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Strengthening Undergraduate Information Systems Education in an Increasingly Complex Computing Disciplines Landscape

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Strengthening Undergraduate Information Systems Education in an Increasingly Complex Computing Disciplines Landscape

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Abstract:

There are concerns that even at times when overall computing degree enrollments are increasing, IS bachelor's degree programs and enrollments continue to decline. IS programs differ from other computing programs in that they include highly interrelated business and technology components. This inherent interdisciplinarity is the source of its value but also one of its challenges. This paper uses the Australian higher education sector as a case study to examine overall computing degree offerings including IS offerings using the ACM/AIS curriculum models and classification of computing disciplines. We find that IS program offerings are indeed trending down and that computing offerings are dominated by Computer Science and Information Technology degrees. IS is not widely present as a "base" discipline, nor is it providing a platform for the integration of new technologies, such as AI and Cyber Security into "business" settings. To strengthen UG IS programs and perceptions, we recommend that higher education providers develop structure and processes that support interdisciplinary UG IS program development and delivery and that professional bodies and curriculum models be revised to reflect and recognize the business outcome focus of IS. These actions, together with clearer messaging around the value of IS competencies, will improve the image of IS.

Keywords: Information Systems Curriculum, Information Systems Education, IS2020, the Information Systems Profession.

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1 Introduction

Concern about declining student interest in Information Systems (IS) bachelor degrees and majors has been a common thread in the IS education literature for some time (i.e., Babb et al., 2019; Burns et al., 2014; Cho et al., 2008; Downey et al., 2009; Zhang, 2007). In the US, traditional computing disciplines have experienced growth with the exception of Information Systems (IS). From 2017-2018 to 2019-2020, IS bachelor degree offerings declined by 2.9%, while the total number of computing bachelor degrees increased by 5.7% (Zweben et al., 2021). In terms of enrollments, the change was more marked with a decrease of 8.5% in IS enrollments while overall computing enrollments increased by 9.7%. This decline is apparent despite a high demand for graduates with starting salaries well above the average for many other graduates, including those from most business degrees (for example in the US, see Mandviwalla et al. (2023)).

In Australia, overall enrollments in computing degrees have also been steadily increasing from a low point of 23,700 in 2009 domestic enrollments have increased each year to 41,469 in 2019 (Department of Education, n.d.). At the same time, international student enrollments at Australian universities increased at an even greater rate from 27,217 to 75,671 suggesting that high demand for professional computing education is widespread. It should be noted that the Australian government imposed hard border controls in 2020 in response to the COVID-19 pandemic, but international student numbers are returning and expected to meet pre-pandemic levels by 2025. Demand for professional computing roles has also been increasing and is likely to continue. Annual reports of Australia's digital technology economy indicated that from 2017 to 2020, the technical, professional, management, and operational workforce grew from 416,359 to 568,614 (Deloitte, 2021). By 2026 the total digital technology workforce is forecast to grow by almost 40%. IS degrees combine technology and business expertise and such graduates are generally regarded to be in high demand and should play an important role in meeting this demand.

A reasonable and frequently asked question for professional IS educators is: why are IS education numbers declining when the employment prospects for graduates are so good? The reasons given include relatively weak identity among computing disciplines (Babb et al., 2019). A lack of clarity or awareness of the discipline in the media and among those friends, family, and teachers who influence senior high school students (Downey et al., 2009) makes it difficult to develop enough interest to consider studies in IS (Burns, et al. 2014; Zhang, 2007). Many students undertake IS degrees because of an interest in innovation and technology (Downey et al., 2009), and the technology space is becoming increasingly filled with new and perhaps more appealing disciplines, such as AI, Cyber Security and Data Science. As a business and a technology discipline, academic administration of IS may fall within Business or STEM schools, presenting challenges not only for identity but in negotiating curriculum.

There is increasing competition from other pathways to perceived IS competencies. Business students can top off their studies with technical skills, such as through coding bootcamps (Waguespack et al., 2018). Some disciplines are combining computing studies as X + Computing. Similarly, encouraging students in other computing disciplines, such as Computer Science to undertake a business major does not necessarily produce the equivalent of an IS graduate. While these types of programs and training can provide value, they are not the same as a well-constructed syllabus that integrates business and technology from day one.

We do not accept that UG IS studies are less relevant. The failures of technology projects stem from a variety of causes, but many do not deliver business value or success, in some cases leading to major business loss, even total failure (Fruhlinger, 2021; Bloch et al., 2012). As technology and its impact become more complex, competencies in assessing technologies in the context of achieving business goals, risks, value, and considering impact are more important than ever. In this paper we explore the Australian UG professional computing landscape as a case study in overall computing offerings, their placement and connections to other disciplines are used to identify ways of strengthening UG IS education. The Australian higher education sector is a contained system, dominated by 37 relatively large universities that account for over 97% of all undergraduate education (Davis, 2017). It is small enough to practically analyze, but large enough and representative enough to provide useful insights from a global perspective.

The paper will provide computing educators and professionals with a complete picture of IS offerings in the context of the overall UG computing degree offerings, their academic placement, and important discipline relationships. Based on this landscape of offerings, the paper will draw conclusions as to how best to promote identity and demand for IS competencies at the UG level.

2 IS in the Computing Discipline Landscape

For students interested in computing and computing careers, choosing among the different degrees and majors must be difficult. The ACM/AIS provides a broad perspective on computing curriculum most recently through CC2020 (ACM, 2020). This model underpins seven curriculum models, with a future curriculum model foreshadowed for AI (see https://www.acm.org/education/curricula-recommendations).

1. Artificial Intelligence (foreshadowed)
2. Computer Engineering (CE2020)
3. Computer Science (CS2013)
4. Cyber Security (CSEC2017)
5. Data Science (CCDS2021)
6. Information Systems (IS2020)
7. Information Technology (IT2017)
8. Software Engineering (SE2014)

These are not meant to be discrete models. There is considerable overlap and most address each of the 6 knowledge area categories: *Users & Organization, Systems Modeling, Systems Architecture & Infrastructure, Software Development, Software Fundamentals, and Hardware* (See ACM, 2020, Table D1, p. 130, on CC2020) to varying degrees. To illustrate this, CC2020 compares CE2020 with IS2020 (ACM, 2020, p. 171). CE2020 has a greater focus on areas within the *Hardware* category, while IS programs emphasize areas within the *Users & Organization* category. IS has a clear overlap with other disciplines. Parts of the IS curriculum rely strongly on CS and SE, and CSec is an important part of the building and management of information systems. The newly created curriculum model for a Data Science (DSc) discipline also overlaps with traditional MIS, Management Support System, and DSS functions of some IS programs. While the Business Analytics curriculum (for example Wilder and Ozgur (2015)) tends to focus on business application, its foundations lie in DSc knowledge areas, particularly Analysis & Presentation, Big Data Systems and Data Acquisition, Management and Governance.

CC2020 also recognizes the interest in combining computing studies with other disciplines such as Computing + X programs as well as X + Computing programs. Computing + X programs typically provide majors or minors that allow students to explore discipline X. Interestingly, IS, as Computing + Business, is identified as an early Computing + X program. As indicated earlier, X + Computing programs where a discipline includes some computing studies may present a particular threat to IS (Babb et al., 2019).

2.1 IS Identity

The IS community has grappled with a clear identity (see Teo and Srivastava (2007) for a review of issues around IS identity) and a strong and enduring influence among academic disciplines (Avgerou et al., 1999; Babb et al., 2019; Clarke, 2006; Gable et al., 2007). In Australia, annual surveys of professors and heads of IS indicate identity as a major ongoing threat to the discipline (Smyth et al., 2016). IS lacks the gravity or broad weight of community support of other computing disciplines such as Computer Science (CS) resulting in less demand from potential students (Babb et al., 2019).

Engendering real interest in IS requires a clear understanding of what IS is, its importance, and what study areas are included in IS programs. Genuine interest in a discipline is a major reasons for choosing that discipline (Burns et al., 2014) and programs deliver on expectations.

CC2020 provides a high-level description of all computing disciplines defining IS as:

> …the discipline of information systems (IS) focuses on information (i.e., data in a specific context) together with information capturing, storage, processing and analysis/interpretation in ways that supports decision-making. The IS field also deals with building information processing into organizational procedures and systems that enable processes as permanent, ongoing capabilities. The discipline emphasizes the importance of building systems solutions, preferably so that they can be continuously improved. At the same time, IS recognizes that in terms of many of the technical computing knowledge areas and skills, it relies on knowledge developed by other computing disciplines. ... information systems as a discipline can make significant contributions to several domains, including business, and that its core areas of expertise are highly valuable or

> essential for the best practices within these domains. The IS discipline focuses on the ability of computing to enable transformative change within domains of human activity, sometimes called IS environments. That is, IS addresses the ongoing and innovative use of computing technologies to enable human activities to achieve their goals in ways that are better, faster, cheaper, less painful, cleaner, or more effective. (ACM, 2020, p. 27)

IS is more than computing and “business”. The business and technology must be intertwined with a clear focus on the role of technology in supporting business goals. We use business as a broad term covering for-profit and not-for-profit enterprises, large and small, and government entities across a range of domains. Technology must enable business solutions, rather than be the solution. It is this approach that must be at the core of IS education. Key elements of IS practice and competence are the ability to develop and manage (typically data-based) systems that enhance the strategic goals of organizations, are lasting, and subject to ongoing enhancement and improvement. Such systems can be central to business success and linked to business outcomes. Importantly, IS competencies should ensure that the ongoing impact of technology in a particular setting, including societal impact and ethical dimensions, are fully considered (Topi, 2019).

Within this broad definition, IS has had different foci in its early development across the globe, MIS in the US, human behavior in an organizational (socio-technical) context in the UK and Scandinavia, and business process automation in Germany (Avgerou et al., 1999). Australian IS education has developed its own path with an early focus on software development in an organizational context. Key courses were *Systems Analysis & Design*, *Programming,* and *Databases*, typically built on an introductory *Computing Foundations* course (Clarke, 2006). There appears to be a clear core to the undergraduate IS curriculum. Several studies examining IS program curriculum in Australia (Richardson et al., 2018), in Sweden (Steen & Pierce, 2019), and in the US (Apigian & Gambill, 2014; Bell et al., 2013; Bohler et al., 2020; Hwang et al., 2015) show commonly addressed knowledge areas to be *Systems Analysis & Design*, *Data & Information Management*, *Application Development/Programming* and studies in the *Foundations of IS*. Knowledge areas addressed to a lesser extent included *Project Management* and *IT Infrastructure*. Surprisingly given their centrality to business application of computing, knowledge areas addressed least commonly were *Enterprise Architecture* and *Strategy, Management & Acquisition*. More surprisingly, *Enterprise Architecture* has been dropped from the core of the IS2020 curriculum model (ACM, n.d.).

IS has been described as a “collaborating and contributing discipline” within computing (Topi, 2019). IS draws on the traditional disciplines of CE and CS to some extent, and SE to a greater extent. IS also has a role with newer and emerging disciplines. As Topi (2019) points out, it is hard to imagine that the introduction of technologies at the center of disciplines such as AI, CSec and DSc into organizational or business settings would not require deep analysis of the context and their impact. The issue for IS will be: how do the technologies and techniques central to these disciplines fit into organizational systems and processes, and contribute to successful business outcomes?

Graduates of all computing disciplines will build careers that focus on the development, deployment, operation, and management of organization information and management systems. To succeed in these environments, graduates will need competencies in the business world. Graduates of more technical disciplines can gain these competencies through experience, or additional training. IS graduates, however, have an advantage through strong exposure to other business disciplines and essential foundations in the business computing environment through studies in areas such as business data and its use, business cases linked to organizational goals and strategic alignment, IS governance, business innovation, and digital transformation. Technical skills are an important part of IS studies, not just in their role as IS professionals. Technology is a major factor in students choosing IS (Cho et al., 2008), and graduates of IS programs will compete with other computing graduates for entry-level roles that require technical competencies.

2.2 IT and IS

Of all the computing disciplines, IT is closest to IS and may represent a threat, if not a source of confusion for potential students. While IT is a widely used term describing the overall field of computing, the ACM model distinguishes it from other computing disciplines, providing a curriculum model through IT2017 (ACM, & IEEE-CS, 2017). IT programs emerged in the 1990s as more general programs separate from CE, CS, IS, and SE, with less emphasis on software development, but more focus on technology, such as servers, networks, and web technologies (Gowan & Reichgelt, 2010). The ACM introduced its first IT curriculum model in 2008 (ACM, 2020). IT is now a common type of degree program in Australia and other countries. Courses in IT programs and their stated program purpose suggest that Australian IT programs generally reflect the definition of IT2017 and target graduates as characterized by CC2020.

> ... the study of systemic approaches to select, develop, apply, integrate, and administer secure computing technologies to enable users to accomplish their personal, organizational, and societal goals. (ACM & IEEE-CS, 2017, p. 18).

> … the focus is on analysis of problems and user needs, specification of computing requirements, and design of computing-based solutions. As general professional capabilities, communication, the ability to make ethically informed judgments, and the ability to function effectively as a team member augment this set. Of the currently identified computing disciplines, IT deals most directly with specific, concrete technology components in an organizational context. (ACM, 2020, p. 28)

Both IS and IT address the process of identifying and developing solutions in an organizational context. Both will appeal to potential students with an interest in technology, its application, people, and outcomes. The key difference is the depth of study in organizational systems and the broader organizational computing perspective, especially in delivering sustainable value. Trends such as commodification of computing and delivering Software as a Service (SaaS) may tend to favor IT graduates more than development-focused IS.

The strength of IS is in its processes and methods, systems that are longer lasting than the technologies themselves (Topi, 2019). CC2020 describes IT graduate's focus as "… analysis of problems and user needs, specification of computing requirements, and design of computing-based solutions. ... Of the current identified computing disciplines, IT deals most directly with specific, concrete technology components in an organizational context." (ACM, 2020, p. 28). The commodification of computing solutions may underpin the rise of programs such as IT and lend support to X + Computing programs, particularly in other business disciplines, despite the concerns of the absence of due diligence in the critical evaluation of technologies and solutions traditionally addressed by IS professionals (Babb et al., 2019).

2.3 Academic Administrative Placement of IS

As a discipline with strong links to both business and technology, IS is delivered from a range of academic units, Business, STEM, as well as dedicated Computing schools. Placement within the academic organizational structure can have an influence on program content (Babb et al., 2019). Babb, Waguespack, and Abdullat (2019) suggest that the close association with Business has not helped IS achieve the standing of other computing disciplines, notably CS. Gable et al. (2008) explored different organization units across four IS groups from Australia and Korea using SWOT analysis and identified strengths and weaknesses related to the organizational proximity to business and/or other computing disciplines such as computer science or software engineering. Other factors affected by organizational placement included conformance to local requirements and the availability of non-core courses and the degree of control over resources and curriculum. There is some evidence that the number of Business schools offering IS programs is declining in the US. In replicating the study of Bell et al. (2013), Bohler, et al. (2020) found only 89 IS programs being offered in AACSB colleges compared to 127 found 5 years earlier.

In the Australian context, a comparison of the findings of Gable et al.'s (2008) comprehensive 2007 study and Richardson et al.'s (2018) study of undergraduate programs conducted a decade later in 2017 suggests that IS activity in the 36 Australian public universities is increasingly moving away from Business to STEM first-level academic divisions. Over the period 2007-2017, first level Business academic divisions administering IS decreased from 25 to 14, while those administered by STEM academic divisions have increased from eight to 17. Dedicated first level Computing-focused academic divisions decreased from four to one. While Richardson et al. (2018) count only those academic divisions offering undergraduate IS programs, Gable et al. (2008) include all other IS activities: service teaching, postgraduate programs, and research. In the 2017 Australian study, the vast majority of IS academic units offered undergraduate programs (32 of 36) as well as undertaking other academic IS activities and the trend away from Business School management of the IS function seems clear.

The inherent interdisciplinarity of IS presents challenges in its academic management. Students in STEM or computing schools may require additional effort to incorporate business and organizational competencies, while Business schools may need to pay more attention to technological components (Coady & Pooley, 2010). All must ensure that material is integrated appropriately across the boundaries of academic units, and not simply offered as discrete loosely connected components. If IS is indeed to be a “collaborating and contributing” computing discipline (Topi, 2019) close connections are needed.

2.4 IS Professional Bodies and Their Influence

Globally, many bodies address the required knowledge and skills of computing practitioners or what should be taught in the academic programs that prepare these professionals. Since its establishment in 1966, the Australian Computer Society (ACS) has been the premier accrediting body for computing programs in Australia. The ACS is a founding partner to the Seoul Accord (http://www.seoulaccord.org/) which mutually recognizes professional qualifications of organizations that perform similar roles in other jurisdictions, including those from the US (ABET), UK (BCS), Canada (CIP), Korea (ABEEK) and Japan (JABEE). The ACS is highly influential in the accreditation of Australian university computing programs. Thirty-five (35) of the 37 Australian universities have at least one ACS-accredited program (ACS, 2022) and the remaining two are in the process of obtaining accreditation. The ACS does not formally distinguish between IS and other computing disciplines.

The ACS Core Body of Knowledge (Australian Computer Society Inc, 2021 provides broad guidance around curriculum, referencing local and international frameworks, including SFIA (SFIA, 2021), bodies of knowledge around IT and Project Management, as well as the ACM curriculum guidelines. For Software Engineering, guidance from the IEEE and the ACS-Engineers Australia Joint Board is recommended. While a few Computer Engineering programs are accredited by the ACS, in general these programs fall under the aegis of Engineers Australia. The ACS is not the only professional body that references the ACM curriculum models. In the UK, the British Computer Society (British Computer Society, 2022) works with the UK QAA (QAA, 2022) which, in its Computing Subject Benchmarking Statements, recommends that ACM/AIS documents inform curriculum.

3 Research Questions and Methodology

The increasing complexity of the computing discipline landscape will present challenges for IS programs. More programs provide more choices for students with an interest in technology. An important first step is to substantiate the anecdotal data with data on IS offerings, their trends, and the links with other disciplines. We would expect a healthy range of IS offerings to include the options in emerging areas such as AI, CSec, and DSc as these are applied in business settings, but also domain studies and other fields of studies. Research questions one and two address this.

> **Research Question 1: What IS programs are offered in the overall context of computing degrees and majors?**

> **Research Question 2: What is the trend in the number of offerings of IS programs?**

Computing + X programs are potential threats to IS programs where X represents business in general or a business domain. This is addressed in research question three.

> **Research Questions 3: What Computing + X programs are being offered?**

As a discipline that encompasses technology and business, IS is managed across both Business and STEM schools. It is useful to identify IS offerings across different types and schools and their characteristics. Where is IS successful and where are their challenges? This is addressed in research question four.

> **Research Question 4: What academic administrative units manage/deliver IS programs?**

3.1 Research Methodology

Ideally, the split across disciplines should be based on enrollments, however, Australian data is not readily available at the level of individual computing disciplines. The number of programs being offered provides a more accessible metric. The previously cited NDC studies (Zweben et al., 2021) show that enrollments and degree offerings are of the same relative order. Bachelor programs that were accredited by the ACS and offered in Semester 1, 2022 were used as the basis for collecting data. Though it does not distinguish between the different computing disciplines, ACS accreditation provides assurance that the programs are computing programs and that they address curriculum at a professional level. As of the time of collecting the data, ACS-accredited programs are offered by 35 of the 37 universities, two relatively small private higher education providers and one public vocational education college now offering Bachelor awards.

University websites and official on-line handbooks were searched to gather information on ACS accredited programs. Only programs found to be offered in Semester 1, 2022 were included in the study. Programs were classified as having a primary focus or intent, which is referred to in this paper as the primary major. These were assigned to one of the eight CC2020 computing disciplines where possible. In many cases, this could be done using program titles. Degree titles in Australia vary considerably. For example, it is common to have a title of Bachelor of IT, with optional sub-majors such as Cyber Security (CSec) or Data Science (DSc). Generally, however, degree labels could be readily classified using the CC2020 categories. For example, a Bachelor of Business Information Systems would be considered IS, a Bachelor of Information & Communication Technology would be considered IT. Similarly, there were a number of programs with titles that were variations on data analytics and these were classified as DSc. Handbook or official catalog entries were also used to verify program intention. In a few cases, it was necessary to examine the program at the course level to establish the program focus. Of the approximately 160 accredited single Bachelor programs, only one Bioinformatics program, two Networking programs from one institution, and three programs focusing on Games or Games Development fell outside of these eight disciplines identified in CC2020 (ACM, 2020).

Most, but not all, programs have a secondary focus, referred to as a sub-major in this paper. To be coded as a sub-major, programs need to include at least one year of Equivalent Full-Time (EFT) study. Sub-majors were sometimes identified in titles, for example, a Bachelor of Information Technology (Information Systems) would be coded as IT+IS, an IT primary major with an IS sub-major. Generally, a review of official handbooks and online material would reveal sub-majors that were not included in the program titles. Where sub-majors were similar they were given a common title. For example, a number of sub-majors (Application Development, Software Application Development, Software Design, Enterprise Systems Development, and Information Systems Development) covered parts of the Software Development Life Cycle and these were classified as Software or Application Development.

In some cases, the sub-majors drilled down in knowledge or competency areas that did not align with the CC2020 disciplines. More frequent secondary foci from outside the CC2020 disciplines groupings were: Networks or Network and Security, Software or Application Development, Games or Games Development or Games and Entertainment, Web and/or Mobile Applications, and User Experience (UX) and/or Interactivity. A small number of sub-majors were not identified as computing knowledge areas but could be more accurately described as application domains, such as Mathematics, Business and Health, or Computing + X.

The coded data may represent a total significantly higher than the number of programs accredited by the ACS as many programs would have a base primary major with a number of sub-majors. The data has been coded on the assumption that a program can address many areas. For example, a CS program that is accredited once but has three sub-majors such as CSec, DSc, and SE will count as three primary/sub-major combinations, one each of CS+CSec, CS+DSc, CS+SE. There is no clear pattern in the ACS list of accredited programs, in some cases, sub-majors are accredited individually, while in others the whole program with all its sub-majors has only one accreditation.

Another mechanism for achieving Computing + X in the Australian context is the double degree system, such as a Bachelor of IT/Bachelor of Business. For example, in double degree programs, students may acquire both a Bachelor of IT (usually three years full-time) and a Bachelor of X (usually four years full-time) over a period of five years or equivalent by exploiting overlap or common courses and using core from one program as elective in the other program.

With respect to double degrees, only primary majors (not sub-majors) are examined further. The sub-major numbers were inflated by three universities that provided many combinations of degrees with sub-majors in other degrees. For example, one university offered four non-computing degrees with each of 10 IS degree sub-majors. The real extent to which double degrees incorporating IS degrees are being offered is best indicated at the primary major level.

In some cases double degrees are accredited separately by the ACS and in other cases only the computing program is accredited. It is possible for students to negotiate courses of study to achieve two degrees on a case-by-case basis. At best, an examination of accredited double degrees can give a partial picture of what combinations are available.

The first, second, and, where applicable, third-level academic unit administering the program was recorded. Some programs allow for multiple smaller minors, typically consisting of one-semester equivalent of study, but the line was drawn at a requirement of at least one EFT year of study to qualify as a sub-major and these minors were not coded.

4 Findings

The program data collected is summarized in Table 1. The 40 providers in total offered 227 accredited computing primary major-sub-major combinations. The CC2020 model provided a good basis for classifying degree programs. Of the 227 combinations, 221 could be classified as having a primary focus on one of the eight CC2020 disciplines. Only one Bio-Informatics program, two Networking programs, and the three Games/Games Development programs fell outside this classification. We exclude Computer Engineering from the rest of our analysis. Computer Engineering is commonly accredited by Engineers Australia, rather than the ACS likely to be under-reported.

Sub-majors were more diverse with about half of sub-majors being classified as one of the eight CC2020 disciplines. The remainder were dominated by Networks and/or Network Security, Software or Application Development, and Games and Entertainment.

Table 1. Accredited UG Computing Bachelors' Degree Offerings – Primary and Sub-Majors

	Primary Major											
Sub-Major	**AI**	**CE**	**CS**	**CSec**	**DSc**	**IS**	**IT**	**SE**	**Bio-Info.**	**Games**	**Network.**	**Total**
None	1	1	17	8	2	6	19	16	1	3	1	75
AI			7				3	1				11
CE			1									1
CS							3					3
CSec			6			1	7	1				15
DSc			9			5	9	1				24
IS			1				17					18
IT												0
SE			2				3				1	6
Net&Net Sec			3			1	13					17
S/W or App. Dev.			5				10					15
Games & Entert.			2			1	6					9
Web/ Mobile Apps.						1	5					6
Mathematics			3			1	1					5
Cloud/ IoT			1			1	1	1				4
Health						1	2					3
Tech. Entrepren.			1			1	1					3
UX/ Interactivity			1			1	4					6
Software Tech.							2					2
Sys. Prog.			1									1
Business							1					1
Geospatial							1					1
Quantum Info. Sc.			1									1
Total All Offerings	1	1	61	8	2	20	108	20	1	3	2	227

4.1 Question 1: What IS programs are offered in the overall context of computing degrees and majors?

IS programs are a relatively small part of offerings with less than 10% of primary major offerings. The great majority of programs have a primary focus of IT or CS. IS is more likely to be present as a major (20 programs) but is also offered as a major in a relatively high number of sub-majors (18), mostly in IT programs. Only DSc has a higher number of offerings as a sub-major.

Most IS degrees also provide a sub-major, but the only one with significant numbers is DSc, commonly delivered as Business Analytics. Even for this specialization, there are only three providers.

Table 2 compares the percentages with the findings from the US NDC and CRA studies (Zweben & Bizot, 2021). The Australian data has been shown in two columns, one that is based on the primary major and one that includes sub-majors. It is assumed that the US data is based on a single major only so the first column of Australian data will be most applicable. The greatest point of divergence is for CS. Only 27% of programs in Australia have been classified as CS, whereas for NDC programs this is almost half of all programs. There is also a significant difference for IS programs with the NDC study reporting twice the proportion as in Australia. On the other hand, the Australian data reveals a higher proportion of offerings for Information Technology and for Software Engineering. When compared to the data from the CRA survey the differences are even more marked, with CS clearly dominating whereas the Australian data shows much higher proportionate offerings of IT and IS.

Table 2. Comparison of Australian and US Computing Program Offering Proportions

Computing Discipline	Australia (Programs Offered Primary Major) 2022	Australia (Total: Primary or Sub-major) 2022	US NDC Study (Programs Offered) 2020	US CRA Study (Degrees Awarded) 2020
Artificial Intelligence (AI)	0%	3%	-	-
Computer Engineering (CE)	1%	1%	6%	7%
Computer Science (CS)	27%	18%	47%	81%
Cyber Security (CSec)	3%	7%	8%	-
Data Science (DSc)	1%	7%	-	-
Information Systems (IS)	9%	11%	20%	13%
Information Technology (IT)	47%	31%	17%	
Software Engineering (SE)	9%	12%	3%	-
Other – Bioinformatics	0%	0%	-	-
Other – Games/Entertainment	1%	3%	-	-
Other - Networking	1%	5%		
Total Numbers	227	353	1494	

4.2 Question 2: What is the trend in the number of offerings of IS programs?

There is little longitudinal data available for undergraduate programs. Richardson, et al. (2018) identified 34 IS programs in their 2017 study. This current study searched university websites to establish the status of these 34 programs in 2022. The classification of IS was verified by the academic unit offering that program. This comparison was identified:

- Five of the IS programs identified in 2017 were still offered but were not ACS-accredited. It may be that some or all of these programs have never been ACS-accredited.
- 22 of the programs were still offered in some form (15 unchanged, three replaced by similar programs, four amended). Using the CC2020 eight computing-discipline categorization, four of these identified as IS in 2017 have been identified as IT, and IT/SE, and not as IS in this current study.
- Six programs were no longer offered.

In addition, this study was able to establish only one new IS program offered by ACS-accredited programs in 2022. This suggests a reduction in IS programs from 34 to 28 over five years. More telling, the number of universities that offer IS programs has dropped from 30 to 26.

Twenty-six (26) may be an overstatement of current universities offering IS programs, as four programs self-identified as IS programs in the in the 2017 study would not be classed as IS in this study.

This would reduce the number of universities providing IS programs to 23 (one still has a second IS program). If the unaccredited programs were not included this would reduce the number of universities further to 21, a little more than half of universities offer ACS accredited IS undergraduate programs.

4.3 Question 3: What Computing + X programs are being offered?

Sub-majors are also ways of delivering Computing + X programs. Only a few non-core computing areas were offered as sub-majors as Computing + X programs: Mathematics (5), Tech. Entrepreneurship (3), Health (3), Business (1), Geospatial (1), Quantum Information Science (1) though for most of these, computing is a necessary enabling discipline. Note that here Mathematics covers all branches of Mathematics. This suggests that there is a low prevalence of Computing + Business and that these would not appear to be alternatives to IS. The provision of IS + X programs was not common. There was only one Business, one Health, and one Mathematics sub-major. A further 11 IS programs offered computing sub-majors. Almost half of these were DSc majors (commonly offered as business analytics). There was one CSec sub-major and no AI sub-majors.

Double degrees with professionally accredited computing components are a more common form of Computing + X. Fourteen universities have received ACS accreditation for their double degree programs where at least one of the programs is a computing program. There were four instances of double degrees encompassing two computing disciplines. One university included the option of doing an IT program with CS and IS sub-majors with a CE+SE program, one university offered the possibility of a CS degree combined with a CE degree, and one a CS degree combined with a Games degree.

Table 3 shows that the most common computing program offered was IT offered in combination with 19 non-computing programs across eight universities. IS has only two universities providing IS programs as part of ACS-accredited double degrees. CS and CE are more likely to be associated with STEM degrees, whereas IT and IS are more likely to be associated with Business/Humanities, Arts, and Social Sciences (HASS)/Law.

Table 3. Computing Majors as Part of Double Degrees

Computing Major	Universities	Double Degree Co-Program(s)	Total Double Degrees
Computer Science (CS)	6	Engineering (4), CE(2), Science (2), Arts, Business/ Commerce, Comms & Media, Games, Health, Law, Mathematics, Medical Science	16
Cyber Security (CSec)	2	Criminology, Law, Psychological Science	3
Data Science (DSc)	1	Business/ Commerce,	1
Information Systems (IS)	3	Business/ Commerce (3), Arts, Law, Science	6
Information Technology (IT)	8	Business/ Commerce (5), Arts (3), Law (3), Science (2), Accounting, Creative Intelligence & Innovation, Criminology, Engineering, SE	18
Software Engineering (SE)	3	Science (2), Arts, Business/Commerce, Engineering, Law, Mathematics, Project Management	8

Table 4. Ranking of Non-computing Co-degrees

Program	Occurrences
Business/ Commerce	11
Science	8
Law	7
Arts	6
Engineering	6
Criminology	2
Mathematics	2
Accounting, CE, Communications & Media, Creative Intelligence & Innovation, Games, Health, Medical Science, Project Management, Psychological Science, SE	1 (Total=10)

Table 4 ranks commonly offered second or co-programs, showing that common co-degrees are traditional areas, led by Business/Commerce, Law or Laws, Science, Arts and Engineering. Of these, only three were combined with IS programs.

4.4 Question 4: What academic administrative units manage/deliver IS programs?

Table 5 summarizes the first-level academic administering units of IS. Leaving aside the four institutions not included in the 2017 study of Richardson et al. (2018), in 2022, 21 universities offered one or more ACS-accredited UG IS programs. Six universities did not offer ACS-accredited IS programs and another ten offered only accredited PG IS programs. Three of the universities provided UG IS programs from within first-level Business academic units, 16 from STEM academic units, and one from a dedicated first-level Information/Computing academic unit.

By the beginning of 2022, only one university persisted with a Computing/IT first -evel academic unit. There has been an accelerated shift from Business to STEM with only three Business-based academic units, down from 14 in 2017 with STEM providers declining slightly from 17 to 16. There would appear to be two shifts occurring, one from Business to STEM and from UG to PG, particularly among Business schools.

Table 5. First-Level Academic Administrative Units offering Computing Programs

First Level Academic Organizational Unit	**2007** (Gable et al., 2008) Note 1: This study included all IS activity, including PG or research only units.	**2017** (Richardson et al., 2018) Note 2: Different units provided IS programs in two universities in 2017. This study identified only those academic units offering undergraduate programs	**2022** Note 3: Different units provided IS programs in two universities in 2022. This study identified academic units that offered undergraduate and/or postgraduate IS programs accredited by ACS. Note 4: Two additional institutions not included in 2017 are included in this 2022 study.	
			Providing UG IS as a Primary Major	Providing UG IS as a Sub-major
Business	25	14	4	0
STEM	8	17	3	13
Computing or IT	4	1	0	1
Total Academic Units	37	32	7	14

5 Discussion

There is good reason to be concerned about the declining numbers of IS program offerings. IS offerings are small compared to CS and IT offerings. IS is not offered as a strong "base" program. Where it is a primary major, it does not draw on new technologies, like AI and CSec, to the extent of providing sub-majors. IS is offered as a sub-major almost as much as it is as a primary major. Does it matter whether IS is offered as a specialty of secondary discipline or as a primary discipline? We argue that it does matter and that to think of IS as an "add-on" to IT or CS is to devalue IS studies and to miss the point of IS competencies. Consideration of business alignment and impact are central to IS and should be an integral part of programs from day one. IS students should be thinking about what is needed from a business perspective as well as what technology can do.

Professional bodies through accreditation and curriculum models have an important role to play. Separate accreditation for IS has been a failed ongoing theme (Topi, 2019), however, being an undifferentiated part of a broader computing discipline has not helped with IS identity or perhaps curriculum guidance. The highly influential ACM curriculum models are detailed but based on the assumption that IS is primarily a technology discipline. The technology is important but there should be an equal major business emphasis. Professionally accredited IS offerings by Business schools are declining. Some are moving to STEM schools, and some may simply no longer be pursuing accreditation as professional computing degrees. This should be of concern to the academic and professional community. IS graduates deserve to have professional recognition, and academic programs should meet standards set by practitioners. Even if IS does not meet the criteria of a profession (Orlikowski & Baroudi, 1988) it is important that IS graduates act professionally (Waguespack et al., 2022) and have the required competencies in a relevant code of conduct. If existing professional bodies are seen as not relevant to IS programs, then there is a case for renewed vigor in the search for separate IS accreditation, whether it be with existing bodies or not.

As an interdisciplinary business and computing discipline, academic placement of the IS discipline is a challenge for providers. Academic grouping into administrative units is often based on the politics of institutions as well as a grouping on academic grounds (Introna, 2023). Failure to maintain strong, relevant academic links can lead to fragmentation with the risk of loss of critical mass. The roots and history of IS programs are in Business Schools. It does not, however, appear to be thriving in Business. For IS programs it is not just about the amount of business content, but about its integration and the consistency of the business-driven solution messages. Business has been described as the *sin qua non* of IS, but also as a factor in its lack of status when compared to CS (Babb et al., 2019). IS can be located with other computing disciplines within STEM schools but care will need to be taken in promoting its status and in ensuring its connection with the business world.

6 Recommendations

It is the level of interdisciplinarity of IS that distinguishes it from other computing disciplines and presents challenges in its identity and general awareness of the value of key competencies, its curriculum development and accreditation, and in a sustainable academic administration model. Three recommendations address these challenges.

Recommendation 1: UG IS degree providers should develop structures and processes that break down the technology and business silos and support the development and delivery of IS as an interdisciplinary program, one that draws on technology and business, but is dominated by neither. Business and STEM Schools must cooperate in creating a dedicated academic unit that manages UG IS programs, drawing on both business and STEM resources but independent from them for decision making. Universities use such mechanisms successfully for interdisciplinary research, but this should be extended to taught programs including UG programs. Such a unit would naturally attract staff who understand the double helix of business and technology.

Recommendation 2: Professional bodies need also to recognize and support the uniqueness of IS as a discipline and a profession. Curriculum models and accreditation guidelines should recognize the business focus and the underlying rationale in a more central way for IS programs. These competencies should be clear and integrated. Many professional bodies treat IS as primarily a technology discipline. It is more than this and professional recognition of this will enhance and clarify the identity and role of IS, both as an academic discipline and in its professional practice. The engineering profession provides a model that also applies to the computing profession. Engineers recognize the commonality of all engineers, but specialties, civil, mechanical, and electrical are also clearly recognized in their own right.

Recommendation 3: Implementing recommendations one and two will go a long to enhance the identity of IS and its image but it needs to be translated into clear messaging to the community. However, more emphasis should be placed on the critical nature of IS in ensuring that implemented technologies are the right ones for a particular context. All computing disciplines have a role to play, but IS professionals are the leaders in the application of technology to responsible business success and require greater recognition as such. There can be no more important technology role in an organization than ensuring that technology solutions deliver business results with an understanding of risks and impact. IS should be promoted as *the* discipline that critically assesses technology solutions in a socio-technical context. This is best led and coordinated by professional bodies but government, academia, and employers should be part of a clear, sustained, aligned program of clear messaging to the community.

7 Conclusion

There are a number of concerning observations we can make from the data collected.

- There are reducing numbers of accredited IS programs, supporting the US experience and our own anecdotal evidence.
- Some Business IS programs are not accredited as computing degrees.
- There is a trend of IS programs moving away from academic placement in Business to STEM.
- IS occupies an ambiguous place in the computing disciplines as both a "base" degree and an add-on (generally in STEM).

This suggests that there may be issues in having suitable accreditation for IS programs and in its academic placement. The literature suggests that students choose IS over other computing disciplines in part because of an interest in people and over other business disciplines because of an interest in technology. Parents, friends, teachers, and the media have been found to be influential in informing potential students. Without a strong professional and academic identity and groups committed to IS leading that messaging it is hard to see how the messaging to the community will improve. Separating out IS from the computing milieu can help.

Contemporary systems are socio-technical systems that need to be managed, guided, developed, and implemented effectively and responsibly. IS is important as the computing discipline that focuses on the interface between the technology space at one end and the social systems at the other. Professional bodies may argue that their professional codes cover this and that it should apply to all computing practitioners. May of those higher education providers delivering IS programs either as majors or sub-majors would also say this is addressed but there are still failed projects. Those who focus on technology can lose sight of the business and social impact. It is a unique role of IS professionals to ensure that considerations around value, risk, and impact are not overlooked and remain central to decision making on socio-technical systems and that a culture of “just get it done” is moderated.

UG education has a key role in defining the boundaries of professional work in a discipline and providing graduates with the tools that will serve them over the long term as they build their careers. For many practitioners, a UG program will be their single most important formal educational experience. IS programs will serve graduates well by laying strong and long-lasting foundations. Technologies will change but the need for business value and rigorous assessment will not.

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