INFO1111 - Group 46

Bachelor of Advanced Computing
Computer Science Major

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21 June 2019

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CHAPTER 1

Overview of the major

1.1 Computer Science

The Computer Science major is one of the four majors offered by the Bachelor of Advanced Computing. This major focuses on the theoretical study of computing, and applying those principles and techniques towards solving programming problems and producing software. In particular, computer science courses focus on such topics as algorithm design and analysis, the theoretical fundamentals of computing and finally the application of such topics to the creation of software. The technical abilities developed in this course are directly applicable to jobs in the IT industry, while the broader range of soft-skills gained apply more generally to many STEM jobs, enabling computer science graduates to be highly valuable professionals in the workplace. While the dynamic and ever-changing nature of the IT industry means the exact nature of these future workplaces is unknown, it is certain that the soft and technical skills gained will allow graduates to solve and create the future programming problems and possibilities, whether quantum computing, artificial intelligence, or a yet-to-be-created field.

CHAPTER 2

Overview of the timeline and courses of the major

The Bachelor of Advanced Computing is a four year degree for all majors, requiring 192 credit points[**14**], split between the degree core, an advanced computing major (in this case, computer science), an optional second major and electives. The particular course timeline of a computer-science major is shown in the following table.

2.1 Courses of major

(Details from Bachelor of Advanced Computing degree page[**6**])

Year	Semester 1	Semester 2
1	MATH1021 (Calculus of one variable) MATH1002 (Linear algebra) DATA1001 (Foundations of Data Science) INFO1110 (Introduction to Programming) INFO1111 (Programming Professionalism)	MATH1064 (Discrete maths) ELEC1601 (Introduction to Computer Systems) INFO1112 (OS & Network platforms) INFO1113 (Object-Oriented Programming)
2	COMP2017 (Systems Programming) COMP2123 (Data Structures & Algorithms) INFO2222 (Usability & Security) Elective	COMP2022 (Formal Languages and Logic) ISYS2120 (Data & Information Management) SOFT2412 (Agile Software Development Practices) Elective
3	COMP3027 (Algorithm Design) INFO3333 (Management) Elective One of: COMP3211 (Distributed System or COMP3308 (Introduction to AI) or COMP3419 (Graphics and Multimedia) or COMP3520 (OS internals)	COMP3888 (Computer Science Project) Elective Elective Elective
4	INFO4444 (Computing for Innovation) INFO4001 (Thesis A) Advanced Elective Elective	INFO4002 (Thesis B) Advanced Elective Elective Elective

2.2 Evaluation of interesting courses

COMP2017 - Systems Programming : teaches programming in C. Covers more low-level aspects of programming, including memory management, hash tables and concurrent threads, as well as programming techniques and debugging practices. Appears to be a very practical, hands-on class that could be useful to gain practice programming. Isn't available in any other majors, but can be done as an elective.

COMP38888 - Computer Science Project : focuses on creating a large project for an external client, utilising skills gained in past courses, project management, and other professional skills. Seems like it would be interesting to apply the theoretical programming skills to a real-world scenario. Isn't available in any other majors, but can be done as an elective.

COMP3027 - Algorithm Design : covers the theoretical background of creating algorithms, including various techniques used for different problems and analysing the speed and similarities of different algorithms. Although it seems like a very theoretical course, nevertheless seems very interesting and like it would have a lot of applications. Also included in the Computational Data Science major, and as an elective.

COMP3520 - Operating Systems Internals : covers the fundamentals of what OS's are and how they work, including the core purposes (such as memory management, process scheduling, etc.) of an OS and how it achieves these. Seems like it would be interesting to understand the deep fundamentals of how computers operate, making it an interesting course. Isn't available in any other majors, but can be done as an elective.

CHAPTER 3

Expected career path

3.1 Types of roles available

Computer scientists have a plethora of potential careers available, with the potential to apply the gained soft-skills in many industries from finance to consulting, and the potential to apply their detailed technical skills in a wide range of IT-related fields from a computer science academic to a cyber security analyst.

Prospects for computer science graduates are quite high, with many companies reporting difficulty sourcing graduates, indicating a current shortage of computer science graduates.

There is a high degree of cross-over with other majors, particularly the Software Design major, with many jobs focusing on the design and creation of software products. The Computer science's theoretical focus however lends itself to some specific jobs, creating some differences in job prospects, particularly in careers such as 'Cyber security analyst', 'machine learning engineer' and 'Computer science researcher / academic'[**7**].

3.1.1 Software engineer

A software engineer utilizes their technical computer skills to produce software-based solutions. They work on a wide variety of products, from consumer-focused apps for smartphones to business-focused industrial management software. A strong understanding of computing fundamentals, practicals and theory is necessary to ensure products are suitably optimized, and to be able to solve necessary programming problems. Computer science graduates working in this capacity will need to work closely with software development graduates, collaborating on solving programming problems and creating software solutions (for more information, see section 3.1 - Software Architects of the Software Development report)

3.1.2 Systems analyst

Systems analysts plan and utilize information systems to solve business problems. Systems analysts can be seen as a bridge between a business analyst and software engineers, able to understand both complex technical computing concepts and the needs of businesses.

3.1.3 Computer science academic

Computer science academics further the collective knowledge of computing theory. Computer scientists research novel and complex computing problems, from highly theoretical algorithmic analysis such as the $P = NP$ problem, to optimising neural networks, or researching the possibilities of software-defined hardware.

3.1.4 Other careers

As mentioned earlier, computer science graduates have an extremely diverse range of potential career paths, both in and outside of the IT industry. Some further examples of careers are:

- Cyber security analyst
- Machine learning engineer
- Database administrator
- Computer system administrator
- IT consultant
- Financial trader (e.g. high frequency trader)
- Business consultant

3.2 Skills and tools required for these roles

The underlying and primal skill needed for success in these, and many other Computer Science roles, is an ability to continually learn and adapt. The necessity of this as a skill cannot be understated; with the nature of the IT industry constantly changing and re-inventing itself, concrete and specific skills may, and most likely will, be rendered irrelevant as today's emerging possibilities become standard within a decade and irrelevant in the following decade - and sometimes simply fail to materialize.

Nevertheless this, there are some general skills that are likely to be useful for these computer science roles[**13**]:

- Technical communication - in the collaborative, technical workplace that computer science graduates will be working in, being able to explain complex theoretical concepts not only to computer scientists but coworkers in other disciplines such as a boss, sales agent or customer support staff is crucial.
- Mathematics - A strong understanding of discrete mathematics, linear algebra and calculus are essential, both for there uses within computer science (e.g. linear algebra and multi-dimensional calculus for neural networks), and for interaction with other disciplines (e.g. engineering designs that are expressed using these concepts)
- Programming languages - A mixed variety of languages covering multiple concepts (e.g. Python, C for an understanding of memory and embedded systems, a Functional programming language such as Haskell, etc.), focusing on learning the general programming concepts, rather than being restricted to a small set of languages
- Data structures & Algorithms - understanding common versions, how to design an algorithm, how to analyze an algorithm and how to implement a theoretical algorithm in a real program are all inherently fundamental to computer science.
- Theory of computation - The most explicitly 'science' part of computer science, an understanding of topics such as computational complexity and models of computation (e.g.

Finite state automata, Turing machines, lambda calculus) are similarly fundamental to computer science.

3.3 Similarities and differences between majors

3.3.1 Differences

The computer science major uniquely focuses on the theoretical and practical fundamentals of computing, as detailed throughout this document. However, other majors tend focus more on the application of computers to various tasks.

3.3.1.1 Computer Science Computational Data Science differences

Computational Data science students study how to use computers to statistically analyze and draw novel conclusions from large data-sets. In particular, Computational Data Science students learn many statistical techniques and skills not covered in the computer science major. Furthermore, more broadly computational data science has a differing conceptual focus than computer science, asking broad questions about the world, and then analyzing data to answer such questions, to produce new insights. Contrasting both the computer science and computational data science majors, software development focuses on the creation of programming solutions to real-world problems. This involves two main sets of skills: Firstly, technical skills related to the development of complex interconnected software systems. Secondly, broader soft-skills necessary to successfully create software, such as how to work in and organize teams successfully.

3.3.2 Similarities

Fundamentally all majors involve a high degree of similarity, with the study of the art of computational problem solving, utilizing the tools and techniques offered by computers to produce solutions to previously unsolvable challenges. This similarity is reflected in the overlapping core content of each major (e.g. with INFO1110) and the high degree of cross-over between many of the offered courses. Ultimately, all the majors prepare graduates for roles throughout the broad IT industry.

3.4 Companies hiring graduates of major

3.4.1 Software development companies - Atlassian

Atlassian develops products for other software companies, managing tasks such as bug tracking, project management, communication and version control. Atlassian strongly believes that a team-focused, honest and caring work culture is the core component of their success, and so focuses on supporting employees and valuing people as individuals, not just as worker[**8**]. However Atlassian does not have focus explicitly on employee career progression, their continuing expansion and trust in employees allows for a moderate amount of career progression.

3.4.2 Engineering - Boeing

Boeing hires many computer science graduates, not only to create the software flying their airplanes, but also in many supporting roles such as creating flight simulation software, cybersecurity to ensure the resilience of their products and to improve and enhance their manufacturing and design processes[**2**]. Being a very large and old company does limit boeing's approach to work culture, following a mainly traditional results-focused rather than people-focused work place. Despite this, they are highly focused on helping employees' career progression, providing a range of programs to fund and subsidies employee training and development both in technical and leadership areas[**1**].

3.4.3 Finance - Commonwealth Bank

CBA hires many computer science graduates across a wide variety of jobs, such as cyber security and web/app development. Viewing technology as the cornerstone of future banking, CBA promotes a flexible, modern workplace to promote innovation[**4**]. Furthermore, CBA promotes career progression both with study assistance and providing internal career progression opportunities[**3**].

3.5 Career fair observations

The career fair hosted a wide variety of companies, mainly focused on STEM fields. The presenting companies were mostly similar to those found hiring Computer Science graduates in Australia, as listed in 3.4 (Companies hiring graduates of major). This included a mixture of technical software-focused firms such as "Infosys", "RecordPoint" and "Macquarie cloud services", engineering firms such as CAE and Douglas Partner, and finance firms such as Optiver, Jane Street and CBA.

Many of these companies had a strong focus on internships and graduate programs, demonstrating the importance of gaining work experience during University.

CHAPTER 4

Emerging possibilities

4.1 Industry Progression

The accelerating digitization of our world is creating many new opportunities to apply the theory of computer science. Many of these possibilities involve combining computer science with the practices of software development to produce technological solutions to both modern problems and existing processes that can be optimized with technology. These emerging possibilities span a wide range of fields in industry including finance, agriculture, transport and healthcare.

4.2 Potential problems of the future

- Cyber security - As computers and the software they run become ever more prevalent and entrusted with ever more important processes, ensuring the continued security of these systems is crucial. From financial records managing billions of dollars to Artificial Intelligence systems running cars and drones with the potential to harm or kill human life, cyber security will rapidly grow from it's already prevalent domain as a major emerging possibility[**11**].
- Artificial Intelligence - The potential for machines that, through neural-network powered machine learning processes and other methods, can dynamically analyze situations and respond to complicated stimulus, is enormous and represents a major emerging possibility. Already being implemented in a major extent, for example as the core algorithm managing YouTube's video recommendations (responsible for 70% of viewing[**5**]), AI's usage will only grow as the situations it can respond in accelerate. However the potential for AI in military uses, able to rapidly make decisions and manage complex automated weaponry, means that professionals in this area must always seriously consider their ethical obligations. Computer scientists working in Artificial Intelligence will need to work closely with Computational Data Scientists in order to process and analyze the vast amounts of data needed to fuel machine learning algorithms (for more information, see section 4.1.3 of the Computational Data Science report).
- Cryptography - heavily related to cyber security, the growing need to ensure the privacy of digital secrets, the research into the theory of cryptography is crucial to ensure the continued viability of encryption and other technologies, such as crypto-currencies. In particular, the advent of Quantum computing threatens to render existing cryptographic methods completely relevant, requiring the creation of new cryptographic techniques that are resilient to, and potentially harness, the power of quantum computing.

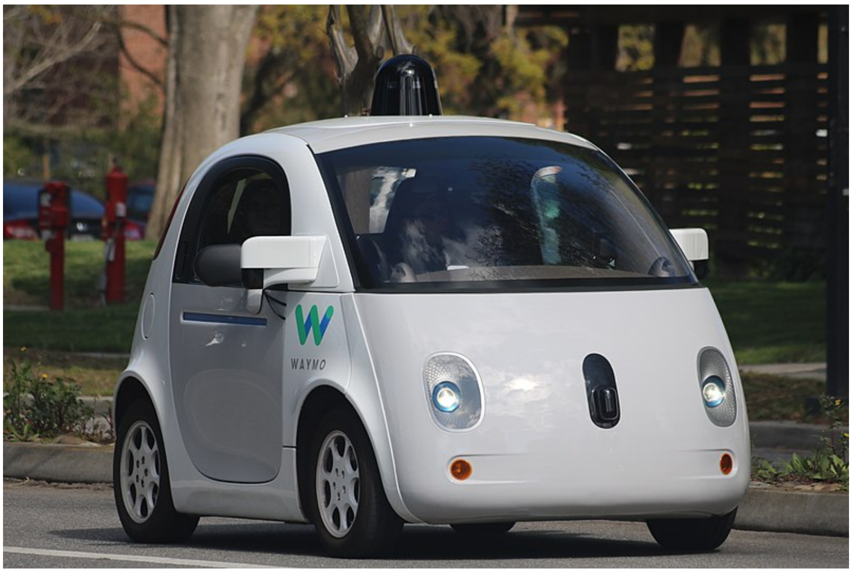

FIGURE 4.1: Google Waymo's self-driving car [**12**]

- Software-described hardware - as new computing applications require extraordinary speed, the potential for re-configurable hardware systems such as Field Programmable Gate Arrays (FPGAs) is enormous. For example, FPGAs are frequently used by high frequency traders to make and execute trading decisions in microseconds.

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