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Big Data and Analytics

Strategic and Organizational Impacts

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Foreword

Few organizations understand how to extract insights and value from the recent explosion of "Big Data." With a billion plus users on the online social graph doing what they like to do and leaving a digital trail, and with trillions of sensors now being connected in the so-called Internet of Things, organizations need clarity and insights into what lies ahead in deploying these capabilities. While academic scholars are just beginning to appreciate the power of big data analytics and new media to open up a fascinating array of questions from a host of disciplines, the practical applicability of this is still lacking. Big data and analytics touches multiple disciplines ranging from sociology, psychology, and ethics to marketing, statistics, and economics, as well as law and public policy. If harnessed correctly it has the potential to solve a variety of business and societal problems.

This book aims to develop the strategic and organizational impacts of Big Data and analytics for today's digital business competition and innovation. Written by an academic, the book has nonetheless the main goal to provide a toolbox suitable to be useful to business practice and know-how. To this end Vincenzo as in his former books has structured the content into three parts that guide the reader through how to control and govern the innovation potential of Big Data and Analytics. First, the book focuses on *Strategy* (Part I), analyzing how Big Data and analytics impact on private and public organizations, thus, examining the implications for competitive advantage as well as for government and education. The last chapter provides an overview of Big Data business models, creating a bridge to the content of Part II, which analyzes the managerial challenges of Big Data and analytics governance and evaluation. The conclusive chapter of Part II introduces the reader to the challenges of managing change required by an effective use and absorption of Big Data and analytics, actually trying to complement IT and non-IT managers' perspective. Finally, Part III discusses through structured and easy to read forms a set of cases of Big Data and analytics initiatives in practice at a global level in 2014.

Use this book as a guide to design your modern analytics-enabled organization. Do not be surprised if it resembles a large-scale real-world laboratory where employees design and conduct experiments and collect the data needed to obtain answers to a variety of questions, from peer influence effects, the influence of

dynamic ties, pricing of digital media, anonymity in online relationships, to designing next-generation recommender systems and enquiries into the changing preference structures of Generation Y and Z consumers. This is a bold new frontier and it is safe to say we ain't seen nothing yet.

Ravi Bapna

Preface

Notwithstanding the interest and the hype that surround Big Data as a key trend as well the claimed business potentiality that it may offer the coupling with a new breed of analytics, the phenomenon has been yet not fully investigated from a strategic and organizational perspective. Indeed, at the moment of writing this book, apart from a series of articles that appeared on the Harvard Business review by McAfee and Brynjolfsson (2012) and on MIT Sloan Management Review by Lavalle et al. (2011) and Davenport et al. (2012), most of the published monographic contributions concern technical, computational, and engineering facets of Big Data and analytics, or oriented toward high-level societal as well as general audience business analyses.

An early joint academics-practitioners effort to provide a unified and comprehensive perspective has been carried out by the White Paper resulting from joint multidisciplinary contributions of more than 130 participants from 26 countries at the World Summit on Big Data and Organization Design held in Paris at the Université Panthéon-Sorbonne during May 16–17, 2013 (Burton et al. 2014). However, it is worth to be mentioned that since 2013 new editorial initiatives have been launched such as, e.g., the Big Data journal (Dumbill 2013). Thus, following up the insights discussed in (Morabito 2014), the present book aims to fill the gap, providing a strategic and organizational perspective on Big Data and analytics, identifying the challenges, ideas, and trends that may represent "food for thought" to practitioners. Accordingly, each topic considered will be analyzed in its technical and managerial aspects, also through the use of case studies and examples. Thus, while relying on academic production as well, the book aims to describe problems from the viewpoints of managers, adopting a clear and easy-to-understand language, in order to capture the interests of top managers and graduate students. Consequently, this book is unique for its intention to synthesize, compare, and comment on major challenges and approaches to Big Data and analytics, being a simple yet ready to consult toolbox for both managers and scholars.

In what follows we provide a brief overview, based on our previous work as well (Morabito 2014), on Big Data drivers and characteristics suitable to introduce their discussion also with regard to analytics in the further chapters of this book, whose outline concludes this introduction.

Big Data Drivers and Characteristics

The spread of social media as a main driver for innovation of products and services and the increasing availability of unstructured data (images, video, audio, etc.) from sensors, cameras, digital devices for monitoring supply chains and stocking in warehouses (i.e., what is actually called *internet of things*), video conferencing systems and voice over IP (VOIP) systems, have contributed to an unmatched availability of information in rapid and constant growth in terms of volume. As for these issues, an interesting definition of "Big Data" has been provided by Edd Dumbill in 2013:

> Big data is data that exceeds the processing capacity of conventional database systems. The data is too big, moves too fast, or doesn't fit the structures of your database architectures. To gain value from this data, you must choose an alternative way to process it (Dumbill 2013).

As a consequence of the above scenario and definition, the term "Big Data" is dubbed to indicate the challenges associated with the emergence of data sets whose size and complexity require companies to adopt new tools and models for the management of information. Thus, Big Data require new capabilities (Davenport and Patil 2012) to control external and internal information flows, transforming them into strategic resources to define strategies for products and services that meet customers'needs, increasingly informed and demanding.

However, Big Data computational as well as technical challenges call for a radical change to business models and human resources in terms of information orientation and a unique valorization of a company information asset for investments and support for strategic decisions. At the state of the art the following four dimensions are recognized as characterizing Big Data (IBM; McAfee and Brynjolfsson 2012; Morabito 2014; Pospiech and Felden 2012):

- **Volume**: the first dimension concerns the unmatched quantity of data actually available and storable by businesses (terabytes or even petabytes), through the Internet: for example, 12 terabytes of Tweets are created everyday into improved product sentiment analysis (IBM).
- **Velocity**: the second dimension concerns the dynamics of the volume of data, namely the time-sensitive nature of Big Data, as the speed of their creation and use is often (nearly) real-time.
- **Variety**: the third dimension concerns type of data actually available. Besides, structured data traditionally managed by information systems in organizations, most of the new breed encompasses semi-structured and even unstructured data, ranging from text, log files, audio, video, and images posted, e.g., on social networks to sensor data, click streams, e.g., from Internet of Things.
- **Accessibility**: the fourth dimension concerns the unmatched availability of channels a business may increase and extend its own data and information asset.
- It is worth noting that at the state of the art another dimension is actually considered relevant to Big Data characterization: **Veracity** concerns quality of data and trust of the data actually available at an incomparable degree of volume,

velocity, and variety. Thus, this dimension is relevant to a strategic use of Big Data and analytics by businesses, extending in terms of scale and complexity the issues investigated by information quality scholars (Huang et al. 1999; Madnick et al. 2009; Wang and Strong 1996), for enterprise systems mostly relying on traditional relational database management systems.

As for drivers, (Morabito 2014) identified cloud computing as a relevant one, besides social networks, mobile technologies, and Internet of Things (IoTs). As pointed out by Pospiech and Felden (2012), at the state of the art, cloud computing is considered a key driver of Big Data, for the growing size of available data requires scalable database management systems (DBMS). However, cloud computing faces IT managers and architects the choice of either relying on commercial solutions (mostly expensive) or moving beyond relational database technology, thus, identifying novel data management systems for cloud infrastructures (Agrawal et al. 2010, 2011). Accordingly, at the state of art *NoSQL* (Not Only SQL)[1] data storage systems have been emerging, usually not requiring fixed table schemas and not fully complying nor satisfying the traditional ACID (Atomicity, Consistency, Isolation, and Durability) properties. Among the programming paradigms for processing, generating, and analyzing large data sets, *MapReduce*[2] and the open source computing framework Hadoop have received a growing interest and adoption in both industry and academia.[3]

Considering *velocity*, there is a debate in academia about considering Big Data as encompassing both data "stocks" and "flows" (Davenport 2012). For example, at the state of the art Piccoli and Pigni (2013) propose to distinguish the elements of *digital data streams* (DDSs) from "big data"; the latter concerning static data that can be mined for insight. Whereas *digital data streams* (DDSs) are "dynamically evolving sources of data changing over time that have the potential to spur real-time action" (Piccoli and Pigni 2013). Thus, DDSs refer to streams of real-time information by mobile devices and IoTs, that have to be "captured" and analyzed real-time, provided or not they are stored as "Big Data". The types of use of "big" DDSs may be classified according to those Davenport et al. (2012) have pointed out for Big Data applications to information flows:

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[1] Several classifications of the NoSQL databases have been proposed in literature (Han et al. 2011). Here we mention *Key-/Value-Stores* (a map/dictionary allows clients to insert and request values per key) and *Column-Oriented databases* (data are stored and processed by column instead of row). An example of the former is *Amazon's Dynamo;* whereas *HBase*, *Google's Bigtable*, and *Cassandra* represent *Column-Oriented databases*. For further details we refer the reader to (Han et al. 2011; Strauch 2010).

[2] MapReduce exploit, on the one hand, (i) a *map function*, specified by the user to process a key/value pair and to generate a set of intermediate key/value pairs; on the other hand, (ii) a *reduce function* that merges all intermediate values associated with the same intermediate key (Dean and Ghemawat 2008). MapReduce has been used to complete rewrite the production indexing system that produces the data structures used for the Google web search service (Dean and Ghemawat 2008).

[3] See for example how IBM has exploited/integrated Hadoop (IBM et al. 2011).

- *Support customer-facing processes:* e.g., to identify fraud or medical patients' health risk.
- *Continuous process monitoring:* e.g., to identify variations in customer sentiments toward a brand or a specific product/service or to exploit sensor data to detect the need for intervention on jet engines, data centers machines, extraction pump, etc.
- *Explore network relationships* on, e.g., Linkedin, Facebook, and Twitter to identify potential threats or opportunities related to human resources, customers, competitors, etc.

As a consequence, we believe that the distinction between DDSs and Big Data is useful to point out a difference in scope and target of decision making, and analytic activities, depending on the business goals and the type of action required. Indeed, while DDSs may be suitable to be used for marketing and operations issues, such as customer experience management in mobile services, Big Data refer to the information asset an organization is actually able to archive, manage, and exploit for decision making, strategy definition, and business innovation (McAfee and Brynjolfsson 2012).

Having emphasized the specificity of DDS, we now focus on Big Data and analytics applications as also discussed in (Morabito 2014).

As shown in Fig. 1 they cover many industries, spanning from finance (banks and insurance), e.g., improving risk analysis and fraud management, to utility and manufacturing, with a focus on information provided by sensors and IoTs for improved quality control, operations or plants performance, and energy management. Moreover, marketing and service may exploit Big Data for increasing customer experience, through the adoption of social media analytics focused on sentiment analysis, opinion mining, and recommender systems.

As for public sector (further discussed in Chap. 2), Big Data represents an opportunity, on the one hand, e.g., for improving fraud detection as tax evasion control through the integration of a large number of public administration databases; on the other hand, for accountability and transparency of government and administrative activities, due to the increasing relevance and diffusion of *open data* initiatives, making accessible and available for further elaboration by constituencies of large public administration data sets (Cabinet Office 2012; Zuiderwijk et al. 2012), and participation of citizens to the policy making process, thanks to the shift of many government digital initiatives towards an open government perspective (Feller et al. 2011; Lee and Kwak 2012; Di Maio 2010; Nam 2012).

Thus, Big Data seem to have a strategic value for organizations in many industries, confirming the claim by Andrew McAfee and Brynjolfsson (2012) that data-driven decisions are better decisions, relying on evidence of (an unmatched amount of) facts rather than intuition by experts or individuals. Nevertheless, we believe that management challenges and opportunities of Big Data need further discussion and analyses, the state of the art currently privileging their technical facets and characteristics. That is the motivation behind this book, whose outline follows.

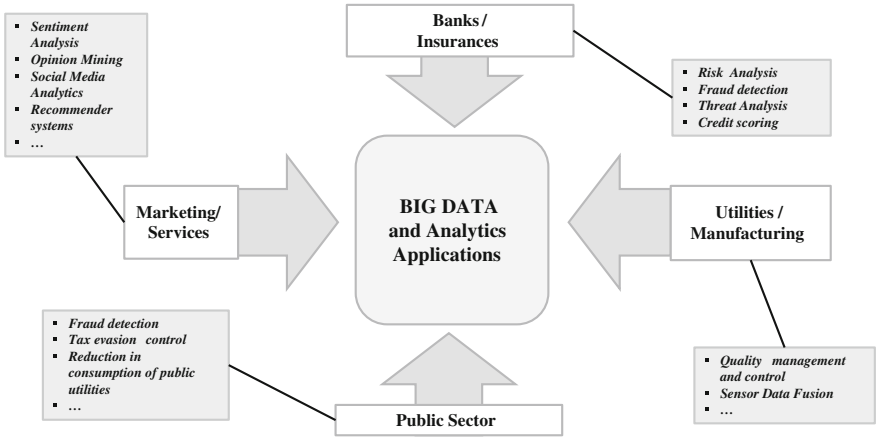

Fig. 1 Big Data Applications. Adapted from (Morabito 2014)

Outline of the Book

The book argument is developed along three main axes, likewise. In particular, we consider first (Part I) *Strategy* issues related to the growing relevance of Big Data and analytics for competitive advantage, also due their empowerment of activities such as, e.g., consumer profiling, market segmentation, and new products or services development. Furthermore, the different chapters will also consider the strategic impact of Big Data and analytics for innovation in domains such as government and education. A discussion of Big Data-driven Business Models conclude this part of the book. Subsequently, (Part II) considers *Organization*, focusing on Big Data and analytics challenges for governance, evaluation, and managing change for Big Data-driven innovation. Finally (Part III), the book will present and review case studies of Big Data *Innovation Practices* at the global level. Thus, Chap. 8 aims to discuss examples of Big Data and analytics applications in practice, providing fact-sheets suitable to build a "map" of 10 interesting digital innovations actually available worldwide. Besides an introduction to the factors considered in the choice of each innovation practice, a specific description of it will be developed. Finally, the conclusion will provide a summary of all arguments of the volume together with general managerial recommendations.

Vincenzo Morabito

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