Investing in America's data science talent
The case for action

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Why data science talent

Despite the explosion of data and the wide range of tools to mine and analyze that data, most corporate decision-makers will need something more to fully participate in the digital economy.

We're in a five-year period of ramping up. Business, government and nonprofits are looking for help, asking for skilled data scientists for predictive modeling and machine learning; and for analytics-enabled workers who can help transform business operations. Talent is the next step in realizing the potential and profit in data.

To meet the demand for talent, we'll need to work together. Jobs data show that the demand for skills is growing fast. But the demand points to a problem. Few in the emerging or existing workforce have the skills that CEOs are looking for. Even now, 79% of US CEOs are concerned that a shortage of key skills could impair their company's growth.[1]

When we look at the signals for change, it's clear:

- Share of job growth is trending upward for workers who can command technology skills and use them to drive profitability and growth in organizations

- Higher education is willing to transform, to teach to a real-world timescale

- Women and underrepresented minority groups need more paths to achieve their full potential

- People want the skills that bring purpose to their work and empower them to solve problems

If we succeed, if we take on this supply-demand challenge, we'll have created jobs for more US workers and a more competitive US economy. If we fail, we risk ceding leadership in the digital economy to other nations and regions across the globe.

Talent is the next step in realizing the potential and profit in data.

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1   *PwC's 20th Annual Global CEO Survey* (January 2017).
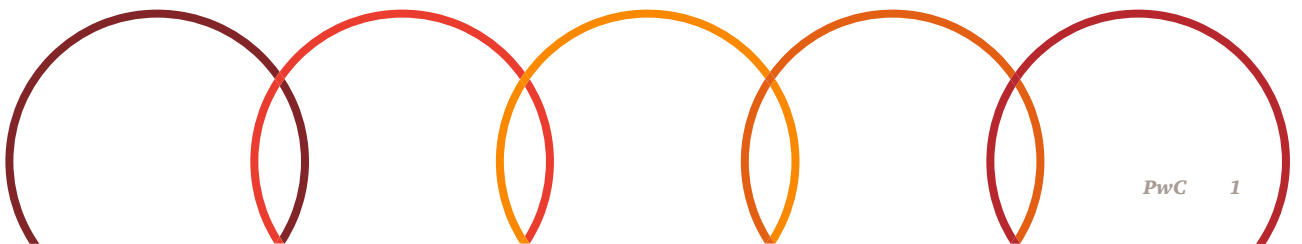
What we know so far

We're working on a full report. For now, here are some highlights:

The demand for analytical talent is now. By the start of 2016, we already had 2.3 million US job postings asking for data science and analytics skills. By late 2016 more than half (58%) of Business Roundtable members, an association of CEOs of leading American companies, said data science and analytics are very relevant to job openings today.[2]

All industries have growing needs. Everyone's hiring data scientists and people who can do analytics. The highest number of openings are in finance and insurance, information technology, and the professional, scientific and technical sectors. Today, 33% of demand is for data scientists and 67% is for analytics-enabled workers.[3]
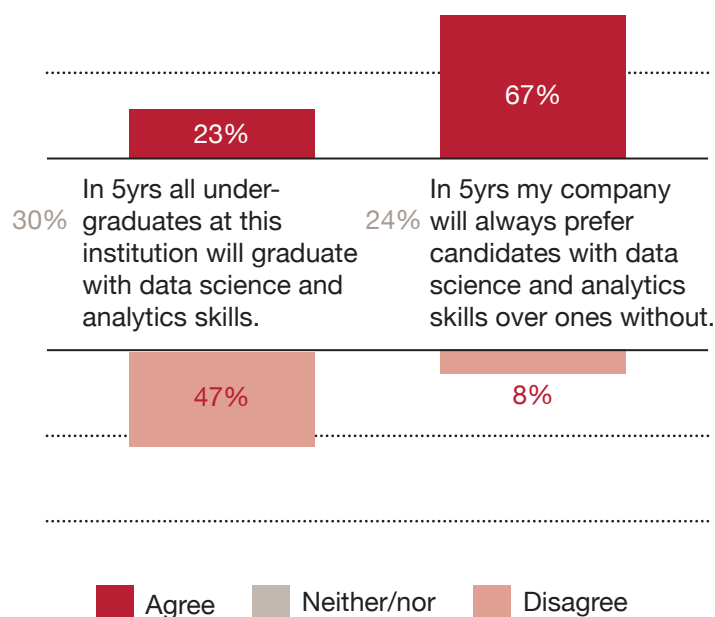
It's a mix of technical and social skills. These jobs are in the economy's fastest job-growth areas. They are higher-paying jobs, but they also require higher levels of preparation and above-average levels of social skills, analytical skills, or both.[4]

There aren't enough women or minorities. Data science courses attract women and underrepresented minorities only marginally better than other STEM programs. This is a top concern. In computer science and engineering, potentially the most receptive groups to learning data science, Hispanics and African Americans are typically less than 10% of graduates. Men already outnumber women 3 to 1 as computer workers.[5]

There are hiring hotspots. Five big metro areas hire for data skills the most: New York, San Francisco, Washington D.C., Chicago, and Los Angeles. There's also active hiring in Dallas, Atlanta, and Philadelphia, plus the places known for hiring data scientists: Seattle, San Jose, and Boston.

Business and education aren't yet on the same page. By 2021, 67% of executives expect to choose job candidates with data skills over ones without. Yet only 23% of educators say their students will graduate with these skills.[6]

The supply-demand challenge

23%	67%
In 5yrs all under-graduates at this institution will graduate with data science and analytics skills.	In 5yrs my company will always prefer candidates with data science and analytics skills over ones without.
30%	24%
47%	8%

Agree   Neither/nor   Disagree

Source: Gallup and BHEF (December 2016).
In this survey, "data science and analytics skills" was defined as the skills needed to discover, interpret, and communicate meaningful patterns in data.

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2   The Business Roundtable, *2016 Education and Workforce Survey* (September 2016).
3   Burning Glass Technologies (January 2017).
4   Pew Research Center, "Jobs requiring preparation, social skills or both expected to grow most" (October 2016).
5   US Census Bureau, *American Community Survey* (September 2013).
6   Gallup and BHEF, *Data Science and Analytics Higher Education and Business Surveys* (December 2016).

Opportunities for action

Closing the skills gap will require talent strategies not only for the incumbent workforce and new technical graduates, but for all of our post-secondary education programs. We need to change our views on the foundational literacies all students must have.

To do this, we'll need leaders across business, education, government, and nonprofits to respond to this imperative. Based on what we know today, we recommend the following opportunities for action:

1. **Clarify needs for your industry with signals that motivate educators and job seekers.** Data science is not one size fits all. Different industries have unique problems, so they need their own levels of knowledge and skill. You can work directly with universities or act collectively to define the common skills, analytical approaches, and job competencies for your industry. Foundational skills should be framed for the future, and not just today.

2. **Use market hotspots for investment impact.** Our data shows that regions vary dramatically in industry need, job density, and growth. So it's better to invest people and programs in certain areas. If your local economy isn't one of the current hiring hotspots, it's going to be harder for students to gain relevant experience and for employers to find the right skills. Employers can cast a wider net for recruiting and start working with higher education to train more local students.

3. **Change talent strategies for the digital economy.** By 2021, 67% of executives say they will hire people with analytics skills over ones without.[7] So companies should be sure to send the right messages when they recruit, develop, and promote employees. Be specific about what you expect people to be able to do in various roles that touch data science. Pay particular attention to aptitudes and skills that allow for growth and development.

4. **Support a culture of continuous learning in the workplace.** Nearly half of companies in Gallup's survey of corporate leaders say that data science and analytics skills will be required of everyone in operations, finance and accounting, and marketing and sales roles within the next three years.[8] Companies can promote a culture of continuous learning and identify how to add to employees' skills for the functional areas that need it most, including supporting certificate and graduate degree programs.

5. **Promote paths for women, minorities, and veterans to get and keep analytical jobs.** College and university presidents and provosts say that their data science courses are only marginally better than other STEM programs in reaching underrepresented groups. Addressing this issue is not just about foundational skills in our K-12 pipeline, but also about building equity in education and training programs from the start. It's critical to increase participation and completion rates. And to help these groups enter the workforce.

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7   Gallup and BHEF, *Data Science and Analytics Higher Education Survey* (December 2016).
8   Gallup and BHEF, *Data Science and Analytics Business Survey* (December 2016).
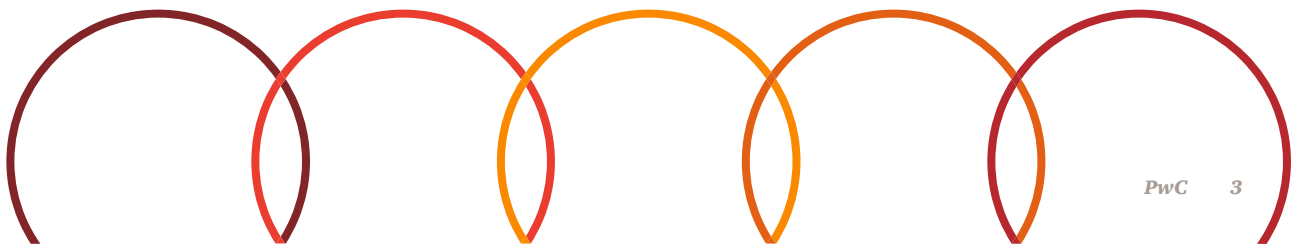
Opportunities for action

6. **Enable all students to become data literate and create new paths to the jobs of the future.** The purpose of a requirement in every major is not to prepare every student to have a career in data science. Instead the goal is to move beyond STEM majors and recognize that many occupations are changing and will require higher levels of analytical skill. As a result, all students should have a foundational knowledge of analytics and the data science process. Currently, few undergraduate computer science and engineering students—potentially the most readily receptive to data science—gain any exposure. Introductory and advanced courses can be added to give students the skills and credentials that are highly valued in the workplace.

7. **Provide access to data science and analytics through interdisciplinary programs.** Data science jobs require competency in computer science, statistics, or applied mathematics, plus well-honed 21st century skills such as communication, creativity, and teamwork. Developing data and analytics skills in problem-solving, interdisciplinary programs can help students develop more than just analytical skills. This applies for continuing education as well as higher education and particularly the liberal arts.

8. **Build a coalition for higher education.** The pace of development for accredited degree programs is dizzying. Since 2010, 303 new accredited programs in data science and analytics came on line in the US, a 52% increase.[9] This is a massive opportunity to learn from each other, build consensus on where the field is headed, and identify agendas for policy and funding priorities.

The purpose of a requirement in every major is not to prepare every student to have a career in data science. Instead the goal is to move beyond STEM majors and recognize that many occupations are changing and will require higher levels of analytical skill. As a result, all students should have a foundational knowledge of analytics and the data science process.

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9   Tableau, *The State of Data Education, 2016 (*November 2016).

I. Job market summary

Burning Glass Technologies, a labor market analytics firm, structured the data discovery for the US job market. Their task was to build a portrait of demand for skills in data science and analytics. Burning Glass mined over 26.9 million job postings from 2015 to identify:

- key roles that comprise the data science and analytics job ecosystem

- 300+ analytical skills requested in the labor market

- occupations that commonly require a mix of these skills

- a jobs category for each occupation to see which types of jobs people could expect to get with a certain level of education and skill

The data set represents 2.3 million US job postings, where employers are seeking candidates with data science and analytics skills. However, it doesn't include hidden markets, unposted positions or gig economy jobs. It doesn't factor for automation of routine tasks.

Figure 1: Data science and analytics postings by state (2015)

Burning Glass identified 2.3 million US job postings asking for data science and analytics skills.
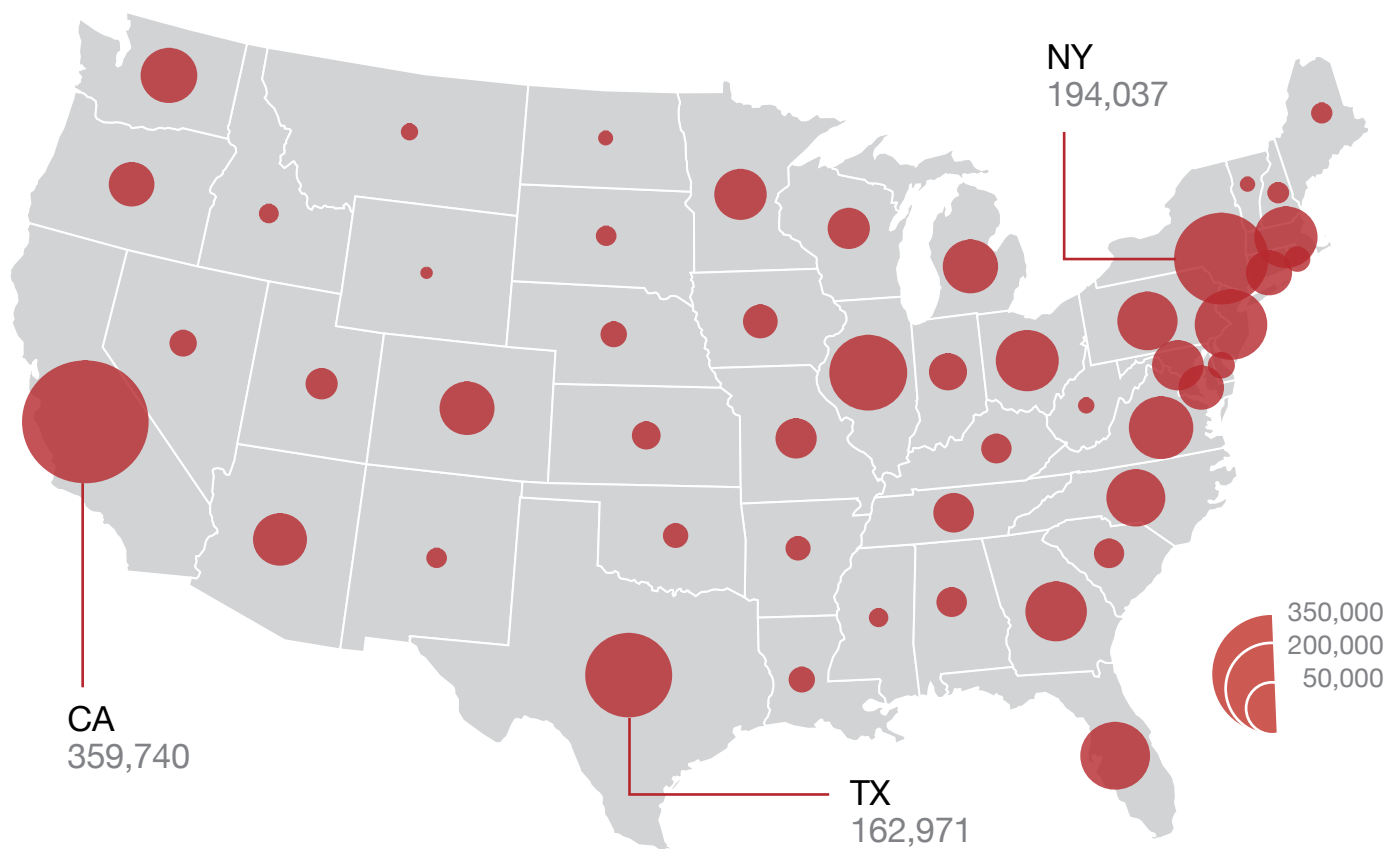
NY
194,037

CA
359,740

TX
162,971

350,000
200,000
50,000

Figure 2: Job families in the data science and analytics landscape

We can learn which roles comprise the data science and analytics jobs landscape by mining for the analytical skills required across a large sample of online job postings. For this sample, 35% of 2.3 million jobs fall within the data-driven decision makers job family.

Data-driven decision makers

Leverage data to inform strategic and operational decisions.

Who are they?

Chief Executive Officer
Chief Data Officer
Chief Information Officer
Director of IT
Financial manager
Human Resources manager
Marketing manager

Total job postings
812,099

US average advertised annual salary

$91,467*

*Actual salaries can be higher than what's advertised

What skills get a salary premium?

Business intelligence
Business solutions
Cloud solutions
Data warehousing
Java
Product development
Product management
Risk management
SAP
Software development principles

Notes: 2015 data
Source: PwC analysis based on Burning Glass Technologies data, January 2017.

Figure 3: Job families in the data science and analytics landscape

Thirty-three percent of 2.3 million jobs fall within the functional analysts job family.

Functional analysts

Use data and models to inform domain-specific decisions.

Who are they?
Actuary
Business/Management analyst
Compensation/Benefits analyst
Financial analyst
Geographer/GIS specialist
HRIS analyst
Operations analyst
Researcher/Research associate

Total job postings
770,441

US average advertised annual salary
$69,162*

*Actual salaries can be higher than what's advertised

What skills get a salary premium?
Business development
Business intelligence
Business process and analysis
Customer relationship management (CRM)
Data warehousing
Microsoft development tools
Risk management
Software development principles
SQL
System design and implementation

Notes: 2015 data
Source: PwC analysis based on Burning Glass Technologies data, January 2017.
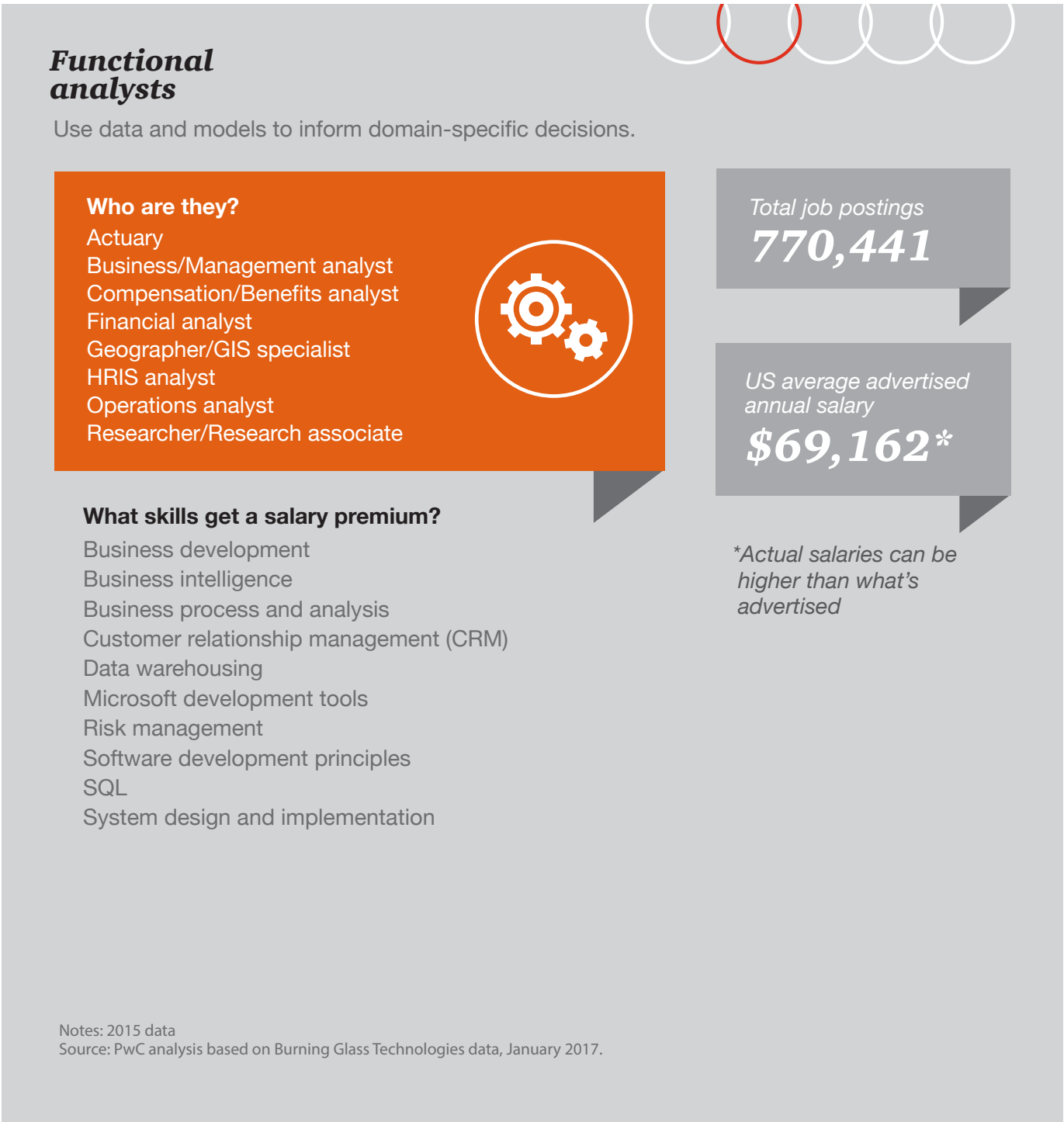
Figure 4: Job families in the data science and analytics landscape

Twenty-four percent of 2.3 million jobs fall within the data engineers job family.

Data engineers (hardware and software)

Make good data available through the design, construction, and maintenance of organizational data and analytical infrastructure.

Who are they?

Business intelligence architect
Computer systems engineer
Data warehousing specialist
Data administrator
Database architect
Systems analyst

Total job postings
558,326

US average advertised annual salary
$78,553*

*Actual salaries can be higher than what's advertised

What skills get a salary premium?

Big data
Business strategy
Cloud solutions
Data visualization
Data warehousing
Scripting languages
Operating systems
Optimization
Product management
Programming principles

Notes: 2015 data
Source: PwC analysis based on Burning Glass Technologies data, January 2017.

Figure 5: Job families in the data science and analytics landscape

Five percent of 2.3 million jobs fall within the data analysts job family.

Data analysts

Leverage data analysis and modeling techniques to solve problems.

Who are they?
Data mining analyst
Business intelligence analyst

Total job postings
124,325

US average advertised annual salary
$69,949*

*Actual salaries can be higher than what's advertised

What skills get a salary premium?
Business intelligence
Data visualization
Data warehousing
Extraction, transformation, and loading (ETL)
Operating systems
Optimization
Scripting languages
Software development principles
Statistical software
ERP systems (SAP or Oracle)

Notes: 2015 data
Source: PwC analysis based on Burning Glass Technologies data, January 2017.
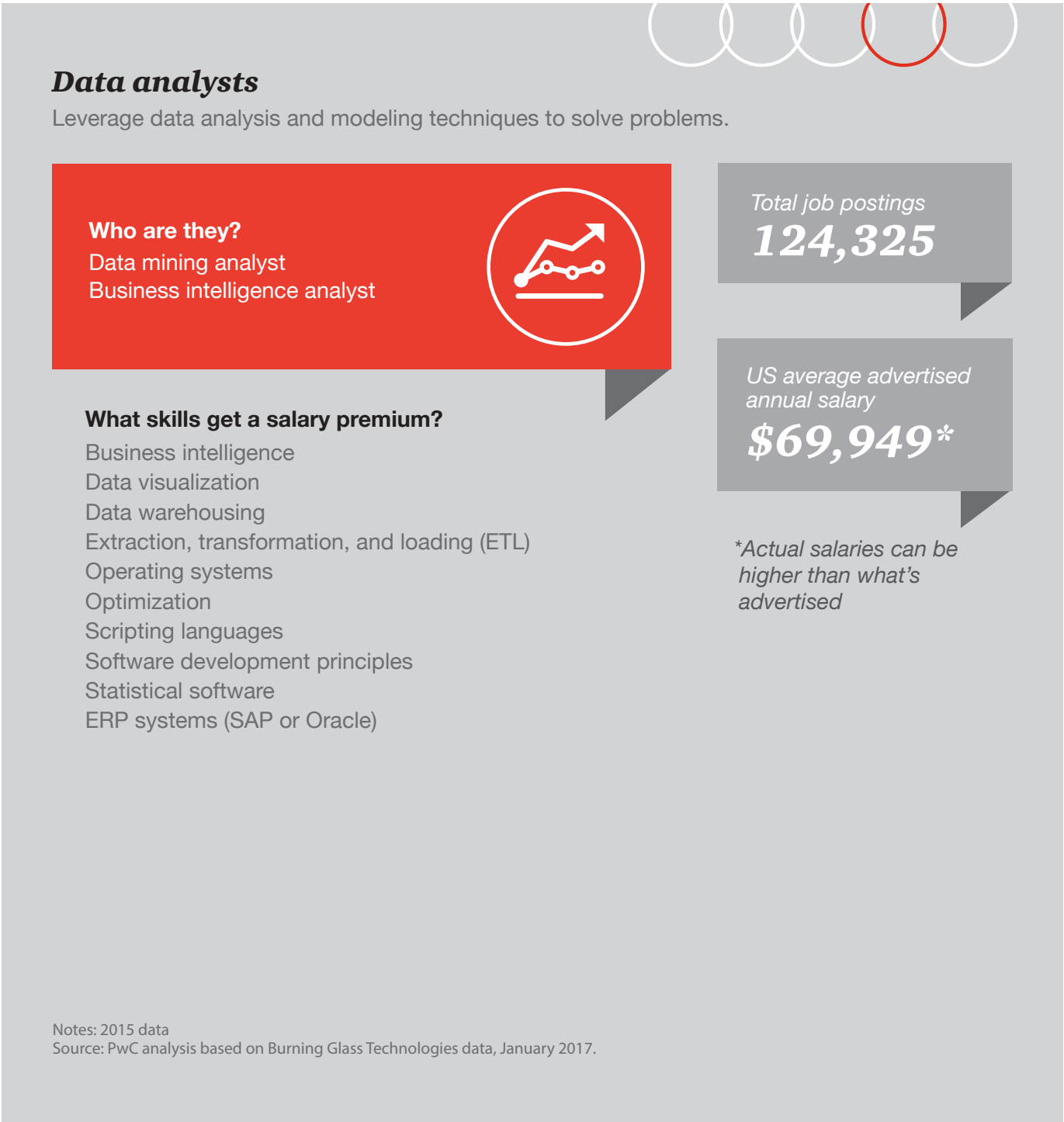
Figure 6: Job families in the data science and analytics landscape

Two percent of 2.3 million jobs fall within the data scientists and advanced analysts job family.

Data scientists and advanced analysts

Develop and implement processes and systems to extract knowledge or insights from data.

Who are they?
Biostatistician
Data engineer
Data scientist
Financial quantitative analyst
Statistician

Total job postings
48,347

US average advertised annual salary
$94,576*

*Actual salaries can be higher than what's advertised

What skills get a salary premium?
Data mining
Data warehousing
Extraction, transformation, and loading (ETL)
Machine learning
Mathematical modeling
Operating systems
Optimization
Product development
Scripting languages
Software development principles

Notes: 2015 data
Source: PwC analysis based on Burning Glass Technologies data, January 2017.

A sixth jobs category, the analytics manager, is not shown. This jobs category represents 1.7% of data science and analytics jobs.

Figure 7: Data skills needed most in an array of industries

The need for analytics-enabled jobs is strong; data science jobs span all major industries.

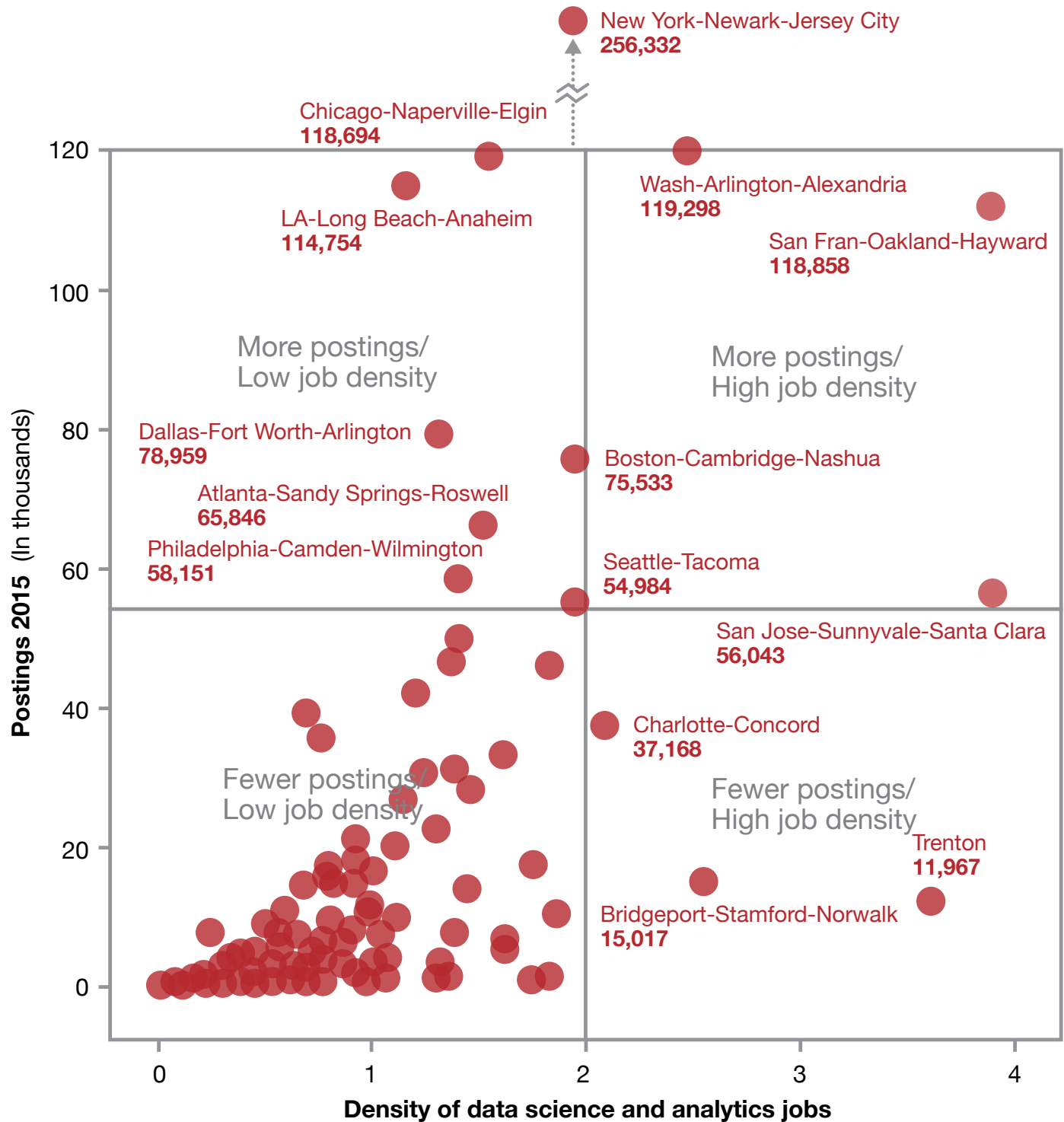|	Analytics-enabled jobs		Data science jobs		
	Data-driven decision makers	Functional analysts	Data engineers (hardware and software)	Data analysts	Data scientists and advanced analysts
Finance and Insurance	26%	51%	13%	5%	2%
Health Care and Social Assistance	32%	44%	15%	5%	2%
Information	43%	23%	26%	4%	2%
Manufacturing	45%	25%	23%	4%	2%
Professional, Scientific, and Technical Services	30%	29%	31%	6%	2%
Retail Trade	46%	35%	13%	4%	2%

Notes: Job category of analytics managers not shown. Totals may not equal 100%.
Source: PwC analysis based on Burning Glass Technologies data, January 2017.
Number of postings: Finance and Insurance (535,683); Healthcare and Social Assistance (100,900); Information (690,833);
Manufacturing (237,484); Professional, Scientific, and Technical Services (511,947); Retail Trade (101,711).

Figure 8. Geographic hotspots for data science and analytics skills

Hotspots help determine where local programs could make an impact.

New York-Newark-Jersey City
256,332

Chicago-Naperville-Elgin
118,694

LA-Long Beach-Anaheim
114,754

Wash-Arlington-Alexandria
119,298

San Fran-Oakland-Hayward
118,858

More postings/
Low job density

More postings/
High job density

Dallas-Fort Worth-Arlington
78,959

Atlanta-Sandy Springs-Roswell
65,846

Philadelphia-Camden-Wilmington
58,151

Boston-Cambridge-Nashua
75,533

Seattle-Tacoma
54,984

San Jose-Sunnyvale-Santa Clara
56,043

Charlotte-Concord
37,168

Fewer postings/
Low job density

Fewer postings/
High job density

Trenton
11,967

Bridgeport-Stamford-Norwalk
15,017

Postings 2015 (In thousands)

120

100

80

60

40

20

0

0   1   2   3   4

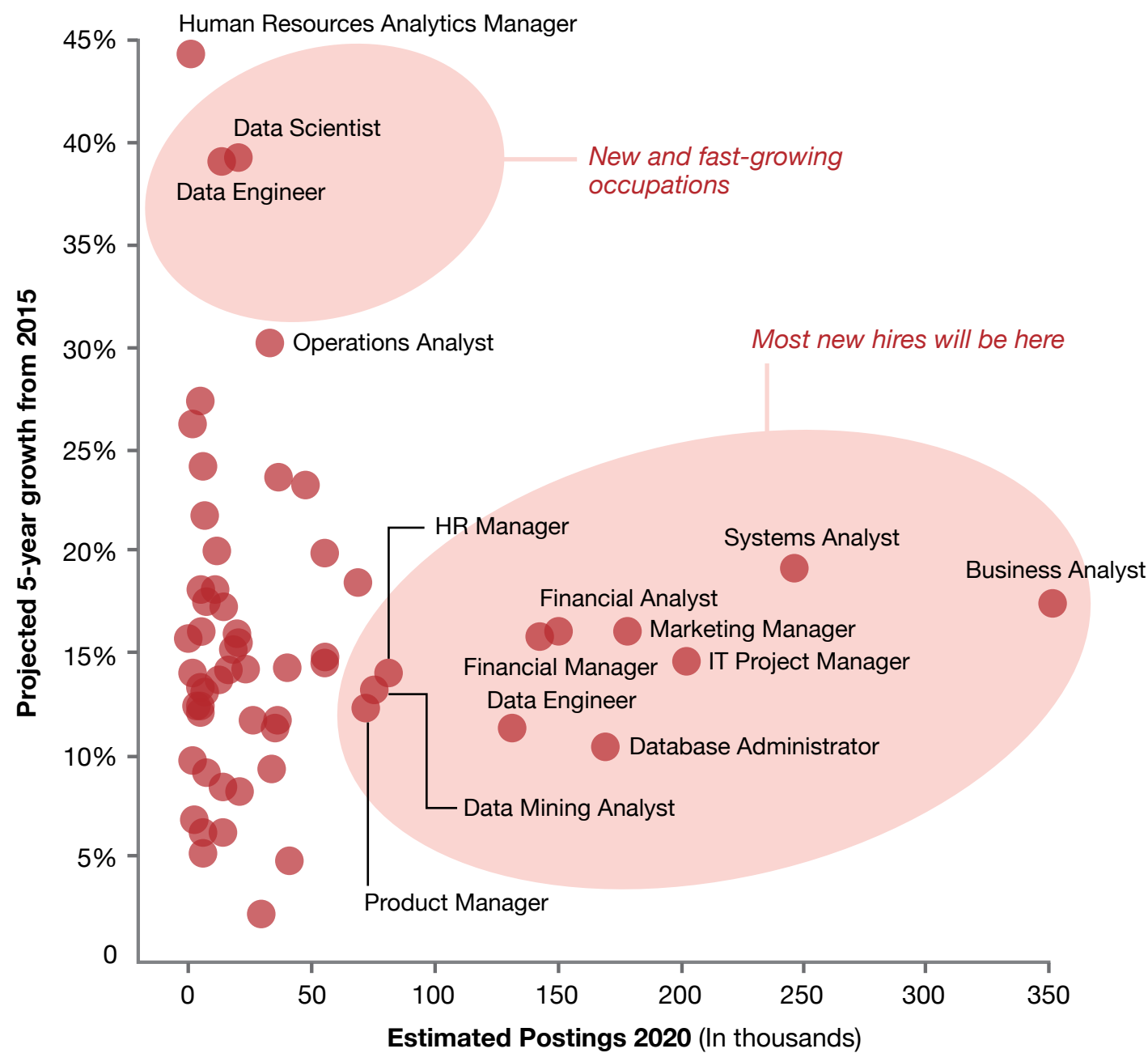Density of data science and analytics jobs

Note: Each dot represents a metro area in the US. For density, we show a four-point scale representing the sum of values for each job category.
Source: PwC analysis based on Burning Glass Technologies data, January 2017.

Figure 9: The 2020 estimate calls for 2.7 million job postings for data science and analytics roles

The landscape has two distinct skills-based markets.

Note: Each dot represents an occupation in the US jobs market where data science and analytics skills are required.
Source: PwC analysis based on Burning Glass Technologies data, January 2017.

II. Higher education survey

Gallup conducted 126 phone interviews from October 31–December 19, 2016 with college and university presidents, chancellors, provosts and deans from public, private, two-year and four-year institutions who have data science and analytics programs in place. The sample consists of 2,450 US college and university leaders. The sample is not nationally representative of US colleges and universities. The sample of higher education leaders was obtained from Higher Education Publications, Inc.

In this survey, "data science and analytics skills" was defined as the skills needed to discover, interpret and communicate meaningful patterns in data.

In this survey, "data science and analytics skills" was defined as the skills needed to discover, interpret and communicate meaningful patterns in data.

Figure 10: Educators expect enrollment to increase, but the pipeline should be stronger

Q: In the next three years, do you expect the number of students who enroll in data science and analytics courses at this institution to increase or decrease?

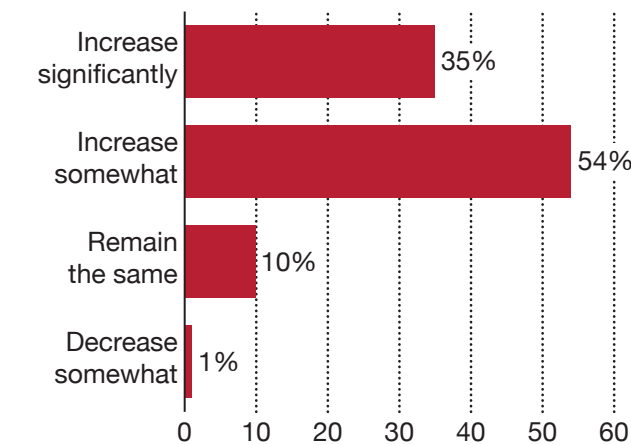Enrollment in data science and analytics courses will...

Figure 11: Most aren't prepared to help students be competitive in the job market

Q. To what extent do you agree with the following statements?
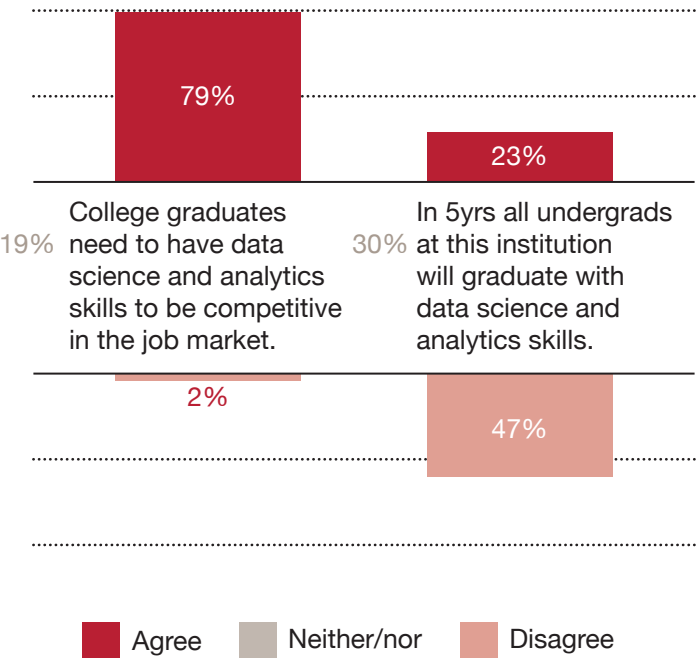

Agree | Neither/nor | Disagree

Figure 12: Those who offer coursework in data science and analytics often do not require it

Q: Is data science and analytics coursework required of all majors, some majors, or not required for any majors?

Business
- 30%
- 52%
- 14%
- 2%
- 2%

Math and sciences
- 21%
- 55%
- 19%
- 4%
- 1%

Engineering
- 23%
- 30%
- 21%
- 11%
- 14%

Social sciences
- 7%
- 47%
- 42%
- 3%
- 1%

Arts & humanities
- 3%
- 25%
- 69%
- 2%
- 1%

Legend:
- Required for all majors
- Required for some majors
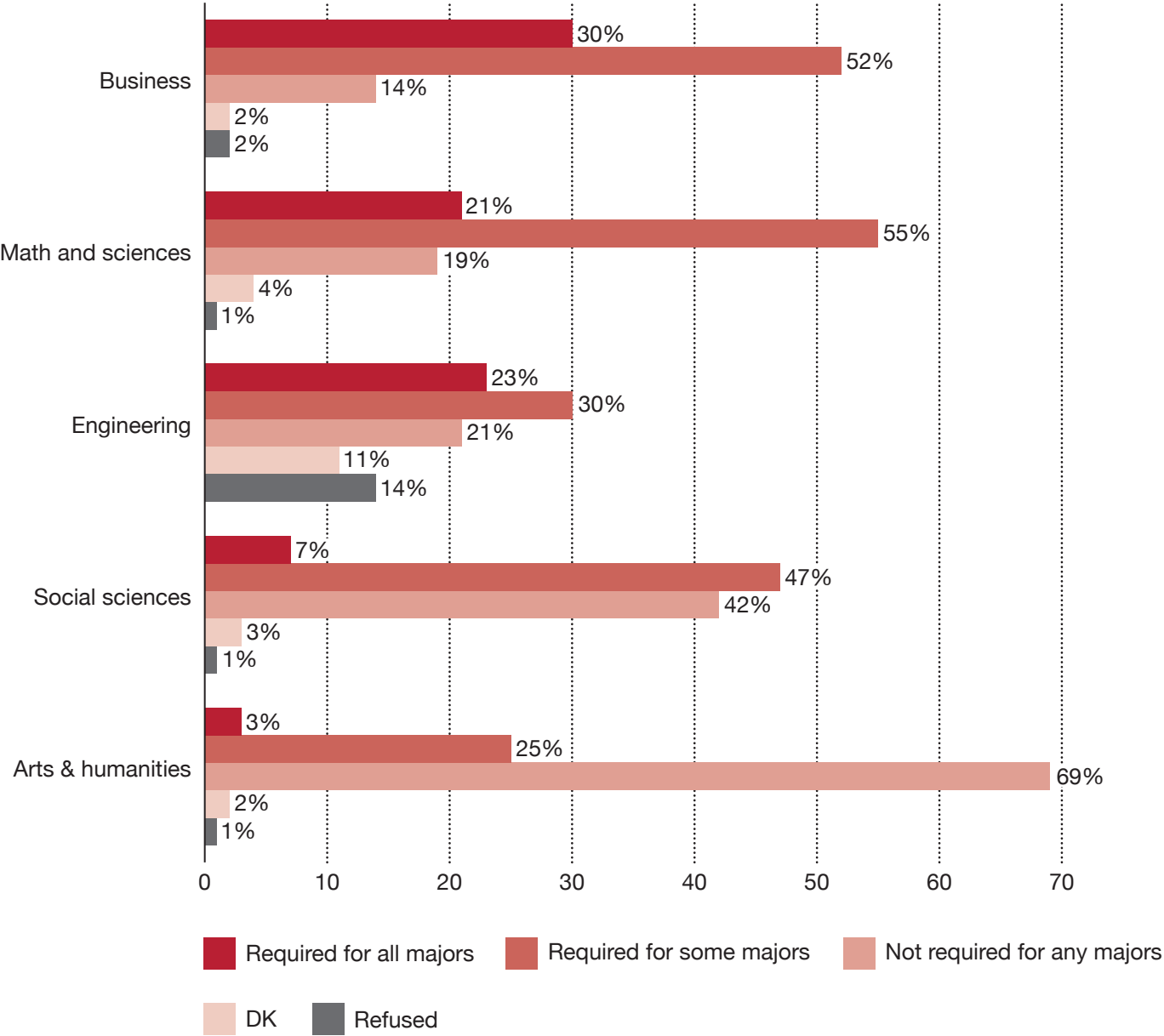- Not required for any majors
- DK
- Refused

Figure 13: Of colleges and universities that offer data science and analytics programs, less than ⅓ say it's extremely important to do so

Q: How important is it to your university that undergraduate students are taught data science and analytics skills?

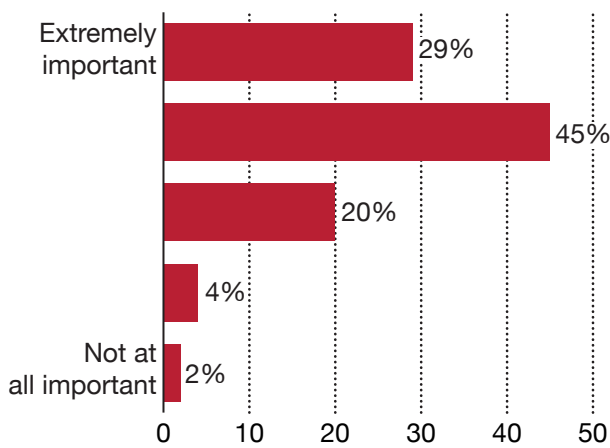|	
Extremely important	29%
	45%
	20%
	4%
Not at all important	2%

0   10   20   30   40   50

Figure 14: Private sector funding is untapped when it comes to data science and analytics programs

Q: Where is your university primarily receiving funding for data science and analytics programs offered to students at your institution?

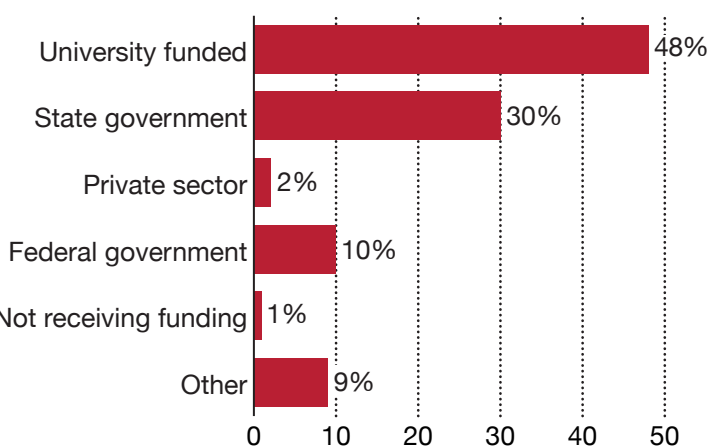|	
University funded	48%
State government	30%
Private sector	2%
Federal government	10%
Not receiving funding	1%
Other	9%

0   10   20   30   40   50

Figure 15: Enrollment and placement rates are top measures for assessing data science and analytics programs

Q: Tell me if your university uses any of the following ways to assess the strength of its data science and analytics programs.

University metrics

Grant funding
40%

21%
Advisory boards reviews

27%
Formal assessments, program evaluations

What should we teach?

How do we know students learned?

83%
Enrollment

70%
Internship placements

76%
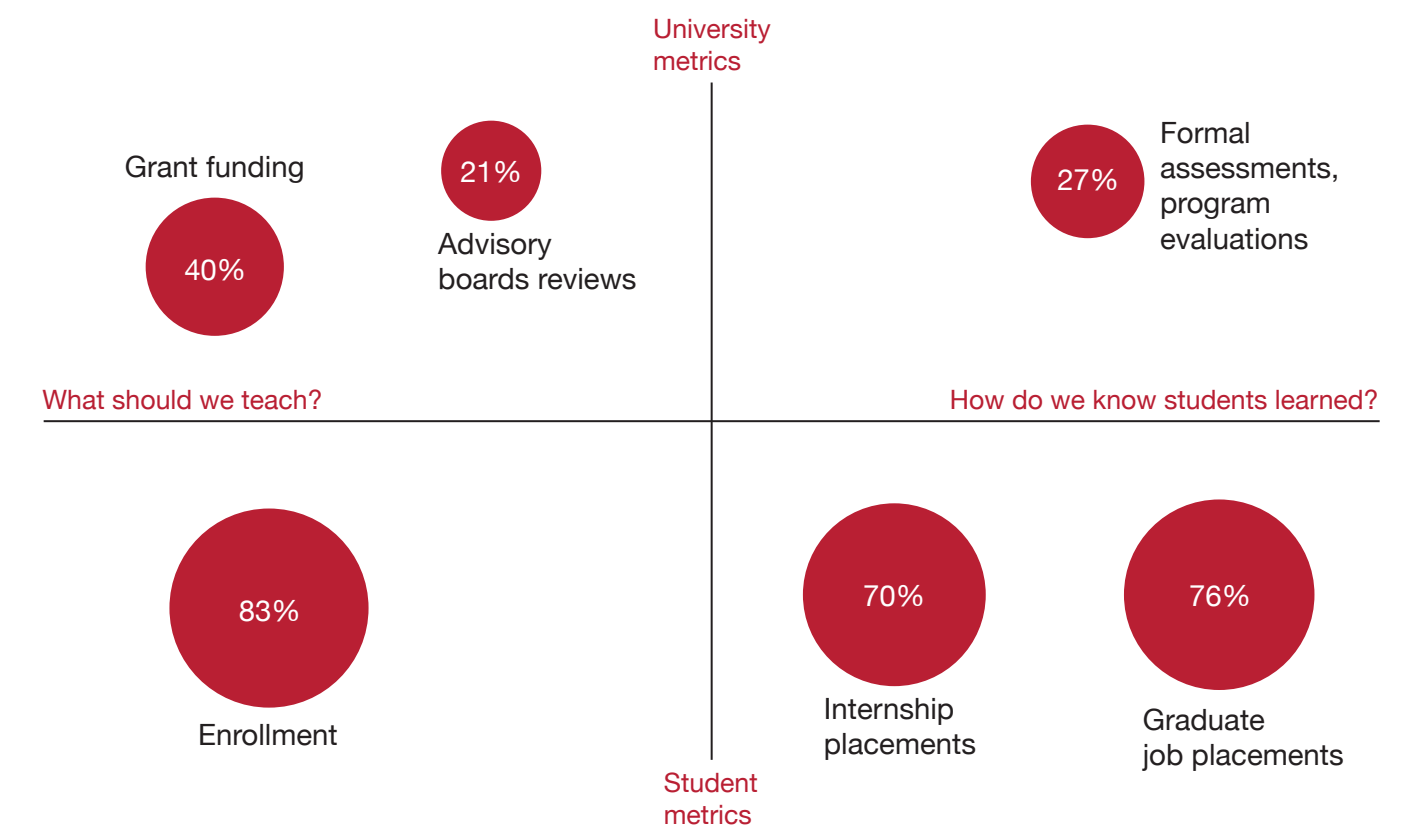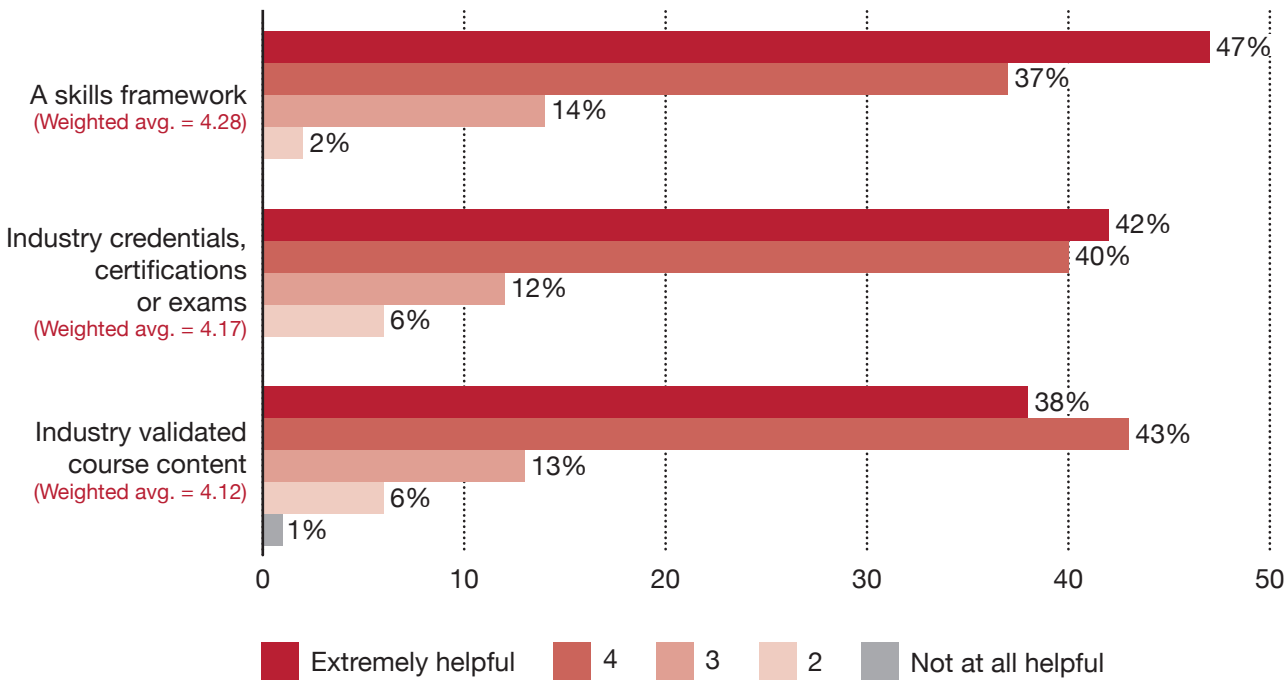Graduate job placements

Student metrics

Figure 16: Educators say a skills framework and more industry involvement would help drive the greatest change

Q: How helpful would each of the following be in helping universities prepare students with the data science and analytics skills that they need in their jobs?

A skills framework (Weighted avg. = 4.28)	47% / 37% / 14% / 2%
Industry credentials, certifications or exams (Weighted avg. = 4.17)	42% / 40% / 12% / 6%
Industry validated course content (Weighted avg. = 4.12)	38% / 43% / 13% / 6% / 1%

Legend: Extremely helpful — 4 — 3 — 2 — Not at all helpful

III. Business survey

Gallup conducted 49 phone interviews from October 31–December 19, 2016 with business leaders. The sample consists of 25,683 chief executive officers, chief information officers, chief technology officers, human resources officers and vice-presidents of human resources and operations at oil and gas, finance, insurance, computer systems, manufacturing, information, biotech, healthcare (HMO medical centers, hospitals and diagnostic labs), retail trade, and transportation and warehousing companies with annual revenues of $10 million or more. The sample is not nationally representative of US companies in these industries. The sample of business leaders was obtained from Dun and Bradstreet.

In this survey, "data science and analytics skills" was defined as the skills needed to discover, interpret and communicate meaningful patterns in data.
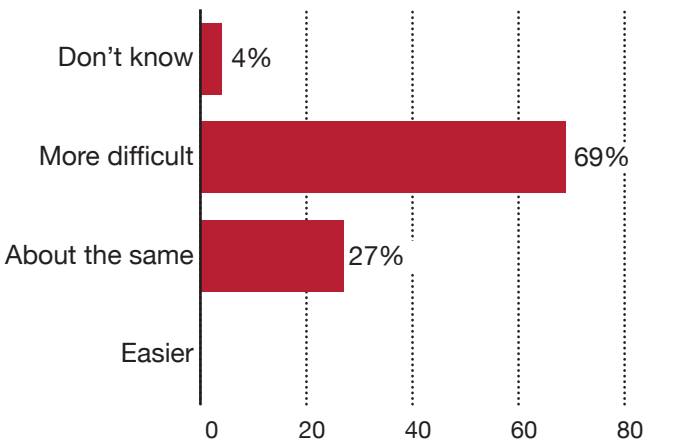
Figure 17: Executive's say the use of data and analytics will impact operations the most

Q: Where do you expect the use of data and analytics to have the most positive impact on your company?

Figure 18: Relative to general business skills, it's more difficult to find people with data and analytics skills

Q: Has it been easier, about the same or more difficult to attract people with data science and analytics skills relative to people with general business skills?

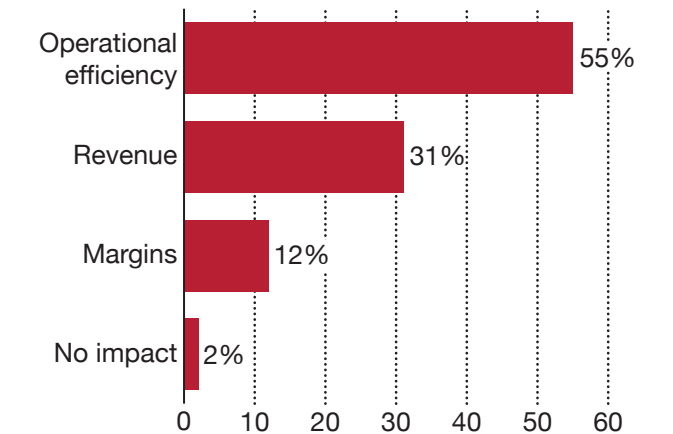General business skills can include things like project management or problem-solving skills.

Figure 19: Half of executives say they don't have enough people with the data skills they need

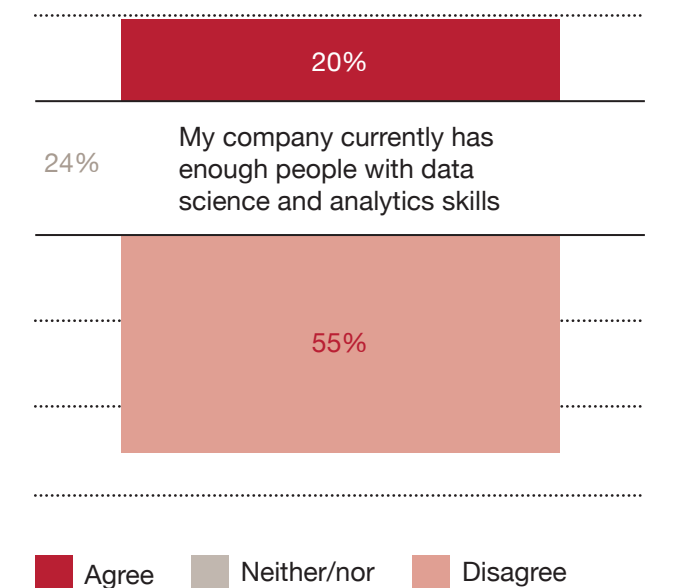Q: To what extent do you agree/disagree with the following statement?

My company currently has enough people with data science and analytics skills

- Agree
- Neither/nor
- Disagree

Q: In the next three years, will data science and analytics skills be required of everyone in this job, some people in this job, or will it not be required for this job?

Finance and accounting managers
- All: 57%
- Some: 41%
- Not required: 2%
- N/A: 0%

Suppy chain and logistic managers
- All: 33%
- Some: 35%
- Not required: 16%
- N/A: 16%

Operations managers
- All: 47%
- Some: 53%
- Not required: 0%
- N/A: 0%

Executive leaders
- All: 45%
- Some: 45%
- Not required: 10%
- N/A: 0%

HR managers
- All: 29%
- Some: 57%
- Not required: 12%
- N/A: 2%

Marketing and Sales Managers
- All: 45%
- Some: 51%
- Not required: 0%
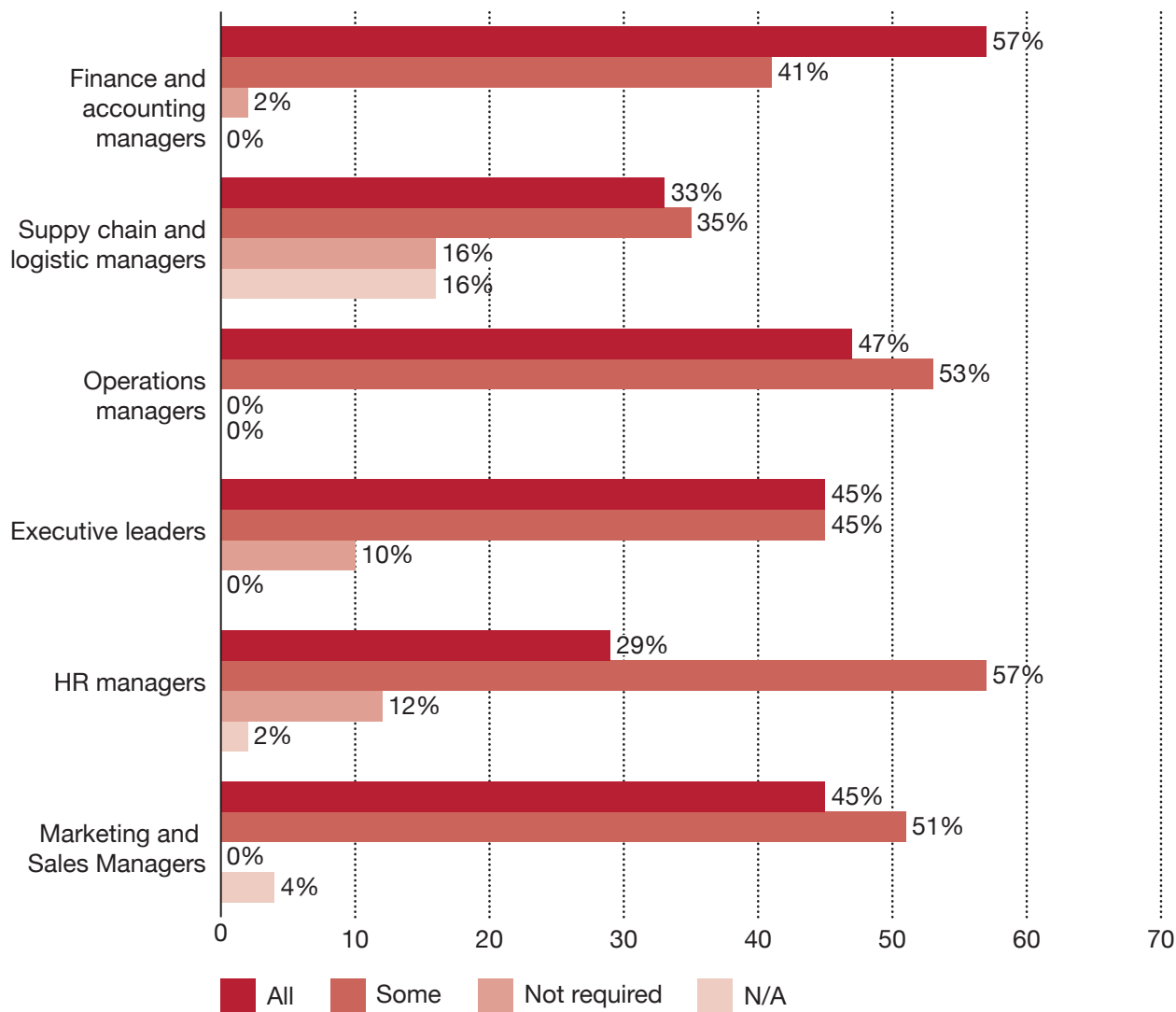- N/A: 4%

Legend: All · Some · Not required · N/A

Figure 21: In five years, analytics skills will be a baseline expectation

Q: To what extent do you agree/disagree with the following statements?

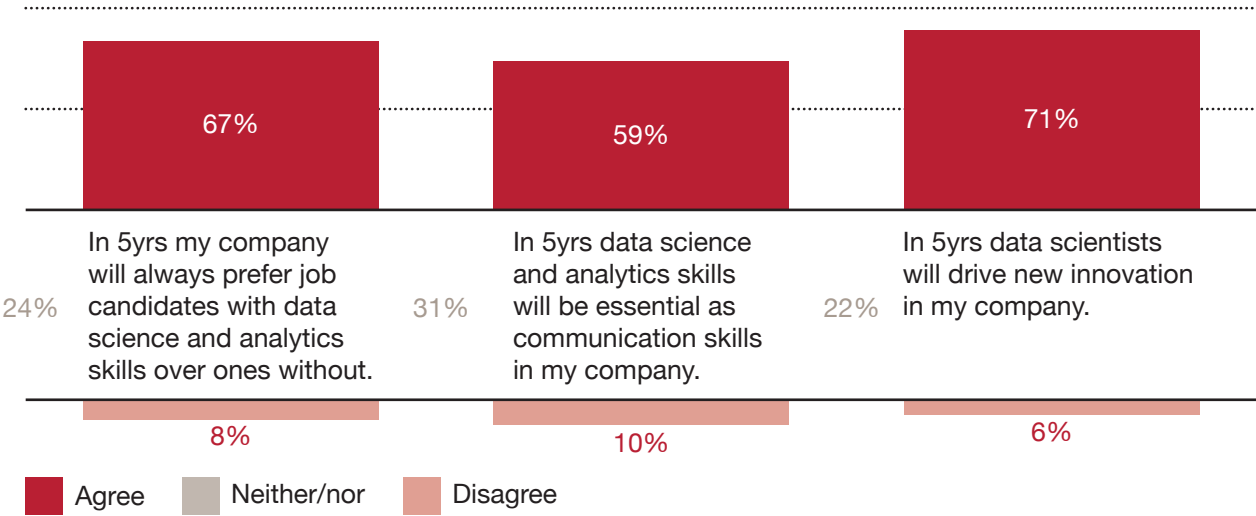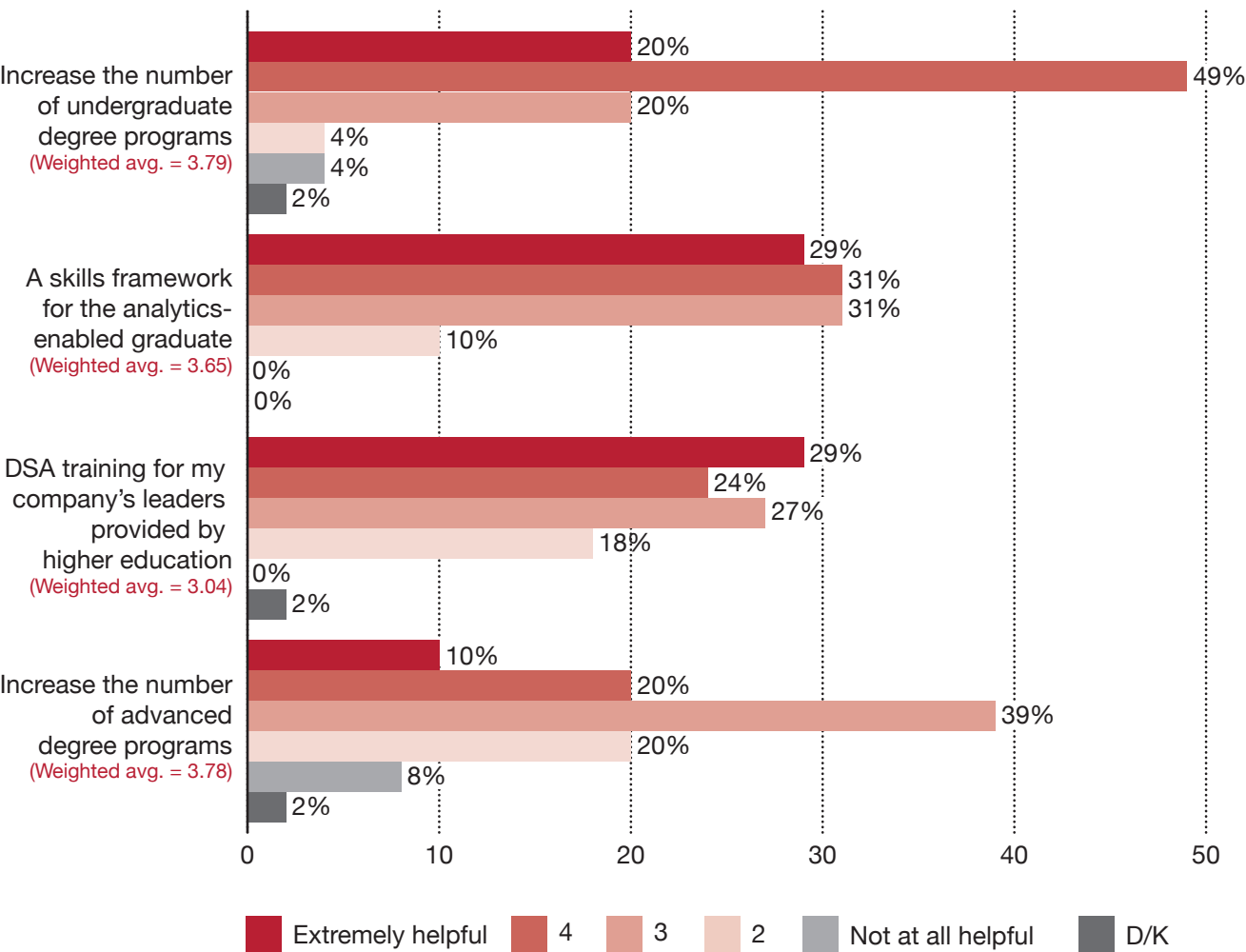|		
67%	59%	71%
In 5yrs my company will always prefer job candidates with data science and analytics skills over ones without.	In 5yrs data science and analytics skills will be essential as communication skills in my company.	In 5yrs data scientists will drive new innovation in my company.
24%	31%	22%
8%	10%	6%

■ Agree ■ Neither/nor ■ Disagree

Figure 22: Executives say increasing the number of programs offered to students and a common skills framework would help the most

Q: How helpful each of the following would be to your company in building a ready and available pipeline of data science and analytics talent?

Increase the number of undergraduate degree programs
(Weighted avg. = 3.79)
- 20%
- 49%
- 20%
- 4%
- 4%
- 2%

A skills framework for the analytics-enabled graduate
(Weighted avg. = 3.65)
- 29%
- 31%
- 31%
- 10%
- 0%
- 0%

DSA training for my company's leaders provided by higher education
(Weighted avg. = 3.04)
- 29%
- 24%
- 27%
- 18%
- 0%
- 2%

Increase the number of advanced degree programs
(Weighted avg. = 3.78)
- 10%
- 20%
- 39%
- 20%
- 8%
- 2%

Legend: Extremely helpful | 4 | 3 | 2 | Not at all helpful | D/K

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