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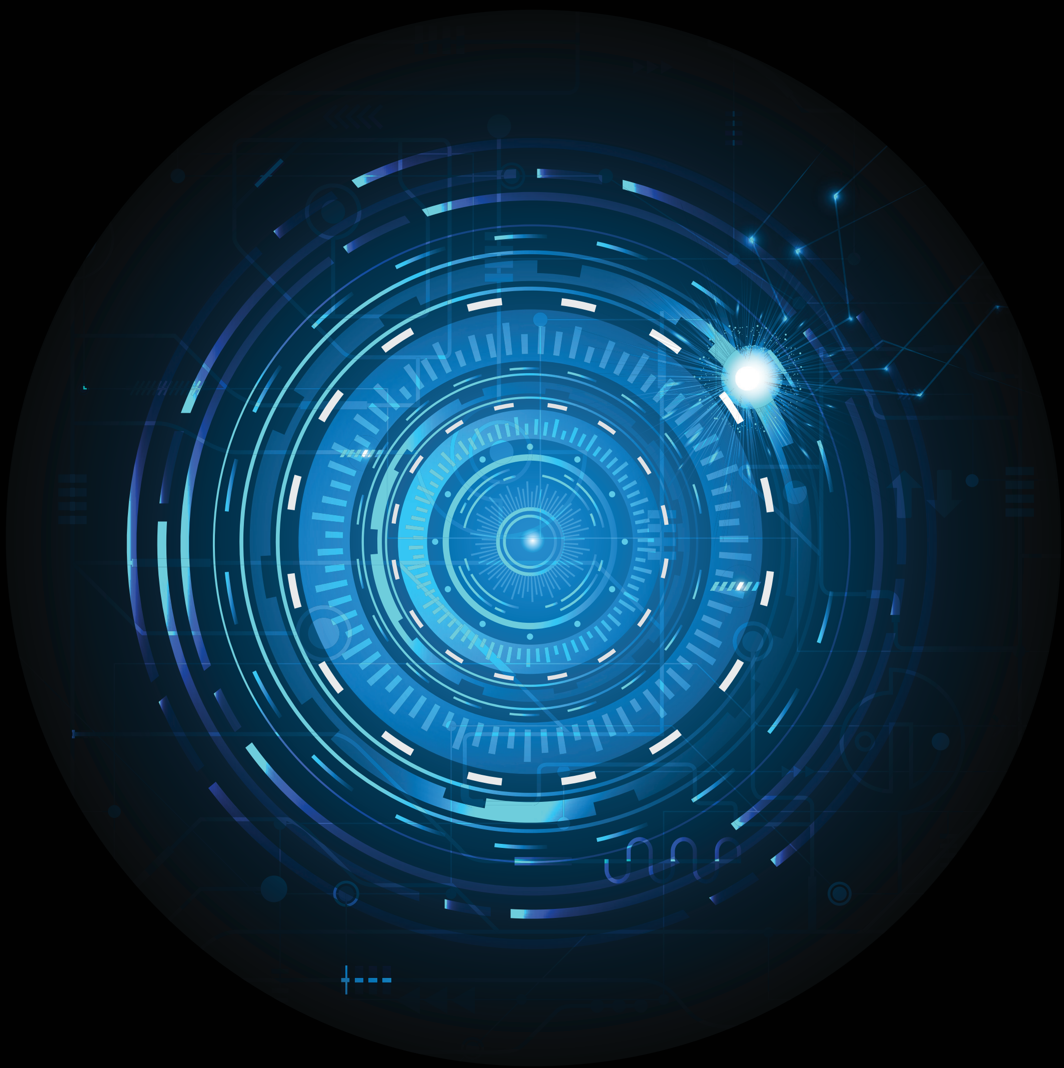

The future of work:
Occupational and education trends in data science in Australia

Prepared by Deloitte Access Economics, February 2018

301,000

Size of Australia's data science workforce in 2016-17

2.4%

Forecast annual growth in data science professionals between 2016-17 and 2021-22
(compared to 1.5% p.a. for overall Australian workforce)

Data science snapshot

Proportion of businesses planning on increasing investment in analytics capabilities over the next two years

76%

Forecast income of data science professionals with postgraduate qualification* in 2021-22

$130,176

* Postgraduate qualification in Information Technology field of education.

New technological capabilities are enabling organisations across a range of industries to translate quantitative data into practical business insights.

The world creates an additional 2.5 quintillion bytes of data each year.

– Data61, 2016

The level of growth and variety of data now available is resulting in companies integrating data and analytics into their daily operations. Therefore, demand for individuals with data science skills has increased, with the development of analytics roles in a diverse array of sectors and applications.

In this context, Deloitte Access Economics has been commissioned to examine how occupational and education trends are developing across the data science workforce in Australia. This report seeks to provide forward looking insights on how the nature of work and study in data science are evolving as a result of ongoing changes to the economic, business and labour market landscape.

The research presented in this report has been developed through a mix of analysis of publicly available data and information sources, targeted consultations with academics and university program directors, and employment forecasting using Deloitte Access Economics' macroeconomic modelling framework.

How are broader trends specifically affecting the data science area?

Rate of change

The rate at which information and data is being generated is faster than ever before. Recent estimates suggest that **the world creates an additional 2.5 quintillion bytes of data each year, with 90% of all data in existence being created in just the last two years** (Data61, 2016). The proliferation of new and existing technology platforms – such as sensory networks and augmented/virtual reality – has contributed to this growth in big data. This trend has been driven by advances in computing power, exponential growth in internet data usage and the shift to cloud computing.

The benefits that organisations can gain from analysing this big data has led to growing demand for data science skills, with increasing applications of techniques such as data mining and machine learning across many industries throughout the economy. Reflecting this trend, LinkedIn has recently reported that **statistical analysis and data mining ranks as the second most in-demand skill requested by employers in posted job advertisements,** and Glassdoor ranked "data scientist" as the best job in 2016 based on the number of job openings, salary and job satisfaction (Murthy, 2016).

Data analytics is increasingly being used to inform and drive business decisions at both an operational and strategic level: a recent global survey of chief information officers has found that 76% of businesses plan on increasing investment in analytics capabilities over the next two years (Deloitte Access Economics, 2017a).

The technology sector is not the only industry that is seeing new applications of data science, with a broad range of other industries such as finance, health and medicine, general sciences, cybersecurity, defence and agriculture also beginning to rely on analytics in order to enhance their core activities and product offerings.

Box A: Data science opportunities across a range of industries

The increasing availability of technology and data throughout all industries in the Australian economy represents a growing opportunity for data science to be applied in a diverse range of areas. As part of our research, Deloitte Access Economics spoke with Professor Ricardo Campello from James Cook University's (JCU) College of Science and Engineering, in relation to the nature of these opportunities and the skills required of data science professionals.

According to Ricardo, there are a wide variety of job opportunities available to individuals with data science skills. These include roles in the technology sector, with large technology companies such as Google, Facebook, Netflix and Amazon utilising data analytics and machine learning techniques within their core product offerings. **Organisations in other industries – such as finance, retail and agriculture – are also increasingly making use of data science capabilities in order to improve productivity and sales. In addition, these skills are seeing growing employment in research (for instance, medical and biological research) and government contexts, particularly in cyber security and defence applications.**

Data science professionals therefore need a solid foundational skillset which can be applied to these various areas. Ricardo suggests that computer programming skills will remain fundamental to the data science area, to ensure individuals build familiarity with computer languages such as R, Python, SQL, SAS, MATLAB and Excel. At the same time, **there is a need to develop an understanding of the whole lifecycle of data, including the acquisition, management and pre-processing of data,** as well as mathematical and statistical analysis, visualisation, reporting and decision making. Understanding this lifecycle is crucial for working with data in any industry or government organisation, as using raw data to produce meaningful business insights is the core task required of data scientists regardless of the particular sector that they work in.

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The ability for analytics to transform these industries stems from the significant growth in data available from new technological developments. For example, **given the increasing use of sensor technology and the Internet of Things in the agriculture industry, the average farm is expected to generate an average of 4.1 million data points per day by 2050, compared to only 190,000 in 2014** (Meola, 2016).

Health is another area where data scientists will be required to analyse millions of patient data points, such as electronic Medicare and prescription records, in order to better target preventative programs. According to University of NSW Centre for Big Data Research in Health director Professor Louisa Jorm, "many [data scientists in the health industry] come from work in areas like indigenous health or health disadvantage... [they] want to do research in an area that is going to make a difference to the population" (Molloy, 2015).

Demand for skills

Given the complexities associated with managing and analysing the huge volume and variety of data that will increasingly become available, workers in the data science area need to develop a range of technical and analytical skills in order to succeed, as discussed in Box A.

The rapid pace of technological change means that data analysis techniques and best practice are continuously evolving. As it can be challenging to anticipate the specific skills that will be required in the context of this ongoing change, workers in the data science area will need to be flexible and agile in adapting their skillsets and training to suit future business requirements.

In this context, **a lifelong learning approach to skills development will be valuable for employees seeking to reskill and upskill their analytics capabilities as required.** Mobile technologies and e-learning are already providing new channels for workplace learning, allowing workers to access training materials and information as they need it on the job (Data61, 2016). According to Data61 chief executive Adrian Turner, "Australia needs more of a growth mindset, which is about continual learning and improving [and] treating everything as a learning experience... we're going to move to more of a concept of lifelong learning where the whole career cycle of people will be looked at and compared with data to better understand where individuals are best suited to work and develop skills" (Stein, 2017).

Which data science occupations are relevant for our analysis?

In order to provide a snapshot of the workforce growth potential associated with the data science area, Deloitte Access Economics has identified a series of occupations that could represent job opportunities for workers with skills and qualifications in the data science field.[1] Since our research aims to evaluate further study in the data science area, the specified occupations are targeted towards roles that would be suitable for employees who have completed postgraduate study, rather than entry-level roles with lower skills and qualification requirements.

The following occupations have been identified using the Australian and New Zealand Standard Classification of Occupations (ANZSCO) as representing potential employment opportunities in the data science area:

- Information and Communication Technology (ICT) Managers
- Actuaries Mathematicians and Statisticians
- ICT Business and Systems Analysts
- Software and Applications Programmers
- Database and Systems Administrators and ICT Security Specialists
- Computer Network Professionals.

1. The occupations have been identified at the 4-digit level based on the Australian Bureau of Statistics' detailed occupation descriptions in the *Australian New Zealand Standard Classification of Occupations: First Edition* (ABS 2006), as well as consultation with university academics and subject matter experts, and research published by relevant industry associations and other publicly available materials.

Further to these IT-related occupations, the increasing integration of analytics capabilities with business operations throughout various industries means that there is increasing demand for data science skills in non-IT areas, such as in finance, agriculture, medicine and professional services. As such, we have identified a number of non-IT occupations and industries which could represent additional job opportunities for workers with data science qualifications and skills. These include:

- Financial Dealers (Financial and Insurance Services industry)
- Economists (Professional, Scientific and Technical Services industry)
- Intelligence and Policy Analysts (Public Administration and Safety industry)
- Land Economists and Valuers (Rental, Hiring and Real Estate Services industry)
- Advertising and Marketing Professionals (Information Media and Telecommunications industry)
- Cartographers and Surveyors (Professional, Scientific and Technical Services industry)
- Urban and Regional Planners (Professional, Scientific and Technical Services industry)
- Agricultural and Forestry Scientists (Agriculture, Forestry and Fishing industry)
- Life Scientists (Professional, Scientific and Technical Services industry)
- Financial Investment Advisers and Managers (Financial and Insurance Services industry)
- Management and Organisation Analysts (Professional, Scientific and Technical Services industry)
- Environmental Scientists (Agriculture, Forestry and Fishing; Professional, Scientific and Technical Services industries)
- Geologists and Geophysicists (Mining; Professional, Scientific and Technical Services industries)
- Medical Laboratory Scientists (Health Care and Social Assistance; Professional, Scientific and Technical Services industries).

The analysis that follows on future workforce growth and the benefits of further study in the data science area are based on the above occupations. We note that while these occupations have been identified on the basis of being relevant to job opportunities for individuals with data science skills and qualifications, not every worker employed in these occupations will necessarily have a specific data science qualification. It is particularly important to recognise that the breadth of occupations included in the non-IT grouping means that it is unlikely that all workers employed in the identified roles will need to have data science skills and qualifications.

To account for this in our employment forecasts, we have used previous research (Burning Glass Technologies, 2017) which estimated the share of job openings that comprise data science and analytics roles in particular industries, and applied these proportions to our workforce estimates for these non-IT occupations by industry. For example, this previous research found that 19% of roles available in the finance and insurance industry were jobs requiring data science and analytics skills; we therefore assume that 19% of the financial dealers occupation in the financial and insurance services industry are data science-related roles in our workforce analysis. Further details on the proportion of data science roles in each industry for this list of non-IT occupations can be found in the Appendix.

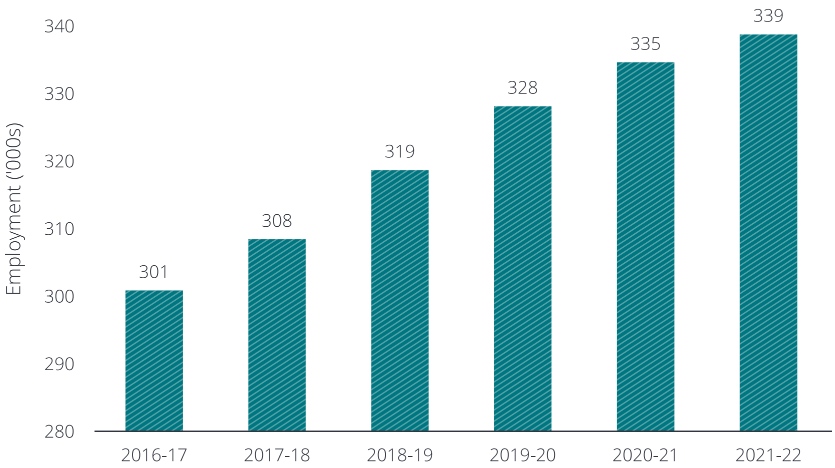
Overall, this list of occupations therefore outlines the broad pool of potential employment opportunities in the data science area across different parts of the workforce, rather than a one-to-one representation of the jobs that employ data science graduates.

The increasing integration of analytics capabilities with business operations throughout various industries means that there is increasing demand for data science skills in non-IT areas.

What is the future growth potential of the data science workforce?

The Australian data science workforce is forecast to see sound growth in the next five years. Aggregating the data science occupations identified above, Deloitte Access Economics projects the relevant workforce will grow from 301,000 persons in 2016-17 to 339,000 persons in 2021-22, an increase of around 38,000 workers at an annual average growth rate of 2.4% (Chart 1).[2]

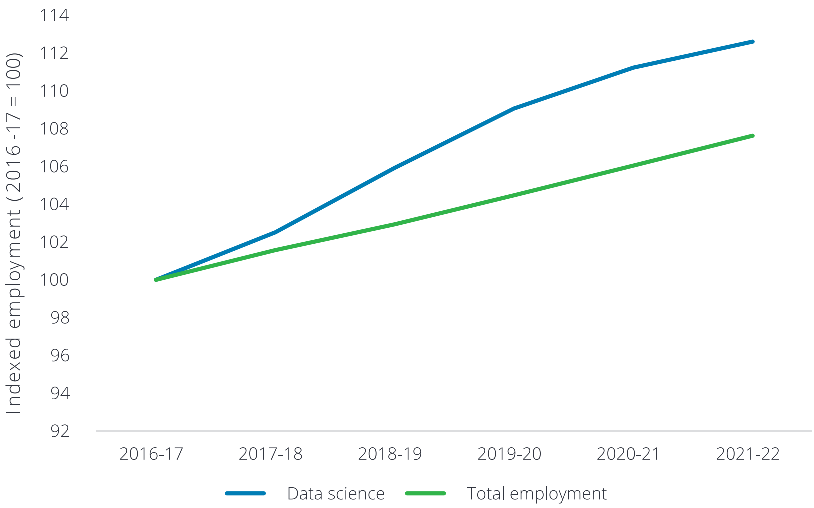
Chart 1: Data science employment forecasts, 2016-17 to 2021-22



Source: Deloitte Access Economics (2017)

The data science workforce is expected to see stronger growth than the Australian labour force as a whole, where employment is forecast to grow at an average of 1.5% per annum over the next five years (Chart 2).

Chart 2: Data science employment and total employment, 2016-17 to 2021-22



Source: Deloitte Access Economics (2017)

2. The data science workforce forecasts for this report have been produced using the Deloitte Access Economics' Macro (DAEM) modelling framework, a macroeconometric model of the Australian economy. For the purposes of this research, employment projections at the 4-digit ANZSCO level have been smoothed using a three-year moving average, in order to provide workforce forecasts that are more reflective of trend jobs growth.

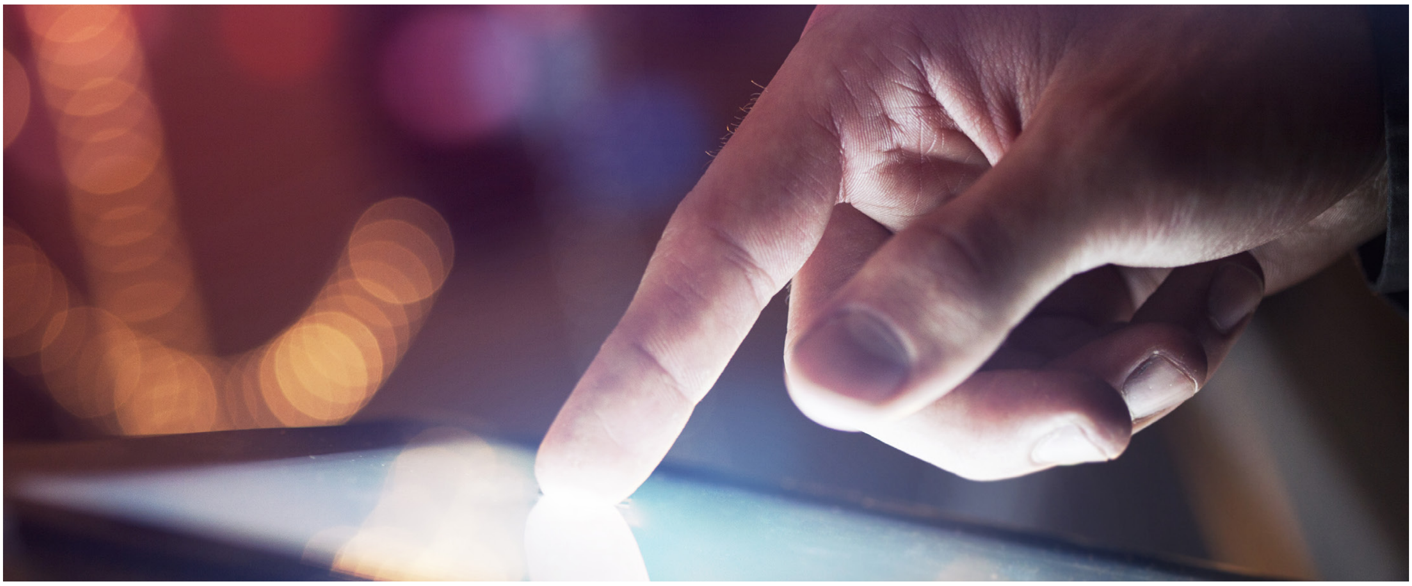


Table 1 provides a breakdown of Deloitte Access Economics' employment forecasts for the data science workforce by the component occupations. Demand for software and applications programmers is expected to grow by almost 18,000 people over the next five years, at an annual growth rate of 3.0%. The forecast growth rate is strongest for the non-IT occupations grouping at 3.2% per annum, with this grouping including roles such as financial dealers in the finance industry, intelligence analysts in public administration and environmental scientists in the agriculture industry (see previous discussion and Appendix for further details). The overall positive outlook for labour market demand in these data science occupations is expected to be supported by the growing digital economy and the increasing applications of data analytics across a diverse range of industries.

Demand for software and applications programmers is expected to grow by almost 18,000 people over the next five years

Table 1: Data science employment forecasts by occupation, 2016-17 to 2021-22

Occupation	2016-17 (000s)	2021-22 (000s)	Change in employment (000s)	Average annual growth rate (%)
ICT Managers	59.6	65.9	6.3	2.0%
Actuaries Mathematicians and Statisticians	7.3	8.0	0.8	2.0%
ICT Business and Systems Analysts	29.0	30.2	1.2	0.8%
Software and Applications Programmers	108.4	125.9	17.5	3.0%
Database and Systems Administrators and ICT Security Specialists	45.0	50.5	5.5	2.3%
Computer Network Professionals	28.9	31.7	2.8	1.9%
Non-IT occupations grouping*	22.7	26.6	3.8	3.2%
Total Data Science	**300.9**	**338.8**	**37.9**	**2.4%**

** Non-IT occupations grouping contains a further 14 occupations for certain industries only, where a portion of these occupations are considered to be relevant for forecasting potential job opportunities in the data science area. A list of these 14 occupations is provided earlier in this report, and a breakdown of the employment forecasts for these non-IT occupations is contained in the Appendix.*

Source: Deloitte Access Economics (2017)

The combination of data science skills and industry-specific knowledge are in high demand from employers across a range of sectors.

How can further study benefit workers in data science occupations?

Increased earning potential

Conventional economic theory suggests that workers who undertake further study are able to realise higher wages in the labour market. From a human capital perspective, education is an important determinant of the overall productivity of labour, which is then reflected in the wages paid to individual workers. The **knowledge and skills derived from education represents an increase in human or intellectual capital, leading to more productive workers who are financially rewarded for their increased efficiency.** Furthermore, signalling theory suggests that further study can be a means for individuals to 'signal' their capability to employers, as more capable individuals may be more successful in completing their education.

Recent Deloitte Access Economics research has estimated the impact of a postgraduate qualification on wages, controlling for other factors which may also contribute to earnings differentials at the individual level (such as demographics and experience). While this study did not specifically examine the wages earned by data science workers, it found that a significant wage premium is attained by workers who have completed postgraduate study in the broader Information Technology field of education.[3] Across all workers who studied Information Technology at the postgraduate level, an undiscounted lifetime wage premium of 51% relative to workers with no post-school qualifications was found to be directly attributable to having completed the postgraduate qualification (Deloitte Access Economics, 2016).

Looking specifically at the occupations previously identified in the data science workforce, data from the latest Census suggests that the average annual income earned by postgraduate-qualified workers who studied Information Technology in these occupations was $111,634 in 2016-17. In raw terms – without accounting for other factors such as demographics and experience – this was 3% higher than the average 2016-17 income of workers employed in data science occupations who have no post-school qualifications. **The average annual income of data science professionals with a postgraduate qualification in Information Technology is forecast to increase over the next five years, rising to $130,176 in 2021-22.**[4]

Broadening career pathways

Further to the increased earning potential, additional study in the data science area can enable workers to develop more specific skills relevant to data analytics techniques, which can assist individuals seeking to move to or progress further in data science roles, as discussed in Box B.

In particular, for workers who are already qualified in their current industry of employment, acquiring data science skills through further study can enable them to perform their existing role more efficiently and/or take on expanded responsibilities. Recent research suggests that the combination of data science skills and industry-specific knowledge are in high demand from employers across a range of sectors, such as in finance and science; however, roles which require this combination of skills are amongst the hardest to fill (Burning Glass Technologies, 2017). With data science capabilities becoming increasingly valued across many industries throughout the economy, **further study in this area can provide new career opportunities and accelerated progression to senior roles.**

3. Information Technology has been identified as the most relevant field of education for data science qualifications. The Information Technology field of education is represented at the 2-digit level in the Australian Standard Classification of Education (ASCED).

4. Future income has been estimated using annual Wage Price Index growth forecasts from the September 2017 *Business Outlook* (Deloitte Access Economics, 2017b).

Box B: Data science qualifications and career applications

Our consultation with Professor Ricardo Campello from JCU suggests that further study in the data science area can enable workers that are currently employed in other occupations, who have an interest in applying data analytics within the context of their role or industry, to build the core skills and knowledge required to be a data science professional. **Learning modules in key areas such as computer programming, statistical analysis, machine learning and information management enable individuals to develop the necessary expertise which can be utilised in a career in data science across a range of sectors and applications.**

Workers who already have previous education and work experience in technical IT competencies can also benefit from further study in the data science area. Businesses are increasingly demanding technical specialists who are also skilled in 'business translation': the ability to understand an organisation's strategy and functions, and ensure that data-driven insights are able to support these broader aspects and be communicated to non-technical audiences (McKinsey Global Institute, 2016). Further study can enable current technical specialists to develop the interpretation and reporting skills required to succeed in such an environment. Ricardo notes that postgraduate qualifications in data science should include course content in data visualisation, decision making and business intelligence in order to build students' knowledge in this area.

Businesses are increasingly demanding technical specialists who are also skilled in 'business translation': the ability to understand an organisation's strategy and functions.

– Professor Ricardo Campello,
James Cook University

What are the key takeaways for current and future data science professionals?

- Growth in Australia's digital economy and the increasing application of data analytics across a diverse range of industries is resulting in an increase in demand for data science skills.
- This is expected to drive future growth in the data science workforce, increasing from 301,000 persons in 2016-17 to 339,000 persons in 2021-22. The average annual growth rate of 2.4% is stronger than the 1.5% per annum growth forecast for the entire Australian labour force.
- Across workers who have completed a postgraduate qualification in Information Technology, a lifetime wage premium of 51% (relative to workers with no post-school qualifications) is directly attributable to their qualification.
- The average annual income of data science workers with a postgraduate qualification in Information Technology was $111,634 in 2016-17, and this is forecast to rise to $130,176 in 2021-22.
- Further study in the data science area can also build core technical competencies for individuals currently employed in other areas (enabling them to pivot towards data-related roles), and enable the development of a greater understanding on the strategic and business applications of data analytics.

References

- Australian Bureau of Statistics. (2006). *Australian and New Zealand Standard Classification of Occupations.*
- Burning Glass Technologies. (2017). *The Quant Crunch: How the demand for data science skills is disrupting the job market.*
- Data61. (2016). *Tomorrow's digitally enabled workforce: Megatrends and scenarios for jobs and employment in Australia over the coming twenty years*.
- Deloitte Access Economics. (2016). *Estimating the public and private benefits of higher education.*
- Deloitte Access Economics. (2017a). *Australia's Digital Pulse: Policy priorities to fuel Australia's digital workforce boom.* Retrieved from https://www.acs.org.au/content/dam/acs/acs-publications/Australia's%20Digital%20Pulse%202017.pdf
- Deloitte Access Economics. (2017b). *Business Outlook* (September 2017).
- McKinsey Global Institute. (2016). *The Age of Analytics: Competing in a Data-Driven World.*
- Meola, A. (2016). *Why IoT, big data & smart farming are the future of agriculture.* Retrieved from Business Insider: http://www.businessinsider.com/internet-of-things-smart-agriculture-2016-10/
- Molloy, F. (2015). *Data scientists the 'rock stars' of business.* Retrieved from The Sydney Morning Herald: http://www.smh.com.au/national/tertiary-education/data-scientists-are-the-rock-stars-of-business-20150819-gj2i0r.html
- Murthy, S. (2016). *LinkedIn Official Blog*. Retrieved from The Top Skills of 2016: https://blog.linkedin.com/2016/01/12/the-25-skills-that-can-get-you-hired-in-2016
- Stein, L. (2017). *Why are fewer people interested in doing IT?* Retrieved from ABC: http://www.abc.net.au/news/2017-02-20/where-is-the-it-crowd/8286396

Appendix

Table A.1: Data science employment forecasts for non-IT occupations, 2016-17 to 2021-22

Occupation	Industry	% data science roles (by industry)	2016-17 (000s)	2021-22 (000s)	Change in employment (000s)	Average annual growth rate (%)
Financial Dealers	Financial and Insurance Services	19	2.9	3.3	0.5	3.1%
Economists	Professional, Scientific and Technical Services	18	0.4	0.4	0.1	3.0%
Intelligence and Policy Analysts	Public Administration and Safety	7	0.1	0.1	0.0	4.4%
Land Economists and Valuers	Rental, Hiring and Real Estate Services	5	0.3	0.3	0.0	1.3%
Advertising and Marketing Professionals	Information Media and Telecommunications	17	0.7	0.8	0.1	3.0%
Cartographers and surveyors	Professional, Scientific and Technical Services	18	1.3	1.6	0.4	5.3%
Urban and Regional Planners	Professional, Scientific and Technical Services	18	0.6	0.7	0.1	2.7%
Agricultural and Forestry Scientists	Agriculture, Forestry and Fishing	6	0.2	0.2	0.0	0.6%
Life Scientists	Professional, Scientific and Technical Services	18	0.5	0.7	0.1	5.1%
Financial Investment Advisers and Managers	Financial and Insurance Services	19	7.4	8.2	1.1	2.7%
Management and Organisation Analysts	Professional, Scientific and Technical Services	18	4.4	5.1	0.8	3.3%
Environmental Scientists	Agriculture, Forestry and Fishing	6	0.0	0.0	0.0	1.8%
Environmental Scientists	Professional, Scientific and Technical Services	18	1.5	1.7	0.3	4.2%
Geologists and Geophysicists	Mining	9	0.5	0.5	0.0	1.4%
Geologists and Geophysicists	Professional, Scientific and Technical Services	18	0.6	0.7	0.1	4.5%
Medical Laboratory Scientists	Health Care and Social Assistance	3	0.4	0.5	0.1	4.4%
Medical Laboratory Scientists	Professional, Scientific and Technical Services	18	1.0	1.1	0.1	2.2%
Total non-IT occupations grouping			**22.7**	**26.6**	**3.8**	**3.2%**

Sources: Deloitte Access Economics (2017), Burning Glass Technologies (2017)

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