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Skills required in Big Data professions

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Abstract:

Large amounts of data have become available to decision-makers as the industrial era gives way to the era of smart and connected products. Big data is a collection of data that is not only large but also diverse and fast, making it challenging to process using typical database management systems.

Even though there have been several research on Big Data analysis methodologies, the study of the abilities necessary to manage this data is still in its infancy. We establish a taxonomy of big data skills using a mix of "Web Scraping" data extraction techniques and content analysis on Algerian job search engines. The goal of this study is to assist Algerian practitioners and academics in assessing and progressing their Big Data abilities.

Keywords: Web Scraping; Big data; content analysis; big data skills

Jel Classification Codes: A10; G00;G31;O32

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1. Introduction :

Information gathering, processing, analysis, and storage is a process that involves not just identifying ideas but also bringing them to life, with the ultimate objective of improving knowledge creation and generating innovations. This method enables the firm to optimize its offer numerically and qualitatively concerning the market, as well as its manufacturing processes (Monino et al., 2014).

The introduction and widespread adoption of new digital technologies such as social networks, mobile technologies, Big Data, the Internet of Things, and cloud computing has prompted businesses across almost all industries to launch a slew of initiatives to investigate and capitalize on their benefits(Fitzgerald et al., 2014; Ross et al., 2016).

This frequently entails both exterior customer-centric changes and internal product and process transformations, as well as business model modifications(Matt et al., 2015). As a result of the maturing of digital technologies and their widespread use in all markets, the firm as a whole is undergoing a quick and drastic transformation(Ebert & Duarte, 2016).

Big data is a term used to describe a collection of data that is not only huge but also diverse and fast, making it challenging to operate using typical database management systems. The modern firm is required to embrace new perspectives to have "strategic information" in this new period, which is challenging old management techniques(Martinet, 1995). While there have been several studies on big data analytic methodologies, research into the abilities necessary to manage big data is still in its early stages.

In the face of big data, what skills do organizations require?

We are establishing a taxonomy of big data skills using a mix of "Web Scraping" data mining tools and content analysis methodology on Algerian job search sites. The goal of this article is to guide Algerian practitioners and academics in the assessment and evolution of Big Data abilities.

The rest of the paper goes like this: The second portion is a survey of the literature on the ideas of digital transformation, Big data, and the new skills that this big data necessitates. Our methodological approach will be presented in the next section. The outcomes of the empirical data are next analyzed in light of the literature. The concluding portion of the study concludes the literature review and empirical data.

2. Big data and human skills: the way towards digital transformation

2.1 Design of the digital transformation

According to Reis et al.,(2018), there are three types of digital transformation:

A technological element of digital transformation in which new digital technologies like as social networks, mobile technology, and analytical or integrated tools are used(Fitzgerald et al., 2014):

A component of digital transformation that necessitates a change in operational procedures or the introduction of new business models on an organizational level(Ross et al., 2016).

. Finally, digital transformation is a phenomenon that has an impact on all elements of human existence(Matt et al., 2015).

In the design of the digital transformation, almost all academics [see table 1] incorporate the se many components. All of these variables are summed up by
Reis et al (2018), who define transformation as the use of new digital technologies to enable substan tial changes in company activity that impact all aspects of consumers' lives.

Table (1): Digital Transformation Definitions

Author(s)	Definition(s)
Stolterman and Fors	Digital Transformation is the changes that digital technology causes or influences in all aspects of human life
Westerman et al.	Digital Transformation is defined as the use of technology to radically improve the performance or reach of enterprises
Martin	Digital Transformation is now commonly interpreted as such usage of Information and Communication Technology, when not trivial automation is performed, but fundamentally new capabilities are created in business, public government, and in people's and society life
Collin et al. [29]; Gimpel and Röglinger [30]; Kane et al.	While digitization commonly describes the mere conversion of analog into digital information, the terms Digital Transformation and digitalization are used interchangeably and refer to a broad concept affecting politics, business, and social issues.
Solis et al. [28]	The realignment of, or new investment in, technology and business models to more effectively engage digital customers at every touchpoint in the customer experience lifecycle
Fitzgerald et al. [1]; McDonald and Rowsell-Jones McDonald and Rowsell-Jones	Use of new digital technologies, such as social media, mobile, analytics, or embedded devices, to enable major business improvements like enhancing customer experience, streamlining operations, or creating new business models [1]. As such, Digital Transformation goes beyond merely digitizing resources and results in value and revenues being created from digital assets [27]

The source: Reis, J., Amorim, M., Melão, N., & Matos, P. (2018, March). Digital transformation: a literature review and guidelines for future research. In *World conference on information systems and technologies* (pp. 411-421). Springer, Cham.

3. Technologies for facilitate digital transformation

Mobile technology, social networks, Cloud computing, big Data, and the Internet of Things are all technologies that help in digital transformation. These are discussed further down.

3.1. Mobile technology

According to Reddi and Zhu (2017), there are more than 3 billion mobile devices linked to the internet in 2015. There will be 50 billion of these gadgets on the market by 2020. This increase is not just in terms of the number of devices, but also in terms of the amount of mobile internet traffic, which frequently outnumbers traditional traffic. "An umbrella phrase used to refer to a multitude of devices that allow users to access data and information from anywhere," according to Bucki (2016). Mobile technology, often known as "human-machine interaction," transports data, audio, and video across a network via a mobile device. The expansion of the mobile computing industry has opened up access to a wide variety of technologies and the integration of many settings, including cloud computing, social media, big data, and analytics (Van Berkel et al., 2017).

3.2. Social networks

All media, technologies, and digital applications that allow Internet users to communicate ideas, experiences, information, and expertise are referred to as social networks(Schlesinger & Doyle, 2015). Social networks, unlike conventional networks, include all media, technologies, and digital applications that allow Internet users to share their thoughts, experiences, information, and expertise(Schlesinger & Doyle, 2015). According to Statista, Facebook is the most popular social media network in 2017, with over 2 billion users, followed by YouTube with 1.5 billion users, and WhatsApp and Facebook Messenger with 1.3 billion users. According to Kaschny & Nolden (2018), a huge and rising number of people are forming social networks and exchanging information on products, services, and businesses. Gone are the days when social media platforms were solely for personal use. Companies are increasingly joining networks and using them for advertising and hiring. These businesses can communicate with present and potential clients regularly thanks to social media. These networks play a critical role in discovering hot issues and spreading viewpoints. There is also the option of actively participating in debates and taking a stand. Therefore, the firm has direct contact with the target group, which reinforces the customer's perspective and can help the company grow.

3.3. Cloud Computing

"Cloud Computing" refers to both applications distributed as services over the Internet and system hardware and software within the data centers that provide these services, according to Armbrust et al.(2010). Software as a Service (SaaS) is a term that has been used to describe services for a long time (SaaS). Some suppliers characterize their goods using words like IaaS (infrastructure as a service) and PaaS (platform as a service). Charão et al (2018) describe Cloud Computing as a paradigm that enables on-demand access to a shared pool of customizable computing resources (networks, servers, storage, applications, and services) that can be swiftly commissioned and released, according to his paper. With minimum effort on the service provider's part This concept has five key features (on-demand self-service, wide-area network access, resource pooling, quick elasticity, and measurable service); three service models (software as a service (SaaS), platform as a

service (PaaS), and infrastructure as a service (IaaS); and four deployment types (private cloud, community cloud, public cloud, hybrid cloud). The advantages of cloud computing include lower costs, technical personnel, and effort. Otherwise,(Charão et al., 2018) these advantages can be split down as follows:

Predictable Costs: Cloud services are typically paid for monthly or on a usage basis with little or no upfront costs.

Reduced total cost: Realize economies of scale as a result of the services that a supplier can provide.

Access to the best technology: Cloud Computing services allow companies to benefit from the best technologies.

Usage-Based Billing: In the cloud services model, companies pay for actual usage rather than maximum usage.

3.4. Internet of things

"A word often used to refer to the connection of common physical items equipped with sensors and capable of detecting different features of their environment and communicating these measurements over a wireless sensor network," according to Miorandi et al (2012). In particular, such items, also known as "intelligent objects" or "Internet of Things agents," must be uniquely identified, capable of doing basic to sophisticated computations, communicate, and, of course, have capabilities capable of detecting and measuring the parameters of their surroundings. Across the coordination of machines, devices, and applications from many sources connected to the Internet through numerous networks, the Internet of Things represents an advancement of the Machine-to-Machine (M2M) idea. These smart gadgets, when paired with other technologies like artificial intelligence, machine learning, and cloud computing, are reshaping the world by enabling the development of new smart services(Miorandi et al., 2012). According to Bucherer & Uckelmann (2011), the Internet of Things allows businesses to progressively modify their business processes. Roussos & Kostakos (2009), on the other hand, limit the Internet of Things' influence to company operating operations in the first place.

3.5. Big Data

Big Data is a collection of data that is larger than the capabilities of typical database management systems to record, store, manage, and analyze. Depending on the industry, the Big Data phenomenon takes on several forms (Benkaraache & Ghanouane, 2020; Manyika et al., 2011). Dealing with Big Data, according to Laney (2001), entails integrating its three dimensions (3V), namely volume, velocity, and variety. The volume refers to the enormous amount of data produced. The pace at which this data must be processed to be processed in a timely way is referred to as velocity. Finally, variety might be viewed as an indicator of data heterogeneity (Benkaraache & Ghanouane, 2020; Gandomi & Haider, 2015). Other Vs., as (Uddin & Gupta, 2014)points out, can be added to the above dimensions:

Variability, that is to say, data whose meaning is constantly changing; truth indicates the result of data usage, where the data is virtually worthless if it is not accurate; and finally, the visualization which is one of the challenges of "Big data", is in the way of presenting the results of data processing (Information) which makes the conclusions clearer.

The term "digital transformation" refers to the reengineering of all manufacturing and sales processes to make them more efficient, albeit this does not always imply the modification or automatic development of new services and products. Digital transformation entails a lot more than just putting new technologies in place (cloud computing, IoT, Big Data, mobile technologies, etc). (Petkovics, 2018). These digital technologies advocated to achieve the objective of digitalization might potentially be harmful if employees do not support the suggested ways (Petkovics, 2018).

4. Human resources for Big Data jobs:A Classification systematic skills required

A method for categorizing the talents necessary Giving meaning to data and transforming it into knowledge has long been a source of discussion among scientists, statisticians, computer scientists, and other disciplines, according to Davenport & Dyché (2013) and Granville (2014). The data scientist term "Data Scientists" has been used to classify workers who develop knowledge by studying data since the introduction of Big Data. At initially, data scientists were known as "Data Scientists" in companies like Google, eBay, LinkedIn, and Facebook, where big data analytics was the only focus of analysis. (Davenport & Patil, 2012) Many other businesses, on the other hand, must combine Big Data with traditional data sources by including them in the analytical process. Other data analysis skills, such as statisticians, software engineers, developers, market analysts, big data architects, data engineers, and so on, are used by these companies (Davenport & Dyché, 2013; Granville, 2014; Hammerbacher & Segaran, 2009; Miller, 2014).

Data scientists usually have a background in computer science, math, or economics, although they can come from any discipline with a strong emphasis on data and computer science (Davenport & Patil, 2012; Patil, 2011). More specific fields are added to the list by Harris, Murphy, and Vaisman (2013), including statistics, machine learning, databases, operations research, business intelligence, and social and physical sciences.

According to the literature, there are three sorts of Big Data skills:

4.1 Technical skills

In terms of technical capabilities, the data scientist's most essential and universal talent is coding, which allows them to create prototypes (Patil, 2011). At the same time, organizations' increasing need to put up automated and predictive decision systems to grasp Big Data has made machine learning a necessary competence. Dhar (2013) summarizes the key abilities that a data scientist must have in addition to machine learning to do their tasks successfully, including:

- Bayesian statistics, which require a working knowledge of probability, distributions, hypothesis testing, and multivariate analysis;

- Knowledge of data structures, algorithms, and systems, including distributed computing, databases, parallel computing, and fault-tolerant computing;
- Scripting languages (for example, Python and Perl);
- Knowledge of correlation and causality;
- Techniques and tools from IT, linguistics, econometrics, sociology, and other disciplines.

According to Miller (2014), data scientists must have a strong foundation in mathematics and statistics, machine learning, predictive analysis, computer science, and programming, as well as fundamental knowledge of information systems, databases, data warehousing, and data mining. Companies are scooping up profiles specialized in machine learning capable of generating creative algorithms in an increasingly competitive industry (Miller, 2014).

Statistics, machine learning, programming, data mining, algorithms, and predictive analytics were the most commonly stated talents in research done by Provost and Fawcett (2013) based on job adverts.

4.2 Professional skills

A data scientist must be able to articulate issues in such a way that they can be solved effectively (Dhar, 2013). Computational Thinking is a phrase coined by Wing (2006) and Dhar (2013) to explain the fundamental abilities that data scientists would need to deal with this digital deluge. Barr and Stephenson (2011) have researched these abilities. Data collection, data analysis, data visualization and analysis, abstraction, model analysis, and validation, automation, testing and verification, algorithms and processes, issue decomposition, control structures, parallelization, and simulation were among the skills they found. Data scientists should have an excellent grasp of business and management, as well as competence in data mining techniques and the ability to spot business difficulties, in addition to analytical abilities. "From a data standpoint"(Dhar, 2013; Provost & Fawcett, 2013; Waller & Fawcett, 2013).

According to Davenport and Patil (2012), data scientists must not only guide decision-makers to a data-driven discourse, but they must also communicate orally and graphically in a way that all players comprehend. By merging data with other parts and imperfect data sources, data scientists must be able to do analysis. They also clean up the dataset that results. Patil (2011) and Davenport and Patil (2012) are two examples. Data architectures, metadata, data quality and remediation procedures, administration dashboards and data management, master data management, matching algorithms, and many other data-specific issues must be integrated with standard database administration abilities Davenport and Dyché (2013). Because analytical models are frequently incorporated into operational processes, Davenport and Dyché (2013) address the importance of mastering change management to make the necessary changes at the role, process, and skill levels.

4.3 Personal skills

The personal skills that characterize the data scientist in all fields are curiosity and associative thinking. These characteristics are necessary to uncover the questions and hypotheses

that data scientists are trying to solve. They need to be creative to tackle problems in innovative ways. (Davenport & Patil, 2012; Patil, 2011). (Davenport & Patil, 2012) emphasize the importance of training and curiosity in any data scientist's quest for Big Data breakthroughs in their paper. Data analysts, too, require analytical skills, autonomy, and the ability to communicate with their coworkers in real-time to respond to management challenges. Data scientists must be innovative, motivated, and tolerant of pressure when high expectations are placed on them to deal with technical restrictions.

It should be highlighted, however, that the literature gives multiple consistent explanations of the attributes that data scientists should exhibit [see Table 2].

Table (2): Non-exhaustive list of the many "traits" that a data scientist

Traits of the Data Scientist	Source
Big Data tools expert	(Miller, 2014; Song et Zhu, 2015; Provost et Fawcett, 2013)
Encoder	(Davenport et Patil, 2012)
Statistician / Quantitative Analyst	(Davenport, 2014, Provost et Fawcett, 2013)
Searcher	(Davenport, 2014)
Data Hacker	(Davenport et Patil, 2012; Conway, 2010)
Listener	(Mayer-Schönberger et Cukier, 2013)
Data Ethics Officer	(Miller, 2014)
Data manager and strategist	(Miller, 2014, Song et Zhu, 2015, Wixom et al., 2014)
Visualization expert	(Provost et Fawcett, 2013, Davenport et Patil, 2012)
Communicator	(Wixom et al., 2014, Chen et al., 2012, Song et Zhu, 2015, Davenport et Patil, 2012)
Project Manager	(Song et Zhu, 2015)
Business expert / advisor	(Chen et al., 2012, Davenport, 2014, McAfee et Brynjolfsson, 2012)

The source: De Mauro, A., Greco, M., Grimaldi, M., & Ritala, P. (2018). Human resources for Big Data professions: A systematic classification of job roles and required skill sets. *Information Processing & Management*, *54*(5), 807-817.

5. Methodology

A two-step process was used to construct this study:

To begin, we obtained a large number of job advertisements as research data. These solutions are tailored to meet the needs of businesses in terms of the profiles they want. The key term "big data" was utilized to identify the offerings that are the topic of our investigation in this article. This initial phase necessitated the use of free applications to harvest material from "Web scraping" websites (octopuses, parse hub, web scraper). Content extraction is a process that includes discovering specific pieces of data of interest in a succession of semi-structured web pages, extracting them with crawlers, and storing them in bigger structured databases (Vargiu & Urru, 2013).

Data collection focused on offers posted on Algerian recruitment sites during 2021. After deleting all duplicate and incomplete data, we were left with a dataset of 80 positions, which we used as data for our research.

. The second phase included using content analysis methods. "Content analysis" is a research approach for the objective, systematic, and quantitative description of the evident content of communication, according to Albig (1952). Coding and classification are at the heart of any content analysis. The process entails categorizing the various perspectives or opinions expressed in the replies so that the findings may be presented quantitatively.

6. Results: a review of data skills and job families

The following results are a description of each category based on the literature. The majority of employment openings demand a bachelor's degree in engineering or a master's degree in engineering. The empirical evidence shows that doctoral training is insignificant. We may deduce from these findings that the higher the academic preparation, the better the possibilities of professional integration. Algerian businesses are very picky when it comes to experience. In general, the periods range from two to five years. The data reveal that information systems consulting activities receive 75 percent of marketing, with the financial sector coming in second with 18 percent.

6.1 Technical skills

In the domain of technical skills, a total of 180 instances were found, the bulk of which pertain to the Big Data process, which ranges from data collection through visualization, indicating a high degree of consistency between the literature and job advertisements at the Algerian level. Algerian enterprises, meantime, are searching for data scientists with a mix of new talents from the Big data universe and a knowledge of classic decision-making information systems [see table 3]. A comparison of the literature with Algerian company job offers for certain technical talents reveals that, in actuality, company research is more extensive, for example, skills in statistics, algebra, and algorithms [see table 3].

Table (3) : Technical skills

Technical skills	Sources	Occurrences
Programming skills	(Patil 2011; Davenport et Patil 2012; Davenport et Dyche 2013; Miller 2014)	21
Machine learning	(Conway 2010; Dhar 2013; Harris, Murphy et Vaisman 2013; Miller 2014)	19
Statistics	(Conway2010, Dhar2013 ; Miller 2014)	15
Maths, algorithms	(Dhar 2013; Miller 2014)	9
Integration of traditional data and Big data,	(Davenport et Dyché2013; Davenport 2013)	75
Predictive analytics	(Dhar 2013; Miller 2014)	5
Network analysis	(Dhar 2013; Davenport 2013)	5
cloud computing	(Pinola, 2015)	18
Operating system	(Pinola, 2015)	15
Build recommendation systems	(Pinola, 2015)	2
Big data-systems	(Pinola, 2015)	20

The source: author

6.2 Tools and technologies

The majority of the jobs listed demand-programming abilities (Python, R, Java, Spark, C++, NoSQL). At the job posting level, the platform, Big Data processing; Hadoop occurs more than standard database management systems [see Table 4]

Table (4): Tools and technologies

Tools and technologies	Sources	Occurrences
Hadoop	(Conwey 2011; McAfee et al. 2012; Davenport 2013; Davenport et Dyche 2013)	35
R	(Davenport et Dyche 2013)	19
Python	(Davenport et Dyche 2013)	26
SQL et NoSQL	(Davenport et Dyche 2013)	25
Hive	(Davenport et Dyche 2013)	8
Excel	(Kiron et al. 2012)	2
SAS	(Davenport et Dyche 2013)	4
IBM DB2	(Davenport et Dyche 2013)	2
Java	(Pinola, 2015)	20
C++	(Pinola, 2015)	4
Spark	(Pinola, 2015)	24

The source: author

6.3 Functional skills

The job offers listed at the level of functional skills include technical know-how. Analytical and computational thinking skills, according to the literature, are a requirement for Algerian companies. Other skills, data scientists, both in terms of the literature and the required profiles, must have communication and management skills; in teamwork and especially in Reporting. However, unlike scientific authors, the majority of Algerian companies are not demanding in terms of knowledge of the business world or sectors of activity, during our data processing, we did not notice any requirement for change management skills. or strategic data management [see table 5].

Finally, the study of job offers from Algerian companies revealed a skill not mentioned by the authors, that of technology watch [see table 5].

Table (5): Functional skills

Functional skills	Sources	Occurrences
Knowledge of the subject/understanding of the business	(Davenport et Patil 2012; Chen ym.2012; Conway 2011; Dhar 2013; van den Driest 2016; Provost et Fawcett 2013; Waller et Fawcett 2013)	24
Analytical skills, Computational thinking	(Wing 2006; Barr et Stephenson 2011; Davenport et Patil 2012; Davenport et Dyche 2013; Dhar 2013; Provost et Fawcett 2013; Waller et Fawcett 2013)	65
Understanding of management, decision management	(Waller et Fawcett 2013; Provost etFawcett 2013; Miller 2014)	40
Reporting skills, documentation skills	(Davenport et Patil 2012; Davenportet Dyche 2013; Driest et al 2016)	35
communication skills	(Davenport et Patil 2012; Chenym.2012)	33
Strategic data management	(Miller 2014)	0
Agile methods	(Patil 2011)	12
Change management	(Davenport et Dyche 2013)	0
Strategic planning	(Pinola, 2015)	12
Teamwork skills	(Pinola, 2015)	27
Old technology		12

Sources: author

6.4 Personal skills

The data scientist, according to Davenport and Patil (2012), is a creative, proactive, and inventive individual who is passionate about his career and flexible in his contact. To tackle challenges, these profiles must also be rigorous and determined. Furthermore, the ability to be self-sufficient is essential (Pinola, 2015). All of the abilities specified in the literature were found in A job advertisements [see table 6].

Table (6): Personal skills

personal skills	Sources	Occurrences
Passionate about problem-solving, Problem-solving skills	Dhar2013; Patil 2012; Patil et (Davenport 2011)	7
Creative, innovative	(Davenport et Patil 2012; Van denDriest 2016; Patil 2011)	20
Good team player, strong social skills	(Davenport et Patil 2012; Davenport2012)	16
Pressure tolerance	(Davenport et Patil 2012)	19
Real-time awareness	(Davenport et Patil 2012)	4
Curious	(Davenport et Patil 2012)	7
Proactive	(Davenport et Patil 2012)	18
Productive	(Davenport et Patil 2012)	28
Ability to learn	(Davenport et Patil 2012)	9
Determined	(Davenport et Patil 2012)	0
Able to work independently	(Pinola, 2015)	21

Sources: author

7. Conclusion:

The scholarly community has tackled Big Data skills analysis from two perspectives: a literature review and empirical research based on job advertising from Algerian enterprises. A website content extraction approach and a content analysis methodology were employed as part of our research. Based on the classification and categorization of scientific writers, the skills gathered via the literature review and empirical data were contrasted. The findings of the study revealed that Algerian companies' requirements are similar to those in the literature, except for knowledge of the business world or business processes, which can be explained by the fact that the majority of announcements come from companies that specialize in information system consulting. Furthermore, this expertise might be used to explain why firms want technical watch abilities.

According to the results, Analytical capabilities, programming and communication skills, machine learning, and data mining are the most crucial talents of a data scientist. Furthermore, the desire and aptitude to use Big Data to address business challenges. For practitioners, this article could constitute a reference to align with the international standards noted in the literature review and the orientations of the Algerian market.

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