In collaboration with Accenture

WORLD ECONOMIC FORUM

Jobs of Tomorrow: Large Language Models and Jobs

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Foreword

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Generative AI and, in particular, large language models (LLMs), underpinned by advancements in machine learning and natural language processing, represent a paradigm shift in how we interact with information and, by extension, how we work. These technologies can create original content, generate insights from large amounts of data, translate languages with near-human accuracy, and potentially even make complex decisions. The versatility and efficiency of these technologies could have profound implications for jobs and the future of work.

While the application of LLMs could lead to significant productivity gains and the creation of new types of jobs, there is also a risk that they could displace existing roles, exacerbating socioeconomic disparities and creating a sense of job insecurity among the global workforce. As such, integrating AI into our workplaces is a balancing act between seizing opportunities and managing potential disruptions.

Generative artificial intelligence (AI) encompasses a broad set of technologies that can perform a variety of tasks. As a result, the public debate on its potential impact on workers is often polarized and uncertain across timeframes. In this report, we focus on large language models and the activities they can perform. This paper takes a structured approach to understanding the direct impact of LLMs on specific jobs. This analysis will enable stakeholders – business leaders, policy-makers, workers and the broader public – to make more informed decisions regarding skilling, workforce planning and other strategic investments.

Generative AI will reshape industries and business in profound ways through new operating models, and new products and services. Yet, by proactively understanding and addressing the direct disruptions, organizations can use LLMs to enhance productivity and unlock new opportunities while ensuring a smooth transition for their workforce. In addition, the structured approach proposed in this paper to analysing the direct impact on jobs also provides a case study for future waves of technological advancement across sectors.

This white paper continues our Jobs of Tomorrow series, which has previously analysed Green and Social Jobs, and now seeks to analyse the impact of LLMs on jobs. At the end of 2023, this series will be concluded with a toolkit that serves as a call to action for businesses. The series complements the results of the Future of Jobs Report 2023, which delves deeper into the expectations of global business leaders on the direction of the workforce transition across all key geographies and industries.

We are deeply grateful to the Centre for the New Economy and Society partners and constituents for their leadership of the jobs agenda, as well as for the partnership of the Accenture team, whose members served as core collaborators on this report. The findings of this paper will serve as a key tool for the Jobs Consortium, which is a global coalition of ministers and chief executive officers that promotes a better future of work via job creation and job transitions, as well as for jobs accelerators, which are country-specific platforms that facilitate public-private collaboration. Structured analysis, planning and proactive preparation by business, government and workers can ensure that generative AI and other technological advancements lead to an improved future of work and new opportunities for workers.

Executive summary

As advances in generative artificial intelligence (AI) continue at an unprecedented pace, large language models (LLMs) are emerging as transformative tools with the potential to redefine the job landscape. The recent advancements in these tools, like GitHub's Copilot, Midjourney and ChatGPT, are expected to cause significant shifts in global economies and labour markets. These particular technological advancements coincide with a period of considerable labour market upheaval from economic, geopolitical, green transition and technological forces. The World Economic Forum's *Future of Jobs Report 2023* predicts that 23% of global jobs will change in the next five years due to industry transformation, including through artificial intelligence and other text, image and voice processing technologies.

This white paper provides a structured analysis of the potential direct, near-term impacts of LLMs on jobs. With 62% of total work time involving language-based tasks,[1] the widespread adoption of LLMs, such as ChatGPT, could significantly impact a broad spectrum of job roles.

To assess the impact of LLMs on jobs, this paper provides an analysis of over 19,000 individual tasks across 867 occupations, assessing the potential exposure of each task to LLM adoption, classifying them as tasks that have high potential for automation, high potential for augmentation, low potential for either or are unaffected (non-language tasks). The paper also provides an overview of new roles that are emerging due to the adoption of LLMs.

The longer-term impacts of these technologies in reshaping industries and business models are beyond the scope of this paper, but the structured approach proposed here can be applied to other areas of technological change and their impact on tasks and jobs.

The analysis reveals that tasks with the highest potential for automation by LLMs tend to be routine and repetitive, while those with the highest potential for augmentation require abstract reasoning and problem-solving skills. Tasks with lower potential for exposure require a high degree of personal interaction and collaboration.

- The jobs ranking highest for potential automation are Credit Authorizers, Checkers and Clerks (81% of work time could be automated), Management Analysts (70%), Telemarketers (68%), Statistical Assistants (61%), and Tellers (60%).
- Jobs with the highest potential for task augmentation emphasize mathematical and scientific analysis, such as Insurance Underwriters (100% of work time potentially augmented), Bioengineers and Biomedical Engineers (84%), Mathematicians (80%), and Editors (72%).
- Jobs with lower potential for automation or augmentation are jobs that are expected to remain largely unchanged, such as Educational, Guidance, and Career Counsellors and Advisers (84% of time spent on low exposure tasks), Clergy (84%), Paralegals and Legal Assistants (83%), and Home Health Aides (75%).
- In addition to reshaping existing jobs, the adoption of LLMs is likely to create new roles within the categories of AI Developers, Interface and Interaction Designers, AI Content Creators, Data Curators, and AI Ethics and Governance Specialists.
- An industry analysis is done by aggregating potential exposure levels of jobs to the industry level, noting that jobs may exist in more than one industry. Results reveal that the industries with the highest estimates of total potential exposure (automation plus augmentation measures) are both segments of financial services: financial services and capital markets and insurance and pension management. This is followed by information technology and digital communications, and then media, entertainment and sports. Additional lists of jobs ranked by highest exposure potential for each major industry category are compiled in the appendix.
- Similarly, a function group analysis reveals that the two thematic areas with the greatest total potential exposure to LLMs are information technology, with 73% of working hours exposed, and finance, with 70% of working hours exposed. As with the industry groups, additional lists of jobs ranked by highest exposure potential for each function group are compiled in the Appendices.
- These new findings connect directly to earlier work done by the Centre for the New Economy and Society in the *Future of Jobs Report 2023*. Many of the jobs found to have high potential for automation by LLMs were also expected by business leaders to undergo employment decline within the next five years, such as bank tellers and related clerks, data entry clerks, and administrative and executive secretaries. Meanwhile, jobs with high potential for augmentation are expected to grow, such as AI and Machine Learning Specialists, Data Analysts and Scientists, and Database and Network Professionals. Together, these two publications identify and reaffirm salient themes in the connection between technological change and labour market transformation.

The findings of this report shed light on how implementing LLMs could alter the landscape of jobs, providing valuable insights for policy-makers, educators and business leaders. Rather than leading to job displacement, LLMs may usher in a period of task-based transformation of occupations, requiring proactive strategies to prepare the workforce for these jobs of tomorrow.

Introduction: How will large language models impact the jobs of tomorrow?

Language capabilities overlap substantially with tasks performed on the job, with estimates suggesting that up to 62% of work time involves language-based tasks.

Labour markets are undergoing rapid transformation from the trajectory of growth, geoeconomics, sustainability and technology. The *Future of Jobs Report 2023* found that business leaders expect 23% of global jobs to change in the next five years.[2] In particular, generative artificial intelligence (AI) has undergone a profound leap in capabilities, embodied in products such as GitHub's Copilot for programming, Midjourney for image generation and ChatGPT as a universal language assistant. The *Future of Jobs Report 2023* also found that AI and text, image and voice processing technologies more generally are top of mind for businesses. The report found that 75% of survey respondents report having plans to adopt AI in their organization's operations, and 62% report having plans to adopt text, image and voice processing technologies.[3] This has raised questions about how this new technology will affect organizations and labour markets around the world.

This white paper examines the potential near-term, direct impact on jobs of a particular type of generative AI, large language models (LLMs), which have been highly visible in public debate over the past year due to their human-like ability to create and understand language. As LLM services have exploded in popularity, with free services such as ChatGPT reaching as many as 100 million active users within the first two months of its debut,[4] the capabilities of these models, paired with their accessibility and rapid adoption rate, suggest that many work tasks – and jobs that emphasize them – could be impacted by the use of LLMs in the years to come. By some estimates, up to 62% of work time involves language-based tasks.[5] Yet, artificial intelligence and text, image and voice processing technologies also have the potential to augment work and create new jobs. In addition, many roles remain wholly unaffected by these developments.

Rapid technological change often generates anticipation regarding its effects on daily life, particularly jobs. In the aggregate, previous innovations have led to more employment opportunities, better-quality jobs and a higher quality of life, but they also create disruption and displacement.[6] This paper aims to support the detailed analysis required to take a clear-eyed view around impact, opportunity and preparation.

Generative AI, LLMs and language tasks

The newest forms of groundbreaking generative AI models are created via deep learning, which is the process of training foundation models on very large sets of data. These foundation models are typically created in the form of a neural network, whose structure is inspired by the arrangement of neurons in the human brain. Large foundation models are trained on vast amounts of data and have seemingly super-human levels of predictive capacity, which can be harnessed by producing text or images in response to a written prompt.[7]

So far, generative AI models have been configured into a variety of different tools to serve different contexts, such as image, audio or video creation, identifying financial fraud and other security risks, and a host of general language capabilities, including the ability to generate natural, mathematical and computational language. While there is a broad range of implementations of generative AI, this study will focus on LLMs and their unique language-generating capabilities, as these models have the greatest potential to impact the largest number of jobs in the near term.

LLMs can perform a broad spectrum of language tasks, usually in response to a simple user prompt, on nearly any topic:

- LLMs can reformulate and provide detailed feedback on a provided set of text, including summarizing it, translating it to another language, proofreading it, discussing its style or tone of voice and even rewriting it in a different style or tone of voice.
- LLMs can also generate new text and provide some degree of expertise on topics present in the LLM's training data, such as in the form of a literature review or completing a task typically done by a research assistant.[8]
- As programming languages are text, LLMs can serve as programming assistants. Implementations like GitHub's Copilot have been shown to increase programmer productivity by 56%.[9]

By integrating LLMs with other systems, these capabilities can be extended to a greater range of abstract tasks, such as scheduling meetings, placing orders, responding to emails, or providing research on a particular topic.

Given the large overlap between LLM capabilities and current job tasks, how will introducing LLMs into the workplace change jobs? Which parts of a job will be impacted the most, and which jobs will be impacted most? Finally, with the introduction of these new technologies, which new jobs can be expected to arise?

A task-based approach to job exposure

To answer these questions, the methods deployed in this white paper assess the potential exposure of language-based job tasks to the ability of LLMs to perform these tasks. The approach is to first think of a job as consisting of many different tasks and then assess how each task may be affected by LLMs. The magnitude of impact on a job ultimately depends on the degree of language-based skills required for specific tasks in that job and the time spent on those tasks. Language-dependent, standardized, routine and process-oriented tasks are prime candidates for automation and replacement by LLMs. At the same time, those requiring a greater degree of human interaction are more likely to be augmented and performed in collaboration with LLMs.

For example, some job tasks are routine and predictable and are performed by people working individually, such as clerks and administrators, which involves reading and entering data, cross-referencing records between different databases and reviewing transactions. These tasks are more likely to be exposed to and ultimately automated by the introduction of LLMs, implying that they will no longer be performed by humans. The outcome is that jobs emphasizing these tasks will either transform to take on non-automatable tasks or go into decline. Other job tasks require a great deal of abstract reasoning, creativity and problem-solving. While language tasks may not be their primary product, they may rely heavily on language and communication. For example, Mathematicians and Editors rely heavily upon language, yet need to incorporate creative insights from their fields of expertise. Similarly, Software Developers work a lot with computer languages but also need to grasp complex systems at various levels of abstraction to create a finished software product. Workers in these jobs would not have their tasks replaced by LLMs; rather, LLMs would supercharge their ability to complete these tasks. Teachers, for example, could rely on LLMs for assistance in lesson planning and correcting student work. According to one study in the US, three in ten teachers have already used ChatGPT for lesson planning (30%), generating creative ideas for classes (30%) and building background knowledge for lessons and classes (27%).[10] Software Developers could turn to LLMs to generate standardized blocks of code with clear functional parameters, speeding up the development process and allowing for more time to be spent on high-level architectural tasks. Software Developers also perform many tasks with high potential for automation, suggesting that many jobs will be **transformed** rather than automated or augmented.

> “Three in ten teachers have already used ChatGPT for lesson planning (30%), generating creative ideas for classes (30%) and building background knowledge for lessons and classes (27%).

The research methods employed in this paper aim to identify which tasks will be exposed to LLMs and how they will be impacted: whether they have the potential to be automated and replaced by LLMs or augmented and enhanced by LLMs. Data for analysis comes from O*NET and the United States Bureau of Labor Statistics (BLS), which characterizes 867 jobs with respect to over 19,000 individual tasks. Using both machine learning and manual methods, job tasks are individually rated with respect to their potential exposure to the adoption of LLMs, thereby classifying them into one of four categories:

1. High potential for automation: Going forward, the task will be performed by LLMs, not humans.

2. High potential for augmentation: Humans will continue to perform the task, and LLMs will increase human productivity.

3. Low potential for automation or augmentation: Humans will continue to perform the task with no significant impact from LLMs.

4. Unaffected (i.e. non-language tasks).

Job tasks are then mapped to the occupations in which they are deployed along with a share of time spent on each task, and with both of these metrics, a measure of potential exposure to LLMs is created at the occupation level.

Chapter 1 of this paper presents these results for tasks and jobs in detail, using the detailed occupations list from the Standard Occupation System (SOC) from the US Bureau of Labor Statistics, the highest resolution list available, featuring 867 occupation titles.[11] This chapter also provides analysis of the differences between industries and functions in terms of the expected impact of LLMs on jobs. In chapter 2, these detailed occupations are aggregated and mapped to the occupation classification system used in the Future of Jobs Survey 2022 to directly connect results on exposure of jobs to LLMs to survey results of global business leaders on the potential for growth or decline of specific jobs, and the forces underlying these trends, as covered in greater detail in the *Future of Jobs Report 2023*.

1 Identifying exposure potential of tasks and jobs

LLMs hold transformative potential and are set to significantly reshape the future employment landscape.

This chapter outlines task exposure to LLMs, providing deeper analysis on two jobs highly likely to be impacted, and ranks jobs by their automation and augmentation potential. It also identifies emerging jobs due to LLM adoption and summarizes exposure risks by industry and job function.

1.1 Exposed tasks

The tasks with the highest potential for augmentation require more abstract reasoning skills, especially those that combine interaction with people.

A preliminary analysis reveals which tasks have the highest potential for automation or augmentation and which have lower or no potential (see Table 1). The tasks with the highest potential for automation by an LLM tend to be more routine, such as performing administrative or clerical activities, and some tasks that relate to elementary analysis, such as designing databases or analysing data. The tasks with the highest potential for augmentation require more abstract reasoning skills, especially those that combine interaction with people. At the top of the list is evaluating personnel capabilities or performance, such as in the context of the responsibilities of a human resources professional, followed by collecting data about consumer needs or opinions. For the latter, while running a survey, for example, could be a highly automated process via email and the internet, the crafting and wording of survey questions still require a high degree of attention and approval by the person collecting the data.

Tasks with lower potential for exposure require a high degree of personal interaction and collaboration, such as negotiation of contracts, development of educational programmes, and other scientific and technical work, the latter of which already employ a strong degree of technical augmentation. Finally, non-language tasks are, as expected, those that emphasize physical movement, such as loading products, materials or equipment for transport, assembly activities, agricultural activities, and grooming and hairstyling.

TABLE 1 | **Key tasks impacted**

Level	Task
Higher potential for automation	Perform administrative or clerical activities
	Design databases
	Analyse data to improve operations
	Monitor external affairs, trends or events
	Obtain information about goods or services
	Document technical designs, procedures or activities
Higher potential for augmentation	Evaluate personnel capabilities or performance
	Collect data about consumer needs or opinions
	Read documents or materials to inform work processes
	Evaluate patient or client condition or treatment options
	Prepare informational or instructional materials
	Test performance of computer or information systems
Lower potential for exposure (automation or augmentation)	Negotiate contracts or agreements
	Advocate for individual or community needs
	Collaborate in the development of educational programmes
	Direct scientific or technical activities
	Coordinate with others to resolve problems
	Evaluate designs, specifications or other technical data
Non-language tasks	Load products, materials or equipment for transport or further processing
	Assemble equipment or components
	Prepare mixtures or solutions
	Perform agricultural activities
	Groom or style hair
	Install energy or heating equipment

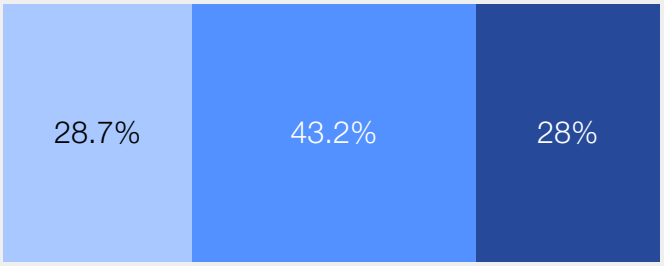
1.2 Detailed examples of exposed jobs

To provide a detailed example of how the tasks involved in a job determine how LLMs will impact the job, Figure 1 presents an analysis of an exposed and non-exposed job and the task exposure of each. The left panel of the figure provides an overview of Software Developers, a highly exposed job in the analysis, showing high potential for both augmentation and automation of tasks. A total of 28.7% of time spent in the occupation has high potential for automation by LLMs, including "analyse data to improve operations" and "analyse the performance of systems of equipment". In contrast, up to 43.2% of time spent on tasks in the occupation has high potential for augmentation, including "preparing informational or instructional materials and evaluating the characteristics, usefulness or performance of products or technologies".

The right panel of Figure 1 provides an overview of Human Resource Managers, which is a less exposed job. Only 16.1% of time has potential for automation, including "determine resource needs of projects or operations and manage budgets or finances", and 22.2% of time has potential for augmentation, including "explain regulations, policies or procedures and train others on operational or work procedures". The majority of tasks involved, totalling 61.7% of time spent, have lower potential for exposure, as these tasks involve working directly with individuals and coordinating and communicating with large groups.

FIGURE 1 **Example of an exposed and non-exposed job**

Software Developers (more exposed)



Higher potential for automation:

– Analyse data to improve operations

– Analyse performance of systems or equipment

Higher potential for augmentation:

– Prepare informational or instructional materials

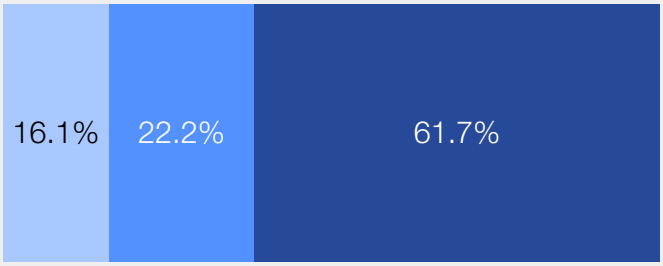
– Evaluate the characteristics, usefulness or performance of products or technologies

Lower potential for automation or augmentation:

– Coordinate with others to resolve problems

– Communicate with others about business strategies

Human Resource Managers (less exposed)



Higher potential for automation:

– Determine resource needs of projects or operations

– Manage budgets or finances

Higher potential for augmentation:

– Explain regulations, policies or procedures

– Train others on operational or work procedures

Lower potential for automation or augmentation:

– Interview people to obtain information

– Coordinate group, community or public activities

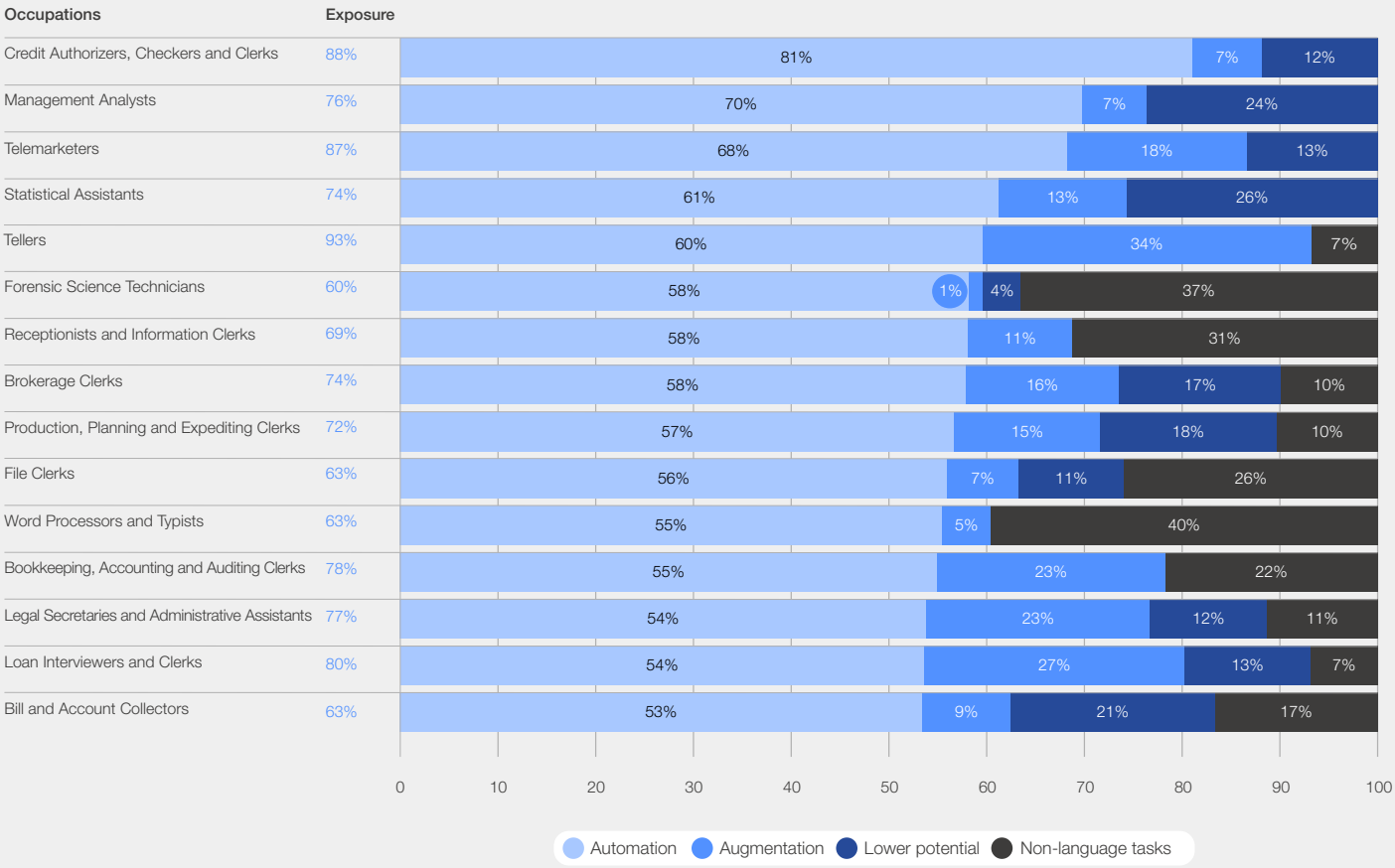
Automation Augmentation Lower potential Non-language tasks

1.3 Analysis by occupation

Jobs with potential for automation

Results from the task-based analysis reveal that jobs with the highest potential for automation of tasks by LLMs emphasize routine and repetitive procedures and do not require a high degree of interpersonal communication. Roles with the highest amount of potentially automatable work time are Credit Authorizers, Checkers and Clerks (81% of time), Management Analysts (70%), Telemarketers (68%), Statistical Assistants (61%) and Tellers (60%). Jobs with high potential for automation often include various kinds of office clerks, particularly those focused on record-keeping and managing information – tasks where LLMs have demonstrated a strong degree of competency. For example, Legal Secretaries and Administrative Assistants spend approximately 54% of their time on tasks with high automation potential.

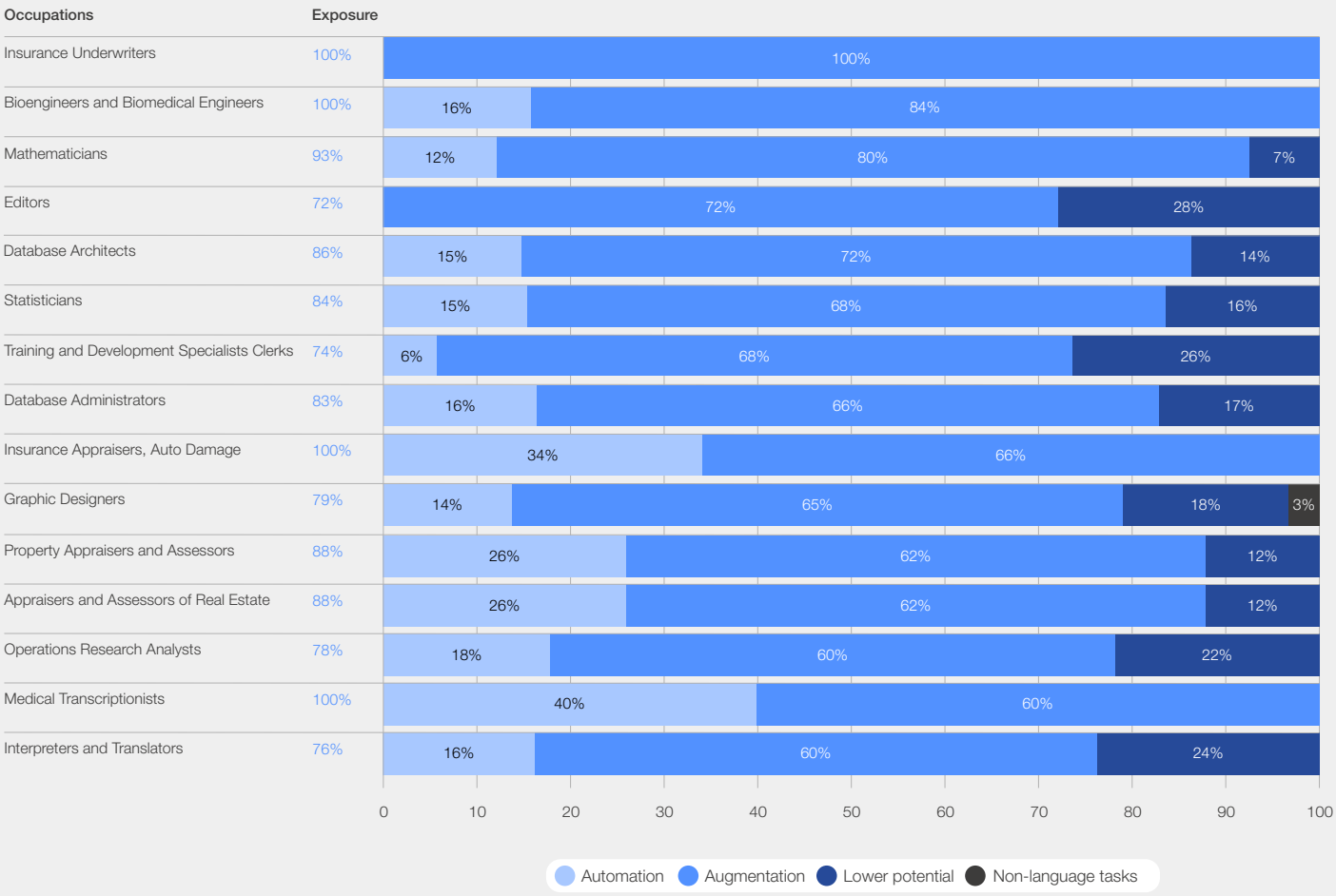
FIGURE 2 **Jobs with the highest potential for automation**



Jobs with potential for augmentation

The same analysis methods demonstrate that the jobs with the highest potential for augmentation by LLMs emphasize critical thinking and complex problem-solving skills, especially those in science, technology, engineering and mathematics (STEM) fields (see Figure 3). Topping the list is Insurance Underwriters, with analysis suggesting that they spend 100% of their time on tasks that have the potential to be augmented by generative AI systems. This is followed by Bioengineers and Biomedical Engineers (84% of time augmentable), Mathematicians (80%) and Editors (72%). The remaining top 15 jobs are likewise technical or highly specialized, often requiring advanced degrees or training, such as Database Architects and Statisticians. Note that many jobs with the highest potential for augmentation also have some potential for automation, resulting in very high total exposure for these jobs, such as Medical Transcriptionists, Insurance Appraisers and Assessors of Real Estate.

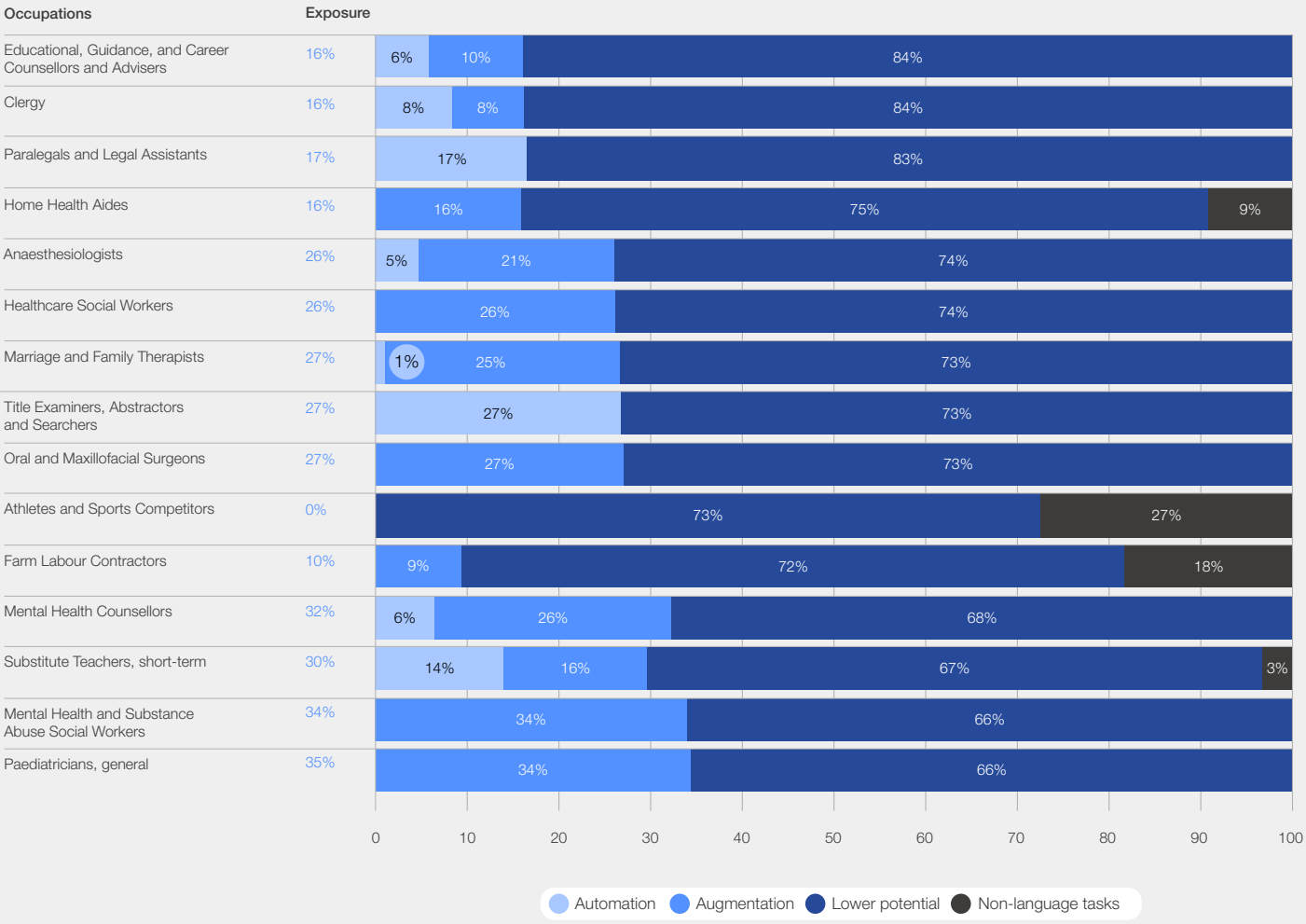
FIGURE 3 **Jobs with the highest potential for augmentation**



Jobs with lower potential for transformation and non-language tasks

Jobs emphasizing non-language tasks are expected to be less exposed, or not exposed at all, to the potential impacts of LLMs. Results of the task analysis suggest this, indicating that jobs with the lowest potential of exposure (either automation or augmentation) are those that require a high degree of personal interaction, such as Healthcare Professionals or Teachers, or physical movement, such as Athletes or Manual Labourers (see Figure 4). The occupation with the highest proportion of tasks rated low potential for transformation, at 84% of total time, is Educational, Guidance, and Career Counsellors and Advisers. This is followed by Clergy (84% of time), Paralegals and Legal Assistants (83%), Home Health Aides (75%) and then Anaesthesiologists (74%). Community, social service and healthcare occupations feature prominently among those with low potential for automation or augmentation, making up 10 of the top 15 occupations with the least exposure potential.

FIGURE 4 **Jobs with the lowest potential for exposure**



Beyond jobs with low potential exposure, a number of jobs feature no language tasks at all and have no potential to be impacted by the adoption of LLMs in the workplace. These jobs include:

- Dishwashers
- Highway Maintenance Workers
- Meat, Poultry and Fish Cutters and Trimmers
- Rail-Track Laying and Maintenance Equipment Operators
- Helpers, Carpenters
- Paper Goods Machine Setters, Operators and Tenders
- Slaughterers and Meat Packers
- Roustabouts, Oil and Gas
- Pressers, Textile, Garment and Related Materials
- Fibreglass Laminators and Fabricators

> AI Content Creators will harness the knowledge and understanding of LLMs to rapidly produce in depth content on a topic in any field or domain.

Emerging jobs

As generative AI introduces a new paradigm of collaboration between humans and AI, it will redefine how work is conducted and reshape the nature of various job roles.

No predictions can be 100% certain regarding which new roles may appear with the widespread adoption of LLMs. Still, it is apparent that there is room for job development in several key areas. The following illustrative groupings of emerging jobs can help unlock the value of generative AI and mitigate associated consequences.

AI Model and Prompt Engineers: Engineers and scientists will continue developing and fine-tuning LLMs at the most detailed level of AI systems innovation. Some of the skill sets in these jobs may already exist, but they will continue to evolve simultaneously with AI systems progress. These jobs cover the range of programmers designing more efficient algorithms, electrical engineers designing custom chips to train and run the models, systems administrators building server infrastructure, and infrastructure and power systems engineers ensuring these systems have the stable energy sources needed for extended runs. In addition, Prompt Engineers will be critical to developing, refining and reframing prompts or inputs for LLMs to reach more optimal results.

Interface and Interaction Designers: Completed and trained LLMs are still highly technical and will require well-crafted interfaces to be accessible to the public. In some ways, Interface and Interaction Designers can be considered user experience (UX) designers for LLMs. This family of jobs will be responsible for crafting LLMs to adapt to a particular kind of user input (for example, typing or spoken voice) or to perform particular tasks, such as in the development of personalized AI assistants, tutors or coaches. These jobs could include the important stage of reinforcement learning with human feedback (RHLF), in which models are trained on favoured responses, and other performance evaluators.

AI Content Creators: Building off the infrastructure of Technologists and Interface Designers, AI Content Creators will harness the knowledge and understanding of LLMs to rapidly produce in-depth content on a topic in any field or domain. The type of content produced could vary from articles and books to teaching and training material to entire storylines for movies and television series, potentially automatically generating any accompanying visual and audio media.

Data Curators and Trainers: Massive training data sets are integral to maintaining the performance of LLMs. Ensuring high-quality data is a priority in LLM development, as the quality of an LLM's output directly reflects the quality of its training data. As most training data are curated from text posted to the internet, data quality and integrity checks are critical and will lead to the development of a dedicated, specialized workforce.

Ethics and Governance Specialists: The presence of prejudiced or other unsavoury language in training data can lead LLMs to produce biased, harmful or unethical content. Not only will training data need to be checked for quality, but trained LLM systems will need to be rigorously tested before being released to the public. This will fall into the purview of specially trained AI Safety Officers and Ethicists at the company level and even domain-specific regulators and lawyers at the government level.

> Introducing these new technologies will change the nature of the labour market but will not necessarily reduce the total number of jobs.

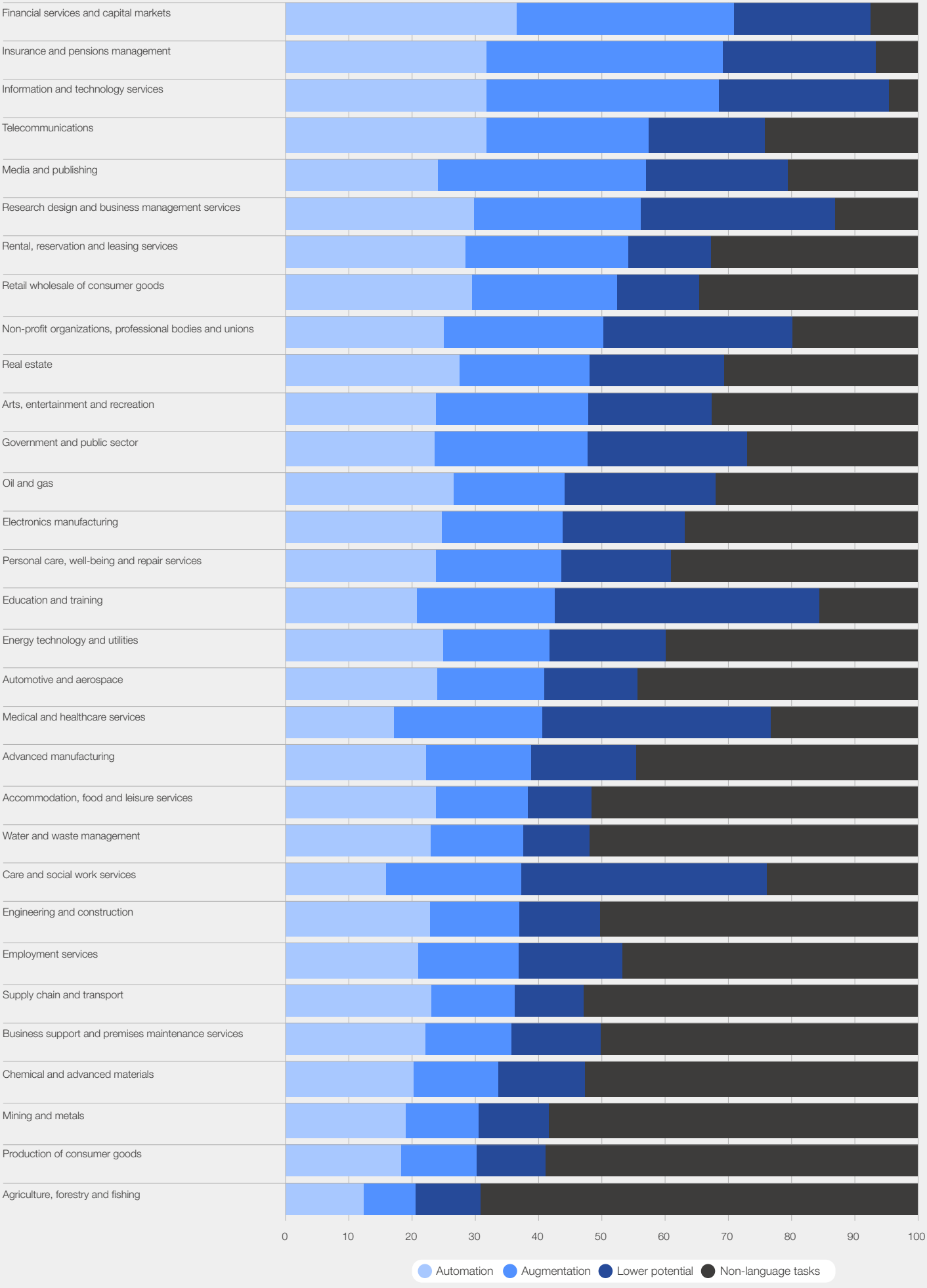
While the emergence of new job categories can be expected, the reinvention of existing roles should also be anticipated. Analysis of the impact of LLMs on customer service jobs found that, of the 13 core customer service tasks, four tasks remained unchanged and within human capabilities, four tasks could be fully automated using generative AI, five tasks could be augmented to enhance human performance, and five new high-value tasks emerge.[12] With generative AI, Customer Service Representatives (CSRs) can engage in new tasks like providing feedback for system improvement, aligning with customer needs, testing for biases and ensuring ethical machine behaviour, and monitoring data privacy. These responsibilities empower CSRs to shape AI deployment, optimize customer experiences and uphold ethical standards in customer service operations. Additionally, another study of CSRs found that the implementation of generative AI was associated with lower employee turnover.[13] These findings demonstrate how organizations could use generative AI alongside human expertise to rethink job design, enhance productivity and improve employee experience.

1.4 Analysis by industry

To take the analysis a step further, the job exposure ratings may be aggregated to generate estimates for potential automation or augmentation at the industry level (see Figure 5). To generate these estimates, the exposure measures for all occupations within a particular industry are averaged, weighted by total employment, and taking into account that occupations may belong to more than one industry. The two industries with the highest estimates of total potential exposure (automation plus augmentation measures) are both segments of financial services: financial services and capital markets, and insurance and pension management. This is followed by information technology and digital communications, and then media entertainment and sports. A trend to note with the industry estimates is that industries with high potential for exposure to LLMs have high potential for both automation and augmentation. This suggests that introducing these new technologies will change the nature of the labour market but will not necessarily reduce the total number of jobs.

The industries rated with high potential exposure also plan to adopt AI technologies, as the business leaders surveyed in the Future of Jobs Report 2023 reported. Three of the top five industries planning to adopt AI technologies are those with the greatest exposure to LLMs – namely, insurance and pension management, information technology services, and media, entertainment and sports.[14]

FIGURE 5 | **Industries with the highest exposure (automation and augmentation)**

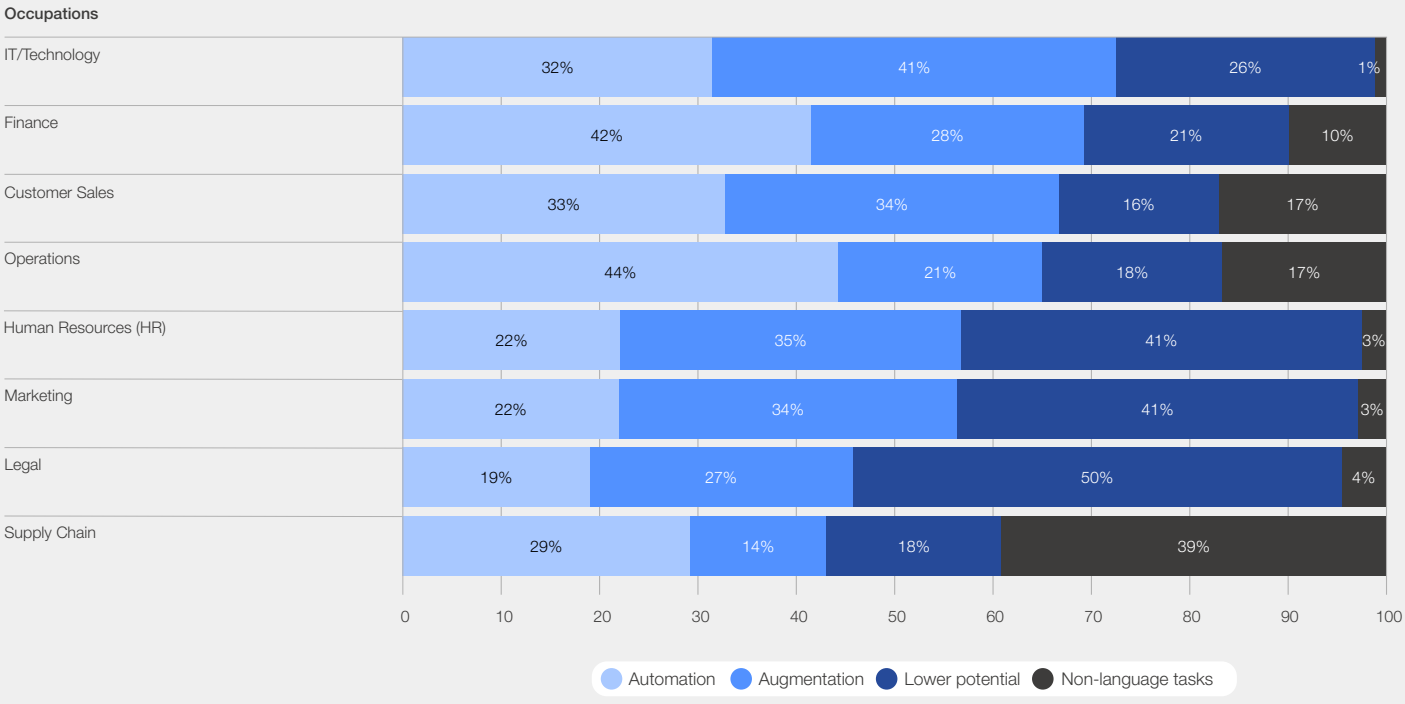


The appendix to this report contains additional lists of jobs ranked by exposure for each of the 31 primary industry groups.[15] For these tables, jobs are ranked by total exposure potential, which is the sum of automation and augmentation measures.

1.5 Analysis by function

The exposure ratings for occupations may also be aggregated into functional groups, which reveals similar themes for potential automation and augmentation (see Figure 6). As was found with the industry analysis and much of the analysis in the *Future of Jobs Report 2023*, the two thematic areas with the greatest total potential exposure to LLMs are information technology, with a total of 73% of work time exposed, and finance, with a total of 70% of work time exposed. These functions are followed by customer sales (67% total exposure), operations (65%), and human resources (57%). Job functions likely to be automated also tend to have a high chance of being enhanced or augmented by technology, and vice versa. This is an important counterpoint to the notion that technological innovation displaces jobs: technological innovation transforms jobs, with some tasks being eliminated and others becoming more important.

FIGURE 6 **Job function groups with the highest exposure (automation and augmentation)**



Similar to the job exposure rankings by industry, the appendix to this report also includes additional lists of jobs ranked by exposure for each of the eight function groups. For these tables, just as with industry groups, jobs are ranked by total exposure potential, which is the sum of automation and augmentation measures.

2 LLMs and the growth and decline of jobs and tasks

Growth expectations underscore workforce shifts in job tasks and titles, suggesting readiness for transformation.

This section identifies common themes between the results presented in this white paper and the findings on expected growth and decline in jobs collected from global business leaders in the Future of Jobs Survey, presented in the *Future of Jobs Report 2023*. Themes emerge in job tasks and specific roles, especially those susceptible to automation, augmentation and those with lower exposure potential.

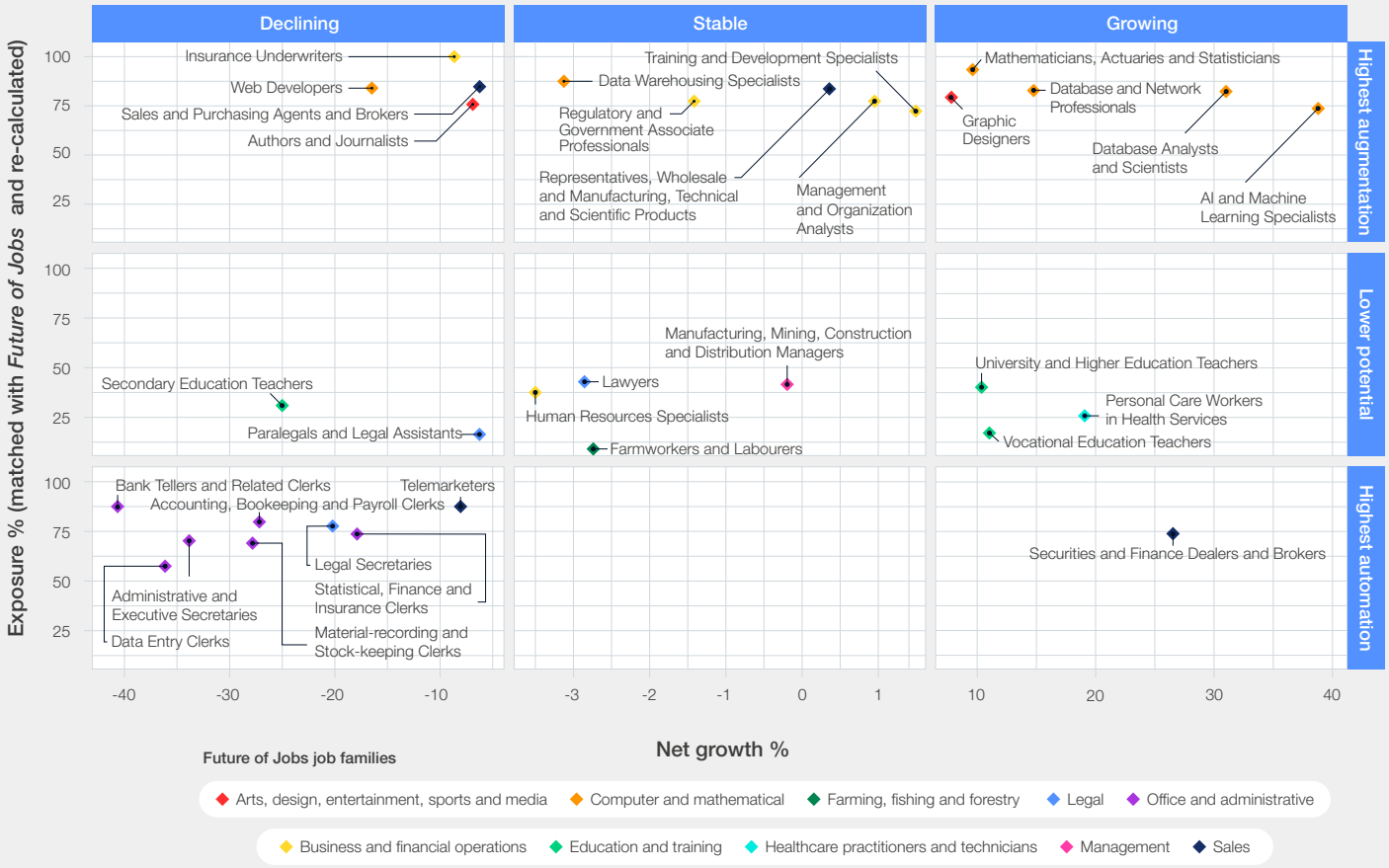
2.1 Expected growth and decline of tasks

The analysis presented in the *Future of Jobs Report 2023* indicates some striking parallels between the results in Table 1 and the predictions of global business leaders.[16] The report found that the number one task predicted to be automated now and in the next five years is information and data processing. The present task-based analysis also indicates that this task has high potential for automation, namely in designing databases, analysing data to improve operations and obtaining information about goods or services. Similarly, results from the *Future of Jobs Report 2023* found that the lowest potential for automation will be in reasoning and decision-making tasks. This paper's task-based analysis denotes decision-making tasks as having high potential for augmentation (especially for evaluating personal capabilities or performance, reading documents or materials to inform work processes, and evaluating patient or client condition or treatment options), or low potential for exposure (such as direct scientific or technical activities). The fact that the survey results from the *Future of Jobs Report 2023* and the task-based analysis in this paper identify common threads underlying the workforce transition suggests that these changes are indeed fundamental shifts. Additionally, it implies that business leaders are already identifying these trends and are expected to be in a good position to prepare their workforces for future changes.

2.2 Expected growth and decline of jobs

Figure 7 combines the key findings on job exposure to LLMs in this white paper with growth expectations for the same jobs, as identified in the *Future of Jobs Report 2023*. In this figure, the vertical axis indicates the exposure potential of jobs, with augmentation potential scores in the top box, low potential scores in the middle box and automation scores in the bottom box. The horizontal axis indicates the net expected growth for jobs within the next five years, measured as the expected percentage change in workforce employment. Note that to produce this chart, the O*NET detailed occupations used earlier in the report have been mapped to the job classification used by the *Future of Jobs Report 2023*. The most immediate takeaway from the figure is the positive association between job augmentation and growth and the negative association between job automation and growth. In contrast, jobs with lower potential for exposure have much lower expected growth.

FIGURE 7 | **Job exposure potential vs growth potential**



Adopting generative AI, with its potential to increase individual worker productivity, could fuel significant job growth.

The jobs with the highest potential for automation are featured in the lower box of Figure 7 (mapped from the list in Figure 2) and overlap significantly with those that are expected to decline over the next five years, as indicated by survey results from business leaders in the *Future of Jobs Report 2023*.[17] The three with the greatest expected declines are Bank Tellers and Related Clerks (87% of time spent on tasks with high potential for automation, 41% expected decline), Data Entry Clerks (58% potential automation, 36% expected decline), and Administrative and Executive Secretaries (69% potential automation, 34% expected decline). All jobs with high potential for automation have negative expected growth, with the exception of Securities and Finance Dealers and Brokers.

The jobs with high potential for augmentation are featured in the upper box (mapped from the list in Figure 3) and mostly align with jobs with strong expected growth over the next five years, as indicated in the *Future of Jobs Report 2023*.[18] Jobs largely in the families of technologists, engineers and analysts have potential for augmentation and growth. AI and machine learning specialists have the highest expected growth (75% of time spent on tasks with high potential for augmentation, and 39% expected growth), followed by Data Analysts and Scientists (84% potential augmentation, and 31% expected growth) and Database and Network Professionals (83% potential augmentation, and 14% expected growth). However, jobs with high potential for augmentation feature significant variation in expected growth, and several jobs in this category have low growth expectations, such as Data Entry Clerks and Web Developers. Nevertheless, the general congruence between augmentation potential and expected growth suggests that adopting generative AI, with its potential to increase individual worker productivity, could fuel significant job growth.

Of the jobs with low potential for exposure, indicated in the middle box (mapped from the list in Figure 4), many are found in the field of education, especially University and Higher Education Teachers, which were also identified in the *Future of Jobs Report 2023* as having modest expected growth within the next five years (41% of time spent on tasks with low potential for exposure to LLMs, and 10% expected growth).[19] Jobs with low potential for exposure also vary in their expected growth numbers but tend to average close to zero expected growth. The prominence of care jobs among those with lower potential for automation by LLMs aligns with earlier findings from the previous edition of the Jobs of Tomorrow report. That report found high levels of unmet demand for care and education jobs across many countries from all income groups.[20] This could be in part because generative AI cannot easily automate these jobs, and yet demand for their services will only continue to grow in the coming years.

Conclusion: Ensuring that large language models work for workers

Adopting LLMs will transform business and the nature of work, displacing some existing jobs, enhancing others and ultimately creating many new roles. Yet, it will be incumbent upon businesses and governments to take proactive steps in preparing the workforce for the imminent transformation to ensure that all members of society benefit from the potential of generative AI.

This paper takes a structured approach to assessing the impact – positive and negative – of LLMs on jobs, allowing stakeholders to responsibly address both challenges and opportunities.

– Policy-makers will need to adapt strategic workforce planning capabilities, lifelong learning systems and social safety nets to manage the upcoming period of disruption. Similar analysis to that shared in this paper can help provide more precise views of the situation in specific geographies. Governments can also partner with and support employers and educational institutions to provide training programmes that prepare workers for the jobs that will grow and benefit the most from LLMs. Additionally, social safety nets and assistance in transitioning to new roles will need to be reimagined and be more precisely targeted for those most likely to be affected.

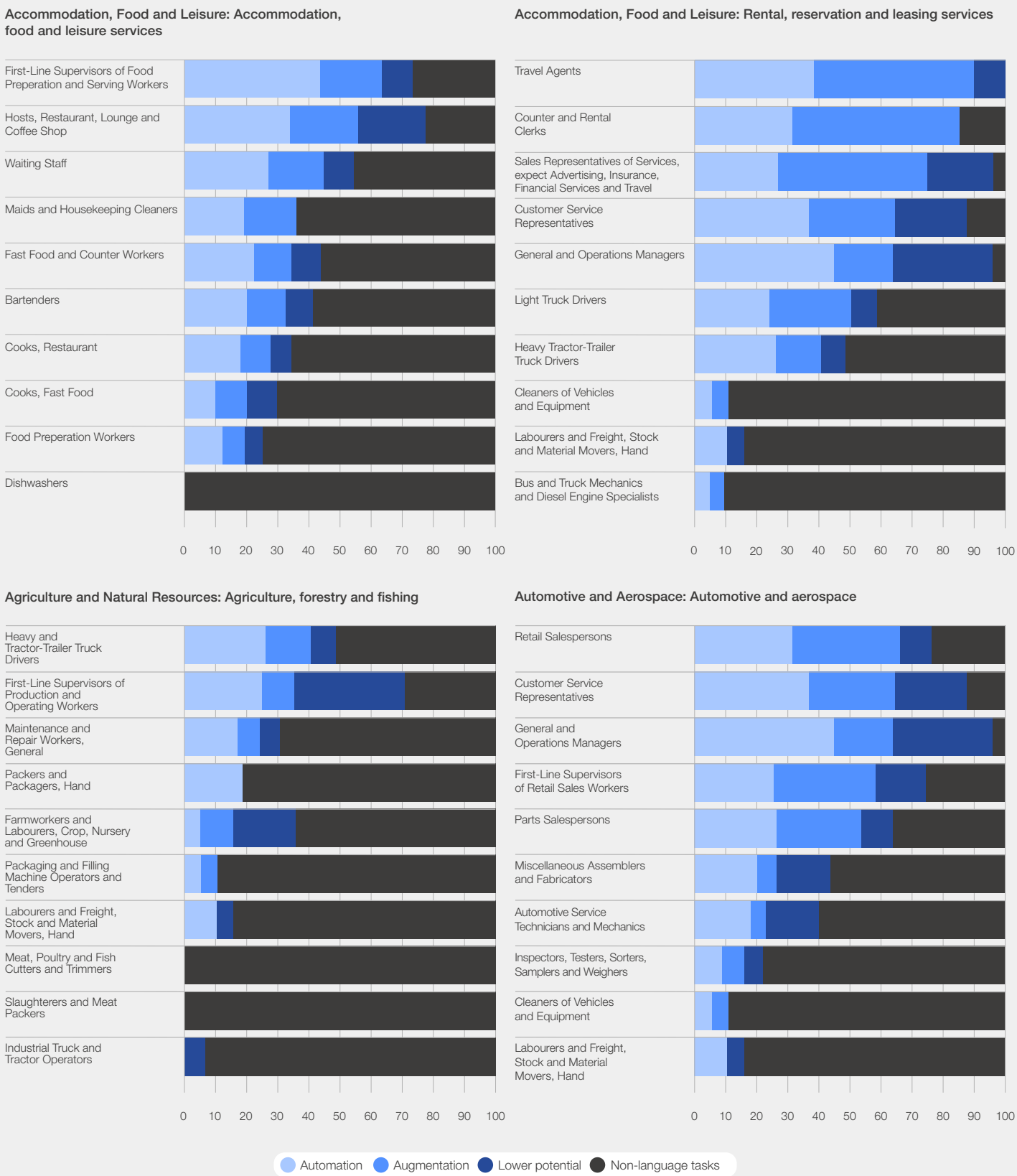
– Business leaders can use insights on the direct impact of LLMs on jobs to understand which roles will be most affected and responsibly support the transition of workers to new roles and ways of working. Internal workforce planning, learning and development, and talent management practices should also be strengthened to support the adoption of generative AI in the workplace, recruit new talent in growing jobs or invest heavily in reskilling and upskilling workers towards growing roles.

Large language models present an opportunity to extend human potential, grow industries and strengthen global economies. Yet their rapid adoption contains both risks and opportunities for the workforce. The approach presented in this white paper helps plan for the direct impact on tasks and jobs and informs government, business and workers on the actions they can take now to prepare for the future.

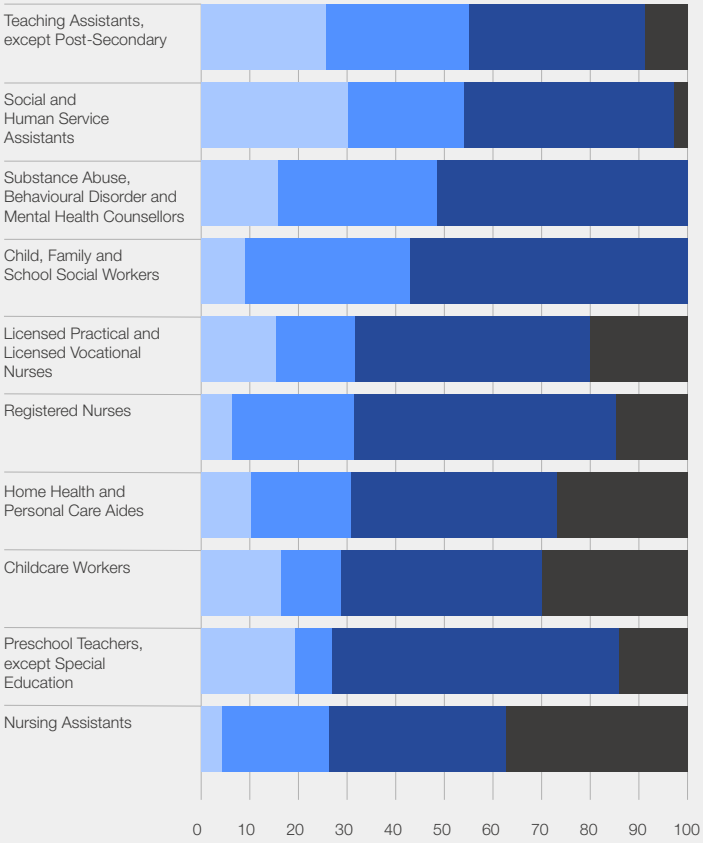
Appendices

A1 Exposure potential by industry groups

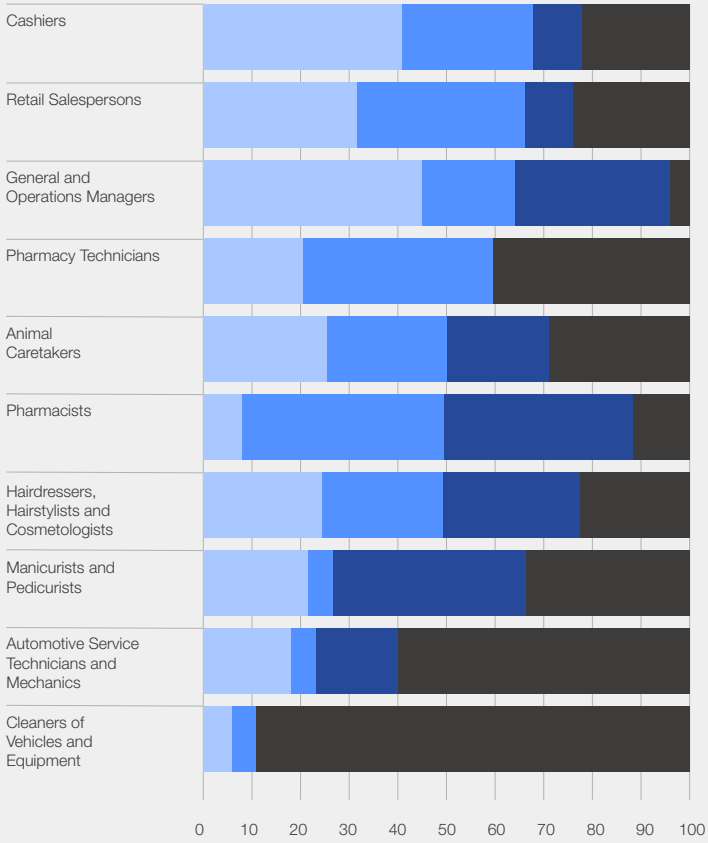
FIGURE 8 **Job exposure by industry: ranked by exposure (augmentation and automation potential)**



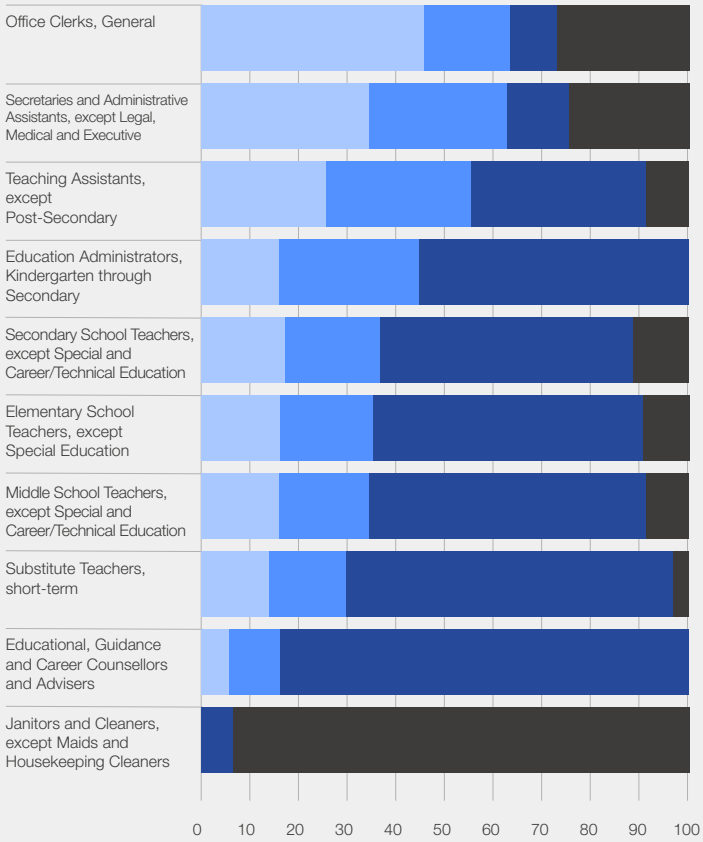
Care, Personal Services and Well-being: Care and social work services



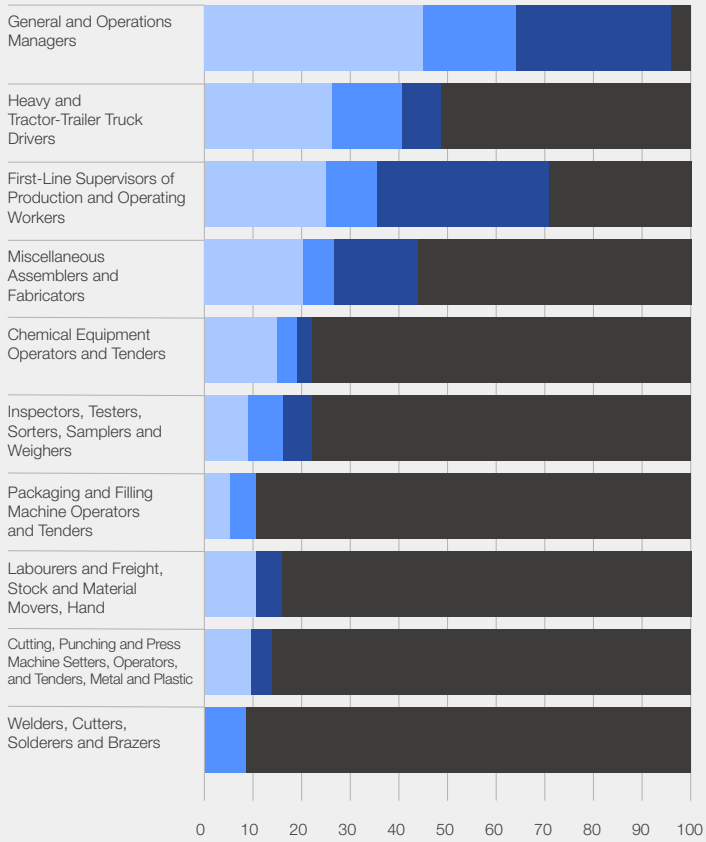
Care, Personal Services and Well-being: Personal care, well-being and repair services



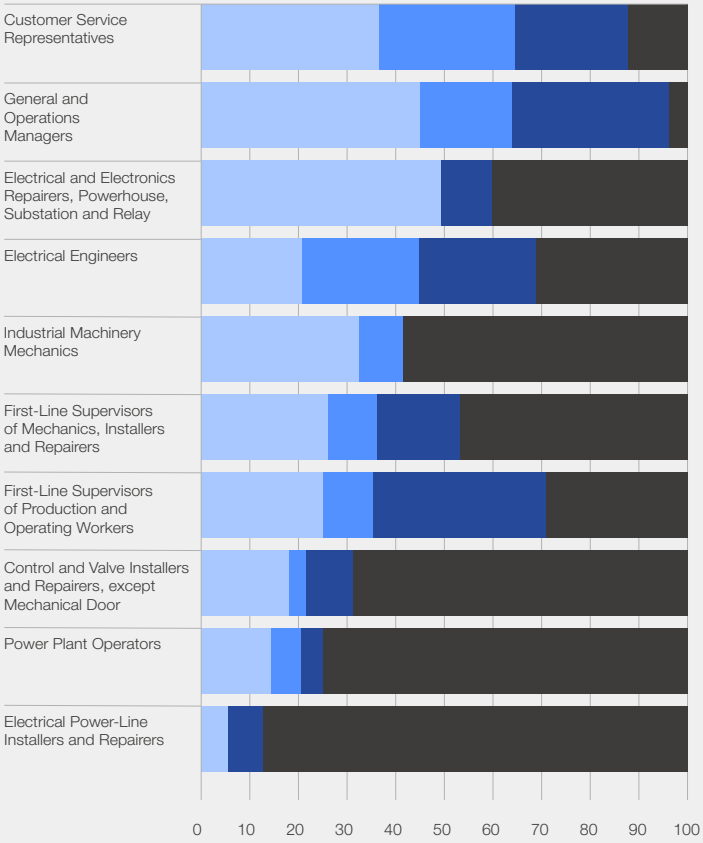
Education and Training: Education and training



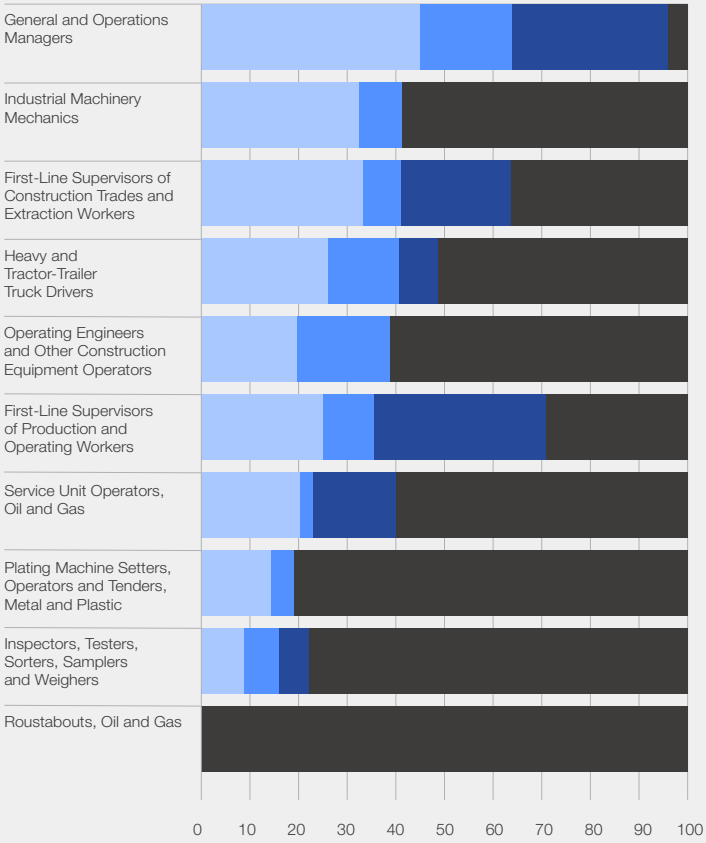
Energy and Materials: Chemical and advanced materials



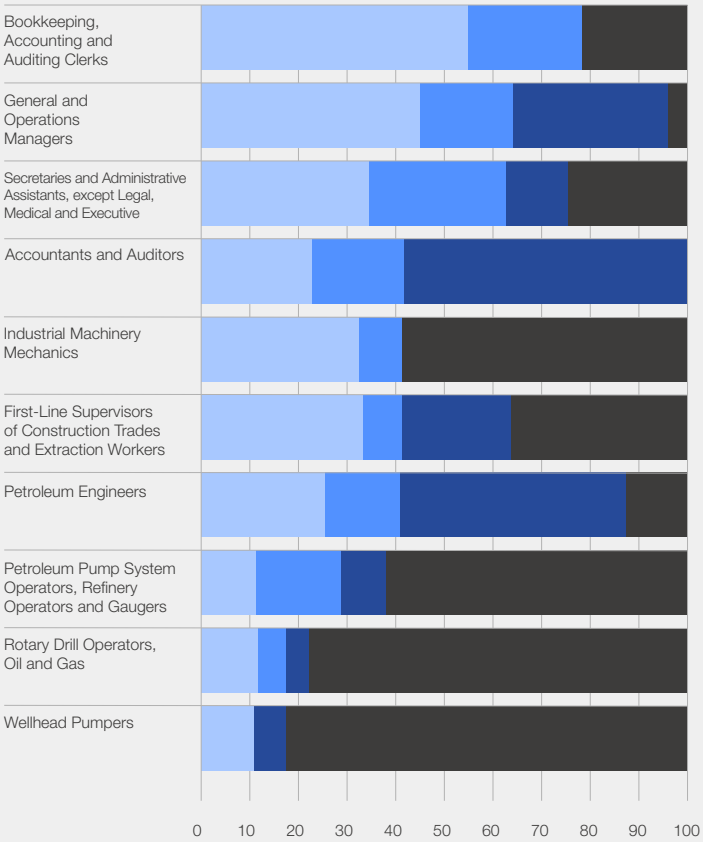
Energy and Materials: Energy technology and utilities



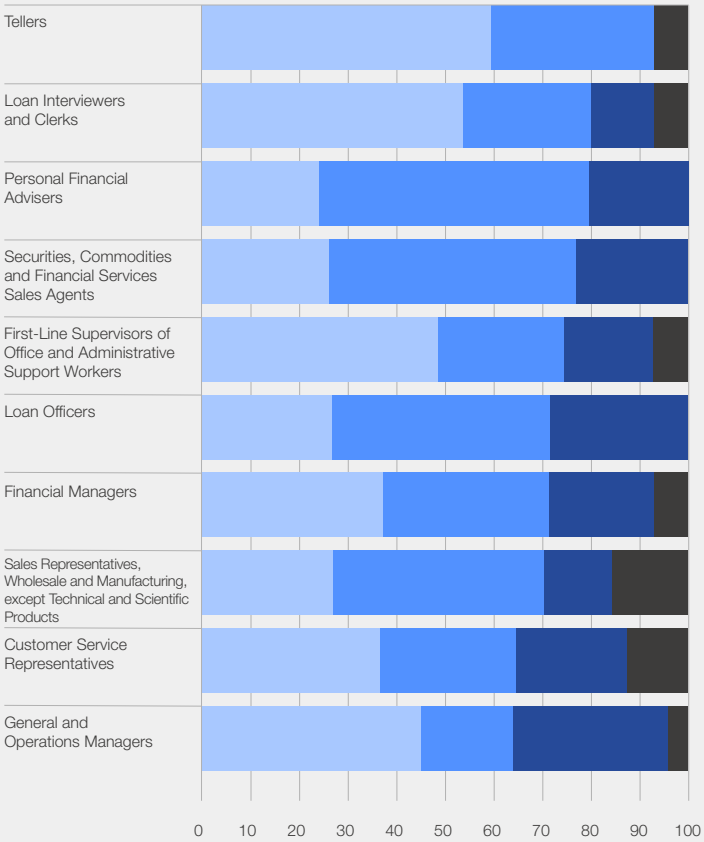
Energy and Materials: Mining and metals



Energy and Materials: Oil and gas

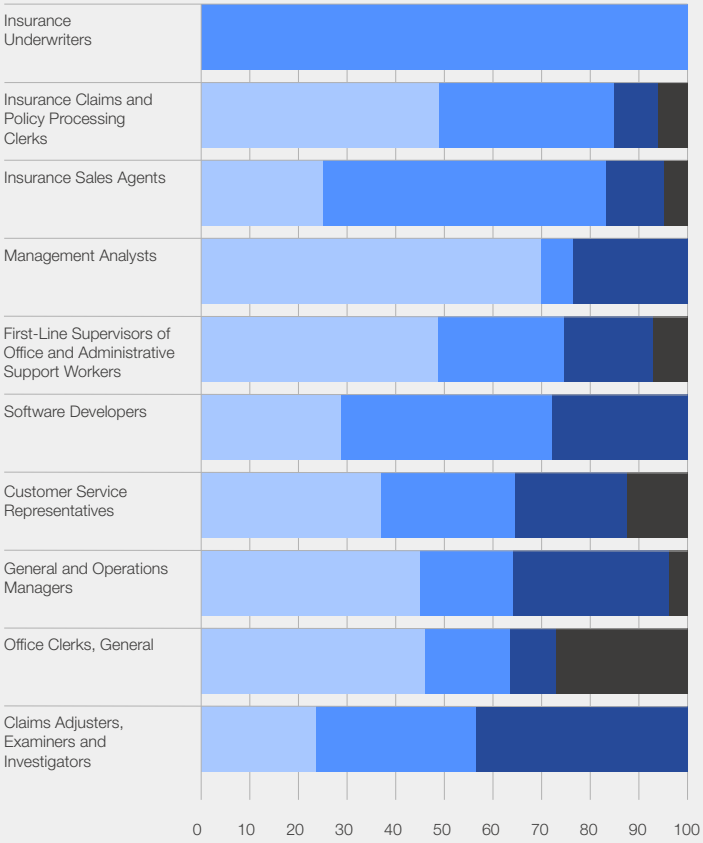


Financial Services: Financial services and capital markets

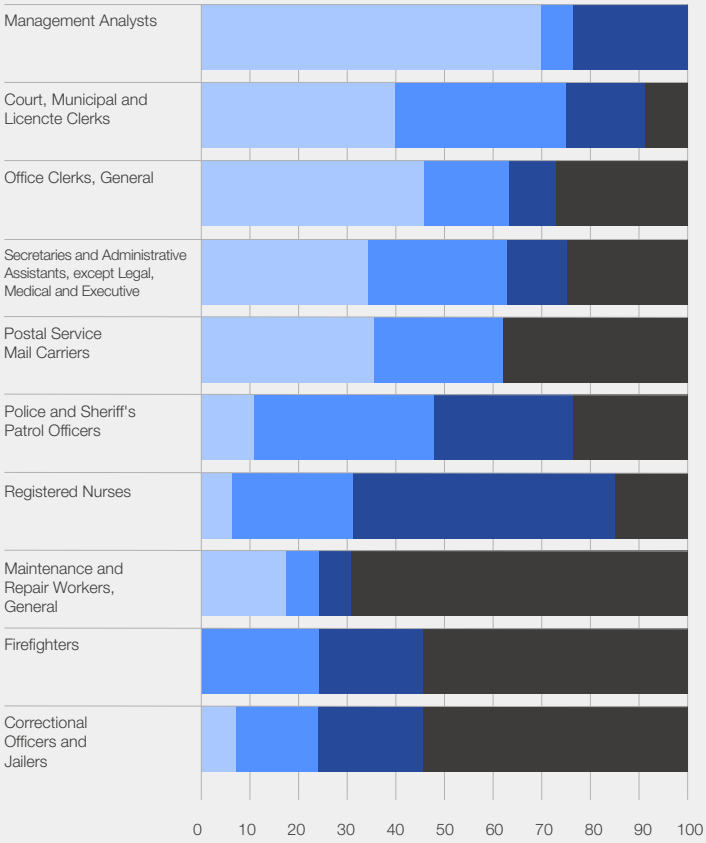


Automation Augmentation Lower potential Non-language tasks

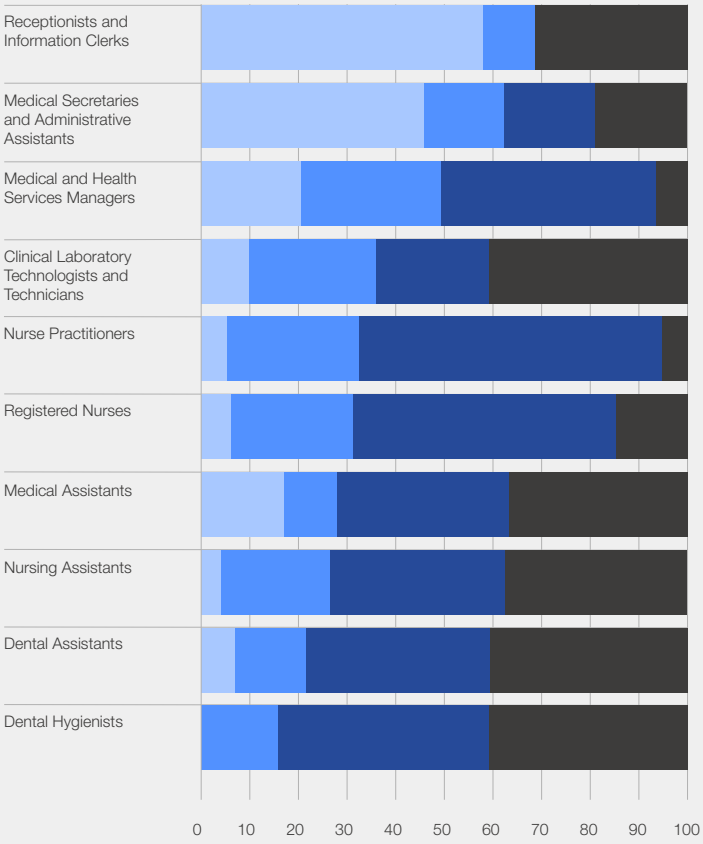
Financial Services: Insurance and pensions management



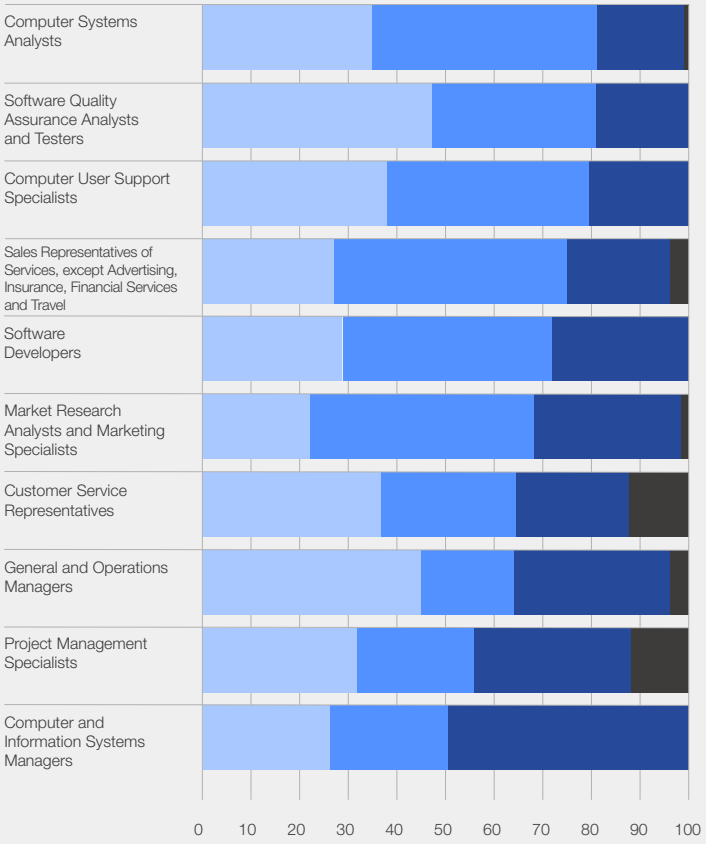
Government and Public Sector: Government and public sector



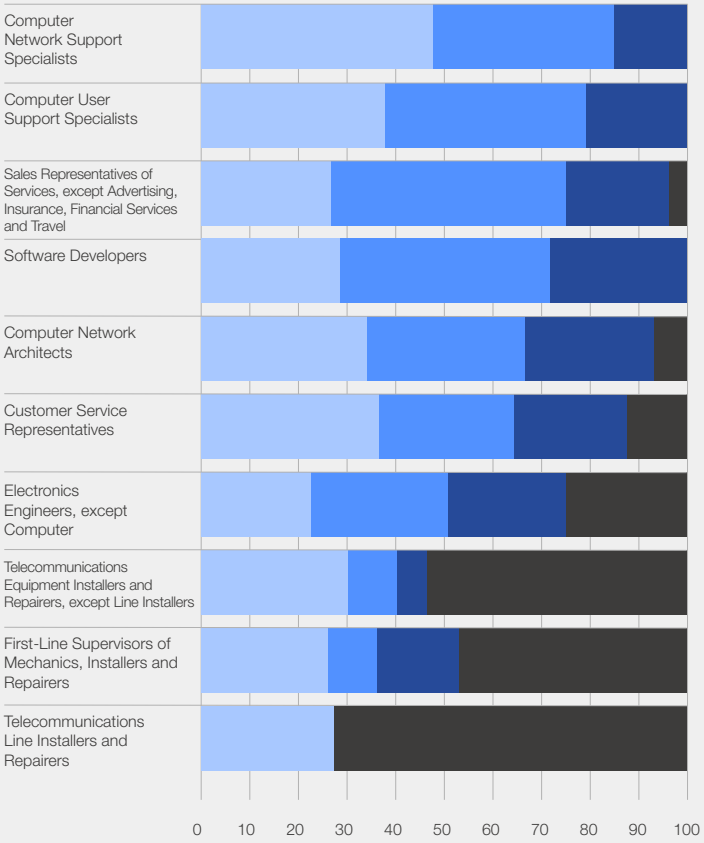
Health and Healthcare: Medical and healthcare services



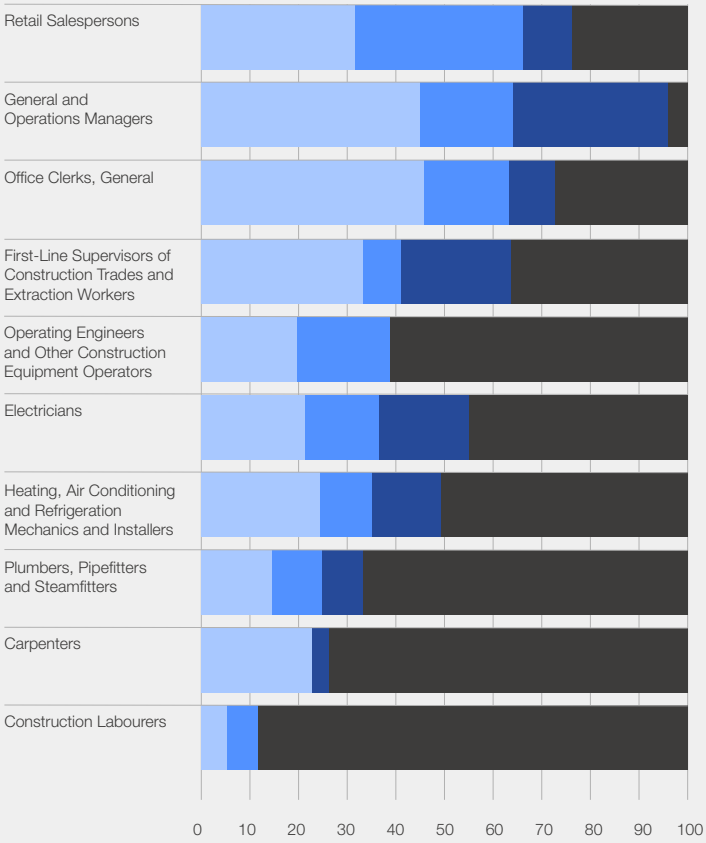
Information Technology and Digital Communications: Information and technology services



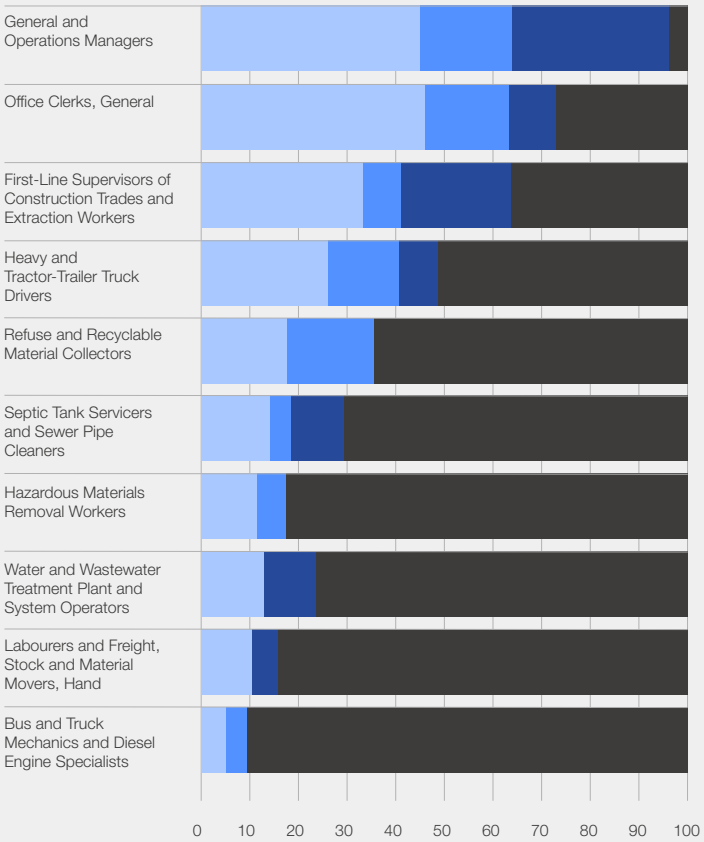
Information Technology and Digital Communications: Telecommunications



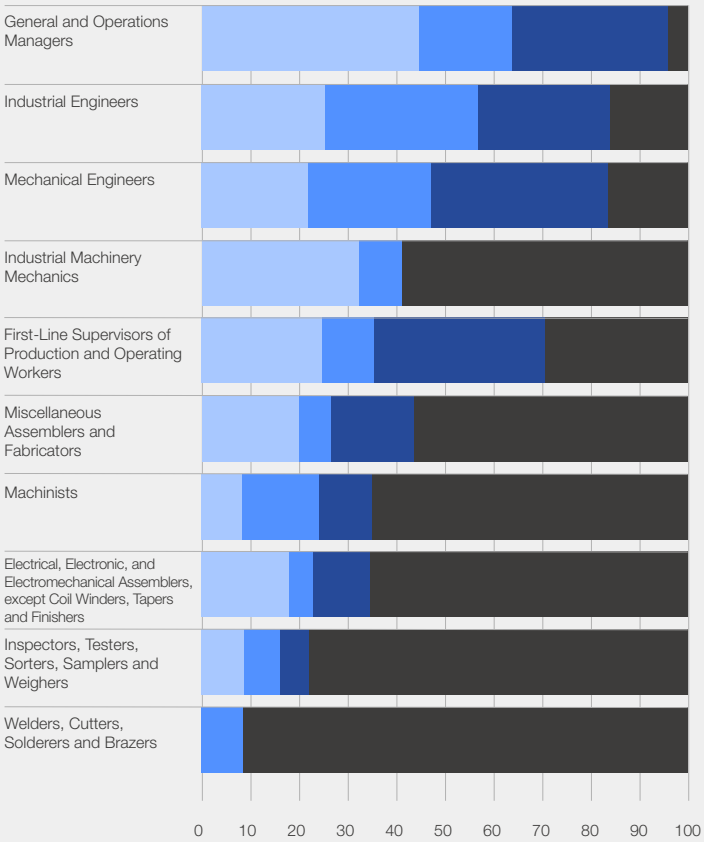
Infrastructure: Engineering and construction



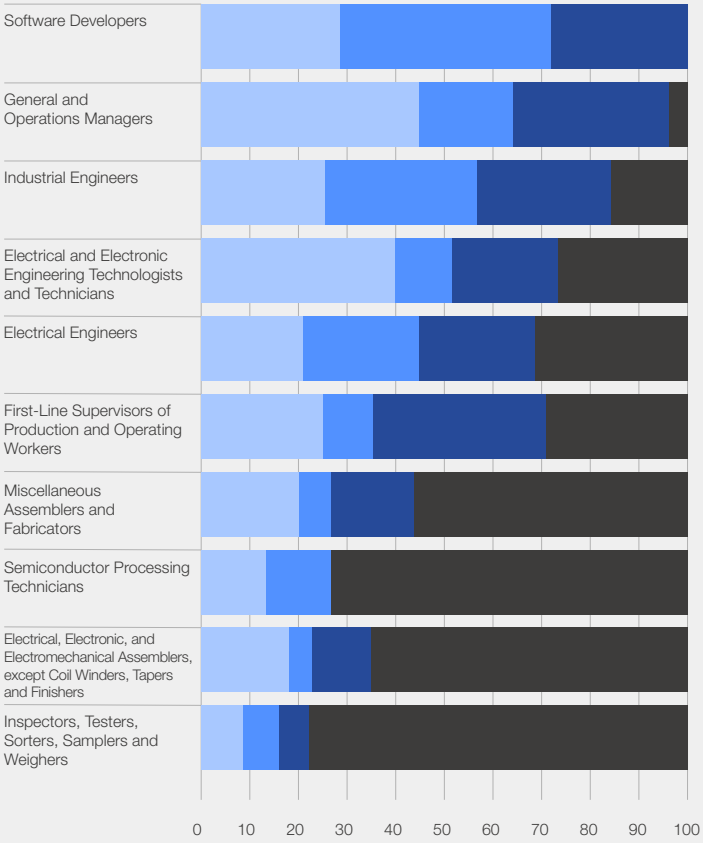
Infrastructure: Water and waste management



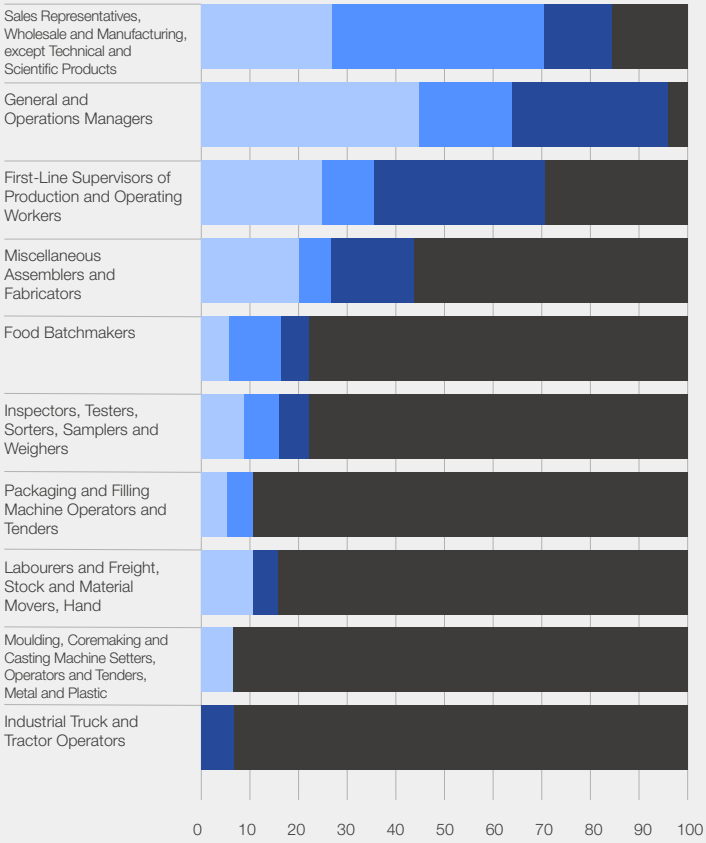
Manufacturing: Advanced manufacturing



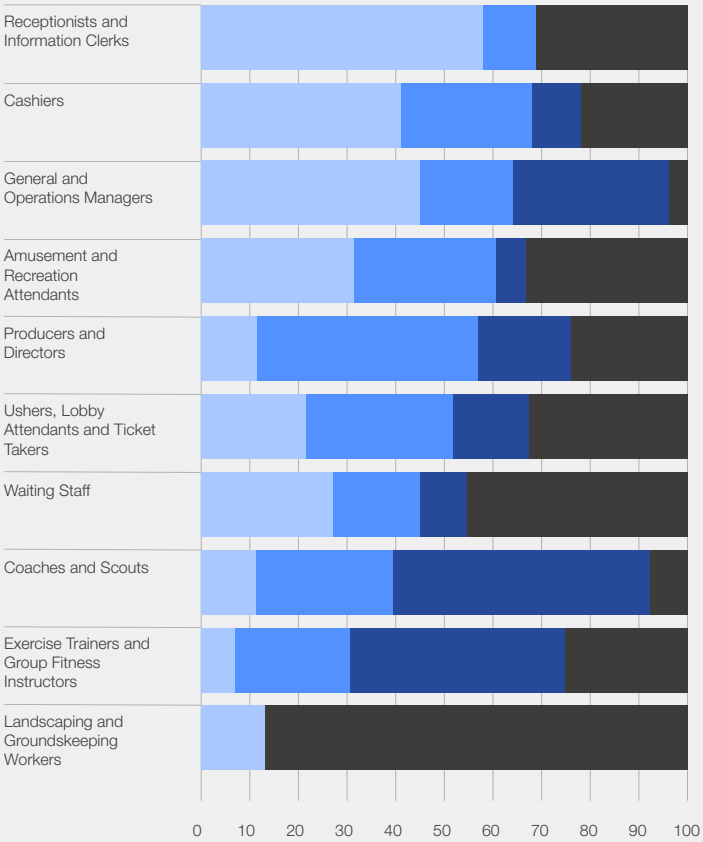
Infrastructure: Water and waste management



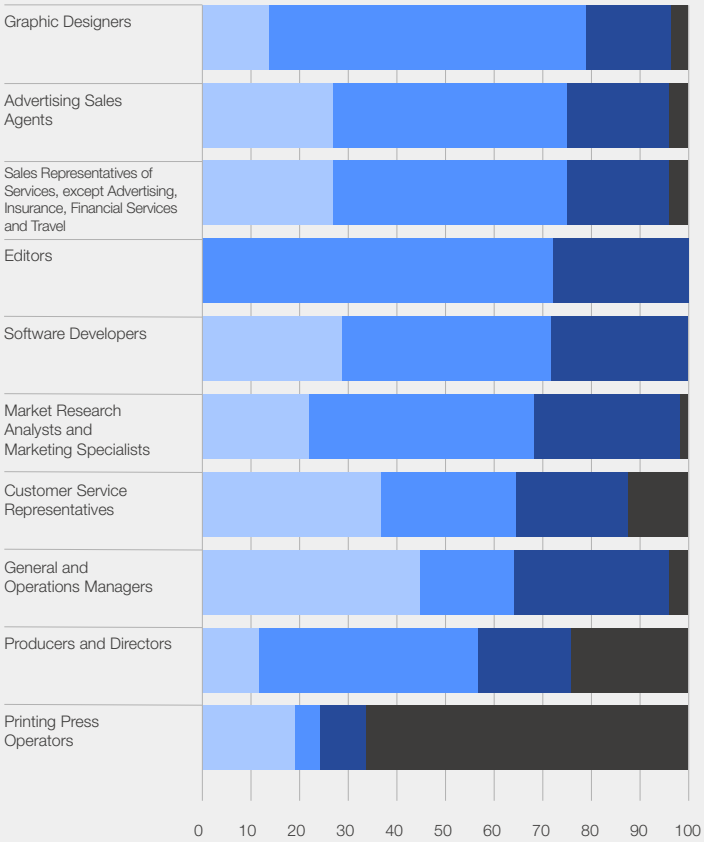
Manufacturing: Advanced manufacturing



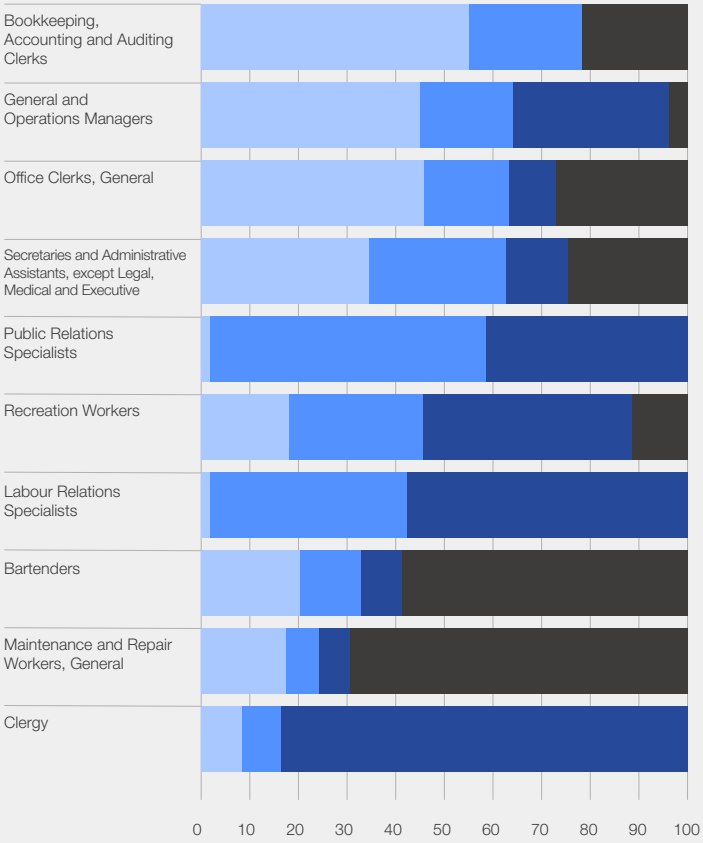
Media, Entertainment and Sports: Arts, entertainment, and recreation



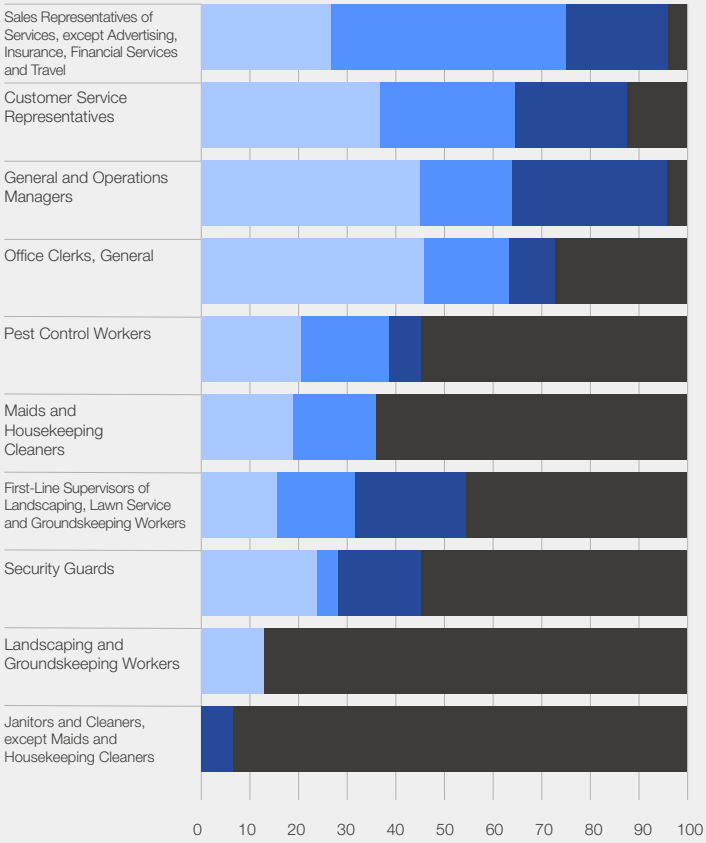
Media, Entertainment and Sports: Media and publishing



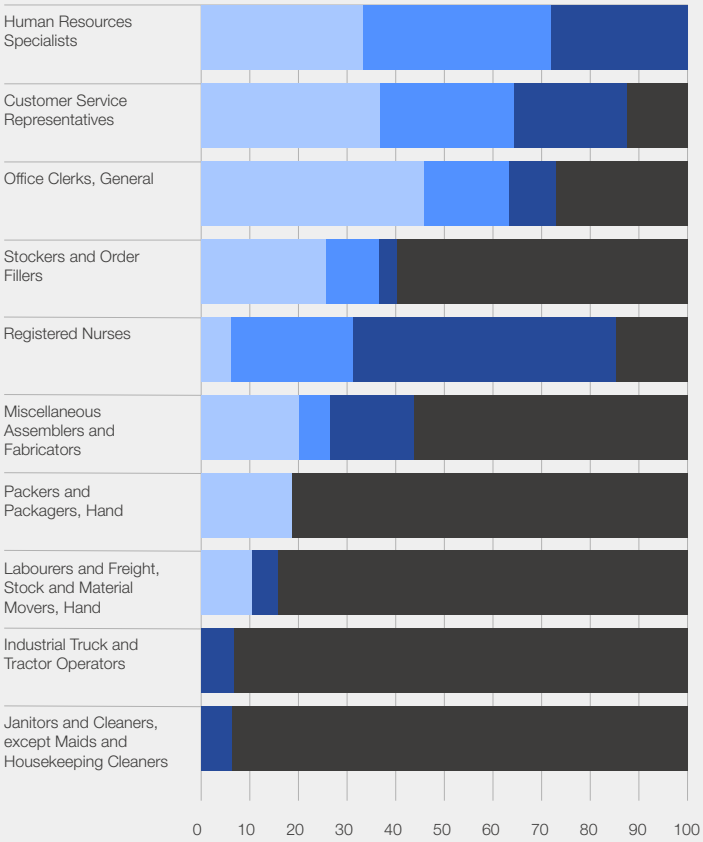
Non-governmental and Membership Organizations: Non-profit organizations, professional bodies and unions



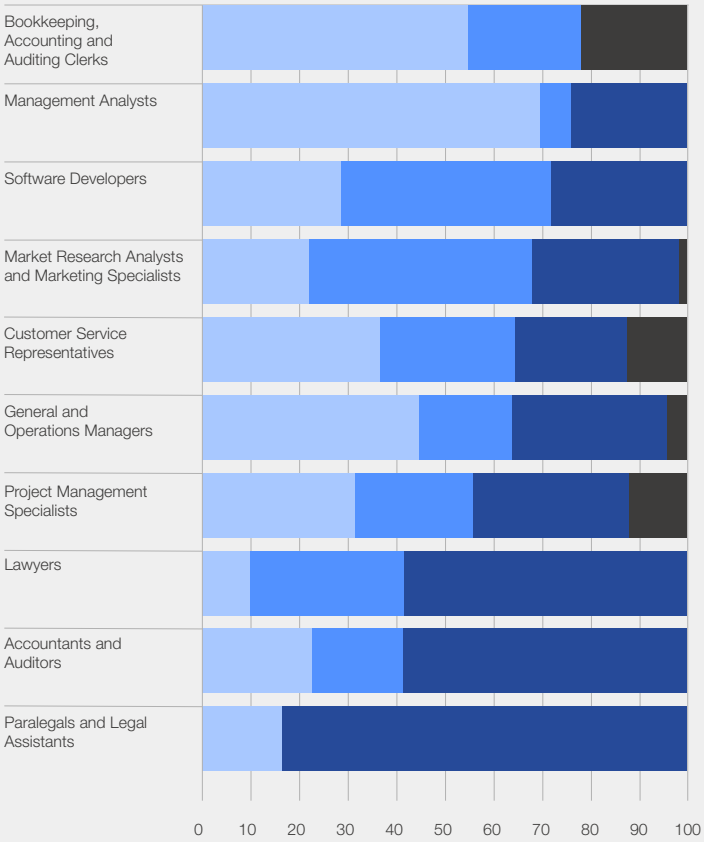
Professional Services: Business support and premises maintenance services



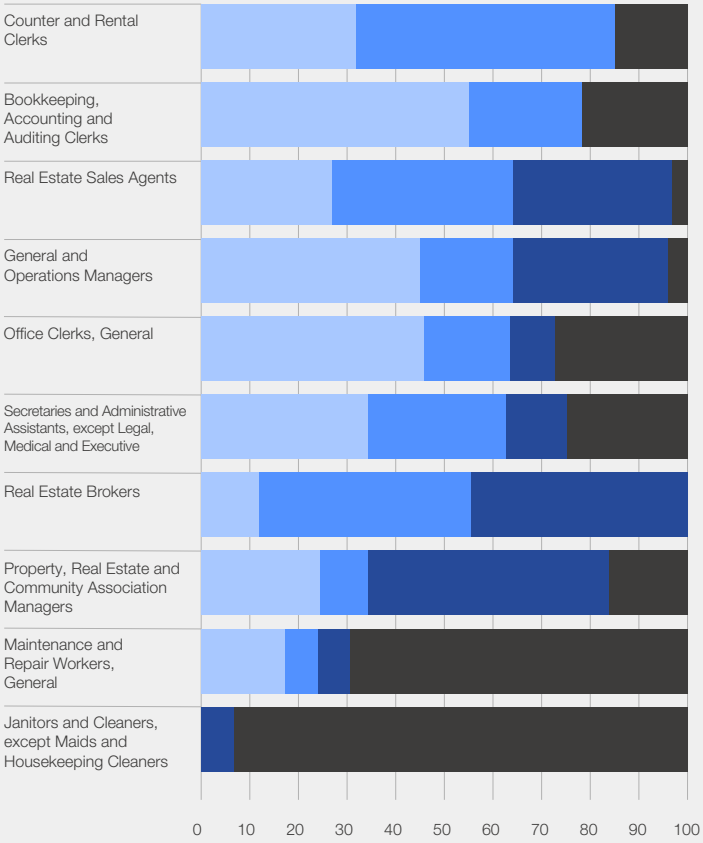
Professional Services: Employment services



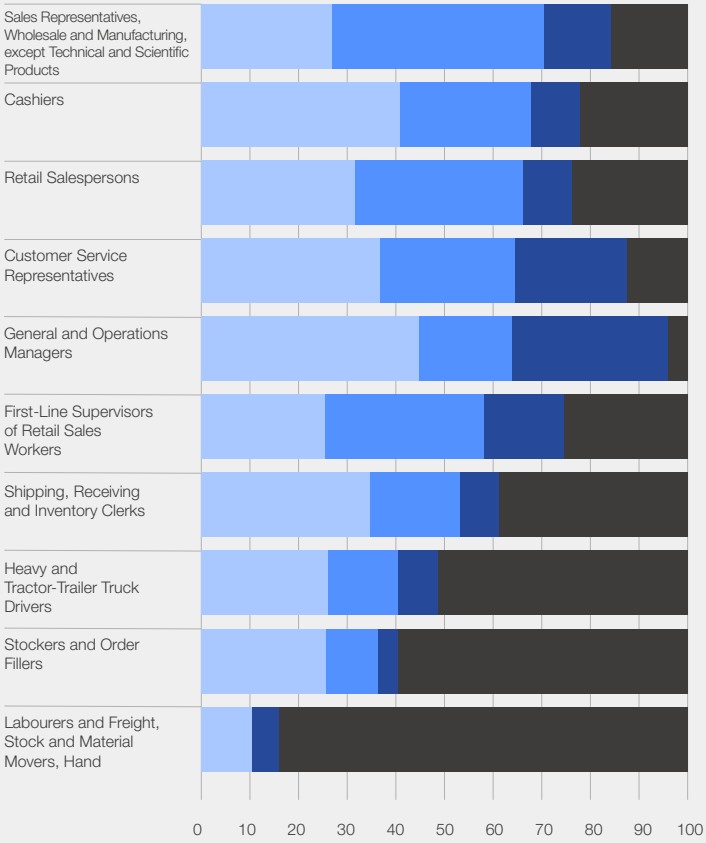
Professional Services: Research, design and business management services



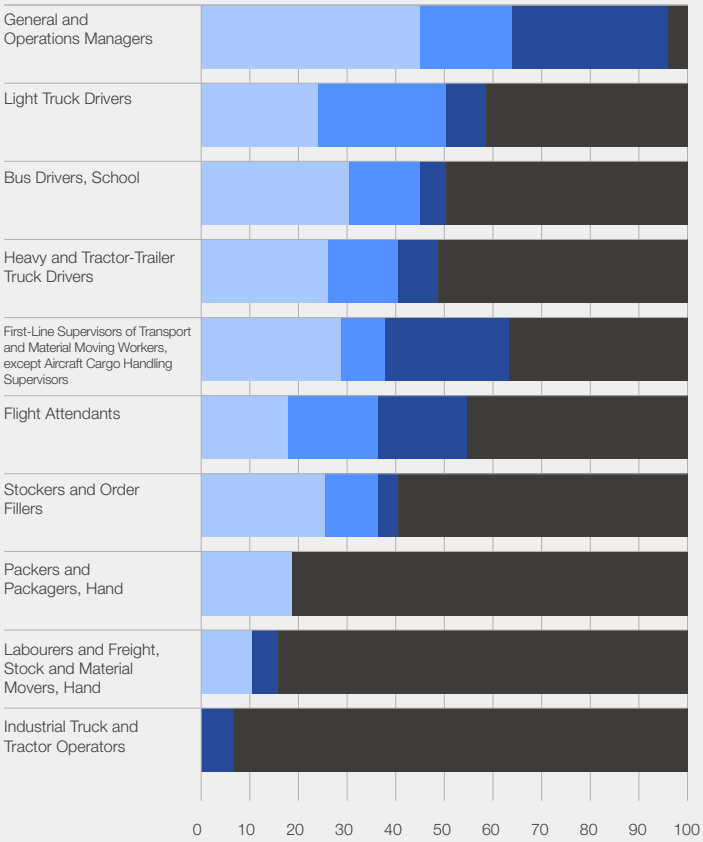
Real Estate: Real estate



Retail and Wholesale of Consumer Goods: Retail and wholesale of consumer goods

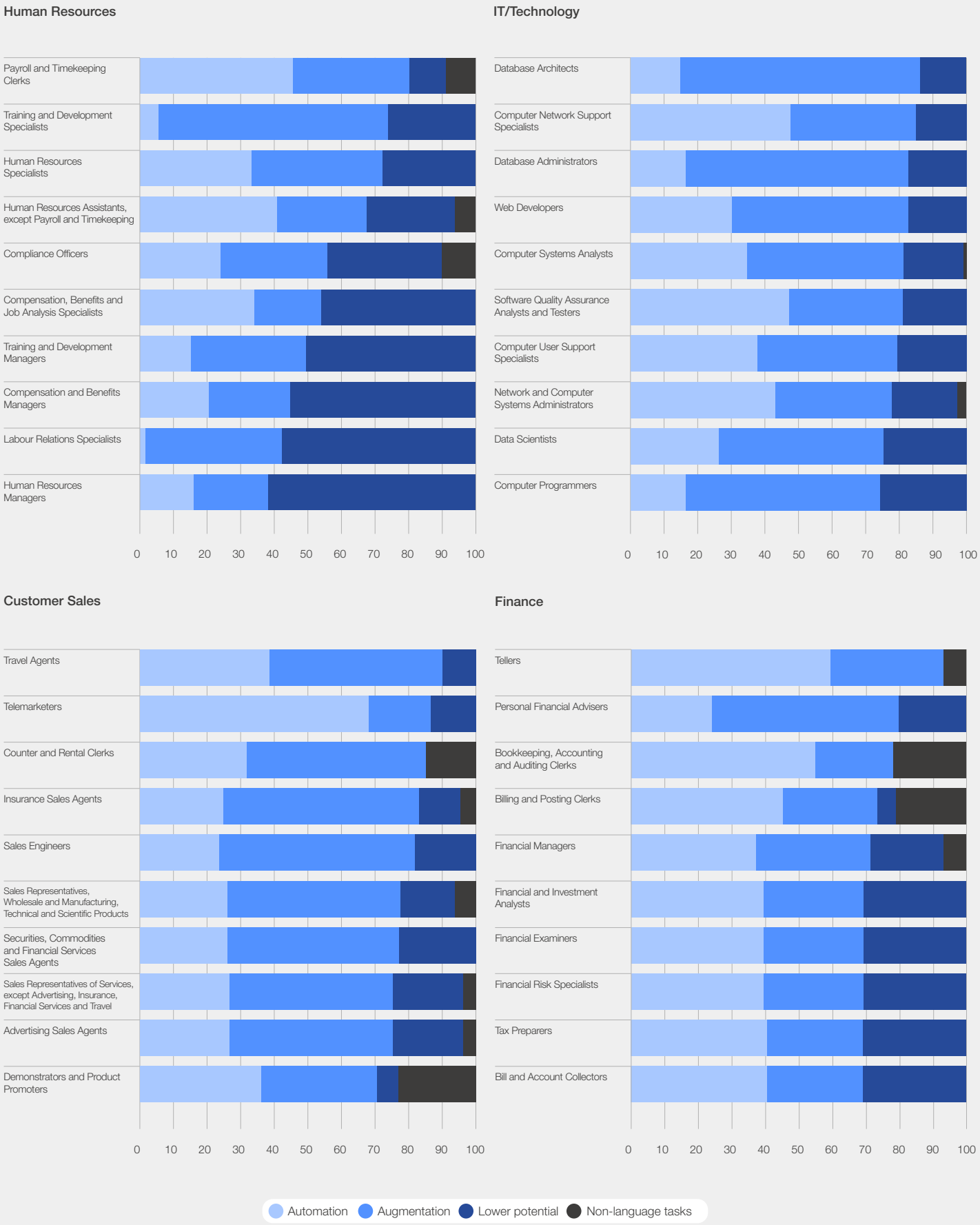


Supply Chain and Transport: Supply chain and transport

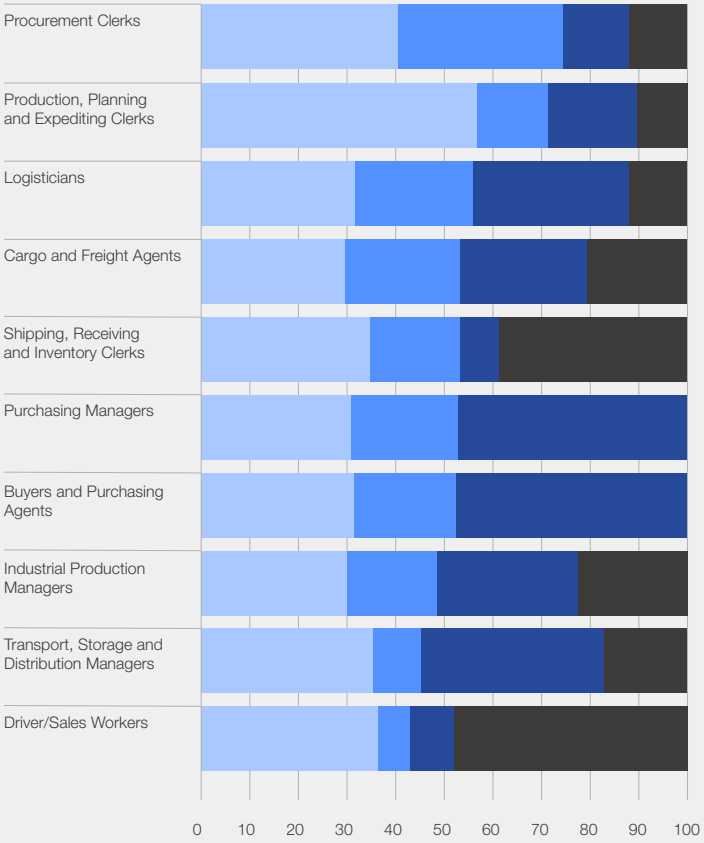


A2 Exposure potential by function groups

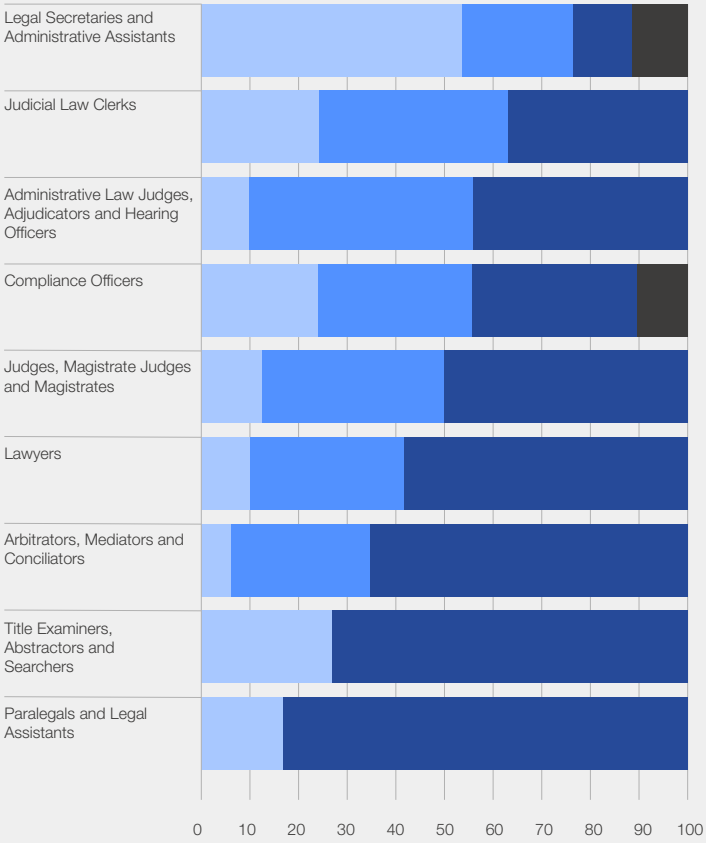
FIGURE 9 **Job exposure by functional area: ranked by exposure (augmentation and automation potential)**



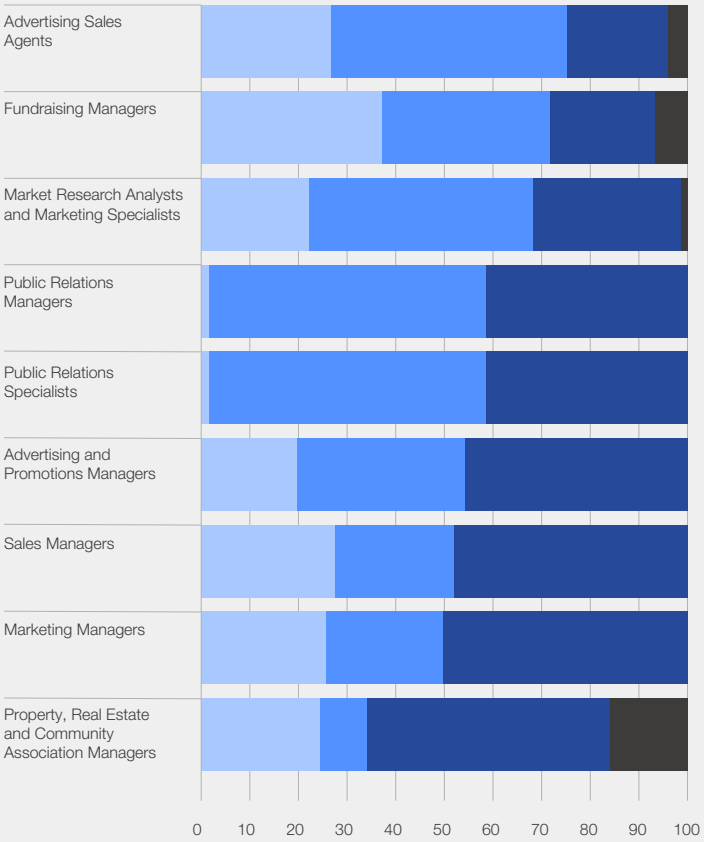
Supply Chain



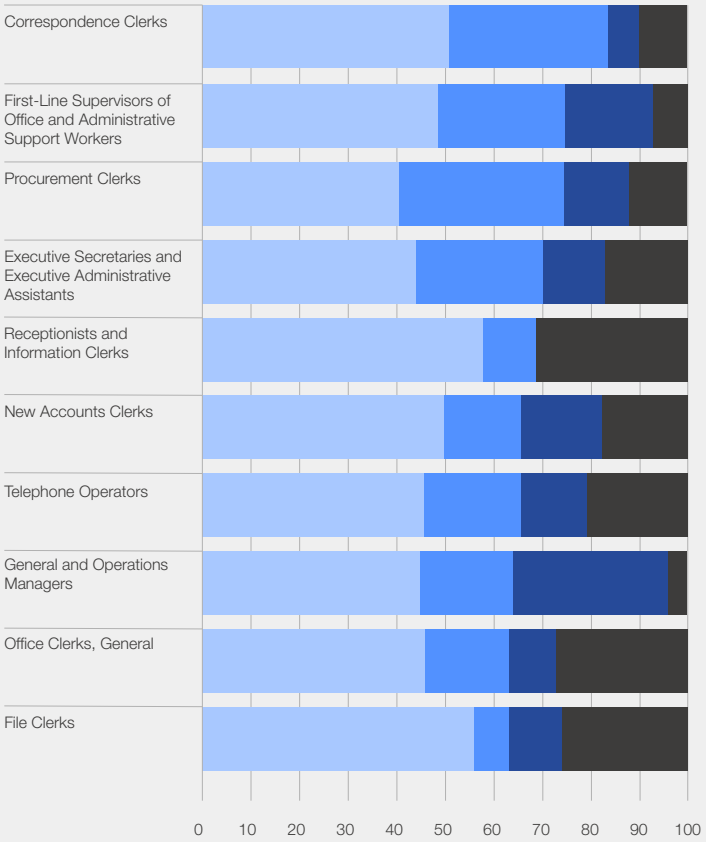
Legal



Marketing



Operations



A3 Methodology

Occupational analysis data comes from O*NET and the United States Bureau of Labor Statistics (BLS).[21] O*NET provides a taxonomy of over 19,000 tasks, a matching of which tasks are performed in which occupations, and a breakdown of the time spent on each task within an occupation. Task frequency was converted to the distribution of time spent on each task, by occupation, and calibrated to 100%. Both machine learning and manual methods were used to classify each of the 19,000 tasks according to their potential for automation, represented by a numerical score.

As a first step, researchers assess which tasks require intensive use of language (natural, mathematical, computational) that would be relevant to large language models (LLMs). A binary value of 1 for yes and 0 for no is assigned to each task.

As a second step, if the task was language-based, three remaining criteria determine the level of human involvement needed:

– Human-to-human interaction (vs human-to-computer): If the task requires real-time human exchange in the same physical space or virtually, a binary value of 1 for yes and 0 for no is assigned to the task.

– The task is non-routine and/or non-well-defined: If the task requires a proactive effort to process complex, unstructured and unrelated information to solve for the task, i.e. non-routine or unstructured, a binary value of 1 for yes and 0 for no is assigned to the task.

– Human involvement enforced by law, ethics or social conventions: If the task requires some level of commitment or compliance, e.g. regarding legal, financial, health or other types of risks, a binary value of 1 for yes and 0 for no is assigned to the task.

A binary value is assigned for each of the four criteria, once by humans and once by a machine learning model powered by GPT-4. These two scores are then added together for each criterion and task. If both humans and AI tag a task as non-language-based, then the task is considered non-language. If the task is tagged as language-based by either method, then the remaining three criteria scores are summed to determine the classification of exposure as follows:

– 0: Higher potential for automation

– 1-2: Higher potential for augmentation

– 3-6: Lower potential for automation and augmentation

Therefore, each task is classified into one of four final groups: high potential for automation, high potential for augmentation, low potential for automation or augmentation and non-language tasks.

Researchers initialized GPT-4 with representative examples of manually tagged tasks and re-trained the model on initially incorrect tags. Any remaining misalignment between human and GPT tags was resolved by favouring lower impact scores to err on the conservative side of estimates.

Combining the task score, BLS data on occupational employment and hours worked, and data from O*NET on task frequency by occupation, the proportion of work time that LLMs could transform can then be determined. Occupations with a high potential for transformation are defined as those with greater than 50% of work time in tasks with a high potential for automation and/or augmentation. Estimates are then aggregated to industry sectors and function groups weighed by the employed population in the US.

FIGURE 10 | **Methodology overview**

Modelling analysis is conducted in four steps

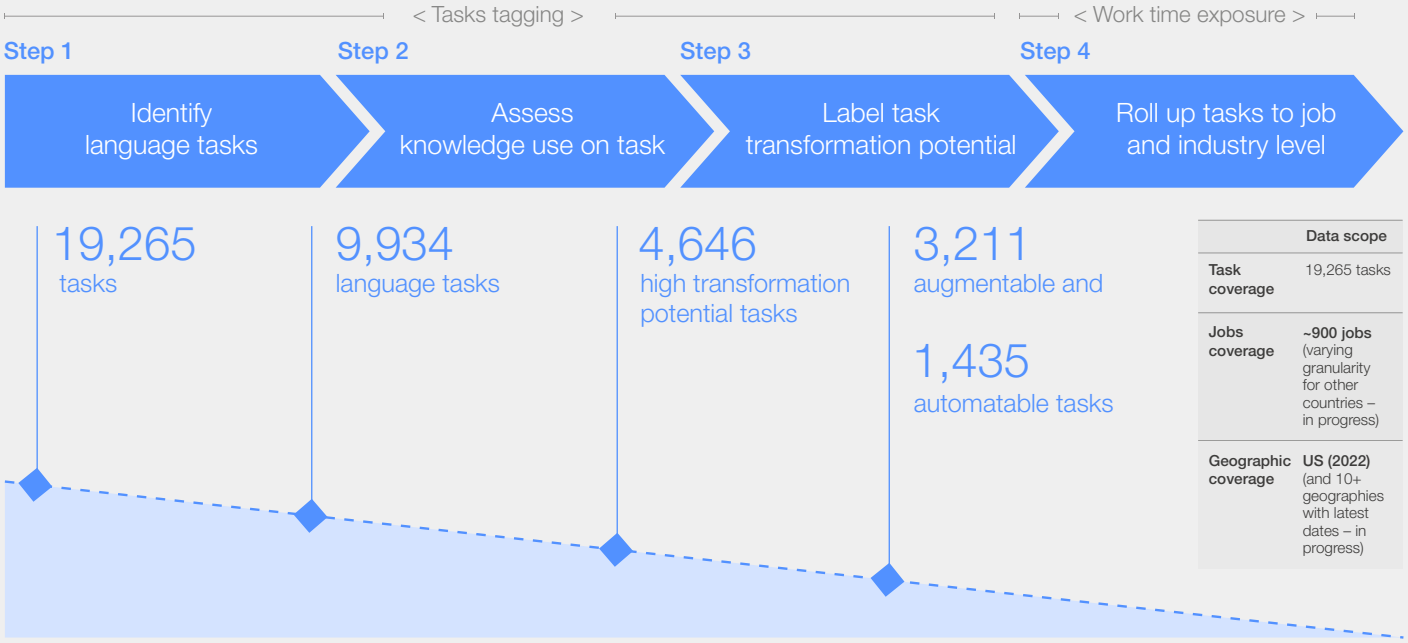
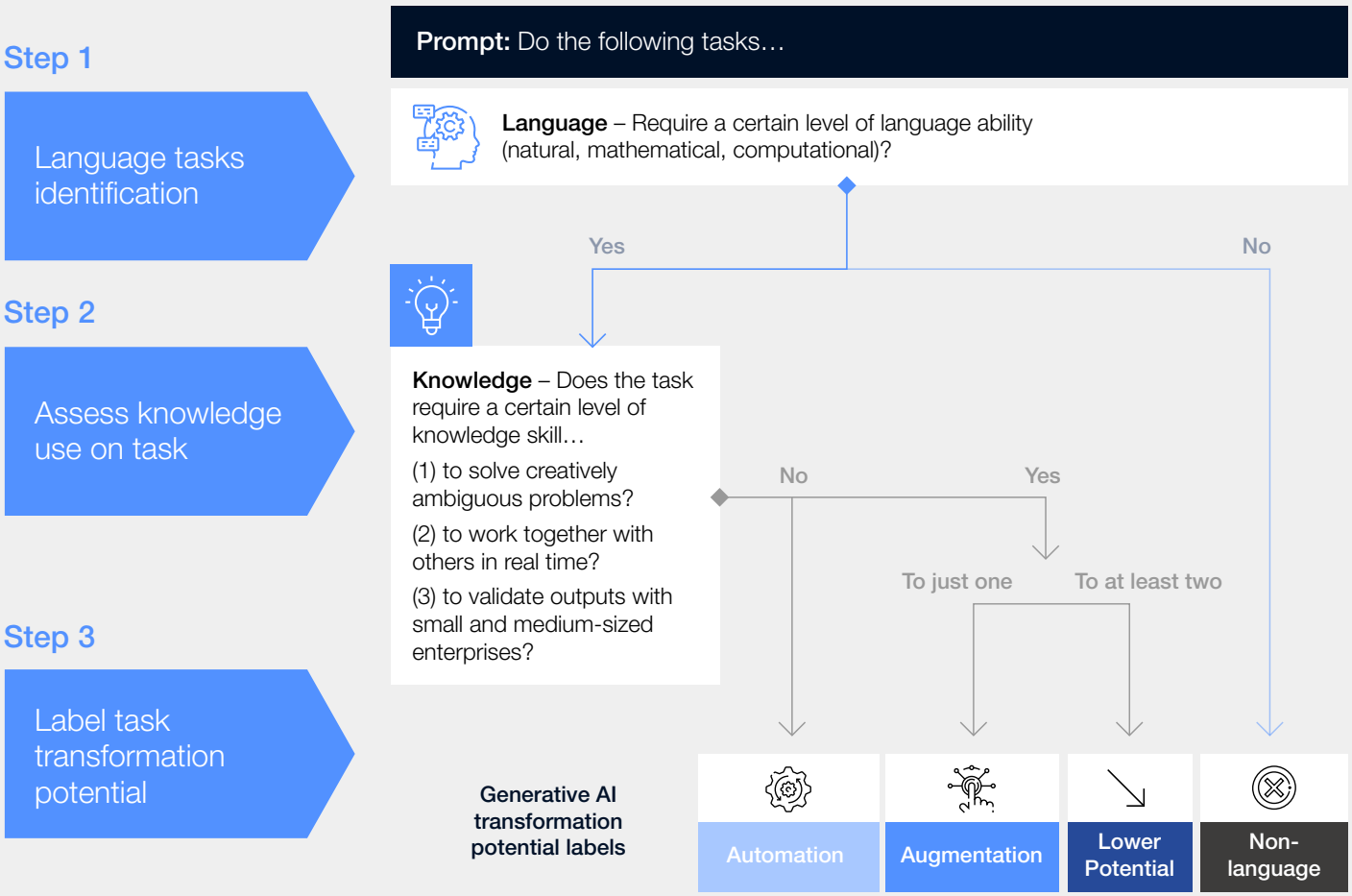


FIGURE 11 | **Task tagging overview**

Three steps to identify the automation/augmentation potential



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