Introduction

In 1882 renowned English scientist Charles Darwin announced that "[t]he chief distinction in the intellectual powers of the two sexes is shewn by man's attaining to a higher eminence, in whatever he takes up, than can woman" (Darwin, 1871, p. 564). This belief in women's inferior intellect was not new,[1] but as an eminent scientist, Darwin's proclamations held great sway in his time and place – and since – although nowadays few would admit to this. Or would they? Jump forward to 1992 and we see the arrival of John Gray's *Men Are from Mars, Women Are from Venus*, which became a phenomenal best-seller (selling more than fifteen million copies globally[2]), and continues to be so. While the book is not as forthright in saying women's intellect is inferior, it does explain the many ways in which men and women differ – including the ways they think (Gray, 1992).

The mindset that assumes men and women have different intellectual abilities and capabilities has a strong hold on public thinking in the United States and many parts of the Western world. Such thinking feeds our stereotypes and our biases and is used to explain why men and women "choose" different areas of study, different careers, and hold different aspirations – including how they relate to computing; computer science (CS); informatics, information, and communication technologies (ICTs); information systems (IS); information technology (IT); and related fields.

This book includes a collection of perspectives that challenge the *pink brain, blue brain*[3] myth and provides voices from multiple cultures and countries. Our inspiration and motivation for this book came from working with computer science majors at Carnegie Mellon University (CMU) in the United States and recognizing that for women to be successful in computer science we did not have to change the curriculum to suit "women's ways of thinking" – women can do the intellectual work as

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well as their male peers – *but we did need to change the culture* (Frieze and Quesenberry, 2015).

Thus, our goal with this book was to collect a range of global perspectives to show that women's participation in computing[4] is largely determined by cultural factors. To accomplish this goal we have brought together a landscape of researchers and educators in this edited volume. We have included brief summaries and quotes of some of their work throughout this introduction to set a foundational understanding of the topics at hand. In the final section of this introduction we have also included a guide to the chapters and their highlights, to help our readers navigate the organization of the contents.

We showcase the role of cultures, which can vary even within one country, and illustrate how a multitude of cultural factors influence women's participation in computing. Along with cultural heterogeneity, women and men are not single separate categories – we are all shaped by intersectionality and complex identities including such factors as race and ethnicities, disabilities, socioeconomic backgrounds, sexual orientation, and religious beliefs. Our experiences are subject to the values, attitudes, and behaviors of cultures at large as well as the micro-cultures we inhabit such as our families, schools, workplaces, and peer groups.

WOMEN IN COMPUTING: DATA ON PARTICIPATION

Gender balance in itself can have particular impact on the individual experiences of women in computing. As one Swedish computer scientist explained, being one of very few women "had the quite strange side effect of [me] quickly becoming a familiar face to almost everyone in the program – on good days it felt like being a celebrity, on bad days it felt like being a zoo animal" (Linquist and Melinder, Chapter 11). Being the only woman on the software engineering team, or being the only girl in the computer science class, can mean being seen as representative of all women and not as another engineer or student. It can also lead to feelings of isolation and non-belonging – and at its extreme to leaving the field.

What we find as we explore the data from different countries and cultures is that women are seriously underrepresented in computing in many parts of the world. This would appear to support a commonplace American belief that computing is a boys' field. Consider that in 2016 in the United States, only 19% of computer science undergraduate degree recipients were female (Zweben and Bizot, 2017) and women held only 26% of computing occupations (Bureau of Labor Statistics, 2017).

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For minority women the situation is worse. For example, African American women represented just 3% and Latinas 6% as recipients of computer science degrees (Zweben and Bizot, 2017). African American women and Latinas hold slightly less than 10% of computing occupations in the United States (National Science Foundation, 2017).

But now consider this:

- 50% of CS majors at Carnegie Mellon University in the United States are women (Frieze and Quesenberry, 2015).
- 55% of CS majors at Harvey Mudd College in the United States are women (Alvardo et al., 2012).
- 59% of students enrolled in CS studies in Saudi Arabia are women (Alghamdi, 2016).
- 50% of engineering graduates in Cyprus are women (UNESCO, 2017)
- 55% of entrepreneurs in the Internet industry in China are women (PRCSCIO, 2015).
- 50% of undergraduates in computing at University of Malaya and Universiti Kebangsaan Malaysia in Malaysia are women (Othman and Latih, Chapter 15).
- 40%, 65%, and 50% of students in CS/computer engineering at the undergraduate, master's and doctorate levels, respectively, in India are women (Huyer, Chapter 2).

While women are seriously underrepresented in computing fields in the United States, and in most of the world, *the situation is not universal* as the above data, and some of the chapters in this book, illustrate. Additionally, women have shown themselves to be strong participants in many fields that were once closed to them on the grounds of biology and perceived innate characteristics. In the United States and Portugal, we can look to medicine as examples of this change. In both countries there is near gender equality in the medical profession (e.g., AAMC, 2017; Lopes, Chapter 12). Furthermore, in 2016, 57% of *all* bachelor's degrees went to women in the United States, while 50.3% of science and engineering bachelor's degrees went to women in 2013 (Girls Collaborative Project, 2016; National Center for Education Statistics, 2016). We see a similar picture emerging globally. For example, in Russia women outnumber men in overall graduation rates, with women gaining 56% of postsecondary degrees (Khenner, Chapter 13). In Portugal in 2009, 59.3% of the total higher education graduates were women. Similarly, the Organisation for Economic Co-operation and Development (OECD) reports that women earn more postsecondary degrees than men, and a UNESCO analysis of women in science,

technology, engineering, and math (STEM) fields found that women represent 53% of the graduates in tertiary education in bachelors and master's programs (OECD, 2017; Huyer, Chapter 2). Such data illustrate women's intellectual potential to succeed in any field and it seems reasonable to suggest that this should include computing. It also suggests that data tell us only part of the story. To get a better understanding we need to pay immediate and close attention to the cultural factors that might be enabling or deterring women's participation in computing. "Cultural understanding is crucial to an understanding of gender influences and barriers because gender is experienced through culture" (Trauth, Chapter 3).

One of the most interesting discussions relating to data challenges some of our expectations and has serious implications for women in computing in the West. Studies have found that affluent, developed countries that *feature highly in gender equality rankings* are more likely to have the *lowest* participation of women in computing (Chow and Charles, Chapter 1). According to a recent study the gender gap in STEM increases with increasing levels of gender equality (Stoet and Geary, 2018). The World Economic Forum (2016) ranked Scandinavian countries as the most equitable of societies.[5] While Scandinavian countries like Norway, Finland, and Sweden are leaders in gender equality they have the largest gender gaps in college degrees in STEM fields (Stoet and Geary, 2018). Meanwhile, Saudi Arabia has good representation of women in high school computing and yet very low ranking – 141 out of 144 – for gender parity according to the World Economic Forum (2016).

GENDER THEORIES: ESSENTIALISM, SOCIAL CONSTRUCTIONISM, AND INTERSECTIONALITY

Historically, there are at least three major theoretical perspectives typically used to explain women's participation in computing: essentialism, social constructionism, and intersectionality theory.

Essentialism is the belief that people have properties that are essential to their composition. This suggests that all members of a particular group (e.g., gender, race, sexual orientation) innately share a common set of fixed, unified characteristics that form the primary components in understanding human actions (Wajcman, 1991). Hence, at the core of essentialism is the belief that since men and women are inherently different in their physical bodies, they are also different in the ways in which they act, behave, *and think* – and in how they relate to computing.

The essentialist way of thinking carries serious, negative repercussions for countries where women are poorly represented in computing. In *Occupational Ghettos: The Worldwide Segregation of Women and Men,* researchers argue that *essentialism* is still entrenched in the dominant culture of many advanced industrial countries where a deep-seated belief in gender differences is maintained and supported by a culture that values individual preferences and self-expression (Charles and Grusky, 2005). Even though such cultures no longer hold that men are *better* than women, they still subscribe to a belief that men and women are *very different*. This continuing belief in difference means boys and girls are more likely to follow gendered studies and career paths even in countries perceived as very progressive on gender issues.

Some fascinating research that challenges essentialism and beliefs in intellectual gender differences has emerged from the field of neuroscience. Lise Eliot, professor of neuroscience at the Chicago Medical School of Rosalind Franklin University of Medicine and Science, debunks the belief that brain differences account for gender stratification in intelligence and capacity for scientific thinking. Eliot's exhaustive review of the scientific literature on human brains from birth to adolescence is explained in her book *Pink Brain, Blue Brain*. She concluded that there is "surprisingly little solid evidence of sex differences in children's brains" (Eliot, 2009, p. 5). Indeed, the work of Eliot and other researchers has shown that men and women are not as different in their intellectual potential as popular wisdom would have us believe (Barnett and Rivers, 2005; Fine, 2010; Halpern, 2000; Hyde, 2005; Hyde and Linn, 2006).

Social construction is the belief that human behavior is rooted in historical and cultural interaction and practices. The central concept of Berger and Luckmann, explained in *The Social Construction of Reality* (1966), is that social systems are based on interactions that eventually develop into habitualized norms and roles. Over time these interactions become institutionalized, and, hence, meaning is embedded in individuals and society such that when a woman enters a male-dominated field she is seen as "stepping out of line" in terms of cultural expectations. Sandra Bem's cognitive theory of *schemas* explains how social norms start early in life and become entrenched unconscious guides to our behavior and attitudes (Bem, 1981). Bem suggests that gender schemas help solidify cultural stereotypes. They provide an "easy" way of perceiving the world around us while we struggle to identify with gender constructs in the cultures in which we find ourselves.

Many suggest that a social construction perspective is key to understanding cross-cultural variation in gender roles and expectations. American-based authors Henry Etzkowitz, Carol Kemelgor, and Brian Uzzi provide a life-course analysis (based on interviews and surveys) of women in the sciences from an early childhood interest, through university, to graduate school, and finally into the academic workplace in their book *Athena Unbound*. They conclude that despite recent advances women still face a special series of gender-related barriers to entry and success in scientific careers.

Intersectionality theory provides a framework to address the many ways in which women (and men) are not one single separate category. Our identities capture a range of interconnections, similarities, and differences that influence how we experience the world. The term "intersectionality" has been credited to Kimberle Crenshaw in her essay "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics," in which she discusses the multidimensional experiences of black women (Crenshaw, 1989). While women are undervalued generally in our culture, individual factors, such as race, socioeconomics, sexual orientation, and ethnicity, can add levels of further marginalization. The theory also reminds us that identities are not fixed but are subject to the changing situations and micro-cultures in which we live our personal and professional lives. For instance, Trauth (2002) uses the "Individual Differences Theory of Gender and IT" to characterize how individual women respond in a range of specific ways to the interplay between individual characteristics and environmental influences.

Intersectionality is particularly important to reflect on in this book of global perspectives, but we have one caveat: we are as guilty as anyone for using the binary terms "women" and "men" in our writings. We are limited by our language and have yet to find a more efficient way to explain our ideas as we address the global situation for women in computing. The chapters in this book represent a variety of theoretical underpinnings – but common to all the perspectives is the acknowledgment that cultural factors – not innate biological considerations based on sex – play a role in the shaping of gender.

This may be a good time to let our readers know what we are not saying. We are not saying that men and women are the same – that there are no differences – clearly our bodies indicate this – but we are saying that in some environments there may be more similarities than we realize. Several psychologists have pointed out that "a focus on factors other than gender is

needed to help girls persist in mathematical and scientific career tracks" (Hyde and Linn, 2006, p. 599). Most importantly we agree that "gender differences are not general but specific to cultural and situational contexts" (Linn and Hyde, 1989, p. 17).

CULTURE

We use the term "culture" to refer to the complex and broad set of relationships, values, attitudes, and behaviors (along with the micro-cultures and counter-cultures that may also exist) that bind a specific community consciously and unconsciously (Frieze and Quesenberry, 2015; Williams, 1958). This community can be localized in the micro-culture of a school or department, or as extensive as the culture of a nation. Culture is bound by context and history and we are born into specific cultures with prevailing values and structures of opportunity.

Gender is first and foremost a cultural issue, not simply a women's issue, and we need to address the underlying cultures in which opportunities and values are situated. It is also the potential "ordinariness" of culture, rife with implicit gender-difference assumptions that can jeopardize our thinking. Gender-difference beliefs easily become mistaken for deep-rooted characteristics appearing to be completely natural while actually being socially constructed in specific cultures.

A cultural perspective can both broaden and focus our thinking. It can broaden our thinking to encompass learning from different cultures, and it can focus our thinking as we identify specific factors affecting specific situations. Galpin (2002) describes the participation of women in undergraduate computing in more than thirty countries, concluding, "The reasons that women choose to study computing will vary from culture to culture, and from country to country" (p. 94). She also reminds us that when we are "seeking solutions for women's low participation in computing, it is important to consider all cultural and societal factors that may affect this participation" (p. 94). German professor Britta Schinzel (2002) also looked at female enrollment in CS around the world, reporting it as "culturally diversified" and noting a multiplicity of reasons accounting for higher and lower rates of female participation. As gender is often constructed differently in different cultures, taking a cultural approach allows us to see quite clearly and convincingly that many characteristics ascribed as natural to men and to women are actually produced in a culture.

We acknowledge that our Western worldview and our own cultural experiences have influenced this work. Our perspective for defining

culture is United States–centric and it is difficult for us to step outside our own cultures, which makes this collection both challenging and riveting. One of our authors asks us to consider this interesting cross-cultural question: As computing becomes more ubiquitous, when we see similar cultural obstacles for women across nations, are we seeing a branding based on Silicon Valley computing culture? "When the Silicon Valley behavioral cultural frame is applied as a template to other geographic areas, it spreads some of the same problems with regard to opportunities, power, and financial inequality for women and others in the computer industry" (Applin, Chapter 8).

Many of us are impatient for change regarding the participation of women in computing. But history shows us that culture is mutable and dynamic, shaping and being shaped by those who occupy it, in a synergistic diffusive process. We believe it is at the level of culture that the most effective changes can occur and lead to women's successful participation in computing.

HISTORY

Western history represents a particularly interesting cultural case that clearly shows the importance of context. Historically women have played a very important role in the development of the field of computing, a role largely determined by the culture, social needs, and trends of the times. Here, we touch on this very briefly (mostly from a Western perspective), and suggest readers refer to the works of specialists (including among others J. Abbatte, D. Gurer, W. Isaacson, and K. Kleiman).

In the early history of computing, Ada Byron Lovelace, a mathematician, played a significant part in the development of the concept of computation, translating a lecture, on Charles Babbage's design of the analytical engine, from French to English. Lovelace added her own notes, which ended up being more expansive than the original article. The collaboration of Lovelace and Babbage on the difference and analytical engine could be seen as leading to the forerunner of the modern computer. Lovelace developed structures that resemble today's programming structures. She visualized how to program the engine to calculate and how to store sequences of operations (Gurer, 2002; Matsui and Chilana, 2004).

A big jump forward to the mid-twentieth century shows how wartime often provides us with good examples to illustrate the changing levels of women's contribution in predominantly male fields. During the 1940s in World War II, women played a major role as code breakers in the

top-secret efforts going on at Bletchley Park in England. Dr. Sue Black (interviewed in Chapter 10), worked to save this famous landmark when it was in danger of being dismantled. She also had the pleasure of interviewing several of the surviving women code breakers.

In England and in the United States many women worked alongside men on calculating weapons trajectories at a time when people were the "computers." In 1943 almost all "computers" were women, and, ironically, women were perceived as best for the job: "Programming requires lots of patience, persistence and a capacity for detail and those are traits that many girls have" (Gurer, 2002, p. 176). Gurer suggests that, historically, praise for computer pioneers has tended to focus on hardware (developed by men), while ignoring the early programmers and inventors of programming (women), but she points out that "[t]oday's achievements in software are built on the shoulders of the first pioneering women programmers" (Gurer, 2002, p. 120). The Hollywood movie *Hidden Figures* documents another often ignored group – African American female mathematicians and "computers" who contributed to the space race. The movie is based on the non-fiction book *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*, by Margot Lee Shutterly, which immortalized women such as Katherine Johnson (Shutterly, 2016).

Admiral Grace Hopper was an American pioneer in computing. She designed the first compiler for programming languages and was one of the first programmers for the Harvard Mark I computer, used in the war effort for World War II. Grace Hopper and her team were credited with coining the computer terms "bug" and "debugging," after discovering a moth stuck in the workings of a computer. Her name and contribution have inspired the greatest global gathering of women in computing: the Grace Hopper Celebration of Women in Computing,[6] which attracted 20,000 participants in 2018.

A CASE EXAMPLE: THE CARNEGIE MELLON UNIVERSITY STORY

Our initial motivation for this collection of perspectives from a wide range of countries and cultures came from observations and studies of undergraduate students in the computer science major at Carnegie Mellon University. This inspired us to challenge the *pink brain, blue brain* mentality that we believe has become a major obstacle to gender

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balance in the field of computing in the United States and many parts of the Western world.

We found that women are "kicking butt"[7] in CS in some environments in the United States. The percentage of women enrolling and graduating in computer science at Carnegie Mellon has exceeded national averages for many years. Indeed, the school hit the news in fall 2017 when an unprecedented 49.7% new women entered the CS major followed by the 2018 entering class with 50% women. But Carnegie Mellon is not alone – other institutions in the United States have also had success in addressing the gender gap. Harvey Mudd College, for example, went from 10% women in CS in 2006, the year Maria Klawe (a highly respected computer scientist) took over as college president, to 40% women in CS by 2012 (Alvarado et al., 2012). Schools that are investing in cultural change may be quite different, and have different approaches, but they share some straightforward practices that have proven to be successful in the United States: they pay attention to the situation; they assess which interventions will work in their particular environments; they have institutional and financial support for diversity and inclusion efforts; they value and believe in women; they are open to change from the status quo; and they have multiple levels of commitment. They are living proof that – as Carnegie Mellon CS professor and Founder of Women@SCS, Lenore Blum says – increasing the participation of women in computing "is not rocket science!"

At Carnegie Mellon the critical strategies for changing the culture were threefold: *institutional support* (involving deans, faculty, staff, administrators, funding, values, and the school's philosophy); *student leadership* through our energetic and creative women's organization, Women@SCS, endorsed by the school and central to the culture (providing leadership, mentoring, encouragement, and peer-to-peer programs involving both undergraduates and graduates); and *leveling the playing field* (to ensure women, and others, do not miss out on valuable social, academic, and professional opportunities and experiences). Overall we have strived to take a holistic approach, recognizing that both academic life *and social life* work together for students to be successful (Veilleux et al., 2013; Walton and Cohen, 2007). Women@SCS has helped provide a strong shield against isolation, a primary factor negatively impacting the experience and performance of women and minorities in computing (Etzkowitz et al., 2000; Smith, 2010; Taylor, 2002).

Since 2002 we have carried out a series of studies to monitor the attitudes, experiences, and perceptions of our CS majors, watching for issues that need attention. What continues to surprise us is how similar

the men and women are (Blum and Frieze, 2005; Frieze and Quesenberry, 2015). Undergraduate students in the CS environment at Carnegie Mellon show a spectrum of attitudes toward the field. We have found many variables among students' experiences, attitudes, and expectations, and a complex spectrum of gender similarities and differences that exist among, and between, men and women – *but no significant gender divide*.

Since 2000 we have learned many valuable lessons about women in CS at Carnegie Mellon. In a nutshell, what stood out to us are the following: for women to be successful in CS we did not need to change the *curriculum* to be focused on so-called women's interests in computing but we did need to change the *culture and environment* (Frieze et al., 2011; Frieze and Quesenberry, 2015). Indeed, gender-difference approaches have not provided satisfactory explanations for the low participation of women in CS, and beliefs in a gender divide may actually be deterring women from seeing themselves in male-dominated fields.

ORGANIZATION OF THE BOOK

One of the most interesting and fun elements of working on this book has been the collaboration with authors who bring their perspectives from around the world. We are delighted to include chapters from twenty-nine experts, practitioners, researchers, educators, and activists who are leaders in understanding how culture shapes women's participation in computing. The authors also represent a variety of different disciplines – including anthropology, computer science, human–computer interaction, information sciences/systems, informatics, policy, sociology, and statistics – which lends to the richness of the work and to their conclusions. The authors raise interesting questions and use a variety of theories, methods, and interventions in their chapters. You may notice that we purposefully kept the authors' language and colloquialisms to add to the richness of the analysis and highlight the diversity of cultural context.

Each chapter includes five to ten discussion questions that we hope will continue the conversation and generate ideas for future considerations.

In organizing the book, we cast a wide net to include as many cultural perspectives as possible and we are pleased to include analyses of more than fifty separate countries across the globe. Yet we do not see this as an end in itself. There are many countries and cultures that unfortunately are not represented in this book. Furthermore, our authors bring a diversity of perspectives to their chapters, but they are not speaking for the full community they represent. Their work is derived from and situated in

their particular cultural community, but by no means is intended to represent a generalization for their entire community. All of our authors faced a tremendous task knowing from our own experience that little global research has been done on women in computing.

Table I.1 gives an overview of the topics covered in each chapter, along with high-level descriptions and keywords. The guide to the chapters includes additional details not summarized in the following paragraphs where we describe the parts of the book and identify themes that are raised among the chapters.

This book is organized in four parts that present perspectives on women's interest, pursuit, and persistence in secondary schools, post-secondary schools, and careers in the computing field. Part I, "Global Perspectives," includes research that explores cross-national comparisons of women in computing from more than a single country perspective. In this part, the authors present fascinating data and analyses of the global picture of women in computing ranging from some of the poorest, least developed countries to the highly modernized. We are fortunate to have chapters from authors who have done exceptional research for many years to increase our understanding of women in computing from a cross-cultural perspective.

Tiffany Chow and Maria Charles show data that challenge our assumptions as we learn that increased gender equity, higher education, and modernization do not lead to higher rates of women in computing. Sophia Huyer summarizes data from a recent UNESCO report showing that while there are opportunities for women to enter STEM fields, a range of cultural barriers (namely, family and childcare considerations) constrain their participation. Eileen M. Trauth complements the previous chapters' quantitative findings as she uses qualitative interviews from field studies in Europe, North America, Africa, and Asia-Pacific to explore how individual variations play a role in responding to cultural considerations. We also see that women's careers often hit obstacles and challenges as they attempt to advance. The reasons for this vary by country but demonstrate how culture plays a central role in the shaping of women's participation.

Part II, "Regional Perspectives," includes research that explores cross-national comparisons of women in computing from a regional perspective. This part includes three chapters that stand alone geographically, but share some of the similarities and differences explored throughout the book. For example, Palma Buttles and Fred Valdez, Jr. argue that women from Latin America and the Caribbean have a shared regional culture, but are still multidimensional and varied. Orit Hazzan, Efrat Nativ-Ronen, and

Table I.1 *Chapter overview*

	Overview	Topics covered
Part I: Global Perspectives		
1 An Inegalitarian Paradox: On the Uneven Gendering of Computing Work around the World *Tiffany Chow and Maria Charles*	Provides a new descriptive mapping of the gender segregation of information and communication technology (ICT) occupations in fifty countries and examines how observed differences map onto variation in socioeconomic modernization, women's educational and economic status, and other relevant country-level characteristics.	Global perspectives, modernization, occupational segregation, work, ICT
2 A Global Perspective on Women in Information Technology: Perspectives from the "UNESCO Science Report 2015: Towards 2030" *Sophia Huyer*	Summarizes a UNESCO report on the global situation of women in STEM fields that found women are well represented at the tertiary level in bachelors and master's programs, but not at the PhD, post-doc, researcher, and manager levels. The data indicate similar cultural issues, and patterns persist across the globe, with some exceptions such as Turkey and Malaysia.	Global perspectives, UNESCO, culture, leadership, employment, family, work–life balance, ICT
3 Field Studies of Women in Europe, North America, Africa, and Asia-Pacific: A Theoretical Explanation for the Gender Imbalance in Information Technology *Eileen M. Trauth*	Presents an empirical analysis of field data from Europe, North America, Africa, and Asia-Pacific that is used to support the "Individual Differences Theory of Gender and IT." The theory argues that within-gender variation in exposure to, experience of, and response to gender messages and barriers about women can explain women's low representation in the IT field.	Europe, North America, Africa, Asia-Pacific, gender theory, individual differences theory of gender and IT, social inclusion, IT workforce

Table I.1 (*cont.*)

	Overview	Topics covered
Part II: Regional Perspectives		
4 Sociocultural Complexities of Latin American and Caribbean Women in Computing *Palma Buttles and Fred Valdez, Jr.*	Illustrates the complexity surrounding the gender gap in computing in Latin America and the Caribbean and identifies potential lines for future inquiry, arguing that women are not homogeneous, but rather are varied and multidimensional.	Latin America, Caribbean, Mexico, Brazil, sociocultural factors, socioeconomic factors, machismo, marianismo, stereotypes, CS
5 A Gender Perspective on Computer Science Education in Israel: From High School, through the Military and Academia to the Tech Industry *Orit Hazzan, Efrat Nativ-Ronen, and Tatiana Umansky*	Describes the story of Israeli female participation in CS from both a gender and a sectorial perspective. Critical to the analysis is understanding the similarities and differences among two cultural groups: Jewish and Arab women.	Israel, Israel Defense Forces (IDF), diversity, Jewish women, Arab women, female representation, culture, CS education, tech industry
6 Factors Influencing Women's Ability to Enter the Information Technology Workforce: Case Studies of Five Sub-Saharan African Countries *Sophia Huyer and Nancy J. Hafkin*	Presents case studies from five countries in East and West Africa – Ethiopia, Kenya, Rwanda, Senegal, and Uganda – which assesses the economic, cultural, infrastructural, and policy factors influencing women's ability to enter the IT workforce in the region.	Africa, Ethiopia, Kenya, Rwanda, Senegal, Uganda, culture, leadership, employment, family, work–life balance, STEM, IT education and workforce
Part III: Cultural Perspectives from the United States and Europe		
7 Against All Odds: Culture and Context in the Female Information Technology Professional's Career Choice and Experiences *Monica P. Adya*	Introduces female IT professionals who have overcome a variety of odds with regard to their choice of, and success in, IT careers. The analysis shows that grit and resilience to cultural influences such as gender-stereotyping of IT careers are central components of female persistence.	United States, career barriers, computing self-efficacy, entrenchment, resilience, career mentors, role of family

8 Cultures and Context in Tech: A Dynamic System *Sally A. Applin*	Examines the impact of Silicon Valley's cultural frame historically on the United States and on the rest of the world. The analysis demonstrates how the Silicon Valley subculture continues to transmit biases against women, limiting the real contributions they can provide and, in turn, their income, livelihoods, and opportunities for advancement.	United States, Silicon Valley, culture, context, anthropology, geography, power structures, branding, marketing, business, CS
9 Perspectives of Women with Disabilities in Computing *Brianna Blaser, Cynthia Bennett, Richard E. Ladner, Sheryl E. Burgstahler, and Jennifer Mankoff*	Provides a history of including individuals with disabilities in education through policy and activism with a particular focus on the inclusion of women with disabilities in computing education and careers in the United States and issues a call to action to increase their participation.	Disability, women, accessibility, accommodations, universal design, disability studies, isolation, independence, interdependence, activism, stereotypes
10 An Interview with Dr. Sue Black, OBE, Computer Scientist and Computing Evangelist *Carol Frieze and Jeria L. Quesenberry*	Summarizes Sue Black's work as a leader for gender parity in computing in the United Kingdom where among her many efforts she started #techmums, the British Computer Society's Specialist Group BCSWomen, and initiated and succeeded in saving Bletchley Park.	United Kingdom, BCSWomen, #techmums, *Saving Bletchley Park*, Sue Black
11 An Overview of the Swedish Educational System with a Focus on Women in Computer Science: Looking Back to Learn for the Future *Sinna Lindquist and Ingrid Melinder*	Presents the history of the Swedish educational system and the status of gender divergence for different academic tracks and levels. The analysis also includes interviews with girls and women interested in computing careers and reflections of six female pioneers in the Swedish computing field.	Sweden, history, education, equality system, gender imbalance, interviews, role model, students, stereotypes, CS, technology

Table I.1 (*cont.*)

	Overview	Topics covered
12 Portugal: Perspectives on Women in Computing *Arminda Guerra Lopes*	Presents two case studies of Portugal – one at the high school level and one at the polytechnic and university level – with women interested in CS. The results show that Portuguese sociocultural influences bring many challenges, but promises for the future can be found.	Portugal, history, sociocultural factors, fascism regime, colonial war, high school students, polytechnic students, university students, CS
13 Women in Computing: The Situation in Russia *Evgeniy K. Khenner*	Provides a detailed description of the history and participation of women in computing in Russia. The study shows the underrepresentation of women is, in large part, due to stereotypes of the profession. The analysis also includes reflections of several female pioneers in the Russian computing field.	Africa, Ethiopia, Kenya, Rwanda, Senegal, Uganda, culture, leadership, employment, family, work–life balance, STEM, IT education and workforce
Part IV: Cultural Perspectives from Asia-Pacific		
14 More Chinese Women Are Needed to Hold Up Half the Computing Sky *Ming Zhang and Yichun Yin*	Examines how women's participation in the Chinese computing field is influenced by deeply rooted attitudes from China's traditional Confucian-based ethics, the intense pressures of balancing work and home, and the prevailing male-dominated environment.	China, Chinese traditional ethics culture, gender diversity, Chinese female practitioners, entrepreneurship, computing industry
15 How the Perception of Young Malaysians toward Science and Mathematics Influences Their Decision to Study Computer Science *Mazliza Othman and Rodziah Latih*	Analyzes the results from a follow-up study of post-secondary students in Malaysia and concludes that young Malaysian men and women do not hold different perceptions of their ability to succeed in CS.	Malaysia, gender similarities, gender differences, gender disparity, computer science education

16 Women as Software Engineers in Indian Tamil Cinema *Joyojeet Pal*	Discusses the emergence of women as software engineers in Indian Tamil cinema. The analysis describes how the role of female software engineers captures the complexity of Indian society's aspirations, prejudices, and fears alike, while offering a positive change in the cinematic representation of women in the workplace.	India, Indian Tamil cinema, social shaping, tradition, middle class, software engineer, technology
17 Women in Computing Education: A Western or a Global Problem? Lessons from India *Roli Varma*	Presents a case study of women in computing in India that shows how computing and gender are constructed more diversely than assumed in Western research. The analysis shows that women are attracted to the computing field, but face challenges that are specific to the Indian social context.	India, confidence in mathematics, geek mythology, Indian female students, patriarchy, underrepresentation of women, CS
18 Challenging Attitudes and Disrupting Stereotypes of Gender and Computing in Australia: Are We Doing It Right? *Catherine Lang*	Provides an overview of the gendered nature of computing in Australia and initiatives to challenge attitudes and societal stereotypes. The analysis also critiques what Australia is "doing right" and identifies areas for future improvement.	Australia, Indigenous youth, student course choices, teacher education, interventions, gender and computing

Tatiana Umansky explore how regional differences in Israel influence the experiences of Jewish and Arab girls and women in the country. Although their chapter focuses on the country of Israel, we felt the cultural themes they explore between Jewish and Arab girls and women are indicative of varied cultural backgrounds of the region. Sophia Huyer and Nancy J. Hafkin describe how in several African countries childcare and maternity policies are inscribed in a nation's constitution to contribute to women's equal opportunities in the workplace. As in several chapters, the significance of representation and stereotypes appears, with examples that serve to reinforce stereotypes, while others challenge our expectations.

Part III, "Cultural Perspectives from the United States and Europe," includes research that explores country case studies from primarily a Western viewpoint and that of Russia.[8] Chapters in this part range broadly, not only by location but also by perspectives. Many of these perspectives emerge from individual interviews and reflections from female pioneers in the computing field. We hear the voices of women who have often been forgotten – women who have played a major role in the history of computing, women with disabilities for whom gender is just one factor in their marginalization, women who moved westward for improved opportunities, women who moved into a culture "branded" by their male colleagues.

This part includes three chapters focused on the United States, yet these chapters highlight various subcultures within the American context. Monica P. Adya investigates female IT professionals who have overcome a variety of odds with regard to their choice of, and success in, IT careers. Her analysis compares and contrasts the experiences of South Asian and American women in the United States workforce. Sally A. Applin gives an in-depth analysis of Silicon Valley's computing culture and its influence on the rest of the world. She identifies cultural biases that have influenced women and speculates as to how these factors will evolve and continue to shape computing worldwide. Brianna Blaser, Cynthia Bennett, Richard E. Ladner, Sheryl E. Burgstahler, and Jennifer Mankoff provide an overview of disability history to highlight the struggles that individuals with disabilities have had with obtaining access to education and careers. They include a discussion with women with disabilities in computing education and careers and found that many of these women feel isolated and marginalized – thus they conclude with steps that can be taken to make the field more welcoming and accessible overall.

Part III also includes several chapters from a European perspective, highlighting four unique country perspectives from the United Kingdom,

Sweden, Portugal, and Russia. Sue Black discusses her work as a leader for gender parity in computing in the United Kingdom where among her many efforts she started #techmums and the British Computer Society's Specialist Group BCSWomen, and perhaps is most well known for initiating – and succeeding – in saving Bletchley Park, as the title of her book reflects. Sinna Lindquist and Ingrid Melinder present a history of the Swedish educational system along with facts and figures on gender divergence for different academic tracks and levels. In doing so, they describe the reasons why women might pursue a career in computing. They also share the perspectives of successful women in computing who discuss how their upbringing and background impacted their choice of education and career path. Arminda Guerra Lopes presents two case studies from Portugal (at the secondary and post-secondary levels) that help to explain the motivation for women to study or pursue a career in computer science. Her analysis concludes that the Portuguese sociocultural influences on women are difficult to overcome and unfortunately do not fully coincide with the concept of a computing professional. Evgeniy K. Khenner provides a detailed overview of the gender imbalance of women in computing in Russia – starting with a summary of the history – and then providing statistics and explanations at the secondary, post-secondary, and employment levels. He suggests that the imbalance is based on both discrimination and female perceptions of "fit" in IT.

Part IV, "Cultural Perspectives from Asia-Pacific," includes research that explores country case studies from an Eastern viewpoint and that of Australia. In this part we include some computing cultures in which women are well represented. Ming Zhang and Yichun Yin describe historical and cultural issues related to women in China's computing communities. They discuss an interesting situation in that women represent a very small percentage of the Chinese computing industry, yet they represent a relatively high proportion of senior positions and entrepreneurs. Mazliza Othman and Rodziah Latih provide an update on their earlier study of women in computing in Malaysia. In their current study, they continue to find that Malaysian women have a markedly different attitude toward science and mathematics compared with their Western counterparts. They conclude that computing is not viewed as a masculine field by young Malaysians and thus there is no gender imbalance. Joyojeet Pal presents a cultural analysis of the emergence of women as software engineers in Indian Tamil cinema. He suggests that the cinematic representation of women in the workplace has played a positive role, while accommodating traditional values, in shaping the perceptions of women in the Indian

computing field. Roli Varma adds to the Indian perspective and in doing so presents a case study that shows how the perceptions of computing are welcoming to women in India since the field offers lucrative jobs, high salaries, professional careers, safe office working environments, and economic independence. Yet women still remain marginalized due to patriarchal values. Catherine Lang summarizes the underrepresentation of women in Australia and reflects on why interventions over the last several decades have had little impact on improving the participation rate of women in the computing field. She suggests that educational institutions should empower teachers to be more creative and to build opportunities for computing competence that spans the silos of traditional educational disciplines.

Throughout Part IV we hear about contexts where traditional patriarchal social expectations create barriers to women's sustained participation. But this is not always the case. In some, despite such challenges, the field of computing opens up new career possibilities for women along with increased confidence and independence. Further, Western stereotypes about the field and perceptions of "fit" are socially constructed and not pervasive in all regions of the world. One important consideration in the part on Asia-Pacific is a reminder that the terminology we use and how we name the various fields of computing may have an impact on perception and participation. Furthermore, the stereotypes and perceptions of the computing field are specific to the social context and not a universal problem that many times is generalized in mainstream media and academic literature.

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