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Known Unknowns in an Era of Technological and Viral Disruptions—Implications for Theory, Policy, and Practice

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Abstract
Technology is composed of the words "Techne" and "Logos" that refer to the artistic/creative and the logical/scientific aspects of its dualism. And so inherent this Promethean concept lie the concepts of the Schumpeterian creative destruction and also the promise and potential for humanity's better tomorrows. We live in an era of artificial intelligence–driven as well as viral disruptions that challenge the mind as well as the body. At the same time, the impact of our pursuit of prosperity at any cost on the environment triggers displaced people floods and viral pandemics undermining the standard of living and more importantly the foundations of trust in institutions and in a better tomorrow feeding populist movements and autocratic trends in democracies as well as emboldening dictators. This work discusses the concepts of Risk Management 5.0, Industry 4.0, Industry 5.0, Society 5.0, Digital Transformation, Blockchain, and the role of AI via the Internet of Things architectures that could enable "smarter as well as more humane solutions to our challenges."

Keywords Industry 4.0 · Industry 5.0 · Society 5.0 · Risk Management 5.0 · Decentralized web · Blockchain · Internet of Things

Introduction

In this paper, we explore ways and means through which the environment and democracy could be better served via leveraging the creative potential of the human mind and the opportunities created by innovation and entrepreneurship enabled by

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artificial intelligence modalities and inspired by triple top and bottom line priorities. In particular, we will be outlining the factors and trends that can serve to help understand and possibly anticipate transformative and potentially disruptive developments across locations, sectors, and institutions.

Moreover, we discuss the concepts of the Quadruple and Quintuple Innovation Helix Frameworks (Carayannis and Campbell 2011; Carayannis et al. 2012; Park 2014). This is where the institutional pillars of Government, University, Industry, and Civil Society mesh with each and with the fifth dimension, the Environment, to define and shape the operational landscape for the design, implementation, monitoring, and evaluation of global/local (glocal) innovation and entrepreneurship ecosystems as the building blocks of the emerging society, technology, and economy paradigms.

Innovation and Entrepreneurship have been drivers of change and outside the box thinking across time and space. The convergence of AI-enabled emerging technologies across all sectors has been creating and diffusing conditions that serve as triggers, catalysts, and accelerators of socio-economic, socio-technical, and socio-political transformation across regions and continents.

The following research questions motivated this work:

1. How Risk Management 5.0 can transform Industry 4.0 that can lead to Industry 5.0?
2. What interconnections may exist between Risk Management 5.0, Society 5.0, and Industry 5.0?
3. What are the current open issues and challenges of the three main pillars of Industry 5.0?

In order to provide thorough answers to the aforementioned research questions in this work, we firstly outline the concepts of Risk Management 5.0, Industry 4.0, Industry 5.0, Society 5.0, and Digital Transformation and then present in details the concepts of Artificial Intelligence, Internet of Things, and Blockchain which constitute the main pillars of Industry 5.0 that could enable "smarter as well as more humane solutions to our challenges informing theory, policy and practice."

The remainder of the paper is organized as follows. "Risk Management 5.0" introduces the concept of Risk Management 5.0. "Industry 4.0," firstly, outlines Industry 4.0 and then extends into the concepts of Society 5.0 and Industry 5.0. "Artificial Intelligence: Innovation Meets Risk Management" summarizes how Artificial Intelligence can aid Innovation. "Blockchain: Towards a Decentralized Web" describes the concepts of Blockchain that could lead to the decentralized web while "Internet of Things" provides an overview of Internet of Things. "Making Sense of It All—Towards "Smarter" Entrepreneurship and Innovation Ecosystems" concludes the paper by describing the main outcomes of this study as well as the interconnections between the concepts that were examined in this study.

Risk Management 5.0

Many years ago, since humanity began writing its history, Risk Managements registers were always present. The Greek and Roman empires which affected modern history

and culture did not have any tools to deal with Risk Management; their fate was depending on their Gods' hands (Costa 2018; Covello and Mumpower 1985). Until now, we really do not know if their outcomes were effective but it was the best thing they could do to deal with uncertainties that were affecting their targets. This type of pre-historic Risk Management endured until the mid-seventeenth century when we had the birth of Risk Management 1.0. During this period, Blaise Pascal and Pierre de Fermat designed Probability Theory (Ore 1960) and altered the way we think and act with regard to uncertainties.

From the prehistoric days until the 1940s, many years have passed and various approaches and processes were developed which provided the opportunity to people to create predictions and forecasts and even take decisions based on those predictions, something which was not possible until that time. During that epoch, risks that could lead to business losses were introduced and considered dangers and threats to business. In the 1940s, we have the actual discovery of Risk Management 1.0 (Stulz 1996).

After the World Wars, we witnessed the influential era of Risk Management 2.0; during this period, the first scientific studies were published, theories were written, and concepts were defined (Dionne 2013). With the evolution of many Sciences such as Mathematics and Engineering as well as other emerging technologies, the world changed, so various risks once considered relevant turned into something irrelevant.

From World Wars until the 1990s, various practices like the common sense and trial and error were swapped by quantitative analysis and at the same time regulation mechanisms were developed by institutions and governmental authorities (Young 1981). Subsequently, in this period, many researchers were awarded with Nobel Prizes for their studies in Risk Management (Michel-Kerjan 2008; Alexander 2009). This epoch is considered to be Risk Management 3.0 (Dionne 2013).

At the beginning of the new millennium and perhaps also due to the end of Cold War, we faced the beginning of modern globalization as well as the start of a huge technological explosion (De Vries 2010). These two facts led to the increase of Project Risk Management and the introduction of Enterprise Risk Management (Lam 2014) that aimed to help firms reach their goals. In this period, Financial Institutions were required to reinvent their line of business, new approaches and procedures were developed, and more tools were demanded by stakeholders and customers. At this time, cyber-attacks and ecological disasters happened, giant techs appeared suddenly (Hendershott 2004), and individuals recognized that negative and positive risks are in our daily lives so you have to manage them; otherwise, your strategies will not go as planned. At this period, we have the introduction of Risk Management 4.0, a more mature version of Risk Management that lasts until now.

The risk management as we know it today consists of the following steps (KukrejaI 2020; Kloosterman 2014):

1. Identify the circumstances: it is important to identify the circumstances in which a risk appears before it can be noticeably assessed and mitigated.
2. Risk identification: is the approach of recognizing the particular risks associated with the threats already identified?
3. Risk assessment or risk evaluation: this step comprises the understanding of numerous risks identified and the determination of how hazardous the certain risks are.

4. Risk control: once the risk is assessed, it has to be controlled. Various control metrics are implemented and documented.
5. Monitor and review: the final step encompasses understanding the impact of the control mechanisms developed on the threat and the risk it poses.

Presently, something is happening once again and a new tactic for Risk Management is occurring (Costa 2018; Dionne 2013). The way people look at the future will be reshaped, so what follows? Firms and organizations will comprehend the real values of Risk Management; they will start using Risking Management to add extra values to their products for the benefit of their customers. Business processes will be reshaped and people will not just administer risks. The whole Risk Management processes will be conducted by risks, and every single organizational choice will target to minimize threats and maximize opportunities. Organizations will become agile and viable in order to reach their goals. New methods to exchange daily information will emerge and will become more widespread. Data will be processed quickly and AI tools will be utilized to forecast future events to aid decision-makers (Costa 2018; Dionne 2013; Aziz and Dowling 2019).

Nowadays, regulations are also affecting decisions (Araz et al. 2020). Everyone is more loyal to laws and contracts since people are not showing willingness to allow behaviors that do not agree with or expose themselves to risks. In the future, sustainability will be more present and obligatory. Currently, as an outcome of the Covid-19 (Gasmi et al. 2020) pandemic, everything worldwide is changing.

All these changes and effects are revolutionizing Risk Management and there is no way we could space from this. People have two choices facing. Passively wait and become outdated or make it occur and get there first. Roll your dice (Costa 2018). Welcome to Risk Management 5.0.

Industry 4.0

Nowadays, the concept of Risk Management 5.0 as outlined in the previous section can be implemented into Industry 4.0 so as to develop new standards that could lead to Society 5.0 and Industry 5.0. As described in Manrique (2019), in Industry 4.0 the generation of knowledge and intelligence is done by humans with the help of technology. In Society 5.0 the generation of knowledge will come from machines through Artificial Intelligence at the service of people.

The rise of the new digital industrial technology, known as "Industry 4.0," made its first appearance in 2011 in a German strategic initiative as a part of its high-tech program and later defined by Kagermann et al. (2011) and Henning (2013) as "a new type of industrialization."

Presently there is no any consensus within the literature on how to correctly define Industry 4.0 (Piccarozzi et al. 2018; Hofmann and Rüsch 2017) even if its execution and operation is at the center academic, political, and governmental interests. Germany was among the first countries through its "High-Tech Strategy 2020" that promoted Industry 4.0 and granted access to millions of euros of funding in the development of vastly innovative and emerging technologies in the production field. Subsequently, other administrations have begun to promote various plans and actions at national

levels to errand Industry 4.0 adoption by firms (Liao et al. 2017). Some examples include, but are not limited to, the Advanced Manufacturing Partenership (AMP) promoted by the US government in 2011, the "Nouvelle France Industrielle" program introduced by France in 2013, the long-term framework outlined by the UK government specifically for its manufacturing sector namely "The future of Manufacturing", and the "Piano Industria 4.0" designed exclusively for Italian companies investing in digital transformation.

Mechanization, electricity, and IT were the results of the first three industrial revolutions, while Industry 4.0 introduces the Internet of Things and Services into the manufacturing ecosystem. Industry 4.0 endorses high economic impacts for both businesses and consumers and promises increased operational effectiveness and efficiency, as well as, new business models, processes, services, and products (Hermann et al. 2016).

One of the core challenges in describing Industry 4.0 originates from the various labels (Industrial Internet, Internet of Things, smart factories, Human-Machine-Cooperation, smart manufacturing) which are currently being used to indicate similar and in some situations same phenomena that are dealing with the application of digital and interconnected technologies to the manufacturing zone. Burritt and Christ (2016) stated that Industry 4.0 is an umbrella term used to call a group of connected technological improvements which are used to increase firms' digitalization.

Hermann et al. (2016) detected four elements of Industry 4.0: Cyber-physical systems (CPS), Internet of Things (IoT), Internet of services (IoS), and smart factory. CPS are systems that actually bring the physical and the virtual worlds together (Hofmann and Rüsch 2017) by incorporating computation, networking, and physical approaches. In a manufacturing framework, CPS involves smart machines, storage systems, and production amenities able of autonomously exchange data, initiate actions, and control each other independently (Kagermann et al. 2011). Machines and other devices that are used in production lines can collect real-time data and use those data to make decisions such as prioritization of production orders, optimization of tasks, and maintenance (Lee et al. 2014). Their application in manufacturing procedures presents a whole new level of control, transparency, efficiency, and flexibility.

The Internet of Things (IoT), or the Internet of Everything which was first presented in (Ashton 2009) as the phenomenon of enhancing new technologies (e.g., Internet) to everyday objects, participates in the processes of Industry 4.0. Nowadays the IoT term has a wider sense and includes a network of things—which are called "internet-connected constituent"—coupled to each other by any form of wireless sensors, actuators, and mobile phones (Nitti et al. 2017) and can be used to provide information about their environment, context, location etc. (Ng and Wakenshaw 2017). Based on this definition, the physical objects now become "intelligent objects" and have the possibility to talk thanks to the Internet. Similarly, to IoT, the Internet of Services (IoS) permits service vendors to offer their services via the Internet and, consequently, add value to their existence. New Web technologies, for example services-oriented architecture (SOA), software as a service (SaaS), or business process outsourcing (BPO), enabled the escalation of new business models where a party can grant temporary access to the resources of a different party to execute a prescribed task. Human workforce and skills, technical systems, information, consumables, and others are some of the resources that can take part in the process (Hofmann and Rüsch 2017); presently,

firms are shifting from the offering products to the offering of integrated product–services, a phenomenon that in literature is called "servitization" (Rymaszewska et al. 2017). The mixing of IoT and IoS in a CPS enables the birth of "smart factories" (Jiang 2018). Smart Factory can be defined as a factory where CPS communicate over the IoT and IoS, which assists persons and machines in the execution of specific tasks (Hermann et al. 2016). In smart factories, human beings, machines, and other resources communicate with each other as naturally as in a social network (Jiang 2018). By equipping manufacturing with sensors, actuators, and autonomous systems, Industry 4.0 helps factories in becoming more intelligent, flexible, and dynamic (Kamble et al. 2017).

Xu et al. (2018) identified various technologies which go beyond the aforementioned four components of Industry 4.0 but also can be considered part of it such as the following: cloud computing (Velte et al. 2009), additive manufacturing, wearables, big data, augmented reality applications, wireless network, and smart cities. Smart cities are cities that connect the physical, IT, social, and business infrastructures to leverage the intelligence of the city's community (Hollands 2008) and to support added-value services for citizens. Interdisciplinary is another element of complexity that exists in Industry 4.0 since Industry 4.0 touches different fields such as engineering, computer science, information technology, manufacturing, human resources, environmental science, and consumer behavior. Piccarozzi et al. (2018) stated in their literature that Industry 4.0 is a cross-cutting theme of many disciplines that influence each other. Even today, it is tough to find a research paper dedicated to the managerial and business aspects of Industry 4.0 due to the fact that in every domain the business aspect blends with the aspects pertaining to technical engineering, ICT, or sustainability.

Societies and Businesses are currently becoming increasingly conscious of the capabilities derived by applying new emerging technologies; this allows them to gain long-term competitiveness, adapt more dynamically to consumer alterations and ecological requirements, optimize decision-making, increase productivity and effectiveness, and, finally, create new valuable opportunities by introducing new services. However, some reports identified various factors that can either foster or hinder the adoption of Industry 4.0 by different companies. Müller et al. (2018) acknowledged three different prospects that serve as antecedents: strategic opportunities (new models for businesses, new value offers for greater competitiveness), operational opportunities (efficiency, decreased costs, better quality, improved speed and flexibility, load balancing and stock reduction), environment and people opportunities (reduction of monotonous work, age-appropriate workstations, reduction of ecological impact). On the other hand, Müller et al. (2018) find three core barriers: future viability and competitiveness (existing business models endangered, flexibility loss, standardization, transparency); organizational and production fit (high operation efforts with regard to costs and standardization); employee qualification and acceptance (employees' anxiety, fear and concerns, lack of know-how).

One of the main challenges in Industry 4.0 is how to do with the role of human resources in the digital revolution (Horváth and Szabó 2019). On one side, new technology could essentially escalate labor shortages, reduce human work, and allow organizations to allocate human resources to higher value-added capacities. On the other side, digital revolution which requires dynamic competencies and the acquisition of knowledge and expertise from outside the organization is essential and needs to be

taken into account when referring to the human resources within Industry 4.0 (Sivathanu and Pillai 2018; Hecklau et al. 2016).

To conclude, among the many driving forces of sustainable practices, Industry 4.0 technologies are becoming more and more important since they can facilitate the growth of green manufacturing procedures, green supply chain management, and also green products (Green et al. 2012).

Digital Transformation

Industry 4.0 is considered to be the digital transformation of manufacturing and related industries; thus, in this section we present the general concept Digital Transformation. During this era, Digital Transformation (DT) has acknowledged an emergent notice both by academics and experts; however, despite various scholars having addressed this topic, a joined definition of DT is still missing (Morakanyane et al. 2017). One of the core reasons for this lies in the fact that DT understanding requires an interdisciplinary approach (Hausberg et al. 2018). Hausberg et al. (2018) emphasize that although various works are focused on the technological aspects of the digital transformation, the "human" component is fundamental as well.

On the one hand, there are studies that consider technology as the main driver of this "radical change" (Morakanyane et al. 2020); on the other hand, there are people who describe digital technologies as an enabling factor for a new organizational shift (Nambisan et al. 2019; Morakanyane et al. 2020) that impacts society and people, as well as, knowledge management (Urbinati et al. 2020). Hausberg et al. (2018) during their in-depth research on DT identified that big data is the research stream with most contributions while AI and machine learning are those technologies that have a substantial presence. Moreover, among the various streams identified by authors in Hausberg et al. (2018), one was "society," which consists of mechanisms that deal with the digital technologies' role in the following matters: Society and communication, Policy and international, Philosophy and ethics (Colli et al. 2020; Vial 2019).

Thus, society, particularly relevant in this study, is characterized by a multidisciplinary approach that takes into consideration the DT from a societal point-of-view, with an actual focus on opportunities, and also risks, connected to the big data adoption. In the following sub-section, we outline how Industry 4.0 can be changed and extended into Society 5.0 that could truly lead to Industry 5.0.

Society 5.0 and Industry 5.0

Under the push of technological development, Industry 4.0 extends its effect to the entire society, which is considered a larger ecosystem. On the one hand, the digitization procedure consists of a series of metrics attributable to the optimization of production processes within industries (supply chain management, manufacturing, and production in smart factories etc.); on the other hand, the digital transformation applies a restructuring of the socio-cultural patterns centered on the most dissimilar technological innovations (Nambisan et al. 2019). At the root of this expansion, the idea of Society 5.0 (or "Super Smart Society") is defined. This prototypical viewpoint initiated in Japan and was outlined as the main concept in the "Fifth Science and Technology Basic Plan" introduced by the Japanese "Council for Science, Technology and Innovation". Society

5.0 was acknowledged as an overall development strategy for Japan, and was recapped in "The Investment for the Future Strategy 2017: Reform for Achieving Society 5.0." Fundamentally, Society 5.0 provides a mutual societal infrastructure for prosperity based on advanced service platforms. Industry 4.0 follows Society 5.0 to a certain degree, but while Industry 4.0 emphasizes on production, Society 5.0 aims to place human beings at the midpoint of innovation, exploiting the impact of technology and Industry 4.0 results with the technological integration to improve quality of life, social responsibility, and sustainability (Onday 2019). This ground-breaking perspective is not restricted only to Japan, but it has common points with the objectives of the UNDP SDGs ("United Nations Development Program" "Sustainable Development Goals"). In addition, unlike the concept of Industry 4.0, Society 5.0 is not obliged only to the manufacturing industry, but it solves social problems with the aid of physical and virtual spaces integration. In general, Society 5.0 is the society where the advanced IT technologies (IoT, Artificial Intelligence, Blockchain, etc.) are aggressively used in peoples' life, industry, health care, and other provinces of activity not for the progress, but for the advantage and convenience of each person (Fukuyama 2018).

In the near future era of Society 5.0, cybernetics will encounter with "Evergetics," as the emerging neoclassical science of bilateral management approaches in society. Evergetics derives from the Greek word (Ευεργέτης) that means "benefactor"; already in its etymological origin we distinguish an emphasis for "good actions" in management processes and decision-making. The author of this neologism expressed it as "... the science of management processes organization in a developing society, each member of which is interested in augmenting his cultural heritage he is producing, which entails a raise of cultural potential of the society as a whole and, as a consequence, an increase in the proportion of moral and ethical managerial decisions and corresponding to them benevolent actions in public life" (Vittikh 2014, 2015). It is clear that to safeguard that the implementation of Society 5.0 is not just a political-ideological theory, it is necessary to integrate numerous dimensions, such as innovation policies (government point-of-view), entrepreneurial attitude (society perspective), and entrepreneurial skills (civil society and institutions perspectives).

A significant perception that links with the social, cultural, and economic aspects is the one of Industry 5.0, which can be considered the answer to the question of a renewed human centric industrial architype, starting from the (cultural, managerial, organizational, philosophical, and structural) restructure of an industry's production processes. The importance of this new perspective originates by the fact that Industry 4.0 is just at the early stage of development and that its main achievements can be expected not earlier than 2020–2025. Moreover, the responsible/irresponsible, ethical/unethical normative decisions and policies that describe Industry's 4.0 global governance do not take into consideration the real impact of such issues. That is the reason why the dialogs on Industry 4.0 and Society have inclined to focus on either a dystopian fearful future shaped by the IoT in which robots ("CoBots") with AI replace humans, or a future that will consistently be benevolent and prosperous for all. Both foresights subscribe, to technological determinism (evolution in organizational behavior and structures, acceptance of robots in the workplace, work ethics, discrimination against robots or people, privacy and trust in a human-robot collaborative work environment etc.) (Demir et al. 2019), and even if the rise of Industry 4.0 and its societal impacts are predetermined, they do not yet acknowledge the need to broaden

the Industry's 4.0 understanding and its possible futures in society (Özdemir and Hekim 2018).

Skobelev and Borovik (2017) stated that, if the main devotion of an industrial revolution is devoted to the technological aspects of its implementation and the human being, with his mental and creative abilities, the only key that dominates the joint discussions agenda is based on the negative changes of labor market caused by the Industry 4.0. This is why the following question arises "How can people and society benefit from Industry 4.0?" It is of great importance that scientists and engineers strengthen their efforts in Innovation management having in mind a new mentality guided by Design Thinking and aligned with the idea of "absorptive capacity" (Badding et al. 2014; Matlay et al. 2009). Design thinking might be the key to the wicked problem of innovation. Stacey and Lauche (2005) explain the wicked problem as a complex and open-ended challenge and propose design thinking as a solution. Numerous authors have highlighted the importance of design thinking for modifying the innovation management structure to construct an ecosystem designed specifically for the IoT and Industry 5.0 era with a focus on human/user centeredness (Fauquex et al. 2015; Taratukhin and America 2018; Buchmann et al. 2018). Similarly, Özdemir and Hekim (2018) presented the role of design thinking in Industry 5.0, which is more human-centric compared to Industry 4.0. Design thinking supports the connection of innovation and technological policies with the corporate strategy of a business; thus, it creates a suitable ecosystem for IoT and Industry 5.0.

In addition, the Organization for Economic cooperation and Development firstly introduced the concept of "implement-ability" of innovation. Innovation should create value for its users; if innovation is not generating any value or does not bring any change in users' lives, then it cannot be considered a true innovation. The concept of implement-ability of innovation puts the customer/user at the center of the entire innovation management process. Since the employee, in a highly technologized and machine-assisted context, would be "the user," finding the right structure that would allow humans and machines to interact by merging various human characteristics in the original design at different levels is challenging.

A way to achieve this is by identifying the prevailing roles of each party. On the one hand, human beings are better at interactions, intuition, and complex decision-making. On the other hand, machines surpass humans on pattern identification and recognition, data processing, and data search. Taking the above statements into consideration, it should be noted that future machines and smart devices will improve human life and work (Ellitan and Anatan 2019; Stojkoska and Trivodaliev 2017).

Artificial Intelligence: Innovation Meets Risk Management

Artificial intelligence is considered to be one of the core pillars of Industry 4.0 and eventually Industry 5.0. The question that arises is on how Artificial Intelligence can aid innovation.

In general, an idea or an invention cannot be labeled as innovative, only by being creative or original. Innovation is mainly a corporate, economic, or business event, manifested with technological and organizational terms. Innovation implies something more radical (Beran et al. 2019) and elevates the result into a product, aimed to be

consumed. Under this notion, radical innovation (Simon et al. 2003) leads to a complete reversal of com-mon views. It defines the beginning of a new field with commercial extensions, including high-risk efforts which, apart from implementation problems, may also face consumers' disbelief. A classic example of such innovation is the electric light bulb.

Electricity and all related phenomena were deeply examined by several scientists in the past, through a large number of scientific publications and patents. However, it was Thomas Edison who first presented the electric lightbulb as a product, while at the same time making it commercial. The light bulb was a product of radical innovation, which came into the market even before it got optimized, thus marking the beginning of the electric light era. Nothing will be the same in the future, not even the man's fear of the dark. The light bulb enables the installation of domestic and city lights and makes night transportation a lot easier and safer, while at the same time enabling the establishment of nightshifts on production lines. In this case, innovation reduces the darkness-related uncertainties through light.

In general, innovation and risk management seemingly do not naturally go hand-in-hand, although this work would argue that they should. A radical innovation identifies not only an opportunity but also an uncertainty or a risk and provides a product to eliminate it. After the electric bulb managed to gain consumers' trust, a new era for researchers has begun. Several scientists and inventors are now working to improve further and enhance the product. For many years, products of incremental in-novation (Tontini et al. 2014) appeared in the market. At first, there were light bulbs with an extended lifetime, then with different luminosity. All those products mainly presented improvements in the initial product. A part of this incremental innovation can also be regarded as the fact that as time passed, modern production lines were developed to reduce production and delivery cost. What-ever is the case, though, the importance of incremental innovation products does not overshadow the product proposed as a radical innovation. The light bulb with different luminosity is still called a light bulb, in honor of the initial product. What has changed over the years is the increased consumer trust in the product, while the uncertainties are minimized, since the risk of the bulb to fail is getting minimum. Incremental innovation, in this case, improved the trust towards the product, eliminating any doubts which in turn lead to uncertainties regarding the well-established electric light bulbs. After many years, the light bulb became an indispensable element of human survival, until a new architecture emerges, which evolves the electric bulb on a new level. LED lights are an innovation in terms of architecture, while the result remains the same: a device that is artificially producing light, in different luminosity, different colors, and low consumption. However, a completely new, improved architecture takes place, being the new standard of light bulb manufacturing. The improvement is significant, as the new architecture dramatically reduces costs and increases the lifetime of the device. Yet, similar to the case of incremental innovation, this type of evolution is not enough to overshadow the initial innovation, the electric light bulb.

However, consumers' trust in new-generation electric bulbs can now be taken for granted. The architectural innovation (He and Sarpong 2020) played a notable role in the wide adoption of the product. Suddenly, the light bulb becomes intelligent. It can now be controlled over a smartphone, change its color according to the type of music playing in the room, and automatically adapt its luminance depending on the external

lighting conditions to create the ideal atmosphere inside the room. It can also detect suspicious movements or actions and inform the police and our doctor. The new light bulb lives with us and tries to improve our life quality. Of course, it is not a product of radical innovation, but a product of disruptive innovation (Christensen et al. 2015). Its goal is not to mimic the traditional light bulb, but to reveal a new market. In the past, the light bulb was responsible for minimizing the darkness-related uncertainties. The disruptive innovation aims at the uncertainties that occurred by the typical light bulb's commercial establishment.

A low-end disruption is a technology that enters the market with lower performance than the incumbent but exceeds the requirements of specific segments of that market. Thus, the technology disrupts that market, although not a radical technology (White and Bruton 2010).

Open-source software and libraries are classic examples of potentially disruptive technologies. Probably the most well-known disruptive technology is Artificial Intelligence (AI). Artificial intelligence is defined as the scientific field which studies those systems capable of assisting or even replacing a human during a specific task.

Those systems comprise of tools that perform either physical activities or even decision-making components. Under this scope, artificial intelligence can be either be a machine or software, whose functionality implies a certain level of intelligence. Artificial intelligence is an important technology that supports daily social life and economic activities (Lu et al. 2018; LeCun et al. 2015). Today, AI became a part of our everyday life, mainly because of our nature imposed it. Our needs to further improve our working conditions, improve our productivity, and ensure a better life quality, urged us to develop technologies which apt to the AI field. Artificial intelligence assists our every step. Smart devices help us reach our destination; help our children to sleep; propose movies, songs, and shows; read articles; and answer to questions/interviews (Fig. 1).

Modern medicine minimizes medical mistakes and improves the precision of surgeries. Artificial prosthetic limbs provide opportunities to improve an individual's life, while low-cost diagnostic tests can prevent heart attacks and strokes. Research in AI has focused chiefly on neural networks and cognitive mechanisms. In terms of the technological aspect, those mechanisms were known for many decades. However, modern machine learning methods have evolved and dramatically improved.

Global human knowledge is transferred to computers to improve their intelligence. For example, it is now enough to have a collection of photographs in which humans manually identified cats. Those photographs are "fed" to the machine and through a neural network–based mechanism; the machine can identify the correlations and features and is now capable of identifying cats in new, unknown photographs.

Users provide to the machine a set of photographs depicting humans, and the machine learns to identify the existence of humans in a new photo stream. The neural network technology is not new; however, the increased number of photographs uploaded by social network users every day, the enormous expansion of the internet, and of course the phenomenal increase of computer power allowed for their evolution. Today, neural networks are the core components of deep-learning technology (Lu et al. 2018; LeCun et al. 2015). Deep learning is the technology trying to simulate the human way of thinking, and it is based on the functionality of the human brain. It allows computational models that are composed of multiple processing layers to learn

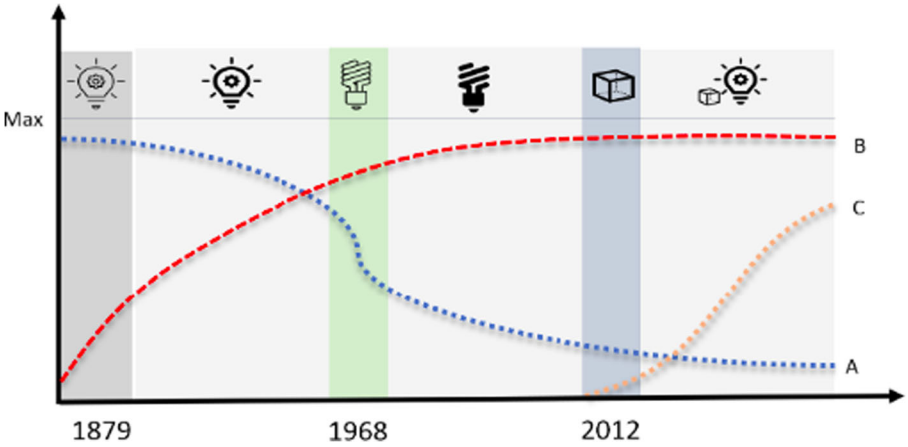

Fig. 1 Innovation towards the years

representations of data with multiple levels of abstraction. Deep learning has brought about breakthroughs in several scientific fields and technologies, allowing us to develop applications that could be regarded as science-fiction in the past. Deep learning is making significant advances in different scientific fields. Using deep learning, scientists manage to capture the first image of a Black Hole. Deep learning made a significant impact on the improvement of autonomous cars, making them more reliable.

There are a significant number of deep learning applications, many of which are already part of our everyday life. Each time we take a selfie, or control with our voice the devices in our home or office, and each time we get a recommendation from our favorite TV platform, a deep learning network is underlying. A network trained by our choices, which continues to be trained based on our decisions.AI technology can reduce risk and uncertainty in many industrial and development aspects. It can predict unwanted and unexpected situations. It can identify the parameters which may probably affect the risk of a mission or a task.

For example, by observing an investment, AI can evaluate how external factors can define the success or the failure of the investment. AI tracks stocks, exchange rates values, and a country's economy. It can predict and inform for forthcoming threats, monitor our health through smartwatches and wearable devices, and can prevent strokes and heart attacks.

Soon, deep learning will get control of our cars, minimizing the risk of accidents. It takes care of heavy duties in the warehouses, eliminating the risk of severe injuries. And this is only the beginning.

Open Challenges of Artificial Intelligence

Although a lot of research was conducted all these years on Artificial Intelligence and deep learning, there are still lot of open issues (Beris 2019) that need to be addressed.

1. Neural network opacity: to explain to professionals why a network came to the specific output and conclusion.

2. Ensuring data quality: deep learning needs lots of high-quality data to become adept at performing tasks.
3. Data security: huge amounts of sensitive real-world business data are needed to serve the needs of stakeholders.

Blockchain: Towards a Decentralized Web

Blockchain technology is considered to be the second main pillar of Industry 4.0, but how can it truly be extended in Industry 5.0? A second concern that arises now is on how decentralized technologies could be utilized in Industry 5.0.

Web 1.0 was primarily introduced back in the 1990s (Berners-Lee et al. 1994) with the commercialization of the Internet (Weis 2010) as a tool for storing, transferring, linking, and sharing content/data between users around the world, which are connected over the Internet layer (Berners-Lee et al. 1994). The Web has led significantly to the e-disruption of many different sectors of applications such as trade, education, and business. Many consider the Web as a large-scale distributed system consisting of billions of Websites or services created by uncoordinated actions of millions of users which are linked together (Lawrence and Giles 1998). Easy, fast, immediate access to large volumes of content/data that is complemented by the development of applications and services describes some of the collective advantages offered by the Web (Aghaei et al. 2012).

The rapid development of Web applications led to the constantly increasing demand of large amounts of data (Witten and Frank 2002; Laender et al. 2002). Data exists in various forms and structures, starting from raw, unstructured data to structured databases accessible by Web portals, applications, and service (Witten and Frank 2002; Laender et al. 2002). Data have always been the key source for enabling computational in attempting to understand knowledge or infer new knowledge from existing. However, the Web 1.0 has mostly contributed to static Web content and isolated data sources. A great challenge remains with the integration of many, dynamic and heterogeneous sources of data.

A continuous effort towards that direction has led to the creation of many specialized tools and methods to support the integration and organization of data, e.g., to provide quality search results (Bosak 1997; Christodoulou et al. 2014; Ansari et al. 2000; Witten and Frank 2002) and navigate to linked, relevant to the user sources of information. The quest to dynamic Web content has led to Web 2.0 which was mainly to explore the development of high-quality, dynamic user content and services with the use of Application Programming Interfaces (APIs).

Daily practices in many areas of our lives, such as education or health or the financial sector or even a person's personal life, have been greatly affected by the rapid development of the Internet, as well as, by services and applications it offers (Aghaei et al. 2012). The endless participation of users in the Web through the applications and services provided, such as social networks or online stores, which are some of the main sources of content generation on the Web, contributed to the flourishing of Web 2.0 (Murugesan 2007). In Web 2.0 the evolution of the Internet and the active participation of users is supported by both hardware and software.

The era of Web 2.0, which is characterized by Social Networking (Thackeray et al. 2008) and real-time access to information, has two aspects that developed