

# Mapping Career Causeways:

A user guide for providers of careers information, advice and guidance, policymakers and employers

Using a data led approach to support job transitions in a changing labour market.



# Contents

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	<b>Introduction</b>	<b>3</b>
	<b>Project overview</b>	<b>5</b>
	Methodology	6
	Key findings	7
	<b>Use cases</b>	<b>9</b>
	Providers of careers information, advice and guidance - Enriching the advice given to workers	10
	Policymakers - Identifying and supporting at-risk workers	15
	Employers - Redeploying and upskilling workers	21
	<b>Algorithm tutorials</b>	<b>24</b>
	Tutorial #1 - Generating and analysing transition recommendations	25
	Tutorial #2 - Exploring the underlying occupation and skills data	26
	Tutorial #3 - Exploring skills gaps	26
	<b>Further information</b>	<b>27</b>



# Introduction

**Automation is changing the landscape of work, accelerated by the COVID-19 pandemic. As economies look to recover, millions of workers across Europe will need to retrain in order to transition into new roles. Focusing on occupations at a lower risk of automation will be a better investment for individuals and economies more widely.**

Nesta's [Mapping Career Causeways](#) project, supported by [J.P. Morgan](#) as part of their [New Skills at Work](#) initiative, applied state-of-the-art data science methods to create an algorithm that recommends job transitions

and retraining to workers, with a focus on supporting those at high risk of automation. The algorithm works by measuring the similarities between over 1,600 jobs in a '[map of occupations](#)', based on the skills and tasks that make up each role. The algorithm does not have a user interface. However, we have released the codebase and developed a range of tutorials which can be used to extract these insights for any given occupation. These are detailed further on in this guide.

This user guide serves as a practical tool for key audiences to take the insights and learnings from the Mapping Career Causeways project and implement them directly in their work. While we have considered career transitions primarily from the standpoint of necessity due to automation risk and exposure to COVID-19, the insights from this project are applicable to anyone who is supporting workers and job seekers as they navigate the labour market.

## Who is this guide for?

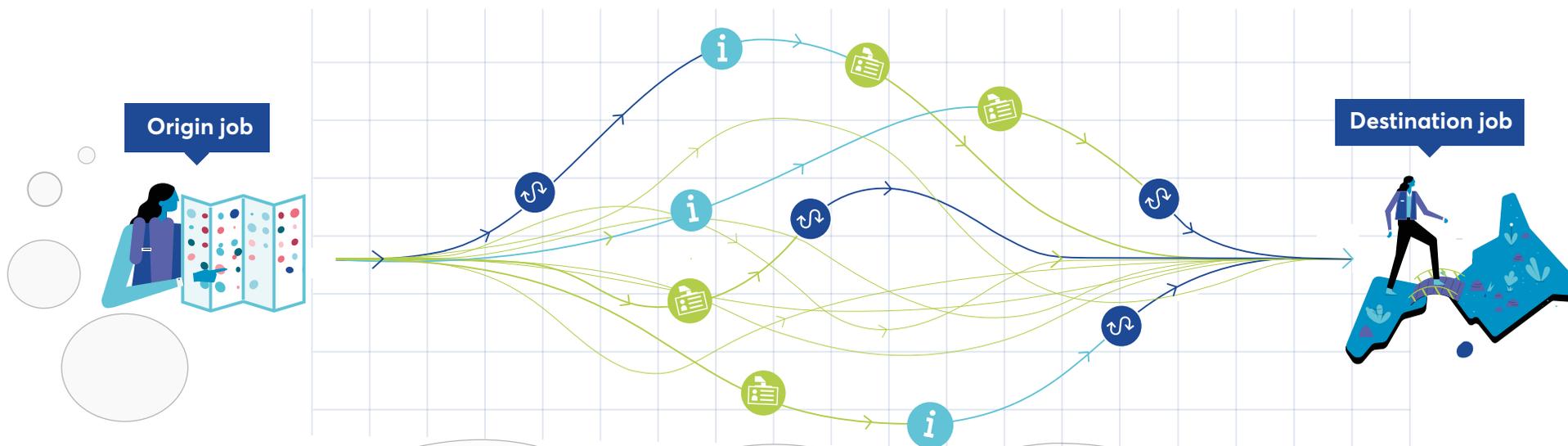
This user guide is aimed at the three key groups that typically act as touchpoints for workers and job seekers as they navigate the labour market:

- i** **Providers of careers information, advice and guidance** (such as career advisors, further and higher education institutions or intermediary organisations)
- ↻** **Policymakers** (via local government interventions and employment support programmes)
- 📋** **Employers** (during recruitment, performance appraisals and restructuring processes)



# Potential worker touchpoints: Unique paths for every worker

This infographic shows that workers and job seekers may seek answers to a variety of questions from three key groups, on topics ranging from retraining to automation risk. For each of these key groups we have identified a primary use case for the Mapping Career Causeway insights to help to provide answers to those questions.



During interactions with:

Workers' questions

Use cases

Outcomes from interactions



## Providers of careers information, advice and guidance

- What career transition options are available to me given my current skills?
- What skills can I learn that will open up more safe and desirable job transitions for me?

**Enriching the advice given to workers:**  
Provide a standardised source of data that incorporates automation risk to recommend career transitions and upskilling opportunities for workers in high-risk roles.

BROADENED CAREER HORIZONS



## Policymakers

- How at-risk is my sector?
- What are the most beneficial skills for me to gain, based on my sector?
- What are the safest jobs and sectors for me to transition to?

**Identifying and supporting at-risk workers:**  
Identify the groups of workers who are most at risk of automation and recommend specific skills that would help these groups to move into lower-risk roles.

LONGER-TERM JOB SECURITY



## Employers

- What options are available for me to progress from my current role?
- What transferable skills do I have?
- What training or skills development should I focus on?

**Redeploying and upskilling workers:**  
Identify more suitable job transitions and skills development opportunities that would lower the automation risk for their workers.

CLEARER PROGRESSION PATHWAYS



# Project overview

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Mapping Career Causeways uses open data to map pathways, or 'career causeways', to occupations for people whose jobs are likely to be adversely affected by automation. This project aimed to fill gaps in existing research and provide new information and tools that can be used to highlight opportunities for workers who are likely to be displaced from their jobs. As the project has progressed, we have seen the beginnings of the devastating impact of the COVID-19 pandemic on the labour market and wider economy. This led us to broaden our approach in order to ensure the project findings would be relevant to a wider audience at this critical time.

# Methodology

A three-step approach was used to measure automation risk for over 1,600 occupations and identify potential transitions for at-risk workers.

## 1 Measuring automation risk

We used the results of a study from the USA by [Brynjolfsson, Mitchell and Rock \(2018\)](#) which rated thousands of tasks that make up US occupations on their suitability for automation. We translated this to a European context by matching each US occupation to a European occupation as these are defined in the European multilingual classification of Skills, Competences, Qualifications and Occupations ([ESCO](#)).

## 2 Identifying at-risk workers

To identify the characteristics of at-risk workers, we focused on three European countries: the UK, France and Italy. We built up a picture of workers (including their gender mix, income and education levels) and their working patterns (i.e. full time or part time) using microdata from the [European Union Labour Force Survey](#).

## 3 Recommending transitions

For each occupation at high risk of automation, we identified alternative occupations that are similar and that a worker could potentially transition into. We measured 'similarity' between pairs of occupations by comparing the essential and optional skills required to perform each job, the particular work activities, the interpersonal, physical and structural work characteristics, and the typical levels of education and experience required for the role.

Those jobs which are sufficiently similar to a worker's current role were deemed '**viable transitions**' for the at-risk worker. The subset of these occupations which offer comparable or higher levels of pay were called '**desirable transitions**'. Finally, among the desirable transitions we identified a smaller subset of roles that will likely reduce a worker's

exposure to automation risk. We called these '**safe and desirable transitions**'.

The risk of automation was measured by assessing the suitability of the tasks within an occupation for machine learning. We also considered the role of 'bottleneck tasks'. These are the tasks that score low on some

automation dimensions and, in doing so, may slow, or even prevent, the automation of an occupation. Of course, suitability for machine learning is a necessary but not sufficient condition for automation, and there may be legal, cultural, financial and organisational barriers that also slow the automation process.



## Key findings

Our research identified several key findings that may aid those supporting workers and job seekers as they navigate the labour market. We have highlighted some of the findings below. For the complete list, please see our [full report](#).

**1 Automation risk is higher when jobs have predictable environments and involve routine interactions.**

The occupational groups with the highest concentration of these tasks, and therefore the highest relative risk, are: sales and customer service workers, financial and mathematical associate professionals, and administrative and business clerks.

**2 A special set of core skills can broaden the options for a range of at-risk workers.**

These core skills are management skills, communication skills, and information analysis and evaluation skills. These skills underscore the role of non-routine activities requiring advanced cognitive reasoning, human judgement and working with other people in protecting workers against automation. Opportunities for acquiring them should be actively pursued and supported, either through on-the-job training or through more informal routes like volunteering.

**3 Women and low-paid workers are disproportionately represented in occupations with high exposure to automation.**

As a result, additional support or upskilling interventions should be provided to these groups of workers in order to increase their career transition options.

**4 Many viable transitions for at-risk workers would place them in occupations that are also at high risk of automation.**

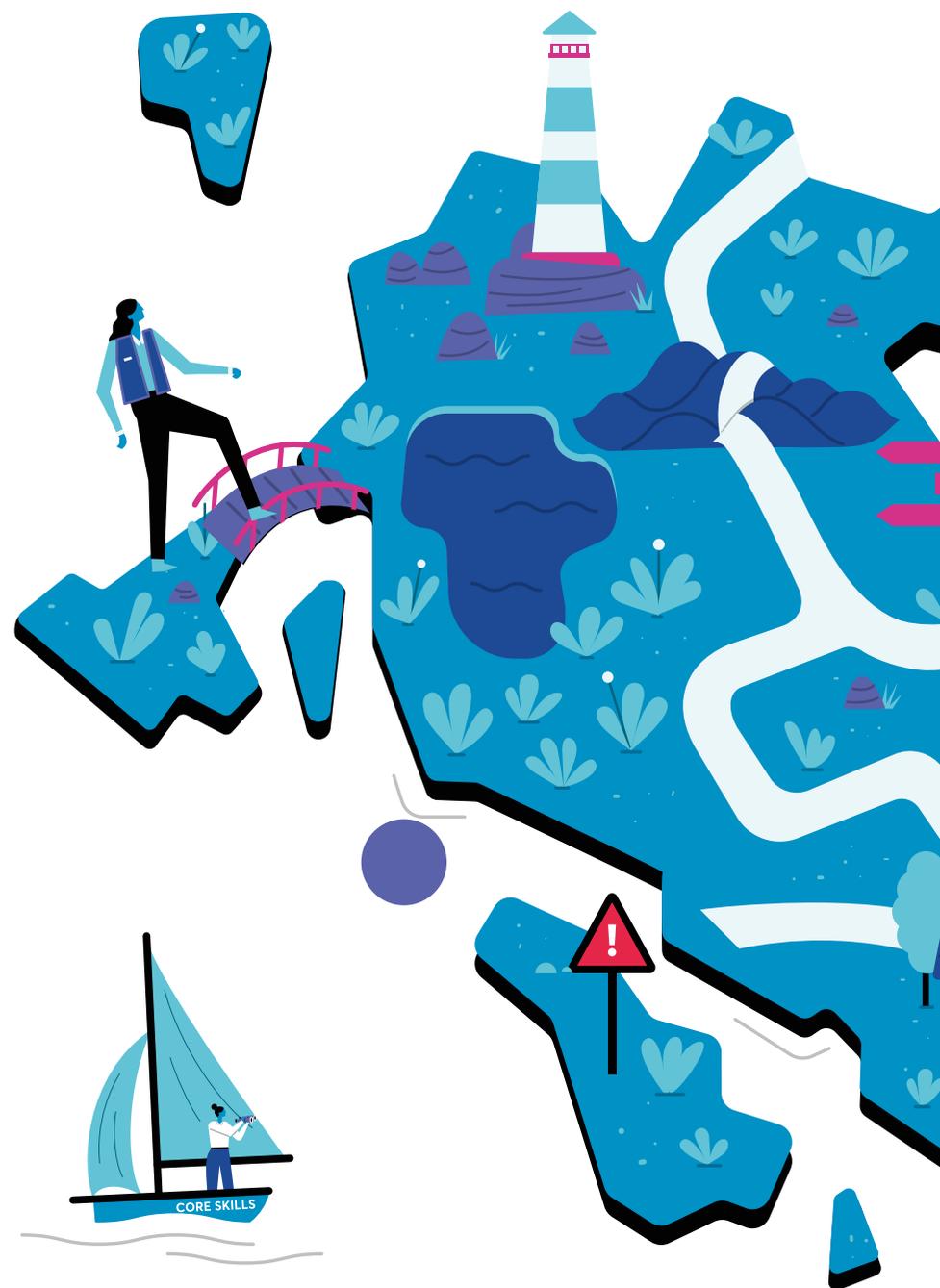
This is because jobs that require similar skills tend to face similar levels of automation risk. Workers in clerical support, business and administration, and sales and services are particularly susceptible to this effect.

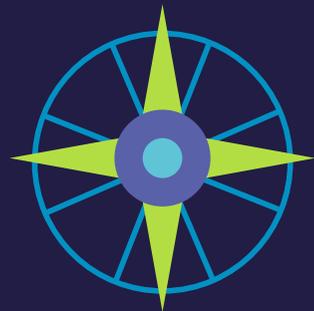
**5 Workers with higher levels of education and experience have more transition options.**

The number of safe transitions is also positively correlated with on-the-job training, showing that training does not have to take the form of an accredited course and that, instead, there are multiple routes to upskilling as a way of raising worker mobility.

# Since the project report was published in November 2020, we have:

- **Interviewed more than 50 different stakeholders across Europe** (including research organisations, training providers, career advisors, employers and government bodies) both to develop the use cases for this guide and to better understand how our research and findings could complement their work.
- **Conducted a crowd experiment** in which the job transitions from the algorithm have been scored by participants and used to refine the algorithm.
- **Published and open-sourced the algorithm and codebase** for the project and created three tutorials on [Google Colab](#) to make the insights accessible to others. These are explored in more detail in the [Tutorials](#) section from page 24.
- **Published a data visualisation** that shows the similarities between occupations in the form of a map. Overlaid on the map is the risk of automation and this highlights that there are clusters of occupations at high risk of automation.
- **Begun collaborations with a range of external partners** to embed the algorithm into existing tools and products, and to test how these insights can help to inform the decisions of workers and job seekers.
- **Identified a number of avenues for future research**, such as defining and identifying 'green transitions'.





# Use cases





## Providers of careers information, advice and guidance

### Enriching the advice given to workers

Providers of careers information, advice and guidance need access to relevant, granular and consistent labour market information which they can use to identify potential career transitions and upskilling opportunities for their clients. The Mapping Career Causeways insights can generate a more diverse set of potential transitions for each of the 1,600 occupations, enabling workers to explore a wider range of options than they may have previously considered. It can also provide clear guidance on the extra skills required to successfully make any given transition between jobs.



### Providing guidance on career transitions and retraining

By providing clarity to workers on the most viable and desirable career transitions, the Mapping Career Causeways insights can identify routes by which workers in at-risk sectors can transition to safer roles. This may aid career advisors and employment services in helping workers to identify and understand their skill sets, and highlighting the range of options available to them, ultimately giving workers more agency in their decisions. Using these insights as part of their wider support offering, employment services can guide workers to carefully consider how each of these options relates to their individual circumstances, preferences and experience.



## Supporting a hotel concierge

Consider the case of a hotel concierge who is at risk of being made redundant and has approached a careers advisor for guidance.

### STEP ONE

## Building detailed occupational profiles

By searching for the worker's job title, the career advisor can provide a detailed profile for their current role that includes the automation risk, earnings and skills. This provides a useful starting point for further discussions and can complement aspects of the worker's wider experience that may not be reflected in their current role.

See [Tutorial #2 \(p.26\)](#) for guidance on how to generate these occupational profiles.

OCCUPATIONAL TITLE:

# Hotel concierge

AUTOMATION RISK:

High

EDUCATION & EXPERIENCE LEVEL:

3/5

ANNUAL EARNINGS:

£19,000

INTERPERSONAL WORK CONTEXT:

Telephone use



STRUCTURAL WORK CONTEXT:

Time pressure



PHYSICAL WORK CONTEXT:

Time spent sitting



Face-to-face discussions



Freedom to make decisions



Exposed to weather



TYPES OF WORK ACTIVITY:

Obtaining information verbally

Providing information and support to the public and clients

Negotiating

ESSENTIAL SKILLS:

Identify customer needs

Provide tourism-related information

Assist clients with special needs

Greet guests

Handle customer complaints

OPTIONAL SKILLS:

Take room service orders

Implement marketing strategies

Maintain incident reporting records

Detect drug abuse

Ensure the privacy of guests

STEP TWO

### Identifying viable, safe and desirable transitions

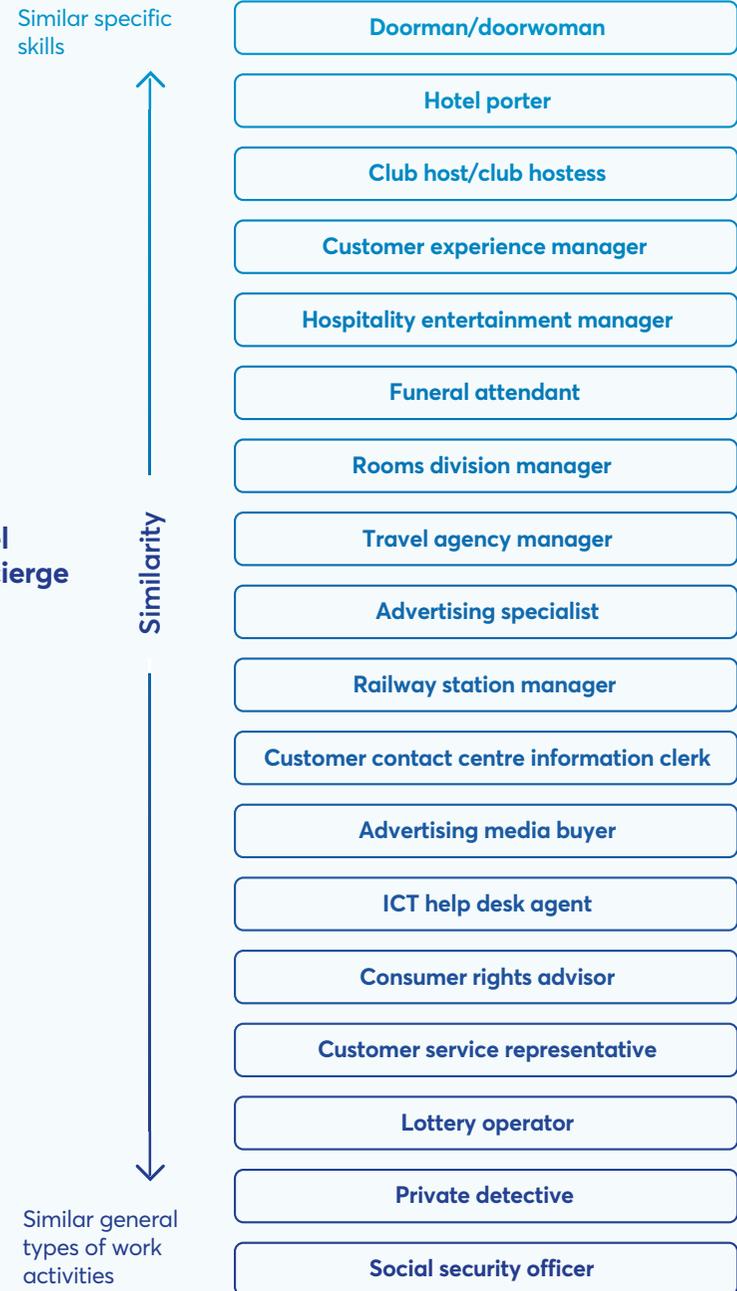
By inspecting the differences and similarities between occupations in terms of skills and competencies, as well as work activities and work context features, the Mapping Career Causeways algorithm can generate a series of viable transitions. For a hotel concierge, the model identifies 51 viable transitions. We are then able to narrow these down to 18 'safe and desirable' transitions. These are jobs that are sufficiently similar to the worker's current role, offer comparable or higher levels of pay and are likely to reduce a worker's exposure to automation risk.

The transitions are ranked such that the destination occupations at the top of the list have a

greater overlap in terms of specific, essential and optional skills. Conversely, occupations towards the bottom of the list are more broadly similar to that of a concierge in terms of general types of work activities and the interpersonal, physical and structural context of the work. The three most similar safe and desirable transitions for a hotel concierge are: doorman/doorwoman, hotel porter and club host/club hostess.

This information may enable the worker to broaden the career options they are considering and explore alternative roles that they may not have previously been aware of.

See [Tutorial #1 \(p.25\)](#) for guidance on how to generate a set of safe and desirable transitions for any given occupation.



**STEP THREE**

**Narrowing down the options**

Once a clear list of potential transitions has been generated for the hotel concierge, the career advisor can support the worker to compare the 'safe and desirable' roles, exploring both skills matches and other elements such as automation risk, typical salary and the risk of exposure to COVID-19.

This enables the worker to refine the list of potential transitions down to a shortlist that they can then explore further, taking into consideration the local labour market and additional factors such as their previous work experience.

In this example, we assume that the hotel concierge is particularly interested in three options that provide a range of development and transition opportunities. These are hotel porter, customer experience manager and social security officer.

The role of hotel porter is the most similar to the hotel concierge's current role and has a strong skills

match. This role does, however, involve more physical activities and a similar risk of exposure to COVID-19, which would need to be taken into account.

The customer experience manager role would require a larger amount of upskilling for the hotel concierge but does provide a higher median salary. With the addition of management and information skills, it would also create an opportunity to develop more of the core skills that reduce the overall risk of automation.

The third role of social security officer also provides a higher median salary than the hotel concierge role and a reduced risk of exposure to COVID-19. It has a poor match of specific skills and knowledge but similar emphasis on communication and activities related to assisting and providing information and support. While this role offers a more moderate pay rise than that of customer

experience manager, it has 11 other safe transitions, opening more potential pathways for future career transitions.

A careers advisor would be best placed to help the hotel concierge

to understand and weigh up these different options. This is one of the key reasons we believe that the Mapping Career Causeways career transition algorithm must be combined with other forms of support for workers and job seekers.



The estimate of occupation-level exposure to the impact of COVID-19 was based on the workers' physical proximity to other people and on the extent to which the work has to be performed on-site. The full methodology, and limitations of this approach, is outlined in the report.

**STEP FOUR**

### Simulating the impact of upskilling

Finally, employment services and career advisors can use the Mapping Career Causeways algorithm to simulate the results of upskilling. By hypothetically adding a new skill to a worker's skill set where training is available, the algorithm allows you to identify which additional career transitions become viable for any given job role, once the new skill has been acquired.

With the example of a hotel concierge, adding the core skill of 'managing staff' to a hotel concierge's skill set unlocks 11 new job transition opportunities. As expected, these new transition destinations are predominantly

management roles, including accommodation manager, advertising assistant and client relations manager. Other effective skills for broadening a hotel concierge's options include developing professional networks (nine new transitions), building business relationships (eight), following company standards (eight), maintaining relationships with suppliers (seven) and using different communication channels (seven). Again, a local careers advisor or guidance service would be best placed to recommend what local training provision is available and/or which training may be best suited to the individual.

See [Tutorial #1 \(p.25\)](#) for guidance on how to simulate the effects of upskilling.





## Policymakers

### Identifying and supporting at-risk workers

It is important to understand which broad groups are most at risk of automation and what core skills would help to reduce this risk. Policymakers can then design specific and targeted policies to support these groups. While the Mapping Career Causeways project focused primarily on the risk of automation, the algorithm could be used to identify and support workers who are vulnerable to other risks, such as precarious work.

#### STEP ONE

#### Identifying who is at risk

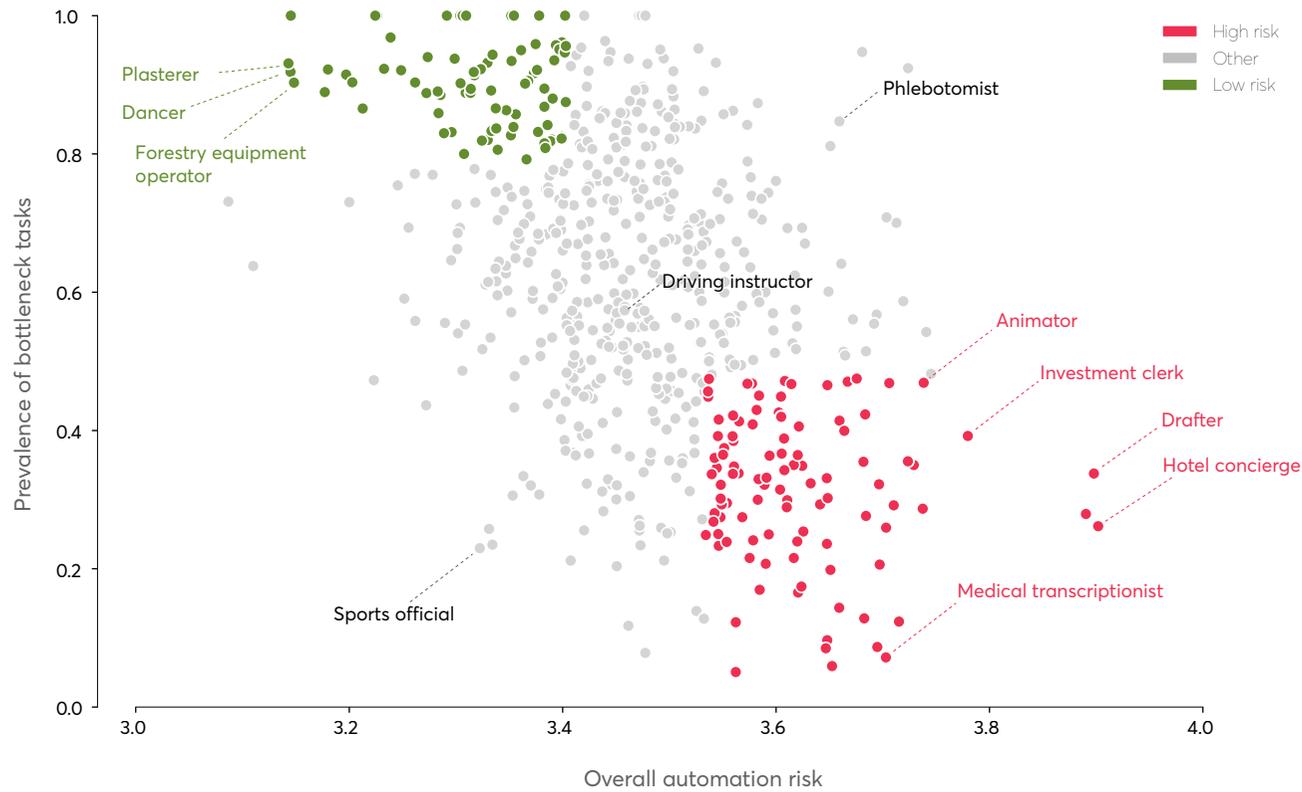
By considering both the automation risk of a worker's current role and the number of viable and desirable transitions from that role, the Mapping Career Causeways project discovered that many transitions for at-risk workers would place them in occupations that are also at high risk of automation. In fact, approximately one-third of all desirable transitions for high-risk workers would put them back into jobs that are equally at risk. If we rule out these transitions, then the median number of safe and desirable transitions for at-risk workers is 15, which is 42 per cent less than for all other

workers (who have a median of 26 safe and desirable transitions to jobs that are not at high risk). In summary, at-risk workers face the challenge of finding a job that is sufficiently similar to their current role that it is a viable transition but also sufficiently dissimilar that it has a lower risk of automation.

Policymakers can use this information to identify and recommend support for those workers who have a particularly limited number of transition options available to them. They can also develop a watch list of at-risk occupations so that tailored support services can be rapidly deployed in the event that particular groups of roles are automated.

### Overall automation risk and prevalence of bottleneck tasks across European (ESCO) occupations

Note: High-risk occupations are shown in red and low-risk occupations in green.



The figure on the left shows the occupations at the highest and lowest risk of automation. It considers both the overall automation risk and the prevalence of bottleneck tasks (tasks that are harder to automate). Our research found that retail and customer service workers, along with administrative and business clerks, make up the bulk of jobs in the high-risk category.

See page 44 in the [report](#) for a more detailed list of the roles with the highest and lowest risks of automation. You can also visit the [data visualisation](#) which shows the clusters of high-risk jobs.

**STEP TWO**

**Identifying the drivers of automation risk**

Understanding the drivers of automation risk is a critical part of supporting workers in high-risk roles. Our research found that automation risk tends to

be raised by activities such as interacting with computers, one-way routine interactions with people, monitoring resources and analysing data. This result is in line with previous studies, which found that activities with significantly higher automation potential were primarily related to collecting

and processing data, as well as performing physical activities and operating machinery in predictable environments.

The table below highlights the top five broad activities that raise automation risk and the top five that lower that risk. For each broad work activity, the

top three detailed work activities are shown. The risk is lowered by activities that require non-routine engagement with the public, knowledge-building, resolving conflicts and negotiating, and more broadly, those activities that involve operating in dynamic and uncontrolled environments.

<p>Activities that raise risk (most risky detailed work activities shown)</p>	<p><b>Interacting with computers:</b></p> <ol style="list-style-type: none"> <li>1. Enter information into databases or software programmes.</li> <li>2. Update computer database information.</li> <li>3. Troubleshoot issues with computer applications or systems.</li> </ol>	<p><b>Communicating with people outside the organisation:</b></p> <ol style="list-style-type: none"> <li>1. Represent the interests of clients in legal proceedings.</li> <li>2. Testify at legal or legislative proceedings.</li> <li>3. Inform individuals or organisations of status or findings.</li> </ol>	<p><b>Selling or influencing others:</b></p> <ol style="list-style-type: none"> <li>1. Sell products or services.</li> <li>2. Distribute promotional literature or samples to customers.</li> <li>3. Merchandise healthcare products or services.</li> </ol>	<p><b>Monitoring and controlling resources:</b></p> <ol style="list-style-type: none"> <li>1. Prescribe medications.</li> <li>2. Collect deposits, payments or fees.</li> <li>3. Monitor availability of equipment or supplies.</li> </ol>	<p><b>Analysing data or information:</b></p> <ol style="list-style-type: none"> <li>1. Analyse market conditions or trends.</li> <li>2. Analyse business or financial data.</li> <li>3. Analyse design or requirements information for mechanical equipment or systems.</li> </ol>
<p>Activities that lower risk (safest detailed work activities shown)</p>	<p><b>Performing for or working directly with the public:</b></p> <ol style="list-style-type: none"> <li>1. Resolve customer complaints or problems.</li> <li>2. Entertain the public with comedic or dramatic performances.</li> <li>3. Respond to customer problems or complaints.</li> </ol>	<p><b>Operating vehicles, mechanised devices or equipment:</b></p> <ol style="list-style-type: none"> <li>1. Navigate water vessels.</li> <li>2. Operate vehicles or material-moving equipment.</li> <li>3. Operate ships or other watercraft.</li> </ol>	<p><b>Updating and using relevant knowledge:</b></p> <ol style="list-style-type: none"> <li>1. Maintain medical or professional knowledge.</li> <li>2. Update knowledge about emerging industry or technology trends.</li> <li>3. Research topics in areas of expertise.</li> </ol>	<p><b>Resolving conflicts and negotiating with others:</b></p> <ol style="list-style-type: none"> <li>1. Arbitrate disputes between parties to resolve legal conflicts.</li> <li>2. Negotiate sales or lease agreements for products or services.</li> <li>3. Resolve operational performance problems.</li> </ol>	<p><b>Controlling machines and processes:</b></p> <ol style="list-style-type: none"> <li>1. Operate pumping systems or equipment.</li> <li>2. Operate mixing equipment.</li> <li>3. Operate cranes, hoists or other moving or lifting equipment.</li> </ol>



### STEP THREE

## Identifying the most effective core skills for at-risk workers

Upskilling is a costly investment in terms of time and resources, and it is therefore important to target this investment in the right direction. One approach for policymakers is to identify core skills that, on average, would broaden the range of options for all at-risk workers. The most effective of these core skills can unlock between two and three new safe and desirable options on average per occupation. Among these skills, there is a strong emphasis on management, communication, and information analysis and evaluation, as well as on compliance-related competencies.

### What training should be offered to workers whose jobs are at high risk of automation?

These skills unlock 2-3 new transitions on average (although the effectiveness of upskilling depends on the occupation type):



#### Management skills:

Skills needed to manage staff, budgets and projects.



#### Information analysis and evaluation skills:

Skills needed to execute feasibility studies, assess financial viability, analyse risk and perform research.



#### Communication skills:

Skills needed to use different communication channels, liaise with managers and authorities, and build and maintain business relationships.



#### Skills related to complying with company guidelines:

Knowledge of health and safety standards and environmental legislation.

In contrast, adding particular aspects of core knowledge (for example, in electrical engineering or physics) for all at-risk workers is not as effective in increasing the number of potential transitions. This is perhaps unsurprising, as domain knowledge will generally differ more substantially across sectors.

Taken together, these observations underscore the role of bottleneck tasks, non-routine activities requiring advanced cognitive reasoning, human judgement and working with other people in protecting workers against automation.

See [Tutorial #1 \(p.25\)](#) for guidance on how adding a core skill can affect a worker's transition options.

**STEP FOUR**

## Customising skill recommendations by sector

As well as highlighting the most effective core skills for all workers whose jobs are at risk of automation, we were also able to customise these skills by sector, in order to identify how the efficacy of core skills varies across occupations. Here we focused on the four skills-based sectors that have the largest number of occupations at high risk of automation: business and administration workers, sales and services workers, ICT workers and arts and media workers.

While management skills are effective across all occupations, we found that their impact differs

depending on the origin sector of the worker. For example, managing budgets is particularly effective at raising transition options for workers in business and administration, sales and services, and arts and media. However for this particular skill, the increase in transitions for business and administration workers is around 40 per cent greater than it is for sales and services workers (4 and 2.8 new transitions on average respectively) and 160 per cent greater than for arts and media workers (1.5 transitions). This suggests that 'one-size-fits-all' programmes for retraining may not be the best approach. Instead, workers in different sectors should receive carefully tailored training to increase their resilience to automation shocks.

### The six most effective core skills for upskilling at-risk workers in the four skills-based sectors that have the largest number of occupations at high risk of automation.

Business and administration workers		Sales and services workers	
ESCO skill	Avg	ESCO skill	Avg
Manage budgets	4.03	Manage staff	3.54
Manage staff	3.79	Maintain relationship with customers	3.40
Maintain relationship with suppliers	3.64	Adhere to organisational guidelines	3.27
Liaise with managers	3.41	Follow company standards	3.27
Build business relationships	3.30	Maintain relationship with suppliers	3.10
Develop professional network	3.28	Manage budgets	2.81
ICT workers		Arts and media workers	
Adjust engineering designs	3.57	Manage staff	2.13
Perform risk analysis	3.43	Develop professional network	1.73
Perform scientific research	2.87	Perform project management	1.53
Execute feasibility study	2.57	Manage budgets	1.53
Assess financial viability	2.30	Perform market research	1.47
Manage staff	2.22	Apply organisational techniques	1.47

Note: Avg = average number of new safe and desirable transitions; all effects of shown skills are significantly different from 0, p-value<0.01.

## Making the case for a skills framework

The Mapping Career Causeways insights provide a strong case for developing open-source frameworks that describe labour market concepts such as jobs and skills. The project relied heavily on two such frameworks: [ESCO](#) (developed by the European Commission) and [O\\*NET](#) (developed by the US Department of Labour). Their standard descriptions of the skills, work activities and work context required in each role allowed us to measure the similarity between roles. As demonstrated,

these similarity metrics then enabled us to provide advice on upskilling and retraining.

In the face of mass labour market disruption, due to both COVID-19 and automation, policymakers need effective tools and guidance to respond to a rapidly shifting labour market. [A framework of skills can help](#), by providing a common language for frictionless communication between workers, employers, educators and learners. Detailed occupational and skills frameworks can ultimately provide a more holistic view of pathways between different jobs.

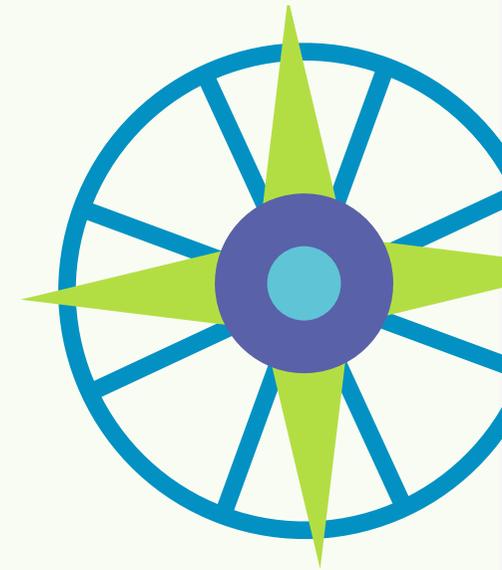




## Employers

### Redeploying and upskilling workers

As skill demands change and new technologies emerge, employers will need to consider how best to support their existing workforce to navigate these shifts. The Mapping Career Causeways insights can help employers to gain clarity on the transferability of a worker's skills. Creating better informed and targeted career transition support in-house will enable employers to retain and retrain their existing workforce. With more bespoke training, led by intelligent data, employers could shift towards more work-based training and skills solutions. This approach benefits both the worker, who is able to avoid job loss, as well as the employer, who is able to optimise their workforce and effectively redeploy staff, saving the costs of recruiting and onboarding new employees.





## Helping a shop assistant to transition between roles

Shop assistants perform various duties, such as advising customers, selling products and ordering and refilling stock. Our estimates indicate that shop assistants face a high risk of automation. The most obvious choices for job transition deemed viable in our research are the roles of retail manager and shelf filler. However, another destination among the most viable options, and one associated with a lower risk of automation, is the role of visual merchandiser. Visual merchandisers specialise in the promotion of the sale of goods and their presentation in retail outlets.

The table on the next page compares the skills of the origin occupation (shop assistant) and the destination occupation (visual merchandiser). This may help both the worker and the employer to demonstrate the transferability of the shop

assistant's skills and identify areas for development (due to key skills gaps).

Only a couple of skills are required in both occupations (highlighted in green). However, by using Natural Language Processing (NLP), we were able to detect several partially matching skills (shown in yellow). For example, the skill of coaching a team on visual merchandising, which is required for a visual merchandiser, is very similar to the skill of supervising merchandise displays, which is required for a shop assistant. Another partial match is detected between the more general skill of communicating with customers and identifying their needs, and the skill of communicating with staff about visual displays.

Where any skills comparisons did not demonstrate a sufficient skills match, we label these as a skills gap (see skills highlighted

We consider the case of a large retailer who is looking to retrain some of their shop assistants into other roles to avoid redundancies.

in red). This approach could be incorporated within a tool to help employers quickly pinpoint potential gaps in workers' skills and identify suitable training opportunities.

Ranking skills by their semantic similarity (where words are scored based on how similar they are, even if they are not exact matches) helps to interrogate this information effectively. Importantly, the ranking works by placing the destination occupation's skills in the context of the workers' skill set, providing information not only about gaps but also about the skills that the worker may already possess. This could help to boost workers' confidence, as they – as well as employers – often find it difficult to recognise and articulate their transferable skills.

See [Tutorial #1 \(p.25\)](#) for guidance on generating skills gap profiles.

Through our interviews with stakeholders, we heard from a number of employers who were having to redeploy their workforce. Many larger employers spoke about the struggle to provide high quality, tailored advice at scale, while also addressing their rapidly changing staffing needs. The insights from Mapping Career Causeways would allow employers to provide specific and personalised advice to individual workers based on their role while also taking the staffing needs of their company into account. Furthermore, by helping employers to identify key skills gaps between their current employees and required workforce, Mapping Career Causeways insights can enable them to provide targeted, relevant training quickly and at scale.

### Skills gap analysis for a transition from shop assistant to visual merchandiser

	Skills for origin occupation (shop assistant)	Skills for destination occupation (visual merchandiser)	Semantic similarity
1	Maintain relationship with suppliers	Maintain relationship with suppliers	1.00
2	Maintain relationship with customers	Maintain relationship with customers	1.00
3	Supervise merchandise displays	Coach team on visual merchandising	0.85
4	Carry out active selling	Deploy merchandising techniques	0.85
5	Identify customer needs	Liaise with appropriate staff for visual display	0.84
6	(Not shown because semantic similarity is too low)	Change window displays	0.79
7		Assess visual impact of displays	0.78
8		Negotiate with suppliers for visual material	0.78
9		Develop store design	0.77
10		Assemble visual displays	0.74
11		Have computer literacy	0.71
12		Execute visual presentation changes	0.68
13		Conduct research on trends in design	0.68
14		Interpret floor plans	0.59

— Very similar    — Somewhat similar    — Not similar

### Additional benefits for employers

The Mapping Career Causeways insights may also help employers to widen their recruitment pool and increase their hiring from other sectors, by showing the transferability of workers' skills across different sectors. Building a more detailed picture of the skills matches between different roles allows for a broader view of potential applicants. This could lead to changes in recruitment practices, whereby job adverts highlight the roles that are most similar to the one being advertised and/or profile the transferable skills that are required in the role. Such a practice could encourage a wider pool of applicants to apply.



**MEDIUM DIFFICULTY**

(May require some data analysis skills)

# Algorithm tutorials

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To assist potential users in running the career transition recommendation algorithm, we have developed three interactive tutorials. These are available on Google Colab (links are provided below), and they do not require you to download or install anything on your machine. We have provided an extended example of Tutorial #1 to help users to generate career transition recommendations. Tutorials #2 and #3 are summarised below and are intended primarily for those with some data analytical skills. However, they may also be of interest to general users, and will help providers of careers information, advice and guidance, policymakers and employers to replicate the use cases from the preceding sections.

# Tutorial #1

## Generating and analysing transition recommendations

This tutorial will help you to:

- ✓ **Generate career transition recommendations** for any occupation from the European occupational framework (ESCO).
- ✓ **Inspect the differences and similarities between occupations**, in terms of skills and competencies, work activities and work context features.
- ✓ **Assess skills gaps** across a collection of job transitions.
- ✓ **Assess the effect of upskilling** (i.e. adding a new skill or combination of skills to an occupation's existing skill set).
- ✓ **Refine the recommendations** by using people's perceptions of transition feasibility, gathered through our [crowdsourcing experiment](#).

▶ To get started, please open [MCC Tutorial #1](#) and follow these steps:

1. Choose an origin occupation title from the [ESCO framework](#).
2. Go to [Section 1](#), titled 'Generating transitions from any occupation'.
3. In [Section 1.1](#), enter the occupation name (e.g. 'hotel concierge').
4. Click on Runtime at the top of the tutorial and select Run All. Immediately below the input form, you will now find a short description of the chosen occupation and some alternative occupation labels.
5. Go to [Section 1.2](#), titled 'Most similar occupations', where you will see a list of other roles that are similar to your chosen occupation.
6. Scroll down to [Section 1.3](#), 'Generate transition recommendations', where you will see the job transition(s) deemed most viable, safe and desirable by the algorithm. In the example of 'hotel concierge' there will be 18 transitions to various roles including 'hotel porter', 'customer experience manager' and 'social security officer'.
7. Go to [Section 2](#), titled 'Detailed comparison of two occupations', and locate the input form under [Section 2.1](#), 'Select origin and destination occupations'.
8. Insert new origin and destination occupation names to replace 'hotel concierge' and 'hotel porter' respectively – for example, 'hotel concierge' and 'customer experience manager'.
9. Click on Runtime at the top of the tutorial and select Run After. Once the code has finished running, [Section 2.2](#) will display a comparison between the skills needed for the origin occupation and transition destination occupation. Skills with similarity values of 1 can be interpreted as direct matches. Skills with similarity values larger than 0.8 can be interpreted as partial matches. Skills with similarity values equal to or less than 0.8 can be interpreted as skills gaps and provide a basis for training.
10. To output this data for your own use, you can scroll down to '[Download the generated tables](#)'. The table generated will be similar to the one on [page 23](#).



## Tutorial #2

Exploring the underlying occupation and skills data

This tutorial will help you to access and explore:

- Occupation profiles
- Occupational groups (ISCO)
- Skills-based sectors and sub-sectors
- Skills and skills categories
- Occupation similarities
- Transitions data



To get started, please open **Tutorial #2** and follow the guidance.



## Tutorial #3

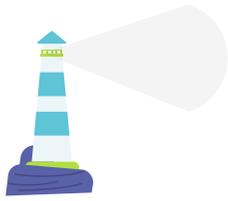
Exploring skills gaps

This tutorial could inform upskilling efforts and training provision for a broader group of workers. Specifically you can:

- Identify a set of origin occupations based on their automation risk or potential exposure to COVID-19.
- Select admissible destination occupations and generate transition recommendations between origin and destination occupations.
- Analyse the composition of the destination occupations.
- Check the most popular destination occupations.
- Analyse the skills gaps involved in the transitions.



To get started, please open **Tutorial #3** and follow the guidance.



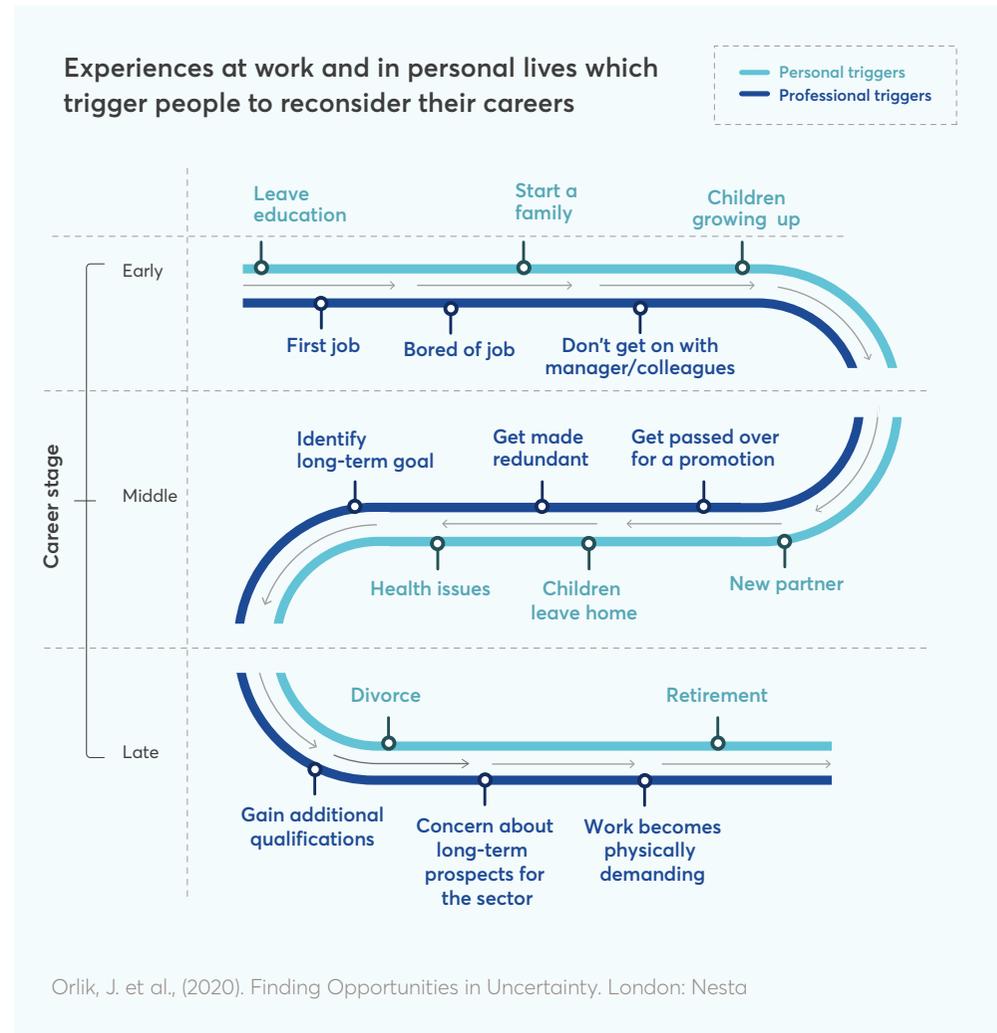
# Further information

## Principles for using a career recommendation algorithm

Workers may face various additional challenges and barriers to switching jobs, ranging from personal circumstances and family commitments to time, geographical, and financial barriers (see figure on the right).

Additionally, each worker will have their own unique set of skills, preferences and experiences that are not captured by considering occupational skill requirements alone. As such, the insights

from the Mapping Career Causeways project should be considered as one ingredient in supporting workers to move between jobs.





We have suggested **4 key principles** for using this algorithm or any other career or skill recommendation tool. The tool should be:

- 1 Viewed as complementary to existing tools, advice or information sources,** such as the services provided by a professional careers advisor.
- 2 Open to scrutiny,** ensuring the method is open-source and transparent to users.
- 3 Used to broaden options,** as opposed to limiting choices or prescribing specific roles to at-risk workers.
- 4 Focused on the long term,** providing sustainable recommendations for jobs that will remain safe from automation (or other labour market shocks) in the coming years.

# Next steps and future extensions of our work

Over the coming year, we aim to trial and test the map of career transitions in collaboration with external partners.

This work will involve seeking feedback on the transition pathways to understand if they support workers in making better career decisions, testing different methods for delivering our insights, and enriching our framework with more localised data on jobs. Through the development of this work, we aim to broaden the information that is available to individuals, employers and public services and drive change that helps to connect people to long-term, desirable work.

In addition to validating and trialling the career transitions, we have identified a number of extensions to the Mapping Career Causeways project that we hope to develop. These include:

- Enriching the map of the labour market with **timely data on local vacancies, occupational growth forecasts and skills training opportunities**. We have started the groundwork for this via our [Open Jobs Observatory project](#).
- Developing **standard and nuanced definitions of green jobs and green skills**, so that we can identify transitions from '[brown](#)' jobs (those in industries with high carbon emissions) to 'green' jobs (those in industries with low carbon emissions).



If you have suggestions or feedback on the project, or are interested in partnering with us to develop any of these extensions, please get in touch by emailing [open.jobs@nesta.org.uk](mailto:open.jobs@nesta.org.uk)

This work furthers Nesta's mission for a sustainable future. We want a future that works better for people and the planet. Our mission is to accelerate the decarbonisation of household activities in the UK and improve levels of productivity. You can find out more about Nesta's previous research on the future of work and skills [here](#).

## About Nesta

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We are Nesta. The UK's innovation agency for social good. We confront challenges that affect millions of people, from inequality and ill-health to the climate crisis.

We believe that innovation offers more potential now than ever before. We see opportunities to mobilise citizens and influence behaviour. Private and public capital that can be used more creatively. A wealth of data to mine.

And so we draw on these rich resources by bringing together diverse teams. Data scientists, designers and behavioural scientists. Practitioners, academics, entrepreneurs and people with lived experience.

Together, we design, test and scale new solutions to society's biggest problems. We partner with frontline organisations, build new businesses and work to change whole systems. Harnessing the rigour of science and the creativity of design, we work relentlessly to put new ideas to the test.

We'll keep going until we change millions of lives, for the better. Find out more at [nesta.org.uk](https://www.nesta.org.uk).

## About J.P. Morgan

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### J.P.Morgan

This project is supported by J.P. Morgan as part of their \$350 million, five-year global commitment to prepare people around the world for the future of work. This commitment will focus on creating economic mobility and career pathways for underserved populations and the firm's employees, by collaborating with educational and research institutions to forecast emerging skillsets in the financial services industry and enable new training programs to prepare the firm's workforce for changes in technology and business.

While this publication has been supported by J.P. Morgan, the contents and opinions in this paper are those of the authors alone and do not reflect the views of the J.P. Morgan Chase Foundation, J.P. Morgan Chase & Co. or any of its affiliates.

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