

# Career Pathways





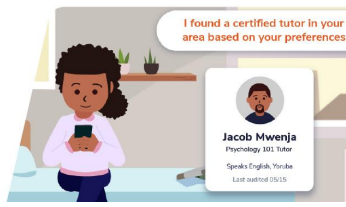
# Career Pathways

Since 1990, employment in STEM occupations has grown 79%, increasing from 9.7 million to 17.3 million. *Pew Research Center*

By the end of 2018, 2.4 million STEM jobs went unfilled.

Out of 100 STEM occupations, 93% of them had wages above the national average. The national average for STEM job annual salaries is \$87,570, where the national average for non-STEM occupations sits at roughly half - \$45,700. *Bureau of Labor Statistics*

The global pandemic created by COVID-19 has intensified the need for STEM. The purpose of this report is to illuminate the connection between Career Pathways, the war against the pandemic and the need for our teachers and students to be able to move seamlessly between concrete and virtual learning experiences for policy makers, educators, and youth service providers



## ENGINEERING

The U.S. has approximately 1.6 million engineering jobs. The engineering field makes up two-thirds of the American engineering workforce. These jobs will continue to grow as technology changes.

## STEM

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# Engineering Design Process

The evolution of 3-D printing is helping power the world of manufacturing, creating new jobs, and increasing innovation across the globe. It promotes sustainability, efficiency and innovation. 3-D printing allows for rapid prototyping, and speed is essential to fill the supply void. Governments around the world have issued various levels of 'stay at home' orders to slow the spread of the disease, and that interrupts supply chains as factories shut down, warehouses close, and freight drivers stay home. Just like all manufactured goods, medical supplies and equipment only get to where they're needed with functional supply chains. There's currently an increased demand for specific medical products and manufacturers are making less of them while an even smaller percentage are being delivered. To compound matters, hospitals keep inventories based on historical need so many hospitals depleted their supplies of masks and ventilators only days into the pandemic.

Three federal agencies have teamed up to collectively leverage and accelerate 3D printing and other advanced manufacturing technologies in the fight against COVID-19. The Food and Drug Administration, Veterans Affairs Department and National Institutes of Health recently signed a Memorandum of Understanding to formalize a unified effort through which they solicit designs for, produce and test 3D-printed personal protective equipment and other medical supplies to support America's response to the worldwide health emergency.

In collaboration with UC Davis School of Medicine, development engineer Steven Lucero who leads the Department of Biomedical Engineering's TEAM lab, is creating 3D printed alternatives to N95 masks. In a similar effort to help address the nationwide shortage of ventilators, the college's Engineering Student Design Centre is using their 3D printers to print ventilator parts.

On March 16th, a public spreadsheet called 3D Printer Crowdsourcing for COVID-19 was created for 3D printing professionals and hobbyists alike to volunteer their time and resources to print masks, valves, or whatever else hospitals are running short

on. Two days later, there were more than 4,800 volunteers on the list from all over the world. Decentralized manufacturing empowered by 3D printing enables this large community to produce thousands of components using the same files, all while maintaining social distancing protocols to minimize the spread of the disease.

The Montreal General Hospital Foundation, in collaboration with the Research Institute of the McGill University Health Centre (MUHC), launched a global innovation challenge, backed by a \$200,000 CAD prize, calling for teams to design a simple, low-cost, easy-to-manufacture and easy-to-maintain ventilator which could be deployed anywhere needed to save lives.



## MOBILE DEV

Mobile devices have become ubiquitous. Two-thirds of the world's population are connected to a mobile device. That's more than 5 billion unique mobile subscribers. The mobile application industry is booming, with total revenues from mobile apps projected to reach \$99 billion by 2019.



# Mobile Development

The spread of COVID-19 has already had a significant impact on the mobile app industry and that will continue in the years to come. According to a revised 2020-2024 market forecast from app intelligence firm Sensor Tower, a sizable increase in app downloads for industries like remote work and education will lead to a large surge in app installs for the early part of 2020 and beyond, despite other decreases in downloads for ride-sharing and fast food apps.

Mobile app spending worldwide is expected to double by 2024.

A new study conducted by researchers at the University of Oxford shows that the spread of the COVID-19 is too fast to be contained by manual contact-tracing alone, and thus, recommends countries to explore the digital route to speed up their preventive actions.

China deployed an app for people to test if they had been in 'close contact' with people exposed to the fast-spreading coronavirus. The app assigned a color code to users. The system, powered by Alibaba's popular payment app Alipay, is in use in more than 200 cities. People can scan a QR code to get a green, yellow, or red tag. The green tag means you are healthy and can roam around the city unrestricted, yellow means a seven-day quarantine, and red means a 14-day quarantine.

Inspired by the way China and South Korea used smartphones to slow the spread of Covid-19, some US technologists have begun working on tracking apps. An open source project called CoEpi sprang up in February to develop an app. Ramesh Raskar, a professor at the MIT Media Lab, and colleagues are developing an app that would let people log their movements and compare them with those of known coronavirus patients, using redacted data supplied by the state or national public health departments. Over time, users would be asked whether they are infected, providing a way to identify potential transmissions.

With over 10,000 deaths already reported in the COVID-19 pandemic, a mobile app is being rolled out in Singapore, one of Asia's most tech-savvy nations, that will enable the government to identify possible cases more effectively and help curb the spread of the virus.

Johns Hopkins Whiting School of engineering is tracking the COVID-19 spread in real time on a mobile interactive dashboard and modeling the spread of the virus. <https://coronavirus.jhu.edu/map.htm>



## Drone



### DRONE

The Association for Unmanned Vehicle Systems International, projected more than 100,000 new jobs in unmanned aircraft by 2025.

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Drones are being deployed in record numbers to help fight the spread of COVID-19. Agricultural models have been modified to spray disinfectant on public areas, and drones have also transported medical and quarantine supplies to reduce people's exposure to each other and reduce delivery time.

Draganfly is deploying "pandemic drones" to remotely monitor and detect people with infectious and respiratory conditions to help stop the spread of the disease. The Dragonfly drones are fitted with a specialized sensor and computer vision system that can monitor temperature, heart and respiratory rates, as well as detect people sneezing and coughing in crowds and other places where groups of people may work or congregate.

Limiting exposure and remaining in our homes has put strain on package and food delivery systems, which are themselves a potential vector of contamination. While drone package deliveries aren't at full scale yet – with only a few prior global tests such as in the US and the Dominican Republic – they have proven to be an efficient and contactless way to hand off critical medical supplies. Most drones can be easily modified with a payload drop mechanism to deliver packages up to 6 KGs, without risk to both parties.

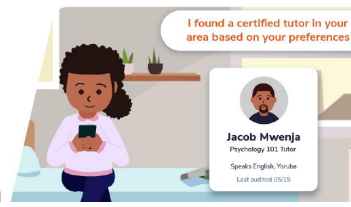
This is particularly important in areas where the presence of the virus is confirmed, such as hospitals actively treating the virus.

In China, most apartment complexes and other buildings implemented a simple temperature check process before admitting visitors into the building. But there is one risk point – the personnel conducting the temperature checks. As they traditionally measure each person with a handheld infrared thermometer, they may come into close contact with the virus and become a spreader themselves. To limit the risk, some teams are using drones equipped with infrared cameras to test temperature measurements. While these drones

are commonly used for public safety operations or inspections, with proper calibration, these drones can instead help measure body temperature. By installing a cotton swab within the field of view of the thermal camera, the camera can get an accurate reading. The calibrated drone camera can then be used to measure body temperatures while the officer remains at a safe distance away.

Drones have been deployed over heavily populated areas in France to urge people to comply with containment measures. The speakers can be heard blaring messages like: "Travel is prohibited unless there are exceptional circumstances." or "Please respect the safety distances."





## ARTIFICIAL INTELLIGENCE

Jobs in the artificial intelligence industry are expected to increase by 2.3 million positions by the year 2030, and according to a report produced by Capgemini's Digital Transformation Institute, 83% of companies that use AI technologies confirm that AI is already contributing to the creation of new jobs.

An Artificial intelligence engineer earns an average of \$171,715.

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## Artificial Intelligence

The rapid spread of COVID-19 around the world has given way to an urgent need to identify which cases will escalate to critical illness. While over 80 percent of cases seem to be mild, those who develop more severe symptoms often need oxygen and prolonged ventilation.

Researchers collected laboratory, demographic, and radiological findings from 53 patients who tested positive for COVID-19 at two Chinese hospitals, with an average age of 43 years. The team then used the data to train AI models designed to get smarter with the more data they consider. "Our goal was to design and deploy a decision-support tool using AI capabilities—mostly predictive analytics—to flag future clinical coronavirus severity," said co-author Anasse Bari, PhD, a clinical assistant professor in computer science at NYU Courant Institute of Mathematical Science.

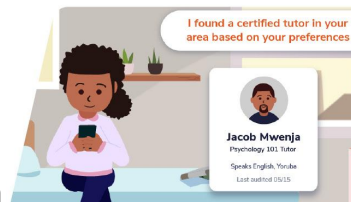
Canada-based Stallion.AI has leveraged its natural language processing capabilities to build a multilingual virtual healthcare agent that can answer questions related to COVID-19, provide reliable information and clear guidelines, recommend protection measures, check and monitor symptoms, and advise individuals whether they need hospital screening or self-isolation at their homes.

Thermal cameras have been used for some time now for detecting people with fever. The drawback to the technology is the need for a human operator. Now, however, cameras possessing AI-based multisensory technology have been deployed in airports, hospitals, nursing homes, etc. The technology automatically detects individuals with fever and tracks their movements, recognizes their faces, and detects whether the person is wearing a face mask.

Part of what has troubled the scientific community is the absence of a definitive cure for the virus. AI can potentially be a game changer as companies such as the British startup, Exscientia, has shown. Earlier this year, they became the first

company to present an AI designed drug molecule that has gone to human trials. A year is all it took the algorithm to develop the molecular structure compared with the five-year average time that it takes traditional research methods.

While the world continues to grapple with the effects of COVID-19, positives can be drawn from the expertise and bravery of healthcare workers, as well as the complementary efforts of AI technology to their endeavors in the above listed ways. As the AI world partners with other sectors for solutions, the light at the end of this tunnel shines brighter, creating the much-needed hope the world needs in these uncertain times.



## CYBER SECURITY

According to the Bureau of Labor Statistics, information security jobs are projected to grow by 37% from 2012 to 2022 — the fastest rate of growth among all occupations. This increase in information security positions will make already high-demand computer science roles even more sought after and critical to our economy.

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# Cybersecurity

As the crisis around COVID-10 continues to expand, organizations are being forced to adapt to rapidly evolving security requirements. These include transitioning employees to remote workers and remaining vigilant against adversaries seeking to take advantage of the crisis.

A prominent effort to re-assess cybersecurity in the United States, The Cyberspace Solarium Commission issued its report on March 10, just as the COVID-19 pandemic exploded beyond China. The commission concluded that —despite twenty years of policy concerns and action—public and private-sector cybersecurity in the United States remains inadequate.

The global scramble and competition to develop treatments and a vaccine for COVID-19 make the public and non-governmental actors involved in such research targets for cyber espionage by governments that want access to the cutting-edge of this crucial pharmaceutical endeavor.

US Dept. of Homeland Security's CISA division has taken a number of steps over the last several weeks to increase cybersecurity preparedness across federal civilian agencies, including enhanced monitoring, issuing recommendations as agencies shift to telework, and identifying and protecting particularly important systems supporting COVID-19 response efforts.

### RDP AND VPN USE SKYROCKETED SINCE CORONAVIRUS ONSET

RDP use is up by 41%, enterprise VPN use is up by 33%. The need to work from home presents increased vulnerabilities. The following are cybersecurity considerations regarding telework. As organizations use VPNs for telework, more vulnerabilities are being found and targeted by malicious cyber actors. As VPNs are 24/7, organizations are less likely to keep them updated with the latest security updates and patches. Malicious cyber actors have increased phishing emails targeting teleworkers to steal their usernames and passwords.

Organizations that do not use multi-factor authentication (MFA) for remote access are more susceptible to phishing attacks.

The Brno University Hospital in the city of Brno, Czech Republic, has been hit by a cyberattack right in the middle of the COVID-19 outbreak. The incident was deemed severe enough to postpone urgent surgical interventions, and re-route new acute patients to nearby St. Anne's University Hospital. The hospital was forced to shut down its entire IT network during the incident, and two of the hospital's other branches, the Children's Hospital and the Maternity Hospital, were also impacted.



## DATA SCIENCE

Stated by the United States of Labor Statistics, the employment of all computer and information research scientists is expected to rise 19 percent by the year 2026, which is deemed much faster than the average for all professions. About 5,400 new jobs are projected over the decade.

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# Data Science

Analyzing and modeling data is a crucial tool in the fight against COVID-19. Only on the basis of clearly presented and well-documented data can governments, organizations and individuals respond effectively to the COVID-19 pandemic.

Government responses are based upon data sets, models showing correlation between the number of confirmed deaths, the length of time it took for that number to double, the relevance to the size of the population, and testing numbers and results.

Epidemiologists model infectious diseases in compartment models; for example, the SEIR model where people transition from susceptible (S) to exposed (E) to infected (I) to removed (R), with  $S+E+I+R = N$ , where  $R$  can be recovered or died, and  $N$  is the total population size. The reproduction number ( $R_0$ ) is the average number of people infected from a person with an infection. This is a crucial parameter in describing an epidemic. If the effective reproduction number  $R_e = R_0 \cdot (S/N)$  is bigger than 1, the disease spreads. Conversely if the time-varying reproduction number  $R_t$  can be reduced over time, the disease can be contained.

To aid researchers, data scientists, and analysts in the effort to combat COVID-19, a hosted repository of public datasets, like Johns Hopkins Center for Systems Science and Engineering (JHU CSSE), the Global Health Data from the World Bank, and OpenStreetMap data, has been created through the COVID-19 Public Dataset Program. Researchers can also use BigQuery ML to train advanced machine learning models with this data.

“Making COVID-19 data open and available in BigQuery is a boon to researchers and analysis in the field,” said Sam Skillman, Head of Engineering at Descartes Labs. “The ability to quickly share results and analysis with colleagues and the public will accelerate our shared understanding of how the virus is spreading.”

“Developing data-driven models for the spread of this infectious disease is critical,” said Matteo Chinazzi, Associate Research Scientist, Northeastern University. “Our team is working intensively to model and better understand the spread of the COVID-19 outbreak. By making COVID-19 data open and available in BigQuery, researchers and public health officials can better understand, study, and analyze the impact of this disease.”





## ROBOTICS

Robotic engineers plan, build, and maintain robots. These engineers plan how robots will use sensors for detecting things based on light or smell, and they design how these sensors will fit into the designs of the robots.

**Demand for Robotics Engineers is expected to go up, with an expected 55,790 new jobs. This represents an annual increase of 5.00 percent over the next few years. The median salary for Robotic engineers is \$102,700 annually.**

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## Robotics

Medtech companies are rolling out robots and drones to help provide services and care to those quarantined or practicing social distancing. This pandemic has fast-tracked the "testing" of robots in public as officials seek out the most expedient and safe way to grapple with the outbreak and limit contamination and spread of the virus.

Danish company UVD Robots shipped robots to Chinese hospitals to disinfect rooms, and when fully deployed, the robots will operate in all Chinese provinces. These robots emit an ultraviolet light throughout an area to kill viruses and bacteria without exposing any human personnel to infection.

These bots are remotely controlled by a health worker who remains a safe distance away. Since there are thousands of deaths each year attributed to hospital-acquired infections, automation to prevent disease is a great opportunity for robots.

The disruption to the world's supply chain will continue to ripple through the global economy even as COVID-19 cases decrease in China. A survey by the American Chamber of Commerce Shanghai found nearly half of the 109 companies polled said that their biggest challenge in the coming weeks was to have enough staff to run the full production lines in factories. This reality will make ramping up robotic automation even more appealing to reduce costs, ensure continuity and productivity even if the country experiences another global pandemic or other shutdowns.

Since robots are immune to infection, tech companies such as JD.com and others have stepped up to the challenge to get more robots out in force to deliver e.g. medical supplies within healthcare environments. Robots are also proving to be valuable when delivering essential items to people who shop and purchase online and are quarantined at home. Meituan Dianping, a delivery app, ramped up their

"contactless delivery" options through autonomous vehicles and robots. Shenzhen-based startup Pudu Technology aimed to reduce cross-infection by implementing home delivery of drugs and meals via robot.



The Virtual/Augmented reality market is growing at a remarkable rate. As it does, more companies and businesses will consider entering the market. That, in turn, will put an even greater demand on the development community as software engineers and VR developers become necessary to bring these experiences to life.

The VR/AR industry revenue is expected to jump from 3.7 billion U.S. dollars in 2016 to over 40 billion U.S. dollars by 2020.



## Augmented/Virtual Reality

“Know your enemy” is the essence of one of the most famous quotes from [Sun Tzu]’s Art of War, and it’s as true now as it was 2,500 years ago. It also applies far beyond the martial arts, and as the world squares off for battle against COVID-19, it’s especially important to know the enemy. Augmented and Virtual Reality Technologies are searching for fatal flaws in the virus that can be used to defeat it.

Companies are trying to figure out the best collaboration tools. Employees are teaming up via video-conferencing platforms such as Zoom, and chatting on Slack, Teams, and other instant-messaging apps. But there’s another, potentially untapped way for people to work together: virtual reality (VR) and augmented reality (AR).

Microsoft’s AR based HoloLens is a way for everyone from surgeons to industrial workers to collaborate over long distances.

George Washington Hospital is using virtual reality technology to assess patients. co-developed by GWU thoracic surgical chief Keith Mortman and Surgical Theater— a well-known developer of VR imagining software — VR video can take the treatment team inside a coronavirus-damaged lung.

At the University of California San Francisco, researchers are using a depth- sensing camera and a VR headset to manipulate 3D models of the SARS virus to determine exactly how SARS binds to its receptor, angiotensin- converting enzyme-2 (ACE-2), a protein expressed on the cell surfaces of many different tissue types. They have discovered how the binding domain of the spike reaches out to latch onto ACE-2 to begin the process of invading a cell; as well as how the immune system responds to and blocks that binding.

VR provides a distraction when travel is ill-advised. Everest VR, an hour- long recreation of an Everest climb – from incense ceremonies and kit run-throughs at Base Camp to crossing deep crevasses – is just one of the experiences available with VR headsets from brands such as Vive and Oculus. Google’s Expeditions app includes VR tours of the International Space Station and the National Museum of Iraq using Cardboard Headsets. “Even viewing nature digitally has been scientifically proven to help peoples’ mental wellbeing, which feels especially important right now,” said Lee Bacon, head of digital at the BBC’s Natural History Unit.