The New Geography of Skills

Regional Skill Shapes for the New Learning Ecosystem

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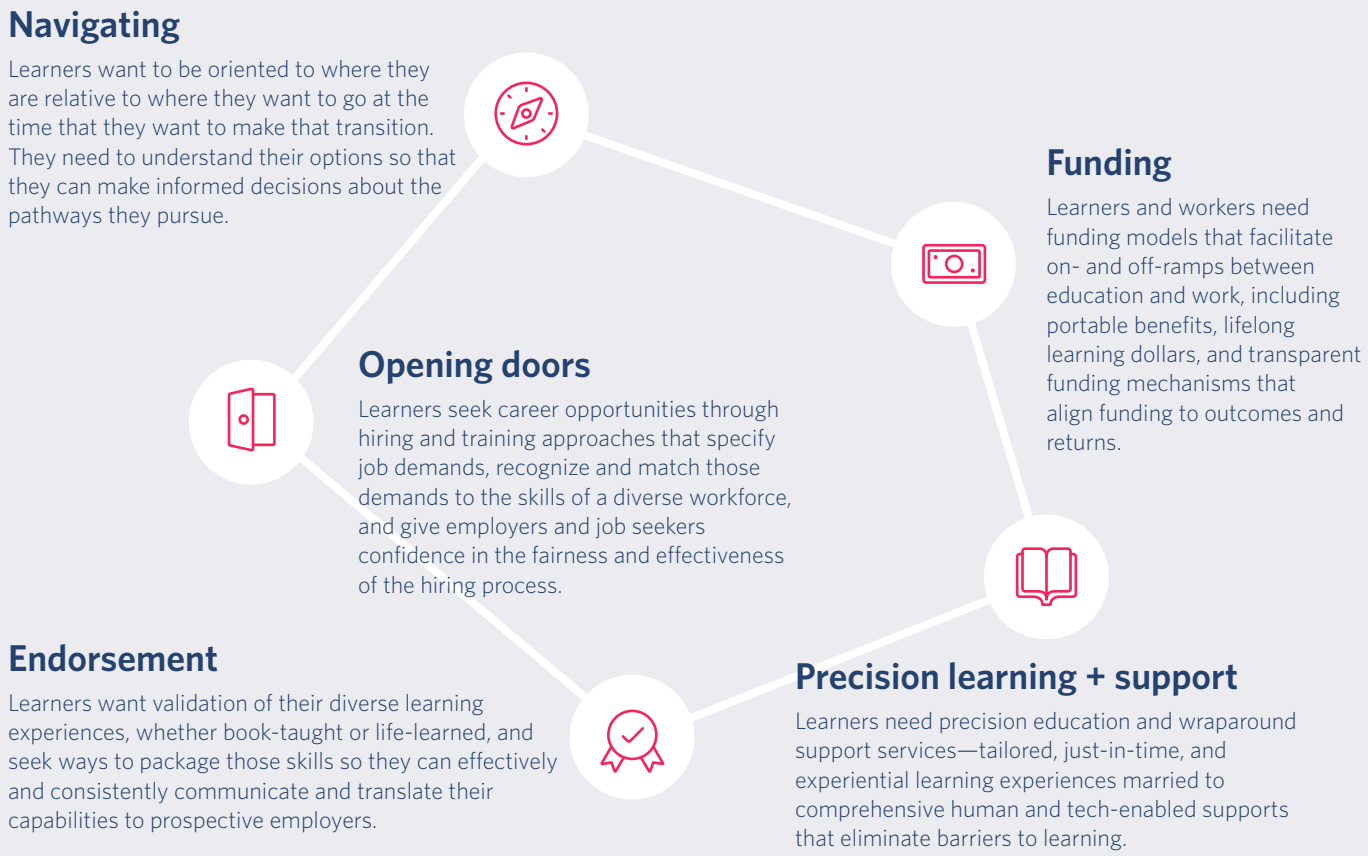
Executive Summary

As the diffusion of technology accelerates the pace of change in the labor market, the imperative for workers to adapt, maintain, and advance their skills throughout their professional lives continues to grow. Jobs are changing. Entirely new skills and fields are being created.

These radical changes have put the concept of a career in flux. Learning and ongoing skill development will become a way of life, but the current systems of education and workforce training are not set up to be easily navigable.[1] Indeed, these systems were not designed with adults in mind. Already, 44 million adults are unemployed or underemployed, lacking the skills, credentials, and networks they need to earn enough income to support themselves and their families.[2] Working learners find themselves in uncharted waters when attempting to navigate multiple work transitions over the course of their lifetimes, without the information and integrated support they need.

At Strada Institute for the Future of Work, we believe in the need for education providers, nonprofits, businesses, funders, and government leaders to come together to design a new learning ecosystem that better serves all workers and learners.

Fig. 1. A new learning ecosystem should offer five critical elements of support to learners:



To ensure that workers are equipped with the relevant skills and competencies to thrive in the jobs of tomorrow, we must build the infrastructure and systems to help people seamlessly navigate between learning and earning today.

New strategies are critical as we confront the changing nature of work. Until now, the lack of a common language among key players in the ecosystem has served as a major barrier to progress. Employers struggle to articulate and communicate the nature of the skills they value most, which heightens the challenge for educational institutions and training providers trying to keep pace with employer demand. States, regions, and organizations know precious little about the capabilities, aspirations, and potential of incumbent workers. Learners are unable to demonstrate to employers what they know and can do because they lack the right credentials or signals.

Against that backdrop, a new vocabulary is emerging to fill the gaps between stakeholders in an increasingly complex labor market. Real-time labor market information, such as job postings and professional profiles, is being combined with cutting-edge analytical methods to provide a unique lens we call "skill shapes." A skill shape refers to the unique skill demands associated with a given career field, region, or individual.

A skill shape goes a step beyond traditional labor market data from government surveys to understand regional workforce needs. With taxonomies of industries and occupations updated only once or twice per decade, skills gaps have often been identified at a broad occupation or industry level, such as a nursing shortage. Today, however, sources of "big," unstructured data—such as job postings and online professional profiles—can be updated as frequently as every few weeks to isolate actionable, real-time data.

Skill shapes provide a new lens into the job market and the unique skill demands associated with a career field, region, or individual worker. By looking underneath occupations and industries, we can understand precisely the skills employers are looking for and how they compare to the supply of skills in the regional workforce.

Ultimately, a better understanding of skill shapes empowers stakeholders to design "precision education"—learning programs that are personalized, aligned with regional workforce demands, and efficiently designed to help learners keep pace with rapidly evolving skill demands. This report therefore delves into a concrete means by which state, city, and regional leaders can identify local skills gaps and deploy workforce dollars with precision through just-in-time training programs.

This idea isn't just good in theory, it's already being applied. The Business Higher Education Forum is utilizing skill shapes to build partnerships between regional employers, higher education institutions, and workforce and economic development agencies to close those gaps. United Healthcare is one of several companies using skill shapes to understand the talents of its employees to inform its business strategy and talent-development initiatives. Western Governors University and Southern New Hampshire University have started using skill shapes to develop and refine their program offerings, curricula, and credentials to better align with regional skill demands in the regions in which they operate.[3]

Strada Institute for the Future of Work and Emsi partnered to put skill shapes into action to illuminate how stakeholders within a region can identify emerging skill shapes and close their talent gaps through precision education pathways. Using case examples, this report delves into how skill shapes in three career fields—manufacturing, digital marketing, and cybersecurity—vary in select regions (metropolitan statistical areas).

Key Takeaways for Stakeholders

State leaders

Skill shapes enable policymakers, workforce investment boards, and economic developers to understand skill gaps and surpluses in specific regions and allocate scarce workforce development funds to the greatest labor market needs and opportunities for targeted workforce training.

Employers

When employers understand the talent supply in their region, they can target recruitment efforts and engage in upskilling and reskilling their incumbent workforce, as well as better communicate their skills needs to workers, learners, and learning providers.

Learning Providers

As employers' needs come into focus with the use of skill shapes, learning providers can align curriculum development to real-time workforce needs.

Learners

Understanding not only the kinds of jobs but also the specific skills that are in demand in a region, learners can identify the learning experiences they need to compete for better jobs.

Our hope is that the insights from this report help labor markets, policymakers, and learning providers work more efficiently and effectively together and engender more economic growth and opportunity.

The New Geography of Skills

In his 2012 book *The New Geography of Jobs*, economist Enrico Moretti underlined an interesting trend: As the U.S. economy has transitioned from a goods-based, manufacturing economy to a service-based, knowledge economy, jobs have moved out of small and mid-sized towns and into cities and suburbs.[4] The ability of cities to facilitate seamless face-to-face interactions has provided a unique advantage in a knowledge economy,[5] both for employers, who benefit from having a large pool of talent to pull from when they have job openings to fill, and workers, who benefit by living in an area with many employers and job opportunities. This dynamic creates a feedback loop: Employers locate where there will be enough talent to fill their job openings, which leads more people to locate there as well. This shift manifests as a kind of centripetal force, in which the urban area keeps attracting more affluent, educated people who can spend more on goods and services. The cities become job engines that are highly resilient to macroeconomic trends.

A handful of larger cities—including New York, Los Angeles, Chicago, San Francisco, and Seattle—have successfully developed diverse, thriving economies by either developing or attracting highly educated workers.[6] Many mid-sized cities like Raleigh and Denver have also successfully developed their economies by growing their talent pool. Other cities—such as Detroit, Greenville, North Carolina, and Youngstown, Ohio—are struggling to reclaim the economic vitality they experienced in the industrial era,[7] with less than 20 percent of the population having a college education.

Clearly, the impact of automation and globalization has had differential effects across geographies. Researchers at the Brookings Institution found that states in America's heartland are likely to experience a larger impact from automation than the coastal U.S., due to their predominantly blue-collar economies.[8] At the same time, however, these differences cannot simply be chalked up to an urban-rural divide. Walmart and McKinsey teamed up to illustrate in *America at Work* that the binary of urban or rural is insufficient to understand the complex mix of communities that make up the country.[9] The report developed a taxonomy of eight community archetypes that fall along an urban-rural continuum, each with its own set of unique workforce challenges.

Although many states, cities, and regions want to be the next Silicon Valley or Research Triangle, they are not sure how to accomplish that. Many states and regions do not have a full grasp of their regional workforce DNA—that is, their defining strengths and characteristics. Rather than attempt to copy or compete with prosperous areas, cities and regions must understand and leverage their unique advantages to develop thriving economies and talent pipelines. With skill shapes, regional workforce and economic developers, learning providers, and policymakers can better understand regional talent needs and align their development initiatives with those needs.

Skill Shapes: A New Model

To date, researchers haven't had actionable data to empower learners and workers to navigate their futures. But with a finer-grained view of labor market demand, as well as a better understanding of the career trajectories of millions of people in the labor market, we now have better visibility into the kinds of pathways that enable workers to acquire the skills they need in order to advance in their work lives.

Real-time labor market information—such as online job postings and professional profiles—is leading to breakthrough planning tools that can help cities, states, and regions understand the skill demands of their employers. This technology provides a view beyond occupation codes[10] and degree classifications[11] into the actual skills that people have and that employers seek.

The analysis in this report relies on Emsi data, including more than 100 million unique professional profiles and more than 100 million unique job postings from over 90,000 companies. Profiles and postings were scraped from tens of thousands of sites, including online resumes, social networks, and professional networking sites where individuals and companies voluntarily share information. Importantly, employers list the skills they are seeking, and people list the skills they have in their own words.

Using natural language processing, Emsi parses job postings and profiles to extract data elements related to skills, titles, occupations, industry, and other relevant data elements. Emsi then uses a unique approach to analyzing skills beyond static libraries or taxonomies by looking for natural relationships between skills and seeing how they group or cluster together. This approach helps define roles and job titles based on the network of related skills as they emerge, shift, and combine in the market.

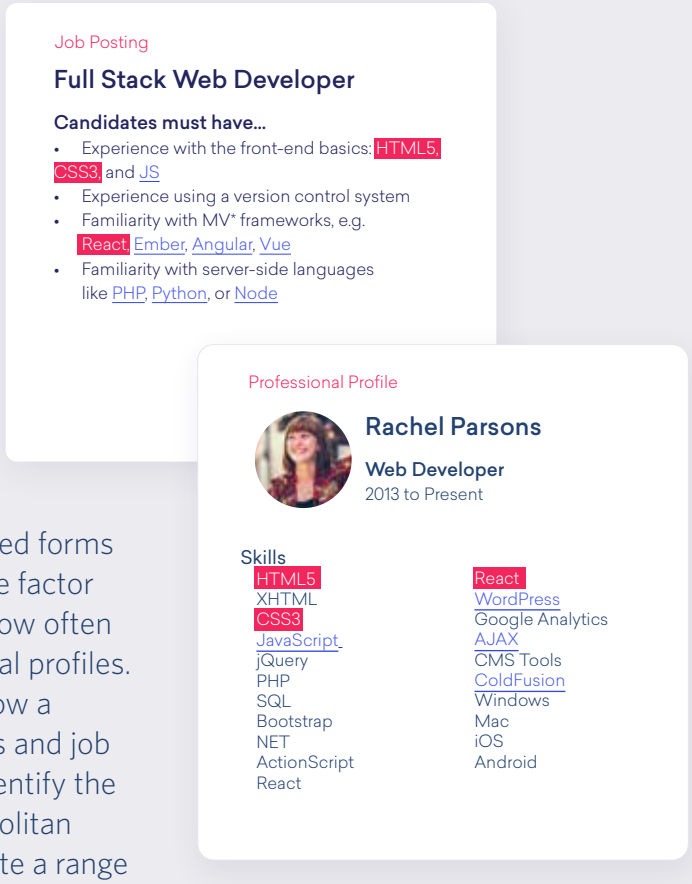


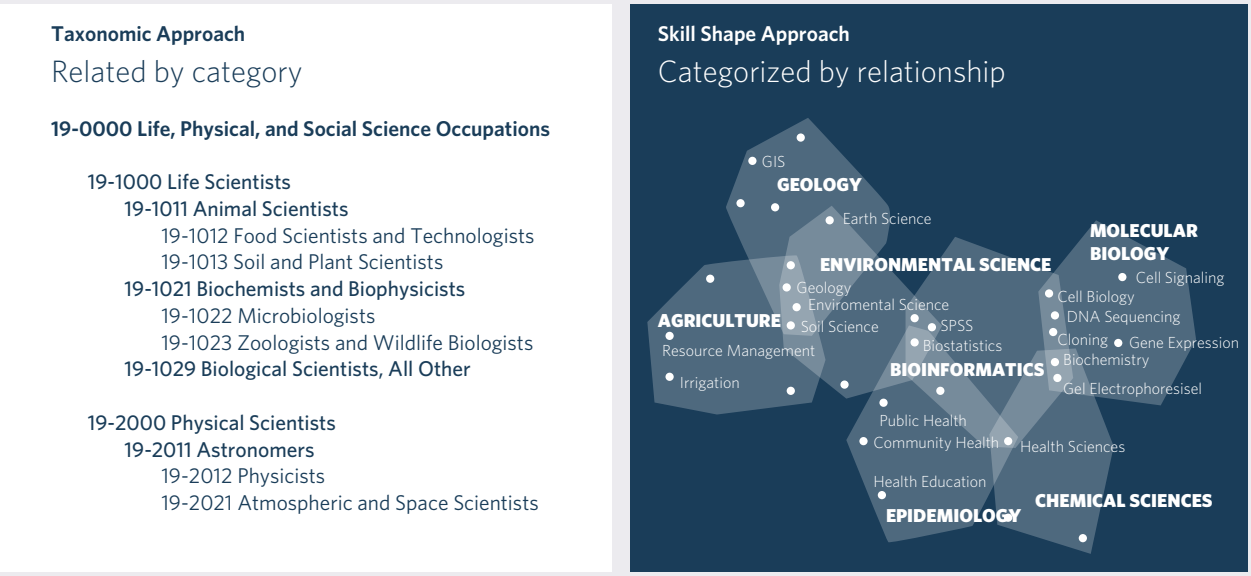
Figure 2.1. Job postings and professional profiles commonly include skills that can be parsed and analyzed using natural language processing.

Emsi applies advanced statistical methods and adapted forms of a technique called factor analysis[12] and overlays the factor analysis with measures of skills' prevalence, that is, how often skills appear in job postings, resumes, and professional profiles. This approach allows us to derive rich insights into how a skills cluster's "definition" or "shape" can impact roles and job titles. The results of the factor analysis are used to identify the "skill shape" of a role in a particular region, or metropolitan statistical area (MSA). Together, these metrics indicate a range of skills that are in demand in a particular career field in an

MSA and can be used to understand a region's unique talent needs and how they vary across the country.

Traditional taxonomic approaches to analyzing skill demands (Figure 2.2, left) group job titles into occupations at multiple levels of aggregation. Surveys of workers and supervisors are then fielded, approximately once per decade, to identify a range of competencies—knowledge, skills, abilities, interests, values, and personality traits—associated with those occupations. Skill shapes, by contrast, define roles based on skills that cluster together as they emerge and evolve in the job market using data that can be updated every few weeks (Figure 2.2, right).

Figure 2.2. While structural data define skills related to job titles and occupations, skill shapes define roles based on skills that cluster together as they evolve in the job market.



Source: U.S. Bureau of Labor Statistics, Emsi Profile Analytics 2019

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The Power of Skill Shapes

Supplemented with traditional labor market information, or LMI, skill shapes offer unique insights into the job market to better understand regional talent demands in the face of increased automation. These data allow for a real-time view of job seekers' skills as well as workers' career transitions. Regional real-time labor market data best reflect skill demands in the job market because they derive from the skills articulated by workers and employers themselves today, rather than from rigid skills taxonomies created by the government or learning providers years ago.

Skill shapes:

Reflect the changing nature of work in real time.

In contrast to traditional LMI, skill shapes do not have a taxonomy that must be updated periodically. Because skill shapes are determined by a machine learning algorithm, skill shapes reflect the evolution of work in real time. In one sense, jobs are collections of tasks that require a set of skills that are continuously evolving as companies innovate and workers adapt, helping them find new, creative approaches to problems.

Isolate the skills that matter.

Because skills, not credentials, are the fundamental units that transmit value, unpacking the skills that are in short supply can give learning providers and funders insights on modularizing traditional degree and certificate programs in favor of more targeted and relevant learning programs, curricula, and related credentials.

Reveal new opportunities.

By mapping the complex web of relationships of skills in the job market, skill shapes reveal adjacent careers that workers likely haven't considered—opening new and promising job opportunities previously out of reach. These skills adjacencies can be used to help workers and students understand the real options available to them as well as obtain a personalized gap analysis and more precise learning pathways to help them achieve their long-term career goals.

Limitations of Skill Shapes

Although job postings and professional profiles serve as promising data fuel for skill shapes, they are not a perfect data source. Unlike structural labor-market data from the Bureau of Labor Statistics (BLS) and U.S. Census Bureau, real-time data are not necessarily representative of the entire labor market, though their coverage increases each year. Job postings also tend to be more affected by seasonal shifts than structural labor-market data. Moreover, not all workers have an online professional profile; these workers are not captured in this analysis. Skills listed on professional profiles are distinctively not skills assessments, and there is likely great variation in the proficiency of workers who list the same skills, such as project management or knowledge of a particular software package.

At the same time, if nearly all would-be candidates are likely to have a skill, such as the ability to speak English, employers are less likely to list the skill, even though it is a requirement of the job. Peter Capelli has also identified what he calls the "Home Depot problem," referring to employers' belief that, for any given job opening, they will find a candidate that is the perfect match—similar to the experience of finding the right spare part at Home Depot.[13] Because employers believe the ideal candidate is out there, they often list skills in job postings that are nice to have rather than those which are essential.

Along the same lines, employers tend to advertise less for job openings that are easy for them to fill because there is already an abundant supply of workers with the skills to fill the jobs. For this reason, job postings tend to reflect jobs and roles where there is a gap in the supply and demand for talent in the job market.

Finally, traditional LMI has some advantages over skill shapes. Traditional LMI better reflects magnitudes, such as the number of job openings in a given region. Taxonomies are also useful on many occasions, such as when distinguishing between broad knowledge categories such as "mechanical engineering" and discrete skills such as instrumentation, turbines, product design, and computer-aided design. Taxonomies deal with these conceptual distinctions better than natural language processing algorithms, which rely on how terms are arranged in sentences. This is why, in this report, we analyze traditional LMI or structural data alongside job postings and professional profiles data.

Mapping a Skill Shape

In the era of big data, we have come to rely on data to support the decisions we make in our daily lives—both personal and professional. However, the data that drive decision making around job creation, job seeking, and employment have largely been limited to labor market data that are often seriously outdated and also out of touch with regional distinctions.

Up until now, education and workforce stakeholders have had to rely on traditional taxonomies from the Bureau of Labor Statistics or O*NET-SOC codes, which categorize the entire American population into 974 occupations. Job titles and occupational codes are too rigid and do not effectively capture rapidly evolving workforce needs and the day-to-day realities of working adults.

Take a formal occupation title like "Computer Programmer" (O*NET code 15-1131.00), a very broad job category.

This is an example of what we call a wooden or rigid shape. In reality, companies don't go looking for a computer programmer. They look for a software engineer and seek specific skills, like SQL, CSS, or .NET Framework. Neither jobs nor people fit in nicely into O*NET's 900 or so rigid boxes. The complaint frequently voiced by learning providers and employers alike is that traditional labor market information cannot keep up with the ever-evolving skill demands in the economy. Occupational taxonomies become outmoded soon after they are created.

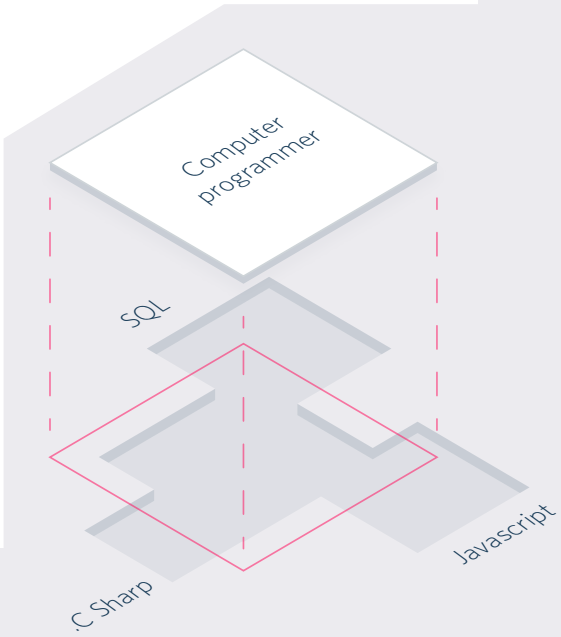


Figure 2.3. The "skill shape" of computer programmers varies across industries, typically requiring a unique mix of technical skills such as proficiency in specific programming languages such as SQL, C#, and JavaScript.

Skills define jobs. Jobs are made up of sets of tasks that require distinct skills in order to be successfully performed. To illustrate, the skill shape for any role like a software engineer is formed by the interactions between companies and industries in a particular region. When Amazon, IBM, or a small business is looking for a software engineer, they will not be looking for the same person with a similar skill shape because the skills depend on the specific work to be done.

As another example, an engineering technologist role within a production environment in Southern California will have a different skill shape than a role with a similar title in Northern California. A growing share of manufacturing jobs are beginning to look increasingly like information technology jobs, requiring a unique mix of human,[14] technical, and business skills. With Northrop Grumman, Lockheed, and Raytheon dominating Southern California, we see that there is more of an emphasis on traditional manufacturing skills, such as welding and machining, mixed with good manufacturing practices (GMP) and lean manufacturing.

We see a strong overlap in traditional manufacturing skills, such as welding and machining, with more advanced industrial engineering skills, such as GMP. Southern California's manufacturing skill shape is regionally distinctive, especially when compared to manufacturing skill demands just up the coast in Northern California.

Figure 2.4. In Southern California, the skill shape of manufacturing roles emphasizes manufacturing process controls, quality assurance, and process improvement.

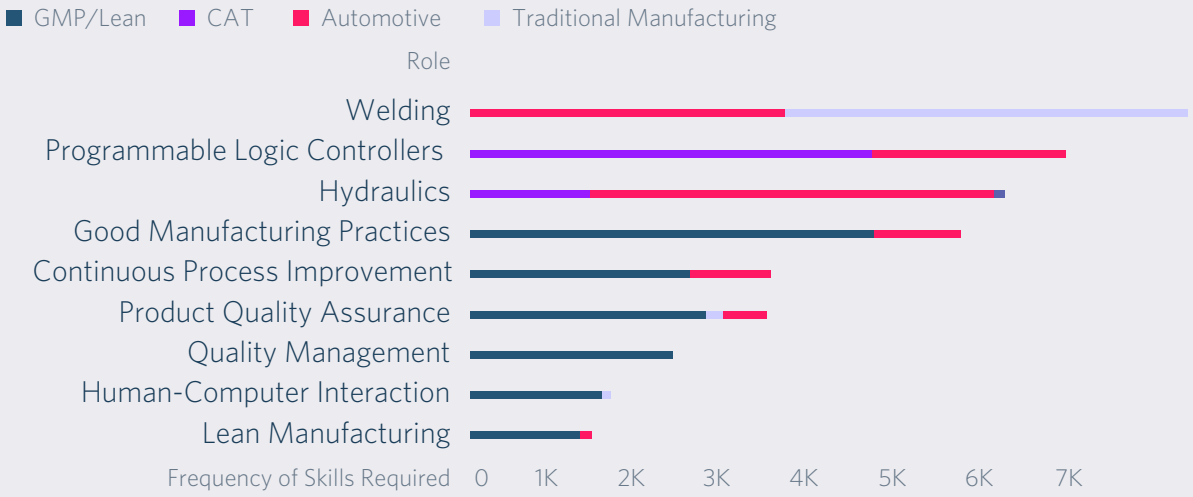
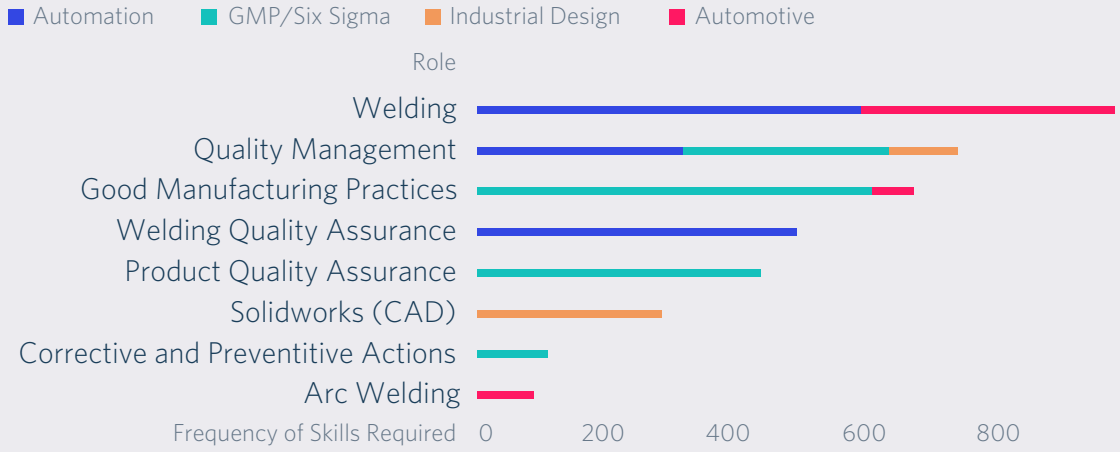


Figure 2.5. In Northern California, the skill shape of manufacturing roles includes a mix of understanding automation and quality control.



Source: Emsi Job Posting Analytics, 2019

In Northern California, the magnitude of demand for manufacturing is smaller and more specialized. The largest manufacturing employers are companies like Apple, Tesla, and Intel, a very different group with significant differences in their demand for skills. The work in Northern California emphasizes vehicles and things that move, as well as energy. Skills related to automated technologies dominate as well as skills in industrial design. There is a strong mix of production and engineering skills; information technology and mathematics, statistics and analytics, and the sciences factor in heavily, meaning that these are not basic skills.

The core skills look quite different, and as a result the skill shape of this particular region in California for a field such as manufacturing looks relatively different. The skills cluster more around prototyping, tooling, and automation—a mix of traditional manufacturing skills and engineering skills.

Compared to traditional analyses, skill shapes significantly improve the fidelity, timeliness, granularity, and actionability of insights about the skills, credentials, and experiences needed for a given job. It is easier to identify accurately regional and local skills gaps and opportunities based on the language employers use in their job postings and allows learning providers to fill those gaps through their program offerings. There is a clearer opportunity to develop microcredentials that are more aligned to the needs of the job market.

Why do skill shapes vary across regions, even within the same industry or career area?

Many factors drive the unique skill demands of a given region. Some of the variation can be attributed to differences in the kind of job openings offered by the unique set of employers in each region, as well as migration patterns, supply chains, and the regional supply of talent. The underlying relationships forming these skill shapes could be extremely complex and elusive. Skill shapes provide actionable intelligence without having to investigate the complex web of relationships driving regional labor market dynamics.

Three Case Studies: Manufacturing, Digital Marketing, and Cybersecurity

To demonstrate how regional skill shapes can help regions build on their strengths and boost local productivity and growth, we analyzed regional skill shapes in manufacturing, digital marketing, and cybersecurity. These case examples demonstrate how regions can glean insights and drive action from these data.

Manufacturing

The story of manufacturing that has been painted in the public consciousness is one of an industry in decline, filled with low-wage, high-risk, dead-end jobs with limited prospects for career advancement. Once the source of one in four jobs in America, manufacturing no longer reigns as the nation's dominant industry.

While many industries are attempting to predict how automation will affect their sector, the change in manufacturing has largely already happened. Overtaken by healthcare, business professions, and retail, the manufacturing sector has greatly transformed.[15] Since the middle of the 20th century, many of the tasks traditionally involved in manufacturing jobs have been automated. Traditional manufacturing jobs involving routine, repetitive tasks were programmed by logic controllers—digital computers attached to mechanical devices—with robots on assembly lines to replicate the timing and sequence of tasks that were previously done manually.[16]

At the same time, however, manufacturing is in no way dead.[17] It remains the source of nearly 13 million jobs in the economy out of a total of 163 million jobs[18] and roughly 500,000 job openings today out of roughly 7 million job openings in the labor market.[19] True, fewer workers are needed, but the jobs are still there; they're just different than they used to be.

As a result, modern production workers must now straddle two spheres: traditional manufacturing and modern manufacturing, or what some have called the "smart factory."[20] Workers must simultaneously keep one foot firmly rooted in the old world of machining and welding while planting the other in the advanced computer-automated technologies of the present and future. Manufacturers today need multi-functional engineering technicians who possess traditional manufacturing and engineering skills, along with human skills like communication and collaboration. A high-value production worker is a hybrid of a boots-on-the-ground technician and an engineer laser-focused on improving how things get done.

Manufacturing Skills at a Glance

At a national level, manufacturing comprises four broad skills clusters:

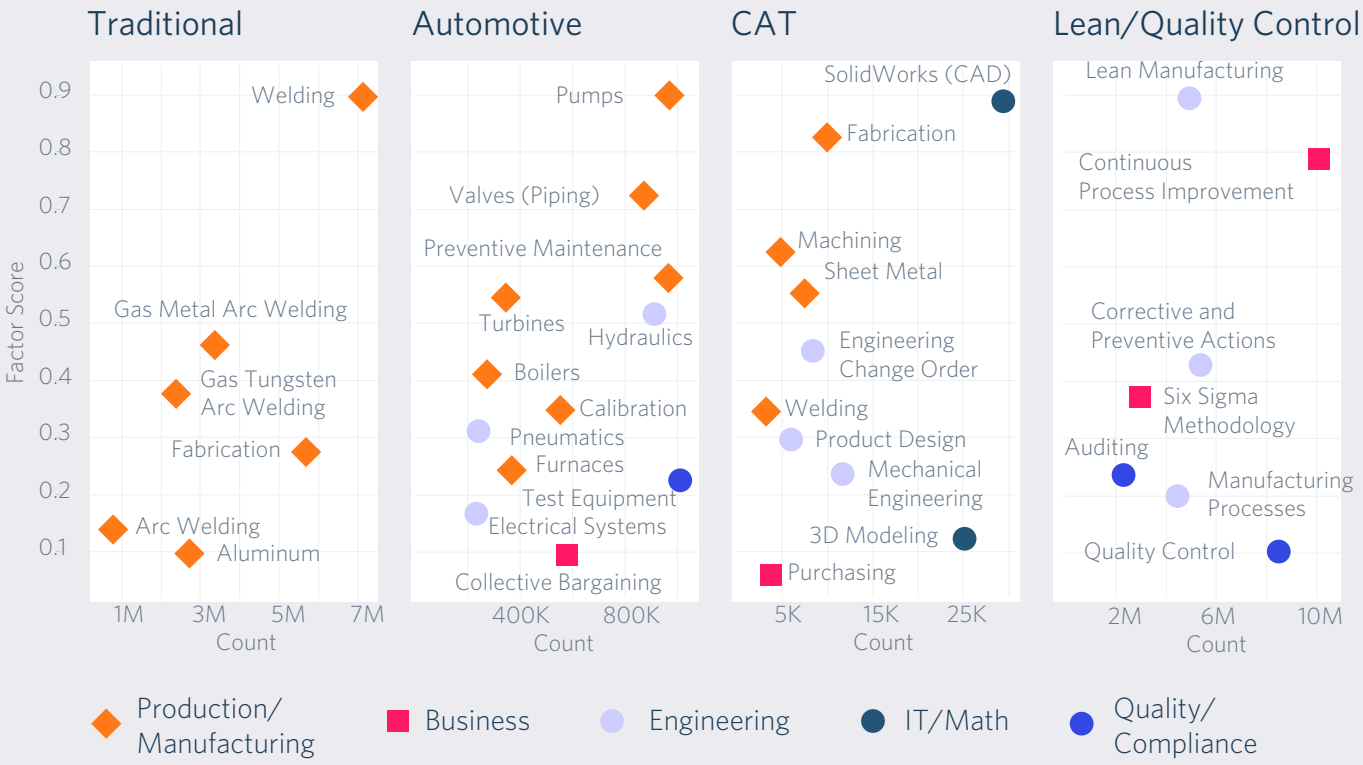
Traditional manufacturing skills: production skills such as welding, gas, metal, arc welding, fabrication, and more.

Automotive manufacturing: a subset within traditional manufacturing that is focused on vehicle production. This cluster involves basic engineering skills such as hydraulics, pneumatics, and electrical systems; and because automotive manufacturing is a heavily unionized industry, collective bargaining is a common business skill.

CAT (computer-aided technology) skills: a combination of manufacturing, engineering, and design skills in order to oversee and augment an increasingly automated production process. The implicated skills include SolidWorks, a computer program for 3-D modeling and design, computer-aided design, programmable logic controllers, and computer numerical control.

Lean manufacturing: a systematic method that originated in the Japanese manufacturing industry, specifically the Toyota Production System in the 1990s, aimed at minimizing waste.

Figure 3.1. Nationally, manufacturing skills cluster into four lanes: traditional, automotive, CAT, and quality control/lean manufacturing.

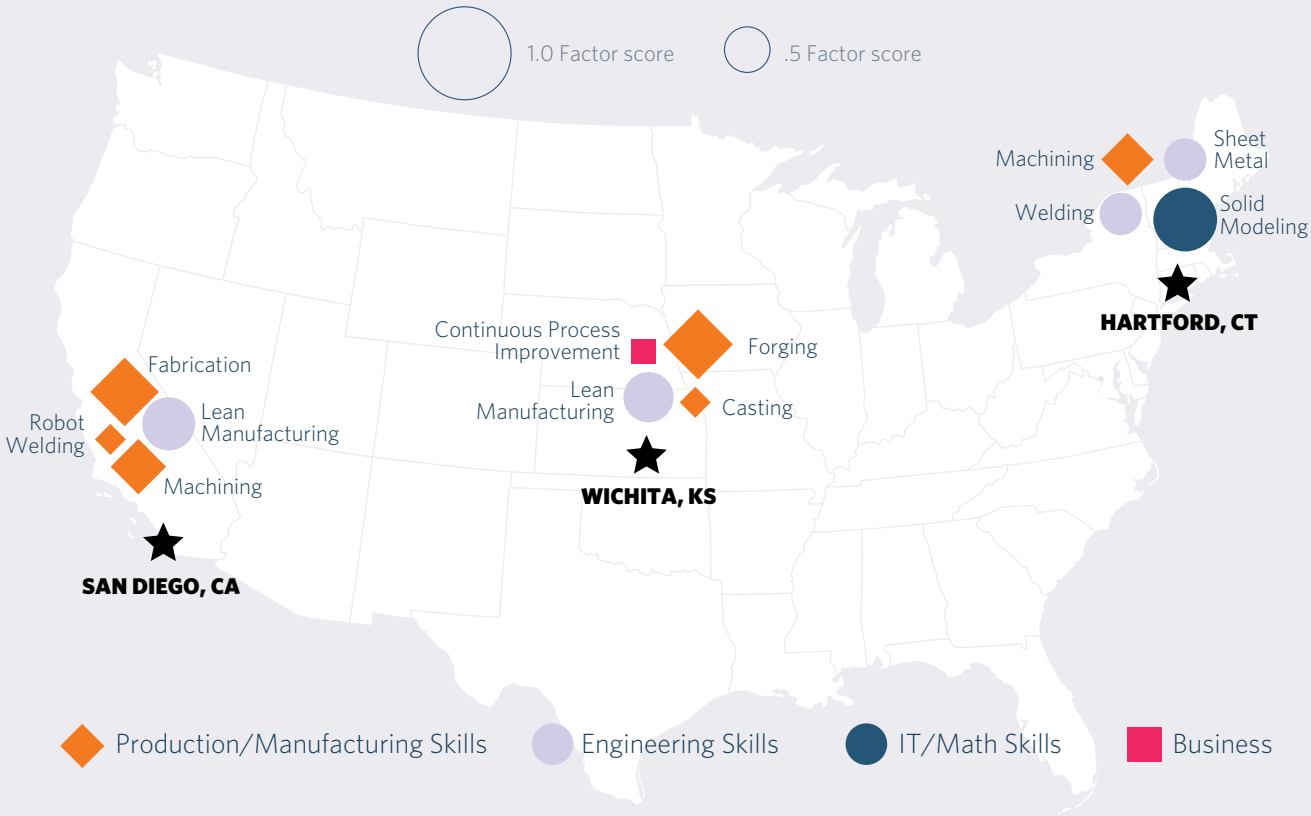


Source: Emsi Job Postings and Profile Analytics, 2019

Note: These four skills clusters reflect the top skills clusters in drafting, manufacturing, and production. Each indicator represents a discrete skill, such as welding, lean manufacturing, or computer-assisted technologies (CAT). The color signifies the type of skill, such as business or engineering. Each lane reflects a cluster of skills that coalesce in a job or role in real-time (job postings and profile) data, determined by a factor analysis (see Appendix 1 for more details). The y-axis reflects a given skill's factor score, or how important the skill is with respect to its cluster; the x-axis reflects the number of times the skill appears relative to the other skills. Skills in the top right quadrant of a skills cluster are in greater demand than skills in the bottom left quadrant of a skills cluster.

Not all manufacturing jobs are created equal, however, which is why regional talent needs vary across the country, even within the same industry. Every region has a unique composition of employers, and each employer requires a unique set of skills.

Figure 3.2. In manufacturing, San Diego, Wichita, and Hartford have unique regional skill shapes.



Source: Emsi Job Postings and Profile Analytics, 2019

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Note: Each indicator represents a discrete skill. The color signifies the type of skill, such as engineering or IT/math. This size of each indicator reflects a given skill's factor score, or how important the skill is with respect to its regional skill shape (see Appendix 1 for more detail).

Consider the skill shapes of three regions[31]—San Diego,[32] Wichita, and Hartford—in which traditional manufacturing is a dominant industry:

Figure 3.3. San Diego's, Wichita's, and Hartford's traditional manufacturing skill shapes take distinct forms: San Diego's skill shape is uniquely oriented toward automation skills, Hartford's skill shape leans toward computer-aided design and engineering tech skills, while Wichita's shape is geared toward lean manufacturing.

Source: Emsi Job Postings and Profile Analytics, 2019

Note: The x-axis represents a given skill's factor score, or how important the skill is with respect to its regional skill shape. The absence of any given skill does not indicate that the skill does not exist in the region or plays no role in the economy. Because factor analysis measures the unique importance of a skill to a particular role within a particular area, it highlights differences in local economies more sharply than simple labor supply and demand numbers allow.

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In San Diego, manufacturing jobs are hybrid jobs, combining traditional manufacturing skills, such as welding, fabrication, and machining with computer-aided technology, as well as automation skills, such as robot welding and systems integration. Companies like Lincoln Electric holdings, a welding manufacturing company, and Audatex, an auto body software company, are both posting for robotic welders in San Diego.

In Wichita, skill demands include a mix of traditional engineering and business skills. Forging is in particularly high demand, likely due to the outsized aerospace manufacturing industry. Wichita-based companies like Omni Aerospace, Lee Aerospace, and Aerospace Products Incorporated are seeking workers who understand aerospace basic quality system standards and have aerospace engineering skills. Knowledge of lean manufacturing practices is critical, followed closely by Six Sigma methods on the business side. A range of process improvement skills are also valued, including quality management, compliance, and corrective and preventive action.

In Hartford, manufacturing skills are less traditional. There is some demand for welding, machining, and sheet metal skills, along with a handful of other basic manufacturing skills. Digital drafting becomes a central function here; skills including solid modeling are highest in demand, followed by engineering drawing. In other words, Hartford is on the cusp of becoming a CAT manufacturing environment. This suggests Hartford is a more challenging job market for workers with traditional manufacturing skills, but it also means that there are multiple avenues for workers to upskill.

As automation continues to advance, the demand for these mixed manufacturing and robotics skills will only grow. In many cities today, the jobs of traditional production workers are at risk. If they don't transform their skillset into more digitized forms of production, they will lose their jobs.

Spotlight: Conexus Indiana

Strada Institute for the Future of Work interviewed Brad Rhorer, Chief Talent Programs Officer at Conexus Indiana, to discuss the evolution of manufacturing and how Conexus is working to address regional talent gaps in the state. This nonprofit organization focuses on promoting and accelerating Indiana's advanced manufacturing and logistics economy, facilitating innovative collaborations among industry, academic, and public sector partners. These industries account for 520,000 (16 percent) out of 3.3 million jobs in Indiana, including major companies such as Cummins, Caterpillar, Honda, Toyota, Subaru, GM, and FCA Chrysler. Indiana manufactures 85 percent of the world's recreational vehicles and hosts large steel, aerospace, and defense manufacturers. Companies like FedEx, Amazon, and UPS leverage Indiana's geographic centrality to move manufactured goods throughout the United States.

Why focus on manufacturing?

BR: "Manufacturing is becoming more advanced with increased automation, higher productivity, and expanded support for workers to deliver at a higher quality. Manufacturing accounts for about $104 billion in our overall economy, and the average annual salary of $77,000 is a great salary to raise a family in Indiana."

How has manufacturing and logistics evolved?

BR: "When I started into the industry nearly 30 years ago, we had a lot of manual welding and hands working on the different pieces of equipment. Now, we have a lot of robotics and other technologies to improve the production of our products. … You've still got workers that remember what mom and dad or grandma and grandpa's life was like in manufacturing. In some cases it was tough. It was dark. It was dirty and kind of dingy. But with innovation and technology now, it looks like a different industry in many ways. A lot of people still have the wrong perception of what manufacturing and logistics is. Concurrently, you've got parents who are trying to push kids to 'go to college, go to college,' even though some of those kids may not quite be ready for that adventure yet."

"We've been able to educate our workforce to grow with our economy and the needs of manufacturers to actually make the jobs better for the employee and more productive for companies. People often assume that their jobs are being replaced by robots, but it's not a replacement, it's a change to what their job looks like and what they do physically."

Is automation creating new jobs or enhancing existing jobs?

BR: "Automation is creating new jobs with different responsibilities. A lot of jobs that we will see in the next 10 years have not even been thought of yet because technology is advancing so quickly. The jobs that we're creating now are more technical in nature. We must take our current workforce and continue to develop their skillsets to evolve with technology to make their jobs better and more meaningful for them."

How is Conexus Indiana working to create a manufacturing and logistics talent pipeline?

BR: "We have a four-week training program that helps people at different career levels acclimate into manufacturing. It can be intimidating if you've never worked in the industry before and you apply for a role and find yourself standing in the middle of a million or two- or three-million-square-foot facility, it can be a little overwhelming. So Conexus has developed a program, Catapult Indiana, to develop a talent pipeline, and to help workers acclimate into the industry and, ultimately, be more successful. … The program is 160 hours of work and learn experience and it's set up to simulate the work environment, it's not a traditional classroom environment. … It teaches them the basics of manufacturing through hands-on activities…troubleshooting, critical thinking, [and] live simulation. … We want workers to embrace continuous learning. This program aims to create a foundation for them to build on and grow as technology grows."

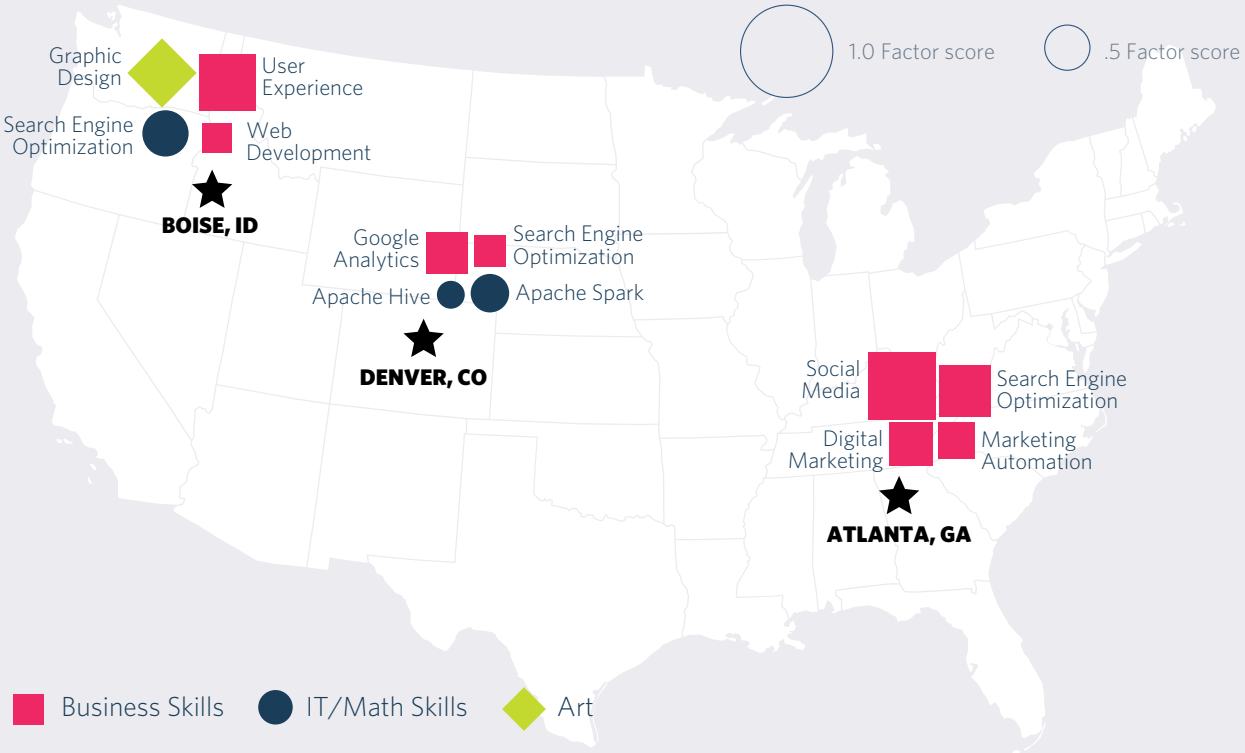
Digital Marketing

Digital marketing careers are a relatively new phenomenon, only a few decades old. In the 1990s, the rise of the Internet led businesses to rethink their marketing strategies and expand into digital media via online channels. The subsequent rise of smartphones and social media in the 2000s further amplified the use of digital marketing as well as its diversification. Digital marketing now comprises a vast array of skills, including search engine optimization,[21] social media marketing, and email marketing. Recently, jobs in some regions have come to emphasize user interface and user experience design, as marketing tactics have become integrated into virtually all digital content.

Job growth in digital marketing now rivals that of any information technology job; business, communications, liberal arts, and social sciences graduates in particular gravitate toward digital marketing from their first job to their third job.[22] Marketing professionals are needed in all industries, as all companies and nonprofits depend on strategic communication roles to get their products or services into the market and to their target audiences.

Marketing roles feature a mix of strategic and analytical skills while also overlapping significantly with the skills needed in IT jobs. Job roles that feature digital marketing skills vary substantially by region.

Figure 3.4. Denver, Atlanta, and Boise feature distinctive skill shapes for digital marketing careers.



Source: Emsi Job Postings and Profile Analytics, 2019

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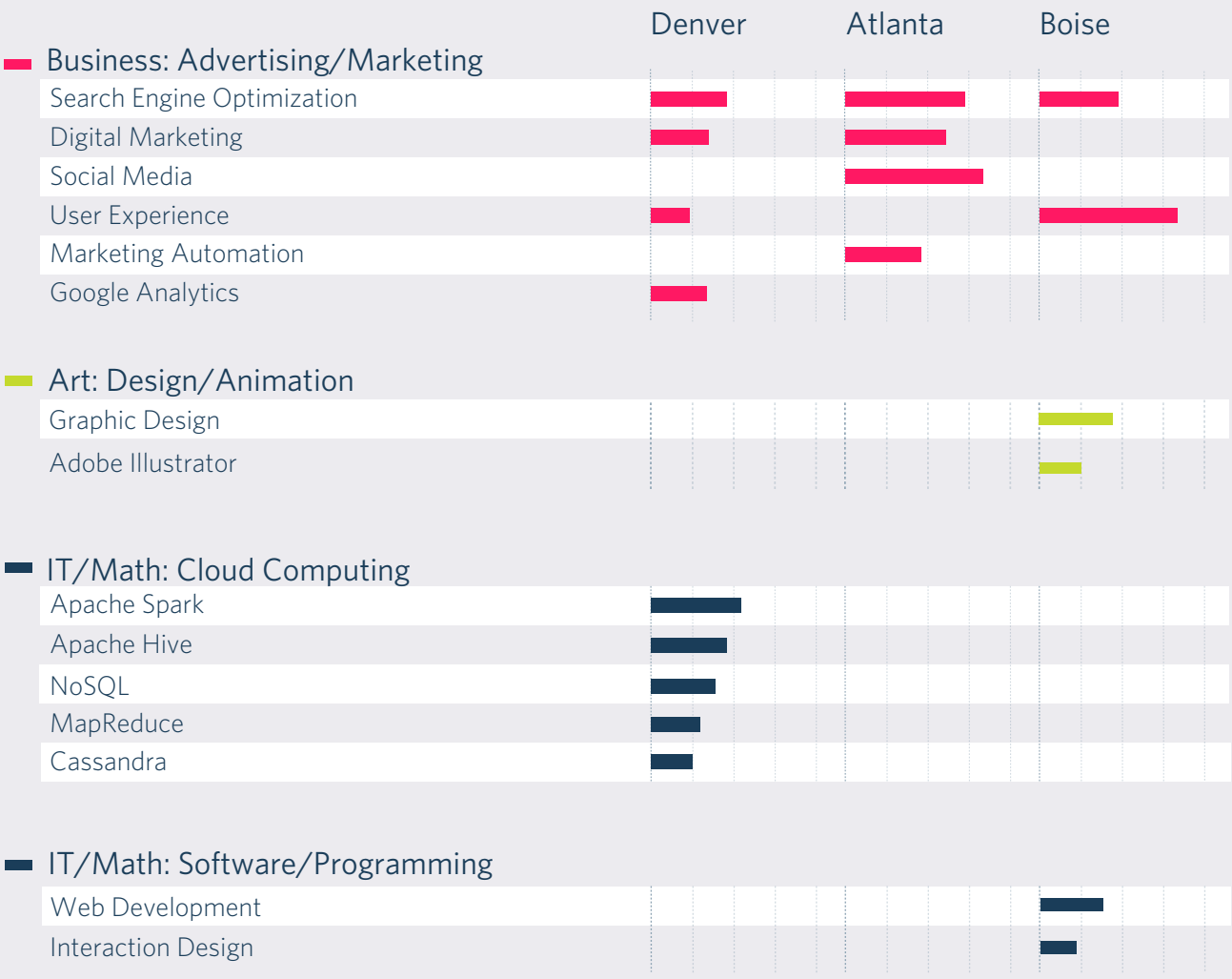
Note: Each indicator represents a discrete skill. The color signifies the type of skill, such as business or IT/Math. The size of each indicator reflects a given skill's factor score, or how important the skill is with respect to its regional skill shape (see Appendix 1 for more detail).

Figure 3.5. In Denver, digital marketing roles are oriented toward analytics and cloud computing. In Boise, the roles revolve around design and web development, while Atlanta features more marketing automation.



Source: Emsi Job Postings and Profile Analytics, 2019

Note: The x-axis represents a given skill's factor score, or how important the skill is with respect to its regional skill shape. The absence of any given skill does not indicate that the skill does not exist in the region or plays no role in the economy. Because factor analysis measures the unique importance of a skill to a particular role within a particular area, it highlights differences in local economies more sharply than simple labor supply and demand numbers allow. Thus, graphic design appears in the skills cluster for Boise and not Atlanta or Denver because graphic design is more important to digital marketing in Boise than comparable clusters in other markets.

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In Denver, big data and cloud computing are now becoming central to digital marketing skills. Employers are looking for a combination of common digital marketing skills, such as SEO and Google analytics, and strong cloud computing skills such as MapReduce, Cassandra, and various Apache suite tools. There is a strong emphasis on "front-end" skills like market research that informs selling strategies, and less on "back-end" skills like content creation and distribution. A few years ago, on-premises data management tools such as SQL were critical to marketing. However, today's marketers need cloud-based data querying tools such as NoSQL. As the industry moves toward context-based advertising and personalized marketing, digital marketers today are becoming more and more like data scientists.

In Atlanta, digital marketing jobs are uniquely oriented toward marketing automation, which refers to software platforms such as Marketo, designed for marketing departments to automate marketing campaigns through multiple channels such as email and social media. Developing and maintaining a steady communications stream for current and potential users is the defining feature of Atlanta's digital marketing cluster.

In Boise, digital marketing is extremely user-centric, requiring the perfect mix of the art and science of user experience. Creativity and design are central to the role here with a strong need for web development, graphic design, and user interface and user experience design. The programming skills used to execute these designs are also critical, including web development and design programming languages, user interface design, and interaction design.

Cybersecurity

Yahoo!. ... Equifax ... Marriott. Every few months, we read about a company that has suffered a massive data breach.[23] Earlier this year, First American, a real estate company, accidentally exposed the financial records of 885 million customers—including Social Security numbers, driver's license images, and bank account numbers—on its website for anyone to access.[24]

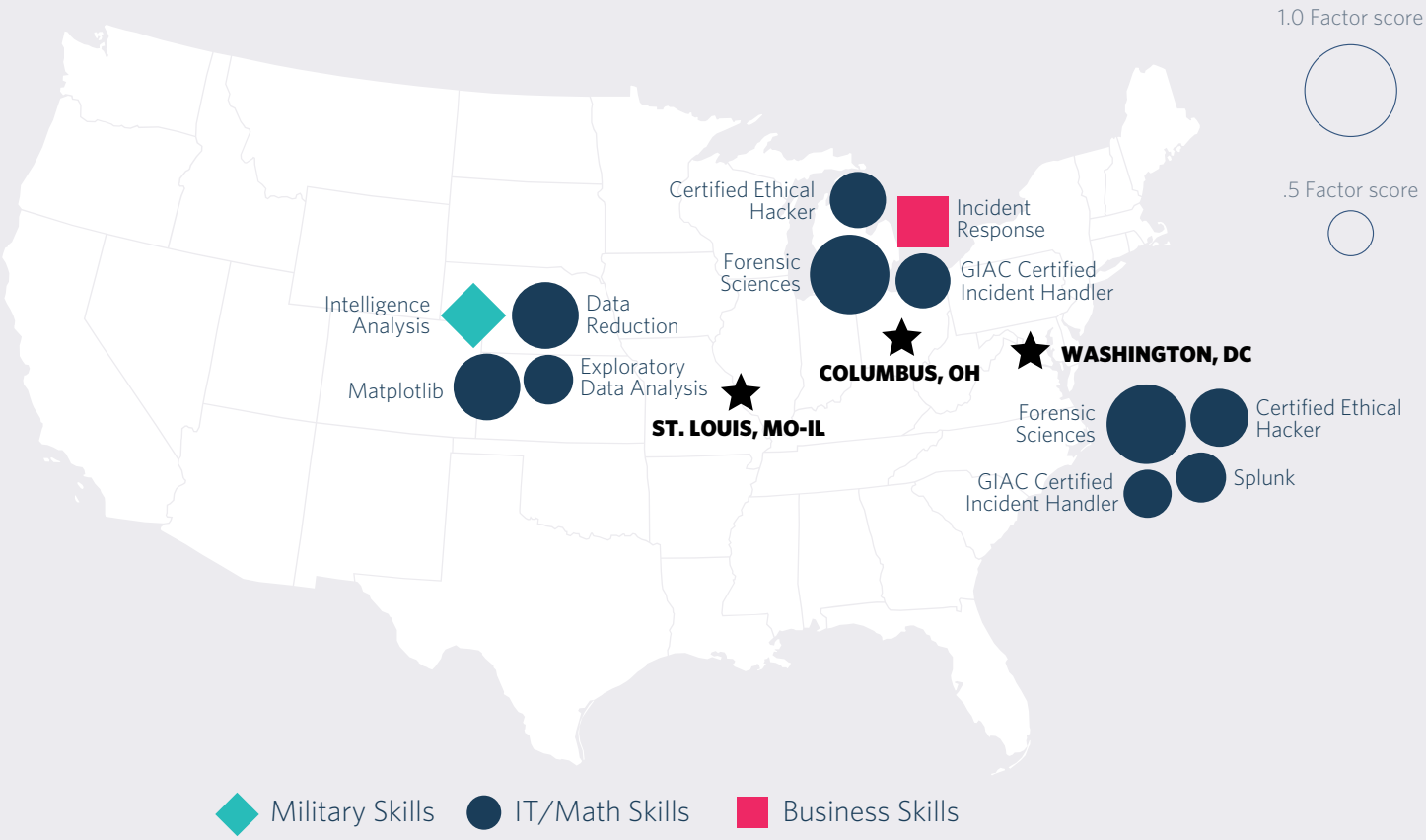
As hackers continue to expose billions of private records, the corporate risks of getting hacked are massive: IBM Security estimates the cost to a U.S. company for a single incident of a data breach at $8.2 million.[25] Financial institutions are especially at risk, defending against one billion attempted hacks each year.[26] It is no surprise then that the demand for cybersecurity professionals has been skyrocketing for nearly a decade. The number of cybersecurity jobs (classified as "information security analysts" by the Bureau of Labor Statistics) has grown by 42 percent since 2014, adding some 35,000 new jobs to the economy, with an additional 22 percent increase expected through 2029.[27]

Between September 2016 and December 2018, employers posted more than 1.5 million job advertisements for those positions.[28] Cybersecurity jobs comprise many distinctive roles, such as information security analysts, cybersecurity engineers, and cybersecurity analysts. Defense contractors like Lockheed Martin and Northrop Grumman, as well as Amazon and Booz Allen Hamilton, a global management and information technology consulting firm, are among the top employers looking for workers with cybersecurity skills. Major metro areas like Washington, DC, New York City, and San Francisco are especially dominant—Washington for its ties to defense and government generally, New York as a financial capital, and San Francisco as a global information technology hub.

Like digital marketing and manufacturing jobs, cybersecurity jobs are hybrid jobs that require a unique mix of skills. Common job tasks for cybersecurity professionals include network administration and monitoring and ethical hacking, which involves identifying vulnerabilities in computer systems from the perspective of a would-be hacker. Due to the rapid growth in the demand for cybersecurity talent, there is a national skills gap in cybersecurity talent, especially for cybersecurity professionals with human skills, such as communications, leadership, and problem solving.

Much like manufacturing and digital marketing, regional skill shapes for cybersecurity vary.

Figure 3.6. Washington, DC, St. Louis, and Columbus feature distinctive skill shapes for cybersecurity careers.



Source: Emsi Job Postings and Profile Analytics, 2019

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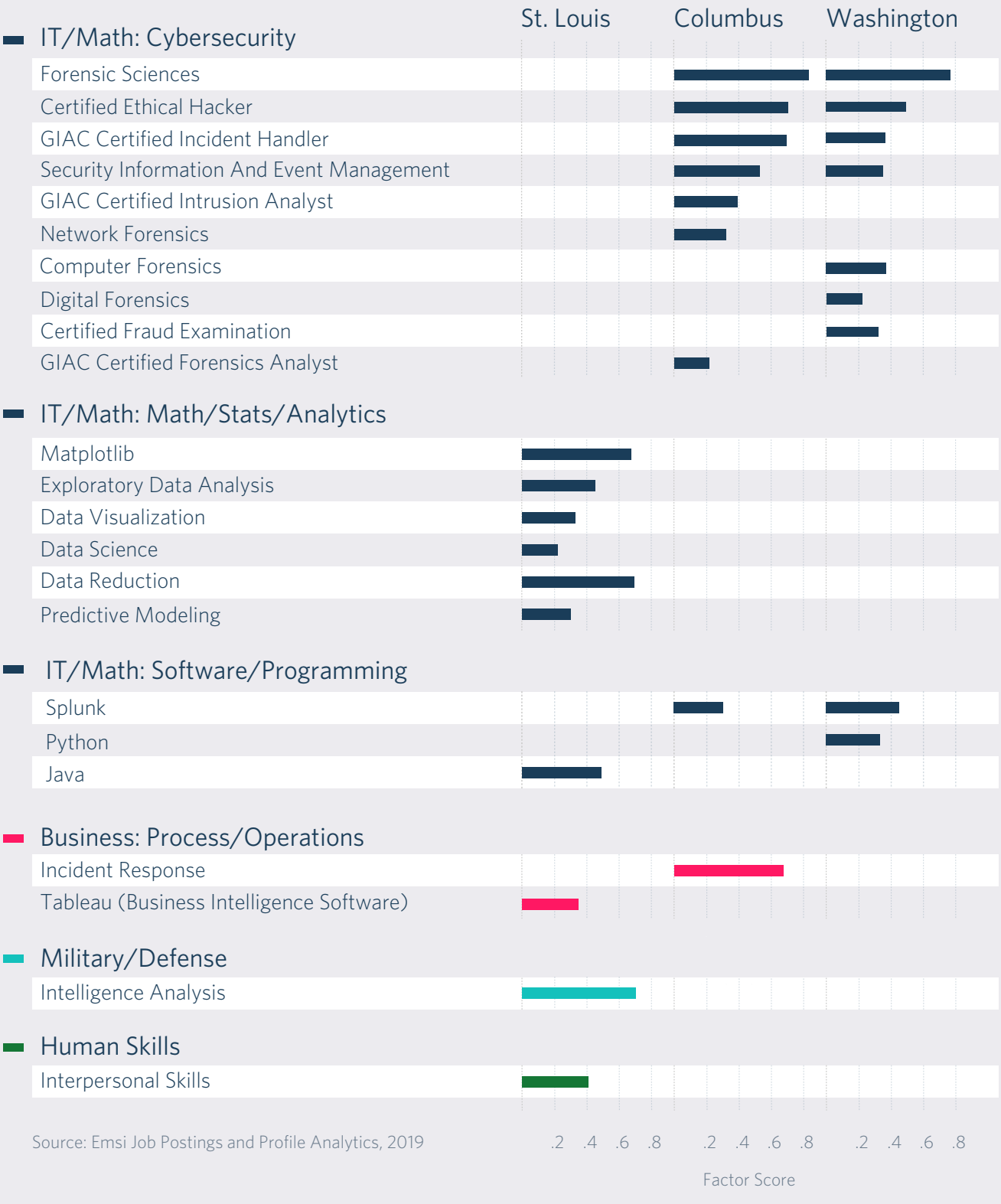
Note: Each indicator represents a discrete skill. The color signifies the type of skill, such as business or IT/Math. This size of each indicator reflects a given skill's factor score, or how important the skill is with respect to its regional skill shape (see Appendix 1 for more detail).

Figure 3.7. In St. Louis, cybersecurity skills are oriented toward data analytics, while Columbus and Washington, DC, involve field-specific technical skills, such as ethical hacking and digital forensics.



Source: Emsi Job Postings and Profile Analytics, 2019

Note: The x-axis represents a given skill's factor score, or how important the skill is with respect to its regional skill shape. The absence of any given skill does not indicate that the skill does not exist in the region or plays no role in the economy. Because factor analysis measures the unique importance of a skill to a particular role within a particular area, it highlights differences in local economies more sharply than simple labor supply and demand numbers allow.

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In Washington, DC, knowledge of federal information security systems and protocols are the dominant skills, including a combination of fraud identification, hacking, and digital forensics, which commonly involves analyzing digital network vulnerabilities related to counterintelligence activities or law enforcement.

In St. Louis, cybersecurity looks like a subset of data science, with advanced statistics, data modeling, and data visualization as more prominent skills. Given the presence of a major National Geospatial Intelligence Agency base, this suggests that much of the demand for cybersecurity in St. Louis is occurring in a national security context. For example, there is high demand for knowledge of the use of predictive analytics, statistical techniques developed to make probabilistic predictions about future events to identify suspicious behavior. In addition, there is a strong emphasis on human skills, particularly interpersonal skills such as communication and collaboration.

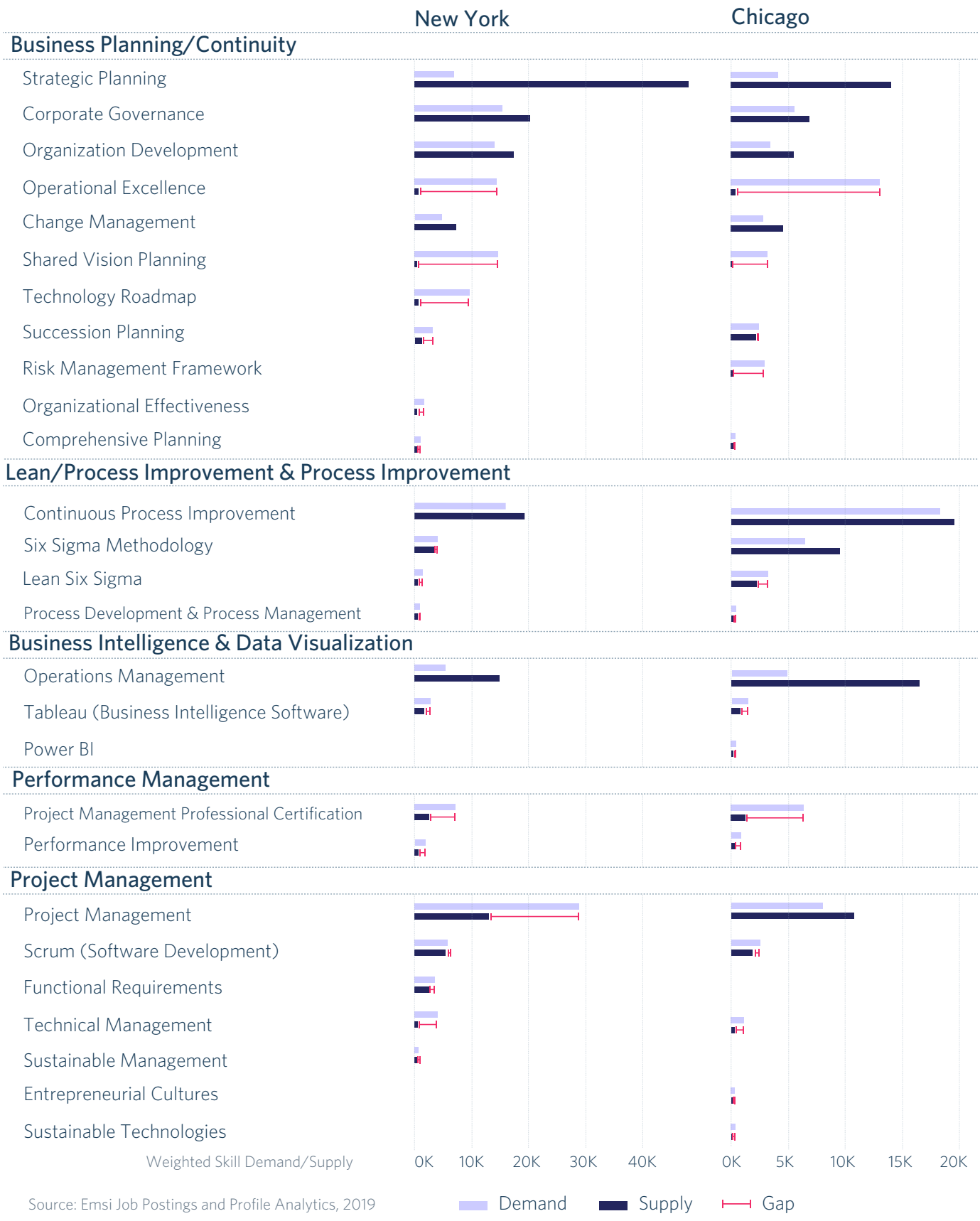
In Columbus, cybersecurity skills most resemble those required in Washington, DC, but with a special emphasis on financial services, as Columbus is quickly becoming a financial services hub. Columbus features a high demand for ethical hacking and network forensics, which focuses specifically on monitoring network traffic. A wide array of certifications are required here, many from the cybersecurity industry's gold standard, Global Information Assurance Certification: certified ethical hacker, GIAC certified incident handler, GIAC certified intrusion analyst, and GIAC certified forensics analyst. This cluster represents what most people think of when they hear "cybersecurity"—testing defenses, handling breaches, and tracking down the origin of successful hacks.

Using Skill Shapes to Identify Regional Skills Gaps

Every skill shape is defined by its regional context, and those skill shapes can then be connected to the skill shapes of the people or the talent in a certain area. Professional profile data indicate the supply of skills in a given region. Together, these data can expose regional skills gaps where the demand for skills is greater than the supply brought by the region's talent. Understanding these gaps is key to supporting the design and development of well-calibrated learning pathways to close those gaps.

These supply-demand gap analyses can be done for any region in any industry domain. Consider how business transformation skills materialize across roles in New York and Chicago (Figure 4.1):

Figure 4.1. Business transformation skills gaps differ for New York and Chicago.



Source: Emsi Job Postings and Profile Analytics, 2019

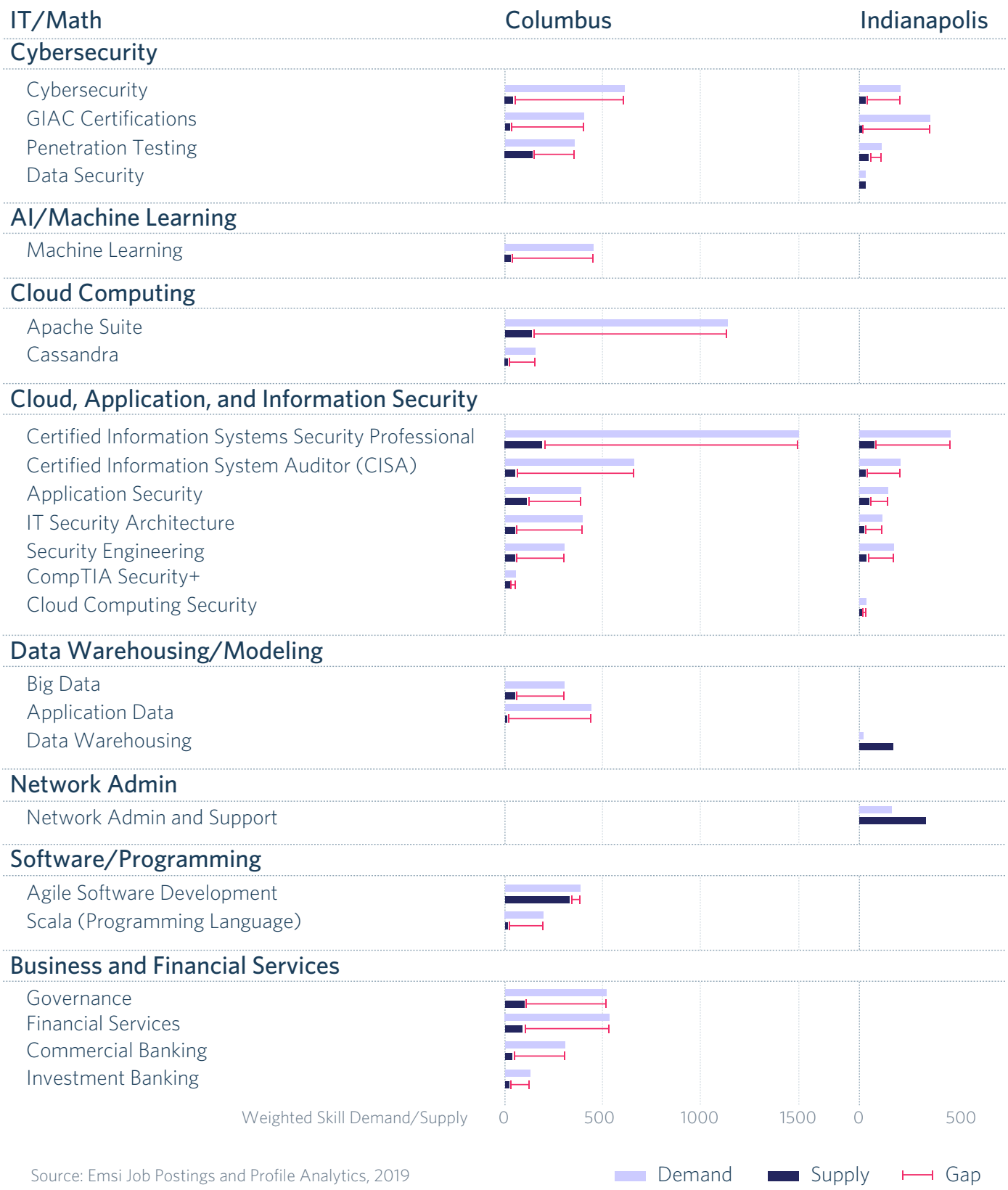
In New York City, business transformation skills revolve around corporate governance, comprehensive and shared vision planning, and operational excellence. There is a strong business intelligence culture driven by a robust management consulting industry that operationalizes key performance indicators (KPIs) as well as measurement and tracking using advanced data visualization tools.

Unfortunately, New York's talent pool is not keeping up with the demand for business transformation skills. New York's regional workforce has an abundance of project management, change management, process improvement, and Six Sigma, but skills in operational excellence and shared vision planning are in short supply. Information technology management skills are also lacking; these include the ability to design effective technology roadmaps and apply technical project management skills, ranging from gathering functional requirements, using advanced software management tools like Scrum, to implementation.

In Chicago, by contrast, the supply of skills in operational management, from bottom-up continuous process improvement to Six Sigma, are abundant. But not only is there a high demand for certified project management professionals (PMPs), new and emerging skills in sustainable technologies and entrepreneurial cultures have also materialized. The biggest skill gaps revolve around risk management framework analysis and operational excellence.

These supply-demand gap analyses can be applied also to more niche jobs, such as cybersecurity, and in smaller cities such as Columbus and Indianapolis (Figure 4.2). We can see very concretely how governors, mayors, and learning providers across these two regions can develop programs tailored to current workforce needs, so that their limited resources more effectively promote equity and upward economic mobility.

Figure 4.2. Columbus and Indianapolis have unique cybersecurity skills gaps that reflect regional skill shapes and the regional cybersecurity talent supply.



Source: Emsi Job Postings and Profile Analytics, 2019

In Columbus, there is a supply shortfall in cloud computing, especially in Apache suite and Cassandra. Many of the roles associated with these skills are hybrid, requiring skills both in financial services and machine learning simultaneously. With a strong financial sector, Columbus is becoming a hub for financial tech, particularly cybersecurity. But the talent in the area is not keeping up with the demand for ethical hacking, intrusion detection and prevention, and network forensics.

Indianapolis, on the other hand, has an abundance of IT network skills, but significant skill gaps in various information security certifications, such as Certified Information System Security Professional and GIAC. The career field of cybersecurity is still taking shape in the region, and cloud computing skills are not yet a critical component of the skill shape in Indianapolis. The region also appears to be showing a surplus of data warehousing skills among cybersecurity professionals.

Skills gap analyses such as these highlight the power of combining data on the demand for talent in a region to the supply of talent in that region. Unmet demand will either erode the competitiveness of businesses over time or will force employers to look elsewhere, i.e., outside the region, for an adequate supply. The most effective strategy would be to use gap analyses so that local education and training providers can determine the skills to teach, ensuring a steady supply of talent within the region.

Precision Education

One of the most exciting aspects of skill shapes is its potential impact on education. With a granular understanding of regional skill gaps and surpluses, learning providers can feel emboldened to build more precise educational pathways for workers seeking to advance or change their careers or protect themselves from potential risks related to automation. Skill shapes empower learning providers in this new cycle of learning and earning by illuminating the precise skills needed for any given domain.

One-size-fits-all, cookie-cutter programs designed for 18- to 24-year-old students cannot and will not suffice for lifelong learners and earners looking to reskill and upskill throughout their working lives. Prospective job seekers come into their job search with different talents and specific upskilling needs. They may not always need every element of a bundled, comprehensive program. It is crucial, therefore, that programs are modular in nature with just-in-time training that allows workers to update and upgrade their skills without duplicating the skills they have already mastered.

We recognize that states already have a vast array of resources that, with the help of skill shapes, can further tailor programs to keep pace with employer demand.

- Community and technical colleges have long served working-class adults who would otherwise be left out of postsecondary education. These public institutions—over 1,000 of which operate across the country—reach approximately 1 million adults annually.[29] They have long been the workhorse institutions of higher education in mitigating workforce shortages and building training programs for companies. For many working-class, underprepared adults, however, the prospect of a two-year degree program is a bridge too far in terms of time to credential and the full cost of attendance, including the forgone earnings associated with attending school instead of working more hours. Skill shapes enable community and technical colleges to build more short-burst training programs in concert with employers that enhance learners' mobility in the labor market

- Federally funded job training programs provide training and employment services to millions of Americans. The Workforce Innovation and Opportunity Act (WIOA) is designed to help Americans access the education, training, and support services they need in order to succeed in today's labor market, as well as to better connect employers and job seekers. Skill shapes offer a concrete means by which state, city, and regional leaders can identify local skills gaps and deploy workforce dollars with precision through just-in-time training programs. It also offers a way to reduce variation in the design and quality of these programs across states and regions.

The purpose of this report is to use data to drive action. Skill shape analyses provide supply-demand gap analyses possible for any region in any industry domain. This groundbreaking approach to understanding regional labor markets helps all learning providers design and refine program offerings, curricula, and credentials that are tightly coupled with actual labor market demands.[30]

Skills certifications and microcredentials more aligned with employer needs would further strengthen local training programs while enhancing predictability in hiring and mitigating risks for employers. With skill shapes, we can empower workers, employers, and policymakers to align and speak the same language—the first step in moving toward skills-based hiring and ultimately boosting economic competitiveness.

Building a Better Way Forward

Even as we debate what the future of work will look like, it has already arrived. The question is: What will we build now in order to keep up and thrive? Although the nature of work has changed and will continue to change, the future of workers remains uncertain. Cultivating talent should be the primary economic development strategy for states, cities, and regions. To develop our talent pipelines, we must move toward a skills-based world so that more Americans can thrive in education, work, and life.

Skill shapes have the potential to:

- Help learning providers and industry groups better understand their existing worker composition and identify opportunities to upskill and reskill employees and develop training programs aligned to workforce demands and talent gaps.
- Inform governors, mayors, and impact investors about how to grow their local economies and leverage their funding most effectively to advance equity and economic mobility.
- Help employers better understand regional talent supplies to inform their site selection decisions and investments in training and talent development.

With skills as the currency of the labor market, each region has the potential to grow local economies by aligning training dollars to more precise learning pathways that match local talent to the skill shape of the region. This is one of the first steps in building a new learning ecosystem to help workers navigate their way to a new career, finance lifelong learning, learn more effectively, and get hired.

Ultimately, we hope that this report illustrates how we start building a common language among all stakeholders in this new learning and earning ecosystem.

Endnotes

1. It is hard to predict the twists and turns of a career. According to a 2018 study by the Federal Reserve Bank of New York, only 27 percent of college graduates work in a field related to their major. A recent report by Emsi, Degrees at Work, reveals the non-linear nature of most workers' career trajectories. The concept of college graduates working "in field" is largely anachronistic; Weise et al. find, for example, that 70 percent of liberal arts and humanities graduates change career fields from their first job to their third job.
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6. Ibid.
7. Ibid.
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10. The Standard Occupational Classification (SOC) system is a statistical standard used by federal agencies to classify workers into occupational categories based on similar job duties established in 1977, revised periodically in the 1990s, 2010, and most recently in 2018.
11. The Classification of Instructional Programs (CIP) is a taxonomy established by the National Center for Education Statistics to track the outcomes of educational programs by field of study.
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31. Emsi, "Western Governors University Creates Value for Students by Mapping Curriculum to In-Demand Skills," 2019.
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Appendices

Appendix 1. Methods and Data Sources

Data Sources

The Emsi profile database is a collection of social and professional profiles that include information about an individual's employer, job title, skills and certifications, and more. It currently includes over 100 million unique profiles, which have been aggregated and deduplicated from the open web. Sources include major online resume, social networking, and professional networking sites where individuals voluntarily share their own information.

The Emsi job posting database is a collection of more than 100 million job postings scraped from tens of thousands of sites on the web, aggregated, and restructured into a single data set. On a given month, this consists of scraping between 6–8 million unique active postings from more than 90,000 companies.

Data Limitations

As outlined in the section "Limitations of Skill Shapes," the data used in this paper is based on the skills that employers list in their job ads and that workers list on their professional profiles. If employers need a specific skill but don't advertise for it, the skill is not captured in these data. Some employers do not advertise positions for various reasons; as a result, the skills needed for those positions are not captured in these data.

Job openings that are not advertised tend to be those that are easier to fill as there is an abundant supply of talent. Unlike randomized sample surveys designed by researchers, real-time data are not necessarily representative of the entire labor market, though their coverage continues to increase each year. Job postings also tend to be more affected by seasonal shifts than structural labor market data.

Similarly, not all workers have an online professional profile; these workers are not captured in this analysis.

Method

The method used in this report relies on Emsi's skills clustering model, which in turn utilizes Emsi's profile and job postings databases. Emsi employs an adapted form of factor analysis that looks into how skills coalesce into roles. This form of factor analysis finds maximally informative latent topics (or skill clusters) in the data based on the relationships between skills. In other words, the method reveals the most distinct roles as described by employers and employees in job postings, and profiles data. This model is run iteratively from different initialization points to better explore the skills space and select the optimal number of roles within each career area. The factor analysis has many possible uses for companies, institutions, and regional economic planners. In this paper, we use the results of the factor analysis to identify "regional skill shapes," or skills clusters in specific metropolitan statistical areas (MSAs) cross-tabulated with the number of times a specific skill appears in job postings in a particular MSA.

Appendix 2. Frequently Asked Questions

What's a "skill shape"?

The term "skill shape" refers to the unique skill demands associated with a given career field, region, or individual as determined by a factor analysis using Emsi's job posting and profiles database (see Appendix 1 for detail).

What do you mean by "geography of skills"?

"Geography of skills" refers to the distinctive regional talent needs of employers and industries, even among similar roles.

How can I be sure job postings and professional profiles are providing a reliable signal of regional workforce needs?

Like any data source, real-time data have limitations. We discuss the strengths and weaknesses of these data in detail in "Limitations of Skill Shapes" above. To be sure, real-time data are best used in combination with traditional labor market data.

How often can skill shapes be updated?

Skill shapes can be updated as frequently as every few weeks. By comparison, traditional labor market information from

government surveys are updated monthly, annually, or less frequently in some cases. The Bureau of Labor Statistics' Dictionary of Occupational Definitions was last updated in 2018, and 2010 before that update.

How does Emsi parse job posting and professional profile data?

Emsi uses proprietary software to crawl the web, clean, and parse various sources of unstructured data.

How does a factor analysis work?

A factor analysis is an admittedly complex but useful statistical technique that allows one to see hidden patterns in the data and variables (in this case, skills) that commonly co-occur. A detailed explanation can be found at: https://stats.idre.ucla.edu/spss/seminars/introduction-to-factor-analysis/a-practical-introduction-to-factor-analysis/.

Appendix 3. Glossary

Apache Hadoop

A collection of open-source software utilities that facilitate using a network of many computers to solve problems involving massive amounts of data and computation

Apache Hive

A data warehouse software project built on top of Apache Hadoop for providing data query and analysis

Apache Spark

An open-source distributed general-purpose cluster-computing framework that provides an interface for programming entire clusters with implicit data parallelism and fault tolerance

Automation

The performance of a process or procedure with minimal human assistance

Benchmarking

Providing employees with measurable targets to meet

Big data analytics

The use of advanced analytic techniques against very large, diverse data sets that include structured, semi-structured, and real-time data

Cloud computing

The use of a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer

Cloud computing security

The set of control-based technologies and policies designed to adhere to regulatory compliance rules and protect information, data applications, and infrastructure associated with cloud computing

Computer-automated technologies (CAT)

Computerized technologies that aid in the design and creation of products

Corrective and Preventive Action (CAPA)

Knowledge of a set of actions, laws, or regulations that require an organization to establish manufacturing, documentation, procedures, or systems to rectify and eliminate non-conformitie

Data warehouse

A system used for reporting and data analysis that integrates data from various sources and which is considered a core component of business intelligence

Deep learning

A subset of machine learning in which networks are capable of learning unsupervised from data that is real-time or unlabeled

Email marketing

Sending a commercial message to potential customers using email

Ethical hacking

Locating weaknesses and vulnerabilities of computer and information systems by duplicating the intent and actions of malicious hackers

Factor analysis

A statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors

Good Manufacturing Practices (GMP)

Prevalent quality control processes in the manufacturing sector that ensure the products meet quality requirements

Google Analytics

Service that provides statistics and basic analytical tools for search engine optimization (SEO) and marketing purposes

Human skills

Skills that enable workers to transfer their knowledge from domain to domain in the face of job obsolescence and to learn new skills in demand

Lean manufacturing

A systematic method that originated in the Japanese manufacturing industry, specifically the Toyota Production System in the 1990s, aimed at minimizing waste

Learning Ecosystem

The comprehensive system of learning providers and facilitators, including colleges, universities, public and private training programs, as well as institutions that support learning and facilitate transitions between learning and work

Learning providers

Institutions of higher education, non-traditional training providers such as bootcamps, companies, and organizations that provide training for employers

Machine learning

Using computerized algorithms and statistical models to perform a task or set of tasks without using explicit instructions

Microcredential

A credential that reflects the mastery of knowledge and skills that is typically more narrow that traditional degrees, certificates, and certifications

Microsoft Azure

Microsoft's public cloud computing platform

Operational excellence

The execution of the business strategy more consistently and reliably than the competition

Natural language processing (NLP)

The use of computers to understand human language

Parsing

The process of analyzing a string of symbols, either in natural language, computer languages or data structures, conforming to the rules of a formal grammar, also known as syntax analysis or syntactic analysis

Programmable logic controllers

Industrial digital computers adapted to control manufacturing processes, such as assembly lines or robotic devices

Search engine optimization

Increasing the quality and quantity of website traffic by increasing the visibility of a website or a web page to users of a web search engine

Six Sigma

Engineering and process improvement methodologies that improve efficiency and effectiveness by removing waste and reducing variation

Skills

Competencies at specific tasks or familiarity with specific subjects acquired through education or experience

Skills cluster

A set of correlated skills that relate to a particular theme of work

Skill shape

The unique skill demands associated with a given career field, region, or individual

Social media marketing

Using social media platforms, such as Facebook and Twitter, and websites to promote a product or service

SQL (Structured Query Language)

A programming language commonly used in database management systems that became the industry standard in the 1980s

User Experience Design (UX)

A set of best practices for enhancing a user's experience with a product or suite of products

User Interface Design (UI)

A set of best practices for designing machine and software interfaces to make them simple and efficient with respect to common user goals

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About Us

Strada Institute for the Future of Work is dedicated to advancing our understanding of the future of learning and work, so that we may begin to build the learning ecosystem of the future. Strada Institute is a part of Strada Education Network, a national nonprofit whose mission is to improve lives by forging clearer and more purposeful pathways between education and employment. Visit **www.stradainstitute.org** for more details.

Emsi is a labor market analytics firm that integrates data from a wide variety of sourcesto serve professionals in higher education, economic development, workforce development, talent acquisition, and site selection. Emsi helps them align programs with regional needs, equip students with career visions, understand regional economic and workforce activity, and find and hire the talent they need. Emsi is also part of Strada Education Network. Visit **www.economicmodeling.com** for more details.

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