AI and the Future of Work in Stockton

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Executive Summary

Artificial intelligence (AI) technologies are changing the way that we live, work, and interact with one another and with the world. Technological advances in this field have led to concerns that AI programs may replace the need for people in some parts of the economy and cause substantial job losses. There is no shortage of studies on how AI is shaping the future of work. Many national governments have started investing heavily in artificial intelligence while crafting national strategies to respond to the economic and social challenges that AI presents. Few studies, however, have examined what technological disruption from AI looks like on a regional or municipal level.

Some cities will be disproportionately affected by AI-driven automation. Stockton, California is one of them. Compared with other cities, Stockton has lower average skills levels and a high proportion of its population working in sectors that will be hard hit by technological change. As the city is the level of government that most citizens are closest to, and a natural first port of call when people are affected by AI-driven automation, city governments such as Stockton need to prepare now for the disruptions ahead.

It is against this backdrop that Oxford Insights was engaged by the Mayor's Office in Stockton to look into the ways that the city's workforce will be affected by AI, and to help the city craft a forward-looking AI and Future of Work strategy. Since May 2018, we have conducted interviews with representatives from city and county government, from big and small businesses, startups, coding schools, investors, incubators, universities, workforce programs, and the health and education sectors. We asked about Stockton's future: the risks it is facing but, more particularly, opportunities for the city and its citizens. We have combined our findings with desk research, data analysis, and insights carried across from other areas of our work internationally. The plans that will result is the first city-level strategy of its kind in the world.

There is a lot that a city government like Stockton can do to cater for the particular needs of its community. A city-level AI and Future is Work Strategy enables Stockton to make a clear statement about its approach to AI, and its plan to manage its impacts. We recommend that Stockton focuses on three areas in particular:

- educating the population about AI and its likely impacts;

- preparing the workforce for future jobs;

- and encouraging opportunities for businesses and civil society to explore the benefits of AI in Stockton.

Predicting the sectors and locations in which jobs will be most affected gives the city powerful information to target programs. We estimate that construction, transportation, and manufacturing will see the largest numbers of Stocktonian jobs affected by automation. Major initiatives focused on creating a city that is more resilient to change, such as current efforts to bring a California State Campus to Stockton, the Universal Basic Income trial, or the current work on transformative climate communities all will be crucial in building up Stockton's ability to prepare its workforce for technological disruption. Working from the foundations set forth in Stockton's Workforce Development Action Plan, this report further emphasizes how important it is for the city to help its citizens transition into a new and changing economy.

The Stockton City Government should see AI technologies as part of its ambitious plans to "Reinvent Stockton". This might include supporting businesses to invest in AI, especially those that do so in a way that promotes economic development; encouraging schools and universities to prepare their students for the job markets of the future; and match-making new partnerships, such as encouraging universities and startups to find new solutions to city challenges, or hosting pilots for technologies such as autonomous vehicles.

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2019 is a critical time for Stockton in developing its approach to artificial intelligence. It has committed leadership across government, private sector, and civil society. Its Congressman and its state Governor have both stated a strong interest in preparing citizens for artificial intelligence, giving Stockton the ability to set an agenda. And with its trial of Universal Basic Income taking place in 2019, there is enormous interest both locally and nationally in how government policy can help to prepare citizens for the future of work.

Key Findings:

1. Our research estimates that:

   - Over the long term (15 years and beyond), roughly **62 percent** of Stockton's jobs could be affected by automation, or a projected **80,370** out of **130,673** jobs.

   - Jobs will also be substantially affected in the medium term (5-15 years), with an estimated impact on **54 percent of all Stockton's jobs**, or a projected **70,688 jobs**.

   - The effect of automation in the next five years will be smaller, but **17,039** jobs, or **13 percent** of the total, are vulnerable to being impacted by automation.

2. In terms of its resilience to technological disruption, Stockton ranks as the 3rd lowest among 10 Californian cities of a similar size due primarily to a relatively low-skilled workforce and the relatively high poverty rate.

3. Due to Stockton's unique set of strengths, the report identifies areas of opportunity where the adoption of AI technologies could create benefits to the city and its citizens. These include the agricultural and healthcare sectors, and the use of AI in government and public services.

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Summary of Recommendations

1. **State a clear and forward-looking vision for the role that AI will play in Stockton's future,** especially how it will affect jobs. This should be led by the Mayor and city leaders.

   a. The vision should be positive, focusing on how Stockton can take advantage of its strengths while also preparing for disruptions as AI technologies are adopted by Stockton's major employers.

      i. Strengths to emphasize include Stockton's geographic proximity to Silicon Valley and Sacramento; its transport networks; its young workforce whose relatively lower skills level offers capacity for growth; its diverse community; and above all, its appetite across the city for transforming Stockton.

   b. Stockton's initiatives to prepare for AI should be positioned alongside:

      i. its overarching agenda to Reinvent Stockton

      ii. its trial of universal basic income (UBI), in order to help explain the role UBI might play in helping Stocktonians to prepare for and manage changes in the way they work;

      iii. Stockton's push towards green jobs for the green economy;

      iv. The Workforce Development Action Plan, including its focus on upskilling and keeping local talent in Stockton.

   c. Leaders should encourage citizens of Stockton to learn about AI and to think about how it might affect their work in particular.

2. **Convene a Stockton AI Council,** to which the City should report regularly on Stockton's AI and Future of Work strategy and ongoing initiatives.

   a. The Council might include representatives from the city and county governments, the school system, higher education bodies, workforce support organizations, major relevant city projects e.g. UBI, big technology companies with either substantial employees or office space in Stockton, and local startups.

   b. Its membership should be varied, but limited in number (we recommend no more than 15 members to ensure conversation is not too unwieldy).

   c. The Committee could be co-chaired by representatives from the University of the Pacific, San Joaquin Delta College and from Stockton's business community to ensure continuity.

   d. The body should help to define its own remit, which should include prioritizing frontier areas for AI exploration, as well as assisting with the direction-setting and implementation of Stockton's AI and workforce strategies.

   e. Once established, the Council may wish to explore the ethics side of AI as it pertains to data and workforce development initiatives that are undertaken.

3. **Engage purposefully with education providers at all levels to prepare Stockton's citizens for the future of work.** This might include:

   a. Leveraging past pilot projects at SUSD that utilize AI tools to improve fundamental educational challenges, like 3rd grade literacy. This includes the ability to personalize student instruction by:

      i. Selecting the best techniques to engage each child

      ii. Calibrating speech patterns and learning styles for different subgroups

      iii. Improving error detection and forecasting across all students

   b. Encouraging a local community college, like San Joaquin Delta College, to develop an "AI essentials toolkit" to educate faculty and students on being prepared to weather transition and change in the workforce (and potentially to share the toolkit with other institutions).

   c. Promoting existing initiatives to teach science, technology, engineering and mathematics (STEM) subjects at the County level, while also ensuring schools encourage students to develop "human specialties" (skills that will not easily be replaced by machines) such as creative thinking, lateral problem-solving, empathy and social skills.

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i. Supporting the County's Code Stack Academy initiative and other similar programs with publicity as well as logistical and strategic support.

d. Supporting hands-on citizen science programs at the K-12 levels that encourage students to focus on likely areas of future jobs growth such as healthcare, design, computer engineering and management.

e. Exploring partnership opportunities with companies and organisations that provide alternative ways of training that are relevant to the future workforce. Examples include:

i. School 42

ii. Lamda School

f. Encouraging students to gain work skills during internship placements or employment with local industries that are implementing AI in their sectors.

i. Raising the profile of the Valley Robotics Academy, a joint collaboration between San Joaquin Delta College and Lodi Unified School District - as a good example of an innovative career technical education initiative.

g. Creating a collective district-wide campaign about AI and its likely impact on the workforce, promoted by the school districts and local colleges as well as by the Mayor and other city leaders, to help citizens think how they might manage likely changes to their own work.

4. **Ensure Stockton's workforce training and reskilling programs are easy to access and fit for purpose.** This includes:

a. Exploring how the City, potentially in collaboration with a university or other partner, can use existing data to help identify those whose job security is most at risk due to technological change - this could include targeting by sector, employer or individual.

b. Working with the Mayor's Skills Taskforce to integrate existing workforce programmes

wherever possible, including by

i. supporting the secure exchange of knowledge and data, and

ii. providing whatever assistance will help move participants more smoothly between programs and support options where needed, and exploring technological options that will help track individuals as they move through the system.

c. Where possible, promote collaborations to help fund support structures for those in most urgent need of training or retraining programmes; these might include child care, subsidised uniforms, or transportation.

5. **Attract and support talent & companies investing in AI,** especially those that can demonstrate their commitment to local economic development.

a. Declare Stockton's intention to become a hub for AI research and development and its desire to work with companies willing to provide jobs locally.

i. align Opportunity Zone tax incentive with AI-focused companies or an Opportunity Fund - exploring opportunities to invest in the city

ii. identify a way to "fast-track" or incentivize emerging technical talent to stay in the Stockton area after graduating

b. Provide information and logistical support to startups unfamiliar with the city so that they can more easily navigate the business environment[1].

c. Provide incentives such as subsidised office space or publicity to companies that demonstrate their commitment to supporting city economic development goals (such as giving to local causes or employing those from disadvantaged groups).

1. See for example the Reno Startup Deck: http://renostartupdeck.com
2. Such as Nautilus Data Technologies

d. Prioritise support for those companies that are training Stocktonians and/or those that may employ smaller numbers but have a high economic impact[2].

e. Publish a scorecard on the City Government's website that ranks business operating locally on their contribution to Stockton's development, social inclusion, the green economy, and other city priorities such as green jobs. This could could be overseen by the Stockton AI Council in Recommendation 2 above.

f. Encourage companies to use Stockton as a location for high-potential AI pilot projects, including public-private partnerships where appropriate, for example in the development of autonomous vehicles.

g. Explore creating safe and secure ways that companies can use the city's data to train algorithms and AI programs, for example via a data sandbox.

h. For startups in particular:

   i. use the city's media resources and access to promote stories of successful local startups using AI tools (e.g. the winners of the competition in rec 7(a) below)

   ii. invite existing successful incubator programmes or coding schools in order to establish more Stockton-based startup incubators (e.g. Stockton's Entrepreneur Lab).

6. **Assess what data the City has (or could easily obtain) that might be useful for new AI programmes or tools.**

a. Where this data does not contain personal information, consider sharing the data under an open license to help support research and development.

b. Explore data-sharing partnerships within the Mayor's Skills Taskforce

   i. Identify organizations who may benefit from understanding their data in new ways (such as WorkNet) with organizations who may have an appetite to uncover insights from that data (for example the University of the Pacific)

7. **Encourage and convene new partnerships** to support sustainable growth in Stockton's AI sector, including between startups, educational institutions and providers of workforce support programs. This

may include:

a. Hosting a regular competition among regional startups to help the city find AI-driven solutions to local challenges such as public safety, transportation, provision of low-cost housing, or citizen engagement in local government. The competition might include:

   i. sharing city data with startups, and

   ii. prioritising those solutions that could be scaled to other cities and regions to help local startups grow.

b. Matching universities such as the University of the Pacific with local startups to help graduates find local employment and to ensure skills training meets demand

   i. Partnering with the Entrepreneurship Network at the University of the Pacific and outside accelerators like YCombinator

8. **Use the city's AI and Future of Work strategy to enable opportunities to work more closely with other levels of government and promote Stockton's interests,** for example:

a. The County Government on schools policy and the new Code Stack Academy

b. The California State Government given Governor Newsom's priority concern of AI ethics and job impacts

c. US Congress, with Stockton's representative Congressman McNerney co-chairing the Congressional AI Caucus.

9. **Maintain a position in City Hall for someone focused on future workforce,** who should help to coordinate overlapping work including the Workforce Development Action Plan, the Mayor's Skills Taskforce, the Universal Basic Income trial, and the AI and Future of Work strategy.

What is AI, and why it matters

What do we mean by artificial intelligence?

Artificial intelligence (AI) refers to machines that can simulate the processes of natural intelligence displayed by people - in other words, computers being able to perform tasks that were previously thought to require human intelligence. These processes include machines performing otherwise human tasks like seeing, hearing, reading, learning, reasoning, or self-correction[3].

Developments in AI are already affecting the economy and workforce as organisations introduce new ways of doing things, including changing the tasks performed by their staff when they make, sell, and distribute goods and services. AI technologies are developing quickly, and so are their applications. These changes will mean opportunities for more interesting jobs, cheaper services, and more tailored products, but they also present threats to existing jobs and systems.

Developments in AI fall into two main categories: artificial general intelligence and artificial narrow intelligence. Artificial general intelligence describes a machine that can think and act the way a human does, including reasoning and interacting socially, such as the robots sometimes depicted in science fiction movies like Terminator or Blade Runner. Though many researchers around the world are working on creating a system like this, nothing close to this exists yet, and most researchers agree that it is at least several decades away.

Artificial narrow intelligence, on the other hand, is already being used. These are systems that are designed to perform specific tasks, such as playing chess or categorising an image for a search engine. Systems like these use advanced techniques in data analytics and statistics. In particular, **machine learning** is a field of AI that involves building algorithms[4] which are designed to progressively improve their own performance on a specific task by making predictions and decisions about data, and being corrected (or correcting themselves). Machine learning is based on the understanding that it is more efficient to teach an AI system to "think and learn" than to design it to perform every possible variation on a task. This key insight has been combined with an explosion in the availability of data, and a rapid increase in computer power and storage, enabling machine learning to address complex problems in situations where programming specific algorithms may be difficult.

Sometimes, several different machine learning programs can be used together to create a more complex tool. A chatbot, for example, combines natural language processing with machine learning. It simulates human conversation through voice commands, text chats, or both, and may also learn from the conversations it has had in the past. For customer service, a chatbot can be faster and cheaper than humans, give more consistent answers, and operate for much longer without getting tired.

Machine learning tools can also be combined with developments in robotics to create useful machines that can perform physical tasks and can get better at them with time. In automated warehouses, for example, robots equipped with machine learning technology may devise new and faster ways to move goods in response to demand.

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3. For the purposes of this report, "learning" refers to progressively improving performance on a specific task, without being explicitly programed whereas "reasoning" refers to the ability to make inferences.
4. In this report, an algorithm refers to a process or set of rules to be followed by a computer in making calculations or other problem-solving operations.

Much of the public fear and media hype about artificial intelligence is about artificial general intelligence. This report focuses instead on more urgent workforce changes taking place due to the development and rapid advances in artificial narrow intelligence[5]. We examine how applications of artificial narrow intelligence may affect job opportunities and economic development in the city of Stockton. In particular, we focus on how artificial narrow intelligence is affecting job loss, wealth inequality, and inclusion.

Developments in machine learning mean that applications of AI are not just confined to jobs that require single repetitive tasks. While this is something that AI is very good at, machine learning has also made possible new applications, and by extension, risks to the workforce – through being able to adapt to different situations, interact with a growing number of variables, and analyze data at quantities and speeds beyond the capability of humans. If handled correctly, these new technologies present important opportunities for the economy and workforce. Without adequate policies and preparation, these technologies put many jobs at risk.

What AI means for governments

Governments are increasingly aware of the transformational impact of AI on their economies and societies. Many also recognise that capitalizing on the opportunities of AI will require forward-thinking policies and frameworks, and in many cases substantial public sector investment.

China is investing at least $7 billion in AI by 2030; the European Union (EU) is expecting to invest over $20 billion by 2020; and Canada is investing $125 million through 2022. These investments have been announced alongside national-level strategies, in which governments including France, China, and the United Kingdom have created policy goals for how their country will maximize the benefits of AI and mitigate against some of its harmful impacts. These strategies broadly share five key themes:

- ethics;
- using AI in government and public services;
- research and development;
- capacity, skills and education; and
- data and digital infrastructure.

The Obama administration put forth two broad strategy documents on artificial intelligence. These were followed in 2019 by an executive order under the Trump administration on maintaining American leadership in artificial intelligence. Both the strategy documents and the executive order include broad thinking on R&D, AI infrastructure, AI governance, the US workforce, and international engagement at the federal level.

"In the American system, at least with federalism, cities are where the rubber meets the road. It is going to be cities that have to deal with what happens when workers no longer have access to the jobs they once had… people aren't going to go to Washington, the federal government and ask what is happening… they are going to go to the [city government]"

- Michael D. Tubbs, Mayor of Stockton, California

Amid the discussion about national governments creating strategies to prepare their countries for artificial intelligence, we think it is vital that city governments take time to develop a clear view on how AI is likely to impact their citizens, and how the city can help. Ultimately, the effects of AI, both negative and positive, are going to be experienced differently at the local level compared with their effects in aggregate at the national level. Globally, for example, many expect that AI will create more jobs than it replaces. But findings like this will vary markedly between cities: a city like Stockton, where a large portion of economic activity takes place in sectors that are highly susceptible to automation, is likely to be disproportionately affected by automation. A recent report from the Institute for Spatial Economic Analysis illustrates this point. The study found that some cities in the United States, such as Las Vegas and El Paso, risk job losses of over 63 percent by 2025. Another report by The Centre for Cities in the United Kingdom similarly found that places like Mansfield and

Sunderland in the north of England are at risk of losing nearly 30 percent of jobs to automation. Concerning Stockton in particular, the Brookings Institution recently published a report that ranked Stockton as the 4th most vulnerable city in the US to disruption caused by artificial intelligence.

Against this backdrop, we were invited by the Mayor of Stockton and his team to carry out a forward-looking study to assess how AI would affect Stocktonians and what can be done now to both harness the technology's benefits while preparing for the threats it presents. Acting now on AI will help to prepare Stockton's workforce and welfare systems for the economy of the future.

How AI is affecting the economy

Applications and uses of AI have expanded into almost every part of the economy and continue to grow quickly. The International Data Corporation estimates that the worldwide market spend in the private sector on AI systems and technology was approximately $19.1 billion in 2018, and will increase further to nearly $57.6 billion by 2021[6]. This rapid increase in investment has resulted in a thriving array of AI-focused startups. Large tech companies including Apple, Google, Facebook, Microsoft, and IBM are all prioritizing AI research and development and expect their expertise in AI to be essential to their future growth. There is also very strong growth in startup companies applying AI technologies in different sectors across the economy (see examples in Figure 1).
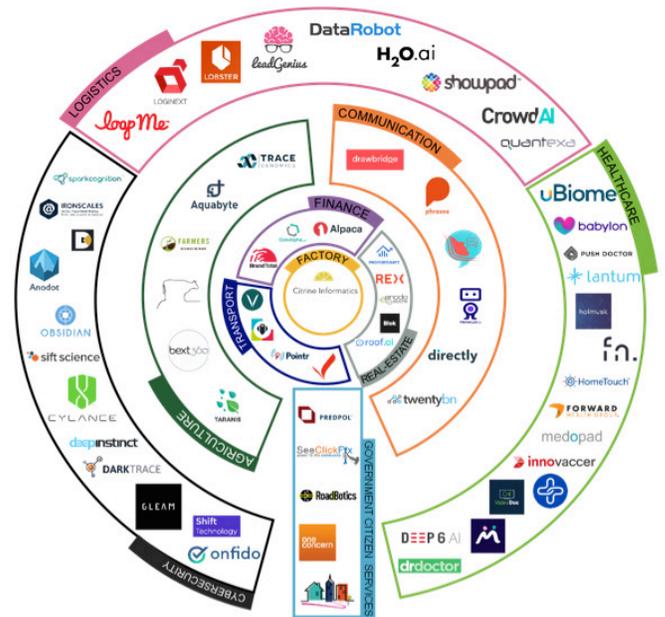
Figure 1: Sample of AI startups across sectors

Many companies beyond the technology sector are integrating AI technologies to capitalize on gains in efficiency and to lower labor costs. AI is already making advances in a variety of sectors such as agriculture, transportation, logistics, finance, and real estate among many others. Governments are particularly looking to the potential impacts of AI in areas like education, health, crime prevention, and criminal justice.
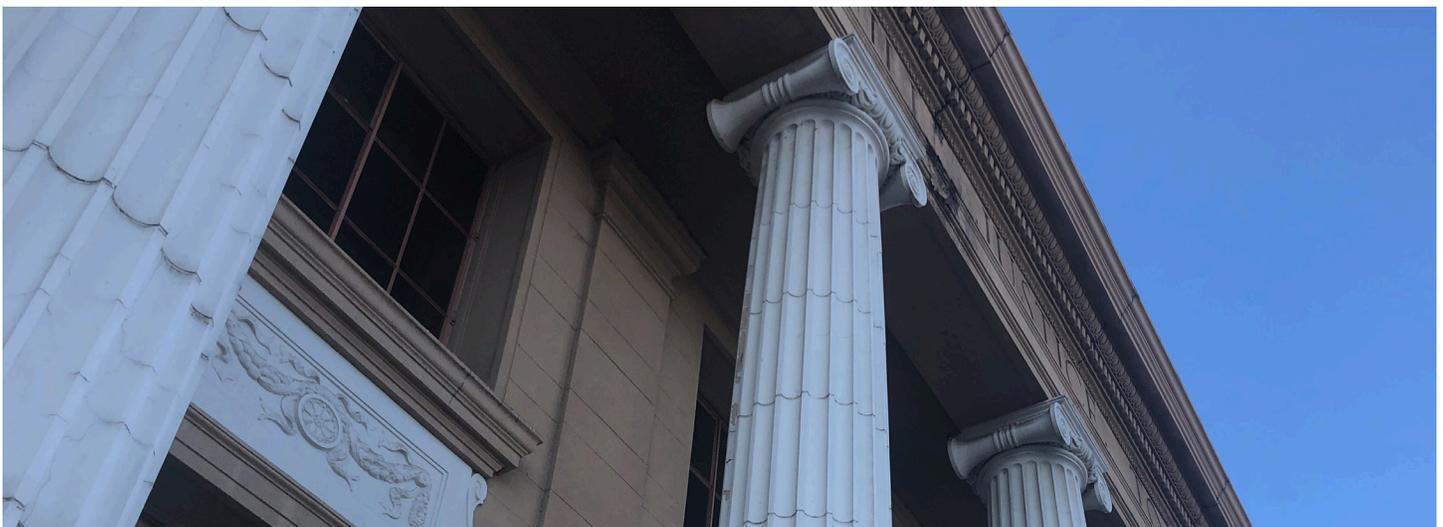
The impact of AI on Stockton

Stockton is an inland port city, and was established as a hub and river port during the California Gold Rush in 1849. It is part of San Joaquin County within the Central Valley, close to the San Francisco Bay Area, Silicon Valley, and Sacramento. The city has a young and multicultural population of just over 310,000 people. According to the 2017 US census bureau, Stockton's population is 42 percent Hispanic or Latino; 22 percent Asian; 22 percent white; and 12 percent black. The median age is just over 32 (compared with a US average of 37.9).

Stockton has successfully emerged from a difficult decade after financial troubles triggered by the 2008 global financial crisis. The city declared bankruptcy in 2012, making it the second largest city in the US, after Detroit, to have ever done so. In the years since, Stockton has recovered quickly, and it is now ranked among the most fiscally healthy cities in California. In 2018, the national non-profit Truth in Accounting ranked the city of Stockton at No. 2 among the 75 most populous cities in the nation in terms of fiscal health, based on debt or surplus per capita.

According to 2017 census data, the median household income of Stockton residents is $48,396 – significantly below the median household income for the state of California which is $67,169. 22.4 percent of city residents live below the poverty line[7].

A growing number of Bay Area workers unable to afford to live near their jobs have affected the housing market in Stockton. House prices in the city have risen sharply over the past 7 years. In 2018, prices rose by 9.8 percent and the rental market has followed suit, making the city less affordable for its most vulnerable residents.

Over 28,000 workers in Stockton are super commuters (i.e. workers that commute more than 90 minutes to work each day). Stockton is the U.S. city with the highest share of its population super commuting.

Stockton has a workforce that US census data estimates as 139,026 people. In terms of people employed, the largest sectors in Stockton are healthcare (19,476 people employed), retail (15,492), and construction (10,827). In terms of contribution to GDP, Stockton's largest sectors are agriculture, transportation, and warehousing. Stockton has an unemployment rate of 6.78 percent, substantially higher than the US unemployment rate which, at the time of writing, is 3.6 percent. There are also an estimated 98,387 adults in Stockton who are not in the labor force, including retirees and those who are unemployed and are no longer looking for work[8].

The educational attainment of the workforce is relatively low (see figure 2), with only 27 per cent of the population having college degrees or higher (compared with a Californian average of 40 percent)[9].
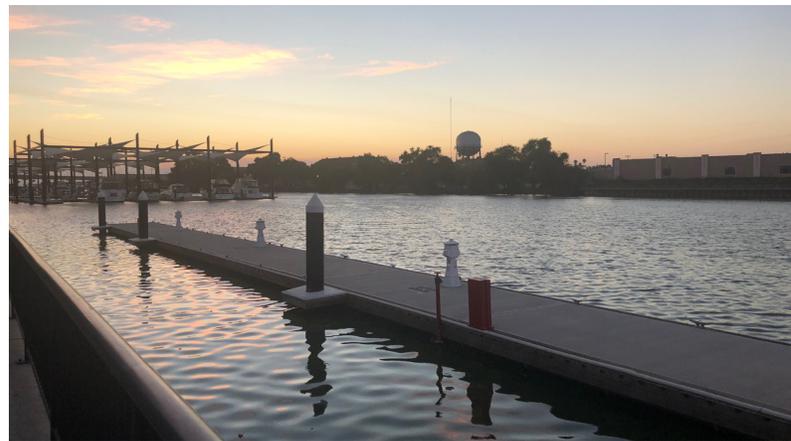
7. https://www.census.gov/quickfacts/fact/table/stocktoncitycalifornia/PST045217
8. Data sources: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF; https://www.bls.gov/eag/eag.ca_stockton_msa.htm; & http://www.advantagestockton.com/demographics.html
9. Data from https://statisticalatlas.com/state/California/Educational-Attainment

Educational attainment of the workforce in Stockton
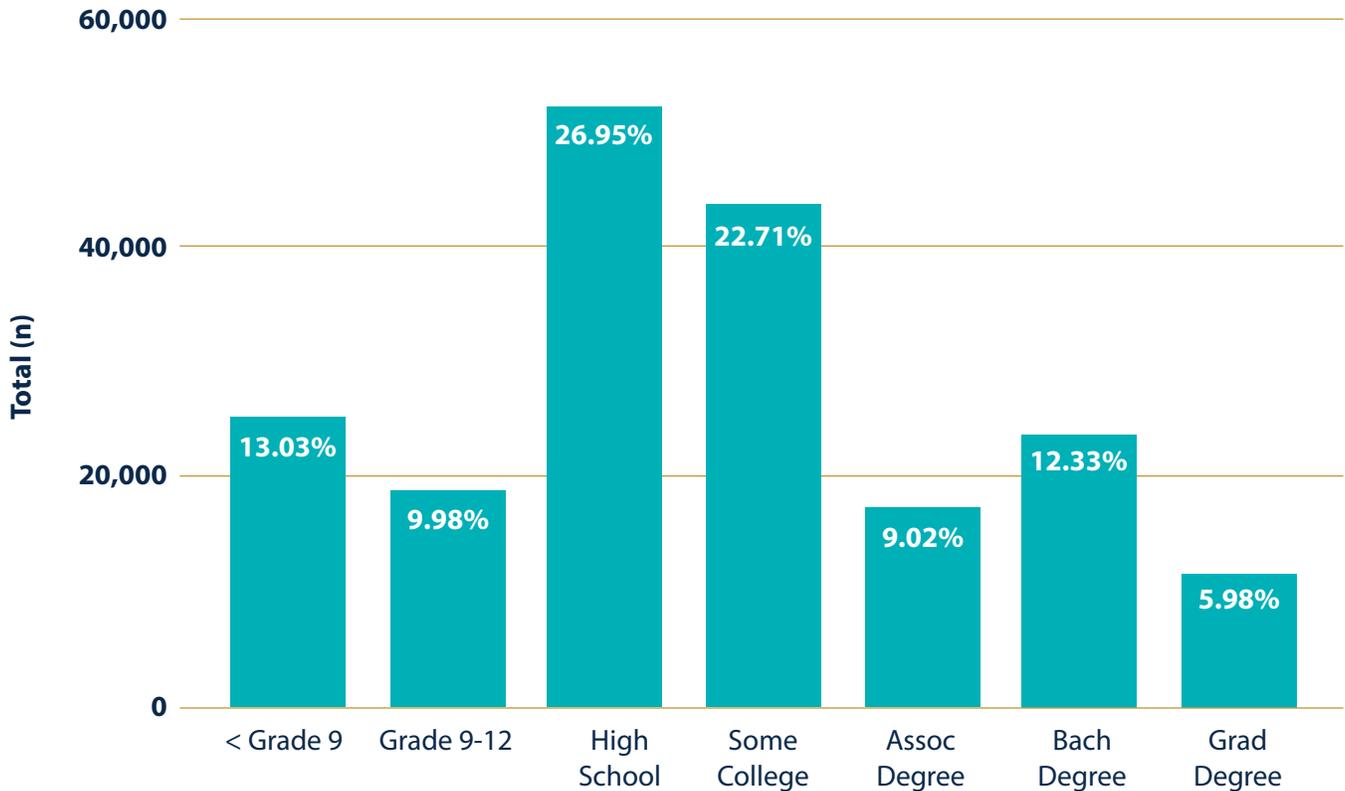
Figure 2: Educational Attainment of Stockton Residents
Data Source: http://www.advantagestockton.com/demographics.html

Below, we discuss the sectors in which AI is likely to have the greatest impact on Stockton's economy. For context, we have also included general information about the current uses of AI in these sectors.

Agriculture
AI is set to help address two of agriculture's biggest current challenges. The first is threats to sustainability caused by an ever growing world population and climate change. The second is labor shortages.

Relating to the first challenge, sustainability, by some estimates, nearly 50 percent of crops are lost through waste, over consumption and production inefficiencies[10]. AI has improved predictions about future outcomes using data mining, statistics, and modelling[11]. Pairing this with enhanced data imaging captured by drones, for example, could help reduce the loss of crops.

In terms of the second challenge, labor shortages, advances in autonomous farm equipment such as tractors or irrigation systems reduce the need for workers on farms, and could eventually work 24 hours a day without much human input or supervision. Companies like Plantix, an AI startup based in Berlin, and Trace Genomics, based in San Francisco, have developed deep learning applications that can be used to identify potential defects and nutrient deficiencies in soil. This data can be used to increase crop quality, including yield and shelf-life. Labor shortages are currently hurting California's agriculture industry and as demand continues to rise, the opportunities offered by AI to keep farms running without much human input is very promising.

10. P. Alexander, C. Brown, A. Arneth, J. Finnigan, D. Moran, M.D.A. Rounsevel *Losses, inefficiencies and waste in the global food system* Agric. Syst., 153 (2017), pp. 190-200.
11. This process is often referred to as predictive analytics.

Agriculture is a major area of opportunity for the application of AI in Stockton and the larger metropolitan area. The San Joaquin Valley (SJV) is California's largest agricultural region, and an important contributor to the nation's food supply. It is facing a variety of resource and environmental challenges such as labor shortages, drought and water scarcity, groundwater overdraft, nitrate contamination of groundwater, and accumulation of salinity in the soil[12].

AI applications can help to address some of these challenges. For example, farmers in SJV need to make predictions about water usage and the county is interested in balancing groundwater reserves by 2040[13]. Pairing predictive analytics with enhanced data imaging captured by drones could help farmers to make better decisions about how to use scarce water supplies. Drones equipped with multispectral sensors could also be used to survey land, take images, and reveal the fertility of specific patches of soil, allowing farmers to use resources more efficiently and providing possibilities for selective idling of farmlands. Indeed, drones are already being used in Stockton by the San Joaquin County Department for Public Works for predictive water level analysis based on rainfall and stream levels, in addition to bridge and road inspections in addition to traffic operations. The city might also consider working with startups specialising in the use of agricultural drones, such as TerrAvion, located in the East Bay area.

For the agricultural sector in Stockton and the San Joaquin Valley, we view AI applications and technology largely as an opportunity rather than a risk.

Transportation
When it comes to transportation, automation isn't new. Commercial airplanes have had autopilot functionality for many years. Pilots still supervise and are responsible for monitoring many of the processes, but this may change in the future with expanded capabilities of AI. In 2017, an AI robot co-pilot named ALIAS, was able to successfully fly and land a simulated Boeing 737. These advances have expanded to include motor vehicles. Companies including Uber, Google, and Tesla are all investing heavily in self-driving innovation, as well as more conventional car manufacturers. BMW, for example, expects their

autonomous iNext car to hit the market by 2021. Toyota's AI companion "YUI", acting as a kind of co-pilot and tracking a driver's habits and attentiveness during trips, will hit the market in 2020.

Passenger vehicles are only one area in which AI is affecting the transportation industry. Since Fall of 2017, autonomous trucks operated by Embark have been transporting electronics on the I-10 freeway from a warehouse in El Paso, Texas to a distribution center in Palm Springs California. In February 2018, the company completed a cross country test run from California to Florida. Through the introduction of fully autonomous passenger vehicles, self-driving cars and trucks, jobs in transportation stand to be negatively affected.

The applications of AI to transportation in Stockton present both risks and opportunities to the city and its workforce. In terms of risk, about 7.2 per cent of Stockton's labor force is currently employed in the transportation sector. As more companies begin to employ autonomous vehicles there is the potential to see major job losses in this sector.

On the other hand, the large number of Stockton residents who commute for work stand to benefit from applications of AI such as traffic management and greater mobility. AI can be used to spot patterns in traffic data to identify how to streamline traffic flow. Similarly, AI can be used to create smarter traffic light algorithms combined with real time tracking. Likewise, AI's ability to make predictive models based on large complicated data sets can also be applied to public transport for optimal scheduling and routing. Finally, AI can be used to reroute the paths of pedestrians and cyclists away from major traffic areas. This might become increasingly important as several Californian cities have started allowing autonomous delivery robots on their streets and sidewalks.

Manufacturing
Manufacturers have been using robots decades to reduce costs and increase production - and indeed humans have been finding ways to automate production for centuries. Factories that have been already built to accommodate automated machinery have helped to enable manufacturing to be one of the early sectors to

12. E. Hanak et al., Water Stress and a Changing San Joaquin Valley Public Policy Institute of California (2017) at https://www.ppic.org/content/pubs/report/R_0317EHR.pdf
13. Ibid.

adopt AI. Artificial intelligence programmes are being added to existing robotics in order to make them faster and more responsive, including by 'learning' from their own processes and errors and 'seeing' defects more easily.

Since 2000, U.S. employment in the manufacturing sector has fallen by nearly five million jobs, or by over 28 percent. (Those losses are in part due to automation, but may also be associated with off-shoring and international trade.) As more manufacturing tasks are automated through AI applications, the number of jobs affected is likely to continue to rise.

On the other hand, research indicates that there is a growing labor shortage in U.S. manufacturing due to an aging workforce and dwindling interest in these jobs among younger workers – creating a skills gap in manufacturing. Deloitte and the Manufacturing Institute estimate that over the next 10 years, more than 2 million jobs will go unfilled. AI will play a role in widening this skills gap as the types of jobs associated with manufacturing become more specialized through the adoption and application of AI technologies. In other words, AI presents both a risk and an opportunity for jobs in this sector. The adoption of the technology may replace some jobs, while creating new jobs that are more specialized at the same time, such as for those who operate robotics technology.

Our analysis suggests that manufacturing is a sector where jobs in Stockton are at risk. 8.5 percent of the workforce in Stockton is employed in this sector, and as more manufacturing tasks are automated through AI applications, many jobs could be lost. Given the labor shortage in manufacturing, it is also an area in which retraining might enable jobs to be redistributed within the sector.

Supply chain management and logistics
According to a 2017 report the State of Artificial Intelligence for Enterprises, supply chain management and logistics is one of the top three sectors where businesses are driving revenues through investment in AI technologies. AI is being used to strengthen traditional forecasting techniques, optimize delivery routes, improve customer service and reduce costs through reduced redundancies and risk mitigation. UPS has a proprietary

technology called On-Road Integrated Optimization and Navigation (ORION), for example, which they are currently using to create optimal routes for delivery drivers based on data that includes customer input, traffic information and weather reports. By 2016, the company was already reporting cost reduction of between $300 million to $400 million due to the technology. IBM Watson Supply Chain Insights is another example of an AI application for supply chain management. Amazon has long been at the forefront of automation in logistics. Today, Amazon has over 100,000 robots in its warehouses worldwide and it plans to add more. The company still employs over 550,000 human employees (and growing) and has made efforts to retrain some of its workforce that has been replaced by robots. As AI continues to bolster the capabilities of robots however, a large proportion of these jobs may be put at risk.

Supply Chain Management and Logistics is an economic area that overlaps with other sectors in Stockton and contributes to our calculations of jobs susceptible to automation in the following section of this report. Transport or warehousing are examples of this. AI can be used to predict the volume of shipments, optimize routes and times of departure, and generally be used to make the decision making process of companies easier (and perhaps requiring fewer human staff to do these jobs). Robots paired with AI can be used to load and unload freight and other shipments from central warehouses further affecting jobs in this sector. Stockton already employs almost 50 per cent more employees in transport and warehousing than other US cities of similar sizes. This means it is at a higher risk for job loss due to automation. In addition, the announcement of a large Amazon fulfillment center in the city will bring thousands of jobs to the city. That said, the city must reckon with the likelihood that these jobs will soon be automated.

Though many jobs in supply chain management are susceptible to being automated, many companies that work in these areas have a track record of retraining employees who are displaced - and this can and should be actively encouraged by the city. Stockton should work with its biggest employers to help create comprehensive retraining programs for employees at risk of disruption caused by automation.

Healthcare

Healthcare is another key sector that many analysts believe is poised for transformation by AI. There are many applications of AI that have the potential to improve the spectrum of care services, enhance diagnostics, give more precise and tailored treatments, and ultimately improve patient outcomes. Much of the promise of AI applications to healthcare have come from the ability of AI programmes to efficiently sift through large data sets. Researchers have begun to use machine learning to compare a patient's case with huge sets of data in order to detect patterns or abnormalities, and can use AI to more efficiently and comprehensively survey medical literature to inform treatment decisions.

Applications of AI like these ones could help address access to healthcare challenges in Stockton. Our interviews suggested that there is great pressure on the healthcare system in the city to find qualified staff. Shortages of trained healthcare professionals can significantly limit access to care. By taking over some of the diagnostic duties typically performed by humans, AI applications could help mitigate the impacts of staff deficits. Staff deficits in healthcare indicate that it is a sector ready for growth at a time when others may suffer from the effects of automation. This may support better access to healthcare in Stockton, but health will remain a growth area for AI, and is also likely to provide opportunities for workers.

Use of AI in government

There are a growing number of promising applications for AI in government ranging from citizen engagement, to efficiency optimization, to furthering public policy objectives.

Advances in speech recognition and natural language processing for example, have enabled the development of chatbots which when utilized effectively can make citizen engagement with government and access to government services easier and more efficient. But there are potential benefits for internal operations as well. Embedding AI into existing public processes - with procurement, as an example - may lead to platforms aimed at providing better user experiences. The output of this would likely increase adoption rates and data gathering - ultimately generating better insights and decision-making for local governments.

Machine learning can be used for better policy analysis using more complex data giving government the opportunity to better tailor services to the needs of citizens. There are also a number of applications in areas such as public safety, criminal justice, education, infrastructure repairs and maintenance, and the allocation of resources. Throughout all of this, there is an opportunity to view the role of AI in government through the lens of liberating humans to discard administrative functions to instead focus on tasks that require higher-order thinking.

There are several important challenges around the use of AI in government that need to be considered such as data security and privacy concerns, transparency and accountability structures for AI technologies, and whether the existing IT infrastructure can support new technologies among other things. In general however, AI has the potential to make public service provision better and more efficient.

The city should explore ways that AI could be trialed for government use to improve public services and tackle major social issues. Stanford's AI 100 project found that AI aimed at solving social problems has traditionally failed to attract investment because it produces few profitable commercial applications[15] . One way of addressing this issue is through the creation of effective public-private partnerships. We recommend that the city host a regular competition among regional startups to help the city find AI-driven solutions to local challenges.

AI has great potential to address many of the predominant issues on the city-government's agenda ranging from addressing homelessness to reducing crime. In just one local example of this, USC's Center for AI in Society has been working with community-based partners to create an AI tool to help match individuals and families experiencing homelessness to housing resources with the highest likelihood of success for them. The city of Stockton could similarly partner with startups and community organizations to develop AI driven solutions to these issues.

15. Peter Stone, Rodney Brooks, Erik Brynjolfsson, Ryan Calo, Oren Etzioni, Greg Hager, Julia Hirschberg, Shivaram Kalyanakrishnan, Ece Kamar, Sarit Kraus, Kevin Leyton-Brown, David Parkes, William Press, AnnaLee Saxenian, Julie Shah, Milind Tambe, and Astro Teller. "Artificial Intelligence and Life in 2030." One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University, Stanford, CA, September 2016. Doc: http://ai100.stanford.edu/2016-report. Accessed: September 6, 2016.

Estimation of effect of automation on jobs in Stockton

Overall effects

The effect of automation on jobs in Stockton will be very large, and will grow over time. Our research estimates that:

- Over the long term (15 years and beyond), roughly **62 percent** of Stockton's jobs could be affected by automation, or a projected **80,370** out of **130,673** jobs.

- There is a potentially significant automation effect in the medium term (5-15 years), with a possible impact on **54 percent of all Stockton's jobs**, or a projected **70,688 jobs**.

- The automation effect in the next five years will be smaller, but **17039** jobs, or **13 percent** of the total, may be impacted by automation.

Our analysis uses 'affected by automation' to mean the variety of impacts that AI can have on jobs. Broadly, there are three likely ways that jobs will be transformed possible kinds of job transformation:

- In some cases, AI will make workers more efficient at performing individual tasks, raising overall labor productivity. While this will benefit some individuals, others may lose their jobs as separate jobs are consolidated.

- Where routine tasks are assigned to AI systems, it is possible that workers will see their roles transformed as they focus on skills that cannot be automated.

- Finally, some jobs will be fully automated by new AI technologies, potentially leading to unemployment.

To calculate our projections, we extrapolated from Frey and Osborne's 2017 estimate of the probability of automation for 702 different occupations, by multiplying each occupation's automation probability by the number of people employed in that occupation in Stockton[16]. This method usefully compares automatability between sectors and locations, and provides an overall figure for jobs affected that reflects the sectoral makeup of the city. It is not intended as a firm forecast of exactly how many jobs will be changed or replaced by new technologies. Moreover, it does not follow that if an occupation can be automated, it will be. For instance, our analysis does not account for changes in the cost of labor compared with the cost of implementing an automated technology.

Automation by type of occupation

In the long term, the impact of automation will be spread differently across occupation groups in Stockton.

- Jobs within the sales and office occupation group have the greatest potential to be affected by automation, with 25,298 of workers potentially affected. This equates to 80 percent of workers in that occupation group, which represents 8 percent of the Stockton population.

- There is also a significant projected effect on service occupations in Stockton, with 19,075 jobs potentially transformed or threatened by automation. This amounts to 68 percent of all jobs in the service occupation group, and 6 percent of Stockton's population.

- Management, business, science and art occupations are likely to be the least affected in terms of the projected number (6,765) and proportion (21 percent) of people in that occupation type.

- Taken together, occupation groups broadly associated with industrial work (production, transportation and material moving and natural resources, construction and maintenance) could see 29,232 jobs affected. This represents 75 percent of all jobs in these occupation groups and nine percent of Stockton's population.

16. Frey, C. and Osborne, M. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting & Social Change, 114: 254-280. Available from: https://www.sciencedirect.com/science/article/pii/S0040162516302244. [Accessed 12 February 2019].

Projected Automation Effect on Stockton Jobs

Legend:
- Natural resources, construction, and maintenance
- Management, business, science, and arts
- Sales and office
- Production, transportation, and materials moving %
- Services %
- Production, transportation, and material moving
- Service
- Natural resources, construction, and maintenance %
- Management, business, science, and arts %
- Sales and office %
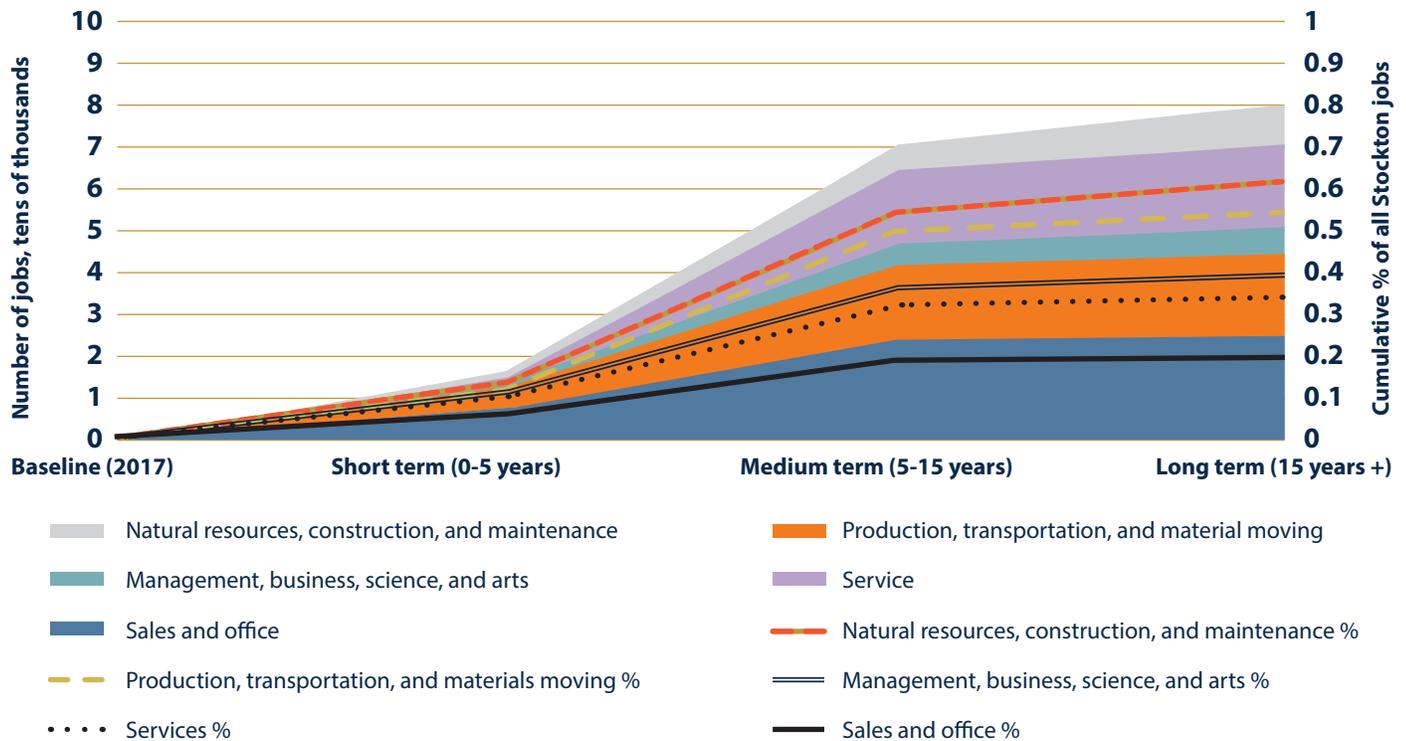
Automation by occupation sub-group

At the level of occupation sub-group, five sub-groups out of twenty-two account for 64 percent of all the jobs that could be affected by automation[17]. They provide clear focus areas for policy makers seeking to manage the effects of automation on the workforce as technology develops. Ultimately, this should enable the city to target individual companies (or even workers) who will be most affected by technological change.

17. The Standard Occupation Classification used in this analysis breaks down the labor force into occupations (e.g. Sales Managers), occupation sub-groups (e.g. Management Occupations) and occupation groups (e.g. Management, business, science and arts occupations). See Annex 2 for a list of the occupation sub-groups and occupation groups considered here.

Number of jobs affected, tens of thousands

Category	Value
Office and Administrative Support	14.9
Transportation and Material Moving	12.7
Sales and Related	10.4
Food Preparation and Serving Related	6.8
Production	6.7
Building and Ground Cleaning and Maintenance	4.7
Construction and Extraction	4.7
Personal Care and Service	4.0
Farming, Fishing, and Forestry	3.1
Protective Services	2.4
Business and Financial Operations	2.1
Installation, Maintenance, and Repair	2.0
Management	1.4
Healthcare Support	1.2
Educational Instruction and Library	1.1
Healthcare Practitioners and Technical	1.0
Arts, Design, Entertainment, Sports, and Media	0.3
Architecture and Engineering	0.2
Computer and Mathematical	0.2
Legal	0.2
Community and Social Services	0.1
Life, Physical, and Social Science	0.1
Total	**80.4**

These five categories make up 64% of all the jobs that will potentially be affected by automation.

These five sub-groups are: Office and Administrative Support; Transportation and Material Moving; Sales and Related; Food Preparation and Serving Related; Production. Notably, these five sub-groups also see high proportions of jobs potentially affected by automation. For example, the 6,811 jobs that may be affected by automation in the Food Preparation and Serving Related sub-group represent 88 percent of jobs in that sub-group.

Top 5 affected sub-groups

Occupation sub-group	Occupation	Number of jobs potentially affected	% of sub-group affected
Office and Administrative Support Occupations	Sales and office occupations	14,942	80%
Transportation and Material Moving Occupations	Production, transportation and material moving occupations	12,749	78%
Sales and Related Occupations	Sales and office occupations	10,357	82%
Food Preparation and Serving Related Occupations	Service occupations	6,811	88%
Production Occupations	Production, transportation and material moving occupations	6,674	78%

'Affected by automation' will not always mean that technological developments cause job losses, as employers may choose to go down a different path. Nevertheless, policy makers should anticipate the likelihood of job losses when labor can be automated. In general, and without targeted re-training, workers will find it easiest to move to other jobs within the same occupation sub-group. However, where high proportions of jobs within a sub-group are at risk, there will be less capacity in that sub-group to offer large numbers of unemployed workers new positions.

This analysis suggests that Stockton should consider two kinds of approach to automation and employment. The first approach is for sub-groups which are likely to be highly affected both in terms of the number and proportion of jobs. In these cases, there is an opportunity to design strategies specific to an occupational sub-group (such as Office and Administrative Support Occupations) to manage transformation and disruption at scale. These might involve the following:

- A deeper analysis of the state of current technology within each sub-group, its likely development, and the proportion of jobs it could replace, transform, or simply make more efficient

- An assessment of workers' education and skills within the sub-group in Stockton,

- Based on this analysis, programme for re-skilling and adult education that is deliberately targeted towards at-risk workers in that sub-group.

A second approach is likely to be more efficient for the 'tail' of sub-groups where lower numbers and proportions of jobs are projected to be affected by automation. A general approach might seek to identify skills less likely to be affected by automation in the future (such as caring or creative skills), develop programmes that will allow a wide range of workers to acquire or develop these skills, and focus on supporting those industries in which these skills will be required.

Stockton's policy makers should also prepare to make social support available for all workers possibly affected by automation. This might take the form of Universal Basic Income, as discussed below.

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Overall jobs automation possibilities (y-axis, 0%–100%)

Automation resilience score (x-axis, 0–1)

Cities plotted: San Bernardino, Stockton, Santa Ana, Anaheim, Bakersfield, Oakland, Chula Vista, Riverside, Irvine, Fremont

Automation resilience and jobs risk across California

It is important for cities to consider their ability to absorb and adapt to the potentially disruptive impact of automation on citizens' jobs, or a city's 'automation resilience'. A range of factors might contribute to this resilience, but we use four in particular to create an estimate: the number of jobs available within a 50-mile radius; education level (the proportion of people with degrees); the poverty rate; and a city administration's annual expenditure per capita. These factors help to determine:

- how easily workers may be able to find new jobs within the same region if they are made redundant;

- how likely it is that workers will have skills that can be applied to different jobs, making them more resilient to job disruption;

- how severe the immediate effects of unemployment are likely to be, as poorer people are less likely to have the personal resources or savings to support themselves through a period of unemployment;

- what resources the city may have available to support people looking for work.

Using data from datausa.io and factfinder.census.gov, we combined these factors to create a composite measure of automation resilience (see methodology described in Annex 3). This suggests that automation resilience negatively correlates with the proportion of jobs that may be affected by automation[18].

Comparing Stockton with nine other cities in California with a similar population size, we found that Stockton **relatively lacks resilience** and is also **relatively highly exposed** to the effects of automation on jobs.

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18. For two of these factors, such a correlation is to be expected. A low-skilled sector is likely to be relatively automatable and will also tend to be associated with higher poverty and lower education levels. However, it need not follow that a low-skilled sector will mean fewer jobs locally or lower local government expenditure.

Of the 10 cities we examined, Stockton is the **third most exposed to the effects of automation on work** and the **third least resilient**, with an automation resilience score of 0.39. This compares with 0.69 for the most resilient city, Irvine, and 0.33 for the least resilient city, Bakersfield. The main contributors to Stockton's position are its comparatively low levels of people with degrees and the fact that it has fewer employment opportunities available than elsewhere, in terms of jobs advertised.

Most of the factors contributing to a low automation resilience score will be hard to change in the short term: for example, a city is not likely to suddenly receive a significantly increased budget. However, Stockton's position reinforces the need for strong policy responses aimed at enhancing the city's long-term resilience. Low education levels can be combated over time through re-skilling programmes and investing in making higher education more accessible; and jobs availability can be increased by encouraging AI-related entrepreneurship in Stockton, as this report recommends. A further possible policy response is Universal Basic Income to target poverty levels, as is being trialled in Stockton throughout 2019 and 2020.

Building future resilience in Stockton

In pursuit of innovation & resilience
Stockton is currently showing a willingness to pursue innovative initiatives and policies that address major social and economic issues. The Stockton Economic Empowerment Demonstration (SEED) city-wide experiments with Universal Basic Income (UBI), the 'Advance Peace' program aimed at curbing cyclical and retaliatory gun violence, and the Stockton Scholars initiative are all good examples of creative programmatic and policy initiatives. More recently, the city was awarded a climate resilience planning grant from the state of California to support the city's most impacted neighborhoods. A comprehensive city-level AI and Future of Work strategy provides another opportunity for the city to engage in creative policy.

Stockton: a transformative climate community (TCC)
Residents within the proposed Transformative Climate Communities (TCC) planning area live in communities that are most overburdened by environmental, socioeconomic and health inequities. These communities have been identified as those with a majority of Census Tracts that fall within the top 25 percent of disadvantaged communities, as defined by the California Environmental Protection Agency, using CalEnviroScreen 3.0. A primary goal of this TCC planning grant effort is to have focused conversations and workshops with neighborhood stakeholders, ensuring community needs and voices will be elevated and incorporated into a Sustainable Neighborhood Plan. As Stockton continues to build climate resilience into its future planning efforts, it is important to recognize the intersection of those efforts with what technology makes possible. One example is a tree census effort currently underway as part of the TCC planning grant. As a basis of comparison, the city of Stockton undertook a tree census in 2011, at that point in time largely relying on manual tree counting practices and relevant software. Only eight years later, a smaller tree census is being conducted - initially conducting a baseline utilizing drones to capture imagery that will render a 3D model of the tree canopy.

Imagine what will be possible in the next 5-10 years. How do we engage young children in the educational nature of this work? Connecting this type of work to the AI and Future of Work strategy will be critical, as it highlights how technological tools can accelerate climate resilience initiatives. It is also a reminder of the new skills that will be required to facilitate and interpret the nuances of the data that results from these new programs.

SEED: demonstrating basic income
With the support of philanthropic partners, Stockton's UBI trial was launched in February 2019 - designed to give a randomly selected 100 residents a guaranteed income of $500/month for 18 months. Eligible households had to be located in neighborhoods where the median income was at or below the median Stockton income (of $46,033).

Part of the impetus for the UBI trial demonstration emerged from the recognition that one in two Americans cannot afford to pay for an emergency, and that Stockton and its citizens are still recovering from the 2008 recession. As more people struggle to make ends meet while

working two or more jobs, many of these challenges will worsen, especially with the looming threat of automation and displacement. Helping to ensure that local citizens receive a guaranteed income or social services every month is one way that the city could mitigate against potential job loss due to AI technologies.

The UBI trial will test for tangible effects on the local community by examining participant wellbeing across financial, physical and emotional outcomes. At the end of the demonstration, the evaluation will help answer questions such as: How does a guaranteed income impact financial insecurity and volatility? To what degree will a guaranteed income impact drivers of inequity and social determinants of health? How does a guaranteed income unleash potential among recipients and generate agency over one's future?

The insights from this work will have important implications for AI opportunities in the city - particularly by understanding how participants spend money, value their time, and how financial stress (or relief from that stress) affects healthy decisions. In turn, these may affect whether participants change their employment status, health provision, or even the regularity with which children in the household attend school.

These patterns could shine a light on future opportunities related to the AI and Future of Work Strategy - which might include investing in a more entrepreneurial workforce, exploring the role of automation in healthcare services, or more deeply integrating technology into educational services.

Stockton Fiber: future-proofing through fiber broadband
Fiber broadband infrastructure is the necessary foundation for any future-ready community adapting to rapidly changing economic conditions. Serving as a critical replacement for aging copper wires, an open access fiber broadband network is essential for students to complete their homework, for businesses to retrain their workforce, or for the city to offer services that are more responsive to its residents.

The vision for the city of Stockton is responsive, stable, powerful, and affordable internet connections for every home, school, library, and community space. Aptly named, Stockton Fiber will ensure open and equal access to information, create the opportunity for all Stocktonians to access the 21st century economy. In the context of AI and workforce, it's a critical foundation for Stockton to build a more dynamic economy that is increasingly diverse and resilient.

All communities must have the right tools to improve educational attainment; train, retain, and retrain the talent required to build a successful workforce; and establish the foundation for smart, responsive infrastructure that will build healthy, vibrant places for people to live and work. Without tools like broadband, communities risk falling further behind - potentially for generations. Stockton Fiber will serve as a transformative asset to close the knowledge gap and unlock new opportunities for Stockton residents.

The Way Forward

Job loss estimates for Stockton are alarming, but there is a lot that the city government can do to prepare Stockton's citizens for change. Emerging applications of AI do not only pose a threat but also present a variety of opportunities for the city. The city can leverage its geographical position relative to Sacramento, Silicon Valley, and the Bay Area together with its unique demographics, structure of the economy, leadership, and current political will for innovation to take advantage of the opportunities of AI. In addition, being one of the first cities in the United States to act on AI on a municipal level, should give the city an early mover advantage. However, if the city does not act quickly, there is a looming threat of massive disruption to its economy and the welfare of its citizens. It is clear from our work in Stockton that the time for the city to act on AI is now.

"I think AI represents an opportunity to really question assumptions about the folks that live in this community in terms of what they are capable of, what type of jobs are they able to do, what sort of education they deserve… if we don't act it represents a threat potentially… but I really think it is an opportunity to create a more inclusive economy"

- Michael D. Tubbs, Mayor of Stockton, California

Pursuing opportunities

Creating a vision
The city needs to state a clear and forward-looking vision for the role that AI will play in Stockton's future, and especially how it will affect future jobs. The vision should be positive, focusing on how Stockton can take advantage of its strengths while also preparing for disruptions that are likely to take place as AI technologies are adopted by Stockton's major employers.

City leaders to talk about a future Stockton with more homegrown companies, exciting pilot projects using AI that are taking place in the city, and workers learning new skills. This will signal hope and opportunity to Stockton's citizens and employers, and encourage potential companies of all sizes to consider locating their operations in Stockton.

"Change takes time to adjust and to accept: we have to start with a grand vision but we will need to show incremental success to the people"

- Kris Balaji, Director of San Joaquin County Department of Public Works

Engaging the public & forging partnerships
A major part of a positive forward-looking vision on AI includes public education on AI technology and the ways that it will affect citizens in the city. Leaders should facilitate public education sessions for public servants, business owners, educators, and the general public on the effects of AI and the initiatives the city is leading. While in Stockton, Oxford Insights ran two free workshops on AI and the future of work to city leaders and at WorkNet. Both sessions were aimed at building awareness and capacity for those working with job seekers to prepare for future changes in workforce needs caused by AI. To

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help raise awareness as broadly as possibly, the city could encourage the creation of materials for public education such as webinars or short infomercials. Similarly, we believe there is an opportunity for University of the Pacific and San Joaquin Delta College to develop workshops for businesses and public service providers similar to those that Oxford Insights presented during its time in Stockton.

Developing and implementing an AI and Future of Work strategy gives the city an opportunity to work more closely with other levels of government and promote Stockton's interests. The County Office of Education, for example, already has innovative initiatives in place such as the Code Stack Academy that offers coding programs for aspiring software engineers. The Valley Robotics Academy enables middle school and high school students to access robotics and automation-oriented curriculum, and then receive credit at San Joaquin Delta College. In select SUSD classrooms and in other communities, AI-powered software is designed to assist teachers in automating student assessment, tutoring and reporting. At the State-level, Governor Newsom has announced the establishment of a Future of Work Commission. It may also be useful to work with any state-based Library Associations to explore programming that supports these types of efforts. On a federal level, Congressman McNerney is co-chairing the Congressional AI Caucus. It is important for the city to continue forging relationships at all levels of government around these proactive efforts. This will also help to create sustainability of these efforts in the region, and increase the impact of city-level initiatives.

Coordinating stakeholders & new approaches
To take advantage of the opportunities presented by AI, it is important that all players in the ecosystem be brought to the table. From our interviews in Stockton, one clear learning was that there is a continued need for coordinating the efforts of startups, educational institutions, and providers of workforce support programs. Many interviewees felt that it was common for stakeholders in the city to work in "silos" or "tribes". The city should use its considerable convening power to bring representatives from each of these sectors together. This observation is the basis of our recommendation that the city convene a Stockton AI Council, an effort that could be spearheaded by key local stakeholders.

Encouragingly, there are some early signs that many from different sectors across the city and county are aware of what's ahead and are already tackling new and innovative approaches to workforce, technology, and digital infrastructure in Stockton and San Joaquin county. For example:

1. **HATCH Workshop**, a new community-based arts nonprofit, is focused on educating young people on the fine arts and entrepreneurship; they view skilled craft work as critical to building resilience against the automation shocks inherent in low-wage work;

2. **Nautilus Data Technologies** is deploying an innovative floating data center at the Port of Stockton, that when completed in 2019, will provide water-cooled data centers to improve the computing infrastructure available to the city and San Joaquin County;

3. **Amira Learning** is an early literacy software tool that helps children learn to read by utilizing AI and state-of-the-art speech recognition; in early 2019, it was pilot tested on a small-scale in a number of classrooms in Stockton Unified School District;

4. **ConSol USA** will provide outsourced technology and operational services to corporate customers in the healthcare and technology sectors, with plans to recruit hundreds of local young people in entry-level roles with the firm;

5. Inspired by a Google-AI competition in early 2019, **University of the Pacific** is collaborating on a big data project linking UOP's data science & AI expertise to understanding the vehicle fleet data being captured by the County's Office of Public Works;

6. The **County Office of Public Works** is testing innovative uses of technology that are currently under development:
   a. Validation of an AI algorithm to automate pavement quality evaluation and analysis for 1,700 miles of County roadways;
   b. Development of autonomous attenuator vehicles for roadside projects. This is similar to trailing safety vehicles during slow-moving highway cleanup and maintenance;

7. **Neighborly** will build critical infrastructure for the city to take advantage of affordable internet; Stockton Fiber will function as an open access network to give communities the ability to access a responsive, stable, and powerful internet;

8. An early-stage startup, **Social Glass**, is currently developing AI to digitize, streamline, and scale good processes for government procurement, testing their product in San Joaquin County;

9. The **San Joaquin Regional Transit District** is exploring the development of a downtown autonomous shuttle in partnership with local city and county stakeholders.

Creating an AI ecosystem

The city should work to attract and support companies investing in AI, especially those that can demonstrate their commitment to local economic development. The city's role in creating an ecosystem is mainly through nourishing a supportive environment where startups can launch, try new ideas, and flourish.

Therefore, the city should declare Stockton's intention to become a hub for AI experimentation and its desire to work with companies willing to provide jobs locally. The city can partner with local companies to pilot their technologies, which might also include creating design challenges around major societal problems such as homelessness, and provide support to winning bids. The city should explore creating safe and secure ways that companies can use its data to train algorithms and AI programs, for example using a data sandbox[19].

The city can also align Opportunity Zone tax incentives with AI-focused companies exploring opportunities to invest in the city and identify a way to "fast-track" or incentivize emerging technical talent to stay in the Stockton area after graduating.

There is a lot that Stockton can do to help make the city a "soft-landing" place for new companies. For example, the city can provide key information and logistical support to startups unfamiliar with the city so that these startups can more easily navigate the business environment[20]. The city can also provide incentives such as subsidised office space or reduced red-tape associated with opening and closing companies. Finally, the city can show it is willing to support local business by continuing to use its various media platforms to highlight local business successes.

Mitigating risks: preparing the workforce

Addressing the threat of AI-driven automation is all about increasing the resilience of the workforce to change and disruption. The city needs to focus on the training, re-training, and upskilling of its workforce, as well as helping citizens to understand why this upskilling is so important.

"We don't have the skills to engage with the knowledge intensive economy right next door to us but at the same time we have the cost due to proximity because of housing and also because our firefighters, nurses, and public administrators have to be paid competitively…"

- Thomas Pogue, Associate Director, Center for Business and Policy Research, University of the Pacific

19. Broadly speaking, a data sandbox is a closed testing environment designed for experimenting safely with web or software products. Regulatory sandboxes are becoming very popular in financial technology for example, as they allow regulations to be crafted around a rapidly changing technological environment. In a sandbox, real data, essential for the creation of effective algorithms, is made safely available to companies to develop and test their models and products. A data sandbox would facilitate public-private partnerships and would make Stockton an attractive location for startups.

20. See for example the Reno Startup Deck: http://renostartupdeck.com

Identifying those most at risk

Our study identifies those sectors that we believe to be at highest risk of automation in the city. This analysis, together with additional work by the Skills Taskforce and other local business leaders and university partners, can help identify those whose job security is most at risk due to technological change - this could include targeting at the sectoral, employer or individual level. Identifying those who are most vulnerable enables targeted support. The city should also begin to craft re-training and upskilling strategies in collaboration with local private companies.

Engaging with education at all levels

The city needs to engage purposefully with education providers at all levels to prepare Stockton's citizens for the future of work. Efforts to bring a CSU campus to Stockton, for example, should incorporate the curricular needs of a future workforce. Similarly, the city can work with education providers currently in the city such as Delta College or the University of the Pacific (UoP) to create alternative course structures (e.g. short courses, night classes, or certificate programs) specifically designed to train and retrain those that are most at risk. In addition, the city should explore partnership opportunities with private companies and institutions such as School 42 that provide alternative methods of training that are more flexible for those with existing opportunities, with lower fees, and teach skills that are especially relevant to the future workforce.

Stockton should also work closely with the county and local school boards to encourage existing initiatives that teach science, technology, engineering and mathematics (STEM) subjects while also ensuring schools encourage students to develop "human specialties" (skills that will not easily be replaced by machines) such as creative thinking, lateral problem-solving, and emotional intelligence. To this end, the city should also assist existing programs such as the county's Code Stack Academy initiative with logistical and strategic support where necessary.

Facilitating access

"It's not as easy as you might think for people to 'just go to training'. People need money for daycare, transport, uniforms, and all the extra things that go along with training. These are the practical things that get in the way of people developing new skills."

- Sandy Paben, CEO of Renaissance Groups and Renaissance Educational Consultants

The city should ensure that Stockton's workforce training and reskilling programs are easy to access and fit for purpose. This may include exploring flexible timings of classes or providing free transportation or child care to those who attend those courses the city feels will be most helpful in preparing for future jobs. Where possible, the city should promote collaborations to help fund support structures for those in most urgent need of training or retraining programmes. Workforce stakeholders should bring forward these challenges to the Mayor's Skills Taskforce, to identify solutions that can integrate existing workforce programmes and funding streams wherever possible.

Broadcasting awareness

The city should support a broad public awareness strategy to help Stocktonians understand the likely impact of AI on the future of work. For example, in partnership with a local community development corporation, Stockton would be wise to encourage a district-wide campaign about AI and its likely impact on the workforce, promoted by the school districts, local colleges and mayor and other city leaders. The objective of this exercise would be to help citizens think about possible changes to their own work. Any media for public awareness could also feature proactive approaches that local groups are pursuing - a subset of which are featured above (see: "Coordinating stakeholders & new approaches").

The city should also support programs at the tertiary level that encourage students to focus on likely areas of future jobs growth such as healthcare, design, computer engineering and management. Furthermore, the city should encourage students to gain work skills while in tertiary study during placements or employment.

Partnering towards the future

As Stockton lays the groundwork for the role of AI as it pertains to its economic future, partnerships will be critical. With the right partners, Stockton is poised to proactively mobilize stakeholders across education, workforce, local government and industry to take advantage of all that AI has to offer - particularly towards questions of how to leverage AI for good.

Interested organizations and coalitions may wish to engage Stockton as an emerging hub in the following areas:

1. *Training*, as it pertains to the development of new workforce programs and offerings;

2. *Infrastructure and research*, as it relates to partnering on data-oriented projects, demonstration labs or symposiums with local companies, school districts, public agencies or institutions of higher education;

3. *Innovation and startups*, particularly for young startups that may wish to test and deploy new tools in new geographies.

Conclusion

There are real challenges ahead for Stockton's labor force as citizens and employers in Stockton adapt to developing AI technologies. Many will see their jobs, or the skills their jobs require, change quickly, and we estimate that 62 percent of jobs in Stockton will be affected over the coming decades.

But anticipating these changes gives the city of Stockton, and its citizens, time to prepare and the enormous advantage that comes from anticipating what lies ahead. As the first city in the world to adopt an AI strategy, Stockton sends a message to its citizens and its employers that it is ready to help them adapt to change, and to take advantage of the many opportunities that come alongside AI's risks. Being a city affected by automation need not be just a cause for concern. Stockton has its young population, its location, and the energy of its citizens, civil society, private sector and government leaders on its side. With that coalition, technological changes offer a chance for Stockton to develop some of its long-held, and emerging, strengths to create a thriving future city.

Annex 1

The Oxford Insights team wishes to thank those who generously shared their time and insights to help us develop this report, including:

Name	Position	Sector
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Johnny Arguelles	Director, Center for Educational Development & Research (CEDR) / Code Stack Academy	Regional government
Kris Balaji	County Director, Public Works	Regional government
Jerry Becker	Former County Director, Information Systems	Regional government
Kirk Brown	Director - STEM Programs, San Joaquin County Office of Education	Regional government
Matt Drury	Vice President - Market Officer, Prologis	Private sector
Fritz Grupe	The Grupe Company/Grupe Operating Company	Private sector
Dr. Kathy Hart	Superintendent / President, San Joaquin Delta College	Education sector
James Hetrick	Fletcher Jones Endowed Professor of Data Science, University of the Pacific	Education sector
Steven Howell	Dean and Professor - School of Engineering and Computer Science, University of the Pacific	Education sector
Tom Knight	COO, ConSol	Private sector
Grace Livingston	Founder & CEO, intrepide.co	Private sector
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Svetlana Matt	Legislative Assistant, US House of Representatives	Regional government
Stacy McAfee	Former VP External Affairs, University of the Pacific	Education sector
Supervisor Kathy Miller	District 2, Board of Supervisors	Regional government
Jamie Mousalimas	Superintendent, San Joaquin County Office of Education	Regional government
Lori Ann Ospina	UBI Expert & Principal, WorkFWD	Nonprofit sector
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Shanna Uhila	Tech Evangelist, School 42	Education sector
Max Vargas	Senior Policy Advisor, Stockton Mayor	City government
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Lita Wallach	Principal, HealthForce Partners	Civil society
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Annex 2

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Annex 3

Occupations and occupation sub-groups, Standard Occupational Classification.[1]

Occupation group	Occupation sub-group
Management, business, science, and arts occupations	Management Occupations
	Business and Financial Operations Occupations
	Computer and Mathematical Occupations
	Architecture and Engineering Occupations
	Life, Physical, and Social Science Occupations
	Community and Social Service Occupations
	Legal Occupations
	Educational Instruction and Library Occupations
	Arts, Design, Entertainment, Sports, and Media Occupations
	Healthcare Practitioners and Technical Occupations
Service occupations	Healthcare Support Occupations
	Protective Service Occupations
	Food Preparation and Serving Related Occupations
	Building and Grounds Cleaning and Maintenance Occupations
	Personal Care and Service Occupations
Sales and office occupations	Sales and Related Occupations
	Office and Administrative Support Occupations
Natural resources, construction, and maintenance occupations	Farming, Fishing, and Forestry Occupations
	Construction and Extraction Occupations
	Installation, Maintenance, and Repair Occupations
Production, transportation, and material moving occupations:	Production Occupations
	Transportation and Material Moving Occupations

Methodology for calculating automation resilience

To estimate the 'automation resilience' of Californian cities similar to Stockton in population size, we created a composite measure from four sets of data:

- the city's budget per capita, with budget data for 2015-6 taken from city websites and population data for 2016 taken from American Community Survey (ACS) 1-Year Estimates;
- the number of job vacancies within driving distance of the city (50 miles), as listed on indeed.com on 30 January 2019;
- the level of poverty in the city, as shown by American Community Survey 1-Year Estimates for 2016;
- The proportion of the population with a Bachelor's degree, as shown by ACS 1-Year Estimates for 2017;

To normalise the scores across these measures, we selected an American city for each dataset that would act as a baseline. We divided our 10 Californian cities' scores in these four datasets by the baseline score. Each city's total score - that is, its automation resilience score - is the average (mean) of its score in the four individual measures.

This methodology is intended to be a comparative measure, broadly reflecting American socio-economic trends and likely geographic disparities, rather than a precise forecast of how cities will react to greater automation of labor.

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