

Apprentices of Automation: Adapting Career Paths to Ever-Smarter Machines

Pauline Anne Chin, Clotilde de Maricourt, Nicolas Alexander Feil, Terry Li Xiang Zhen, Krittika Ray

BSc Students
London School of Economics and Political Science

KEYWORDS

Automation
Occupational choice
Future
Uncertainty
Individual perceptions

ABSTRACT

This paper examines the effects of automation on seven different professional sectors, and the degree of uncertainty this creates among current and soon-to-be professionals. It then looks at whether or not the individuals concerned make decisions accordingly, and if so, what the nature of these decisions are. A mixed method approach was chosen, incorporating a quantitative survey and qualitative interviews. The survey investigated 106 students' decisions regarding future career prospects and if they intend to develop skills relevant to automation. The interviews were conducted with 11 individuals working in fields affected by automation, or in which they have knowledge of the development of this technology. Comparing these two groups: workers and students entering the workforce within 0-5 years, demonstrated that students were more adaptive to automation (44% were learning to code or considering it vs 0% of professionals), despite a clear sample size limitation. Due to time constraints, a quantitative survey with professionals was not possible.

All interviewees acknowledged that automation will replace their job or change it significantly. However, only the teacher was subsequently concerned about job security. The other interviewees' relaxed view may be explained by proximity to pension or strong unions.

So far, literature on the topic of automation has focused on the concrete effects of technological developments on professional sectors themselves as opposed to the actual perceptions and adaptation of individuals. We therefore hope that this research will work as an impetus for further research on workers' and students' reactions to automation. This could have implications for social policy directions linked to job protection and adaptability.

Introduction

Our aim in conducting this research was to gain a deeper insight into the ways in which automation, robotics, and artificial intelligence (AI) affect workers' and students' decisions regarding their professional future, and potential factors which may play on these perceptions. The research questions that guided our methodological journey were the following:

1. How do the recent developments in automation affect professions and students and how does this shape their perceptions and decisions about the future of their careers?
2. What factors might influence people's certainty regarding their future in the context of the increasing

prevalence of automation technologies?

3. Considering how widely cited Frey and Osborne's prediction of automation impact (2013) is, do their perceptions align with their prediction?

We found that professionals and students seem to have different perceptions and reactions regarding technological developments. Whilst the former group remains relatively passive in the face of potential job-automation, the latter tend to actively adjust their skills to adapt themselves to the automation trend. We also found that gender and the sectors they would like to work for in the future could, to some extent, contribute to the students' degree of certainty regarding future automation. Furthermore, we found some inconsistencies between the perception of our respondents and

Corresponding Author
Email Address: n.a.feil@lse.ac.uk (N. A. Feil)

Frey and Osborne's work (2013) with regard to the likelihood of automation in some types of industries.

This paper starts off with a review of the literature, followed by a justification of our methods, the analysis of survey and semi-structured interview results, and our conclusion.

Literature Review

1. Careers and Sectors Most Affected

To quantify the proportion of jobs likely to be affected by automation in the US, Frey and Osborne (2013) asked computer scientists for probabilities that certain jobs can technically be performed by a machine in the near future. They did this by looking at the skills required for each job as listed in O*NET 2010 job descriptions (Occupational Information Network). They found that 47% of jobs are highly likely automatable in the near future, especially in transportation, administrative support work, and production occupations, services, sales and construction (2013:41). They might underestimate automatability as O*NET descriptions might overestimate skill requirements; the descriptions were compiled through a survey, to which mainly those might have responded who use more skills than the average job occupant (Handel, 2016:160).

Deloitte (2015) used Frey and Osborne's findings and data from the ONS labour force survey to analyse the effects of automation specifically in the UK. There, jobs with the highest probability of being automated "were largely administrative in nature or involved routine manual activities". Jobs with the lowest probability of automation required high "manual dexterity", "cognitive or social skills", and the least routine. Those latter sectors, such as "caring, leisure, and other service occupations", were expected to grow (p. 3).

2. The Longer Term: Will More or Less Jobs be Created through Automation?

While the above makes clear that many jobs can be automated, the equilibrium impact of automation remains unclear. While jobs may be lost, the concept of creative destruction posits that new jobs will at the same time be created. Investigating this net effect, Willcocks and Lacity (2016a) analysed four cases of Robotic Process Automation (RPA) in the US, UK, and Canada. RPA refers to automation of "swivel chair" service tasks, such as transferring data from one software to another, say from e-mails and spreadsheets to Enterprise Resource Planning systems (Willcocks and Lacity 2016a:66). RPA did not result in layoff of internal staff, but at most in job wastage (Willcocks and Lacity, 2016b). This is

concordant with some of our interviews, in which it seemed that those already working in a certain profession were made to change tasks but not asked to leave the company.

Rainie and Anderson asked experts and interested members of the public whether educational and training programmes would help adapt to the "jobs of the future" (2017:3). While some were hopeful, concerns also arose regarding the replacement of more jobs than would be created, and the socio-economic negative impacts this would entail for the workforce (p.22).

Applying John Maynard Keynes' "technological unemployment" theory in a meta-study, Petropoulos (2017) looked at both positive and negative impacts of automation on employment. On the negative side, a 'displacement effect' may take place where workers lose their jobs (e.g. the introduction of automobiles had laid off horse-related-job workers). On the positive side, there may be a 'productivity effect' where more job opportunities are created. An example of the productivity effect is the reduction in the number of bank clerks following the introduction of Automated Teller Machines. The respective cost-reduction allowed for the opening of more bank branches, and therefore new employees. Similarly, self-checkout machines did not (yet) completely replace cashiers because humans have to correct their errors, as reported in two of our interviews with supermarket staff.

In contrast, Acemoglu and Restrepo state that for every industrial robot introduced in the US economy, between 3 and 5.6 workers may lose their jobs, and introducing one more robot per thousand employees may reduce wages between 0.25-0.5% (2017:35).

3. Which Skills Workers should Develop to Adapt to Automation

The consensus in the literature was that soft skills are less likely to be automated than hard skills (Deloitte 2015, Frey and Osborne 2013, Susskind and Susskind 2015). Rainie and Anderson confirmed that members of the public interested in developments in technology think the same (p.13). Moreover, many believed that skills used for working in the development of robotics and AI itself would become primordial, although others acknowledged that this might lead to an overload of programmers, not all of which would be able to work in the sector (p.14). Other respondents mentioned that technological advancements would not leave many skills left to learn once most jobs were replaced, and that shifts in training mechanisms were both difficult to fund and harder for individuals to engage in (pp.17-22). Also mentioned were programming

and computing skills useful for the generation of automation technologies. Respondents saw a rise in individualised self-learning (e.g. through online courses), and the increasing availability of coding and programming classes (p.15). This served as a starting point for our student survey of students' decisions regarding future careers, in which many reported developing certain computational skills for their future prospects.

Finally, Susskind and Susskind hypothesised that within 10 to 20 years, all professions will display these trends, leading to a "post-professional" society in which people will be trained for skills rather than jobs (2015:263). Accordingly, only a small fraction of individuals will continue to work as they previously did since their expertise and talent will not be automatable (p. 264).

However, given the ever-increasing development of technology and the shift towards better-performing AI, the literature is composed mainly of predictions or to-date effects of automation, which are continually changing. Individuals' perceptions of these changes are evolving and therefore have yet to be documented, and the aim of our research is therefore to explore these responses.

Methodology

Survey

The survey was conducted online in 2017. Respondents were recruited via social media among undergraduates and graduates at both, UK and foreign universities. The first part of the survey asked about gender, household income level, future career choices, and the importance assigned to several factors while making such a choice. The second part asked about the choices regarding programming and coding courses, and explored the reasons why the respondents may choose or not to learn such skills. The third part of the survey, after providing basic definitions of automation and AI, asked respondents to rate their understanding of the recent developments in the two categories, the degree of positive or negative impact they thought such developments would have in their chosen prospective career, and how much importance they attached to such impact while (1) choosing the career in the first place and (2) choosing to learn (or not learn) a programming or coding skill.

Qualitative interviews

Semi-structured qualitative interviews with working individuals or with at least one year work experience allowed us to ask about specific topics based on pre-existing knowledge, while taking the

form of a conversation, with flexibility in adapting our questions to the flow of the discussion (Mason, 2002:62-63). Since our aim was to delve into individuals' own perceptions and experiences, we allowed them to voice their beliefs and attitudes, with less constraint than specific close-ended questions (Savage, 2010:186). While our questions were non-suggestive (see full list in Appendix), we acknowledge that no data is ever fully objective; interpretation being an on-going process involving the choice of topic, questions, sample and analysis. We therefore do not claim that our findings are generalisable, but rather that they provide an in-depth window of understanding into the views of our participants. Interviews were in 2017, all were in London but the taxi drivers (Milton Keynes) and the interpreter (France).

We interviewed one teacher, two tube drivers, three taxi drivers, two retail supermarket workers, one interpreter, one prospective solicitor, one prospective investment banker, and a computer-engineering student. Interviews were conducted in person in locations convenient for our interviewees or over the phone, and were, all but three, recorded with the informed consent of respondents. Confidentiality and anonymity were protected and ensured through consent forms signed by both parties. Interview data was coded using hybrid thematic analysis incorporating an a priori approach based on prior research, with an inductive one (to a greater extent) based on participants' answers (Fereday and Cochrane, 2006). Coding the interviews, we identified three main themes: 'Degree of automation', 'Temporal estimations of automation', and 'Role of institutions in professional security' (see Analysis).

Analysis

Survey

For sample demographics see Appendix.

The survey was completed by 106 respondents and had an almost proportionate mix of genders, income levels, and countries of origin. However, the pool of respondents is restricted (albeit to a small extent) by the socio-economic and cultural backgrounds of extended friend circles of the researchers. It is therefore advisable to treat this as a survey not of undergraduate students of all possible international demographics, but rather as a somewhat restricted pool of undergraduates with some international exposure – perhaps more aware of global culture and developments than the average UK undergraduate. This, though restrictive, is still a very varied and influential demographic to study.

44.3 % of respondents were learning some form or programming electively (unlike required by

degree regulations). Comparing sector-wise, the difference between percentages of students learning programming for each sector was significant at the 5% significance level, with those in the banking, finance and consultancy sector being most likely, and those in the politics, civil services and diplomacy sector being least likely to learn it (see Figure 1).

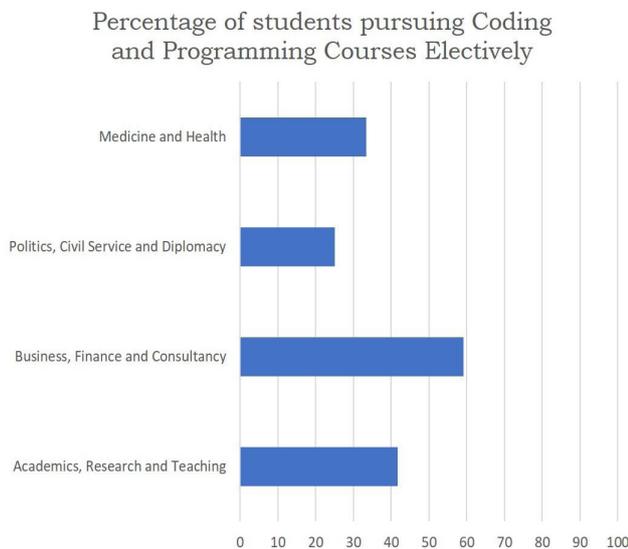


Figure 1.

When asked about why they choose to learn it, “strengthening future career” was the most important reason across all sectors of intended future careers, with the highest mean value being computed for those intending to work in banking, finance and consultancy sectors (The value was assigned from a 1 to 5 scale, with 1 being “Not important” and 5 being “Extremely important”). Furthermore, of all respondents, those who wanted to go into banking, finance, or consultancy, found coding most relevant to their career. Those who did not learn any programming were asked why they chose not to learn it. Those in the banking, finance, and consultancy sector were significantly more likely than any other sector to state the only reason being that they were “not skilled enough”, and least likely to say because it was “not relevant to their career” or that they were “not interested” (see Figure 2).

Those intending to work in the medicine and health sectors have assigned the maximum mean value (following the same scale) of 3.5 to how much importance the future role of automation and AI had on their choice of career. This could be interpreted in accordance with the idea that healthcare roles such as doctors, psychologists, therapists, nurses, etc. are less likely to be impacted by automation and AI, particularly in the near future, since they require characteristics of empathy and feeling to satisfy patients. Therefore, those intending to work in those sectors feel that automation and AI will only have some positive impact on their future careers.

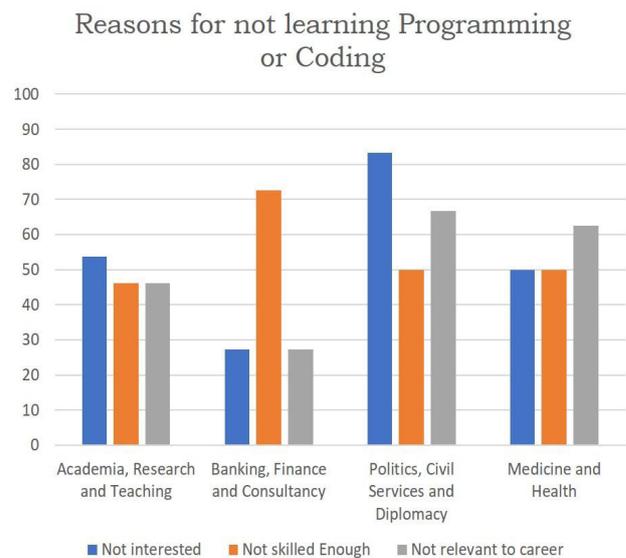


Figure 2.

Similarly, they seem to assign less importance than all other sectors (excluding, understandably, politics and diplomacy) in the said impact being a factor in their choice to pursue programming, something those in academia, teaching, and banking and finance give greater importance to.

The mean perception of impact of automation and AI on their own career was calculated by sector, with the scale ranging from -5 being “extremely negative” to +5 being “extremely positive” (see Figure 3). Notably, no sectors’ mean value was negative. This, while a broad generalisation, could be explained somewhat by the fact that in reality as of today, jobs most immediately threatened by automation and AI tend to be jobs that are not usually occupied by those who shall be graduating from university, and thus in general, such students on average have a positive outlook – perhaps expecting advances in ease and accuracy to supplement their own intended jobs as opposed to replacement or competition from automation and AI. A limitation of this finding is of course that it does not capture more basic, non-AI forms of automation.

A median split on interaction of gender and income on the perception and nature of the impact of automation and AI on their careers was performed. The result showed that in the upper 50% of the income distribution (above £25,000 household income p.a.), there was no statistically significant effect of gender on perceptions, but in the lower 50%, females seem to think the impact of automation and AI on their career will be somewhat positive (mean=2.2), while males seem to think the impact will be limitedly negative (mean= - 0.98), $p=0.02$. This may be due to a female bias toward (automation-safe) soft skill jobs.

The literature does not indicate if females tend to certain jobs because of soft skills or other factors. For example, being a secretary requires some soft skills and 98% of UK secretaries are female (ONS 2017), but instead of soft skills, females could also go (or be pushed) there because it offers lower barriers to entry after parental leave.

	Mean	Standard Deviation
Academia, Research and Teaching	0.982 (Limited positive impact)	2.45
Banking, Finance and Consultancy	0.92 (Limited positive impact)	2.95
Law	1.6 (Some positive impact)	2.04
Engineering	2.49 (Moderate to significant positive impact)	2.1
Medicine and Health	1.58 (Some positive impact)	2.6
Politics, Civil Services and Diplomacy	1.625 (Some positive impact)	1.6

Figure 3.

Qualitative Interviews

Degree of Automatability

All respondents but the taxi drivers stated that automation will change or replace their job. The majority thought their job could only be supplemented, not automated, while a minority anticipated a replacement of their job. The former group justified their projection with the fact that their job involves skills no machine could ever do. Most of these were “human skills” mentioned in the literature review such as empathy and building rapport and trust. Rapport is crucial to make the customer buy, as noted by a retail manager: “[shop assistance] is about the lasting impression the customers have”. He did not think it viable that shop assistance could be automated entirely, and drew on experience with self-scan machines, which he and the other respondent said had neither destroyed jobs nor led to wastage in their stores. The interviewees’ response is highly aligned with the ‘productivity effect’ argument stated by Petropoulos (2017) as well as being consistent with the view that jobs with ‘cognitive and social skills’ are less likely to be replaced by automation. Additionally, trust was pointed out as a factor for gaining investment banking clients as well as for taxi-driving: “Business people won’t trust driverless pods to drive them around.” Apart from the above non-automatable skills, one interpreter added the skill to review translations which she thought could never be done by a machine.

The minority which expected complete replacement was composed of the tube drivers (however, they relied on alternative jobs guaranteed by their union, see Role of Institutions) and the teacher. Although human skills are required for teaching itself, the teacher thought that a lot of other teacher tasks were automatable. Answering student questions in writing could be done by an AI teacher displaying capacities beyond those it had been programmed for, as demonstrated at a teachers’ conference: “The students were learning things that they wouldn’t have learned from an actual physical teacher”. In turn she thought that “[E]ven the jobs that we assume are safe, that we assume require soft skills and human communication (...) are not safe”.

The interviewees’ minority perception agrees with a minority of students who think that automation will reduce their career prospects. The positive interviewees however, those whose jobs would be supplemented, did not express that it would also increase their job or progression prospects. This disagrees with the other part of students, who thought it would have a positive impact. Overall, only two out of 106 students responded automation would have no effect on their career prospects at all, and 80% indicated an effect of 3 or higher on our 1-5 scale.

Estimations of How Soon Automation will be a Reality

In asking respondents about potential worries regarding the degree of automation in their own lives and across society generally, feelings of uncertainty mentioned were to a large extent influenced by how soon they thought it would be implemented. Although Transport for London (TfL) services aim to implement fully automated tube trains by the 2020s (The Independent, 2014), both tube drivers we interviewed reported thinking this was an ‘ambitious’ project, and that it would take longer to introduce driverless trains on all lines without any human presence to supervise. Moreover, some tube and taxi drivers reported that if driverless transportation was likely to affect future generations, their own age and upcoming retirement meant that their job stability would not be affected. Regarding AI, one computer engineering student reported that the current levels of this technology were not yet developed enough to fully replace human jobs, but that this was a real possibility, especially with the introduction of quantum computing. This eventuality was seen as an impending threat by the teacher mentioned above who had attended a conference displaying an AI teacher. The fact that this technology already existed was a source of worry for herself and other colleagues who feared that their implementation might replace ‘physical teachers’ in the near future,

a similar concern to that found by the Pew Research Center’s pessimistic responses about any jobs ever remaining that would not be automated (Rainie and Anderson, 2017:22).

Role of Institutions

During the interviews we conducted, workers across sectors revealed their personal perceptions regarding the role of different institutions in the age of automation, which we hypothesised might be a vital factor affecting people’s degrees of uncertainty about their jobs. With regards to the government’s plan to invest in driverless cars, a taxi driver in Milton Keynes said: “They’re going to spend [...] £56 million on these driverless pods, I think half of that’s going to be paid by the government. We’ve got people living on the streets, do you really think we should be affording that? It’s not going to work.” However, this might be interpreted as “driverless pods are not economically feasible”. Furthermore, concerns about the likely impact of government policies were observed in tube drivers. In addition, respondents tended to think that authorities were more likely to invest in automation if its profitability was significant. One Bakerloo Line tube driver commented: “Bakerloo [line] is not very profitable [...], the line that makes the most money will get changed earlier”. A similar opinion was also conveyed by a university teacher we interviewed, who believed that if automation seems profitable, it will happen. Moreover, organisations like labour unions may impact people’s perceptions regarding the uncertainty of their job. Both of tube drivers we interviewed perceived the union’s power as strong, and showed less concern about job-loss, due to their belief that the union would protect their interest. In contrast, the teacher who perceived the teachers’ union as having weak power seemed more worried about automation, as she did not think it would be able to secure teaching jobs if those were to be automated. Her opinion that the institution representing her sector did not really care about her job security was mirrored in a taxi driver’s claim that the council was not doing anything to protect them against competition from another city: “They’re affecting our livelihood. And that’s why I haven’t earned any money.”

Conclusion

Perhaps the sampled professionals underestimated the effect of automation on their job. Most interviewees, especially taxi drivers and the interpreter, did not see the potential immediacy of changes as suggested by Frey and Osborne (see Table 1). This might indicate that they irrationally underestimate the risk to their job, however it could also be explained by the way Frey and Osborne

calculate automatability. Their probabilities only indicate technological feasibility, not economic feasibility. Accordingly, self-driving taxis may very likely be feasible by 2020, but still be too expensive to pose any threat to taxi drivers.

In contrast, the undergraduate students surveyed generally seemed to attach greater importance to the advances of automation and AI and were more likely to adjust their career decisions and skill sets accordingly. Intuitively, such observations make sense due to the facts that (1) the undergraduate students are at a more flexible stage of their career where they can pivot their activities around developments as they become more apparent but that (2) because they do not yet have full time jobs, they are more uncertain about securing a job in the future as opposed to those interviewed, most of whom already have a job. A further finding is that gender has an effect on how automation is perceived in the lower income bracket – women have a positive and men a negative view. We hypothesise that this may be due to a female tendency to choose professions that require extensive soft skills, which are inherently less automatable. If not, then this might signal that females underestimate the effect of automation compared to males. Further research should try to control for the skillset of the jobs women and men are pursuing.

Profession	Automation probability (Frey and Osborne 2013)	Interviewees: Automation will...
Taxi Drivers	0.89	Not replace my job because people do not trust it
Tube Drivers	Not available	Replace my job entirely
Retail Managers	Not available	Complement my job to a low degree
University Teachers	Not available	Replace a large part of my job
Interpreters	0.38	Complement my job to a low degree
Financial Analysts	0.23	Complement my job to a low degree
Lawyers	0.035	Complement my job to a low degree

Table 1. Source: Interviews, Frey and Osborne 2013

Professionals’ and students’ underestimation of automation, should it be substantiated, could be addressed by both public awareness campaigns and by career advisors in job centres and university

career services. However, we recognise that our research is not detailed enough to establish this substantiveness, given the time and resources available. However, our survey findings can help devise a quantitative survey of professionals. A questionnaire for professionals should be structured similarly our student questionnaire, asking if respondents learn coding and why. However, a first part should disentangle the actual effect on fear of job security of automation fear, from other factors such as the business cycle, local competition, or outsourcing. Questions could include adapted versions of our interview questions, e.g. "How confident are you in the stability of your job on a scale of 0 to 10?". The survey should also control for union membership and its strength, as three of our interviews identified union membership as a potential bias.

References

- Acemoglu, Daron, and Pascual Restrepo. (2017). 'Robots and Jobs: Evidence from US Labor Markets'. w23285. Cambridge, MA: National Bureau of Economic Research. doi:10.3386/w23285.
- Deloitte LLP. (2015). 'From Brawns to Brains: The Impact of Technology on Jobs in the UK'. London: Deloitte. <https://www2.deloitte.com/uk/en/pages/growth/articles/from-brawn-to-brains--the-impact-of-technology-on-jobs-in-the-u.html>.
- Eleftheriou-Smith, Loulla-Mae. (2014). "'Driverless" Tube Trains: See inside TfL's New Fleet for London'. The Independent. October 9. <http://www.independent.co.uk/news/uk/home-news/driverless-tube-trains-see-inside-tfls-new-london-underground-fleet-9785034.html>.
- Fereday, Jennifer, and Eimear Muir-Cochrane. (2006). 'Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development'. *International Journal of Qualitative Methods* 5 (1): 80-92.
- Frey, Carl Benedikt, and Michael Osborne. (2013). 'The Future of Employment: How Susceptible Are Jobs to Computerisation?' Oxford: Oxford Martin School. <http://www.oxfordmartin.ox.ac.uk/publications/view/1314>.
- Handel, Michael J. (2016). 'The O*NET Content Model: Strengths and Limitations'. *Journal for Labour Market Research* 49 (2): 157-76. doi:10.1007/s12651-016-0199-8.
- Keynes, John Maynard. (1963). *Essays in Persuasion*. Norton Paperback. New York: Norton.
- Lacity, Mary Cecelia, and Joseph W. Rottman. (2008). *Offshore Outsourcing of IT Work: Client and Supplier Perspectives*. Technology, Work and Globalization. Basingstoke [England]; New York: Palgrave Macmillan.
- Mason, J. (2002). *Qualitative Researching*. 2nd edition. Sage Publications.
- O*NET Resource Center. (2017). 'Questionnaires'. Accessed June 6. <https://www.onetcenter.org/questionnaires.html>.
- ONS. (2017). 'EMP04: Employment by Occupation. April to June 2017'. Office for National Statistics (ONS). <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyoccupationemp04>.
- Petropoulos, Georgios. (2017). 'Do We Understand the Impact of Artificial Intelligence on Employment?' Bruegel Blog Posts. April 27. <https://search.proquest.com/docview/1893850011?accountid=9630>.
- Rainie, Lee, and Janna Anderson. 2017. 'The Future of Jobs and Jobs Training'. Pew Research Center. <http://www.pewinternet.org/2017/05/03/the-future-of-jobs-and-jobs-training/>.
- Savage, Michael. (2010). '1951: The Interview and the Melodrama of Social Mobility'. In *Identities and Social Change in Britain since 1940: The Politics of Method*. Oxford University Press.
- Susskind, Richard E., and Daniel Susskind. (2015). *The Future of the Professions: How Technology Will Transform the Work of Human Experts*. First edition. Oxford, United Kingdom: Oxford University Press.
- Willcocks, Leslie P., and Mary C. Lacity. (2016a). *Service Automation: Robots and the Future of Work*. A Steve Brookes Publishing Book. Warwickshire: Steve Brookes Publishing.
- Willcocks, Leslie P., and Mary C. Lacity. (2016b). 'Businesses Will Increasingly Use Robots to Deal with the Explosion of Data'. LSE Management. February 2. <http://blogs.lse.ac.uk/management/2016/02/02/businesses-will-increasingly-use-robots-to-deal-with-the-explosion-of-data/>.

Appendix

Survey respondent demographics

Respondents by Gender

	Frequency	Percent
Female	66	62.3
Male	39	36.8
Other	1	.9
Total	106	100.0

Respondents by Annual Household Income

	Frequency	Percent
Below £10,000	21	19.8
£10,000 to £25,000	25	23.6
£25,001 to £50,000	13	12.3
£50,001 to £100,000	12	11.3
£100,001 to £250,000	9	8.5
£250,001 to £500,000	2	1.9
£500,001 to £1,000,000	2	1.9
Above £1,000,000	1	.9
Don't know	13	12.3
Prefer not to say	8	7.5
Total	106	100.0

Respondents by region of origin

	Frequency	Percent
East Asia	18	17.0
Middle East	5	4.7
South Asia	27	25.5
Southeast Asia	32	30.2
USA	1	.9
West Europe	23	21.7
Total	106	100.0

Respondents by place of study

	Frequency	Percent
UK	45	42.5
India	19	17.9
Malaysia	17	16.0
USA	6	5.7
France	5	4.7
Germany	5	4.7
Singapore	2	1.9
China	1	0.9
France	1	0.9
Germany	1	0.9
India	1	0.9
Israel	1	0.9
Kazakhstan	1	0.9
Lebanon	1	0.9
Total	106	100.0

Respondents by intended sector of career

	Frequency	Percent
Academia, Research and Teaching	23	21.7
Banking, Finance and Consultancy	30	28.3
Creative Industry	4	3.8
Engineering	7	6.6
Interpersonal relations	1	.9
Journalism	2	1.9
Law	5	4.7
Medicine and Health	12	11.3
Other	14	13.2
Politics, Civil Services and Diplomacy	8	7.5
Total	106	100.0

Survey questionnaire

- What is your age?
- What is your gender?
- What is your country of origin?
- Which country do you currently primarily reside in?
- What is your approximate annual household income level?
- What is your current level of education?
- What subject/degree do you plan on pursuing/are you currently pursuing?
- Why do you want to pursue the degree or subject you have mentioned in the previous answer?
 - o Below we have listed some common reasons. Please pick a number from 1 to 5 for each of these reasons according to their importance in making your decision, with the key being: 1: Not important 2: Somewhat important 3: Moderately important 4: Quite important 5: Extremely important.
 - o Personal interest
 - o Family's opinion or choice
 - o Future employment stability
 - o Future earning prospects
 - o Leaves scope for experimenting in different career paths in the future
- Do you have any other particular reason?
- What career/profession do you plan on having in the

future?

- Are you currently doing or planning on doing any coding or programming courses by choice?

- o If yes:

- Which programme(s) do you plan to learn/are you learning? (Mention “undecided” if not sure of which programme)

- Where do you plan to learn it/are you learning it?

- At school/college/university

- In an online course

- At a separate institution or from a personal tutor (ie, not at current school/college/university)

- Why are you learning it or planning to learn it?

- Below we have listed some common reasons. Please pick a number from 1 to 5 for each of these reasons according to their importance in making your decision, with the key being: 1: Not important 2: Somewhat important 3: Moderately important 4: Quite important 5: Extremely important.

- Personal Interest

- Strengthening future career prospects

- Trying to expand skills

- Common choice among peers

- Family’s choice or advice

- o If no: Why do you not learn such a programme? (check all that apply)

- Not interested.

- Not skilled enough at programming or coding.

- Not relevant to my career plans.

- How informed, in your opinion, are you about recent developments in the fields of automation and the concept of Artificial Intelligence (AI) in general?

- o Use the scale of: 1: Not informed at all 2: Somewhat informed 3: Moderately informed 4: Reasonably well-informed 5: Extremely well-informed

- Here we have provided definitions and short explanations of two concepts. Please read them before proceeding to the next section.

- o Automation:

- o It is the use or introduction of automatic equipment in a manufacturing or other process or facility.

- o For most of documented history leading up to current times, machines and automatic equipment gradually replace corresponding manual labour by humans. In most cases, due to such replacement, skill sets of the labour force accordingly adjust over time to meet newer types of skills demanded in production processes.

- o Artificial Intelligence (AI):

- o This is a subset of automation that has seen significant progress in recent years. Essentially, machines that have AI operate independently, perceive their environment, adapt to change, and create and pursue goals to achieve the best expected outcome. A significant characteristic that sets AI apart from conventional automation is that while regular automation usually replaces mostly physical work carried out by humans, AI essentially replaces more and more sophisticated functions of the human brain.

- Quick comprehension question: What aspect of AI is different from conventional automation? (Only proceed to next section until correct answer selected: AI mimics brain functions more than conventional automation does.)

- Having read the information provided, how informed, in your opinion, are you now about the concept of AI in general?

- How much impact do you think AI will have in the future prospects of the career/profession you have previously mentioned that you wish to pursue?

- In your opinion, will this impact generally be of a positive or negative nature?

- How much did you take into account your idea of any such impact while making your choice of such a career?

- How much did you take into account your idea of any such impact in deciding to learn or planning to learn (or deciding not to learn) any programming?

Interview questions

Tube drivers:

1. Do you mind telling us your age?
2. How many people live in your household? How many of them are earning money?
3. What kind of work are you doing? Can you briefly describe your job? What does the job require you to do?
4. How long have you been working in this job? Had you been working in the same field before that?
5. What made you go into this field and job?
6. What kind of steps did you take to get there? (probes: education, vocational training, contacts etc.)
7. What do you value about your job?
8. How confident are you in the stability of your job? Would you be able to rank that on a scale of 1-10?
9. Are you aware of any impending risks to your job in the near future?
10. (depending on answer to (3))Have you driven a train on either Jubilee, Central, Victoria and Northern line? Are we right that these trains only require drivers to open/close doors?
11. How is working on these trains different from other lines? pay?
12. Are you aware that Transport of London intends to introduce driverless tube trains on the Central, Bakerloo, Piccadilly, and Waterloo & City lines by the mid-2020s?
13. Do you have any alternative plans in the case that you should be replaced in your job because of automation?
14. What does this imply in terms of your financial prospects?
15. How do you think the trade union is going to affect your level of stability in terms of jobs sustainability.. What role do you think the trade union will play in the age of automation?

Supermarket middle managers:

1. Age, how long have you been working in this line
2. How many people live in your household? How

many of them are earning money?

3. What kind of work are you doing?
4. How long have you been working in this job? Had you been working in the same field before that?
5. What made you go into this field and job?
6. What kind of steps did you take to get there? (probes: education, vocational training, contacts etc.)
7. What do you value about your job?
8. How confident are you in the stability of your job? Would you be able to rank that on a scale of 1-10?
9. British Retail Consortium predicted UK's 900,000 shop jobs would disappear by 2025 as companies use technology instead of people. Are you aware of potential job loss in the next decade?
10. How soon do you think that the self service kiosk will completely replace cashiers? It is claimed that self-service check-out/kiosk...
 - Is more convenient (for companies like Mcd- can improve order accuracy)
 - Can save labour cost
 - As the fight for a higher minimum wage continues, some argue that higher labor costs will force companies to cut staff. What is your opinion on this?
11. Are you aware of any impending risks to your job in the near future?
12. How is working as a cashier different from other lines (with automated tills different from work with classic tills)? Pay?
13. Do you have any alternative plans in the case that you should be replaced in your job because of automation?
14. What does this imply in terms of your financial prospects?
15. Are you a member of USDAW? Any other union? Y What do you think this union's role will be in ensuring the sustainability of your job?

Prospective Investment Banker / Economics Student:

1. Age, degree, year of study
2. Household composition and professional status

3. Reasons for choice of degree
4. Ideas of future jobs/prospects
5. What kind of courses do you take and additional knowledge of technological and computing skills do you have?
6. Knowledge of AI (how do you understand it and how it's being introduced in society and the labour market, do you think it's more of a positive or negative thing etc)
7. Do you think AI is a potential threat to certain professional sectors? How soon do you think this will be an important reality?
8. How confident are you in the stability of jobs you might be interested in? On a scale of 1-10
9. If it turns out that fields you are interested in are increasingly replaced by AI, what alternatives are you considering looking into?
10. Are you confident when planning your professional future? (Probe: any uncertainties, doubts, back-up plans etc)

Taxi drivers:

1. Age
2. How many people live in your household? How many of them are earning money?
3. What kind of work are you doing?
4. How long have you been working in this job? Had you been working in the same field before that?
5. What made you go into this field and job?
6. What kind of steps did you take to get there? (probes: education, vocational training, contacts etc.)
7. What do you value about your job?
8. How confident are you in the stability of your job? Would you be able to rank that on a scale of 1-10?
9. Are you aware of any impending risks to your job in the near future?
10. We found out that recently, a few months back, driverless pods were tested in Milton Keynes, which is why we came up here today. The initial trials will be developed into a larger scale programme that will see a fleet of 40 self-driving pods on pedestrianised streets and road-based autonomous vehicles in

Milton Keynes and Coventry.

Do you think things like this would affect the stability or future of the job that you do?

11. Do you have any alternative plans in the case that you should be replaced in your job because of automation?
12. What does this imply in terms of your financial prospects?
13. Are you part of a trade union?
14. How do you think the trade union is going to affect your level of stability in terms of jobs sustainability.. What role do you think the trade union will play in the age of automation?