1. Artificial Intelligence (AI) and Machine Learning

Artificial Intelligence, or AI, has already received a lot of buzz in the past decade, but it continues to be one of the new technology trends because of its notable effects on how we live, work and play are only in the early stages. AI is already known for its superiority in image and speech recognition, navigation apps, smartphone personal assistants, ride-sharing apps and so much more.

Other than that AI will be used further to analyze interactions to determine underlying connections and insights, to help predict demand for services like hospitals enabling authorities to make better decisions about resource utilization, and to detect the changing patterns of customer behaviour by analyzing data in near real-time, driving revenues and enhancing personalized experiences.

The AI market will grow to a $190 billion industry by 2025 with global spending on cognitive and AI systems reaching over $57 billion in 2021. With AI spreading its wings across sectors, new jobs will be created in development, programming, testing, support and maintenance, to name a few. On the other hand AI also offers some of the highest salaries today ranging from over $1,25,000 per year (machine learning engineer) to $145,000 per year (AI architect) - making it the top new technology trend you must watch out for!

Machine Learning the subset of AI, is also being deployed in all kinds of industries, creating a huge demand for skilled professionals. Forrester predicts AI, machine learning, and automation will create 9 percent of new U.S. jobs by 2025, jobs including robot monitoring professionals, data scientists, automation specialists, and content curators, making it another new technology trend you must keep in mind too!.

Robotic Process Automation (RPA)

Like AI and Machine Learning, Robotic Process Automation, or RPA, is another technology that is automating jobs. RPA is the use of software to automate business processes such as interpreting applications, processing transactions, dealing with data, and even replying to emails. RPA automates repetitive tasks that people used to do.

Although Forrester Research estimates RPA automation will threaten the livelihood of 230 million or more knowledge workers, or approximately 9 percent of the global workforce, RPA is also creating new jobs while altering existing jobs. McKinsey

finds that less than 5 percent of occupations can be totally automated, but about 60 percent can be partially automated.

For you as an IT professional looking to the future and trying to understand new technology trends, RPA offers plenty of career opportunities, including developer, project manager, business analyst, solution architect and consultant. And these jobs pay well. An RPA developer can earn over ₹534K per year - making it the next technology trend you must keep a watch on!

3. Edge Computing

Formerly a new technology trend to watch, cloud computing has become mainstream, with major players AWS (Amazon Web Services), Microsoft Azure and Google Cloud Platform dominating the market. The adoption of cloud computing is still growing, as more and more businesses migrate to a cloud solution. But it's no longer the emerging technology trend. Edge is.

As the quantity of data organizations are dealing with continues to increase, they have realized the shortcomings of cloud computing in some situations. Edge computing is designed to help solve some of those problems as a way to bypass the latency caused by cloud computing and getting data to a datacenter for processing. It can exist "on the edge," if you will, closer to where computing needs to happen. For this reason, edge computing can be used to process time-sensitive data in remote locations with limited or no connectivity to a centralized location. In those situations, edge computing can act like mini datacenters.

Edge computing will increase as use of the Internet of Things (IoT) devices increases. By 2022, the global edge computing market is expected to reach $6.72 billion. And this new technology trend is only meant to grow and nothing less, creating various jobs, primarily for software engineers.

4. Quantum Computing

Next remarkable technology trend is quantum computing, which is a form of computing that takes advantage of quantum phenomena like superposition and quantum entanglement. This amazing technology trend is also involved in preventing the spread of the coronavirus, and to develop potential vaccines, thanks to its ability to easily query, monitor, analyze and act on data, regardless of the source. Another field where quantum computing is finding applications is banking and finance, to manage credit risk, for high frequency trading and fraud detection.

Quantum computers are now a multitude times faster than regular computers and huge brands like Splunk, Honeywell, Microsoft, AWS, Google and many others are

now involved in making innovations in the field of Quantum Computing. The revenues for the global quantum computing market are projected to surpass [$2.5 billion by 2029.](#) And to make a mark in this new trending technology, you need to have experience with quantum mechanics, linear algebra, probability, information theory, and machine learning.

5. Virtual Reality and Augmented Reality

The next exceptional technology trend - Virtual Reality (VR) and Augmented Reality (AR), and Extended Reality (ER). VR immerses the user in an environment while AR enhances their environment. Although this technology trend has primarily been used for gaming thus far, it has also been used for training, as with [VirtualShip](#), a simulation software used to train U.S. Navy, Army and Coast Guard ship captains.

In 2021, we can expect these forms of technologies being further integrated into our lives. Usually working in tandem with some of the other new technologies we've mentioned in this list, AR and VR have enormous potential in training, entertainment, education, marketing, and even rehabilitation after an injury. Either could be used to train doctors to do surgery, offer museum goers a deeper experience, enhance theme parks, or even enhance marketing, as with this [Pepsi Max bus shelter](#).

Fun fact: 14 million AR and VR devices were sold in 2019. The global AR and VR market is expected to grow to [$209.2 billion by 2022](#), only creating more opportunities in the trending technology, and welcoming more professionals ready for this game-changing field.

While some employers might look for optics as a skill-set, note that getting started in VR doesn't require a lot of specialized knowledge - basic [programming skills](#) and a forward-thinking mindset can land a job; another reason why this new technology trend should make up to your list of lookouts!

6. Blockchain

Although most people think of [blockchain technology](#) in relation to cryptocurrencies such as Bitcoin, blockchain offers security that is useful in many other ways. In the simplest of terms, blockchain can be described as data you can only add to, not take away from or change. Hence the term "chain" because you're making a chain of data. Not being able to change the previous blocks is what makes it so secure. In addition, blockchains are consensus-driven, so no one entity can take control of the data. With blockchain, you don't need a trusted third-party to oversee or validate transactions.

Several industries are involving and implementing blockchain, and as the use of blockchain technology increases, so too does the demand for skilled professionals. From a birds eye view, a blockchain developer specializes in developing and implementing architecture and solutions using blockchain technology. The average yearly salary of a blockchain developer is ₹469K.

If you are intrigued by Blockchain and its applications and want to make your career in this trending technology, then this is the right time to start. To get into Blockchain, you need to have hands-on experience of programming languages, the fundamentals of OOPS, flat and relational databases, data structures, web app development, and networking.

7. Internet of Things (IoT)

Another promising new technology trend is IoT. Many "things" are now being built with WiFi connectivity, meaning they can be connected to the Internet—and to each other. Hence, the Internet of Things, or IoT. The Internet of Things is the future, and has already enabled devices, home appliances, cars and much more to be connected to and exchange data over the Internet.

As consumers, we're already using and benefitting from IoT. We can lock our doors remotely if we forget to when we leave for work and preheat our ovens on our way home from work, all while tracking our fitness on our Fitbits. However, businesses also have much to gain now and in the near future. The IoT can enable better safety, efficiency and decision making for businesses as data is collected and analyzed. It can enable predictive maintenance, speed up medical care, improve customer service, and offer benefits we haven't even imagined yet.

And we're only in the beginning stages of this new technology trend: Forecasts suggest that by 2030 around 50 billion of these IoT devices will be in use around the world, creating a massive web of interconnected devices spanning everything from smartphones to kitchen appliances. The global spending on the Internet of Things (IoT) is forecast to reach 1.1 trillion U.S. dollars in 2022. New technologies such as 5G is expected to drive market growth in the coming years.

And if you wish to step foot in this trending technology, you will have to learn about Information security, AI and machine learning fundamentals, networking, hardware interfacing, data analytics, automation, understanding of embedded systems, and must have device and design knowledge.

8. 5G

The next technology trend that follows the IoT is 5G. Where 3G and 4G technologies have enabled us to browse the internet, use data driven services, increased bandwidths for streaming on Spotify or YouTube and so much more, 5G services are expected to revolutionize our lives. by enabling services that rely on advanced technologies like AR and VR, alongside cloud based gaming services like Google Stadia, NVidia GeForce Now and much more. It is expected to be used in factories, HD cameras that help improve safety and traffic management, smart grid control and smart retail too.

Just about every telecom company like Verizon, Tmobile, Apple, Nokia Corp, QualComm, are now working on creating 5G applications. 5G services are expected to launch worldwide in 2021 with more than 50 operators offering services in about [30 countries by the end of 2021](#), making it a new technology trend you must watch out for, and also save a spot in.

9. Cyber Security

[Cyber security](#) might not seem like an emerging technology, given that it has been around for a while, but it is evolving just as other technologies are. That's in part because threats are constantly new. The malevolent hackers who are trying to illegally access data are not going to give up any time soon, and they will continue to find ways to get through even the toughest security measures. It's also in part because new technology is being adapted to enhance security. As long as we have hackers, [cybersecurity](#) will remain a trending technology because it will constantly evolve to defend against those hackers.

As proof of the strong need for cybersecurity professionals, the number of cybersecurity jobs is [growing three times faster than other tech jobs](#). Also, the need for proper cyber security is so high that by 2021, [$6 trillion](#) will be spent globally on cybersecurity.

You must note that however challenging the [field](#) is it also offers lucrative [six-figure incomes](#), and roles can range from [ethical hacker](#) to security engineer to Chief Security Officer, offering a promising career path for someone who wants to get into and stick with this evergreen trending technology.

1. Artificial Intelligence

[Artificial intelligence](#) (AI) is the technology used for equipping computer systems with the ability to make decisions like humans. Being one of the trending technologies, when AI programs are fed to systems, the aim is to mimic human intelligence for performing complex tasks such as pattern recognition, speech recognition, weather forecast and medical diagnosis.

AI is used in navigation based applications like Uber, voice assistants like Siri, video streaming services like Netflix, IoT devices and in search engines like Google and Bing. AI helps in automating tasks such as traffic, scheduling trains, making business predictions and designing driverless cars!

By 2030, AI automation is expected to create more than 70 million jobs. The sad fact is that AI might wipe out more than 23 million jobs by the same time frame. AI will create jobs in areas such as testing, support, maintenance, programming and data science. Software developers who know AI earn much more than developers who don't.

So, learning AI will help you secure jobs such as

- Machine Learning Engineer
- Data Scientist
- Computer Vision Engineer
- Business Intelligence Developer
- Data Analyst
-

2. Data Science

Next up in the list of latest technology concepts is not surprisingly Data Science. Data Science is the technology that helps to make sense of complicated data. You know that data is produced in a humungous amount every day by companies. This includes business data, sales data, customer profile information, server data, and financial figures.

Most of this data is in the form of huge data sets that are unstructured. The role of data scientists is to convert these unstructured data sets into structured datasets. Then, these data sets can be analyzed to identify patterns and trends. These patterns are useful for understanding the company's business performance, customer retention, and how these areas can be improved.

The **average salary of a Data Scientist is $117,345/yr**. No wonder the Harvard Business Review called it the "**sexiest job of 21st Century**". But getting a job in this field will require you to have a thorough understanding of mathematics, statistics, computer science, and programming. Learn more about data scientists salary in India.

Future scope of data science is bright which will create opportunities for the following career roles:

- Data Scientist
- Data Architect
- Business Intelligence Manager
- Data Engineer
- Data Analyst
- Business Analyst

3. Internet of Things

The IoT (Internet of Things) is a network of devices that are connected to each other. Their devices caninteract and share data with each other. These devices may be connected via WiFi, and they share data about their environments and how they are being used. These devices have a computer chip that facilitates this exchange.

It is predicted that more than **41 billion devices powered by IoT will be used by 2025**.

IoT not only enables the connection between different devices but also their remote access. For example, you lock doors of your car remotely, preheat your ovens and geysers. The FitBit that you use for tracking the number of calories you burn also runs on IoT technology. IoT chips embedded on machines help businesses to assess the performance of those machines and assist in their maintenance. Learn about the real world IoT applications in 2021.

Learning this latest technology will help you find jobs such as:
- IoT Software Developer
- System Design Engineer
- IoT Product Manager
- IoT Research Developer
- IoT Solution Architect

4. Blockchain

Blockchain is the foundational technology that powers electronic currencies such as Cryptocurrencies. In simple terms, a Blockchain is an electronic ledger that can be shared among different users. This helps in creating a record of transactions that cannot be altered. Each of these records is time-stamped and linked to the previous one.

So every time a new transaction is added to the ledger, it is stored as another block in the chain of transactions – hence the name. Blockchain is updated after the different parties contributing to the ledger agree. After new data is fed into a block, it cannot be erased. This makes technology verifiable and secure.

This validation of transactions helps companies reduce their costs as no third party has to be paid. The system is very secure and there is no need for paying for centralized entities, as the technology is decentralized. Transactions are easier to track using Blockchain. There is a rise in careers in Blockchain and it will create different job positions which are as follows:
- Blockchain Developers
- Blockchain Quality Engineer
- Blockchain Legal Consultant or Attorney
- Blockchain Engineer

5. Robotic Process Automation (RPA)

Robotic Process Automation (RPA) is a technology used for automating daily tasks, similar to artificial intelligence. Here, the software is used for automating repetitive tasks such as handling and replying to emails, processing transactions, and handling business data.

This technology is used for automating tasks for low-level employees to higher-ranking officials. RPA can automate more than 40% of daily tasks. According to McKinsey, more than 60% of all repetitive tasks can be partially automated using RPA. So, this technology is going to threaten a lot of jobs.

On the other hand, this latest technology will also create many job opportunities in the automation sector.

Read: RPA Architecture, Components, Examples, Tools & More

The most popular vendors that provide RPA tools are Pega Systems, Blue Prism, UiPath, Automation Anywhere, and WorkFusion. Companies such as Accenture, Deloitte, and Capgemini use RPA tools to automate their daily operations. So, the demand is huge for professionals skilled in RPA.

The different RPA job roles are as follows:

- RPA Developer
- RPA Business Analyst
- RPA Consultant
- RPA Solution Architect
- RPA Project Manager

Know more: What is Robot Process Automation?

6. Virtual Reality

VR is the technology by which you can immerse yourself in an environment that seems astonishingly realistic. It is the use of computer technology for creating a simulated environment. It is very popularly used for playing computer games. Unlike traditional games where you experience the gaming environment by viewing it on the screen, you are directly placed in the environment!

Senses such as touch, hearing, smell, and vision are simulated in these environments. Using VR gear such as headsets, you can walk around and play the game in that 3D world. Augmented Reality (AR) is the technology used for improving this virtual environment. The major players in this field are Facebook's Oculus Rift, Sony's PlayStation VR (PSVR), and the HTC Vive.

The VR technology is not only used for entertainment, but it is also used by the U.S. Navy and Coast Guard for training staff. They use a

VR game called VirtualShip. AR and VR are used by doctors while performing surgery. Visitors in an amusement park or a museum can also use the technology to enhance their experience.

The VR industry is expected to reach close to $40 billion by 2021. Here are some VR job positions you can look out for:

- Content Producer
- AR and VR Content Writers
- Product Management
- Software Engineer
- UI and UX Design
- Quality Assurance

7. Edge Computing

Edge computing is the latest technology trend that is getting famous by the day. The technology is based on the philosophy of bringing computing power as close to the data source. This helps in reducing bandwidth and latency.

The technology aims to run fewer processes in the cloud and shifting those processes to locations such as the user's system or an edge server. Bridging this gap between the data and the computation reduces the long-distance communication between the server and the client, which in turn enhances the speed of the process. This is why edge computing is used for handling time-sensitive data stored in remote locations that have limited connectivity to the central location. The technology will make cloud computing and IoT devices faster.

It is estimated that by 2022, the edge computing market will be worth $7 billion. The technology will be popular in areas such as healthcare, retail, and manufacturing. Thus, it will open the doors to many job opportunities. It is expected that the salary range of an Edge computing professional will be around **$100,400 to $123,000 per annum**

8. Intelligent apps

Intelligent apps are software applications that make use of AI components such as machine learning, deep learning, data analytics,

robotics, and natural language processing. They help you in making decisions based on real-time data or historical data.

Examples of Intelligent apps are voice assistants such as Siri, Google Assistant, and Alexa. As companies such as Google, Apple, and Oracle continue investing in these applications, it is bound to create a lot of jobs in the future. Intelligent applications developers are sure to bring home fat paychecks!

Big Data Analytics

"Data is the new science; Big Data holds the answers"
– Pat Gelsinger, the CEO of VMware.

Data holds the key of today's fold and is unfolding dynamics for critical decisions, businesses, marketing, etc. It revolves around the problems which happened in the past propose successful solutions to tackle these situations.

These data-based decisions are proving to be more accurate, they minimize human errors and maximize the efficiency expected in the industries.

At this point in time, there is sufficient data that can help people to derive the results they are looking for. Almost 3 billion terabytes of data are generated by a single cross country flight. If we look around, data analytics is almost everywhere and companies are continuously making their attempts to make its effective use.

2. Artificial Intelligence

With the global growth of the robotics industry, its worth is expected to increase by **$80 billion** till 2024 and students should consider it a perfect option to pursue it as a career. This is one of the most intriguing options for the students of computer science and all multinational tech giants are continuously investing in this field.

It has an immense scope of breakthrough opportunities that can promise a bright future. AI helps to perform tasks efficiently and accurately as compared to humans. It mimics human intelligence and performs tasks such as image recognition, speech and patterns, and decision making.

Students should study deeply about this field before opting for it as a career. Try to find sufficient material online and absorb it as much as possible to develop an interest in the field which attracts you. Look for term papers for sale or get them from some experts who can provide you the detailed information.

Master AI technology with DataFlair's [Artificial Intelligence Tutorial.](#)

3. Cyber Security

According to stats shared by the US [Bureau of Labor Statistics](#), jobs related to cybersecurity are going to increase tremendously. 28% of growth is expected from 2016 to 2026, which is a lot more than the jobs in other sectors.
It also shows that there will be a shortfall in the domain if bright students didn't pursue it as a career. All educational institutions and organizations should collaborate to develop the best ways in this regard.

Cyber Security teaches how to protect operating systems, networks and data from cyber-attacks. It helps to reduce risks and track all threats which might affect the system. This digital era shows that there are numerous opportunities that hackers might attack the systems and networks and one needs to take extra measures to protect their data.

4. Edge Computing

Recently a new field emerged under the umbrella of computer science and is promised to flourish more in 2020. The edge computing is known as a variety of applications which are being applied in multiple industries. Its demand is increasing with each passing day as it offers everything needed in the industry with customized factors from the development level.

Computing, storing and networking will incorporate flexibility, which will help to handle current and future demands of artificial intelligence and allows faster responses.

5. Virtual Reality

Virtual Reality known as VR helps to enhance the user's experience and is vigorously used all over the world. All the tech giants are the prominent players of VR, which include Google, Samsung, Oculus, as well as emerging tech startups. All you need is basic programming skills and a forward-thinking approach to get started with this field.

All those creative people, this is your time to get in the innovations tech world.

What Is the Future of Tech: 23 Technologies by 2022

1. **Security Cross-Cutting Issues**
   The growth of large data repositories and emergence of data analytics have combined with intrusions by bad actors, governments, and corporations to open a Pandora's box of issues. How can we balance security and privacy in this environment?
2. **Open Intellectual Property Movement**
   From open source software and standards to open-access publishing, the open IP movement is upon us. What are the implications?
3. **Sustainability**
   Can electronic cars, LED lighting, new types of batteries and chips, and increasing use of renewables combat rising energy use and an explosion in the uptake of computing?
4. **Massively Online Open Courses**
   MOOCs have the potential to transform the higher-education landscape, siphoning students from traditional universities and altering faculty and student roles. How significant will their impact be?

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5. **Quantum Computing**
   Constrained only by the laws of physics, quantum computing will potential extend Moore's Law into the next decade. As commercial quantum

computing comes within reach, new breakthroughs are occurring at an accelerating pace.

6. **Device and Nanotechnology**
It is clear that MEMS devices, nanoparticles, and their use in applications are here to stay. Nanotechnology has already been useful in manufacturing sunscreen, tires, and medical devices that can be swallowed.

7. **3D Integrated Circuits**
The transition from printed circuit boards to 3D-ICs is already underway in the mobile arena, and will eventually spread across the entire spectrum of IT products.

8. **Universal Memory**
Universal memory replacements for DRAM will cause a tectonic shift in architectures and software.

9. **Multicore**
By 2022, multicore will be everywhere, from wearable systems and smartphones to cameras, games, automobiles, cloud servers, and exa-scale supercomputers.

10. **Photonics**
Silicon photonics will be a fundamental technology to address the bandwidth, latency, and energy challenges in the fabric of high-end systems.

11. **Networking and Interconnectivity**
Developments at all levels of the network stack will continue to drive research and the Internet economy.

12. **Software-Defined Networks**
OpenFlow and SDN will make networks more secure, transparent, flexible, and functional.

13. **High-Performance Computing**
While some governments are focused on reaching exascale, some researchers are intent on moving HPC to the cloud.

14. **Cloud Computing**
By 2022, cloud will be more entrenched and more computing workloads run on the cloud.

15. **The Internet of Things**
From clothes that monitor our movements to smart homes and cities, the Internet of Things knows no bounds, except for our concerns about ensuring privacy amid such convenience.

16. **Natural User Interfaces**
The long-held dreams of computers that can interface with us through touch, gesture, and speech are finally coming true, with more radical interfaces on the horizon.

17. **3D Printing**
3D printing promises a revolution in fabrication, with many opportunities to produce designs that would have been prohibitively expensive.

18. **Big Data and Analytics**
The growing availability of data and demand for its insights holds great potential to improve many data-driven decisions.

19. **Machine Learning and Intelligent Systems**
    Machine learning plays an increasingly important role in our lives, whether it's ranking search results, recommending products, or building better models of the environment.
20. **Computer Vision and Pattern Recognition**
    Unlocking information in pictures and videos has had a major impact on consumers and more significant advances are in the pipeline.
21. **Life Sciences**
    Technology has been pivotal in improving human and animal health and addressing threats to the environment.
22. **Computational Biology and Bioinformatics**
    Vast amounts of data are enabling the improvement of human health and unraveling of the mysteries of life.
23. **Medical Robotics**
    From autonomous delivery of hospital supplies to telemedicine and advanced prostheses, medical robotics has led to many life-saving innovations.

The top 12 technology trends predicted to reach adoption in 2020 are:

1. **Artificial Intelligence (AI) at the edge (AI@Edge).** The last decade has seen an explosion of machine learning (ML) in our daily interactions with the cloud. The availability of massive crowd-sourced labeled data, the increase in computer power efficiency at lower cost, and the advances of ML algorithms, lay the foundation of this disruption. As techniques improve and become robust enough to automate many activities, there is an increased demand for using ML in new ways that are more pervasive than the initial cloud use cases. Combined with ubiquitous connectivity such as 5G, and intelligent sensors such as the Internet of Things (IoT), ML applications will rapidly move to the "edge," the physical world close to us all. In the upcoming years, we expect to see the widespread deployment of ML in areas that will have a far greater impact on our daily lives, such as assisted driving, industrial automation, surveillance, and natural language processing.

2. **Non-volatile memory (NVM) products, interfaces and applications.** NVM Express (NVMe) SSDs will replace SATA and SAS SSDs within the next few years, and NVMe-oF will be the dominant network storage protocol in five years. NVMe enables NAND tiering technologies and programming functions that increase endurance, enable computational storage, and allow more memory-like access to data. Emerging memory technologies such as MRAM, ReRAM and PCM will provide future higher performance NVMe devices.

3. **Digital twins, including cognitive twins.** Digital twins are a reality in the manufacturing industry, and major IoT platforms, like Siemens MindSphere, are supporting them. They have also become a widespread tool in complex system operations; railways and power plants have been used in cities since Jan 1, 2019. The Singapore administration uses digital twins for planning, simulation and operations in Singapore. Cognitive digital twins are in the early stages of trial and experimentation.

4. **AI and critical systems.** (AI) will be deployed increasingly in more systems that affect the health, safety and welfare of the public. These systems will better utilize scarce resources, prevent disasters, and increase safety, reliability, comfort, and convenience. Despite the technological challenges and public fears, these systems will improve the quality of life for millions of people worldwide. Within five years, there will be a significant increase in the application of AI in critical infrastructure systems, or "critical systems", that directly affect the health, safety, and welfare of the public and in which failure could cause loss of life, serious injury, or significant loss of assets or privacy. Critical systems include power generation and distribution, telecommunications, road and rail transportation, healthcare, banking, and more.

5. **Practical delivery drones.** Parcel delivery is an industry of enormous economic impact, and yet has evolved relatively slowly over the decades. It can still be frustratingly slow, wasteful, labor-intensive, and expensive. These inefficiencies, combined with recent developments in drone technology, leave the field ripe for disruption. Several companies have recently worked to develop practical delivery drones, which may now be ready to completely transform this industry, and consequently society as a whole.

6. **Additive manufacturing.** 3D printing has existed since at least the early 1980's but has largely been confined to part prototyping and small-scale production of special-purpose or exotic pieces. Currently, new processes, materials, hardware, software, and workflows are bringing 3D printing into the realm of manufacturing, especially for mass customization. Unlike traditional manufacturing, additive manufacturing makes it economically viable to produce a high volume of parts where each one is different. For instance, companies like SmileDirect now use 3D printers to generate tens of thousands of molds each day, each customized to make an orthodontic

aligner for an individual person. Stronger and more robust materials, finer resolution, new finishing techniques, factory-level management software, and many other advances are increasing the adoption of 3D printing in industries such as healthcare, footwear, and automotive. In 2020, we expect to see this trend continue as other industries discover the benefits of mass customization and the opportunity to print parts that are not easy or affordable to produce using traditional means.

7. **Cognitive skills for robots.** Robots are spreading more and more from the manufacturing floors into spaces occupied by humans. There is a need for robots in such environments to be able to adapt to new tasks through capabilities such as increased comprehension of the environments within which they are situated. We predict that recent breakthroughs in large-scale simulations, deep reinforcement learning, and computer vision, collectively will bring forth a basic level of cognitive abilities to robots that will lead to significant improvements in robotic applications over the next few years.

8. **AI/ML applied to cybersecurity.** Cybersecurity is one of the key risks for any business today. The growing attack surface includes amateur threats, sophisticated distributed denial of service attacks, and skilled nation-state actors. Defense depends on security analysts who are rare, lack adequate training, and have high turnover rates. Artificial Intelligence and Machine Learning (AI/ML) can help detect threats and offer recommendations to security analysts. AI/ML can drive down response times from hundreds of hours to seconds and scale analyst effectiveness from one or two incidents to thousands daily. It can preserve corporate knowledge and use it to automate tasks and train new analysts. We predict advancing the adoption of AI/ML applied to cybersecurity through a partnership among members of industry, academia, and government on a global scale.

9. **Legal related implications to reflect security and privacy.** Data collection and leveraging capabilities are becoming more sophisticated and sensitive, often incorporating live feeds of information from sensors and various other technologies. These enhanced capabilities have yielded new streams of data and new types of content that raise policy and legal concerns over possible abuse: nefarious actors and governments may repurpose these capabilities for reasons of social control. Similarly, new technology capabilities also strain the abilities of average people to discern the difference between legitimate and fraudulent technology content, such as accepting an authentic video versus a "deep fake." As such, the next year will prove critical to maintaining the fragile balance between preserving

the social benefits of technology, on the one hand, and preventing undesirable repurposing of these new technology capabilities for social control and liberty deprivation, on the other. More aggressive legal and policy tools are needed for detecting fraud and preventing abuse of these enhanced technology capabilities.

10. **Adversarial Machine Learning (ML).** ML generally assumes that the environment is not maliciously manipulated during the training and evaluation of models. In other words, most ML models have inadequately considered the ways in which an adversary can attack and manipulate the model's functionality. Yet, security researchers have already demonstrated that adversarial, malicious inputs can trick machine learning models into desired outcomes, even without full information about a target model's parameters. As ML becomes incorporated into other systems, the frequency of malicious attacks on ML will rise. As such, security research into adversarial machine learning and countermeasures aimed at detecting manipulation of machine learning systems will become critically important. Similarly, recognition of the fallibility and manipulability of ML systems will begin to inform policymaking and legal paradigms.

11. **Reliability and safety challenges for intelligent systems.** Intelligent systems, capable of making autonomous decisions, are nowadays attracting an increasing economic investment worldwide. We expect that they will be increasingly adopted in several fields, including smart cities, autonomous vehicles, and autonomous robots. Depending on the application field, the autonomy of intelligent systems has been formalized by defined levels. Of course, the higher the level of intelligence and consequent autonomous capabilities, the stronger the requirements in terms of reliability and safety for the intelligent systems' operation in the field, where reliability is defined as the likelihood of correct operation for a given amount of time, while safety refers to the ability to avoid catastrophic consequences on the environment and users. Guaranteeing the required high levels of reliability and safety that are mandated for highly autonomous intelligent systems will be one of the major technological challenges to be faced by 2020, to enable a smarter world.

12. **Quantum Computing.** The quest for practical quantum computing will move forward in 2020, yet remain incomplete. At the beginning of 2020, experimental quantum computer demonstrations consume about 1/10,000 the energy of the world's largest supercomputers while outperforming them by 1,000x or more–yet the demonstrated applications look like quantum

computer self-tests. If quantum computers are destined to be successful, they will come about by increasing relevance and generality, having already demonstrated a computational advantage. We project demonstrations to become more compelling in the next year. For example, a quantum computer might perform a chemical simulation impossible by any standard supercomputer, leading to a more nuanced debate about whether the chemical that may be discovered will be useful to society.

The tech predictions analysis included a review of technologies that are considered very promising yet are not likely to reach broad adoption until after 2020. Such technologies include seamless assisted reality; virtual reality for business; distributed (cooperative) robotics; simulating whole world; autonomous vehicles; and printable bio-materials and tissue.

Technologies that were reviewed yet considered to have already reached broad adoption are photonic-based communication in data centers, facial recognition, 5G, multi-agent systems, security of IoT devices, disaggregated servers, and Blockchain.

The IEEE CS team of leading technology experts includes Mary Baker, HP Inc.; Tom Coughlin, Coughlin Associates; Erik DeBenedictis, entrepreneur; Paolo Faraboschi, Hewlett Packard Enterprise VP and Fellow; Eitan Frachtenberg, data scientist; Danny Lange, VP of AI at Unity; Phil Laplante, professor, Penn State; Andrea Matwyshyn, Professor and Assoc. Dean of Innovation, Penn State Law – University Park, and professor, Penn State Engineering; Avi Mendelson, professor, Technion and NTU Singapore; Cecilia Metra, professor, Bologna University and IEEE CS President; Dejan Milojicic, Hewlett Packard Enterprise Distinguished Technologist and IEEE Computer Society president 2014; Roberto Saracco, Chair of the Symbiotic Autonomous Systems Initiative of IEEE-FDC; and Jeffrey Voas, NIST. **The technical contributors for this document are available for interviews.**

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At the end of 2020, the IEEE CS tech experts will review the past predictions to determine how closely they match up to technology's reality. [Check back in December 2020](#) as IEEE CS grades its latest predictions. For past technology forecasts visit the [2019 technology predictions](#), and view the [2019 prediction scorecard](#) for evaluations and grades of our predictions.

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