

# Women's Contribution in Computer Science

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The presence of women in teams seem to increase collective intelligence, and if those women have decision making positions, success probabilities increase in startups. When women are not involved in designing products and addressing social and political problems, then needs and desires unique to women may be overlooked.

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## 1. Women in STEM Studies and Inclusion Initiatives

The exclusion of the contribution of women scientists in STEM history is a concern in specific academic and industrial sectors around the world. Some studies suspect that the lack of critical mass of visible female scientists and professionals is one of the reasons for the increasing desertification of women in the field over the last three to four decades.

Different academic organisations in the global north like IEEE (women in engineering), ACM (women in ACM) in the US, the European Institute of Gender Equality in Europe, the CNRS through the "Mission pour la place des Femmes" and the "Comité parité-égalité", the Institute of Gender in France, and major technology companies (e.g., Microsoft, Google, Facebook) have recognised the importance of understanding and organising actions that can promote a more gender-balanced, diverse and inclusive STEM (science, technology, engineering and mathematics) community. The opportunities and economic share, and return of investment in different disciplines in STEM are not homogeneous.

Some international actions in industry and academia have been organised to make women's contributions to computing visible. One of the most established actions is the Anita Borg Institute, founded by computer science PhDs Anita Borg and Telle Whitney to recruit, retain and advance women in technology. Other international organisations are working to promote the visibility of women in computing:

- the Association for Computing Machinery (ACM) Committee on Women;
- the Association for Women in Computing;
- the Center for Women in Technology;
- Girl Develop It;
- Girls Who Code;
- In Latin America and the Caribbean, there is Meninas na Computação and Meninas Digitais of the Brazilian Computer Society; Mexicanas en Computación, of the Mexican Academy of Computing, the University of Chile organises the Latinity conference "Latinas in Computing"; the conference CLEI organises a special call for women in STEM in Latin America;
- Similar organisations in Africa, the Middle East, Asia-Pacific and Oceania have emerged.

This list is not representative of the diversity of groups and forums working for the inclusion and visibility of the contribution of women in computing. There are too many, and there is no integrated map enumerating them. This diversity demonstrates both the interest in the issue, the lack of coordinated actions, and the lack of scientific gender studies applied to women in computing and women in STEM considering fine-grained analysis, for example, by field or geographic region. Some governments and universities have created gender studies institutes with dedicated chairs for science, technology, engineering and mathematics. Yet, despite exceptions, the topic remains considered of second class and not an absolute priority.

## 2. Women in Artificial Intelligence and Data Science

The persistent absence of women employed in the AI and DS fields is troubling. According to the report of the World Economic Forum in 2018 (<https://www.weforum.org/reports/the-global-gender-gap-report-2018>, accessed on 1 June 2022), over three-quarters of professionals in these fields globally are male (78%); less than a quarter are women (22%). What about other underrepresented communities <sup>[1]</sup>? How are they represented in the DS and AI workforces, and which are the part of opportunities offered by these promising areas taken by these communities? Of course, to acquire a complete understanding of this phenomenon, it is necessary to treat the female community <sup>[2]</sup> and other underrepresented communities <sup>[1][3]</sup> as multifaceted and heterogeneous groups, with a plurality of experiences, and where gender intersects with multiple aspects of difference and disadvantage <sup>[4]</sup>. Discrimination at work must indeed be studied with an intersectional approach to acquire better and fine-grained understanding of the problem <sup>[5]</sup>.

In the last decade, the role of data and scientific and technical skills used to exploit it have created promising career and economic spaces. AI and DS have emerged as promising areas for developing careers with critical financial benefit perspectives. Nevertheless, professional career perspectives in these disciplines are not equal depending on gender <sup>[6][7]</sup> and other criteria <sup>[8]</sup>, including race/ethnicity, socio-economic level, the institution's reputation where people did their studies, etc. For example, in the United Kingdom, the House of Lords Select Committee on Artificial Intelligence in 2018 advocated increasing gender and ethnic diversity amongst AI developers. In France, several companies like Renault and Engie, through the "Laboratoire de l'Egalité", signed a call for widespread awareness of the discriminatory effects of AI and a commitment by its supporters to correct them. It is addressed to leaders in the public and private sectors, research and training organisations, companies that produce digital technology, companies that use digital technology and AI consultants. In 2020, the European Commission (European Commission (2019). 'Women in Digital Scoreboard'. Retrieved from: <https://digital-strategy.ec.europa.eu/en/library/women-digital-scoreboard-2020>, accessed on 1 June 2022. European Commission (2020a). Opinion on Artificial Intelligence—opportunities and challenges for gender equality. Advisory Committee on Equal Opportunities for Women and Men. (18 March). European Commission (2020b). Gendered Innovations 2: How Inclusive Analysis) noted that it is time to reflect on the interplay between AI and gender equality. French, European, and international organisations and agencies <sup>[9][10][11]</sup> perform studies for observing workforce shares in industry and sometimes in academia from a global perspective. Few fine-grained studies have studied underrepresented communities' workforce evolution and gaps from the gender perspective in disciplines such as AI and DS <sup>[12][13]</sup>.

A thorough understanding of the way the workforce accesses the AI and DS opportunities in industry <sup>[14]</sup> and academia <sup>[15]</sup> <sup>[16]</sup> is essential for building fair and inclusive societies <sup>[17]</sup>. This understanding can also be crucial for ensuring that countries obtain the full benefits of developing these areas to achieve better economic and social conditions and leading positions in the international arena through technology self-sufficiency.

Despite the economic and symbolic capital investment seeking a fair distribution of AI and DS opportunities for women and underrepresented communities, the crystal ceiling must still be broken <sup>[18]</sup>. Part of the explanation resides in data (!) <sup>[19]</sup>. Indeed, many studies agree to consider that quality, disaggregated, intersectional data are still missing. These data are essential to interrogate and tackle inequities in the AI and data science labour force <sup>[12]</sup>. As stated in the Alan Turing Institute study, "Where are women?" <sup>[12]</sup>, the Royal Society has noted that a significant barrier to diversity is the lack of access to data on diversity statistics. The AI Roadmap recognises diversity and inclusion as a priority to make data-driven decisions to determine where to invest and ensure that underrepresented groups are given equal opportunity.

## 3. Awarded Women in Computer Science

The history of computing seems to have an equivalent gender balance issue <sup>[20]</sup>, as it has acknowledged with difficulty and marginally the contributions of women or at least their participation in the advances of this young science. Few documents outline the history of computer science, including women, and documents systematically include men: Alan Turing, Charles Babbage, Herman Hollerith, etc. The documents that list female computer scientists include Ada Lovelace, Hedy Lamarr, the ENIAC programmers (although their names and faces are unknown), Grace Hooper, Mary Allen Wikes, Lois Haibt or Radia Perlman. However, even members of the computing community are probably unaware of who these women scientists were and what their contributions were besides Ada Lovelace and Grace Hooper (the [Appendix A](#) lists a non-exhaustive but a more extended set of contributions authored by female computer scientists).

The history of women's contribution to computing is spread across blogs, websites and news articles. Some films acknowledge women's role as "calculators" <sup>[20][21][22][23]</sup>, and female labour is mentioned as a curiosity in the history of science, insisting on "pencil-dragging" tasks rather than on how they developed as programmers and became part of the

core of digital computing advances [24]. The objective in referring to the term “calculator” is intended to show that contribution of women has been considered paper dragging even if they played a relevant role in the projects they participated in. Despite the importance of their contribution, they were not regarded as leaders of projects, and they remained invisible for a long time for history. The films have contributed to give visibility to these women. Still their stories and their contributions must be studied with methodological approaches and then included in books and in study programs, etc.

Histories of computing are not abundant, but they do exist; for example [25][26]. Reconstructing history is a complicated undertaking, to the extent that there are special series on the subject in well-known publishers such as Springer and IEEE. In Springer, the series is entitled “History of Computing” and in IEEE, it is entitled Annals of the History of Computing. These papers name the works of the illustrious scientists who have become the pillars on which computing is founded. Not surprisingly, the most prestigious prize in the field, the Turing Award, has only been awarded to three female scientists since it was first awarded in 1966. This event first occurred in 2006 (40 years later!). Can you name three or five names of people who have received the award? Are there any women's names on your list? The names of the three female Turing Award laureates are:

- Frances E. Allen, pioneer in compiler optimisation, IBM Emeritus (2006);
- Barbara Liskov, programming languages, operating systems and innovations that have led to data abstraction, modularity, fault tolerance, persistence and distributed computing, Massachusetts Institute of Technology (MIT, 2008);
- Shafi Goldwasser, complexity theory, cryptography and number theory, MIT and Weizmann Institute of Science (2012).

The cases of other awards are similar. For example, the ACM SIGMOD Contributions Award in the area of databases, initiated in 1992, has recognised the work of Maria Zmankova (1992), Laura Haas (2000 with Michael Carey), Marianne Wenslett (2012) and Meral Özsoyoğlu (2018), Juliana Freire, Ioana Manolescu with four other male colleagues in (2020). The ACM Edgar F. Codd Innovations Award, also in databases initiated in 1992, has recognised Patricia Selinger (2002), Jennifer Widom (2007), Laura Haas (2015), and Anastasia Ailamaki (2019)—four in thirty years by 2022. The Internet recognises approximately thirty-six women who contributed to advances in computing; Wikipedia lists about sixty-four women's contributions between 1842 and 2022 (in 180 years). Since the beginning of this science, outstanding contributions have been made by women in programming languages and programming (Fortran, Smalltalk C, C# Ruby). Many famous women programmers are clustered in video games, operating systems, software engineering and software evaluation. There is also an ambition to disseminate knowledge and active participation in computer education. These names do not include, for example, the recipients of the ACM SIGMOD Award Contributions or the ACM Edgar F. Codd Innovations Award. This situation demonstrates the dispersion when it comes to reconstructing history and accessing the memory of forgotten science when it comes to remembering the names of women scientists [27].

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