Technology Accelerated Innovation & Responsible AI

STRATEGIC INTELLIGENCE BRIEFING

Generated for Team Digoshen on 10 December 2023

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Explore the interactive version online

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Below is an excerpt from the transformation map for Technology Accelerated Innovation & Responsible AI , with key issues shown at the centre and related topics around the perimeter. You can find the full map later in this briefing.

1 Latest insights

A synthesis of the most recent expert analysis.

Below are your latest updates on the topic of Technology Accelerated Innovation & Responsible AI spanning 15 different sources.

1.1 Current perspectives

United States Institute of Peace

A Role for AI in Peacebuilding

06 December 2023

Since OpenAI launched ChatGPT in fall 2022, there has been a tremendous amount of global attention on the risks and benefits of artificial intelligence (AI). With so many unknowns about the capacity of private companies and governments to harness this technology for peace and security, it is difficult for the public and private sectors to identify a clear and straightforward path on addressing AI's challenges. In this evolving environment, peacebuilding organizations can and should play a critical role in engaging with companies, multilateral institutions and governments on AI development and application to advise and shape its uses to advance peace and mitigate societal harm that could contribute to conflicts.

Bruegel

Web3: the next internet revolution

01 December 2023

Web3 is a new paradigm that could define a new internet era. It is based on blockchain, a technology through which a network of computers – called nodes – can execute and validate changes to a public ledger. Blockchains can be used to record ownership of goods and claims to services, and because this information is public, ownership can be verified by anyone. This could mark a shift that will disrupt current digital business models by offering firms and consumers new types of opportunities. To get the most out of this upcoming digital revolution, however, new rules, legal guidelines, marketing strategies and user awareness need to be established.

Frontiers in Medical Technology

Eye tracking technology in medical practice: a perspective on its diverse applications

17 November 2023

Eye tracking technology has emerged as a valuable tool in the field of medicine, offering a wide range of applications across various disciplines. This perspective article aims to provide a comprehensive overview of the diverse applications of eye tracking technology in medical practice. By summarizing the latest research findings, this article explores the potential of eye tracking technology in enhancing diagnostic accuracy, assessing and improving medical performance, as well as improving rehabilitation outcomes. Additionally, it highlights the role of eye tracking in neurology, cardiology, pathology, surgery, as well as rehabilitation, offering objective measures for various medical conditions. Furthermore, the article discusses the utility of eye tracking in autism spectrum disorders, attention-deficit/hyperactivity disorder (ADHD), and human-computer interaction in medical simulations and training. Ultimately, this perspective article underscores the transformative impact of eye tracking technology on medical practice and suggests future directions for its continued development and integration.

Frontiers

Chromosome-level changes and genome elimination by manipulation of CENH3 in carrot (Daucus carota)

15 November 2023

Hybrid cultivars are valuable in many crop species

due to their high yield, uniformity, and other desirable traits. Doubled haploids, which have two identical sets of chromosomes, are valuable for hybrid breeding because they can be produced in one generation, in comparison to the multigenerational process typically used to produce inbred parents for hybrid production. One method to produce haploid plants is manipulation of centromeric histone H3 (CENH3). This method of producing haploids has so far been successful in Arabidopsis, maize (Zea mays), and wheat (Triticum aestivum). Here we describe modification of CENH3 in carrot (Daucus carota) to test for the ability of these modifications to induce uniparental genome elimination, which is the basis for haploid induction. Base editing was used to make cenh3 mutant plants with amino acid substitutions in the region of CENH3 encoding the histone fold domain. These cenh3 mutant plants were then outcrossed with CENH3 wild-type plants. Using PCR-based genotyping assays, we identified two candidates for genome elimination. One candidate was classified as a putative aneuploid plant in which chromosome 7 is in a single copy state. The other candidate was characterized as a putative tetraploid that was likely haploid during its genesis. Our results suggest that this putative tetraploid inherited all of its chromosomes from the CENH3 wild-type parent and that the genome of the cenh3 mutant plant was lost. This study provides...

Frontiers in Microbiology

Draft genome sequencing of Tilletia caries inciting common bunt of wheat provides pathogenicity-related genes

15 November 2023

Common bunt of wheat caused by Tilletia caries is an important disease worldwide. The T. caries TC1_MSG genome was sequenced using the Illumina HiSeq 2500 and Nanopore ONT platforms. The Nanopore library was prepared using the ligation sequencing kit SQK-LSK110 to generate approximately 24 GB for sequencing. The assembly size of 38.18 Mb was generated with a GC content of 56.10%. The whole genome shotgun project was deposited at DDBJ/ENA/GenBank under the accession number JALUTQ000000000. Forty-six contigs were obtained with N 50 of 1,798,756 bp. In total, 10,698 genes were predicted in the assembled genome. Out of 10,698 genes, 10,255 genes were predicted significantly in the genome. The repeat sequences made up approximately 1.57% of the genome. Molecular function, cellular components, and biological processes for predicted genes were mapped into the genome. In addition, repeat elements in the genome were assessed. In all, 0.89% of retroelements were observed, followed by long terminal repeat elements (0.86%) in the genome. In simple sequence repeat (SSR) analysis, 8,582 SSRs were found in the genome assembly. The trinucleotide SSR type (3,703) was the most abundant. Few putative secretory signal peptides and pathogenicity-related genes were predicted. The genomic information of T. caries will be valuable in understanding the pathogenesis mechanism as well as developing new methods for the management of the common bunt disease of wheat.

STAT

Patent buyouts could spur vital innovation in antibiotics, vaccines, and other medical fields

14 November 2023

The announcement by the Center for Medicare and Medicaid Services that ten drugs will be subject to price negotiation under the Inflation Adjustment Act has unleashed a storm of debate. Most observers agree that the negotiations will reduce spending for both consumers and taxpayers. The real dispute centers on whether the prospect of price negotiations will reduce future innovation by shrinking the expected future profits for patented drugs. This debate sidesteps the larger issue of whether the patent system delivers the value it should in health care.

There is little doubt, and much evidence, that innovators respond to expected future profit.

Oliver Wyman

Inside The Competition For Big Money

15 November 2023

Digital money and tokenization have the potential to transform the business of high-value flows, spurring competition between big banks and digitally native firms and driving a major reordering of the financial system.

The high-value transactions at the heart of this competition include large transfers between banks, payments by big corporations, and multi-billion-dollar investments by companies, asset managers, and asset owners like pension and sovereign wealth funds. Banks have long dominated this space, but tokenization will accelerate trends that have challenged bank business models.

Distributed Ledger Technology (DLT) such as blockchain potentially enables computerized networks governed by smart contracts to enjoy the kind of trust that clients have historically placed exclusively in banks, according to a new paper from the Oliver Wyman Forum, Inside The Competition For Big Money. This capability can blur the lines between payment and liquidity products as new competitors look to capture the best of both worlds, for example, by using tokenized money market funds to make payments.

The Conversation (French)

Vote par Internet : doit-on choisir entre confort et sécurité ?

03 December 2023

Le confort du vote depuis son canapé se fait au prix de la sécurité du scrutin – de quoi limiter l'utilisation du vote électronique pour les élections à fort enjeu.

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Frontiers in Virtual Reality

Older adults exhibit declines in instrumental activities of daily living during a virtual grocery shopping task

29 November 2023

Introduction: The successful performance of instrumental activities of daily living (IADLs) is critical in maintaining independence for older adults. Traditional IADL questionnaires and performance-based assessments are time consuming, potentially unreliable, and fail to adequately consider the interplay between cognitive and motor performance in completing IADLs. The Cleveland Clinic Virtual Reality Shopping (CC-VRS) platform was developed to objectively quantify IADL performance through the characterization of cognitive, motor, and cognitive-motor function. The CC-VRS combines an immersive virtual grocery store with an omnidirectional treadmill to create a scenario in which the user physically navigates through a virtual environment. The primary aim of this project was to determine the known-group validity of the CC-VRS platform to characterize IADL performance in healthy older adults and young adults. Methods: Twenty healthy young (n = 10) and older (n = 10) adults completed the Basic and Complex CC-VRS scenarios. Position data from VR trackers on the hands, waist, and feet were used to quantify motor performance. Cognitive and dual-task performance were automatically calculated by the application during specific shopping sub-tasks. Results: Older adults exhibited significantly worse performance on multiple cognitive, motor, and dual-task outcomes of the CC-VRS (e. g., average walking speed, number of list activations, and stopping frequency). Discussion: The CC-VRS...

Royal United Services Institute (RUSI)

Too Fast, Too Furious? Cryptocurrency as Legal Tender

04 December 2023

Too Fast, Too Furious? Cryptocurrency as Legal Tender

Main Image Credit Not without risk: attempts to adopt cryptocurrency as legal tender hold lessons for other countries contemplating such a move. Image: jd-photodesign / Adobe Stock

What can countries learn from recent experiments in adopting cryptocurrency as a legal tender?

Wired

Social Media Sleuths, Armed With AI, Are Identifying Dead Bodies

15 November 2023

Poverty, fentanyl, and lack of public funding mean morgues are overloaded with unidentified bodies. TikTok and Facebook pages are filling the gap—with AI proving a powerful and controversial new tool.

Science Daily

When we feel things that are not there

14 November 2023

Virtual reality (VR) is not only a technology for games and entertainment, but also has potential in science and medicine. Researchers at Ruhr University Bochum, Germany, have now gained new insights into human perception with the help of VR. They used virtual reality scenarios in which subjects touched their own bodies with a virtual object. To the researchers' surprise, this led to a tingling sensation at the spot where the avatarized body was touched. This effect occurred even though there was no real physical contact between the virtual object and the body.

Oliver Wyman

The Blockchain Evolution ? All Roads Lead To Rome

13 November 2023

In ancient times, Rome was more than just the capital of an empire, it was also the nexus of connectivity and commerce, linked by a sophisticated network of roads. This is mirrored in the blockchain universe, where both public and private domains reflect these ancient pathways and side gardens, especially in financial services. Though each domain brings unique challenges akin to different terrains, they all converge towards a shared vision: an interoperable and scalable ecosystem. Today, public and private blockchains offer distinct solutions to safeguarding privacy and enabling interoperability, catering to specialized use cases. This paper offers an overview of the evolving blockchain landscape, equipping financial institutions, regulators, and policymakers with insights into the sector's challenges and the innovative solutions developed over time.

Frontiers in Virtual Reality

Haptic feedback in a virtual crowd scenario improves the emotional response

28 November 2023

Research has shown that incorporating haptics into virtual environments can increase sensory fidelity

and provide powerful and immersive experiences. However, current studies on haptics in virtual interactions primarily focus on one-on-one scenarios, while kinesthetic haptic interactions in large virtual gatherings are underexplored. This study aims to investigate the impact of kinesthetic haptics on eliciting emotional responses within crowded virtual reality (VR) scenarios. Specifically, we examine the influence of type or quality of the haptic feedback on the perception of positive and negative emotions. We designed and developed different combinations of tactile and torque feedback devices and evaluated their effects on emotional responses. To achieve this, we explored different combinations of haptic feedback devices, including “No Haptic,” “Tactile Stimulus” delivering tactile cues, and “Haptic Stimulus” delivering tactile and torque cues, in combination with two immersive 360-degree video crowd scenarios, namely, “Casual Crowd” and “Aggressive Crowd.” The results suggest that varying the type or quality of haptic feedback can evoke different emotional responses in crowded VR scenarios. Participants reported increased levels of nervousness with Haptic Stimulus in both virtual...

The Conversation (Spanish)

Aprobada la primera terapia basada en CRISPR

20 November 2023

Reino Unido ha aprobado la primera terapia CRISPR para tratar pacientes de anemia falciforme y beta-talasemia, dos enfermedades raras de la sangre.

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The Conversation

FTX and Binance: how latest crypto scandals could influence public opinion on digital currency regulation

01 December 2023

True believers in cryptocurrency have had a rough few weeks. The US government just fined Binance – the world’s largest crypto exchange – US$4.3 billion (£3.4 billion) for its involvement in money laundering.

It forced the firm to accept intrusive monitoring and demanded that its secretive boss, Changpeng Zhao, step down and pay a personal fine of $50 million. Zhao, known as CZ, has been called the most powerful man in crypto.

The industry is still reeling from the conviction of Zhao’s bitter rival, Sam Bankman-Fried, earlier in November on seven counts of fraud and conspiracy.

The Conversation (French)

Comment la réalité virtuelle peut aider les sportifs

23 November 2023

S’entraîner, non pas sur un terrain, mais dans une salle avec un casque de réalité virtuelle sur la tête peut sembler saugrenu, et pourtant des effets très bénéfiques existent.

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Frontiers in Computer Science

Reality bites: highlighting the potential discrepancies between multisensory taste perception in extended and physical reality

15 November 2023

Introduction When we taste, we take in a variety of sensory information that can be completely independent from the properties of the food itself: the ambient lighting and environmental sounds can all influence our taste perception and affective responses. However, current multisensory research is mixed as to whether these In Real Life (IRL) findings also apply to Extended Reality (XR) environments. A potential reason for this may be the limited realism of some XR scenarios, which this study aimed to overcome through an immersive Virtual Reality experience (VR, chosen for its greater realism relative to other XR applications) whilst also expanding the scope to flavour perception. Methods A total of 34 participants rated food samples under neutral, red, and green ambient lighting in VR. Participants ate either lime flavoured, strawberry flavoured, or “Neutral” (no added flavour) samples. Results While participants were equally immersed in all three environments, they rated the red and green lighting environments as substantially less natural than the neutral lighting environment. Interestingly, while participants associated sweetness and sourness with red lighting and green lighting respectively, this minimally extended to their behavioural ratings, when sampling the stimuli in VR. Samples eaten under red lighting were rated as significantly sweeter than those eaten under neutral lighting. However, neither red nor green lighting...

The Conversation

Florence Bell died unrecognised for her contributions to DNA science – decades on female researchers are still being sidelined

22 November 2023

Almost 80 years ago, Florence Bell quietly laid the foundations for one of the biggest landmarks in 20th century science: the discovery of the structure of DNA. When she died on november 23 2000, her occupation on her death certificate was recorded as “housewife”.

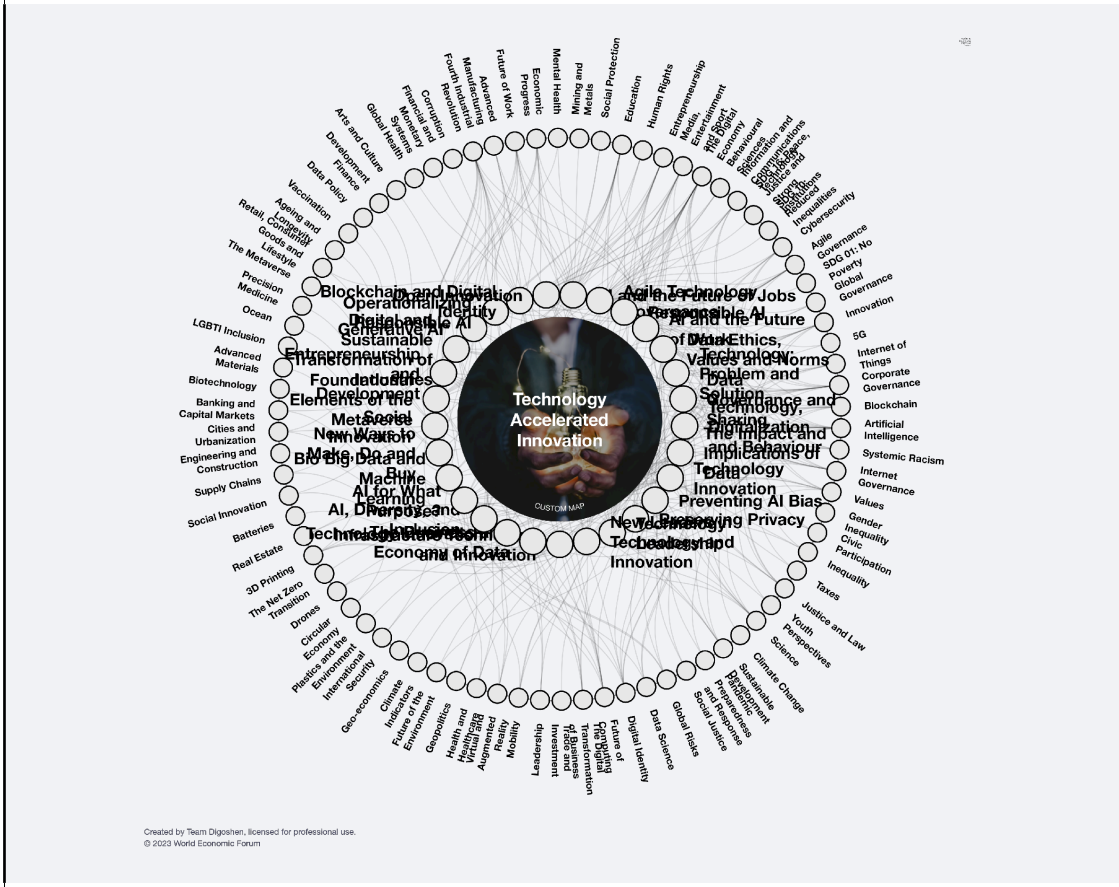
Decades later, female researchers are still being sidelined. Research has shown that deep systemic problems block women from advancing or push them out of science. This isn’t inevitable – there are changes universities could make to level the playing field.

2 Strategic context

The key issues shaping Technology Accelerated Innovation & Responsible AI .

The following key issues represent the most strategic trends shaping the topic of Technology Accelerated Innovation & Responsible AI . These key issues are also influenced by the other topics depicted on the outer ring of the transformation map.

FIGURE 1 **Transformation map for Technology Accelerated Innovation & Responsible AI**



2.1 AI and the Future of Jobs

Preparing for a future without human work will require more than addressing basic financial needs

Is artificial intelligence coming for your job? While some reports suggest nearly half of all jobs may be automated, other analyses note two important nuances. The first is that AI creates as well as replaces jobs. AI systems still need humans to develop them, handle nonroutine cases, provide a human touch, and monitor for failures. New technologies can also sometimes create entirely novel jobs - like social media

influencer. A second nuance is that - at least for the foreseeable future - AI systems will only be able take over specific tasks rather than entire jobs. One report estimated what while 60% of all jobs have at least some tasks that could be automated, only 5% are under threat of full automation. And, as AI excels at routine tasks, it can free up humans for more interesting challenges. This augmentation-rather-than-automation approach offers the best opportunities for not only preserving employment but also ensuring effective and valuable AI. Actively involving workers in the development, adoption, and implementation of the technology can result in systems that are more practical, innovative, and effective.

Even with an augmentation approach, however, AI systems will result in potentially significant job disruptions - and call for a rethinking of education, employment, and policy systems. While technology skills would seem a worthwhile investment focus, there is also a need for general skills that can improve employment adaptability - such as critical thinking, and the skills that AI struggles with replicating such as creativity, human touch, and emotional intelligence. It is not certain whether human work will eventually disappear, but two features of the current situation are particularly troubling. The first is prevalent wealth inequality both within and between countries. If AI does lead to widespread job displacement, extreme inequality could lead to disastrous outcomes. The second is the central role that work plays as a source of personal worth and meaning in many societies. One popular proposed solution to a future without work is a universal basic income, where people receive regular payment regardless of employment. While such a program might address financial need, truly preparing for a future without work requires a deeper reinvention of human identity.

Related topics: Fourth Industrial Revolution, Advanced Manufacturing, Future of Work, Economic Progress, Mental Health, Mining and Metals, Social Protection, Education, Human Rights, Entrepreneurship, Media, Entertainment and Sport, The Digital Economy

2.2 Agile Technology Governance

Some reinvention may be necessary to better understand new technologies requiring regulation

Governments may have to reinvent the ways they operate in order to keep pace with technology. Powerful digital tools like artificial intelligence are swiftly disintermediating entire markets - taking influence away from traditional regulators and unskilled workers, and increasingly handing it to corporations and skilled labour. Meanwhile public sector officials everywhere are being challenged to move beyond simply understanding major technological advances to being able to mitigate, shape, and harness them in order to better govern - by becoming more accessible, transparent, and trustworthy. Governments making this transition will have to change their approaches to creating and enforcing regulation, not least in order to safely stimulate rather than stymie innovation. These governments may have to create brand-new ways to cope with the spread of new technologies, either by nurturing internal expertise or by working together with the private sector. Those that are sufficiently agile will be able to find ways to better understand the task at hand - and to steer technological development in ways that improve the state of the world for everyone.

Faster, 5G mobile networks promise to make digital communication even more ubiquitous, and increasing levels of processing power and storage capacity are boosting the amount of knowledge readily available to just about any computer user. When coupled with the increased availability and quality of data, conveyed through increasingly rich and varied visualizations and other analytic techniques, these trends have the potential to fundamentally reshape online discourse, news reporting, and public services - in ways that can respond more directly to the needs of the public. But there are also serious related risks that need to be managed. According to Cisco's 2018 Annual Cybersecurity Report, cyber attackers targeting governments have developed increasingly sophisticated and threatening malware, and can cover their tracks with encryption while exploiting novel vulnerabilities in cloud computing and the Internet of Things. New and evolving rules of the road such as the European Union's General Data Protection Regulation, which came into effect in 2018, will be critical for managing the consequences of such threats - but will also introduce their own new complexities to governing.

Related topics: Blockchain, Internet of Things, Behavioural Sciences, Innovation, Cybersecurity, Information and Communications Technology, 5G, Corporate Governance, SDG 10: Reduced Inequalities, Agile Governance, Media, Entertainment and Sport, SDG 01: No Poverty, SDG 16: Peace, Justice and Strong Institutions, Global Governance

2.3 Responsible AI

Ethics, transparency, diversity, and inclusion must all be considered

Responsible artificial intelligence means developing and using AI systems that are ethical, transparent, inclusive, and unbiased. AI systems must not be designed with the intent to harm or discriminate. And transparency necessitates that the operation of that system, and the data it uses, be clearly documented and explained; this can help build trust and accountability. Meanwhile bias and inclusivity must be considered throughout the entire development process, from data collection and preparation to use. Ensuring the responsibility of generative AI systems is challenging. Careful oversight is necessary to monitor and prevent harmful or unethical content, such as deepfakes or biased text. Both governments and private organizations are constantly implementing new policies to ensure that AI systems are developed and used responsibly.

Related topics: Artificial Intelligence, Systemic Racism, Internet Governance, Values, Gender Inequality, Media, Entertainment and Sport, Civic Participation, Inequality

2.4 AI and the Future of Work

How exactly will artificial intelligence impact jobs?

There has been a great deal of speculation and debate about the impact of artificial intelligence on the future of work - particularly in terms of the toll it will take on available jobs. Some argue it will eliminate a significant number, and will predominantly impact low-skilled workers in ways that exacerbate existing inequality. Others believe AI could create new job opportunities, by adding nuances to existing work and making it more creative. Generative AI is particularly likely to transform the workplace; its ability to create new and seemingly original content can automate tasks ranging from editorial processes to the design of scientific experiments and software coding. Companies can potentially ease the impacts of AI integration in the workplace by developing programs to support employees during a transition period - such as retraining. To increase worker trust in AI systems, diverse teams of developers and data scientists must try to create systems using fair and unbiased training data. And policy-makers at multiple levels must set ethical, fair standards for the use of AI in the workplace.

Related topics: Agile Governance, Education, Taxes, Justice and Law, Corporate Governance, Youth Perspectives, Media, Entertainment and Sport, Economic Progress, Future of Work, Science

2.5 Data Ethics, Values and Norms

Data can be deployed to solve global problems and achieve the SDGs, with the right oversight

The development and deployment of any emerging technology keys on social values, preferences, and ethical norms. It is important for organizations to understand these factors in a local context before formulating how they will govern data and artificial intelligence; in addition to whether local values and norms are adequately reflected, they should seriously consider the interplay between technology and individual rights, and how to put safeguards in place that incentivize responsible and human-centric development. Ensuring the trustworthiness of an organization's data practices is essential, often for practical reasons; for example, Facebook was sued in the US in 2019, after the Department of Housing and Urban Development alleged the company was violating a prohibition on housing discrimination because its machine learning algorithms functioned like an advertiser that excludes users based on race, ethnicity or religion. Certain foundational elements should be considered at the start of commercial projects: privacy, accountability, safety and security, transparency and explainability, fairness and non-discrimination, human control of technology, professional responsibility, and the promotion of human values. Understanding these in the relevant context is necessary for responsible data use.

By using data responsibly, businesses, non-profits, and governments can better address many of the unprecedented social and environmental challenges we now face - not least current and future pandemics, and environmental disasters aggravated by the worsening impacts of climate change. For example, artificial intelligence can play a significant role in achieving the UN Sustainable Development Goals - one study published in 2020 found that AI can enable the accomplishment of 134 targets across all 17 global goals if its development is supported by the necessary regulatory oversight (though it may also inhibit 59 targets). Some

of the levers at hand that can help facilitate the use of data for good include global digital trade, the facilitation of equitable access to data flows, and responsible data collection. Technical elements such as data portability and interoperability are also important. The need to mitigate risks calls for putting firm safeguards in place related to cybersecurity, encryption, risk management, accountability, and overall data protection. Some uses of data and machine learning present particular sets of risks, like privacy breaches and phishing attacks.

Related topics: Systemic Racism, Climate Change, Internet Governance, Cybersecurity, Values, Agile Governance, Sustainable Development, Corporate Governance, Pandemic Preparedness and Response, Justice and Law, Social Justice, Global Risks, Artificial Intelligence

2.6 Technology: Problem and Solution

A solution when it comes to transparency, a problem when either intentionally or unintentionally misused

Technology is sometimes presented as a solution to corruption, often building on theories of transparency - but it can also be a problem. Social media services, for example, can enable people to flag the corruption affecting them and learn about how it operates elsewhere (platforms such as “ipaidabribe” in India have facilitated this). Meanwhile increased computing power has aided complex financial crime investigations, which require searching through millions of documents and transactions. Two of the most often-cited uses of technology for tackling corruption are open government and open contracting. The first strives to increase transparency and accountability through access to information, and foster participatory dialogue between citizens and political decision-makers. Moving towards open data on the part of both governments and companies has depended on tech platforms; the underlying philosophy is “transparency by default,” or regarding all data as potentially available to the public, unless there is a genuine justification for it remaining confidential. Open contracting, meanwhile, provides for full transparency on public procurement in order to improve efficiency while deterring and detecting corruption. One example of open contracting is the ProZorro system for healthcare procurement in Ukraine, which uses a sophisticated tech platform to facilitate extensive transparency.

Another example of tech-enabled procurement reform reducing corruption and increasing competition is the introduction of open contracting to the education department and national public procurement agency in Bogotá, Colombia, which dismantled a school meal price-fixing scheme worth $22 million while expanding the pool of suppliers. Technology can also have negative impacts. Cryptocurrencies were at first lauded as a means of countering money laundering, due to the ability to trace ownership - though in practice, an unregulated market and associations with the dark web and organized crime have rendered them no more traceable than conventional currencies. And of course, social media can be a haven for conspiracy theories and fake news, while the use of artificial intelligence has stirred concerns that its underlying algorithms can be corrupted or deliberately employed for corrupt purposes. For example, AI may be deliberately misused to hide the proceeds of corruption, or for surveillance. However, AI is also increasingly viewed as a potential tool to address corruption, as it can be used to analyse large datasets and identify patterns indicating problematic behaviour. This could, potentially, assist evidence-gathering during law enforcement investigations, or even identify corruption risk and thereby help prevent corruption before it occurs.

Related topics: Data Science, Artificial Intelligence, Blockchain, Internet of Things, The Digital Economy, Fourth Industrial Revolution, Digital Identity, Future of Computing

2.7 Data Governance and Sharing

Ready access to data and responsible use are necessary to inform research and evidence-based policy

The sharing of data, the use of software necessary to generate and process it, and the models that are trained from it are becoming key elements of any research process. Data sharing enables the verification of published scientific results and the reuse of data - something that is ideally put into practice by governments, companies, and academic researchers in order to accelerate discovery and make timely, informed decisions. Ultimately, sharing data with an electorate, shareholders, and the scientific community provides greater accountability and transparency. It is already generally understood that data associated with publicly-funded research should be made available to the public, whenever possible. But there should also be incentives for private sector entities to share more of their data, in order to help advance related research and bolster accountability. Any form of data sharing should include guarantees for its owners to retain their rights to any that may be shared, and to ensure that the data are shared responsibly - with the aid of privacy-preserving

methods or access controls when needed.

We should not fall into a false dichotomy that holds that data must be either fully open, or not shared at all. The infrastructure, technologies, methods, and policies for responsible, privacy-preserving data sharing are in continuous development, and their use should be encouraged by anyone or any institution involved in related processes. The methods employed for data sharing should focus on providing greater privacy, fairness, and utility. In order to advance artificial intelligence and automated pipelines for discovery, for example, data must be findable, accessible, interoperable, and reusable - and not only by humans, but also by machines. This is in line with the "FAIR" principles (findability, accessibility, interoperability, and reuse), an international effort to provide guidelines for data sharing and stewardship. These principles have been endorsed and implemented by a growing number of data repositories. Given that research- and evidence-based decision making is increasingly international and collaborative, an open, distributed network of FAIR repositories and services that support quality control and the sharing of data, publications, and other digital assets has become a necessity.

Related topics: Internet Governance, The Digital Transformation of Business, The Digital Economy, Digital Identity, Trade and Investment, Agile Governance, Justice and Law, Pandemic Preparedness and Response, Science, Corporate Governance, Artificial Intelligence, Leadership

2.8 Technology, Digitalization and Behaviour

Human interaction can be enriched with technology-enabled behavioural insights

Technology and digitalization have transformed our lives, often by making them more efficient and comfortable. Technology is also an important force for enabling changes in behaviour - particularly in terms of boosting productivity and supporting active lifestyles. Fitness trackers can help motivate people to exercise, for example, especially when paired with social media platforms. Meanwhile brightly-coloured graphics and tactile interfaces enable the gamification of challenges that otherwise might be more difficult to overcome. One example: the sudden popularity of "Pokémon go" several years ago, which managed to get millions of people off of the couch and outside even if just for a little while. In order to reap the maximum benefit of these technologies, their design must encourage seamless interaction; the so-called "uncanny valley" effect of human representations that are less than 100% convincing, for example, can cause feelings of revulsion. The behavioural sciences can inform the design of technologies - like mobile apps, avatars, and driverless cars - based on knowledge about how users think and make decisions. Which designs appeal? Which can be intuitively understood? By providing answers to these questions, the interplay of humans and machines can result in maximum benefit.

In addition, behavioural scientists can help provide answers to pressing questions about the risks of increasing digitalization - such as what is the cost of monitoring and quantifying every aspect of our personal lives, how will this affect our well-being, will we feel like autonomous beings any longer if technology takes over so many of our daily tasks, and what are the consequences of the digital footprints we leave behind. And, of course: will we feel more disconnected as human interaction increasingly moves from physical to virtual. According to a 2013 academic paper, "Private Traits and Attributes are Predictable From Digital Records of Human Behavior," artificial intelligence can predict, with a high degree of accuracy, private traits like sexual orientation or political and religious views from just a few Facebook likes. This is potentially alarming, not least because in some parts of the world people can be legally prosecuted for their homosexuality or political views. A 2017 paper by faculty at the University of Nottingham suggested that artificial intelligence could do a better job than established algorithms of predicting, based on medical records, the likelihood that a patient will suffer a heart attack - potentially making it easier to educate at-risk populations about precautionary measures. Artificial intelligence's potential to be a curse or a cure depends in large part on whether policy-makers manage to adequately define the boundaries of its use.

Related topics: Mobility, Internet of Things, Data Science, Artificial Intelligence, Information and Communications Technology, Virtual and Augmented Reality, Cybersecurity, Media, Entertainment and Sport, The Digital Economy, Health and Healthcare, Digital Identity

2.9 The Impact and Implications of Data

As artificial intelligence becomes more prevalent, assessing its real-world impact becomes more essential

The people designing data-powered artificial intelligence systems are increasingly aware of their power to

have transformative, long-term impacts. The Canadian government, for example, has introduced an "algorithmic impact assessment" tool, to help determine the potential real-world impacts of automated decision-making systems used for tasks like visa application processing. Some have questioned the transparency of governments (and businesses) when it comes to the use of AI to deliver services; in 2018, officials in New Zealand announced a "stocktake" of how government agencies were using algorithms to analyse data, amid concerns about potential racial profiling in automated visa application processing. Impact assessment is integral to responsible data governance. There are several methods for quantifying the impacts of technologies and policies, for both the private and public sectors. There are also qualitative methods for better understanding how technology and data affect different populations differently - these can generally be relied upon to help ensure the effective identification and participation of different stakeholders, and to evaluate the effectiveness of systems in terms of supporting an organization's stated values.

These methods can also be used to evaluate the appropriateness of policy and regulatory responses (in the form of standards and guidelines), to better understand social and environmental ramifications of data practices, and to divine the values and norms that can better promote positive aims. The speed at which emerging technologies and new datasets develop means that evaluating impact - whether positive or negative - can be fraught with difficulty. Addressing basic questions such as what constitutes "good enough" evidence, and what mechanisms are available to ensure the sharing of critical evidence, is essential for the legitimacy of impact assessment efforts. Increasingly complex and dynamic social systems, incomplete and often siloed datasets, and methodological constraints can only further complicate matters. Regardless, impact evaluations and assessments are important tools that can help build public confidence in the design and deployment of data systems. This will only become more important, in light of the increasingly prominent role artificial intelligence is playing in maintaining global stability, implementing adequate cybersecurity, managing global power dynamics, and maintaining international security.

Related topics: Geopolitics, Data Science, Corporate Governance, Information and Communications Technology, Future of the Environment, Artificial Intelligence, Cybersecurity, The Digital Economy, Climate Indicators, Geo-economics, International Security

2.10 Technology Innovation

'General purpose' technologies like artificial intelligence can have profound consequences for society

Some innovation, like the development of new pharmaceuticals, has an obvious and direct link to novel scientific research. Other types may result from using existing technology in new ways, or even from developments in unrelated fields. Many companies behind the sharing economy, for example, are essentially offshoots of existing internet and mobile technologies. While certain technologies like drones or 3D printing may create new markets and disrupt existing networks, technical innovation in the form of so-called "general purpose" technologies has the potential to disrupt entire groups of industries; examples have included the steam engine, the automobile, the personal computer, the internet and, potentially, artificial intelligence - all of which have had profound consequences for society. Since research and development is key, policy-makers have been keen to focus on ways in which it can be improved. Common areas of focus include national systems for research funding, systems for awarding and protecting patents (which are sometimes state-subsidized), improvement in translating university research into value for the private sector, and tax incentives for innovative firms (such as R&D tax credits, or special tax regimes for revenue derived from intellectual property).

The physical and biological worlds are merging, partly due to the creation of new materials designed to emulate the biological world; the discovery of new classes of recyclable, thermosetting polymers (plastics) called polyhexahydrotriazines is a major step towards a more sustainable economy, for example. New materials are now routinely being used in medical implants, for tissue engineering, and for the creation of artificial organs - and 3D printing is increasingly being used to create customized structures. The biological and digital worlds overlap most controversially in the world of genetic engineering. Widely accessible and affordable gene sequencing and editing systems, such as CRISPR/Cas9, make it possible to reliably and precisely remove or replace sequences in the genomes of both plants and animals. The biological and digital worlds are also overlapping in the form of sensors used to monitor health and behaviour - and to understand and influence brain activity. Advances that might have once been confined to digital systems, like the application of cryptography to blockchain technology to create programmable, secure, and distributed records, are also now having an impact in the real world, in terms of managing land records, for example, or tracking deforestation.

Related topics: Drones, Science, Circular Economy, Blockchain, 3D Printing, Plastics and the Environment, Sustainable Development, Innovation, Future of Work, The Net Zero Transition, Taxes, Entrepreneurship,

2.11 Preventing AI Bias

Focusing on diversity and inclusion can improve fairness in AI systems

Errors or inaccuracies introduced into AI systems via the data used to train them, and the related decisions made by developers, can easily result in bias. Biased AI systems can replicate or even amplify existing human biases and social inequality, potentially worsening discrimination against typically underrepresented groups like women and people of colour. The accuracy of some facial-recognition algorithms, for example, appears to be lower for people with darker skin tones. Managing bias is especially important for generative AI systems, because bias imputed into training data can carry over into the output of these systems (whether that is text, images, or other content). Design and testing teams made up of people with varied ethnicities and backgrounds can help foster AI systems that incorporate diverse perspectives. The data used to train AI systems should be widely representative, and specific techniques should be applied to identify and remedy potential sources of bias in both data and algorithms. In addition, there should be continual assessment of the impacts of AI systems on particular groups and individuals - particularly those who are traditionally marginalized.

Related topics: Future of Work, Digital Identity, Artificial Intelligence, Systemic Racism, Inequality, Values, Social Justice, Real Estate, The Digital Economy, Global Risks

2.12 Preserving Privacy

Those with identification suffer from a lack of privacy and portability

Today, technical innovation at the intersection of web3 and ID has produced an alternative- a means of maintaining the safety and security of institutions while offering individuals private, user-controlled access to critical services. Yet, the lack of public-private collaboration on privacy-preserving digital ID risks curtailing the efficacy of these systems. Public sector emphasis on intermediated compliance has resulted in systemic vulnerabilities, high costs, and exclusion. Likewise, private sector intermediators shoulder the costs of an expansive compliance regime. In short, even though web3 models of digital ID offer an opportunity to achieve both institutional security and individual empowerment, without fit-for-purpose policy, regulation, and technology, the potential for these systems to have pro-social impact will be severely limited.

Related topics: Human Rights, Blockchain, The Digital Economy, Digital Identity

2.13 Technology Leadership

The unprecedented impact of emerging technologies calls for leaders to rethink their roles

The Fourth Industrial Revolution, a new era characterized by emerging technologies fusing the physical and digital worlds at a potentially disconcerting pace, is opening up competitive gaps among economies and global businesses. Seven of the world's 10 largest companies by market capitalization are now technology firms, most of which were founded less than a generation ago, and all of which are based in just two countries: the US and China. As they shred old assumptions about how businesses can create value, the ascendance of these market-dominating, often technology-driven firms appears inexorable, creating unforeseeable economic and political consequences. The uncertainties and opportunities that major technological advances generate will have a dramatic effect on the legitimacy (and effectiveness) of both private sector and political leaders. "Technology leadership" describes the way that these leaders can harness change, in order to meet strategic goals, generate value, and create an inclusive economy. Technology leadership is not only an ability to operate in the space between technology development, and traditional public and private structures; it is about being comfortable delving into both realms. Twitter CEO Jack Dorsey, for example, must not only understand the nuts and bolts of his product, but also grasp the impact that this platform has on free speech and news dissemination.

The International Telecommunications Union estimates that less than half of the global population is now connected using some form of internet-enabled device. This reflects the stubborn digital divide separating

those with internet access from those who remain without. Connectivity growth has been moving in the right direction in the world's least developed countries, however, with internet user penetration in these areas projected to reach 17.5% by 2017, from 15.6% the prior year, according to an ITU report. The varying pace at which powerful tools like internet access and artificial intelligence are spreading sharpens existing divides and creates challenges for regulators - by removing parts of existing markets from under their purview, and creating new, unregulated sectors (traditional economic actors and workers are also affected). In addition, the blurring of traditional boundaries separating sectors imposes demands on leadership teams, which must go beyond simply understanding major technological advances to understanding how to mitigate their impact on traditional organizational structures.

Related topics: Artificial Intelligence, The Digital Economy, Entrepreneurship, Fourth Industrial Revolution, Economic Progress, Information and Communications Technology, Cybersecurity, Education, Innovation, Science, Media, Entertainment and Sport

2.14 New Leaders in Technology and Innovation

Emerging-market multinationals are playing a more prominent role in global innovation

Multinational corporations from emerging markets have matured into technological leaders and innovators, significantly shaping their respective fields. This is evident in their volume of patent applications, and enabled by both their R&D investment levels and by spending on education and key infrastructure in their home countries. Many governments have intensified efforts to boost local science, technology, and innovation capabilities, helping to create once-inconceivable competition for companies from advanced economies. In the 2020 Global Innovation Index, published by Portulans Institute and the World Intellectual Property Organization, seven emerging economies - China, Malaysia, Poland, Thailand, Russia, India, and the Philippines - featured among the top 50, compared with five a decade earlier. China ranked 14th in 2020, above Canada and Japan, and just below France and Israel. At the same time, Latin America lagged as Mexico, Brazil, and Argentina ranked 55th, 62nd, and 80th, respectively. Separately, four emerging-market countries were counted among the ten largest R&D spenders in 2018, according to UNESCO: China (2nd), India (6th), Brazil (8th), and Russia (9th), which collectively accounted for almost a third of all global R&D spending.

According to the European Commission Industrial R&D Investment Scoreboard, emerging-market multinationals, led by those from China, accounted for one in four of the biggest global R&D spenders in 2019. As emerging-market multinationals have proliferated, China and India have come to rank among the top 10 countries in terms of number of companies with high R&D spending. China has become a leader in terms of 5G, mobile payments, electric vehicles and batteries, and artificial intelligence. It has also completed its BeiDou Navigation Satellite System (BDS), which rivals America's GPS and Europe's Galileo. Similarly, other emerging economies have made significant advancements in new products and services, production processes, and innovative business models in fields including medicine, pharmaceuticals healthcare, nuclear technology, and e-commerce - as evidenced by China's Alibaba, Nigeria's Jumia Group, and Argentina's Mercado Libre. These online marketplaces and other emerging-market multinationals have been able to transform challenges into opportunities, by developing payment systems and business models tailored to their particular markets needs - often finding themselves at the forefront of technological development and the global digital economy as a result.

Related topics: Innovation, Education, Advanced Manufacturing, Artificial Intelligence, Social Innovation, Entrepreneurship, The Digital Transformation of Business, Science, Mobility, The Digital Economy, Batteries, 5G, 3D Printing

2.15 Infrastructure Technology and Innovation

The adoption of emerging technologies in infrastructure development lags behind other sectors

More actively embracing new technologies is not only a way to potentially improve existing infrastructure, but also a key potential means of closing an infrastructure investment gap expected to reach $22 billion in India, $100 billion in China, and $162 billion in the US by the year 2030, according to the Global Infrastructure Hub. Due to the economic and political importance of infrastructure projects, and related sensitivities, developers and investors are often hesitant to incorporate emerging technology into their planning. As a result, the engineering and construction industry remains among the least digitally transformed, leading to project

delays, poor design, environmental damage, and ballooning costs. This is happening even as emerging technologies have the potential to transform entire infrastructure systems through the use of advanced materials, robotics, 3D printing, the Internet of Things (which strings devices and appliances together via an internet connection), and data analytics. Examples of the impact of technology on construction include China-based Broad Sustainable Building's construction of a 57-story tower in just 19 days in 2014 - in part by using advanced prefabrication techniques.

Building Information Modeling (BIM) is another example of helpful innovation, thanks to the way it enables developers to create data-based, digital 3D models of projects so that architects, engineers, and contractors can simultaneously collaborate. This potentially increases efficiency and quality, while reducing errors, delays, and costs. Better integrating new technology into infrastructure development could not only result in more badly-needed infrastructure, but also in more sustainable and efficient infrastructure. Drone deliveries could take vehicles and related emissions off the road, autonomous vehicles could boost road capacity, and more digital tracking of road use could help to better predict the need for new infrastructure, according to a report published by the McKinsey Global Institute in 2016. However, new regulatory and business models will need to be created in order to pave the way for new technologies, while the general thinking about infrastructure development should shift to more strongly emphasize connectivity between mobility and utility systems, and between living and work spaces (particularly in urban environments).

Related topics: Innovation, Supply Chains, 3D Printing, Cities and Urbanization, Mobility, Internet of Things, Artificial Intelligence, Future of Computing, Advanced Manufacturing, Engineering and Construction, Drones

2.16 The Business and Economy of Data

Legitimate questions have been raised about advantages afforded to digital incumbents

The global economy is now largely built on a foundation of data. It is completely redefining the ways business is done, economies function, and societies interact. Data has a number of unique properties that distinguish it from the physical resources that have traditionally shaped economies in recent centuries, which have created new possibilities but also new threats and troubling consequences. While social media platforms like Facebook and TikTok have grown exponentially in recent years, enabling people to find each other and information quickly and often at no direct cost, the related rise of online advertising has made people the product - more specifically, their personal data. As a result of the ascendance of related business models and services, relatively novel ethical considerations have come into play (according to one estimate, digital ads accounted for 58% of all media ad spending by 2020). Legitimate questions have been raised about advantages afforded to digital incumbents, based on network effects and economies of scale, unequal access to user data, a general lack of transparency, conflicts of interest, and vertical integration.

The collective nature of data means most people are more impacted by other people's than their own. Much like climate change, the threats stemming from the collection and use of data are both globe-spanning and personal. On one end of the spectrum, companies have been accused of misusing data and exploiting the public's lack of understanding about the subject, while on the other organizations are trying to act more responsibly and finding ways to create shared value (many are doing a bit of both, intentionally and unintentionally). Regardless of motivation, the practices common in the data economy raise difficult questions, including whether businesses are mere stewards or owners of data, what their proper role is in terms of enforcing data rights, and whether data should be treated as a utility, an asset, or something else entirely. Finding the right answers demands that we - as consumers, citizens, corporations, and civil society - actively engage with the troubling issues at hand to ensure that data-based economies benefit everyone, while protecting them from the unintended and intended harm omnipresent in the digital realm.

Related topics: Banking and Capital Markets, Corporate Governance, The Digital Economy, Economic Progress, The Digital Transformation of Business, Internet Governance, Values, Artificial Intelligence, Media, Entertainment and Sport, Digital Identity

2.17 Technology Innovation

The promise of emerging technologies is matched by a need to manage related uncertainty

Emerging technologies like quantum computing, augmented reality, and gene editing tools present many opportunities. At the same time, they are the cause of immense uncertainty. Some particular sources of that uncertainty include the market applications a new technology will serve, the users who will adopt it, the

related activities that will support its expansion; and the business models that will be deployed to commercialize it. A holistic approach can help managers unbundle specific sources of uncertainty and the potential interaction among them, according to an article published in Strategy Science in 2021. For example, quantum computing has made several exciting technological advances, yet it can still be difficult to predict how it will evolve and create genuine value. Several questions remain regarding the technology, including at what point it can consistently and reliably outperform existing high-performance computing solutions. While some early-stage approaches have utilized "quantum annealing" technology - which is an alternative method of quantum computing that is already becoming commercially available - the next generation of the technology, dubbed universal gate-based quantum computing, is not expected to become widely-scaled-up for several years.

In terms of specific applications, quantum computing can serve many industries. Possible use cases include finance (for trading and risk management) and logistics (scheduling and planning), and eventually pharmaceuticals (drug development), security (encryption), and more. Still, there may be uncertainty about how various actors will contribute to the technology's value proposition; quantum computing does not necessarily hold utility when used simply to solve current problems faster than existing solutions, so to realize its full potential reformulating old questions or raising new ones is needed (companies such as 1Qbit, which specializes in "recasting" questions and problems related to quantum computing, have grown in value). Cloud-based ventures, including those focused on data storage, will also be important for bringing quantum technology to commercial fruition. Ultimately, it will require a business model - though that is difficult to design when the technology is still rapidly evolving, and use cases are still not fully defined. It will likely be several years before its true potential becomes clear. Meanwhile governments via initiatives like the Barcelona Supercomputing Center (and its spin-off Qilimanjaro) and companies like IBM have been shouldering substantial related upfront investments.

Related topics: Entrepreneurship, Artificial Intelligence, Information and Communications Technology, Advanced Materials, Internet of Things, Future of Computing, Blockchain, Biotechnology, Virtual and Augmented Reality, 3D Printing, Fourth Industrial Revolution

2.18 AI, Diversity, and Inclusion

One way to avoid problems with the technology is to create more diverse development teams

Artificial Intelligence tools are often promoted as an opportunity to improve diversity and inclusion. However, the news is full of stories about AI systems going horribly awry in ways that have the opposite effect. Some aspects of AI - such as its large scale, automated processes, and data-based decisions - could in principle expand access to resources and foster fairer treatment. Yet these same features also risk creating only the illusion of objectivity, while they encode inequality and injustice on a vast scale - or are used to further oppress disadvantaged groups. While AI tools do have the potential to improve diversity and inclusion, that power comes not from AI itself but rather from their creators. Current AI is not capable of abstract reasoning, nor can it predict the impacts of major change, necessitating human creators who understand why a current system may be problematic - and how AI might improve it. Similarly, the problematic impacts of AI on diversity and inclusion stem not only from issues related to data and algorithm design, but also from their creators misreading and oversimplifying social systems - and not anticipating unintended consequences.

For example, a scandal erupted in the United Kingdom in 2020 related to an algorithm used to grade crucial university entrance exams that undercut the scores of less-affluent students (though it was not a full AI system) - illustrating how algorithm creators may not anticipate how their tool will reinforce existing inequalities. Consideration of the diversity and inclusion impacts of AI systems should be incorporated into the design and evaluation of all AI tools, as well as their regulation and oversight. In addition, subject matter experts are necessary to understand the context in which an AI system will be deployed. Perhaps the most critical need is for AI development teams themselves to become more diverse - through changes in access to education and resources, hiring practices, and organizational cultures. Numerous examples exist of AI systems that are problematic because they reflect the world views and assumptions of their creators. While diverse teams are not a guaranteed fix, they reduce the odds that diversity and inclusion impacts will be overlooked. Diverse AI talent also broadens the innovation landscape more generally in ways that can push the technology forward on all fronts.

Related topics: The Digital Economy, Values, Economic Progress, Future of Work, Global Risks, Fourth Industrial Revolution, Education, Systemic Racism, Social Protection

2.19 AI for What Purpose?

We should consider whether some applications of the technology should be banned entirely

While current artificial intelligence algorithms may be limited to learning a single task, the technology's underlying principles and techniques are applicable to a surprisingly wide range of uses. Indeed, almost every sector of the economy and society has been affected by AI - or will be soon. Given this broad applicability, and the current shortage of AI-related talent, it is necessary to consider how we should develop and use this new tool to its maximum positive benefit. We should also consider whether some AI systems create such a high risk of potential misuse that they should not be allowed at all. Facial recognition, for example, is one area of AI that has come under particularly intense public scrutiny, both because of related privacy concerns and due to the technology's potential use as a tool of oppression; it therefore serves as a particularly thorny test case for when and how a particular area of AI both can and should be shut down entirely, and whether it is possible to use such technology responsibly and benevolently.

In other cases, challenges related to AI lie not with the broad technology itself but with its specific use. Algorithms applied within the criminal justice system, for example, have come under strong criticism - as they not only have potentially huge impacts on individuals' lives, but are also subject to the deeply-embedded biases and historical inequities reflected in the training data and human developers that inform them. In this context, AI systems risk exacerbating existing inequities in consequential and damaging ways. Even among less controversial uses of AI there remains the question of how to best leverage scarce resources. A huge portion of AI-related talent, for example, has been directed at the development of autonomous vehicles and other private, for-profit company endeavours, and military applications - leaving fewer capable people dedicated to deploying AI for the common good. As we foster a technology that many believe has the potential to reshape society, we need to find new ways for it to represent the interests of many different stakeholders, and to play a positive role in our future.

Related topics: Systemic Racism, Global Risks, Corporate Governance, Education, The Digital Economy, Digital Identity, Science, Global Governance, Justice and Law, LGBTI Inclusion, International Security, Mobility, Values, Agile Governance, Human Rights, Ocean

2.20 Bio Big Data and Machine Learning

The automated analysis of increasingly large sets of genetic data promises to transform health care

Biomedical science is transforming into big-data science. Thanks to next-generation genomic sequencing technology, there has been a dramatic data explosion; as of 2016, more than 100,000 human genomes had been sequenced from normal and diseased tissue, and petabytes of raw sequence data are now being produced and deposited in public genome data repositories such as International Cancer Genome Consortium data portal. This is transforming the scientific landscape, and entire healthcare systems. Currently-archived datasets represent only a small fraction of the genome-related big data yet to be produced, as sequencing capacity will continue to grow. If the current growth rate continues, doubling capacity about every seven months, exabytes-worth of genome data (one exabyte is equivalent to about 250 million DVDs worth of video) will be yielded in the next 5 years. As the global population pushes toward 8 billion within the next decade, it is possible that 15% or more of it will have their genome sequenced. In addition to genomics, high-resolution imaging, medical records, and lifestyle-related datasets will add new dimensions to bio big-data, and provide a foundation for next-generation healthcare.

However, there is a long road ahead before big data can help deliver precision medicine - based on a patient's genetic makeup and environmental circumstances - to the masses. There are immense challenges when it comes to data storage, distribution, and proper interpretation in biomedical contexts. Large-scale machine learning systems need to be integrated with vast computing infrastructure in order for deep learning, one of the most promising branches of artificial intelligence, to help better enable the navigation of big data and detect things that are impossible to catch manually. Machine learning could facilitate the mining of gene-to-gene interaction, the classification of cellular images, and finding links between datasets. Yet, machine-learning algorithms require large-scale, high-quality "ground truth" data for algorithm training - which is difficult to acquire. In addition, machine learning can be biased, and understanding exactly how machine learning algorithms are classifying the features in datasets can be challenging. Still, the analysis of big data will eventually have an enormous impact on disease prevention, on the ability to cure and care, and on the global healthcare system.

Related topics: The Digital Economy, Behavioural Sciences, Data Science, Innovation, Artificial Intelligence,

Fourth Industrial Revolution, Health and Healthcare, Precision Medicine, Future of Computing

2.21 New Ways to Make, Do and Buy

Virtual and augmented reality are helping to improve quality in innovative new ways

Virtual and augmented reality tools have been readily adopted by manufacturers aiming to improve efficiency, safety, and connectivity as they develop and repair their products. According to a report published by PwC in 2016, more than a third of US manufacturers surveyed were either already using virtual reality technology, or planned to do so in the next three years. In terms of product design, the technology facilitates remote collaboration, and many products can be "experienced" before they are actually made - potentially increasing product quality for consumers. In 2016, MIT Technology Review reported that commercial construction companies had begun using augmented reality technology to help them identify and avoid problems before starting work at a site; one senior manager at a firm in Rhode Island was able to use a Microsoft HoloLens head-mounted display unit in order to look at a mockup of a project and see that steel frames he planned to order would actually be too long to fit the design. His company then asked the supplier to cut the frames shorter in advance of delivery, enabling it to save thousands of dollars in unnecessary labour costs.

While virtual reality can help businesses visualize store layouts before they are built, augmented reality can fundamentally change the way retailers deliver their products to consumers. The functionality and quality of products can be assessed from anywhere, anytime. A Harvard Business Review article published in 2016 presented several possible use cases: virtually trying on clothing in the comfort of one's own home; testing out the look and fit of furniture at home; and potentially enabling people in different locations to go shopping together. The free augmented reality app KabaQ, released in 2017, can render compelling 3D models of food - which enable people to preview their meals on a tablet before ordering. AR may ultimately prove to be the easiest option for retailers seeking to bolster their services, given that the technology can be accessed on any smartphone. Virtual reality, on the other hand, still requires special equipment and so may be more suitable for other types of businesses - at least, for now. However, as the technology inevitably matures, virtual reality shopping will likely take off.

Related topics: Advanced Manufacturing, Fourth Industrial Revolution, The Digital Economy, The Metaverse, Real Estate, Corporate Governance, Retail, Consumer Goods and Lifestyle

2.22 Social Innovation

Profit is not the only source of inspiration for innovators

Examples of social innovation are all around us; they include everything from kindergartens and hospices to Wikipedia, Kahn Academy, and microfinance (small loans made to entrepreneurs in the developing world who do not have access to traditional financing). Social innovation is often defined as innovation that aims to tackle both social problems and the means used to address those problems. This can take the form of new products, services, initiatives, business models, or simply novel approaches to accessing public goods - often achieved by creatively re-combining already-existing elements. The field has developed rapidly in recent years, according to a 2022 report published by the Academy of Management, as new sources of funding, public policies, academic research, and networks emerge. The everyday work of social innovation typically happens within social enterprises (organizations working to solve social problems using market-based approaches), charities, non-governmental organizations, social movements, or patient groups. Universities, large companies, and governments also play roles, particularly in terms of validating ideas; results have included the construction of public playgrounds and the commercialization of community-developed, open-source software.

One notable development in the realm of social innovation is the deployment of pay-as-you-go (PAYG) technology. This enables companies to cater to people living in relative poverty, by accepting small individual payments for key services. As with prepaid phone services, customers can buy small and therefore more affordable amounts of credit. Solar energy companies like Angaza and affordable water organizations like eWater Services use PAYG technology to reach customers that might otherwise be denied such services. However, a lack of immediate commercial incentives can make it difficult to raise the capital needed to support such social innovation. As a result, organizations continue to experiment with frugal innovation - to make potentially scarce resources stretch further. One example of this is the M-Pesa mobile phone-based payment and micro-financing service, which has been deployed in countries in Africa, Asia, and Europe to

facilitate banking services without requiring access to an actual bank. Due to their limited funding, social enterprises often adopt hybrid for-profit and non-profit legal structures - enabling organizations like Sanergy in Africa to supplement revenue with philanthropic donations.

Related topics: Entrepreneurship, Agile Governance, Future of Work, Ageing and Longevity, Fourth Industrial Revolution, Civic Participation, Vaccination, Sustainable Development, Circular Economy, Social Innovation, Cities and Urbanization

2.23 Foundational Elements of the Metaverse

This virtual world will rely on real technologies and emerging behavioural patterns

Ultimately, there will be no metaverse without the chips and software required to power it. After Meta, the parent company of Facebook, announced plans in late 2021 to move aggressively into developing virtual reality and the metaverse, shares of chipmaker Nvidia hit record highs. Nvidia designs chips and graphics cards that generate high-resolution, 3-D images, as well as software that can be used to design virtual worlds. Other pieces of hardware required for participating in the metaverse include controllers that register hand and finger movements to interact in a virtual environment, and headsets. Some headsets currently available can cost thousands of dollars, though many are available for a few hundred dollars. According to an estimate published by eMarketer, the number of virtual-reality headsets in use globally should increase from 35 million in 2022 to 70 million by 2026. However, the company has also noted "pain points" for users that include the fact that headsets can be hot and uncomfortable, especially difficult to use for people who wear glasses, and suffer from poor battery life. Efforts are underway to develop alternatives to headsets for gaining metaverse access.

Other basic elements likely to feed into the early versions of the metaverse include the burgeoning use of cryptocurrencies. Just as the initial versions of the internet disrupted industries that rely on transferring information (like the news media), cryptocurrencies are disrupting industries that transfer value - like video games, or banking. The expansion of the metaverse will likely rely heavily on trading in such virtual currencies and assets, underpinned by blockchain technology. Other "metaverse activities" already proliferating, even as this next version of the internet remains theoretical, include shopping at virtual stores, watching films and TV shows, completing jobs for real money, and attending live concerts all within games. Roblox, a game platform first released in 2006, has players create avatars that can chat with others in the virtual world, earn virtual currency ("Robux"), or host parties. One Roblox executive said in a published interview that much of the platform's appeal is due to its emphasis on "unstructured play," at a time when many children are now more restricted when it comes to real-world activities than previous generations.

Related topics: The Digital Transformation of Business, Data Policy, Cybersecurity, Future of Computing, Behavioural Sciences, Information and Communications Technology, The Digital Economy, Mental Health, Media, Entertainment and Sport, Blockchain, Banking and Capital Markets, Fourth Industrial Revolution, Internet Governance, Virtual and Augmented Reality

2.24 Entrepreneurship and Development

The SDGs frequently set the agenda for entrepreneurs aiming to make a positive contribution

"Development" is often defined as balancing social prosperity, economic performance, and environmental resilience - for the benefit of both current and future generations. Entrepreneurship plays an important role in development, by creating and expanding access to new products, technologies, and services, often in concert with public initiatives. These efforts can have both positive and negative impacts on social behaviour, general well-being, employment, and the environment. This raises practical and policy questions about the merits of entrepreneurial activity beyond the accumulation of wealth - including about how it may benefit some communities more than others. On one hand, entrepreneurship generally creates jobs, drives economic growth and innovation, and contributes to better living standards. On the other, its benefits are often unevenly distributed, frequently lead to the overexploitation of natural resources, and can negatively impact vulnerable populations. Within the context of development there is therefore a need to reconsider some common assumptions about entrepreneurial activity, and focus on ways to make it work better (and more fairly) for society. At present, the agenda for entrepreneurs aiming to make a positive contribution to development is often set by the United Nations' Sustainable Development Goals (SDGs).

When entrepreneurial efforts coalesce around development challenges (particularly the most pernicious,

persistent, complex, and widespread), the intent is often to expand access to goods and services, and to generate more sustainable and socially-inclusive innovation. Entrepreneurial networks and new ways of organizing are key, as single actors may not have the capacity necessary to address complex challenges on their own. The core questions are how value is best created and distributed, and how to create an enabling ecosystem where entrepreneurial activity on the part of companies, governments, and community groups can flourish. The success of entrepreneurial activity cannot be judged simply on the basis of shareholder value; instead, the value created for the most marginalized communities becomes key. Numerous entrepreneurial experiments in the context of development in recent decades have taught us how crucial the local cultural and political context is for both the process and outcomes - and many examples have illustrated the need for equal amounts of discipline and inspiration for future generations of entrepreneurs. The challenge now is to learn from these efforts, whether large-scale, state-subsidized capacity- and infrastructure building, or the work of civil society agencies at the village level.

Related topics: Geopolitics, Economic Progress, Development Finance, Supply Chains, Future of Work, Values, Sustainable Development, Youth Perspectives, Corporate Governance, Inequality

2.25 Digital and Sustainable Transformation of Industries

The pandemic has accelerated both digital immersion and a digital transformation gap

COVID-19 catapulted organizations everywhere into the digital-first world. Greater access to connectivity and digital services had already been reshaping industries, business models, and supply chains; the pandemic accelerated these trends, requiring organizations of all types to rely more heavily on digital operations and business models to create new value and experiences. But while some organizations are making progress on their digital transformation goals, others have not. The pandemic widened this digital transformation gap; as some speed ahead, others struggle to survive, let alone thrive. Without a comprehensive government approach to digitally equipping an economy, including sustainable investment in connectivity infrastructure and services, inequalities widen. A complete and responsible digital transformation of industries requires careful consideration of digital infrastructure investments and related policies, to enable a transition across an entire economy - in ways that benefit society as a whole, and not just now but for years to come.

Governments have an opportunity to make step changes in terms of technological advancement across industries and in their own operations, through sound policy and investments in digital skills and infrastructure. Research shows that digital transformation could help reduce emissions in hard-to-abate sectors by as much as 20% by 2050. In addition, the World Bank estimates that the digital economy is equivalent to 15.5% of global GDP, having grown two-and-a-half times faster than global GDP over the past 15 years. Low productivity and scaled back growth, coupled with an inability to fully (and responsibly) benefit from technologies such as cloud computing, 5G, artificial intelligence, and high-performance computing will lead to a deteriorating quality of essential services - and block the transition to a more advanced economy. Interoperability will be vital for ensuring information exchange, and enabling collaboration.

Priorities for collaboration:

-Encourage a cross-sector, public-private dialogue on value creation to design new frameworks around sustainable investments in connectivity infrastructure and services.

-Stimulate growth through digitally enabled collaboration models that enable transformation of industries.

Related topics: Virtual and Augmented Reality, The Digital Transformation of Business, 3D Printing, Corporate Governance, Economic Progress, Artificial Intelligence, Leadership, Blockchain, Fourth Industrial Revolution, Innovation, Entrepreneurship

2.26 Generative AI*

Generative AI is a type of artificial intelligence that creates new content based on patterns and data it has learned from

Unlike other forms of AI that are designed to perform specific tasks, such as recognizing objects in an image, generative AI creates new and unique outputs, such as images, texts, music, or even computer code. The

opportunities provided by generative AI are numerous and exciting. For example, it has the potential to revolutionize many creative industries, such as graphic design, writing, and music composition, by automating tasks and freeing up more time for human creativity. In healthcare, generative AI can assist in drug discovery and disease diagnosis. In education, it can help generate personalized study materials for students. The potential for generative AI is vast and varied, and its applications are limited only by our imagination. However, despite its potential benefits, there are also key concerns about generative AI.

One of the most pressing concerns is the potential for AI-generated content to spread misinformation, particularly in areas like fake news or deepfake videos. Another concern is the impact that generative AI may have on job markets, as automation could potentially displace human workers. Additionally, there are ethical concerns around the use of AI-generated content, such as questions around who is responsible for its creation and the potential for it to be used in harmful ways. In conclusion, generative AI is a fascinating and rapidly evolving field that has the potential to bring about many positive changes in various areas of society. However, as with any new technology, it's important to approach it with caution and carefully consider the potential consequences of its use. By balancing the potential benefits and risks of generative AI, we can ensure that it is used in a responsible and ethical manner, for the greater good of society as a whole.

*The text for this key issue was entirely generated by OpenAI's ChatGPT chatbot using the following prompt: "Write a 300 word text providing a non-technical description of generative AI, its opportunities, and key concerns about it."

Related topics: Future of Computing, Economic Progress, Future of Work, Civic Participation, Media, Entertainment and Sport, Education, Arts and Culture, Health and Healthcare, Fourth Industrial Revolution, Internet Governance

2.27 Operationalizing Responsible AI

Ethical principles can have very different meanings depending on location and cultural context

There has been a growing recognition of the potentially negative impact of artificial intelligence on society. Survey results published by the Center for the Governance of AI in 2019 suggested that more Americans think high-level machine intelligence will be harmful than think it will be beneficial to humanity, for example. In response to sentiments like this, over a relatively short period of time more than 160 different sets of principles for ethical AI have been developed around the world. While these differ in terms of emphasis and cultural context, they all point to a growing consensus around a central set of tenets: respect for privacy, transparency, explainability, human control, and mitigating bias. The challenge now is how to best put these principals into broad practice and enforce their use - as there is an increasing awareness that considerable barriers still exist when it comes to actually operationalizing AI principles. Many of the principles are very general, for example, requiring considerable work to translate them into day-to-day practices, and some of the most important related questions regarding accountability, auditing, and liability remain unanswered.

For example, some of the principles may come into conflict with one another during implementation. And, while there may be general agreement on the principles in name, their specific interpretation and meaning will vary (sometimes considerably) according to context and culture. As a result, there is a critical need for further international cooperation on developing ways to operationalize ethical principles of AI that are mutually beneficial and constructive. While many companies and government leaders say that they want to ensure responsible development and behaviour, without easy-to-use solutions and clear guidelines the effort and cost required to operationalize effectively will discourage action. As we seek to facilitate the guidelines, we also need to increase the cost of inaction - every organization should be expected to not only endorse the responsible use of AI, but to also provide clear evidence that their own practices match their rhetoric. Meanwhile lawmakers should use both informal and formal means to hold these organizations accountable for their use of AI, while promoting responsible practices and uses of the technology.

Related topics: Global Governance, Corporate Governance, Agile Governance, Justice and Law, Future of Work, Future of Computing, The Digital Economy, Fourth Industrial Revolution, Leadership, Education

2.28 Blockchain and Digital Identity

Current systems for identity management are siloed and inefficient, and call for new models

About one billion people around the world remain without the official proof of identity often crucial for

receiving services and benefits - and those with official proof often have little-to-no control over how it is being managed. The concept of digital identity has therefore become increasingly important for many governments and institutions, given the ways it can potentially help knock down barriers when it comes to everything from property ownership, to political participation, to receiving fair access medical care and services. The COVID-19 pandemic has only brought issues related to identity management further into focus - as pandemic relief and stimulus payments, medical records, and address information all generally reside in separate systems with no means of interoperating. Many governments are therefore now exploring the use of blockchain technology to enable more seamless and secure systems for identity management. Some countries, such as Estonia, had already become leaders in the use of blockchain-based digital identity; an estimated 98% of Estonian residents have a national ID-card that functions as a travel ID, health insurance card, proof of identification for banking, and more.

In Canada, blockchain technology has been used to credential over 500,000 businesses through its "Verifiable Organizations Network." In any country, adequate oversight and management are central to the use of blockchain - not least because unique and consistent identifiers are prerequisites for decentralized services. For example, blockchain-based currency transactions are routed via public addresses that represent a transacting entity, and signed off on via a unique private key (a cryptography tool used to encrypt and decrypt code). However, the anonymity this enables may come into conflict with regulations related to identification that are designed to minimize illicit transfers of funds. As a result, blockchain-based digital identity systems still face considerable technological, managerial, and regulatory issues. In addition to the scalability considerations first required in order to support billions of individual users, data integrity will be critical - especially given the potential for administrators to interact with a large volume of relatively unsecure, "off-chain" data. Regulatory models will likely need to adapt, in order to accommodate new models of identity and prevent adverse related consequences such as social exclusion or widening digital divides.

Related topics: Global Health, Future of Computing, Innovation, Digital Identity, The Digital Economy, Retail, Consumer Goods and Lifestyle, Internet Governance, Fourth Industrial Revolution, Financial and Monetary Systems, Corruption

2.29 Open Innovation

Many talk about corporate venturing, relatively few know how to successfully implement it

Established companies innovating together with startups, often called "corporate venturing" or "CV," is a fast-growing phenomenon that takes many forms. These include corporate venture capital, corporate accelerators, venture clients, venture builders, and joint proofs of concept, to name a few. Since 2016, corporate venture capital investment has increased four-fold globally; this is a part of open innovation, a growing paradigm that assumes firms can and should use external ideas and paths to market as they look to advance their technology. These external inputs may come from startups, governments, universities, venture capital investors, or accelerator programs. The South Korean multinational Samsung, for example, gained a foothold in next-generation quantum computers by directly investing in the startup IonQ, which later went public, and German athletic apparel company Adidas partnered with the California-based startup Carbon to develop a 3D-printed shoe. On average, nearly 69% of corporate-startup innovations fail, however, according to a report published in MIT Sloan Management Review. So, what is the remaining roughly 31% doing differently? What is the right structure, degree of autonomy, and sources of deal-flow for the teams running corporate venturing and startups, for example?

Some popular myths include the notion that corporate venturing is only for large corporations (many small- and medium-sized enterprises are pursuing it), and that it is just corporate venture capital (it encompasses other mechanisms such as the "venture client," where the corporation is the first client of the startup). Some also mistakenly think CV is just about intuition; abundant data are available to drive it forward strategically. Looking ahead, there are two predominant trends. The first is a growing number of corporations innovating with deep-tech startups, or those with emerging technologies based on scientific discoveries and offering a substantial advance over established technologies (illustrated by the expansion of the American chipmaker Intel's deep-tech startup accelerator Ignite). The second is a growing number of corporations forming small groups to innovate with startups - so called "CV squads" - to share costs, anticipate opportunities, and strengthen value propositions. The carmaker Volvo, for example, did this by teaming up with telecommunications firm Ericsson and others. To capture the true value of corporate venturing, in terms of fielding innovative new products and services, chief innovation officers should make a point of reviewing their existing CV strategies.

Related topics: Internet Governance, Fourth Industrial Revolution, Education, Sustainable Development, Entrepreneurship, Science, Justice and Law, Agile Governance, Cities and Urbanization

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Our Transformation Maps are dynamic knowledge visualisations. They help users to explore and make sense of the complex and interlinked forces that are transforming economies, industries and global issues. The maps present insights written by experts along with machine-curated content. Together, this allows users to visualise and understand more than 250 topics and the connections and inter-dependencies between them, helping in turn to support more informed decision-making by leaders.

The maps harness the Forum network's collective intelligence as well as the knowledge and insights generated through our activities, communities and events. And because the Transformation Maps are interlinked, they provide a single place for users to understand each topic from multiple perspectives. Each of the maps has a feed with the latest research and analysis drawn from leading research institutions and media outlets around the world.

At the centre of each map is the topic itself. This is surrounded by its "key issues", the forces which are driving transformation in relation to the topic. Surrounding the key issues are the related topics which are also affected by them. By surfacing these connections, the map facilitates exploration of the topic and the landscape within which it sits.

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