Which digital skills do you really need?

Exploring employer demand for digital skills and occupation growth prospects

Jyldyz Djumalieva, Data Science Research Fellow, Nesta
Cath Sleeman, Quantitative Research Fellow, Nesta

By 2030 the job market will look dramatically different. Previous Nesta research has predicted that about 10 per cent of workers are in occupations that are likely to grow as a share of the workforce and 20 per cent will shrink. As for the remaining jobs, their outlook is more uncertain. Although unsettling, this disruption needn't be disastrous for the workforce. There is an opportunity for employees in uncertain or shrinking occupations to improve their prospects by investing in the right skills.

Policymakers consider digital skills to be a top priority for investment. They are seen as offering people greater employability and job resilience. But are all digital skills created equal?

Our analysis, described in detail below, shows that not all digital skills will be equally important in the future. In fact, occupations which we are more certain will have poor prospects, are more likely to require a digital skill than the occupations that are most likely to grow by 2030. This is because the relationship between the digital intensity of an occupation and its potential for growth is not straightforward: there are occupations that are currently not digitally intensive, but are expected to grow in the next 10-15 years, as varied as teachers and chefs. The type of digital skills needed in a job also makes a difference: the digital skills most likely to be needed in growing occupations are ones that are used in non-routine tasks, problem-solving and the creation of digital outputs.

This is exploratory analysis that takes a novel approach. At Nesta we will continue to study the demand for skills and the future of work, which is in itself a shifting landscape.

Job adverts can help us to measure the demand for digital skills

To find out which digital skills will be most needed in the future, we investigated employer demand for digital skills using online job adverts. Online job postings are a great source of near real-time information on the labour market. In addition to vast volumes (our dataset contains 41 million UK adverts), job adverts also offer more granular data than skill surveys as they allow employers to describe their skill needs more precisely.

The data that we used for the analysis was collected between 2012 and 2017 by Burning Glass Technologies, a labour market analytics software company. For each job posting, Burning Glass identified and extracted skills that had been mentioned in the advert. There are 11,425 unique skills mentioned across all job adverts. In this context, 'skills' is a broad term that refers to all employer requirements including knowledge and competences.

We use machine learning methods to identify digital skills

The definition of digital skills can vary depending on the objective, audience and context and this makes it challenging to determine which skills are digital and which are not. For this analysis, we start with a list of skills that are actually software programmes, such as **Maya** or **PeopleSoft**. Next, we add skills which tend to be mentioned alongside software skills in job adverts. Examples of these skills are **3D animation**, **Data mining** and **Agile development**. To find these skills we use a machine learning technique called word embeddings.[1] We train a word embeddings model on all job adverts and generate vector representations of skills, which we can then use to measure skill similarity. Two skills will have a high similarity if they tend to co-occur in the same job advert. For example, **Frontend technology** is often mentioned in the same adverts as the software framework **Angularjs**, so we add the former to the digital skills list. In total, we identify 1,358 digital skills: 756 because they are types of software and 602 additional skills via word embeddings.

Given the large number of digital skills, we group them into clusters using a skills taxonomy, which we have developed as part of Nesta's contribution to a research centre called ESCoE (Economic Statistics Centre of Excellence).[2] In some instances, the name of a skill cluster might refer to a broader range of skills than just digital. For example **Taleo** or **Applicant tracking systems** are digital skills used in **HR Management** which is a cluster that also includes non-digital skills. In these instances, we only focus on the digital skills within the cluster. See Table 1 for examples of the most popular digital skills in each skill cluster.

We focus on occupations most likely and least likely to grow

In the *Future of Skills* report,[3] Bakhshi et al., estimate the probability that individual UK occupations will grow or shrink, as a share of the workforce, over the next two decades. They arrive at these estimates using a combination of expert judgement and machine learning. The authors find that around 30 per cent of workers are in occupations either highly likely to grow as a share of the workforce (probability of growth >= 0.70) or highly likely to shrink (probability of growth <= 0.30). The prospects for the remaining 70 per cent of jobs are much more uncertain. Our analysis focuses just on the first two groups in order to better contrast digital skill needs across occupations.

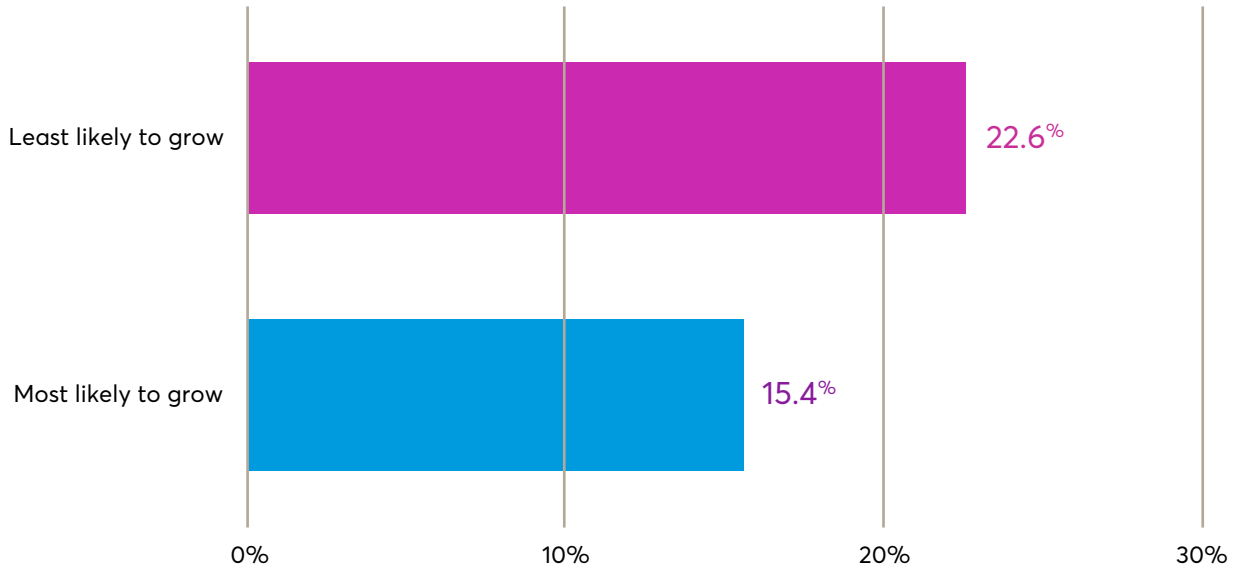
In order to explore how demand for different digital skills varies between the two groups of occupations we fit a logistic regression model and analyse which skill clusters are most closely associated with each group.

Here are some key findings and insights.

Measuring only overall demand for digital skills can be misleading

The overall demand for digital skills does not tell us much about an occupation's growth prospects. As shown in Figure 1, the occupations that are least likely to grow have a higher digital intensity. Digital intensity can be measured in different ways using the information contained in online job adverts: here, it is measured as the proportion of job adverts for that occupation that mention at least one digital skill. If anything, it appears that occupations that are most likely to decline have a higher level of demand for digital skills.

Figure 1. Digital intensity* of occupations that are most and least likely to grow.



*Weighted average digital intensity is calculated using Labour Force Survey data on share of employment in each 4-digit Standard Occupational Classification (SOC) code

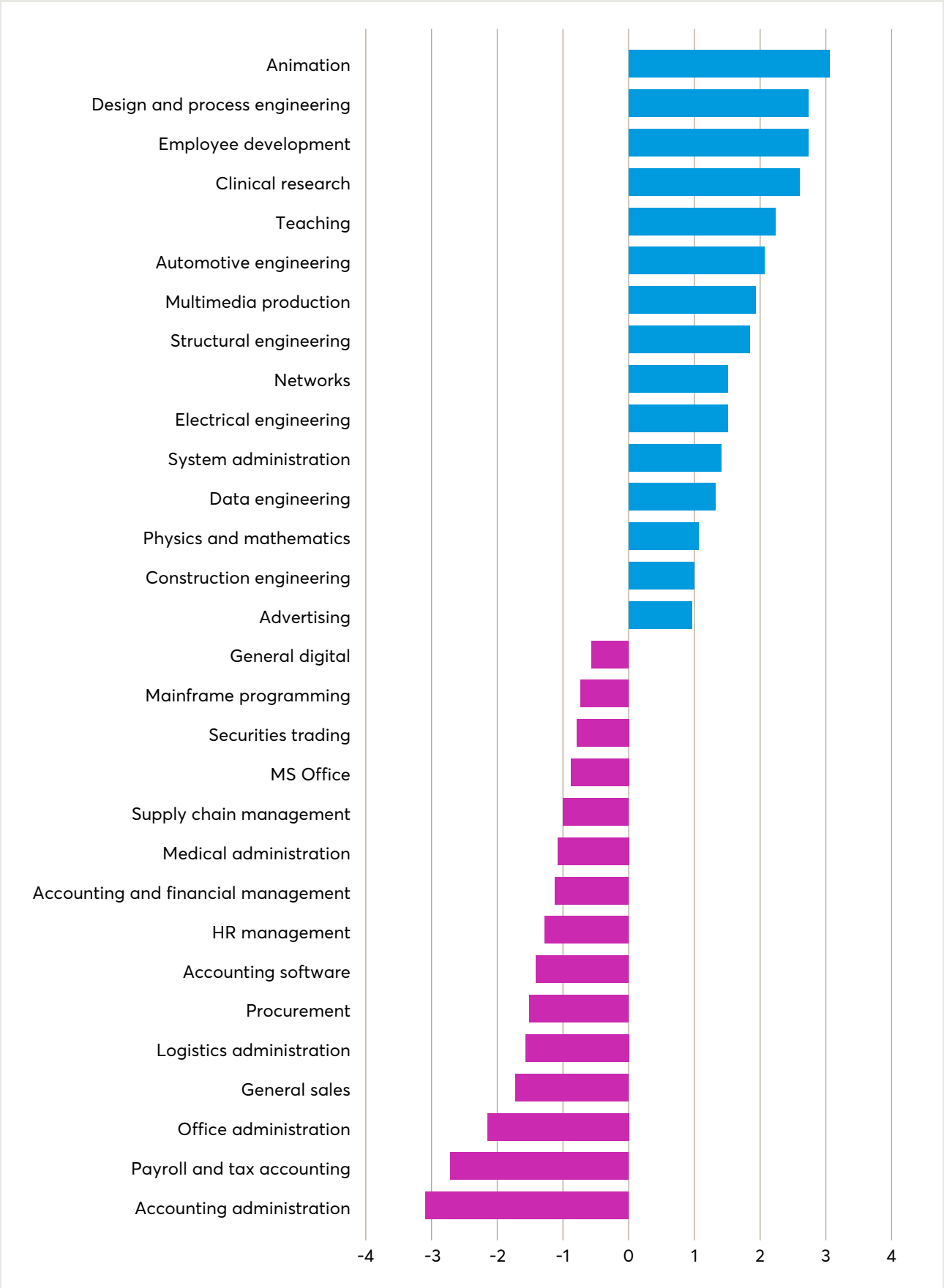
However, we see noticeable differences between the occupations when we factor in the type of digital skills required.

Certain digital skills are much more prominent in occupations with a low probability of growth

The analysis shows that skills related to using software for administrative purposes (e.g. payroll, accounting, supply chain, sales, etc.) are more prevalent in occupations that are predicted to decline. Examples of these software tools include **ADP Payroll**, **Navision** and **SAP Warehouse Management**.

In contrast, digital skills used in animation, engineering, education and computing are more prevalent in occupations that are predicted to grow (Figure 2). Examples of these software include **Autodesk MotionBuilder**, **Ansys** and **Blackboard LMS**.

Figure 2. Coefficients for 15 skill clusters that are most and least predictive of an occupation's growth prospects.[4]

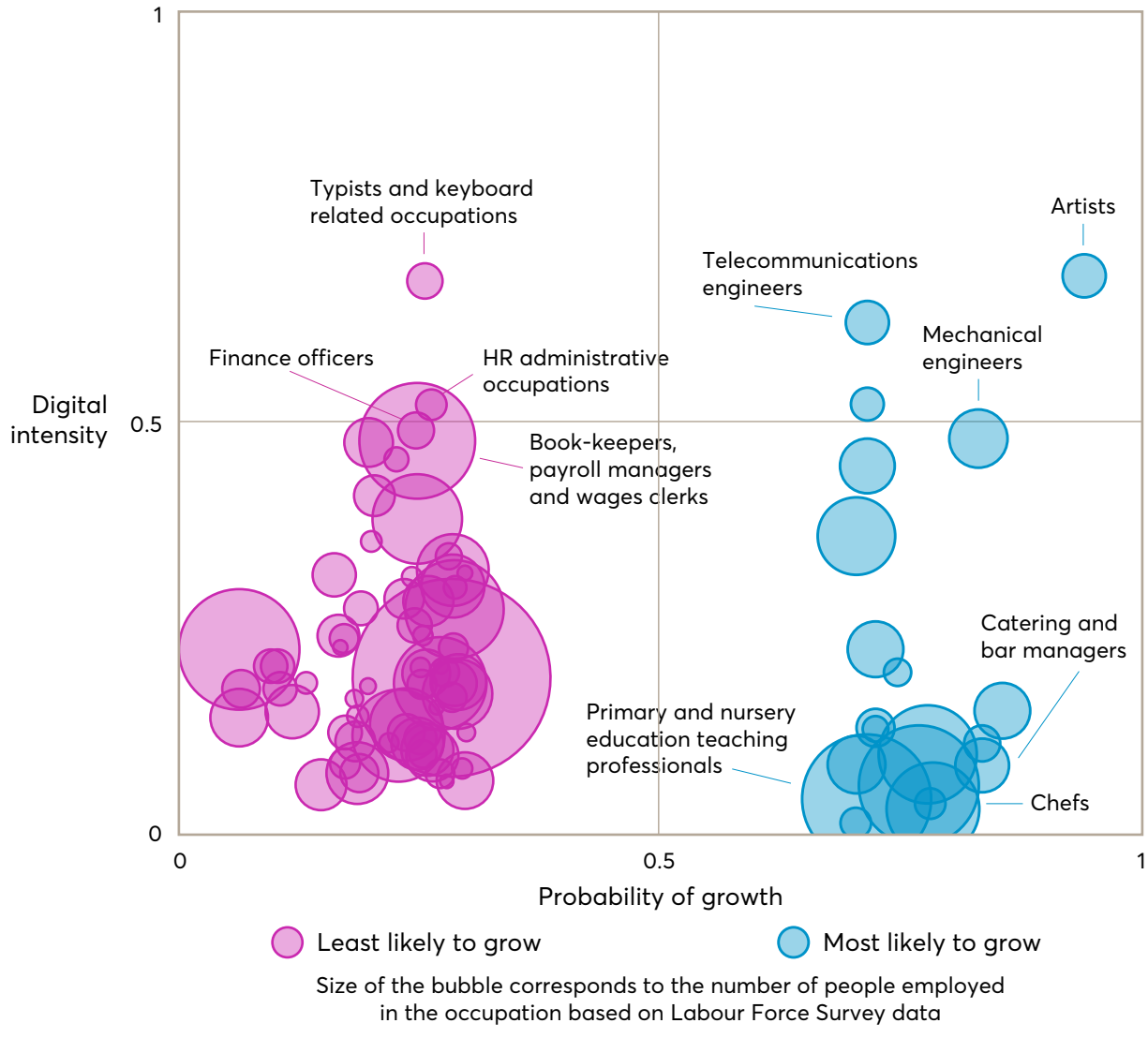


These findings suggest that **not all digital skills will be equally important in the future**. The demand for those digital skills which involve non-routine tasks, problem-solving and creation of digital content (e.g. graphic and engineering designs, software products/services, analytical outputs, etc.) is positively correlated with occupations that have brighter outlooks.

The relationship between digital intensity and probability of growth is not straightforward

Some occupations are likely to grow, but are not currently digitally intensive (bottom right hand quadrant of Figure 3). These occupations include **Primary and secondary teaching professionals**, **Chefs**, **Catering and bar managers**. Other occupations, including **Artists**, **Mechanical engineers** and **Telecommunications engineers**, both require digital skills and are likely to grow (top right hand quadrant of Figure 3).

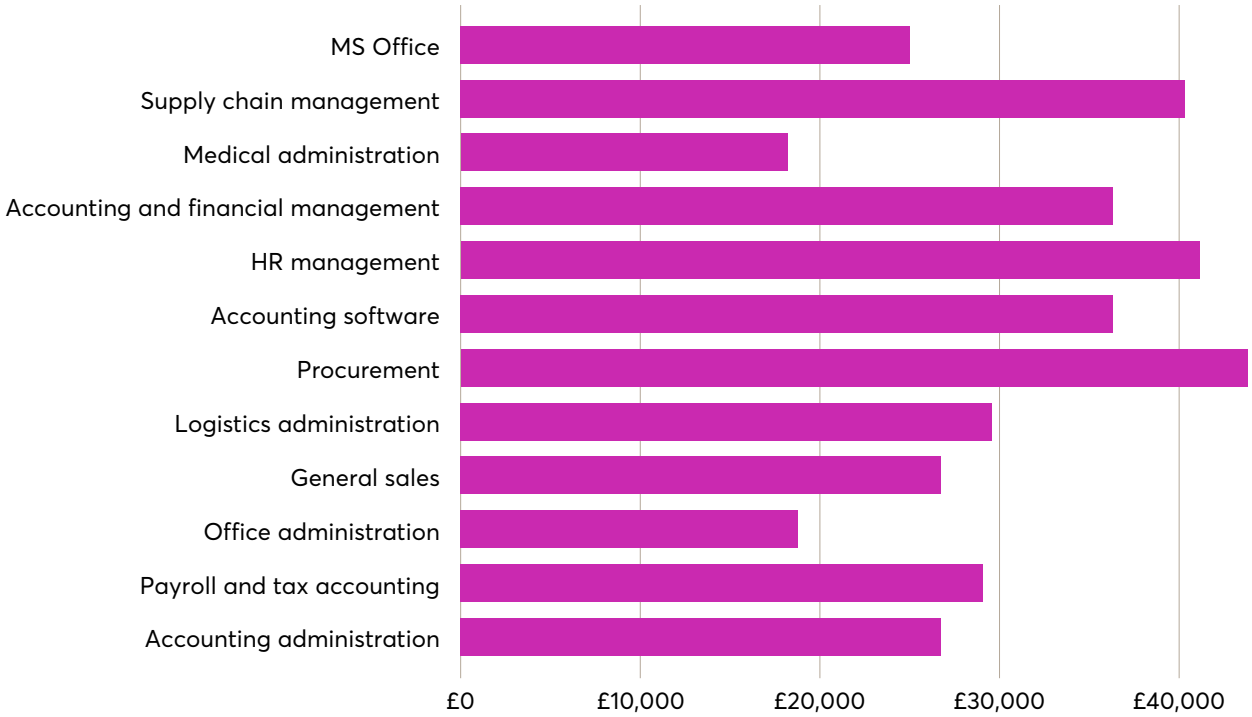
Figure 3. Digital intensity and occupations' probability of growth.



Some skills that pay relatively well are more closely associated with occupations that are expected to shrink

It is not only low paid skills that are linked to occupations that are likely to shrink. As shown in Figure 4, there are digital skills in **Supply chain management**, **Procurement** and **HR management** that offer a relatively high salary, but are used primarily in occupations that are likely to shrink. If these predictions are correct, then these skills may become less important in years to come.

Figure 4. Average offered salary over 2012-2017 across skill clusters most prominent in occupations least likely to grow.



Limitations of the analysis

It is important to mention several limitations of this analysis. First, online job adverts have imperfect coverage and tend to be biased towards high-skilled occupations. There are also job adverts with incomplete information on employer requirements. This means that we are potentially missing data on demand for skills, including digital skills. At the same time, compared to alternative sources of data on skills demand, online job adverts still provide the largest sample size and highest granularity for employer skill needs. The adverts also describe digital skills in the language used by employers and because of this are more useful for job seekers and training providers.

Conclusion

In this paper we examined the relationship between digital skills and predictions about the future of employment. We found that the digital skills most likely to be needed in the future are ones that are used in non-routine tasks, problem-solving and the creation of digital outputs. On the other hand, the digital skills that are linked to occupations least likely to grow tended to relate to the use of software for administrative purposes. We also found that the relationship between the digital intensity of an occupation and its prospects for growth is not straightforward: there are occupations that are currently not digitally intensive, but are expected to grow in the next 10-15 years.

In summary, not all digital skills appear to be of equal importance. Decision-making on investment in digital skills development should take these differences into account. Otherwise, we may risk funding training in certain digital skills that then become redundant in the not too distant future.

Acknowledgements

We would like to thank Burning Glass Technologies for supplying the data and ESCoE for their support.

Table 1. Examples of the most popular digital skills in each skill cluster.

Skill cluster	Skill examples
Accounting administration	Accountancy systems, QuickBooks, VLOOKUP
Accounting and financial management	Management reporting, pivot tables, data manipulation
Accounting software	Accountancy software, Navision, Oracle Financials
Advertising	Media planning, web analytics, Google AdWords
Animation	Adobe After Effects, Maya, game development
App development	Android, Objective-C, mobile application design
Automotive engineering	Vehicle systems, fuel cell engineering
Bi and data warehousing	Oracle, Visual Basic, data warehousing
Business analysis and IT projects	Microsoft SharePoint, PRINCE2, Microsoft Dynamics
Civil engineering	Structural design, MicroStation, CEng
Clinical research	Biostatistics, clinical data management, Clinical Data Interchange Standards Consortium (CDISC)
Complex sales	Salesforce, outbound marketing, WideOrbit Automation
Construction engineering	Microsoft Project, Primavera, interior design

Data engineering	Optimisation, Python, trading systems
Design and process engineering	Mechanical design, product design, CATIA
Diagnostic imaging	Radiology, medical imaging
Digital content authoring	ActionScript, proofreading, Adobe Flash
Digital marketing	Online marketing, Google Analytics, social networking
Electrical engineering	SCADA, switchgear, CIMPLICITY
Electronics	Electronic design, simulation, test equipment
Employee development	Sales automation software, learning management system, virtual training
Environmental planning	Geographic information system (GIS), urban design, ArcGIS
Event planning	Newsletters, copywriting, website management
Financial asset management	Fund accountancy, econometrics, SharePoint portal server
General digital	Computer skills, data analysis
General sales	Customer relationship management (CRM), CRM software, GoldMine
Graphic and digital design	Adobe Photoshop, Microsoft Publisher, website design
HR management	SAP HR, HRIS, HRMS
IT support	IT support, application support, Microsoft Exchange
Journalism and writing	Blogging, news editing, feature writing
Logistics administration	Order management, electronic data interchange, order tracking in SAP
Mainframe programming	Mainframe, COBOL, TestDirector
Manufacturing methods	ISO 9001 standards, computer-aided manufacturing (CAM), failure modes and effects analysis (FMEA)
Marketing research	SAS, SPSS, data mining
Marketing strategy and branding	Database marketing, e-marketing, Eloqua
Medical administration	Word processing, medical records organisation, medical records retrieval

MS Office	Microsoft Excel, Microsoft Office, Microsoft PowerPoint
Multimedia production	Multimedia, camera operation, Final Cut Pro
Networks	Wide area network (WAN), switches, network installation
Office administration	Typing, Microsoft Outlook, Lotus applications
Payroll and tax accounting	Payroll reports, PeopleSoft, data validation
Physics and mathematics	Mathematical modelling, machine learning, high-performance computing
Procurement	Purchase-to-pay, procure-to-pay, mySAP
Recruitment	Taleo, applicant tracking system, talent management system
Research methods and statistics	Statistics, quantitative data analysis, Stata
Securities trading	Visual basic for applications (VBA), risk system, Misys
Servers and middleware	Apache web server, extensible stylesheet language (XSL), SOAP
Shipping and warehouse operations	SAP implementation, SAP Warehouse Management, Maximo
Software development	SQL, Java, Microsoft c#
Structural engineering	Engineering design, structural drawings, piping design
Supply chain management	SAP, enterprise resource planning (ERP), supply chain solutions
System administration	Linux, Citrix, Windows Server
Teaching	Moodle, maintaining student records, managing student data
Web development	Hypertext preprocessor (PHP), jQuery, MySQL

Endnotes

1. Jurafsky, D. and Martin, J.H. (2017) 'Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition.' London: Pearson.
2. Djumalieva, J. and Sleeman, C. (forthcoming) 'An Open and Data-driven Taxonomy of Skills Extracted from Online Job Adverts'. London: Nesta.
3. Bakhshi, H., Downing, J., Osborne, M. and Schneider, P. (2017) 'The Future of Skills: Employment in 2030'. London: Pearson and Nesta.
4. The results are obtained by fitting a logistic regression model. Model coefficients are used as indicators of the extent to which a skill cluster is predictive of an occupation's probability of growth. All but one of the coefficients are statistically significant at $p <= 0.01$.

About Nesta

Nesta is a global innovation foundation. We back new ideas to tackle the big challenges of our time.

We use our knowledge, networks, funding and skills - working in partnership with others, including governments, businesses and charities. We are a UK charity but work all over the world, supported by a financial endowment.

To find out more visit **www.nesta.org.uk**

If you'd like this publication in an alternative format such as Braille, large print or audio, please contact us at: **information@nesta.org.uk**

58 Victoria Embankment
London EC4Y 0DS

+44 (0)20 7438 2500
information@nesta.org.uk
@nesta_uk
www.facebook.com/nesta.uk
www.nesta.org.uk