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Chapter 12: Envisioning the future of education and energy through connected intelligence, cross-sector collaboration, and technological foresight

12.1 Introduction

We are currently witnessing a very rapid transformation in the world of work. Lower skill blue-collar and white-collar jobs are under threat owing to advancements in artificial intelligence, machine learning, automation and robotics. The pace of change has been faster than we anticipated and, this time, it is not restricted to the usual off-shoring of low-skill jobs. We see the integration of these emerging technologies into a variety of higher skill task domains that were hitherto regarded as fail-safe for workers. The current surge has been triggered by the favorable economics of the technologies, data and the availability of cheap, powerful, energy-efficient and highly connected processing, communication and storage hardware. However, the economics of robots and hardware breakthroughs alone cannot explain the recent rapid change that has caught government, industry and business leaders unawares.

There are applications that require arrays of state-of-the-art GPUs consuming megawatts of electrical power. However, some applications such as driverless cars need to be tightly integrated with highly energy-efficient, scalable and secure mobile technologies, robotics, communication and distributed infrastructure. The focus should be on energy efficiency across the stack as opposed to energy-hungry devices that push for larger batteries, fuel cells and energy harvesting solutions. Providing well connected, secure, and scalable high performance computing technologies that can execute a wide range of artificial intelligence algorithms at the edge is a formidable challenge. Nevertheless, the potential benefits of using such devices for healthcare, defense, supply chain logistics and employing them in heartland industries are enormous. To ensure continued growth and prosperity the state needs to initiate and nurture pre-competitive R&D through partnerships with industry, academia, government and organizations, and seed pre-competitive shared facilities.

12.1.1. Overview of Connected Intelligence and Its Significance

In this paper, we describe the vision of connected intelligence, an important development with the potential for wide-ranging impact over the next decade. Connected intelligence refers to the distributed collective intelligence emerging from a large-scale union of people and computing resources facilitated through the internet. Several trends of development in this century are poised to greatly increase the collective intelligence of society as emerging from connections between people and aggregations of computing resources over the internet. We anticipate that the thriving five-year-old World Wide Web and associated internet tools will form a framework for a much richer collaborative environment that emerges as a tool; those who have access to a connecting network have access to it.

This effort is significant not only because we are interested in both education and energy – two of the most important markets in our society – but also because it represents an intersection and integration of significant components of our national information infrastructure, leading to new advances and reinterpreting the results at a different level of abstraction and application. We consider high-performance computing and communications to be two of the key elements in society's expanding progression to an information-based economy. They are exemplified in high performance computing modernization programs from the hardware level.

12.2. The Role of Connected Intelligence

The concept of designing and enabling machines to use context-aware information and historical and real-time data for real-time decision-making is often called "connected intelligence." This concept is a natural evolution of the "industrial internet," a term used to denote how networked sensors and software applications allow for deeper automation. Connected intelligence through the industrial internet has moved beyond sensing functions into the realm of real-time decision-making to transform traditional business processes. In the realm of learning, connected intelligence aids in "adaptive learning and support" in a unified, high-performance learning continuum. This support is powered by devices and systems that are evolvable and self-configurable, providing both a connected learning experience and a connected learning infrastructure. The realization of connected intelligence in the energy and education ecosystems has been constrained thus far by the initial costs of the high-performance infrastructure required for advanced communication and computational capabilities. In the realm of energy, complex power systems with fewer assets and greater operational rigor are not enough. Energy consumers need to gain insight into consumption to make informed choices. The new energy mix needs a two-way flow of electrical power and information. In education, technology has opened doors to expanded and accelerated learning, but our digital learning experience is fragmented, frustrating, and less enduring than it could be. For substantially enhanced learning outcomes and research achievements, we need a forward-looking strategy for cyberinfrastructure.

12.2.1. Defining Connected Intelligence

A fundamentally important area of technological change that underpins the future of many different domains involves the creation of connected intelligence. Although there is no agreement on a precise definition of this concept across fields, in simplistic terms, connected intelligence refers to a step beyond intelligent systems. It describes the systems created when these intelligent systems are connected together, making increasingly sophisticated use of the Internet of Things, distributed computing, machine learning, computer visualization, and human-computer interfaces. The term is sometimes used interchangeably with related concepts, but nonetheless provides a convenient label for the cross-cutting changes that the development of an ever-more connected world will bring about.

Fig 12 . 1 : Future of Education and Energy Through Connected Intelligence

In essence, connected intelligence is about environments that can perceive the current state of the world and respond appropriately. The field comprises advances in technology as well as in research into how those advances can be used to address challenges and opportunities across many areas of our rapidly changing world. However, there are specific ways in which this is more than simply a continuation of the current digital revolution. First, the rapid growth in the technology surrounding the collection, management, and analysis of data means that we are seeing rapid advances in the availability of very large data sources. Second, the increasing number of these data sources are connected together using high-speed networks that allow these data sources to be combined. Finally, the use of machine learning to perform not only assessments but a growing number of actions means that these linked data sources are capable of assessing the data in ever more complex ways, potentially taking decisions in ways that previously were only possible for humans.

12.2.2. Applications in Education

The educated person of the future may be well-informed about a particular aspect of his discipline and philosophically adept at abstract thinking. In a machine-like world where the practical functions of today's educated person are progressively delegated to others, the person who survives in the world will be the individual who uses his advanced education to think and reflect, to see and to wonder, to integrate and ponder on the relationships between divergent areas of knowledge. Increasingly, the survival education of the 21st century will also depend not on the reach of specializations but on the facility with which an individual can make use of generalization. Society will be richer for this growing analytic point of view as a vital resource for formulating problems and planning strategies to address them.

The good teacher of the future will replace the tautological language and amorphous examination that test an individual's ability to remember with a teaching process that inculcates into the educated ones the ability to use intelligence and knowledge to devise solutions to complicated real-world situations. The knowledge creation function that the college has to serve society by providing readiness to solve problems for which society itself has been unable to find solutions. The message has only been a constant belief. What is new arising from the work of connected intelligence is that education that catalyzes the development of general capacity for mastery of complex thought can become the normal, rather than the exception, despite the penetration of society by specialized automatistic technology.

12.2.3. Applications in Energy

There are several grand challenges in energy research: weaning the planet off fossil fuels, moving to a sustainable energy infrastructure based on renewable sources, achieving material efficiency in the energy landscape, and addressing climate change due to rising levels of atmospheric carbon dioxide. It is towards these pressing societal problems that two of our case studies in smart grid and solar energy are directed. By introducing CI methods and concepts in these applications, they not only stand to gain efficiency but also be part of the growing momentum worldwide in building cities, countries, and continents that are "smart." The last few decades have seen tremendous advances in energy science and technology, affecting virtually every aspect of modern living. However, the realized potential of major players in the energy field has also had the large undesired side effect of greenhouse gas emissions, which in turn affect virtually every aspect of the environment as well as the quality of life of present and future generations. It has reached a stage when most of us are in agreement to build and operate a "Smart Grid" that can effectively accommodate the trade-offs between energy—multiple sources, balance of supply and demand, pricing, and being informed by state and local environmental regulations. In this paper, we outline exciting opportunities to pull in innovations from CI and introduce interconnected intelligence that can add entirely unexpected but much needed performance upgrades to solutions to current technology roadblocks. They can thus offer new insights in energy science and play a significant role in addressing the two unsolved grand societal challenges of (i) providing a new infrastructure that can assess, plan, and operate systems according to efficiency for both the economy and the environment, and (ii) retrofitting cities and countries with as much intelligence as possible to parameterize, calibrate, and validate projections of the future energy landscape in both the developed and developing worlds.

12.3. Cross-Sector Collaboration

To solve many of the big challenges in society, the world needs to be driven by relevant, actionable research and insights across academia, government, and the private sector. Academics can produce unbiased fundamental research. Industry leaders can leverage this knowledge to develop it into products that are scalable and can be commercialized. Government can help facilitate the process by employing tools such as tax credits at the frontier of technology, as well as stringent regulations in established markets. Increasingly, these three knowledge-sharing sectors are coming together to create a connected intelligence that makes it possible to solve some of society's toughest challenges that were previously beyond solving. No one field can solve global problems alone. The modern electrified world's education system is one area of research that has a direct link to the world's electrification organization. While the development of scalable fusion technology will hinge on building tomorrow's workforce, the availability of inexpensive clean energy will provide the ability for that workforce to access basic education. Educational systems will also need to help retrain the workforce in future job demand skill sets. There have been long discussions on how, through a unified innovation process, we are communicating that an investment in education will provide a solution to achieve scaling of this climb to future productive commercial large-scale fusion plants. In addition, an overarching roadmap is being proposed that the alignment and coordinated investments, as well as concurrent progress in energy innovation fields, advanced manufacturing innovation fields, and the related skill sets interrelated at different places on the timeline, will need to be simultaneously pursued.

12.3.1. Importance of Collaboration

In today's interconnected world, it is imperative to collaborate and work in an interdisciplinary realm so we can enable learning and reveal solutions that tackle pressing social and technical challenges. Collaborating within the context of education and energy is especially significant, as there are clear dependencies in innovation across these sectors. The use of ecosystem principles can provide contexts for studying relationships among elements. Collaboration among multiple tiers in the knowledge ecosystem is essential for harnessing education and energy as driving forces of future beneficial societal outcomes. These ecosystem and collaboration ideas are part of change that continues to challenge individuals, building connections for innovation within and far beyond the institution.

Change is occurring within and beyond traditional models in both of these critical sectors, with improvements blurring the lines of focus within our very contrasting activities of education and energy production. In essence, the futures of energy and learning are evolving as connected intelligence, leveraging physical and social changes with emerging communication mechanisms that interconnect groups of experts with other experts and with learners. We focus here on some of the ideas, education advances, and illustrative problem solutions that use the connected intelligence for future progress in learning and energy domains.

12.3.2. Case Studies in Education

In any educational environment, a few key principles are to manage knowledge and share it effectively, stimulate collaboration, create immersion, and establish an environment in which students and teachers are not aware that technology is in use, because communication is seamless. With connected intelligence, an architecture is created that can absorb, integrate, and deliver massive volumes of information at high speeds, affordably, through technological advances, allowing the emergence of collaborative educational tools for digitally mediated human relationships.

Considering educational content, there is a process of creating personalized curriculum and resources along the lines of a personalized news master, which will seamlessly integrate relevant materials in the appropriate media form and language for each user within the educational environment.

A real-world experiment approached this trend, exploring ways in which high school education might be transformed based on the assumption that one should not design the future of education based on the present state of future technologies. Its most specific goals were to elevate the quality of education, enhance student experience, provide personalized instruction, and open the world's knowledge, remaining sensitive to operational realities: it needed to deliver sustainable and scalable results. Such experiments are useful for many reasons, but one significant one is that in order to piece the design elements of digital educational environments into a transformative organization, one specifically needs a test bed to validate the universal design patterns.

12.3.3. Case Studies in Energy

The paper presents case studies in the area of energy. The broad impacts of the predictions extend to several areas, including the domains of energy and education. In the energy area, we explore three different case studies that collectively impact many areas, including climate science. The case studies include the use of content-based analysis of the news, the use of macroeconomic models, and intelligent outcome ads. The ability to explore huge amounts of content has far-reaching implications in energy education. The abundance of data, as well as the computed relationships between concepts, introduces an era of learning at the intersection of ideas in a new way involving connected intelligence. Our ability to visualize and explore these relationships by using static or dynamic dashboards allows us to provide science-based experiences. Such visualization generates insights making such predictions easy to share and build consensus.

Energy education is an area of focus for several science and education policy perspectives. These underscore the importance of the general public having access to well-reasoned scientific knowledge. The goal is to help promote renewable and sustainable energy on a grand scale. Connected intelligence has a central role in the future of energy education. Here we highlight an emphasis on the human dimension of intelligence. We are looking ahead to a decade, or several from now, to determine how energy is going to be utilized and what some enabling industries may be. The mental pictures we draw are very dependent on our concept of society. In this locus of endeavor, connected intelligence interacts with the issues of, or opportunities for, education, industry, and economic models of how society operates. Contained in our mental models are social models inclusive of what are the quotidian activities of everyday citizen scientists and experts. Because our mental models are set up interactively with our daily reality, we can make meaningful contributions through short-term agility-minded decisions.

12.3.4. Barriers to Collaboration

There are serious institutional, governmental, and cultural barriers that can impede more rapid progress in these terms Challa, 2022; Chava, 2022; Komaragiri & Edward, 2022). While the potential for win-win commercial payoffs in both energy and education that benefit from the same technologies has long been appreciated, this is far from self-enacting and requires significant risk and organizational resource sharing, including IP in addition to research funding. The science and engineering basis of much of the relevant technologies is, however, increasingly the same in each of the domains considered, making this an excellent area for any holistic academic collaboration. Governments within both domains are, however, principally structured around single university mandates and separate departments and funded principally through research council-based models. Aligning similar funding programs for both domains, at least for the generic technologies and basic science, is non-trivial given the barriers to simultaneous applications of resources.

While working with state schools in their areas is normally well-established for most universities, particularly with a focus on outreach and widening participation, the financial flows in the two systems are mostly completely disconnected, especially internationally. For energy or finance-rooted businesses, the potential human resourcing benefits of a closer university-school relationship are not just obvious but seriously disruptive to this established USP for their offerings, which are focused on independent school clientele, despite that sector being relatively well looked after by their own university alumni. In the longer term, one would, of course, argue that the collective data exploitation from the whole of society approach to learning supported by connected intelligence attraction of educational analytics in either education world means that some cross-funding from energy data analytics could be justified.

12.3.5. Strategies for Effective Collaboration

Although significant advances toward building software to support collaborative work of many types have been made, it is still the case that no development environment is ideally suited for the creation of complex simulations by diverse groups of participants within the complex social and interdependence networks. The challenge for an organization becomes how to effectively support this form of electronic collaboration. Ultimately, dependent upon the success of the group's work, significant new conceptual and technological advances to collaboration may itself result. To identify potentially interesting future directions, we present several strategies that represent the leading edge of the current discussion within the diverse global community of groups and projects engaged in the development and support of diverse distributed scientific communities.

Effective data and information sharing, management, and discovery among remote collaborators is critical for this research, and enables it by fostering its emergence on the global landscape. Several strategies that are more subtle than direct strategies for collaboration are also closely related and particularly interesting. For instance, the optimal ways of structuring diverse groups of distributed workers to perform the range of tasks related to modeling and first principles we have discussed are not well understood. Similarly, the global spread of work opportunities is likely to alter the nature and scope of those involved with such models.

12.4. Technological Foresight

The laser pen, which plays an important role in our presentation of the work reported in this book, was introduced in 1960. However, if asked in the 1950s to envision in detail the usage of semiconductor materials and quantum mechanical effects, it would be impossible to foresee the many ways that it is used today, such as in the CD, DVD, or the Blu-ray disc. In 1961, a company introduced the first commercial integrated circuit. Today, it has over 40,000 products. While at that time a few people understood what a semiconductor was, the impact that its usage would have was totally missed. These examples demonstrate the difficulty of anticipating the multifaceted uses of new materials along with the development of new technologies. Today, we are in the midst of an information age that—as the computer age before it—is shaped by both the relentless advance of technology and an accelerated transfer of new technology to the market. Indeed, this has been a defining characteristic of the computer age. The what-to-do question is a difficult one reflecting the growing difficulty of anticipating future innovation.

The what-to-do question is a complex one, and the answer depends on both how we view this complex social problem and the knowledge and tools we bring to bear on it. More often than not, technological foresight efforts are either too broad or too narrow. This reflects the complexity and the interdisciplinary nature of the problem. As an example of an approach that is "too broad," consider long-range planning, which focuses on external forces to shape the long-range trajectory. This approach is very historical and not very future-oriented. It hides the true role of technology in shaping society by treating technology as an unconstrained force with a direction of its own, then looks for ways to adapt to it. On the other hand, the approach is often "too narrow" because it is focused primarily on the narrow R&D agenda to meet near-term military and civilian needs.

Typically, it is based on the fundamental belief in a clear system with a set of targets and solutions. After all, the military mission is clear and includes a number of incremental goals leading to the system of systems vision. The research and development centers are pretty straightforward and operate on the basis of a list of alternative military futures. For example, the management of a laboratory believes that the 10-20 year military mission should be "clearly defined." Further, the management of these system-only unclassified R&D laboratories only invests when there is a clear operational military customer. In the end, the avoided and the loss potential frame the competitive landscape. The current management model is to stop and start. Finally, proposals not driven by this thinking are restricted to apply only for a small set of opportunities.

12.4.1. Emerging Technologies in Education

Education plays an important role in society as an investment in human capital (Chakilam & Rani, 2024; Challa, 2022; Chava, 2022). The finance world may have the stock markets but education has the futures market as investment in these formative years can determine the future potential of any individual. Over the years, there have been many such proposals that have led to changes in the way the educational system is managed and delivered from individual special education needs to the general pedagogic techniques. The needs of individuals may range from a special diet to concentrate in the class to individualized attention by a class aide to enhance the learning process. The conventional educational system has been around for a few centuries. The disruptive nature of technology development may change the future of education as we shall propose.

Educational institutions form an important part of any society. Over centuries, they have served as centers for learning as well as medical services for both the poor and the rich. In the information age, many education do not necessarily have to take place within the physical walls of existing institutions. Improvements in visualization technology, lab experiments may not necessarily be restricted within the confines of the educational institutions. A plethora of masses of open online courses are being offered by institutions or professors and these have seen the number of enrollments running into the hundreds of thousands. Although, turn rate is very low as the completion rate is far lower than the enrollment rate. The trend towards continuing education separate from degree conferring education has already begun. The development of competencies earned across the career, rather than a commitment to a multi-year program, is gaining currency. The education institution model we forecast will not get disrupted but the delivery and payment models will undergo great changes to better meet the needs of the customer.

12.4.2. Emerging Technologies in Energy

Huge global challenges await our solution-generation society. The growing per capita consumption of electricity in China and India will stress world oil production. Cheap and abundant oil will become increasingly scarce, resulting in a disastrous increase in corruption similar to that demonstrated by the collapse of communism. A continued increase in nuclear energy production raises the issue of long-term storage of fission products. Increased use of coal by the U.S. and China, even in the present best-case sequestration, will not limit the atmospheric CO2 level to 500 ppm, unless increasing the quality of life of 2 billion people living in India and China can be reconciled with constraining CO2 output with the available technology set. In the United States, durable solutions must accommodate the cantankerous character of the U.S. Senate, where a supermajority is required for lawmaking. Three emerging technologies are destined to revolutionize the energy sector: fusion, nanotechnology, and quantum dots for photovoltaics, in addition to present technological advances in nuclear fission. Fusion requires vast amounts of data analysis to optimize the minimal possible heat anchor points of a virtual structure. Additionally, the molecular encasing of nanomaterials greatly affects their function. High-throughput calculation of the mechanical characteristics of prospective shells is crucial for nanoparticle investigation. Today's major elements in grid operations are load forecasting and unit commitment. Two software functions are portrayed concerning wind power, although the concept for any non-dispatchable renewable is similar. We additionally note that interval-based load forecasting is an emerging application through the creation of customer profiles combining load and energy utilization signals. We have proposed a beam search algorithm for this problem.

12.4.3. Predictive Analytics and Trends

We are concerned with societal dynamical problems and more specifically with analyzing the structure and organization of societal processes, as well as the primitives and parameters involved with the available societal data. This leads to the development of models that become the basis for solving societal problems, such as improving education outcomes and developing energy landscapes. We are now more capable of studying, understanding, and making decisions about how massive numbers of diverse items or diversely behaving units are organized and how they interact, making use of this scientific progress. In this paper, we introduce our current and future work, a two-pronged effort. The first prong involves the development of a data system for education as well as scenario building for society-specific applications. The second prong produced an integrated development model for an emerging sustainable energy landscape and society.

Big societal data promotes an interdisciplinary approach with consequences extending beyond the scientific area on which it is focused. We provide methods for ascertaining one fundamental aspect of this approach – the extraction of empirical models of societal primitives and parameters, given massive empirical data on commodities and their demand in a sector of the economy. With cheap data, predictive analytics has become key. We propose and implement a new predictive method, using coupled key parameter sets for state-of-the-future prediction models. We describe a model and prediction models for education and electricity demand. With requisite societal data, these predictive models can be used as a tool for scenario building, a process in which several competing models can be used to extrapolate future societal trends. While the ability of predictive methods to actually predict societal events, such as energy landscapes, stands on its own, our contributions within the fishing simulation model provide a practical illustration, where the model is tested using the only relevant existing data set. In education, we propose a norms activation process, a plausible way to deal with neglected practical details and the nitty-gritty required to achieve certain goals. It takes as input available and relevant agent internal motivation levels and educable abilities associated with identifiable groups. Such practice often leads to predictions of potential pitfalls and conflicts, providing a number of scenarios that policymakers can choose to avoid by reacting to some outputs rather than others.

12.4.4. Impact of AI and Machine Learning

In the upcoming sections, we will present an overview of the long-term impact of AI and machine learning, respectively. The presentation consists of a short introduction to the opportunities and transformative factors enabled by each enabler of connected intelligence, followed by a literature review of both fields that highlights quantified results, critical hypotheses for impact, and the related evidence. Before diving into AI and machine learning, it is important to acknowledge that these are not qualitatively different paradigms than the other ones encountered above.

They are tightly interconnected with the evolution of technology and stand on the shoulders of both hardware evolution and the growing body of empirical evidence behind the other enablers. Modern AI and ML would not have been possible without the foundational work of the semiconductor industry, the performance improvements in networks and storage technologies, the availability of large datasets that stand behind supervised learning, or the experience accumulated in system design and optimization practices. AI, and especially ML, are key contributors to the technological and societal transformations to come, but they are not separate from the other forces – they are both consequences and contributors to the progress of technology, being enabled at the same time as they enable unprecedented progress paths in various domains of human activities.

Fig 12 . 2 : Impact of AI and Machine Learning

12.5. Integrating Education and Energy Sectors

We build upon the ideas of connected intelligence by conducting a study that examines and contrasts education and energy policy in the United States. Our treatment of the respective educational and energy pipeline issues as a single network within the framework provided by the digital economy, big data, and connected intelligence policy relies on our belief in an integrated, rather than an isolated, response to the looming demographic and economic challenges. Our objective is to demonstrate the potential benefits that emerge from linking the educational and energy sectors within a robust analytical policy framework, capitalizing on their shared challenges. Both fields are inherently local system problems with nationwide portfolios of policies that regulate and guide their structures. The novel part of our proposed approach is not the concepts of big data, human capital pipeline, informed knowledge generation, or systems analysis. What is groundbreaking is the juxtaposition of the systems models of the education and energy sectors and the other frameworks that are developed to address the local pipeline issues in a coherent fashion. It also makes examining prospects and developing policy recommendations much easier, as it reduces the number of messages and the related complexity of communication with fellow citizens. We can learn from the experiences in the energy sector as big data starts to have a larger impact. We place the analytical policy framework in the context of the digital economy, which has created jobs at its heart starting well before connected intelligence and the Internet of Things.

12.5.1. Interdisciplinary Approaches

The most interesting research opportunities are at the intersection of the interdisciplinary. This type of work can target a variety of challenges by leveraging expertise from different fields - for example, those who combine sensing, imaging, modeling, and control to bring new solutions to difficult problems. These interdisciplinary approaches place a high premium on sharing knowledge in effective ways, as well as generating new knowledge through the interesting work that is inspired by these intersections. We are particularly encouraged about the future of the educational process in this context, especially because new tools for reflective practice with digital portfolios, social computing, and other concrete means are beginning to have an impact on practice. Since feedback is so critical to the learning experience, we are also exploring the generation of electronic learner models to capture the adaptations that students make, and the use of these models to design better support systems to improve learning.

We are similarly encouraged about interdisciplinary solutions to the future of energy, particularly with the advent of a resulting convergence of cognitive radios and wireless sensors with the smart grid. This combination enables the smart grid to think about not only when and how to use electric vehicles - itself an interesting and growing problem - but to form a closed loop with other systems about what to do when the grid is under contention. The second issue associated with thinking about energy in decision-making is the challenge of providing power to the smart grid itself. Here, we are entering the age when the cost of renewable power generation and storage is good enough to not only provide emergency backup, but to become part of the mix for delivering power at scale. These are a series of very exciting challenges that transcend the traditional boundaries of a single discipline, and it is fascinating to see not only the interesting problems that result from these intersections, but the range of social implications and feedback that result from action with purpose in this space.

12.5.2. Curriculum Development

The curriculum development is a multidisciplinary research and education activity that includes two types of courses. The educational type consists of classes designed for college students of Computer Science and Electronics degrees with different specialties. The class should have 60 contact hours and labs with real implementation using probing stations and load features presented in previous sections. Practically all the classes include solving energy or quality problems present in the sensor or the Internet of Things, where the 's' also includes people. The main educational objective is to make these two classes a novelty for undergraduate students, which are mainly based on classes of digital systems and telecommunications systems. These two classes also bring to the undergraduate curriculum new topics in physics and mathematics that are frequently taught by professors of engineering programs at the university. The students become fascinated by new problems that are experienced, such as brightness function, smart load, and load not conforming to standards.

The research type is designed to invite researchers from different universities to engage with other members of a multidisciplinary research group, published journals, and undergraduate and master's theses. In some way, the goal of these meetings is to obtain low-cost patents or scientific publications in the field of sensors for artificial intelligence in the future of education, taking advantage of the multidisciplinary orientation of the research group. An unexpected creative activity was the development of short videos on the impact of the Internet of Things in society, entertainment, and the future of the planet. It contains examples of subjects related to 5G. Small videos like these are used during a series of transdisciplinary lectures at the university to engage students from different majors to learn the basics of CIn applied in energy or another important application like intelligent farms. During these topics, experienced CIn researchers will be invited to describe some of their experiments, patents, or the best marketing ideas for the societies influenced by the new approaches of the Internet of Things.

12.5.3. Sustainable Energy Education

This chapter addresses many challenging issues pertaining to the future of teaching and learning and educational infrastructure. Every recommendation I make calls for a mix of technology advances, new processes, educational experiments, and new policies and guidelines. I have argued that the community needs to experience a mentality shift to enable the rapid widespread dissemination of these advances as their research agendas shift from simply networking the scientists and into supporting the research and education enterprise in the broadest sense.

In the United States and Europe there are several places where people are actively talking about educational networking beyond the national or regional communities. These sessions are usually called Campus Focused Working Group sessions. To me these sessions are weird because this is usually the first time that I have seen people in the research and educational networking community ask anything seriously about the problems confronted by the administrative and operational personnel who are their closest customers. I have also been struck to see where these conversations are happening: Normally outside of the main conference panels, in hallways, or over breakfast. This is not to say that the research education networking technical community has been asleep at the wheel.

12.6. Policy Implications

Over the past hundred years, social policies have evolved to address unhealthy living conditions, inadequate educational resources, economic stagnation, and environmental degradation. As in the past, future policy considerations will be required to foster both technological and social innovation. Equity and justice issues associated with the consequences of the transition to the future of education and energy shall not be underestimated, and solving them will require substantial social policy research and innovation. The cloud, coupled with globally shared big data repositories and powerful analytics, will challenge our economies and our culture and necessitate adjustments to our institutions to ensure sustainable innovation, including changes to the research support infrastructure.

It will also be instrumental to elicit regulatory and policy frameworks for data uses that protect privacy and intellectual property, and to mitigate threats and liabilities, ensuring that the potential energy and educational benefits of consumer access to big data can be capitalized on. Big data openness advocates often extol how open access is fundamental to a democratic society. Indeed, big data openness offers enormous potential assets to society. These tools can hold promise for enhancing participation in democratic processes, whether by enhancing competitiveness through richer voter and consumer information or by systemic transparency in the workings of societal offices. Such technologies need to be used appropriately to realize those gains. We need a discourse around big data openness that keeps in mind not just the perceived benefits of transparency and access but also the potential costs and risks.

12.6.1. Regulatory Frameworks

Nowadays, the regulatory frameworks that are developed to manage the extensive usage of energy and to maintain high reliability and security are based on the concept of information asymmetry: utilities have a large quantity of information that consumers ignore. However, this concept is being changed by introducing intelligent grids, and the consumer is not going to be only a client; instead, they are going to be transformed into a prosumer or specialized consumer producing their own energy. Therefore, the change in the participation of the consumer in an intelligent grid needs general principles that make it possible to accommodate different services and privacy levels.

Legal dimensions are closely linked to regulatory rules. Both, however, are two very different things. On the one hand, regulatory rules refer to specific rules and guidelines that regulatory institutions develop to achieve particular goals. On the other hand, the legal dimensions might be the result of an extensive process like a parliamentary procedure or the development of standards or even a constitutive process. However, rules could emerge from courts.

When a regulatory authority creates a regulatory framework, its regulation must adapt to the legal framework in which it develops; it has to be coherent with the law. In other words, it must keep a teleological interpretation of the law. Therefore, by developing a general regulation in order to protect the consumer in this new environment of the intelligent grid based on the legal framework that protects them, it must follow the principles that these rights are based on. There might exist several legal dimensions that could be studied when a regulation is created with the aim of allowing the development and operation of societal services through an intelligent grid.

12.6.2. Funding and Investment Strategies

There are many ways energy and education could be improved by leveraging connected intelligence if there were adequate investment in inventing and deploying such systems. In order to get there, we need to address the chicken-and-egg problem: we need to invent and deploy prototypes so that industry investment can be attracted to the new opportunity, but it is difficult to invent and deploy prototypes without such investment. One problem is that the investment community is less likely to invest in game changers rather than incremental improvements that would have benefits this year or next year. Consider the loyal technology constituents of the utilities and of the educational establishment, and you can see the dilemma. Thus, modifications, whether incremental or game changing, in applications such as creating a network for your home, are being pursued generally because the benefits are realized in months, not in decades. Issues of connectivity, privacy, interference, and reliability might require novel technologies and paradigms for technology to succeed, but there are benefits today. The government, however, can afford to invest in research because the private by-products will become available to raise the standard of living for everyone.

12.6.3. Global Perspectives on Policy

As the world grapples with its response to COVID-19, resiliency and flexibility are essential to managing energy, climate, and ultimately human health and well-being. It is recognized that energy must be both accessible and affordable. For centuries, economic resurgences have been tied to the exploitation of new energy sources, from early water and windmills through the coal and oil revolutions. We are in a similar moment as we steer toward an energy future. Society's value system connects energy and social welfare in terms of financial prosperity, comfort, mobility, social support, inclusion, and a clean, healthy environment. Energy is a key part of society's competitiveness, security, and overall stability. Connectivity provides strength to a system and is a critical and tangible metric of society's measures toward social well-being.

All governments periodically feel the need to reestablish legitimacy through a cycle of national redefinition of goals and strategies. Not merely reform or tweaking, but doing away with ossified institutions established by past generations to address past problems. The leaders can be leaders of state, thought, and community. There comes a simultaneous desire to reach out and pull in the best and brightest from around the country and from around the world. Interdisciplinary endeavors thrive in environments where frontier research and education enter into social dialogue for public grand challenges. Each department can develop considerable strength in solving complex problems in which global discovery knowledge becomes needed by local society and political decision-making. Degrees respond to these societal, industrial, and political needs. Small things become possible at large, and results are globally popular, applicable, and acceptable.

12.7. Future Scenarios

Every time we develop an idea of what could be an overall paradigm, whether for education, a sustainable society, energy, science, or technology, we are both enriched by the idea and for the future. As we analyze what we believe and whether society is going in the right direction, it always becomes possible to understand what our weaknesses and failures are and fix them in a positive way. Anticipation is a powerful tool that we can use to prepare for the right future changes. The future scenarios invented can be long-term, large-scale, or niche simulations that will give us the possibility to deal with specific challenges better and improve our ability to address scientific problems overall. The collaborations fostered through the discussions generated around exploring potential futures offer the possibility to grow unique communities of practice that can be extremely efficient and creative. The exploration of large-scale pictures will inherently decrease our inability to be positioned better to work towards a common desirable future.

The focus is on the possibility of fostering the development of a series of interconnected communities of practice devoted to the analysis of potential future scenarios in an active and responsible way. The future scenarios we like to explore are initially selected to be: 1) education, 2) sustainable society, 3) energy, 4) science, and 5) technology. They are an ambitious and complex goal characterized by a series of deeply challenging connections. The obvious objective of this particular work is to explore the possibility of connecting our present and future research activities around a series of specific themes characterized in turn by a series of closely related challenges. The extremely broad perspective is, in principle, what makes the results extremely useful and interesting for a number of distinct areas. The reasons why we believe that it is critical to foster and support what we envision as communities of practice are discussed, and a series of specific and concrete ideas to make the project succeed are presented.

12.7.1. Optimistic Scenarios

Consider a future in which everyone has access to the world's information, collaborations that once took weeks now occur at the speed of light, and constraints of geography dissolve. Imagine "high touch" professional services, like a lawyer's counseling or a professor's office hours, as convenient as an ATM and as easily accessible as a company's phone system. These advances do not undermine educational methods of nurturing a student's natural creativity, curiosity, and resilience, nor do they freeze the status quo. Children use the tools of invention and design as they engage in simulated adventures, learning about the world rapidly and immersively from their creations. Schools, teachers, and families play critical roles in shaping the development of students' social skills. No one lacks basic needs for sustenance and protection, and the role of teachers increases - their mastery of subject matter just as valuable as always, but joined by enhancing skills with people and craft. The system builds on the elemental human impulses to educate, instill, question, compete, find, and not just predict the future. Would such a future nurture a cadre of experts who are insulated from humility, who become enthralled by the instant effects of power that arise from the illusion of being omniscient and omnipotent? Would there be time for other disciplines that expand our critical thinking, promote empathy, explore the broader implications of our actions, construct a common code of ethics, and reveal our creative spirit?

Of course, this vision will not be realized without flaws or without risks. In the broader context of human services, such advances have both positive and negative aspects: well-designed systems free individuals to pursue meaningful activities; poorly designed systems straitjacket human creativity and squander time and natural resources. For moral guidance, society has a tradition of using ethics and custom, as well as a system of laws and regulations. Such moral guidance faces a challenge in the legal realm - many of its foundations rest on the ability to distinguish human action from machine action - but legal mechanisms have been very flexible, and there is every reason to expect them to adapt. However, no matter what changes occur, problems in the legal and moral frameworks will rarely pose the greatest risks. The gravest dangers may be deeper and, to some degree, societal. Their character may be subtle, a soft shifting of culture that is almost sensed but not understood, as we move from designing tools and utilities to creating intelligent, creative, and possibly unpredictable systems that employ our tools and utilities. If society fails to acknowledge the difficulties, the results may be dangerous or even catastrophic. But, by addressing such questions implicitly, the path can still avoid most of the hazards while realizing a service revolution that is an exciting, motivating, and unifying vision for those who work in the arenas of capital and connectivity for the future.

12.7.2. Pessimistic Scenarios

First, we note that pessimistic Nash equilibria are always a potential outcome. For the education and energy system described above, for instance, one could imagine the following downward-spiraling sequence of actions and reactions in which the outcome could be inefficient or even catastrophic: teachers in schools staffed by underperforming students become frustrated and reduce the effort they put forward, and students respond by exerting even less effort, moving the overall class quality further downward. As energy capabilities of humans ebbed, frustration would likely also increase, with the same effect on overall education quality. When the focus is only on holding down energy costs, the inefficient or catastrophic state corresponding to loss of overall societal productivity can become an equilibrium.

Fig 12 . 3 : The future of sustainable energy through AI-enabled circular economy policies

Repressive global brain type downside, should the technology at some point become capable of such consciousness, such that it would attempt to seize power from humans. In such a disparity of power between humans and the technology, a cataclysmic battle for control could result, with huge corresponding downside risk. Displacement of humans in research and decision-making roles by AI technologies could also reduce the interest level of talented young people in the disciplines that enable and support AI. Given a material shortage of machine intelligence dedicated to improving those disciplines, the quality of improved AI tools would likely plateau. Overly powerful AI research organizations, focused almost exclusively on the AI quality improvement question, might become too much like goal-driven me first athletes who seek to dominate the competition rather than to care about the health of the overall ecosystem.

12.7.3. Adaptive Strategies for Uncertain Futures

The discussion in this chapter demonstrates the plausibility of the vision of future outcomes of networking because it constitutes the results of campaigns that we have run and whose effects we have observed. Yet, the outcomes are not inevitable: if the capabilities of networking infrastructures or the content that they deliver should develop otherwise, the conclusions of this chapter may come apart or in full undone. Many large adjustments, adaptations, and changes will be necessary to achieve the vision outlined here, and as we have never before been able to enjoy the benefits and richness of a pervasively connected common infrastructure, many of the necessary adaptations are not at all clear to us. To be sure, the need for them places stringent demands on our institutions of learning and commerce, but we, as an informed and empowered society, also need to take on age-old challenges and opportunities for our common good. An era of connected intelligence is getting underway. In its infrastructure focus, the chapter emphasizes the networking technologies that will make connected intelligence not only possible but also commonplace. In this way, the chapter contributes to the policy and public discourse; it gives a sense of the opportunities and challenges that we face not only in terms of new infrastructures but also of the social and economic structures that will embed them and that they can enable. However, while infrastructures are necessary for much of what we suggest in this chapter, they are not enough. To achieve our goals, society in general and the information networking sector, in particular, must confront many varied adaptation opportunities and pressures. Unless we effectively rethink traditional processes for resource allocation through often contentious policy and regulatory processes, we risk the possibility that the potential contributions of networking to the march of humanity will be lessened.

12.8. Conclusion

In conclusion, to address growing global challenges such as poverty, disease, and hunger, as well as the increased competition that has resulted from globalization, we offer a vision of the future of both education and energy that rests on an interconnected set of technological and social changes. By increasing access to education as well as improving its quality, we can enhance opportunities for talented individuals. In particular, by enabling a remarkable education for all who seek it, we can accelerate the rate of change, and hence the rate at which the standard of living of the world might be improved. Online education built on the principle of rediscovering the way the internet is used for learning by organizing interconnected intelligence would combine four key elements. Doing so would enable people in time and space across the world to learn more as well as create more. In essence, we propose real magic. If society rises to this challenge, we can enable profound changes in education as well as energy. It is only by addressing profound issues such as these that we can hope to engage, inspire, and lead. Given the continued convergence among online education, a new generation of average citizens, and sundry principles of scalable education by offering video courses from leading instructors that adapt to one's learning needs and provide interactive exercises to drive excellence, any motivated individual anywhere in the world should have the opportunity to study at this level. We seek to see this capacity harnessed in ways that create far-reaching improvement in people's lives and in the world as a whole, while enabling pioneering research. We want to set a new global standard for education – a standard that is, thus far, not even imagined. We are confident that, collectively, we can develop ways to unleash an incredible force for positive change.

12.8.1. Final Thoughts and Future Directions

This chapter conducted reflection and integration around the use of connected intelligence in addressing issues related to energy and education. Several points of integration and divergence were identified, along with important areas for future exploration. By integrating across the energy and education domains, and by leveraging shared concepts such as the distribution of energy and education, new opportunities for connected intelligence that can benefit both domains—and indeed can integrate across other domains—were presented. Notably, we showed that the powerful combination of delivering the right information to the right decision-maker at the right time can be well addressed by knowledge sharing and recommenders in the domain of education, and the use of intelligent distribution systems using energy informatics in both domains.

To this end, we presented the potential for future domain integration to research in connected intelligence, and showed how connected intelligence could yield novel insights at the intersection of important problems in adjacent domains, such as those related to education and energy. However, when closely integrating two key but dissimilar connected peering systems, additional challenges can be created. Unlike the existing diverse, distributed, and user-focused structures of these individual intelligence technologies, including their interaction with broader infrastructures, the act of closely intertwining intelligence technologies is suggestive of a more centralized, potentially system-of-systems approach that places a greater emphasis on their ability to jointly perform tasks only partially related to the domain of either. This is not a major technique-oriented criticism of either intelligence technology, though it does suggest that the application of combined intelligence approaches is not always optimized when using existing domain-specific applications in a closely interconnected manner.

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