure of analytical programs and projects (solutions and technical architecture). It is also responsible for building plans, priorities, infrastructure and skills that enable the organization to make strategic, forward-looking decisions using BI and analytics software capabilities.

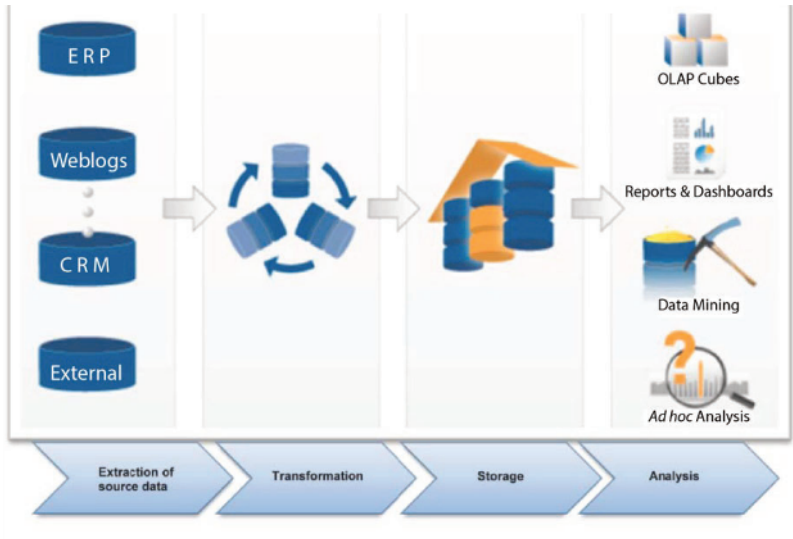

Figure 1.1. *Diagram showing the transformation of information into knowledge*

Companies (mainly large companies, given the costs associated with implementing such solutions and processes) have acquired real know-how in terms of data processing and its transformation into knowledge. They have equipped themselves and organized themselves around competence centers, the BICCs (often large vertical business units: Marketing & Sales, Finance, Logistics, HR, etc.) and are backed by tools available on the market (publishers of BI solutions are quite numerous). But it has to be said that the continuous flow of information generated in a world that is becoming more and more digital every day has become a real problem for companies (in the early 1990s, the world was producing less than 100 gigabytes[4] of data per second. By

4 1 Gigabyte = 1,000,000,000,000 bytes. 1 byte = 8 bits, and is used for encoding information; 1 bit is the simplest unit in a numbering system, which can only take two values (0 or 1). A bit or binary element can represent either a logical alternative, expressed as false and true, or a digit of the binary system.

2020, we will exceed 50,000 according to the IDC International Data Corporation). Companies are finding it increasingly difficult to cope with this continuous flow of information, as the time frame for decision-making and therefore ultimately for taking action in our connected world is now just milliseconds. The processes, tools and staff (which are increasingly scarce resources) required to run BI departments are no longer sufficient. Companies are forced to make choices (in terms of analysis, and/or the ability to interact in real time); however, "choosing is depriving oneself". The advent of connected devices is accelerating this "analytical rupture[5]", as BI must reinvent itself and find new ways to process these data. Perhaps Artificial Intelligence is part of the answer.

1.3. Artificial Intelligence

There are many definitions for Artificial Intelligence. Wikipedia has one too (which I will let you look up in your own time). In this book, and in order not to get lost along the way, we will focus solely on the "learning" dimension for decisions and actions. We will look at how Deep Learning and/or Machine Learning, which will be described in detail in the next section, are becoming more and more common in companies to complement existing BI tools and processes. The main advantage of Artificial Intelligence versus BI is undoubtedly its ability to analyze and make decisions in a few milliseconds within a context of very complex analyses. Its raw material is Big Data and it takes just a millisecond (or even less in some cases) to make a decision. Another advantage is its ability to learn, or the ability of Artificial Intelligence tools to learn from their experiences (analyses, decisions, actions): "there is no good or bad choice, there are

5 The company is overwhelmed by its "data". In general, less than 10 % of the data actually available to the company are formally analyzed and/or used in a decision-making process.

only experiences". This is how Artificial Intelligence approaches human intelligence, learning from experience and remembering it (one way or another). This digital memory, which gets enriched as different experiences occur and develop, will be the keystone of decision-making processes, and over time it will constitute the company's memory.

Thus, we refer to Tom Mitchell's (1997) definition of Machine Learning:

> A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E.

In other words, a self-learning process of decision-making and action is linked to one or more objectives to be achieved. The result of this decision/action will be measured relative to the objective and will be propagated back into the model in order to improve the probability that the decision/action will be able to achieve its objective (each new iteration will be seen as a new experience, which will enable the process to quickly adapt to changing situations).

1.4. How BI has developed

BI, like most disciplines with a strong adherence to technology, evolves with technological progress (of which there have been many in recent years). BI has experienced many of these in less than 20 years, which is summarized in Figure 1.2.

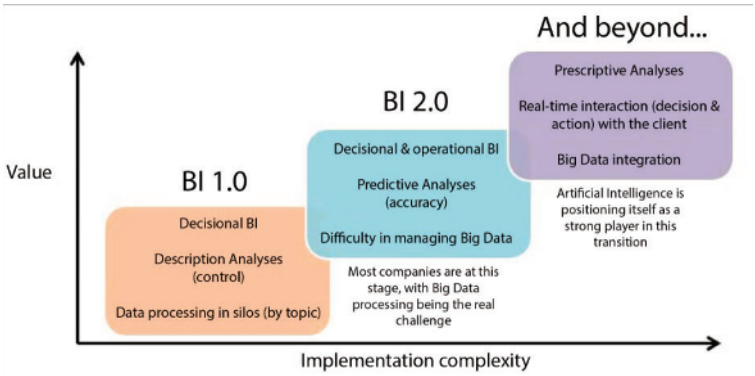

Figure 1.2. *Business Intelligence evolution cycle*

1.4.1. *BI 1.0*

In the late 1990s and early 2000s, companies organized themselves around BICCs to streamline and optimize their reporting activities. At this stage, BI was mainly decisional[6] and organized in silos (by subject such as marketing, logistics and finance). No or few management indicators (updated in "real time", or more precisely, aligned with the temporality of operational processes) were available for operational actors; this was still very much a world for experts, where BI (through its tools) had some difficulty in spreading itself throughout a company (for both technical and "political" reasons). Most of the solutions were subject-

6 Decisional Business Intelligence (in the context of BI 1.0) is mainly focused on large data processing, which can be lengthy. The volume of data to be processed and the analytical processing of these data take precedence over the timing (frequency of updating indicators, etc.). The "consumers" of this decisional BI are mainly analysts and/or managers, rarely operational staff (at least not in "real-time" monitoring and optimization of processes), because of a lack of "temporality" of the data (an activity-monitoring indicator that is only updated once a day [in the morning] for data on the previous day allows no or little operational optimization).

oriented, and data were organized and stored by type of activity (marketing data, HR data, financial data, etc.) with no or few possible crossovers between the different silos. The methods of analysis are said to be "descriptive", which involves drawing up a picture of a situation (for example managing a sales activity) as it appears subsequent to following the compilation and classification of data. It allows the data to be managed, monitored, classified, etc., but provides little or no information on situations to come.

1.4.2. *BI 2.0*

In the mid-2000s, operational needs became more prevalent, thus operational decision-makers saw the arrival of a new generation of tools that enabled them to manage and optimize their operational processes in real time: operational BI was born and with it, the temporality of information and its processing became the key point. BI platforms have been integrating more and more prediction functions, and BI has been becoming increasingly more democratic as communication technologies (tablets, smartphones) have evolved to allow access to information anytime and anywhere. These developments and the increase in the number of people connected to the Internet have multiplied the volumes and formats of data to be processed, and thus Big Data was born. Most companies are at this stage now, with Big Data management still being a real challenge for companies. The BI solutions in place are not well-adapted to the poorly structured data management of data produced on the Internet (images, videos, blogs, logs, etc.); their volume and velocity are additional difficulties on top of the formatting issue. Big Data are generally defined by four dimensions (the 4V):

– *Volume*: the Internet generates a continuous flow of all types of data, of which the volumes are growing exponentially (the Internet of Things will accelerate this

growth even more), making it virtually impossible to process the data through existing BI solutions. New solutions are emerging (such as Hadoop[7] for massive data processing).

– *Velocity*: the Internet never sleeps, data arrive in a constant uninterrupted stream and it must be processed in near-real time if we want to extract the maximum value from it.

– *Variety*: Big Data are structured or unstructured data (text, data from sensors, sound, video, route data, log files, etc.). New knowledge is emerging from the collective analysis of these data.

– *Value*: Big Data are the new "gold mine" that all companies want to be able to use, and the rampant digitization of our world is increasing the value of these data every day.

1.4.2.1. *Hadoop platforms*

Hadoop platforms were launched by Google (in 2004) to process huge volumes of data (billions of requests are made

7 (From Wikipedia) Apache Hadoop is an open-source software framework used for distributed storage and processing of dataset of big data using the MapReduce programming model. It consists of computer clusters built from commodity hardware. All the modules in Hadoop are designed with a fundamental assumption that hardware failures are common occurrences and should be automatically handled by the framework.
The core of Apache Hadoop consists of a storage part, known as Hadoop Distributed File System (HDFS), and a processing part that is a MapReduce programming model. Hadoop splits files into large blocks and distributes them across nodes in a cluster. It then transfers packaged code into nodes to process the data in parallel. This approach takes advantage of data locality, where nodes manipulate the data they have access to. This allows the dataset to be processed faster and more efficiently than it would be in a more conventional supercomputer architecture that relies on a parallel file system where computation and data are distributed via high-speed networking.

every day on the Internet via search engines). It was inspired by the massive parallel processing solutions used for large scientific calculations. The principle was to parallelize the processing of data (MapReduce) by distributing them over hundreds (or even thousands) of servers (Hadoop Distributed File System) organized into processing nodes. Apache (open-source) embraced the concept and pushed it to evolve into what it is today. MapReduce is a set of processes for distributing data and processing it across a large number of servers (guaranteed by the "Map" process in order to ensure parallel processing). The results are then consolidated (guaranteed by the "Reduce" process) and fed into the analytical suite (Smart Data) where this information will be analyzed, consolidated, etc., in order to enrich the decision-making process (whether human or automated).

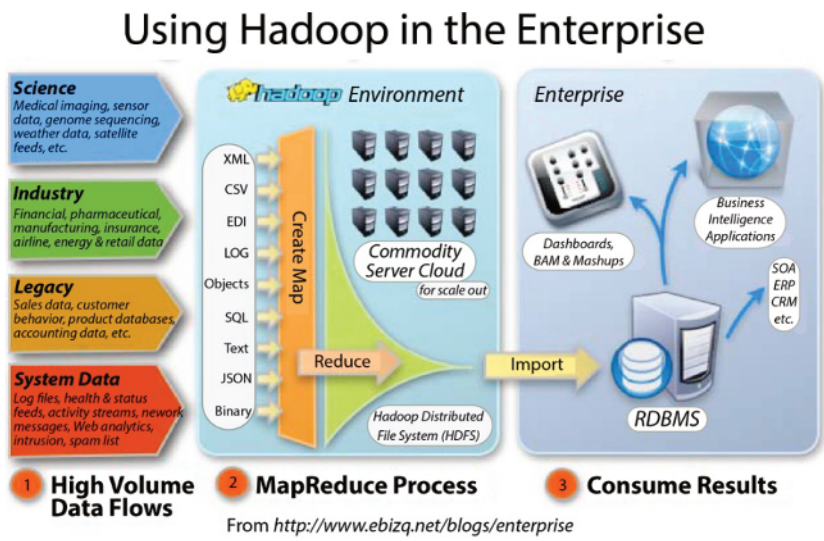

Figure 1.3. *The Hadoop MapReduce process*

1.4.3. *And beyond...*

History is yet to be written but Artificial Intelligence is already positioning itself as a strong candidate in this transition. The reconciliation between Big Data and Artificial Intelligence platforms (especially those linked to "Machine Learning") are beginning to make an appearance. Solutions are now available on the market and companies are increasingly interested in them, particularly within the framework of improving customer experience (CXM). In the following chapters, we will discuss how these solutions work and how they could challenge the established order in terms of BI. New BI solutions will (and must) integrate the notion of prescriptive analysis, which goes beyond forecasting (anticipating what will happen and when it will happen) and allows us to understand how and why it will happen based on scenarios of decisions and actions, as well as the associated impacts in order to optimize opportunities and/or minimize or even eliminate risks. Descriptive analysis merely explains a situation based on descriptive variables. It consists of drawing up a "portrait" of the situation as it appears subsequent to compilation and classification of the data based on so-called descriptive variables (which describe the situation we are trying to explain), for example defining customer segments, purchasing behaviors, desire for a product, etc. Descriptive analysis is the data analysis method that is probably the most used by existing BI solutions, whether for sales, marketing, finance or human resources. It answers questions such as "what happened", "when" and "why". This is based on so-called "historical" data (analysis of past data).