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Cognitive automation as part of Deakin University's digital strategy

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Cognitive Automation As Part of Digital Strategy at Deakin

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Introduction

In our research program into cognitive automation (CA), we have been finding numerous organizations wrestling with how to apply CA technology to customer enquiry processes. This is a fundamental business challenge as, whether it is in, for example, banking and finance, hotel chains, insurance, utilities, retail , transport, or the public sector, the number of enquiries continue to grow dramatically and arrive from many sources. Deakin has been in the forefront of actually applying these technologies at scale, in this case to student enquiries, and also producing value to a range of stakeholders.

We call the technologies being utilized here "cognitive automation", defined as "a software tool that analyzes unstructured and structured data using inference-based algorithms to produce probabilistic outcomes."[1] We, like most executives, have been seeking answers to the practical question: ***Will investments in cognitive automation technologies produce business value? And if so, what practices work for realizing value?*** At Deakin we have found some answers of wide business relevance.

Enterprises have begun to adopt cognitive automation technologies. One survey of 235 business executives reported that 38 percent of enterprises were already using cognitive automation (CA) technologies in 2016 and 62 percent will use them by 2018.[2] Our survey of 63 senior executives in 2017 found that 24 percent of respondents were actively considering or trialing CA tools and 15 percent had deployed at least one CA application.[3]

Academic research that informs practice is needed in this area, as the media mostly covers extreme events of grand victories, for example IBM Watson's *Jeopardy!* win in 2011[4], and Google's DeepMind triumph over Lee Se-dol, the reigning human world champion of the game

[1] Inference-based algorithms include both supervised and unsupervised machine learning algorithms where computers are programed to perform tasks competently based on prior examples, not just based on logic rules. (Lacity, M., and Willcocks, L. (2016), "A New Approach to Automating Services," *Sloan Management Review*, Vol. 57, 1, pp. 41-49.)

[2] Press, G. (2016) "Artificial Intelligence Rapidly Adopted By Enterprises, Survey Says", Forbes, https://www.forbes.com/sites/gilpress/2016/07/20/artificial-intelligence-rapidly-adopted-by-enterprises-survey-says/#69c010412dae

[3] Lacity, M., Babin, R., and Willcocks, L. (2017), "Research Center: Service Automation Trends Survey," Pulse Magazine, Issue 28, pp. 40-44.

[4] For indepth coverage of IBM's development of Watson and Jeopardy! win, see the NOVA documentary, "Smartest Machine on Earth," Aired May 2, 2012 on PBS. http://www.pbs.org/wgbh/nova/tech/smartest-machine-on-earth.html.

Go in March of 2016,[5,6] When failures materialize, including with IBM Watson, splashy headlines also follow[7,8,9] Beyond the bounded worlds of games, the media does report on organizational adoptions, but the optimistic reports are often forward-looking and aspirational rather than what has actually occurred.

Thus, the media has been awash in both victories and defeats about cognitive automation's true capabilities, but offers few lessons for how executives can realize business value from CA investments. A few scholars are beginning to produce good insights from their research. Thomas Davenport offered lessons from early IBM Watson adopters which highlighted the amount of work required to get the tool to perform proficiently[10]. He and Julia Kirby developed a useful framework for describing what cognitive technologies can and cannot do. They note that CA technologies are not self-aware, and have no contextual awareness or learning to competently perform digital tasks.[11] Based on interviews with 33 organizations, Jeanne Ross and her colleagues at MIT's Center for Information Systems Research (CISR) also uncovered the amount of effort required for CA proficiency, and argued that most companies should proceed incrementally.[12]

We believe that executives would benefit from detailed, researched case studies of organizational adoptions of CA technologies that actually produced good business value. Deakin University's IBM Watson adoption is one such case study. We first explain Deakin University's vision and the role IBM Watson played within that larger picture. Then we describe the university's entire adoption journey from conception and deployment to future plans. We document the 'triple-win' value the investment yielded for the university, students, and staff. Finally, we offer key lessons on how Deakin achieved that value.

[5] "Artificial intelligence: Google's AlphaGo beats Go master Lee Se-dol" BBC news, March 12, 2017. http://www.bbc.com/news/technology-35785875.

[6] But there are exceptions, as sometimes the media reports actual organizational outcomes that are successful. For example, the US television show, *60 minutes*, reported on The University of North Carolina's Linenberger Comprehensive Cancer Center's adoption of IBM Watson as being successful at extending the capabilities of physicians; physicians would have missed important treatment options in 30 percent of patients according to the US television show. "Artificial intelligence positioned to be a game-changer," 60 minutes special, aired Oct. 9, 2016 http://www.cbsnews.com/news/60-minutes-artificial-intelligence-charlie-rose-robot-sophia/

[7] For example, "MD Anderson Benches IBM Watson In Setback For Artificial Intelligence In Medicine," Forbes, https://www.forbes.com/sites/matthewherper/2017/02/19/md-anderson-benches-ibm-watson-in-setback-for-artificial-intelligence-in-medicine/#3cb66bf93774

[8] In March 2017, the NHS's adoption of DeepMind came under fire when over the amount of patient information being shared and the lack of public consultation. Wakefield, J. (2017), "Google DeepMind's NHS deal under scrutiny," BBC News, http://www.bbc.com/news/technology-39301901

[9] Microsoft's Tay, a Twitter account run solely by cognitive automation software. Tay had to be taken offline in just 16 hours because the software was tweeting or re-tweeting racial slurs, neo-Nazi propaganda, and other dubious messages.Hern, Alex (24 March 2016). "Microsoft scrambles to limit PR damage over abusive AI bot Tay". The Guardian.

[10] Davenport, T., "Lessons from the Cognitive Front Lines: Early Adopters of IBM's Watson," *The Wall Street Journal*, December 3, 2015

[11] Davenport, T. and Kirby, J. (2016) "Just How Smart are Smart Machines?" *Sloan Management Review*, Vol. 57, 3, pp. 20-25.

[12] Ross, J., Beath, C., and Tarafdar, M. (2016), "Five things you should know about cognitive computing," *CISR Research Briefing*, Vol. XVI, 12, pp. 1-4.

Introduction to Deakin University

> *"Deakin University offers a personalized experience, enhanced by innovative digital engagement. We lead by creating opportunities to live and work in a connected, evolving world."* — Deakin University Website[13]

> *"LIVE the Future essentially distills down to this: we don't care where a student is geographically, we care where they are academically and helping each student succeed during his or her entire journey."* — Professor Jane den Hollander AO, Vice Chancellor for Deakin University

Nearly 40 Australian universities compete for national and international students in a country of 24 million people. In this paper, we examine how one public university, Deakin University, competes for students by reimagining higher education through it's "LIVE the Future" Vision. The vision is enabled by aggressive investments in digital technologies that enhance the student experience. Deakin University's adoption of IBM Watson is one such investment.

Despite being located in what might seem to be "distant" Australia from a global perspective (see Sidebar: About Deakin University), the university's innovativeness has brought it international attention, and has grown enrollments to 54,000 students by 2016. With its roots in and reputation for quality distance education, a third of its student body studies exclusively online. Deakin University's administrators think that online enrollments can increase substantially over the next ten years, provided the university delivers an exceptional student experience, significantly enabled by digital services.

SIDEBAR: About Deakin University

Deakin University is a public university in the Australian state of Victoria. Established in 1974, it had over 53,000 students in 2016[14] across its four physical campuses in Melbourne, Geelong, Warrnambool and Burwood.[15] The university calls its "Cloud Campus" its fifth campus. About 1/3 of its students study solely online.[16] Deakin prides itself on its overall student satisfaction score, which was rated the highest among Victorian universities for six consecutive years. Deakin was also rated Victoria's top ranked university for students under 50 years of age for the past two years.[17]

[13] http://www.deakin.edu.au/about-deakin
[14] http://www.deakin.edu.au/about-deakin
[15] https://en.wikipedia.org/wiki/Deakin_University
[16] Deakin University Vice Chancellor Professor Jane den Hollander's speech at IBM World of Watson, https://www.youtube.com/watch?v=BQU7Ko63E5k
[17] Student satisfaction scores are measure by Australian Graduate Survey http://www.deakin.edu.au/

"LIVE the Future"

Professor Jane den Hollander, the Vice-Chancellor, is credited as the architect of the "LIVE the future" vision, a strategy that aims to put Deakin University at the edge of the digital frontier in higher education.[18] The Vice Chancellor, however, also credits Deakin University's entire community for the plan. When she took the position in 2010, she was an outsider to Deakin and engaged stakeholders to develop the new vision. She said, "When I arrived, I knew we needed a new plan because the university was shutting down its distance learning. We assembled all the staff and invited everybody to answer the question: What should we do next?" The university community settled on "L-I-V-E the Future" through **L**earning, **I**deas, **V**alue and **E**xperience. Professor Beverley Oliver, Deputy Vice-Chancellor (Education), further explained, "Underneath those words we have four large plans: student learning experience, research and development, community engagement and internationalization. It's about giving people a brilliant education, where they're at physically, academically, philosophically and where they want to go in life."

Focusing on the student experience part of the vision, the university tries to create effective and personalized digital experiences. Lucy Schulz, the Director of Cloud Campus, explained, "The vision of the student journey program is to bring students to the centre of our thinking—in every area and on every level—so that students are enabled to be successful and feel supported throughout their time at Deakin."[19] William Confalonieri, Chief Digital Officer for Deakin University, explained that technology investments are informed by the student culture, which he describes as "the age of impatience" — students want digital technologies that are always on, always easy to use, and always fast.[20] Five megatrends inform the university's eStrategy: Place, Pace, Face, Space, and Trace, which corresponds to mobility, flexibility, personalization, collaboration, and information. [21] All of Deakin's technology investments, ranging from its learning management system to collaboration tools, are orchestrated under one cloud-based hub called DeakinSync.[22] DeakinSync is the one-stop personalized dashboard that aggregates essential information for every student. When Deakin University decided to invest in IBM Watson, it was within the context of further enhancing the student experience and integrating the tool into the cloud-based hub.

Deakin University's IBM Watson Adoption Journey

[18] https://en.wikipedia.org/wiki/Jane_den_Hollander

[19] Lucy Schulz, "Kicking goals with Watson," presentation at ATEM Student Services Centres conference, May 29, 2015

[20] William Confalonieri, "Creating effective and personalized digital experiences," presentation for the Connect Show, Melbourne, April 22, 2015.

[21] William Confalonieri, "Creating effective and personalized digital experiences," presentation for the Connect Show, Melbourne, April 22, 2015.

[22] William Confalonieri, "Creating effective and personalized digital experiences," presentation for the Connect Show, Melbourne, April 22, 2015.

This cognitive automation journey is based on detailed research by the authors in a one year time frame interviewing senior executives, operational staff, academic staff and students participating in and impacted by the project. Appendix A provides a research note on methods and data collection. As citizens of the world, many of Deakin University's administrators, staff and students were already familiar with IBM Watson from its televised championship on the game show, *Jeopardy!* Over the course of three days in February of 2011, Watson competed against the reigning human champions, Brad Rutter and Ken Jennings.[23] Watson won, earning $1 million dollars. This bellwether event signaled that the age of cognitive automation was upon us. For what other applications might Watson be used?

From 2011 to 2014, IBM Watson had primarily been deployed in healthcare. No university had bought the technology for any other application. In mid-2014, IBM personnel visited Deakin University's Vice Chancellor and Deputy Vice Chancellor to show them Watson. The administrators could immediately see the potential value, but they needed to learn more. They engaged IBM to do a cognitive value assessment. After that exercise, the administrators concluded there was enough potential value to pilot the new technology within a limited domain of responding to common asked questions using Watson's Engagement Advisor application.

Deakin University adopts Watson

In October 2014, Deakin University officially announced that it would adopt Watson. The aim was to provide students with a single source of accurate, current, and relevant information available on any device.[24] (see Appendix B for a simplified explanation of IBM Watson). The university wanted Watson to improve the student experience by tailoring a student's queries to his/her own student profile. The Vice Chancellor summarized the vision as personalizing the student experience by providing advice and information "just in time, just for me, anytime, anywhere, on any device."[25]

William Confalonieri, Chief Digital Officer for Deakin University, noted that the decision to implement Watson was not necessarily in response to a specific need. Rather it was seen as an opportunity which aligned well with Deakin's strategy and its vision in the digital frontier: providing high quality, consistent responses to student enquiries on a 24x7 basis anywhere, and on any device. The reputational effect of being the first University globally to adopt Watson also influenced the decision.

[23] NOVA documentary, "Smartest Machine on Earth," Aired May 2, 2012 on PBS. http://www.pbs.org/wgbh/nova/tech/smartest-machine-on-earth.html

[24] Adhikari, S., "ANZ, Deakin University set to harness Watson," Oct 8, 2014 *The Australian,* http://www.theaustralian.com.au/business/latest/anz-deakin-university-set-to-harness-watson/news-story/3b35da14a4571bb30406afab0cdf7a45

[25] Deakin University Vice Chancellor Professor Jane den Hollander's speech at IBM World of Watson, https://www.youtube.com/watch?v=BQU7Ko63E5k

IBM was the technical lead and Deakin University was the business lead. The university's IT department was also involved in various technical activities such as linking Watson to Deakin's website. At that time in 2014, there were very few Watson experts in Australia, so IBM sent a team from the United States to launch the development.

Project Development

By December 2014, Deakin University and IBM had agreed to a plan with three releases targeted for February, June, and September of 2015. The first release would provide answers to commonly asked questions by incoming students, with access provided through its cloud-based hub, DeakinSync. The second release would expand Watson's range of question categories, with the aspiration to make Watson a comprehensive destination for student queries. The third release aimed to personalize and contextualize the answers. The first release was divided into three stages:

Release 1, stage 1: Collect Questions. The first stage required collecting students' questions. The Deakin University team gathered nearly 20,000 questions from staff and administrators in charge of recruiting, scheduling, counseling, advising, and orientation. The IBM team helped to categorize the questions by student "intent", as many questions were essentially seeking the same information, even though they were worded quite differently. From the initial collection of questions, 2,000 questions were selected for its first release.

Release 1, stage 2: Find correct answers. The second stage of the first release required getting the correct answers to each of the 2,000 questions. The content could come from many sources: verbal answers from experts, written responses contained in emails and documents, or multi-media content posted on webpages. As many first time CA adopters often discover, sources were not always up to date or accurate. The university had to assign a single content owner responsible for each subject area and have them provide the correct answers. For Watson's first public release, all the answers were composed by staff to ensure accuracy and appropriateness with the help of 100 content owners from across campus.

Release 1, stage 3: Ready content for Watson ingestion. Once the correct answers were identified, the third stage entailed "content uplift", where answers were appropriately worded and structured for Watson ingestion. Watson was ready to be tested.

The university asked students to volunteer during their break to test and further train Watson. Over 200 students volunteered. Students indicated if Watson's answers were correct, incomplete, or inaccurate. Their feedback was incorporated into the application to improve Watson's performance.

Release 1 Launch

Deakin University took only four months to get Watson ready for launch in time for student orientation week. During orientation week, the Watson team focused on creating awareness of Watson with new students. They erected a booth at orientation and showed students what Watson was and how to use it. According to one student who worked at the booth, "We were inundated by student interest." [26] The Watson developers explained that Watson was still learning and that the university needed each student's help to further train Watson. The university launched a marketing campaign with the slogan, "I'm helping train Watson" to engage students and staff..

Students and staff were told, "the more you use Watson, the better it will get at helping you".[27] This campaign served to temper users' expectations of Watson's initial performance. Besides the booth at orientation, students were made aware of Watson on Deakin's website, and on the current student webpage portal (see Figure 1). Students access Watson through DeakinSync by signing on with their logon ID and password. Although Watson is designed primarily for students, Deakin staff members were encouraged to use it for their own enquiries. Additionally, about 100 staff members became content owners, responsible for Watson's content going forward.

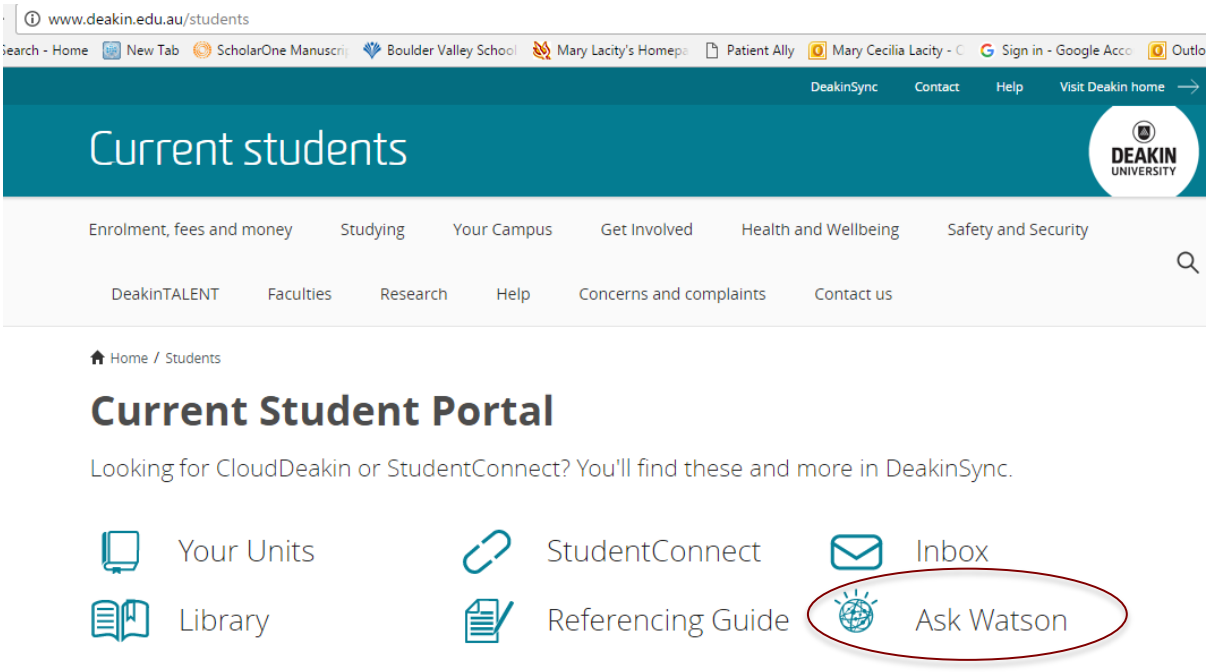


Figure 1: Student access to Watson through DeakinSync
Source: http://www.deakin.edu.au/students

Watson's Initial Performance

[26] "Watson @ Deakin University" video posted March 18, 2015; https://www.youtube.com/watch?v=MK9gakgPDoc
[27] "Watson @ Deakin University" video posted March 18, 2015; https://www.youtube.com/watch?v=MK9gakgPDoc

Watson answered over 55,000 questions during the first twelve months. The university anticipated that students would most frequently ask questions about educational processes, such as how to enroll in classes. In reality, students most frequently asked Watson for information about finding dates, finding food, and the location of course materials—in that order.[28] Common questions, however, do change over the course of a semester. For example, questions about finding classrooms are more frequently asked at the beginning of the semester; questions about exams are more frequently asked later in the semester.

Deakin University tracked Watson's response accuracy very closely, counting the number of direct questions Watson answered correctly or incorrectly, the options Watson generated appropriately or inappropriately, and the number of queries Watson indicated it did not know how to answer (see Figure 2). ***Watson performed quite well, correctly answering direct questions or offering appropriate options about 80 percent of the time.***

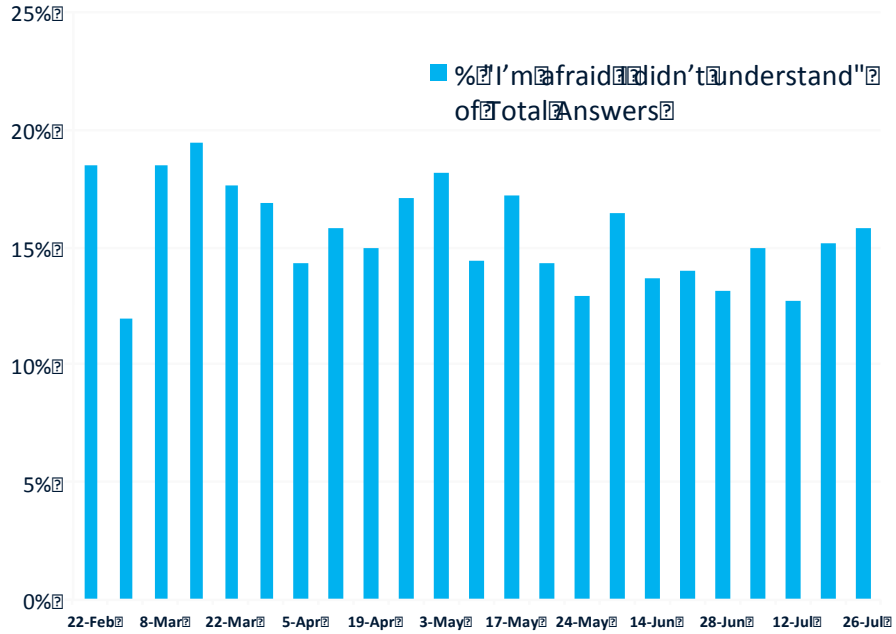


Figure 2: Percentage of questions Watson did not initially understand
Source: Deakin University presentation, March 2015

In addition to monitoring Watson's logs of actual conversations to assess performance, Deakin's Watson team members also looked at students' ratings of Watson's performance. After each conversation, Watson prompts the student to rate the quality of Watson's responses (see Figure 3). Based on a sample of 1,130 feedback ratings, students gave Watson "good to excellent" ratings for 63 percent of the queries. This feedback was used to improve performance over time.

[28] Adhikari, S., "ANZ, Deakin University set to harness Watson," Oct 8, 2014 *The Australian,* http://www.theaustralian.com.au/business/latest/anz-deakin-university-set-to-harness-watson/news-story/3b35da14a4571bb30406afab0cdf7a45

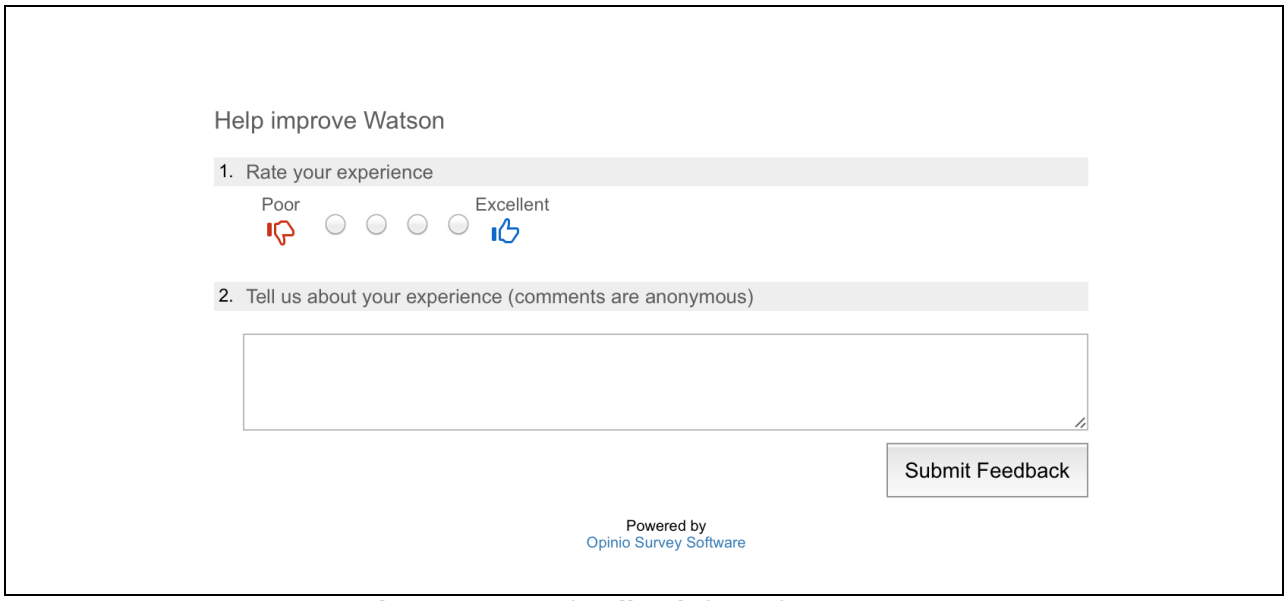


Figure 3: User feedback form for Watson

Releases 2 and 3: Expanded Capabilities

Deakin University continued to expand Watson's capabilities through its second and third releases. By November 2015, Watson was connected to Deakin's website and online handbook to find more answers, was further programmed to personalize information based on campus and student type (domestic vs. international), and started to share its confidence ratings for its answers with students.[29] As of late 2017, Watson could guide students through common processes like submitting assignments, paying for parking, and re-enrolling in study.[30] Watson has been trained to answer 6,000 questions (see Appendix C for sample conversations with Watson). Having concluded the IBM Watson adoption journey up to 2017, we next discuss the value generated from the investment. In addition, we outline subsequent developments, such as Deakin Genie, that emanated from the learning gained during the Watson project.

Case Discussion: Towards the "Triple-win"

Deakin's adoption of cognitive automation delivered value to three major stakeholders: The University as an institution, students, and staff (see Figure 4). Deakin University is not alone in achieving such results. Across our cognitive automation cases, we have called the realization of multiple sources of value the "triple-win" of service automation.[31]

[29] IBM Watson helps Deakin drive digital frontier, press release November 25, 2015, http://deakinprime.com/news-and-publications/news/ibm-watson-helps-deakin-drive-the-digital-frontier

[30] http://www.deakin.edu.au/life-at-deakin/why-study-at-deakin/ibm-watson

[31] See for Example: Lacity, M., Willcocks, L. and Craig, A. (2017), "Service Automation: Cognitive Virtual Agents at SEB Bank," " The LSE Outsourcing Unit Working Research Paper Series.

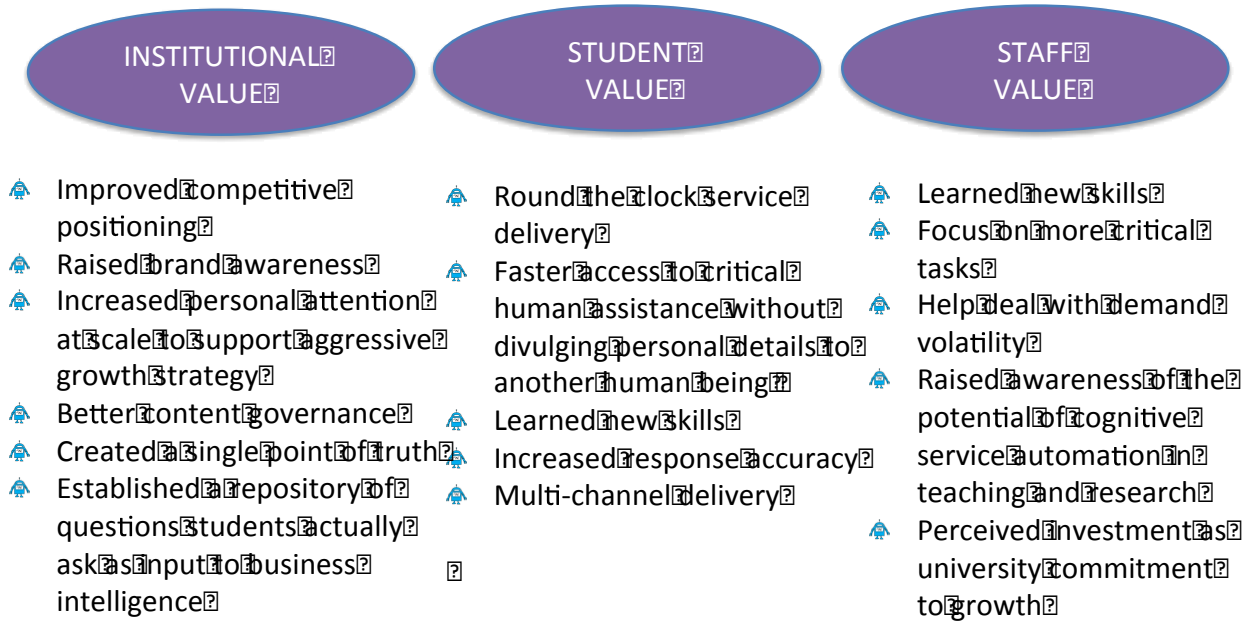


Figure 4: Benefits from automation at Deakin

We note also that, as a fourth stakeholder, IBM's Watson team received value in terms of learning about developing and implementing their tools in specific contexts as was the case here with tertiary education.

Institutional value

> *"What were the outcomes? One main value was reputation and profile building for the university. It was worth the investment."* — Professor Beverley Oliver, Deputy Vice-Chancellor (Education) for Deakin University

Deakin University was the first university adopter of IBM's Watson for student services, which gave the university worldwide media attention.. Its Watson application won prestigious awards. For example, Deakin University earned 1st place for the global "Wharton-QS Re-imagining Education Stars" award within the ICT Support and Services category in 2015.[32] Requests for interviews, site visits, and speaking engagements came pouring in from across the globe. For instance, Deakin's Vice-Chancellor spoke at the 2015 IBM World of Watson as a keynote speaker.[33] The media attention, awards, and public events delivered institutional value in terms of **improved competitive positioning** and **raising brand awareness.** Media attention was not just Australian, but regional across Asia Pacific, and also global, in business magazines, national newspapers, and multiple types of online outlets.

[32] "Deakin University Vice Chancellor at IBM World of Watson," http://application.reimagine-education.com/the-winners/2015

[33] https://www.youtube.com/watch?v=BQU7Ko63E5k

Deakin University also gained value from its Watson investment in terms of progressing towards its goal of **"personal attention at scale"**. University administrators aspire to double or even triple enrollments over the next decade, but scalability cannot cannibalize its rich student journeys. The administrators see Watson as enhancing the student experience while at the same time improving scalability.

Deakin University reported an unexpected source of value from its Watson investment: **better content governance**. In the process of curating content for Watson, Deakin University discovered that many of its data sources reported outdated or inaccurate content. So for example, many sources reported conflicting library operating hours. The university remedied this by identifying content owners responsible for "**a single point of the truth**". Now, the content owners post the correct data on their own webpages and any other departments that want to include that content within their own domain webpages must point to the original source rather than copy and paste content. So for example, the library is the sole content owner for library hours and other sources should point to the library's webpage rather than copy the content. Professor Jane den Hollander, Vice Chancellor for Deakin University, explained the value of a single point of truth, "You go to Deakin, you ask a question, and it's always answered." Deakin also experienced another benefit from establishing a repository of questions students actually asked: **better business intelligence**.

To present a balanced view on institutional value, we also report that Deakin University's investment did not produce measurable operational efficiencies or returns-on-investment (ROI) in the short-term. Indeed, Gartner reported on Deakin University's ROI in 2016: "The university does not yet have hard return on investment (ROI) metrics for the Watson deployment. Attributing ROI budget benefits in terms of reputation and student satisfaction will likely remain hard to quantify. Part of the reason for this is the difficulty of attributing benefits to individual IT systems such as Watson."[34] This lack of measurable ROI was a common finding across our other CA adopters. In the lessons learned section, we answer the question: How does an organization calculate a return on investment when no staff is laid off as a consequence of automation?

Student Value

Our respondents reported that IBM Watson yielded multiple sources of student value, including round the clock service delivery, faster access to critical human assistance, enhanced skills, increased response accuracy, and multi-channel delivery.

Deakin University aimed to use cognitive automation to provide **round the clock service availability and delivery**. Prior to Watson, students were contacting the university's offices at

[34] Ingelbrecht, N., and Lowendahl, J. (2016), "Deakin University Uses Smart Machines to Innovate Student Engagement," Gartner Report G00300625.

any time of the day or night and on weekends to ask questions, but most offices closed at 4:00pm local time and only operated on weekdays. Students were forced to leave voice messages or send emails when the offices were closed. If a student left a message after hours on a Friday, it could take three days for the student to receive a response. Professor Jane den Hollander, the Vice Chancellor, explained, "Our counselors would come in the morning and immediately start dealing with 73 voicemail messages." As Deakin University increasingly expanded its online programs to students around the globe, 24-hour service availability became critical. The Vice Chancellor continued, "As our students started to come from everywhere, we knew our big vulnerability at the digital frontier was that we couldn't service them at 24/7. Watson is always up and running, making services available to students at anytime."

Watson also provides **fast access to critical <u>human</u> assistance.** Student depression is a concern on every university campus. Deakin University has professional counseling services available for any student. Its website states, "If there's something bothering you, however big or small, help is at hand. Our counselors are registered psychologists and social workers. They have extensive experience working with students with mental health issues, ranging from adjustment stress to common mental illnesses like anxiety and depression. The service is free and confidential."[35] Students don't always have the courage to contact the counseling office directly, but some students have confided their despair to Watson. Watson is programmed to point students to critical human assistance and it proactively alerts the counseling staff that a student needs help. Professor Jane den Hollander, the Vice Chancellor, explained, "We've stopped more than a couple of people from spiraling down into depression through urgent intervention. Students know that when we are concerned for them, we have someone confidentially contact them."

Hundreds of students were involved in the training and testing of Watson to ensure Watson understood the student voice. Professor Jane den Hollander, Vice Chancellor for Deakin University, explained, *"I wanted students involved because I thought who's going to be clever with this technology? - it will be the students.* So we got the students engaged and they thought the technology was cool. They loved the idea of training a machine. They understood quickly that the more they interacted with the machine, the better the machine performed. There were some very smart students who led all that." Student engagement proved very valuable, not only in enabling the first release to be delivered on time, but it gave students the opportunity **to learn new skills** while developing a new leading-edge digital technology.[36]

The students recruited for Watson's content curation, testing, and training learned valuable new skills about the technology. Additionally, their involvement also helped to hone more general skills; Deakin University has eight specific learning outcomes for all students, regardless of major. There are: (1) digital literacy, (2) communication skills, (3) critical thinking, (4) problem solving, (5) discipline-specific knowledge, (6) self-management, (7) teamwork and (8) global

[35] http://www.deakin.edu.au/life-at-deakin/support-services/counselling
[36] "Watson@Deakin" Reimagine education award announcement, http://application.reimagine-education.com/the-winners individual/2015/72/6e06cbde6c4067bc9b8edc6d624c222f/Deakin+University

citizenship. The university believes these skills are highly valued by employers and prepare students to be work-ready. The students involved in the Watson project had to work on a team to quickly solve problems to meet a tough deadline of just four months! They also had to help disseminate knowledge to the entire student body.

Students also gained value from the university's better content governance and single point of truth: they now get **more accurate responses** to their questions. Prior to Watson, phone contact and email inquiries were the main channels for students' questions. Watson opened **another channel for service delivery**.

Staff Value

> Watson objective: *"Free up time for student service staff to enable them to respond and attend to more critical and complex issues."*[37]

Given that automation technologies can threaten human jobs, one might naturally assume that the staff would feel threatened by the technology. Deakin University initially faced a small amount of apprehension that was quickly overcome when the university told them the purpose of Watson was to help them, not eliminate them. Professor Beverley Oliver, Deputy Vice-Chancellor (Education), explained, "We told the narrative very carefully when we introduced Watson because we didn't want people to worry: Am I going to lose my job?" The university was very careful about messaging the intent and purpose of Watson as an alternative channel and not as staff replacement.

Some value to staff members was evident. The staff members who serve as content owners **learned new skills** in curating content for Watson ingestion and ongoing upkeep. Watson also **freed up staff for higher-value student support**, which was a main objective from the start. Watson also helped to **deal with demand volatility**, as students' service needs are not uniform over a semester. As of 2017, Watson answered about 3,000 queries per week—questions the staff did not have to answer. We note, however, that as enrollments increased, all channels were experiencing increased volumes, so while the staff was answering fewer common questions, they were no less busy. William Confalonieri, Chief Digital Officer for Deakin University, observed that Watson provided a highly convenient channel to interact with the university, accounting for an increase in the query volume.

The Watson project also made staff aware of the **potential of cognitive automation in teaching and research** in addition to student services. And certainly, the staff perceived the investment as evidence of the **university's commitments to growth and quality**.

How did Deakin University deliver value to the institution, students, and staff? The university enacted a number of practices that serve as lessons for other organizations.

[37] Watson@Deakin" Reimagine education award announcement, http://application.reimagine-education.com/the-winners individual/2015/72/6e06cbde6c4067bc9b8edc6d624c222f/Deakin+University

Lessons Learned

As an early adopter of cognitive technologies, Deakin University's case study offers a number of insights for other organizations considering similar technologies. Given the university's ambitions to reimagine higher education and its subsequent adoption of the most formidable of all cognitive tools—IBM Watson—the learning points may not apply to organizations seeking more modest aims. Where possible, we supplement Deakin University's lessons with lessons from our other case studies.

General Management Lessons

Before we move to distinctive lessons for CA deployment, it is important to point out that Deakin also had to carry out certain management action principles central to the delivery of any large scale technology deployment. In Deakin's case these were:

Strategy drives technology investment*s.*. Deakin University does not have a "Watson" strategy; rather it has an international growth strategy focused on enhancing the student journey through its "LIVE the Future" vision. Watson just happened to be one among many investments that enable the strategy. In our other CA research, "digital transformation" was a common C-suite strategy. Digital strategies aimed to ease customer journeys from initial prospecting through to account set up, ordering, delivering, receiving, maintaining, and paying for products and services seamlessly—a digital assembly line if you will. In contrast, several of our less successful cases became enthralled with automation technologies and bought software licenses or started building bespoke systems before envisioning its strategic value. One manager said, "My boss is walking around the organization with an automation-shaped hammer." Organizations miss value by not understanding the triple-win, by putting shiny objects before strategy, by thinking too small and short-term, by delegating too low in the organization, by funding too little, or by viewing automation only as an opportunity to cut costs.

Manage expectations up and down. Deakin University, like all institutions, needs to justify investments in cognitive technologies and to set realistic expectations as to when concrete returns will materialize. As the IBM Watson decision occurred at the upper-most level of the university, there was less pressure to commit to a hard ROI. However, other organizations will need to aggressively manage expectations to senior executives. Across our case studies on cognitive automation adoptions, ***a common finding was that measurable returns on investment (ROIs) occurred only in the long run***, as it did with Deakin University.

How does an organization calculate a return on investment when no staff is laid off as a consequence of automation? Deakin University was experimenting with financial measures, such as the cost per query. In our other research, "hours given back to the business" was an emerging value metric. These calculations are based on estimating the number of hours it

would have taken if humans were still performing the tasks. In Deakin's case, that measure might be calculated by estimating how many hours it would take for humans to answer the 3,000 questions Watson now answers per week.

Concerning the students, Deakin University set realistic expectations for Watson's performance. This prevented students from complaining too much about the 20 percent of queries Watson did not answer initially. Across our research, best practice organizations were transparent with customers about the fact that customers were interfacing with a piece of software. Like Deakin, they said the tool was still learning, and quickly diverted customers to a human when conversations became unproductive.

Manage expectations across, and out. As with any automation technology, employees may feel threatened by cognitive automation. From our prior research[38], organizations are advised to envision, communicate, and deliver the following potential value to employees: they will perform fewer repetitive and boring tasks, focus more on customer service, problem solving, and complex tasks, will learn new skills, and will be recognized as an innovators.

Concerning Deakin University's staff, Chris Williver, Technical Project Manager for Deakin University, explained, "we distilled the message that Watson was never going to be perfect or even great from day one." The university's staff members came to understood that they were not going to be replaced; they were going to be an integral part of Watson's success in terms of content curation, management and training.

At the same time Deakin had to 'manage out' against competitors' reactions. Professor Beverley Oliver, Deputy Vice-Chancellor (Education), said "We were careful about the narrative. I did not want our competitors to twist what we doing and launch their own campaign, 'come study here and talk to a real person because Deakin only lets you speak to a robot.'"

Expect technical challenges as a first-mover. As noted above, Deakin University gained considerable gravitas from being the first university to adopt Watson for student services. The university gained a first-mover competitive advantage in terms of heightened brand awareness globally, but it also brought the challenges of dealing with a young tool. IBM designed Watson to win the US game show *Jeopardy!* and thus did not initially design the architecture nor its interfaces for commercial usage. This meant that Deakin University's IT staff was working with some rudimentary tools with unfriendly scripts and configuration files. Also, Watson was initially designed to load data; it was not designed for on-going curation. This meant that IBM was simultaneously improving the tool while developing the student query application. Such parallel developments are quite common experiences for first-mover adopters. IBM Watson staff was also relatively unfamiliar with applying IBM Watson tools to the university education sector (unlike in, for example, the health sector). This meant that Deakin's in-house IT teams and project managers had to take on quite a lot more work than first envisaged. The good news for

[38] Lacity, M. and Willcocks, L. (2017), *Robotic Process Automation and Risk Mitigation: The Definitive Guide*, SB Publishing, UK.

later Watson adopters is that Deakin University helped to pave the way for improvements from which other organizations will benefit.

Continually innovate because today's "cool" is tomorrow's "yawn". William Confalonieri, Chief Digital Officer for Deakin University, described student expectations as "expecting a digital world to be highly fast and functional, beautiful and usable, optimized for mobile, and consistent and seamless."[39] Students were initially very excited by the Watson application, but as time went on, their technology expectations rose. One interviewee said, "When we started, students were amazed it could answer a question. Within a year, they ceased to be impressed and some stopped using it because it lacks speech to text capabilities." (Indeed, Google reported in 2016 that 20 percent of mobile queries were voice searches.[40]) Student expectations are massive; students want their universities to at least match the technical capabilities of their own personal devices.

To meet students' high expectations, Deakin University has to continually innovate. It's most recent application is called Genie[41]. It's a platform made up of chatbots, artificial intelligence (e.g., Watson), voice recognition, and predictive analytics,[42] presented to users as a proactive, virtual personal assistant launched on their mobile devices. The platform went live in March 2017 as a pilot for some business and law students. Deakin University will incorporate feedback from the pilot to improve Genie before a broader launch scheduled for Fall 2017. The organizational learning gained through Deakin's Watson experience, has contributed to the organization's ability to develop service innovations such as Genie.

Distinctive Cognitive Automation Practices

Lesson 1 - . Don't under-estimate the data challenge

The reality is cognitive automation tools can take months or even years of intensive human training before the technology becomes proficient. The issue is not the technology per se, but rather the quality, quantity, availability and structure of the data needed to establish a reliable "ground truth". Deakin University, like all organizational adopters of CA tools, had to deal with ***difficult data***, which we define as data that is hard for a machine to read (like a fuzzy PDF image), unexpected data types, or poorly worded natural language text. ***Dark data*** is also a challenge, in that much of an organization's data may be un-locatable, untapped, or untagged. Finally, organizations have to clean up ***dirty data*** that is missing, incorrect, inconsistent or

[39] William Confalonieri, "Creating effective and personalized digital experiences," presentation for the Connect Show, Melbourne, April 22, 2015.

[40] Sterling, G., "Voice search growing as virtual assistant market heats up," posted May 18, 2016 on: http://searchengineland.com/google-reveals-20-percent-queries-voice-queries-249917

[41] For an overview, see https://www.youtube.com/watch?v=zsRPuU53E74.

[42] Coyne, A., "Meet Genie, Deakin Uni's virtual assistant for students," posted March 3, 2017 on https://www.itnews.com.au/news/meet-genie-deakin-unis-virtual-assistant-for-students-453230

outdated. As noted above, Deakin spent a lot of time and received significant value from improving content governance and creating single points of truth.

Lesson 2 - Treat cognitive technologies as lifelong learners

Organizations are also advised to think differently about when cognitive technologies projects are "finished". Like human learners, cognitive technologies are never "finished" because they can continually improve performance over time as more data is entered and as more users provide feedback. Additionally, cognitive applications need to be updated when the domain content changes. Based on early CA adopters, one can infer the lesson to treat cognitive technologies as lifelong learners.

Deakin University actually made Watson's incompletion a selling point for its users by recruiting students to help train Watson. It launched Watson with only 2000 question-answer pairs. During orientation week in 2016, the university explained that Watson was still learning and that the university needed each student's assistance to further train Watson. Students were given buttons with the slogan "I'm helping train Watson" to engage students and staff.[43] As of 2017, Watson can respond to 6,000 different questions and personalize responses based on student profile.

Lesson 3 - Supervise all new learning

> *"One of the weaknesses is we can't train it fast enough to keep up with humans. So AI's great but it's not as clever as a human."* — Professor Jane den Hollander, Vice Chancellor for Deakin University

Initially, all of Watson's learning is highly supervised until a "ground truth" is established. After Watson's "ground truth" has been established, the technology has some self-learning features designed to alter its own responses without human intervention. Other CA tools also have unsupervised learning capabilities. Organizational adopters need to consider whether it is wise to enable such features. One only has to remember the unintended consequences of unleashing Microsoft's TayTweets to understand the issue: Microsoft created a Twitter account called Tay and tasked the algorithm with learning to communicate with US millennials without any human supervision. Tay functioned as designed, but it had to be taken offline in just 16 hours because the software was tweeting or re-tweeting racial slurs, neo-Nazi propaganda, and other dubious messages.[44]

For Deakin University's application, Watson's "ground truth" was based on the newly written answers by staff to the first 2,000 questions. Deakin University decided humans would supervise all of Watson's learning in the future as well. The university did not want Watson to assimilate unverified facts or to adjust its affinity weights based on conversations and response feedback with students or staff. One interviewee explained, "We didn't want Watson to serve up popular answers rather than accurate answers." Deakin University

[43] "Watson @ Deakin University" video posted March 18, 2015; https://www.youtube.com/watch?v=MK9gakgPDoc

[44] Hern, Alex (24 March 2016). "Microsoft scrambles to limit PR damage over abusive AI bot Tay". The Guardian.

reviews the logs of Watson's conversations to ascertain whether Watson needs retraining. Retraining could be as simple as adding a question variation or rewording a response to more complicated revisions such as reorganizing the intent clusters.

Lesson 4 - Keep subject matter experts continually engaged in curation

At Deakin University, the subject matter experts (SMEs) across campus are responsible for Watson's content. Traditionally, the SMEs were responsible for managing web-based content, which has its own particular structure and editorial style. For Watson, SMEs needed to write content in a form that a virtual system would provide, rather than what students would read on a web page. Thus, the SMEs had to be educated on how to write and structure content for Watson ingestion, which most did so enthusiastically.

After the exhilaration of Watson's launch, time marched on, and some SMEs were forgetting to inform the Watson support team when content needed to be changed. Chris Williver, Technical Project Manager for Deakin University continued, "Some people starting to take their eye off the ball a little bit, forgetting that what they wrote 12 months ago needed updating. People naturally go back to their old ways of doing things. Ongoing engagement with the community is important." Chris predicted that over the next 3-5 years, the vast majority of student interactions with Deakin's online content will be via bots and virtual agents like Watson rather than reading web pages.

Lesson 5 - Negotiate the optimal level of client-provider transparency

Another common issue in joint application developments is the level of appropriate transparency. Naturally, clients want full transparency into the provider's tool and processes, but providers need to protect their intellectual property. Providers want full access to client's proprietary data. Initially, many clients and providers get frustrated, as evidenced by many of our prior case studies.[45] Eventually, clients and providers negotiate an appropriate level of transparency in high-performing relationships.

This typical scenario was also evident at Deakin University. Initially, members of the IT staff at the university wanted the provider to be fully transparent. One interviewee said, "*The challenge for us during the project was trying to get an understanding of what was going on inside the black box. We were not invited to technical meetings with the people who understood the machine learning algorithms…we kept asking them to let us in the tent."* In the end, the parties negotiated the appropriate level of transparency on a "need to know" basis. Deakin University learned enough about Watson's functional components and architecture to optimize Watson's performance and to provide ongoing support. The university understood that IBM needed to

[45] We have many cases that cover the issue of transparency in client-provider relationships reported in: Lacity, M., and Willcocks, L., (2015), *Nine Keys to World-class Business Process Outsourcing*, Bloomsbury Publishing, London. For survey results pertaining to transparency, see: Lacity, M., and Rottman, J. (2011), "Building a Better Outsourcing Community," *Globalization Today*, March, pp. 29-31.

protect its intellectual property on machine learning algorithms and how the technology classifies natural language. IBM also gained valuable insights from a high level of transparency into Deakin's environment—certainly Deakin University informed some of Watson's product development directions.

Lesson 6 - Put in place a strong cognitive automation in-house team

It is critical to have dedicated team members in place at both operational and executive levels to ensure continuity throughout the different stages of a project of this magnitude. Having such team roles in place also reduces the risk of project delays, reinvention and scope creep.

Certainly, this was key to Deakin University's success. It had a team in place that supported all the stages of an organization's cognitive service automation journey from start to end. The team incorporated (i) subject matter experts in the areas of student support and associated university policies, (ii) facilitators who could interact with students to develop the initial set of questions at the onset and augment these questions throughout the project duration, (iii) in-house technical experts, with knowledge about the different Deakin systems as sources of information to address student questions, (iv) a dedicated Watson Project manager who could orchestrate the overall journey from start to end internally, and work closely with IBM as external technology partner, and, (v) custodians at executive level who supported the project execution, resourcing and overall direction, including its future innovation potential.

What's next for cognitive at Deakin?

> *"In five or ten years time, we'll be at 100,000 students and 50,000 of them will be global and access us digitally on any device"* — Professor Jane den Hollander, Vice Chancellor for Deakin University

Deakin has been sensitive to automation being just one cog in its overall digital journey towards dealing with student 'customers' at ever increasing scale over the next five years. The parallels with, and lessons for businesses in a similar position are very clear. Deakin provides much food for thought on future direction for every senior executive wrestling with the customer experience and digital journey challenges.

For Deakin, Chief Digital Officer, William Confalonieri, explained the next phase vision for cognitive technology usage: "The future of education is personalized, but to do that at scale will only be possible with technology…I'm not suggesting that the human element will be replaced, but the balance will change. I see a completely different education. We are taking the opportunity to define what is possible with this technology." [46] Deakin University was also

[46] Adhikari, S., "ANZ, Deakin University set to harness Watson," Oct 8, 2014 *The Australian,* http://www.theaustralian.com.au/business/latest/anz-deakin-university-set-to-harness-watson/news-story/3b35da14a4571bb30406afab0cdf7a45

considering the possibility of using Watson as a teaching assistant, much like Georgia Tech has done.[47],[48] We mentioned 'Genie' above. William Confalonieri described its potential uses: "Genie is a proactive agent. So if you have an exam in two days and you haven't been reading the material, Genie is going to remind you that the exam is coming up and you haven't touched your material." In order to deduce that situation, the application accesses the learning management system to determine the last time the student opened course materials. William Confalonieri offered another example: "If you have been studying in the same place for ten hours, it's going to tell you that's not good for your health, you should go walk for a bit."[49] In order to deduce that situation, the student would need to grant the application permission to track his or her location.

Professor Beverley Oliver, Deputy Vice-Chancellor (Education) for Deakin University offered another potential Watson application: "If MOOCs[50] can deliver course content to scale, perhaps cognitive virtual agents like Watson could engage students and perform student assessment to scale." Deakin University will continue to reimagine higher education.

Conclusion

There is much hype and fear about the capabilities of cognitive automation. IBM Watson has also received mixed press and assessments in the global media[51]. At the same time we are finding amongst businesses across every sector enormous interest in how to best deploy these such kind of technologies to address business imperatives. But by end of 2017, most organizations were still at Proof-of-Concept or very early deployment of CA tools. This makes independent, empirical case studies like the present one highly useful for capturing, demonstrating and assessing the actual value of cognitive technologies.

Our evidence is that developing and deploying cognitive automation tools like IBM Watson is very challenging indeed. Deakin had several things working in its favor, other organisations

[47] Trounson, A. (2015), "Answers are elementary to Deakin's Watson Computer," The Australian, November 25, 2015; http://www.theaustralian.com.au/higher-education/answers-are-elementary-to-deakins-watson-computer/news-story/9fc95931f3576f2f2a01d8f376ec69c4

[48] "A teaching assistant named Jill Watson", Professor Ashok Goel's Tedtalk at https://www.youtube.com/watch?v=WbCguICyfTA

[49] Ibid.

[50] MOOC in an acronym for Massive Open Online Courses

[51] See for example: A Reality Check for IBM's AI Ambitions (https://www.technologyreview.com/s/607965/a reality- check-for-ibms-ai-ambitions/); IBM pitched its Watson supercomputer as a revolution in cancer care. It's nowhere close (https://www.statnews.com/2017/09/05/watson-ibm-cancer/); MD Anderson Benches IBM Watson In Setback For Artificial Intelligence In Medicine (https://www.forbes.com/sites/matthewherper/2017/02/19/md-anderson-benches-ibmwatson-in-setback-for-artificial-intelligence-in-medicine/#47a30dcb3774).

need to consider. While "moonshots" are risky, Deakin selected a highly targeted deployment. Secondly it was not nearly as expensive as other deployments would be because of favourable pricing in this case. Thirdly, Deakin was willing, with its students, to put a lot of effort in getting the input data into the right shape, and fourthly, built a good retained capability to manage the overall project, to augment IBM's technical skill.

One of the strengths of Deakin's experiences here is that, while some of its lessons apply to the deployment of any innovation, several learnings are unique to CA tools. One of these is treating cognitive technologies as lifelong learners. Another is supervising all new machine learning. A further lesson is keeping subject matter experts continually engaged in curation. We also think the lesson about negotiating the optimal level of client-provider transparency is vital, as organizational adopters will want to know why their CA tools produced the answers they did, but tool providers will want to protect their intellectual property. As this is still early days for CA, more scholarly research that informs practice is desperately needed.

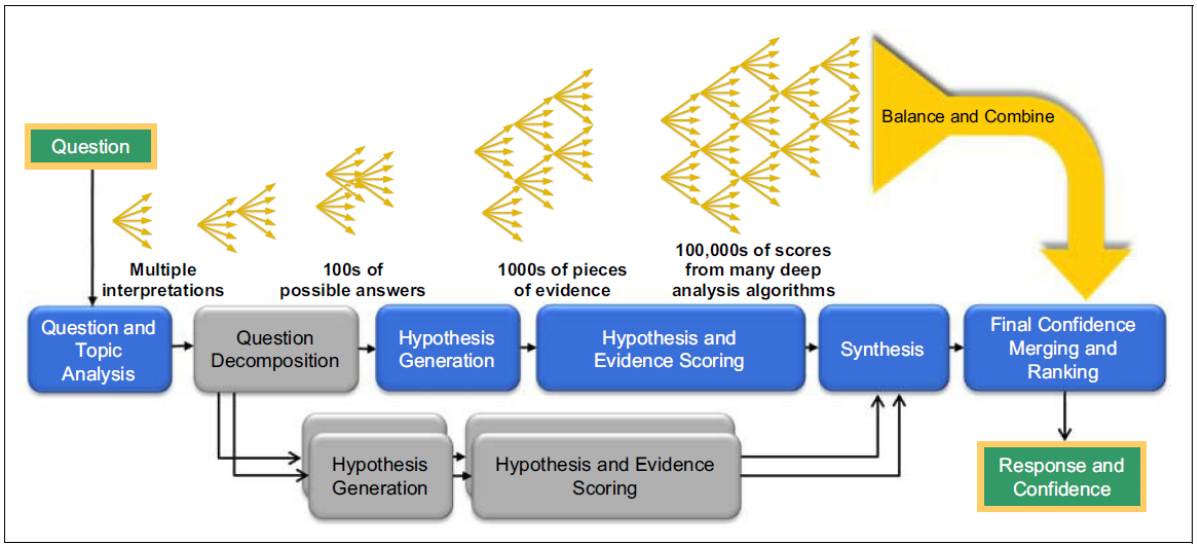
Appendix A - Research Note

We conducted a sequence of interviews with senior executives operational and academic staff in a two week period in November 2016. These included the Vice Chancellor, Deputy Vice Chancellor - Education, Director of Cloud Computing Services, Chief Digital Officer the technical project manager and less formal discussion with members of the student body and academic staff. One author provided participative observation throughout the 2016-17 period and carried out ongoing discussions with involved students and staff throughout. We returned to respondents iteratively throughout 2017 as new requests for information emerged, including to develop further the present paper. We had access to multiple documents relating to the project, covering the technical aspects, strategy, program plans, progress, assessments and details of outcomes. With three active researchers we were able to iterate data, triangulate interpretations, and arrive at insights and lessons, also comparing the findings here with findings of two of the researchers in cognitive automation research projects running in parallel over the 2016-17 period.

Appendix A: Simplified explanation of IBM Watson [52]

IBM Watson is an example of a question-and-answer cognitive computing system. Watson provides users with answers to questions pertaining to a body of structured and unstructured information within a particular domain (in the Deakin case, the domain is student support).

Watson decomposes questions posed by the user in natural language, taking into account the context of a question in relation to the particular domain (i.e., particular vocabulary, terminology) (see figure below). A question is decomposed into parts of speech to identify its grammatical, relational and structural sub-components. Multiple language analysis algorithms are utilized in this process (McCord et al., 2012). In this manner the semantics and intent of a question are derived. The sub-components are then used to determine candidate answers, again by using multiple linguistic models and matching algorithms. To arrive at specific answers, hypotheses are generated and evaluated against the body of information. Weighted evidence scores are calculated and candidate answers are thus ranked. In this manner the most likely set of answers is provided to the user.



Source: High, R (2012): The Era of Cognitive Systems: An Inside Look at IBM Watson and How it Works. IBM Corporation, Redbooks (Note, Permission to use figure to be obtained from IBM).

The body of information (called the corpus of knowledge by IBM), is initially developed by domain experts. The system is then trained to utilize this corpus of knowledge correctly. Experts

[52] This appendix was condensed from the following sources:

High, R (2012). The Era of Cognitive Systems: An Inside Look at IBM Watson and How it Works. IBM Corporation, Redbooks.

McCord, M. C., Murdock, J. W., & Boguraev, B. K. (2012). Deep parsing in Watson. *IBM Journal of Research and Development*, *56* (3/4), pp.3:1-3:15.

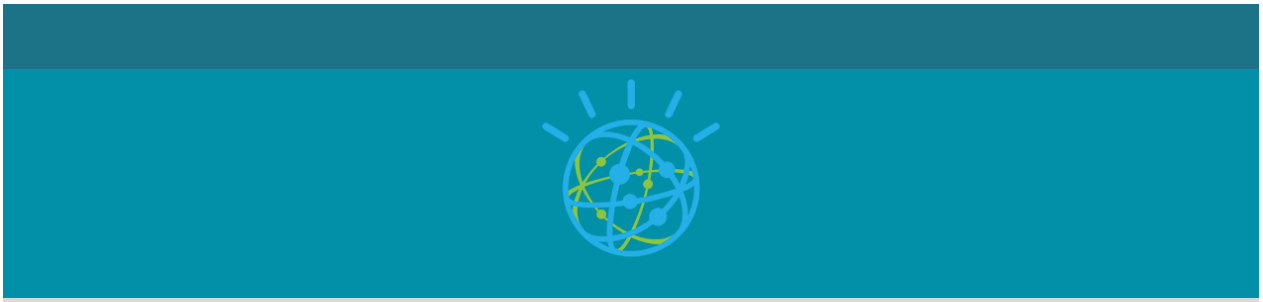
IBM Corporation (accessed October 2017). IBM Watson: How it Works, https://www.youtube.com.

develop typical question/answer pairs to train the system on linguistic patterns of meaning within the domain. Utilizing machine learning approaches, the system then continues to improve its responses via ongoing interactions with users. Answers to user questions are periodically reviewed by experts to ensure appropriate responses. Where necessary, adjustments are made to the system. In this manner, new information can also be added to the corpus.

Once trained, the system can be used to interrogate the corpus of knowledge, and provide evidence-based answers to users. Patterns can be inferred across the full domain of knowledge, providing potentially new insights to users.

Appendix B: Sample Conversations with Watson[53]

1. Conversation with Watson showing a similar response to similar, though differently worded post-exam queries.



Emma Ann: Can I see my exam?

Watson: I think there's a good chance this is what you're asking about, Emma Ann.
Here's what I found for you in Deakin's online info:

Can I request to see my exam paper?

Routine feedback will not normally be provided to students for individual exam papers. Contact your Faculty Course Adviser or Unit Chair if you have further queries.

Emma Ann: I would like to see how I did in my exam.

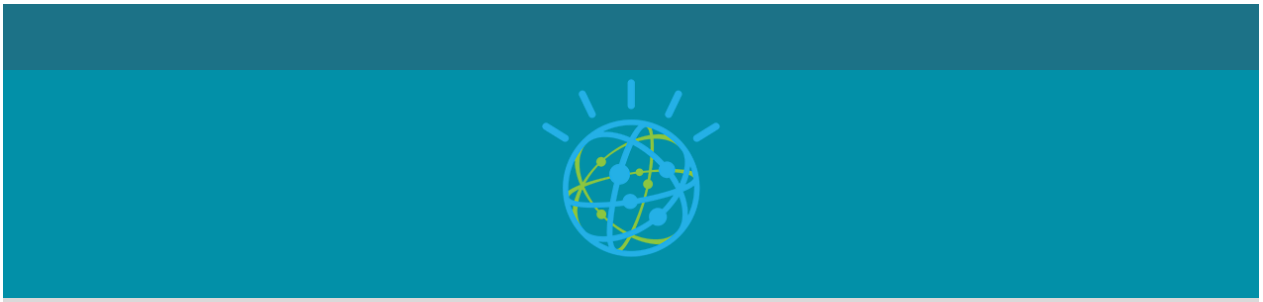
Watson: I'm not completely sure, but this might be what you're looking for.
Here's what I found for you in Deakin's online info:

Can I request to see my exam paper?

Routine feedback will not normally be provided to students for individual exam papers. Contact your Faculty Course Adviser or Unit Chair if you have further queries.

[53] *Emma Ann* is a fictitious student account that was set up to test Watson.

2. Sample conversation with Watson responding to a post-exam query where meaning of the question is different.



Emma Ann: I think there may have been a mistake on my exam.

Watson: I'm not completely sure, but this might be what you're looking for.
I found this for you in Deakin's online info:

Can I request a review of my result?

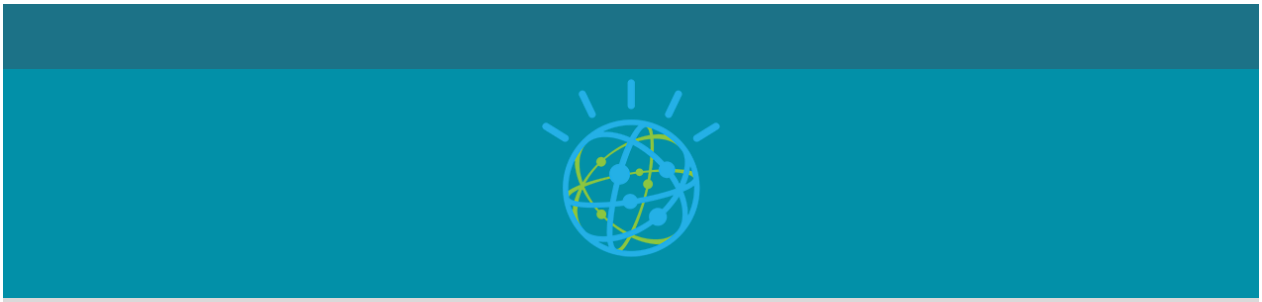
You may apply to the Unit Chair to check the administrative accuracy of your result. You can find their details in your online unit site in DeakinSync.

There is also a formal process to apply for a review of result through each Faculty Academic Progress and Discipline Committee (FAPDC) within 5 working days release of results. The procedure is outlined in the Assessment (Higher Education Courses) Procedure. Before starting this process, you should discuss this with your Faculty. The Review of Result process may result in your grade/mark being marked higher or lower.

You should follow the faculty process of the unit that you are studying. These webpages below provide further information on each Faculty process for Review of Results

[*Details truncated*]

3. **Sample conversation where Watson did not provide a specific response to the question.**



Emma Ann: What are good exam strategies?

Watson: We seemed to be doing ok, Emma Ann, but I'm not sure I understood your last question correctly.

You could try asking it in a different way, or click on one of the popular topics below.

- Enrolment
- IT Help
- Timetable
- Exams
- Fees
- Orientation
- Parking
- Health and Wellbeing
- Accommodation
- Transport