Article

Building a Territorial Working Group to Reduce Gender Gap in the Field of Artificial Intelligence

Karina Gibert [1,2] and Aida Valls [2,3,*]

1   Intelligent Data Science and Artificial Intelligence Research Center, Universitat Politècnica de Catalunya (IDEAI-UPC), Catalonia, 08034 Barcelona, Spain; karina.gibert@upc.edu
2   donesIAcat, Gender Working Group of the Catalan Association of Artificial Intelligence, 08034 Catalonia, Spain
3   Intelligent Technologies for Advanced Knowledge Acquisition Research Group, Departament d'Enginyeria Informàtica i Matemàtiques, Universitat Rovira i Virgili, 43005 Tarragona, Spain
*   Correspondence: aida.valls@urv.cat

Abstract: The gender gap (both at vocational and professional sides) in Artificial Intelligence (AI), and scientific and technological fields in general, is one of the most critical challenges that the current digital society must solve. This paper describes the proposal of the gender commission donesIAcat to create a gender working group formed by Catalan AI scientists and professionals who work in a network for bridging this gap. The main objectives for letting girls know that they can study and work in the AI field are presented in this paper. A general methodological framework is proposed, following the internal organization of the Catalan group donesIAcat. Several key actions are explained and classified into six blocks. A relevant contribution of the paper is the definition of the guidelines required to build a territorial network-based structure capable of launching several AI-related activities targeting people at different stages of their life. The activities done at donesIAcat illustrate the possible outcomes of the proposed methodology and show successful initiatives to engage girls in technology and AI. The paper shows the validity of this model for small homogeneous territories where activities can be suitable for the different cities in the region. Proximity is one of the advantages of such a model and one of the reasons for its success.

Keywords: Artificial Intelligence; gender gap; equity

1. Introduction

Jobs in the area of STEM (Science, Technology, Engineering, and Mathematics) constitute a large proportion of the available professions nowadays. Among them, those related to Computer Science and Information and Communication Technologies (ICT) are highly demanded in Europe and worldwide. As it is said in the 2018 report of the European Center of Development for vocational training [1] entitled, Skills forecast: trends and challenges to 2030, the demand for ICT professionals is expected to increase 12.8% by 2030. The US census bureau published Figure 1, where we can see that women are nearly half of the workforce, but only 27% are working in STEM. We can observe that, since 2000, the number of women employed in Engineering is quite stable at around 10%, but Computer Science is the only field showing a decreasing trend, with only about 20% of women in this area in 2019 [2]. Social sciences, mathematics, physics, and life sciences have a percentage of women above 40% and below 60%, showing a good balance between genders. The numbers shown for computer workers are alarming, considering that we are working towards a digital society in the near future where many jobs will be in the STEM fields and women should be there together with men.
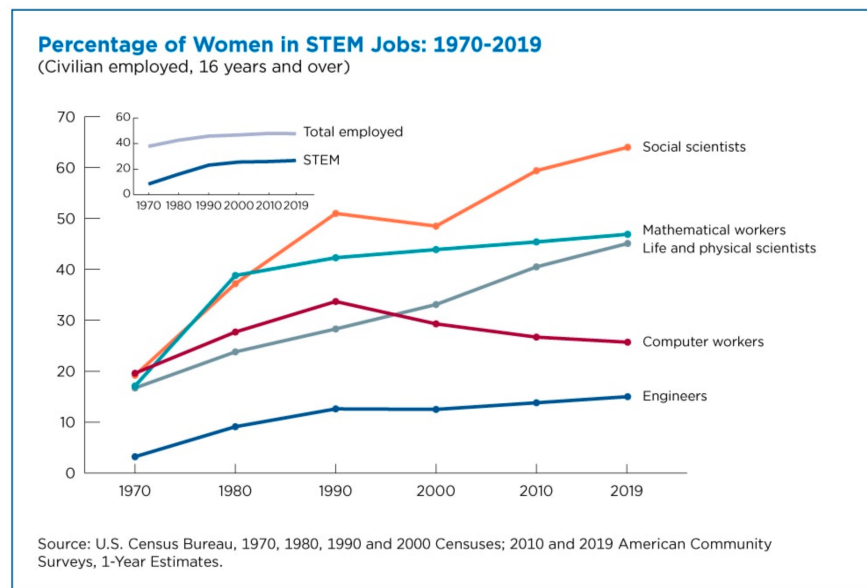
Figure 1. Employment of women in the US from 1970 to 2019.

In the region of study of this paper, Catalonia (Spain), the Catalan Talent Observatory regularly publishes job demands. Figure 2 shows the five most demanded occupancy profiles in 2021; computer programming and consultancy being the largest with 67% of the share, followed by the other three ICT-related jobs and total 78% of the job offers in Catalonia.
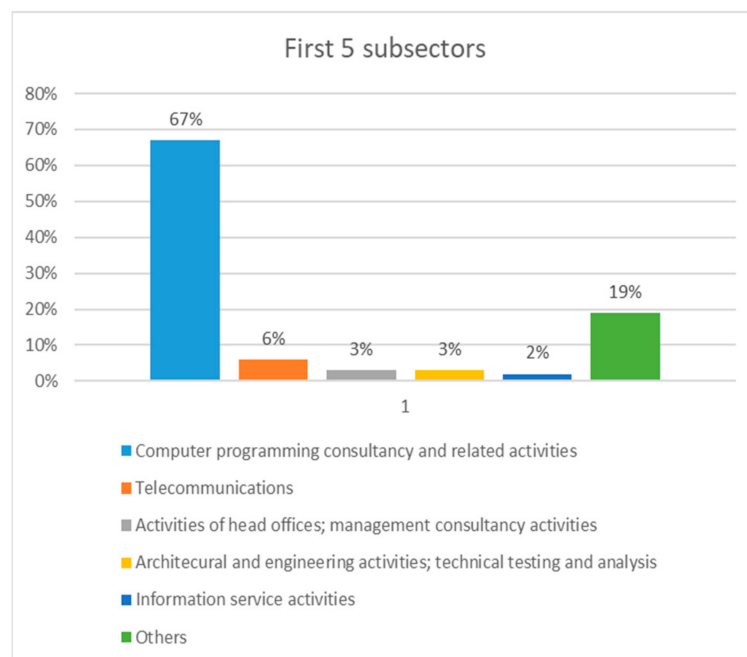
Figure 2. Occupational demand in Catalonia in the last 12 months (published December 2021), from The Catalan Talent Observatory (aqu.cat).

The presence of women in ICT educational courses and jobs is known to be smaller than men. Traditionally, those professions have been associated with males, leading to gender inequality in the digital area. The European Commission in its 2018 report [3] highlights this bias, observing that there are four times more men taking ICT-related courses than women. The same report also detects that there are 313% more men than women working in digital professions. These differences lead to the problem of leaving

women out of some of the most relevant professions in the near future, such as the ones related to Data Science and Artificial Intelligence. Since the presence of women in STEM and AI is too low in the professional sector, it is difficult to claim there are balanced panels in round tables, professional teams, or women in directive positions in the field. Thus, in the particular case of Informatics or AI, a previous challenge is now a priority: to inspire girls to choose a degree in the field so they can get the proper training to become professionals.

Artificial Intelligence (AI) is a discipline highly connected with Computer Science as it emerged from the idea of building intelligent software running in a standard computer or embedded in a robot. Therefore, AI methods are studied in bachelor's degrees in Informatics although recently some universities have started to offer specific AI degrees. The field of AI devoted to data mining or data science is also strongly connected with degrees in Mathematics and Statistics. AI-focused masters and doctorates also permit students to specialize in this field. These courses are given in Engineering and Polytechnic universities. The majority of students in these branches are male, which raises an alarm about the low influence that women will have in AI and, consequently, in the design of the near-future technology. Figure 3 shows the gender distribution progression in Spain in the last five years, taking three university years (2016–2017, 2018–2019, and 2020–2021) [4]. The percentage of women is increasing slightly in Engineering and Informatics, but has decreased a bit in Mathematics and Statistics (also related to ICT jobs). The total sum of these three fields of the study indicate a very small increase in women's share. It is clearly seen that informatics has only 12–14% of women, which highlights that the presence of women in this sector is significantly lower than other STEM degrees.
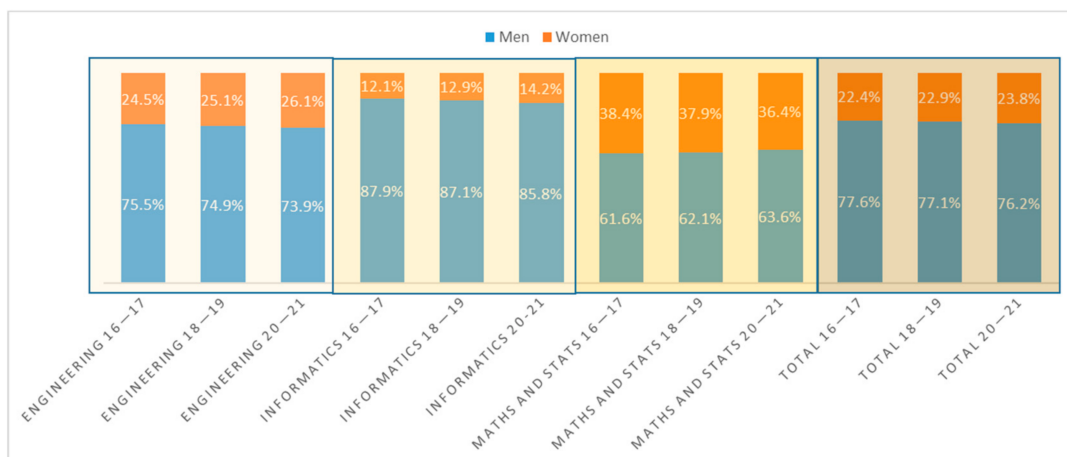
Figure 3. Gender distribution of university students by field in Spain 2016–2021.

The loss of interest in technology occurs at very early ages [5], near the moment when children identify their gender. Family and culture seem to be determinants [6] in the association of technology roles with boys, while girls are pushed more towards roles linked to care and humanistic activities. This push is supported by the messages unconsciously transmitted by the media. In [7], authors analyzed how media contributes to gender stereotypes in children and youth, observing that girls are underrepresented and their characters usually have limited personality traits and show stereotypes about beauty and sex appeal. Among other biases, the work in [7] also includes research papers that show how youth's expectations and preferences concerning academic degrees and jobs are influenced by the media. In particular, they highlight that the lack of women professionals in the media diminishes the aspirations of girls. Among this lack of female role models, the case in Engineering and Informatics is even higher, leading to the gender-driven division of interests in youth. Engagement in technology or, more precisely, in robotics and AI-related fields, has been seen to be different by gender. As an example, the US statistics company Statista published a graphic illustrating the familiarity with some virtual digital

assistants by gender in 2016 (see Figure 4). It can be seen that men duplicate or triplicate the familiarity in the majority of voice assistants with respect to women (except for Siri).
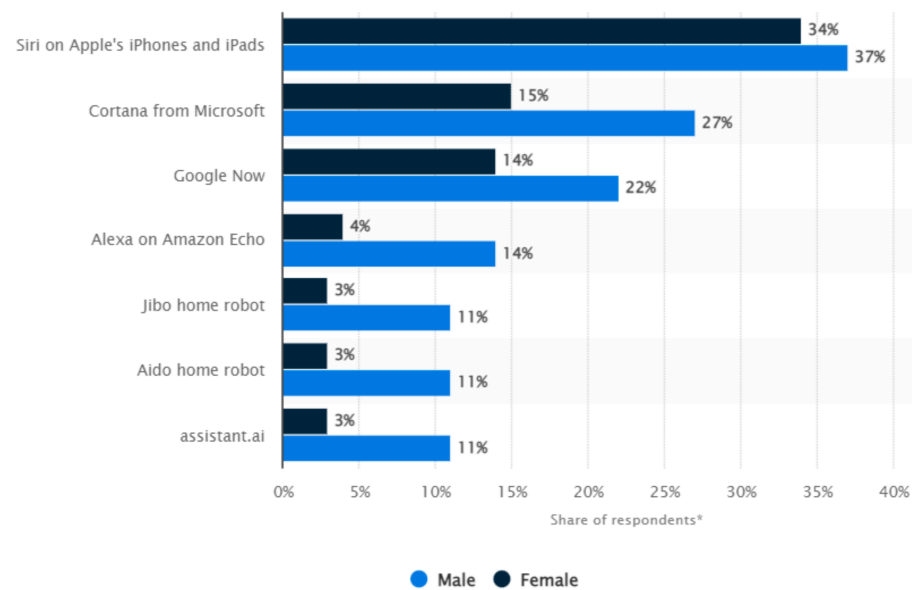
Figure 4. Familiarity with virtual digital assistants in the United States (from Statista 2021). * 492 respondents, 18 years and older.

Regarding women's interests, the Pisa Report 2015 states that the majority of girls enrolled in scientific careers declared expectations of working in the health sector [8]. Researchers have found that women search for societally meaningful jobs, that is, jobs to improve the lives of people [9]. The tacit pressure of the entire society to push girls and women to play a social and humanistic role is so heavy that, unless girls are exposed to explicit messages about other possibilities, they tend to align their vital decisions with those stereotyped systemic expectations, choosing those humanistic and social components in their training programs. In Catalonia, the students formalize an application to the Education Department from the Catalan government indicating their preferences about higher education around March so that they follow the admission processes in the different High Schools. Data from 2021 indicates that applications to pure ICT bachelor's degrees (like informatics engineering or telecommunications engineering) show 16% of females. However, when double training programs combine an ICT bachelor with some more "social" degree (like biotechnology or business administration), the applications of females raise to 30% (data extracted from the Department of Education of the Catalan government). This increase indicates that girls tend to feel more comfortable applying for training programs including this social and humanistic component, even if they are interested in technology.

However, the lack of association of Informatics with improving the lives of people is wrong. The reality is that developments in computers have led to huge benefits in the quality of life of many people. In the same line, Artificial Intelligence is also strongly connected to meaningful jobs as shown in [9], where different applications of Machine Learning and Data Science positively influence wealth in areas such as health care, business, education, or environmental protection. The possibilities of AI for society are enormous, and women can certainly find their place in it if they are able to discover the possibilities of the tools in data analysis, machine learning, robotics, and computer vision among others.

In this paper, we will use the term *gender gap* to refer to all inequalities related to gender observed in the STEM sector. The main inequality is the presence in the sector. Moreover, other expressions of the gender gap are the difficulties of the STEM women to promote their careers, for example. Therefore, in this paper this term will have a wide interpretation and, depending on the context, it will refer to the lack of female professionals in the sector, to inequalities in salaries, or promotion in career, etc.

The need to engage women and bridge the gender gap in STEM and AI has been recognized by several local and international institutions, and some actions to mitigate it have started in academic and professional sectors [10,11]. Some teams have been created to promote STEM in girls [12]. Other initiatives try to gather professionals in these fields to make them visible, such as *Women in AI*, an international non-profit organization to create an AI female community for inspiring and empowering women to become AI and data experts [13]. They organize large events such as AI camps, master classes, or hackathons. Similarly, *Humans for AI* is a non-profit organization focused on democratizing AI to attract minorities, not only to diversify gender but also to include different socioeconomic statuses or races [14]. Regarding research, there are many conferences for women to facilitate networking, such as Women in Data Science (WiDS), Women in Robotics, or Women in Machine Learning (WiML). However, to spread the AI interest to all girls at different ages, having local territorial structures may be more appropriate since we can find the girls instead of waiting for them to discover and join a specialized international association.

In this paper, we present a set of objectives, a conceptual model, and a work methodology for addressing the gender gap in AI in the different stages of women's lives. This methodology is based on building a working group of AI professionals with a territorial structure which facilitates the efficient de-centralization of cooperative actions for promoting the AI field from girls' childhood. This project is aligned with the Sustainable Development Goals of the United Nations for 2030, in particular, with the goal SDG5: achieve gender equality and empower all women and girls [15]. The proposal has been built from the experience of the donesIAcat group, which is a team of AI women who belong to the scientific Catalan Association for Artificial Intelligence.

The main contribution of this paper is a conceptual framework for reducing the gender gap in Artificial Intelligence at a national or regional level. This model has two main distinctive characteristics: first, members are organized in a territorial network, which facilitates the rapid dissemination of information and activities in the region of influence, with rapid and solid connections in each remote corner of the territory; second, the model identifies six types of actions to pursue goals addressed to the different target population (students and professionals) and at different ages. Section 2 presents the Catalan gender working group, donesIAcat, which will be used to illustrate the proposed methodology. Section 3 explains the general conceptual model and its agents. Sections 4–7 explain each of the actions and provide examples from the experience of donesIAcat in the Catalan-speaking regions. Finally, Section 8 presents some conclusions and future work.

2. The Gender Working Group: donesIAcat

The gender working group donesIAcat belongs to the Catalan Association of Artificial Intelligence (ACIA, www.acia.cat (accessed on 17 March 2022)). First, we want to make a short presentation of the framework of the scientific association ACIA, and then we will describe the gender group and its mission, structure, and activities.

2.1. The Catalan Association of Artificial Intelligence (ACIA)

The Catalan Association of Artificial Intelligence (ACIA) was created in 1994 as a non-profit association to gather the scientists, professionals, and students that work in Artificial Intelligence in Catalonia. ACIA was born with the aim of being a meeting point for all the researchers who were pioneers in the study of AI in Catalonia. The main goals of ACIA include (1) the facilitation of the communication between professionals and organizations that work in AI, (2) the promotion of AI courses, techniques, and applications within the Catalan society, and (3) the organization of social and scientific events (e.g., conferences, workshops, and meetups) to disseminate the knowledge about AI. Among its many activities, we highlight the periodic publication of the association's magazine (ACIA's Bulletin, later called *Nodes*), and the organization of an annual International Congress about AI (called CCIA) since 1998, whose proceedings are published by IOS Press. ACIA also provides some

benefits for its members, especially youth, such as discounts in sponsored conferences or the annual award prizes to the best AI doctoral thesis and the best master thesis.

Today, ACIA gathers most of the Catalan scientific community as well as alumni and professionals in the sector. Currently, the association has more than 220 individuals and institutional partners. Despite being the association of a small territory, ACIA has been a member of the European Association for Artificial Intelligence since 1995 (first denoted ECAI and now named EurAI). As an example of its international scientific leadership, we can mention that 10 members of ACIA have been distinguished as EurAI fellows, a program that started in 1999. This distinction is given to less than 3% of the EurAI associates. Only France, Germany, the United Kingdom, and Italy associations have more awarded scientists than ACIA.

These numbers show that ACIA is the largest and oldest inter-institutional AI association in Catalonia. It has served as a connection point for the scientific community and as a link with companies and society in general.

2.2. donesIAcat (WomenAIcat), the Gender Commission of ACIA

On 8 March 2019, International Women's Day, donesIAcat was founded by Prof. Karina Gibert as a working group inside ACIA. The main goal of this working group was to increase the presence of women in the Artificial Intelligence sector in Catalonia, thus reducing the gender differences. Currently, the association only has 17.5% of female members. The first board of donesIAcat involved five members from the different areas where ACIA had associates which soon organized in a territorial structure as will be explained later in this paper.

In line with other recent Catalan actions about gender, some of the women in ACIA decided to create the working group donesIAcat to make visible the work we were already doing to reduce the gender gap in AI and achieve a more balanced AI community. Being born from a scientific association, donesAIcat is mainly constituted of members with a scientific profile who work at universities or research centers in Catalonia. Due to this profile, some of the members of ACIA have been working to stimulate technological vocations in girls for years, but the lack of coordination of these individual initiatives made the work much harder. The formalization of this group permits them to have a supporting structure for coordinating and disseminating their actions, as well as to jointly identify new lines of work. The existing previous contacts between those women facilitated the decision of creating donesIAcat as well as the engagement in defining, sharing, and participating in gender-based activities for the dissemination of AI.

The mission of donesIAcat is to contribute to bridging the gender gap in the Artificial Intelligence field with a focus on the territorial scope of ACIA, which is the area known as Catalan Countries (70,000 km^2) that includes all territories where the Catalan language is spoken.

The working group donesIAcat is connected to other gender organizations in Catalonia and Spain. For example, it has close relations with donesCOEINF (the gender commission of the Official Professional Chamber of Informatics Engineering in Catalonia) and the two collaborate in some initiatives with the aim of being more effective together.
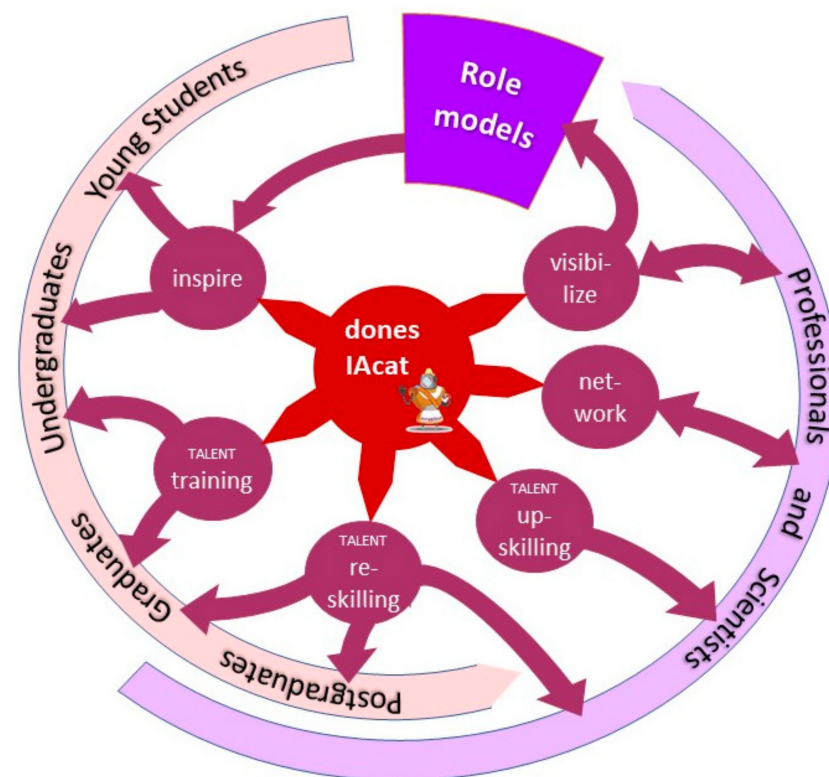
3. Conceptual Working Framework for Gender-Bias Reduction

The discovery of the interest in Artificial Intelligence (or in STEM in general) may happen at different moments in life. Moreover, it can be triggered in different ways and by different activities and goals, depending on the target audience. Establishing a well-defined framework is crucial to structure the actions done by women working groups in order to materialize effective lifelong support of women.

In this paper, we propose a conceptual framework based on different kinds of goals for the different target populations and different ages. This proposal is the result of synthesizing the expertise accumulated over the years from developing gender-oriented activities and collecting personal evidence of what works, for better or worse. The joint

experiences of all members of the working group allowed us to find the essential actions that have positive impacts and has permitted the authors to elaborate on this conceptual framework. Figure 5 shows a graphical representation of this circular framework which is organized around a central node (the gender working group). The outer circles represent the female population, separated into students from primary school to postgraduate, and working people (professionals and scientists). The actions of the working group towards this population are grouped into six lines:

- Inspiring new vocations in children and undergraduates.
- Talent generation and training at university age.
- Talent Up-skilling of students and professionals.
- Talent Re-skilling of students and professionals.
- Networking of AI professionals and scientists.
- Making female AI professionals visible to create role models.

Figure 5. Conceptual working framework for the gender-bias reduction in AI.

A crucial step in this conceptual model is the feedback that arrives to the central women association by means of visibility and networking actions. AI professionals and scientists who received inspiration and talent formation can later become part of the working group, becoming new role models who inspire the next generation of girls. Maintaining and growing a territorial network structure is the core of this organizational model.

4. Inspiring New Vocations in Children and Teens

The first line of action is targeted at K-12 students, from elementary school to university undergraduates. Activities must consider the age of the participants to appropriately present the field of Artificial Intelligence and its potential impact on society. The inspirational message must be given by AI women, that will implicitly act as a role models for these young ages, as the experience of current AI females indicates [16]. The presentation of relevant women in AI and Informatics is a good starting point (e.g., Ada Lovelace, Grace Hooper, Margaret Hamilton, etc.). However, explaining AI from a personal perspective, such as presenting personal motivation and ongoing AI projects, usually has a greater

impact on girls. Additionally, presenting current professionals that can be perceived as closer to the girls is important. We propose two different types of activities for this period: inside or outside school.

- Inspirational activities in the school: These kinds of activities are done by a female role model in the student's classroom and during school time. They can be done just with the girls or with both genders together, but it is worth noting that students do not choose to participate in the activity, as it is mandatory for them. This permits us to arrive at all possible kinds of children's profiles, even if one of them has never thought of technology or AI. Thus, they can learn about the field and maybe discover an uncovered interest not manifested before. These activities usually consist of a presentation of the role model and some short participatory activities (question-answer, logic puzzles, etc.) for 60 or 90 min. Some examples of activities made by donesIAcat in this line are talks at primary school that might be part of a frame project or not. Among those framed in bigger projects, members of donesIAcat participate in the program Aquí-STEAM (https://aquisteam.upc.edu/ca (accessed on 17 March 2022)) for children between 9 and 14 (from University Politècnica de Catalunya in the province of Barcelona) and INSPIRA-STEAM (https://inspirasteam.net/ (accessed on 17 March 2022)), which is a Spanish project addressed to children aged 11–12 lead by the University of Deusto and the University Rovira i Virgili in the province of Tarragona; some members of donesIAcat also visit specific schools on their own with similar sessions or in the framework of Catalan events for female empowerment (like Girls Day (https://www.urv.cat/en/campus-life/corporate-responsibility/equality-observatory/girlsday/ (accessed on 17 March 2022)) or 100tífiques (https://100tifiques.cat/en/home/ (accessed on 17 March 2022)). We also mentor the research works of students at secondary school (16–18 years) by participating in their interviews with AI experts, providing them suitable references to AI, or supervising some practical experiments with AI tools.

- Open activities outside school: These inspirational actions may include invited conferences to some technology-related forums (e.g., giving a talk at the closure of the Technovation Girls (https://technovationchallenge.org/ (accessed on 17 March 2022)) event for developing apps, at the province of Lleida), being members of the evaluation jury in tech-related activities for juniors (such as the First Lego League (https://www.etse.urv.cat/flltarragona/ (accessed on 17 March 2022)) in Tarragona-Reus), or participating in special workshops for schools on programming and robotics organized during the weekends in social innovation labs (Citilab, Barcelona). The previous actions belong to projects led by other entities with synergic aims within the territory. However, the gender working group itself has also initiated and led some activities open to teenagers. In the framework of the annual Mobile World Congress in Barcelona, donesIAcat organizes an AI stand in a co-located event called YOMO (Youth Mobile Festival) which is usually visited by 25,000 students from many secondary schools in Catalonia. The teens participating in these kinds of activities are usually interested in STEM in advance and they choose to attend those events. Therefore, the role models should focus on giving more detailed knowledge about Artificial Intelligence and its multiple applications and sub-fields, as well as encouraging them to choose the university degrees that give the formation needed to become an AI expert.

5. Talent Generation

The previous inspirational actions were aimed at enabling young people to discover the Artificial Intelligence field and its diverse applications. Female role models try also to convince youth that this is not a male field, but a nice job for any person, encouraging girls to break stereotypes. Making the fundamental role of AI in the current health or environmental fields visible becomes crucial to stimulate the interest of girls in the field. The second main line of work is devoted to the education of women in Artificial Intelligence.

This goal should be addressed differently depending on the life stage of the participants. We propose three different groups of actions:

- Training: Regular courses about AI in bachelor's and master's degrees for the students mainly in Informatics or AI degrees.
- Re-skilling: Short courses for giving insights in particular areas of AI, addressed to university students, postgraduates, or professionals with a STEM background who want to work in AI-related projects, such as students of Mathematics, Statistics, Business, or other Engineering specializations.
- Up-skilling: Short courses or training camps for professionals of other disciplines who want to get some general concepts to begin to understand AI.

5.1. Talent Training

Having scientists and researchers in a women association is a great value for taking certain actions. These AI researchers may promote and participate in teaching actions within universities, as some of its members are involved in the coordination of courses or degree programs. It is important to try to be influential in the curricula definition with regards to AI, giving a female perspective. Being involved as teachers is also a way of being role models for the next generation at bachelor and master levels. It is indicated in Figure 5 as talent training actions.

The experience of donesIAcat in this line is quite large, since many of their members are researchers at universities with more than 25 years of teaching experience in regular training programs, both at public and private centers. Some of our members created the first AI subjects in the Informatics degrees at different universities of Catalonia since 1995. Currently, donesIAcat has members in 12 different universities spread throughout the Catalan Countries. Recently, some of our members have to lead the definition of two Artificial Intelligence bachelor's degree programs, started in 2021 at the Universitat Politècnica de Catalunya (official degree recognized by the Spanish Education Ministry) and the Universitat Autònoma de Barcelona (specific title offered by UAB, currently in process of officialization). In both cases, the participation of donesIAcat in the definition of competencies and elaboration of the curricula of these degrees has been acknowledged. We have also been involved in master courses and the coordination of AI master studies in several universities. It is worth mentioning the inter-university Masters on Artificial Intelligence, given jointly by three Catalan universities, where our members give eight different specialized courses, such as multi-agent systems, intelligent decision support systems, machine learning (including artificial neural networks and deep learning, among others) or computational intelligence.

5.2. Talent Re-Skilling and Up-Skilling

Artificial Intelligence is a field of specialization related to many other disciplines (Statistics, Business Intelligence, Telecommunications, etc.) and with many different fields of application. For this reason, having some knowledge about AI may be of interest to students and professionals that have not studied AI at university.

Re-skilling and up-skilling courses could be promoted from an AI female association. These training programs can be addressed only to women or they can be open to any attendant. The support and orientation from the AI women association are important to define appropriate training program contents that include the discussion about gender bias in AI and how the gender perspective must be included in the design of AI apps, databases, machine learning algorithms, and reports. Additionally, if women from the association participate in teaching, this implicitly generates role models and inspires the female attendants to become AI professionals too.

Some members of the group donesIAcat participate and promote a recent re-skilling training program on AI for girls that are at the end of their STEM bachelor's degrees or have recently graduated. The program is called Top Secret Rosies (https://topsecretrosies.soko.tech/ (accessed on 17 March 2022)) and the women of the research center IDEAI-UPC

(with 13 women out of the 70 AI researchers) have the academic and scientific direction of the program and have designed and elaborated the training contents and the methodology. In its first edition, it has filled the 21 seats available (from 53 application forms received) with women from many different countries and backgrounds. Some of them have won an internship to work in AI at international companies.

The women association members can also take part in professionalizing masters, giving courses on high specialization where gender perspective can be applied as well, and their professional experience can be communicated to students. From donesIAcat, we participate in many initiatives. The members of donesIAcat from UPC take part in many advanced courses from UPC Foundation, the permanent training program at UPC, participating as lecturers and advisors in programs like Master on Industry4.0, Master on eHealth, Master on digital transformation, or Master for CIOs in innovation. Specialized professionals enroll in these masters, and can apply what they learn directly to their jobs, so the presence of donesIAcat brings to those professionals the gender perspective and new ways to address their daily work.

6. Visibilization of AI Female Talent

Women do not appear in media or other public technological dissemination events as frequently as men do. According to the last study in 2020 of UN Women [17] on women's representation in society, only 24% of persons read, heard, or seen in the news are women. In the science and health fields, it raises to 35%, but it is still much lower than men's visibility. It is known, as said in Section 3, that this biased view induces gender stereotypes in the young. Therefore, it should be a priority goal of AI women associations to make visible the female talent by means of different actions. We propose two basic directions:

- To explain and make visible what female professionals (from our association or not) do in the AI field.
- To identify role models among STEM women and engage them in activities that increase their visibility (as keynote speakers in international conferences, panelists in round tables, etc.).

In the first line of work, donesIAcat has started to make some dissemination publications. We have addressed scientific publications, such as a position paper in a specialized STEM conference [10] and a paper in a scientific journal [12], which discuss the gender bias in technology in order to make this fact visible. Other kinds of publications include articles in magazines, such as Forbes [18], with a text explaining the challenge of being a woman in technology, or an article about why girls are not engaged in STEM at The Conversation (in Spanish) [6].

Promoting the publication of scientific papers can be a strategic action to explain what women make in AI. For this reason, editing special issues in relevant journals focused on women authors is important for visibilization. The current special issue is edited by two members of donesIAcat, who spread the call for papers not only in the Catalan Countries but all over the world by means of several AI mailing lists. In addition, donesIAcat presents the work done over the year at the yearly conference of ACIA in a public session of the international CCIA conference.

Regarding the second line of work, the first set of actions of women associations is devoted to monitoring that the organizers of AI-related events avoid gender bias. This bias can happen on the invited speakers, on the selection of round table members, or the configuration of panels of experts. In this sense, donesIAcat achieved the inclusion of these ideas for gender gap reduction in the guide for organizing the CCIA conference (International Conference of the Catalan Association for Artificial Intelligence).

Another set of actions is focused on promoting and participating in specific events in technology and AI. For example, some members of donesIAcat became ambassadors of the Women in Data Science (WiDS (https://sites.google.com/isglobal.org/widsbarcelona (accessed on 17 March 2022))) for Barcelona and were the leading organizers of the WiDS international event 2021 (they are currently preparing the one for 2022). Others

participated in the organization of a round table with the title "Women in Tech; an inclusive approach", as an event scheduled in 4YFN 2020 (part of the Mobile World Congress), and still others participated in the panels at the Catalan forum Cicle Hipàtia (https://www.50a50.org/es/iniciamos-el-ciclo-hipatia/ (accessed on 17 March 2022)) (50 × 50 shared leading association), or on the set of talks about "Sex and Gender Bias in Artificial Intelligence and Health: Building a Future for Equality", held in Barcelona during 3 months at Caixaforum.

This leadership in some events, as well as the promotion of role models made from the association, brings new opportunities to participate in other activities organized at the different locations of the territory. Our associates are now included in the list of AI women who work in the inspirational activities done with students, presented in Section 2. Moreover, our members are called to participate in initiatives of other entities for gender visibilization like the PreInf (https://enginyeriainformatica.cat/preinf/ (accessed on 17 March 2022)), the portal for promotion of Informatics in women (from the Illustrious Official Chamber of Informatics Engineering of Catalonia), TEDx events (e.g., a motivational talk about Data Science by Dr. Karina Gibert at TEdxIgualada in 2021), or The Women in Computer Science and STEM workshop at the AICCSA 2021 conference.

These two lines of promotion of women in AI facilitate the consolidation of the AI working group, increasing the opportunities of being enrolled in future AI activities. It is worth noting that, although many actions are focused on making AI female experts visible to society, we have also presented specific initiatives for professionals and AI scientists.

7. Constructing a Network

This paper addresses the case of creating a women's AI working group for serving a certain territory (i.e., a country or a subset such as the Catalan Countries). This locality may be beneficial for many people of all ages by means of the activities previously presented, which range from inspirational sessions at elementary schools to training courses for professionals.

Most gender groups and associations are flat structures, with a board and a set of members. However, as the main goal is to arrive at different locations of the territory, we propose building the association with a territorial organization network structure. The area of influence is divided into sub-areas according to some administrative structures (such as provinces, regions, or others) and a node is created for each of these parts. There is one representative of the commission at each territorial node who knows the local context regarding AI well. She will be in charge of implementing the gender actions in her area with the support of other members who live in the same area. This node representative works in line with the board of the commission which is integrated by the president of the commission and all the other territorial delegates.

This network structure brings several advantages:

- A better understanding of the reality of AI expertise and knowledge in each part of the territory. This local knowledge is crucial to adapt the actions to the particularities of specific areas.
- Ease in finding local professionals with the availability for deploying the initiatives in their local city, reducing effort and travel time, and facilitating the scheduling.
- Providing a capacity to react very quickly to interventions in all territorial areas, not just in big cities as it usually happens.
- Providing territorial proximity that facilitates the success of certain actions.

These advantages are aligned with significantly reducing the reaction time on the appearance of new activities, which increases the potential of the network.

As this network structure depends on each territory, in the following subsections we will explain the network organization of donesIAcat.

7.1. Organizing Based on a Territorial Structure for donesIAcat

Catalan Countries include the Spanish regions of Catalonia, the Balearic Islands, Valencia, and parts of Aragon (La Franja) and Murcia (Carche), as well as the Principality of Andorra, the department of Pyrénées-Orientales (including Cerdagne, Roussillon, and Vallespir) in the south of France, and the city of Alghero in Sardinia Island (Italy); all of the territories where Catalan is spoken. Based on these administrative regions and taking into account the population of the areas and the number of schools, donesIAcat has defined seven district nodes, each one with a local representative as shown in Figure 6.
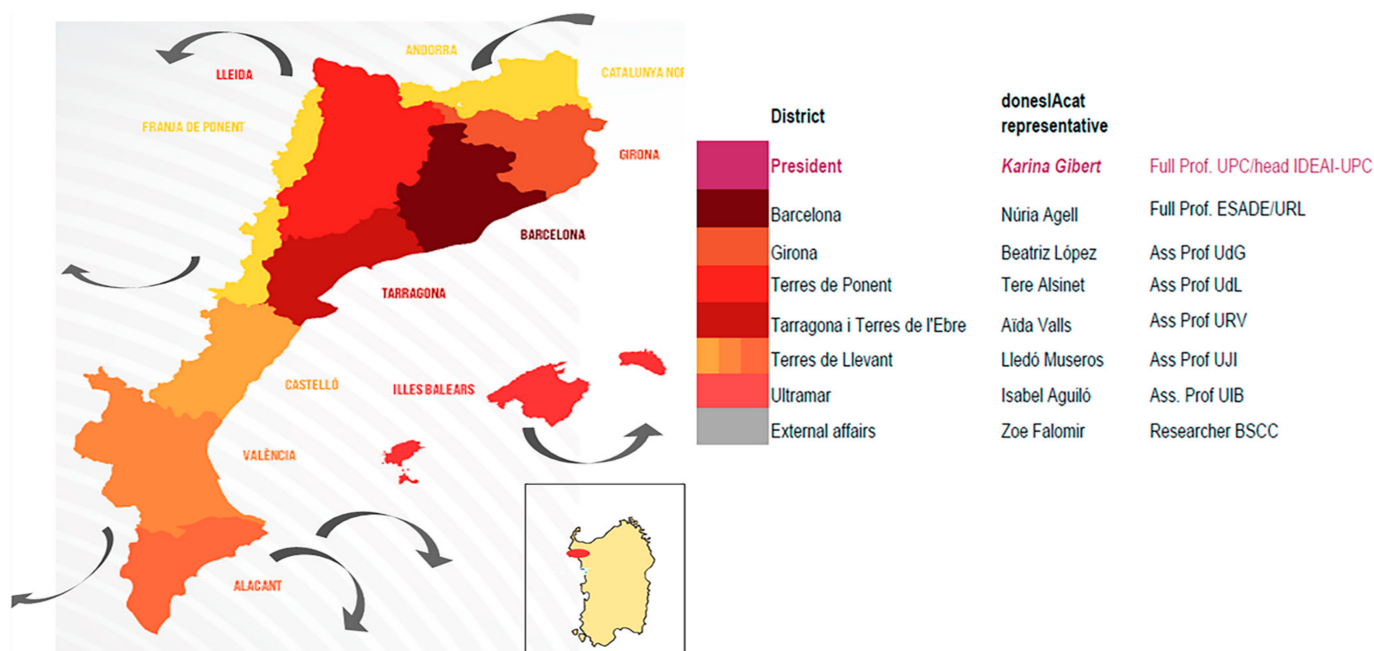
Figure 6. Territorial network organization of donesIAcat.

We have four nodes in Catalonia, one for each of its provinces and neighboring areas: Barcelona, Girona (including south of France), Terres Ponent (for Lleida province and Aragon area), and Tarragona i Terres de l'Ebre. Another node in the south corresponds to the Terres de Llevant region which gathers Castelló, Valencia, Alacant, and Carche. Finally, a node for the territories in islands is denoted Ultramar (which includes the Balearic Islands and Alghero).

In addition to these six local nodes, we propose to establish at least one international node with the aim of gathering national women that are now working abroad. A good connection with the professionals and academics that work in other countries is extremely for international role models, to make our talent and experts visible outside the territory, and to facilitate connections to the new AI professionals that participate in our talent programs.

7.2. Corporative Image

Defining a brand image is relevant for providing a unified view of the actions that come from the gender commission and facilitating the identification of the entity. In this line, a logo or icon image can help the user easily associate an activity with the commission. Logos are the symbol of the organization and should inspire an immediate recognition of the working group. They can be composed of an emblem or symbol and a wordmark. Meanwhile, an icon is an artistic picture that represents what is being offered by the organization. Icons help viewers to understand immediately what the organization is about.

In the gender commission donesIAcat, we have both a logo and an icon. As donesIAcat is a workgroup inside the ACIA association (Catalan Association for AI), the logo was

designed using the same brand image from ACIA but adding some new elements that represent women. In Figure 7 (left) you can see the ACIA logo and (right) the logo of donesIAcat. This new logo adds the flower to represent women and uses a purple color which is associated with female actions. The original typography, background color form, and style were maintained to have a unified image with ACIA and let viewers identify the link between both.

Figure 7. ACIA and donesIAcat logos.

In addition to this abstract logo, donesIAcat also has an icon image, displayed in Figure 8. It represents a friendly female robot dressed in traditional Valencian clothes, mixing the idea of intelligence in an artificial body, feminization, and Catalan Countries. This icon was designed by a professional illustrator in 2015 as an image for the CCIA conference held in Valencia. She was called Rita, a typical Valencian female name. One of the organizers of CCIA 2015, who is also a member of the donesIAcat, gently transferred the use of Rita as a donesIAcat icon with a previous modification to add the donesIAcat brand in the dress of the robot. Rita officially became the icon of donesIAcat in 2020.

Figure 8. The icon image of donesIAcat called Rita.

The design of the logo and the icon should be carefully studied. Colors and symbols may have different meanings depending on the culture. In the case of donesIAcat, the members of the working group did a selection among different options. For example, the purple color is used in Spain to represent actions that are pro women's rights. However, it is important to take into account who is the target audience of the actions and then define a logo and icon that do not reinforce the stereotypes we are seeking to eliminate.

7.3. Communication Channels

The communication strategy, both with internal and external people, must be also appropriately defined. First, it is important to establish communication protocols with the members of the working group that enable agile decision-making. In our case, WhatsApp lists among members of donesIAcat permit quick dissemination of information and communication of new events or interesting issues. We have a second list for the board members that includes all the territorial representatives. Inside each territory, a specific list helps to spread the information in that location. This channel guarantees that information is spread quickly to all the territorial structures. Whatsapp, Slack, or Telegram might

be good possibilities to fulfill this purpose. The advantage of the laters is that they are more robust and have more elaborate privacy protocols. Nevertheless, it is also important to have the possibility of doing at least one live meeting every year. In this regard, the working group donesIAcat has a yearly meeting of the majority of its members during the annual conference organized by ACIA to share their experiences, discuss improvement actions, and strengthen the relations between the members. Additionally, when convenient, online meetings are arranged throughout the year for specific issues that become difficult to manage through the Whatsapp or telegram lists. We must note that the kind of interactions in online meetings are not the same as presential yearly meetings. However, with the territorial scope of donesIAcat so wide, it is difficult to organize more than one presential meeting per year.

For communication outside the group, we created a Twitter channel (@donesIAcat) and have a section on the webpage of the ACIA association. (https://www.acia.cat/catala-dones/ (accessed on 17 March 2022)).

7.4. Institutional Relationships

Gender committees should be connected with the relevant institutions in their countries not only to be known but also to establish relationships and participate in joint activities. The working group donesIAcat is in close contact with *donesCOEINF*, the gender commission of the Official Professional Chamber of Informatics Engineering of Catalonia, and with Mujeres en IA (from AEPIA, the Spanish Association on Artificial Intelligence). At the same time, they are linked to other gender structures in Spain, as well as at the international level. Establishing synergies may help us to be more effective in our goals. In Catalonia, there are some other institutions that work to reduce gender bias in a more general framework. Some members of donesIAcat are representatives in the associations "50 × 50 liderage compartit" (https://www.50a50.org/es/ (accessed on 17 March 2022)) (association created by the Commerce Chamber in Barcelona) and promoters and leaders of the "Red de Mujeres del Sector Digital" (https://sheleader.eu/web/es/redes/mujeres-sector-digital (accessed on 17 March 2022)) (an ICT network created from donesIAcat, SheLeader, donesCOEINF, and Telecos.cat). As gender issues are often related to ethics as well, it is relevant to mention that some donesIAcat members are members of the Ethics Advisory boards of entities like the Catalan Observatory on Ethics in AI (OEIAC) or the Centre of Innovation and Development of Artificial Intelligence in Catalonia (CIDAI). DonesIAcat also has two women that are part of the experts' group of the Artificial Intelligence strategy of the Catalan Government (catalonia.ai) which is now deploying. Fortunately, the Catalan Parliament has a special interest in gender equality and equity and has started several initiatives to achieve them. Gender working groups should be aware of these governmental activities and participate in them. In our case, every year since 2019 one representative from donesIAcat participates in the panel sessions of the Catalan Parliament entitled "Effective women and men equality: a country challenge" and follows meetings led by the Catalan Parliament President around different topics in the field.

8. Discussion and Conclusions

The implications of Artificial Intelligence in current and future societies are enormous. Traditionally, we developed machines and software programs for solving specific and concrete problems. In contrast, today we are developing technologies that can learn and adapt dynamically, being more autonomous. Knowing, understanding, and participating in the design and implementation of these new AI systems will be important for future generations. Women must be working in the field with equal capabilities and opportunities with respect to men.

This paper has started by showing that the number of women studying Informatics is around 14%, which significantly reduces the presence of women with knowledge about AI and consequently, there are few women working in the field and influencing the design of new AI technology. Having recognized that reducing the gender gap in this sector is a

challenge, we have proposed a conceptual model for creating national or regional working groups to work effectively and efficiently to bridge this gap. This model is organized into six axes around three main lines from which we can extract some conclusions:

- Inspiration and talent training: Activities to stimulate AI interest in girls and to give AI knowledge by means of educational programs designed for different stages of life and serving different purposes (regular university degrees, up-skilling courses, or re-skilling training). This paper has presented different activities conducted inside and outside educational centers. As female AI experts are the teachers and mentors of these activities, they become role models for the youths. This is a key point in the proposed conceptual framework since it is known that gender stereotypes can be reduced by making female talent visible as role models.

- Visibilization actions: Actions presented to make AI experts visible were targeted mainly to impact the general society by means of more appearances in public events to help women have equal opportunities in job promotions, in the market, and in leadership positions. These women can then become part of the gender commission or participate in inspirational activities for girls, becoming new role models. In addition, it is also important to carry out some activities for professionals or AI scientists (e.g., in fairs, congresses, and journals), as women in these fields are currently in a minority. Only a global view of visibilization will be able to effectively make a change.

- Networking: We have seen some useful tools for the internal organization of the network and for having a unified image for communication. Our model is based on the creation of territorial structures that contribute to decentralizing the activities and facilitating the dissemination to every city in an easy way. Once the internal aspects are solved, it is important to find collaborations with other entities, creating synergies with existing initiatives already established in the territory.

This network-based organizational model is suitable for relatively small territories or countries where it is feasible that women in the working group know each other and contacts between them are easy to establish. For larger areas, a different kind of organization, such as a hierarchy, would be probably better. This model is also appropriate for territories sharing a common history, language, and way of living, so that the activities proposed in the group are suitable for the different cities in the region. Proximity is one of the advantages of such a model and one of the reasons for the success of the inspiration and visibilization actions.

This conceptual model is supported by the experience of the gender working group donesIAcat of the ACIA association which holds its activities in the Catalan Countries. Since its foundation at the beginning of 2019, the group has been able to consolidate a large number of activities following the proposed methodology.

One of the limitations encountered is the lack of funded projects oriented to the development of activities to reduce gender bias. Although there is a general agreement about the importance of increasing female presence in AI, until now, most of the activities done in this commission are currently made voluntarily, without any return, and using the non-working time of the members of the commission to develop and prepare the activities. This is of course limiting the kind of actions that can be activated since we cannot, at the moment, think of working plans that require too much personal effort from the members of the working group or too many material resources. Some concrete actions have accounted for specific sponsors from companies, but they are not easy to find. Universities have also provided some funds for some actions organized with them, especially inspirational activities and talent training courses. We must highlight that recently, the Catalan government approved the strategic plan on AI from Catalonia (https://politiquesdigitals.gencat.cat/ca/tic/catalonia-ai (accessed on 17 March 2022)) which recognizes the gender gap in AI and identifies gender gap as a strategic priority in Catalonia [19]. We want to highlight this pioneering policy in favor of promoting the societal transformation required to balance the presence of women in STEM. This policy may also open the possibility of new financial resources for the actions done in gender groups.

The activities of donesIAcat started just three years ago and some of them will show results in the mid-term, so they cannot be properly measured yet. However, we can provide some insights about the kind of impact related to the actions developed from donesIAcat. The first inspirational and dissemination actions were with children in schools, as well as in the YOMO congress. After 3 years, some of the girls that participated have arrived at the university and even though we have not made a formal study, we can observe an increase in the number of female students in the Informatics degrees. For example, at UPC (in Barcelona) there has been an increase in the presence of women from 7% in 2019 to 14% in 2021; similarly, in the Universitat Rovira i Virgili (in Tarragona) the increase was from 8.7% in 2019 to 11.5% in 2021.

Moreover, building a network of female professionals creates the atmosphere to share glass-ceiling experiences and can provide resources to help the affected woman better manage the situation and minimize the impact on her career. After several years, the awareness and capacity of all members of the working group to identify gender inequalities in their working contexts has increased and they have acquired expertise in gender issues so that they can also help other women in their companies. This training helped, for example, to build a new type of promotional speech to promote the new official degree on Artificial Intelligence in the Barcelona School of Informatics that started in September 2020 and has attracted 45% of female students. Based on this evidence, the school is now redesigning the promotion programs of the bachelor of Informatics Engineering using the same technique of enhancing and making explicit the social role of technology and how these professions are useful in contributing to health, wellness, or sustainability from a professional position different from that of doctors, psychologists, or environmental scientists, for example.

We certainly need a more temporal perspective to collect rigorous evidence associated with our actions, but we can already observe some promising results that encourage us to continue working in the proposed directions. However, after analyzing the work done by donesIAcat until now, we can say that we are proud of being quite active along the territory. We must continue to engage women to increase our presence in some parts of the Catalan Countries.

We would also like to get men involved in this gender balance goal. As said before, ACIA only has 17.5% of female associates, and being a minority, it is possible that the board of ACIA, composed of 77% of men in 2019, did not accept the creation of the donesIAcat working group. Fortunately, the situation was contrary and the initiative to create donesIAcat was highly welcomed by the ACIA board. This guaranteed that the working group was officially integrated into the association structure and approved by the government of the association. In addition, our experience is that 82.5% of male associates in ACIA support the activities of the donesIAcat and encourage us to continue working to bridge the gender gap in the AI sector. However, we would like to design specific activities to also involve men in the dissemination of our message and the development of activities where they can participate to contribute in a more effective way to bridge the gender gap in AI.

Some other tasks are also in our plans, such as the creation of an online procedure for subscription to the working group or to receive news from the group. Another line of work is the development of a communication plan that facilitates the presence in the media to disseminate the activities done and to consolidate activities to reach more girls and to support more professionals in their professional development. We should have a community manager and then create specific content on social networks like Instagram or Linkedin. We strongly believe that our young working group will be able to reach these goals and give girls the opportunity to know what Artificial Intelligence is and that they can study and work in the AI field if they want to.

Abbreviations

The following abbreviations are used in this manuscript:

ACIA	Catalan Association of Artificial Intelligence
AEPIA	Spanish Association on Artificial Intelligence
AI	Artificial Intelligence
AICCSA	ACS/IEEE International Conference on Computer Systems and Applications
CCIA	International Conference of the Catalan Association for Artificial Intelligence
CIDAI	Centre of Innovation and Development of Artificial Intelligence in Catalonia
EurAI	European Association for Artificial Intelligence
ICT	Information and Communication Technologies
IDEAI	Intelligent Data Science and Artificial Intelligence Research Center
OEIAC	Catalan Observatory on Ethics in Artificial Intelligence
STEM	Science, Technology, Engineering, and Mathematics
UPC	Universitat Politècnica de Catalunya—BarcelonaTech
WiDS	Women in Data Science
WiML	Women in Robotics or Women in Machine Learning
YOMO	Youth Mobile Festival

References

1. CEDEFOP. *Skills Forecast: Trends and Challenges to 2030*; Publications Office CEDEFOP Reference Series; European Center for the Developement of Vocational Training: Luxembourg, 2018. Available online: http://data.europa.eu/doi/10.2801/4492 (accessed on 12 December 2021).
2. Martinez, A.; Christnacht, C. Women Are Nearly Half of U.S. Workforce but Only 27% of STEM Workers; US Census Bureau Report, Online. 26 January 2021. Available online: https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html (accessed on 12 December 2021).
3. European Commission. Women in the Digital Age. 2018. Available online: https://op.europa.eu/en/publication-detail/-/publication/84bd6dea-2351-11e8-ac73-01aa75ed71a1 (accessed on 12 December 2021).
4. Ministerio de Universidades, Gobierno de España. Datos y Cifras del Sistema Universitario Español 2020–2021. Available online: https://public.tableau.com/views/Academica20_EEU/InfografiaEEU?%3AshowVizHome=no&%3Aembed=true#7 (accessed on 12 December 2021).
5. Bian, L.; Leslie, S.J.; Cimpian, A. Gender stereotypes about intellectual ability emerge early and influence children's interest. *Science* **2017**, *27*, 389–391. [CrossRef] [PubMed]
6. López-Iñesta, E.; Forte, A.; Botella-Mascarell, C.; Marzal, P.; Rueda, S. Niñas y Disciplinas STEM: Si no Están, Será Porque no les Gusta. Available online: https://theconversation.com/ninas-y-disciplinas-stem-si-no-estan-sera-porque-no-les-gusta-155339 (accessed on 12 December 2021).
7. Ward, L.M.; Grower, P. Media and the development of gender role stereotypes. *Annu. Rev. Dev. Psychol.* **2020**, *2*, 77–99. [CrossRef]
8. OECD. *Pisa 2015 Results (Vol 1: Excellence an Equity in Education)*; OECD: Paris, France, 2016.
9. Hoffman, S.F.; Friedman, H.H. Machine Learning and Meaningful Careers: Increasing the Number of Women in STEM. *J. Res. Gend. Stud.* **2018**, *8*, 11–27. [CrossRef]
10. Gibert, K.; Pérez, C.; Castell, N. Deployment of territorial structures to reduce gender gap in technology and some real cases in Catalonia. In Proceedings of the 2019 24th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Zaragoza, Spain, 10–13 September 2019; pp. 1823–1830. [CrossRef]
11. Samuel, Y.; George, J.; Samuel, J. Beyond STEM, How Can Women Engage Big Data, Analytics, Robotics and Artificial Intelligence? An Exploratory Analysis of Confidence and Educational Factors in the Emerging Technology Waves Influencing the Role of, and Impact Upon, Women. 2018. Available online: https://doi.org/10.2139/ssrn.3735279 (accessed on 12 December 2021).

12. Benavent, X.; De Ves, E.; Forte, A.; Botella-Mascarell, C.; López-Iñesta, E.; Rueda, S.; Roger, S.; Perez, J.; Portalés, C.; Dura, E.; et al. Girls4STEM: Gender Diversity in STEM for a Sustainable Future. *Sustainability* **2020**, *20*, 6051. [CrossRef]

13. Roopaei, M.; Horst, J.; Klass, E.; Foster, G.; Salmon-Stephens, T.; Grunow, J. Women in AI: Barriers and solutions. In Proceedings of the IEEE World AI IoT Congress, Seattle, WA, USA, 10–13 May 2021. [CrossRef]

14. Prives, L. AI for all: Drawing women into the artificial intelligence field. *IEEE Women Eng. Mag.* **2018**, *12*, 30–32. [CrossRef]

15. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. 2015. Available online: https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed on 12 December 2021).

16. Callaghan, S.; Darbyshire, T.; Rafajnia, S. Ada Lovelace day and celebrating women in STEM, Editorial. *Patterns* **2020**, *1*, 3. [CrossRef] [PubMed]

17. UN Women. Visualizing the Data: Women's Representation in Society. UN Digital Library. February 2020. Available online: https://www.unwomen.org/en/digital-library/multimedia/2020/2/infographic-visualizing-the-data-womens-representation (accessed on 12 December 2021).

18. Agell, N. Women in Technology, a Major Challenge for the Future. Available online: https://www.forbes.com/sites/esade/2021/03/08/women-and-technology-a-major-challenge-for-the-future-of-work/?sh=444ee95aeeeb (accessed on 12 December 2021).

19. GENCAT. *Catalonia.AI: L'estratègia d'Intel·Ligència Artificial a Catalunya*; Department of Digital Policies: Barcelona, Spain, 2019. Available online: https://politiquesdigitals.gencat.cat/ca/tic/catalonia-ai (accessed on 12 December 2021).