

Sonification of Women in Sound and Music Computing – The Sound of Female Authorship in ICMC, SMC and NIME proceedings

by Emma Frid

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Comment by PerMagnus Lindborg

Frid's article is an important milestone in the study of the social dynamics of research, specifically in the field of computer music. Focusing on author gender across proceedings of ICMC and other core conferences, her approach is systematic and data-intensive, aligning with that of Essl and Xambó, amongst others. In addition to analysis, the presentation of the study's results includes a creative information design via data sonification. For these reasons, I believe that Frid's article merits to be reprinted and gain a wider readership.

Post scriptum by Emma Frid

In 2017 I published an ICMC paper highlighting the computer music gender gap through sonic representations of female author names in the ICMC, NIME, and SMC proceedings. Findings revealed values consistently below 20%. In 2021, this work was expanded through the Array article "The Gender Gap and the Computer Music Narrative" (see <https://youtu.be/rEgMKINIU5E>), revealing a small but positive trend.

"Gender prediction" based on author names obscures the social constructs and performative acts shaping gender identities. Such an approach disregards intersections with ethnicity, class, sexual orientation and disability, as well as the lived experiences of those identifying as women. Nevertheless, these works triggered important discussions on initiatives towards change.

In times when women's rights are largely threatened in many parts of the world, underrepresentation remains increasingly relevant. Underrepresented community members still face an extra burden in our field, but we can all contribute by calling attention to lived experiences of structural inequality, encouraging critical analysis of our work environments, and striving to be better allies.

ABSTRACT

The primary goal of this study was to estimate the number of female authors in the academic field of Sound and Music Computing. This was done through gender prediction from authors' first names for proceedings from the ICMC, SMC and NIME conferences, and by sonifying these results. Although gender classification by first name can only serve as an estimate of the actual number of female authors in the field, some conclusions could be drawn. The total percentage of author names classified as female was 10.3% for ICMC, 11.9% for SMC and 11.9% for NIME. When merging data from all three conferences for years 2004-2016, it could be concluded that names classified as female ranged from 9.5 to 14.3%. Changes in the ratio of female vs. male authors over time were further illustrated by sonifications, allowing the reader to explore, compare and reflect upon the results by listening to sonic representations of the data. The conclusion that can be drawn from this study is that the field of Sound and Music Computing is still far from being gender-balanced.

1. INTRODUCTION

Although some of the first pioneers in computer science were women (Ada Lovelace and Grace Hopper, for example), the field of computer music, as well as the fields of science, technology, engineering and mathematics (STEM) are struggling with gender balance. There has been an increase in women in the STEM fields within the past 30 years; however, women still make up less than 15% of the audio engineering field [1]. University admission statistics also show that very few women enter programs giving music technology or recording engineer degrees [1]. In a recent British study [2], it was concluded that students taking music technology undergraduate degrees were overwhelmingly male.

The terms "technology" and "music" are often categorized as male domains [1] and when these terms are combined to refer to electronic music or audio engineering, the gender stereotyping is enhanced [3]. In a paper on constructing and contesting gender in thinking about electroacoustic music [4], the author Andra McCartney states: "to be a woman composer of electroacoustic music is to straddle two worlds, both gendered male". She gives specific

instances of language metaphors and imagery that may discourage female exploration of electroacoustic music. In [5], Elizabeth Hinkle-Turner states that reference material on more avant-garde and experimental women composers has become extensively available only in the past decade. In her paper, she gives an overview of notable women in the field, emphasizing that these female musicians have been virtually ignored in the majority of historical twentieth century music texts, school curriculums, concerts, as well as conferences on electronic- and computer music. Hinkle-Turner emphasizes that comprehensive studies of women's work in electroacoustic music is just beginning to gain momentum. Her work "Women Composers and Music Technology in the United States: Crossing the Line" [6], a chronicle of contributions to electroacoustic music made by American women from the 1930s until today, could be considered the most definitive attempt to address these questions up to this point. However, this work is limited in the sense that it only portrays American women. Other notable work exploring gender issues in electroacoustic music include e.g. [7, 8, 9, 10] and the Contemporary Music Review's special issue on "Gender, Creativity and Education in Digital Musics and Sound Art" [11] (see e.g. [12, 13]).

There are, of course, numerous examples of women who have contributed substantially to the development of computer music. Examples of pioneers include Clara Rockmore, Johanna M. Beyer, Else Marie Pade, Bebe Barron, Daphne Oram, Pauline Oliveros, Delia Derbyshire, Wendy Carlos, Jasia Rechart, Anette Peacock, Éliane Radique, Jin-Hi Kim, Laurie Spiegel, Suzanne Ciani, Mara Helmuth, Laurie Anderson, Daria Semegen, Alice Shields, JoAnn Kuchera-Morin and Mary Simoni [1], to name a few. Many more recent examples of prominent women in the field are mentioned in [1]. According to Hinkle-Turner [5], the creative technological impetus of prominent women in the field has not necessarily assured a strong contingent of women continuing to contribute to all aspects of music technology. On the contrary, her research, involving taking surveys of women's enrollment in electronic music classes and fielding several panel discussions, indicates an actual decline in interest and technical activity among young musical women.

Even after many years of extensive efforts to promote female participation in computing, the area still remains a heavily male-dominated field [14] (see e.g. [15] for an extensive discussion about underrepresentation of women in computer science). In [16], it is suggested that the reason for the underrepresentation can be traced to awareness of that many of the cultural constructions surrounding technology are directly at odds with other cultural constructions surrounding femininity. It has been shown that social and environmental factors can contribute to the underrepresentation of women in engineering and science [17]. Moreover, it has been suggested that women's achievements often are undermined or trivialized in these contexts, and that this could influence women to enter or remain in these fields; much of the problems stem from social and cultural normalization of power dynamics and gender roles [1]. In the work "Women in Audio: Contributions and Challenges in Music Technology and Production" [1], Mathew et al. state that the idea that women tend toward

the social over the technical needs should be dismantled, referring to work by Margaret Rodman [18], who claims that technology itself, or the interest in technical subjects, does not differ much between boys and girls; it is the connections to the environment and groups in this environment that affect how we mediate and interact with technology. Another factor that has been raised as a contributing factor to the underrepresentation in the STEM fields is the lack of role models [19].

As Georg Essl stated in [20], gender is mostly unexplored in the field of new music interface technology. Essl presented figures of female versus male authorship in Proceedings of the *International Conference on New Interfaces for Musical Expression conference (NIME)* for the years 2001-2002. He concluded that men outnumbered women, that participation in the field displayed a gender imbalance and that gender itself was practically absent from academic discourse in the community of new music technology interface researchers. Moreover, Essl noted that theoretical ideas put forward in gender and queer theory suggest that the particular field of new music interface technology is particularly suitable for exploration of differences of gender construction.

In [1], gender balance in the *International Computer Music Association (ICMA)* and *Audio Engineering Society (AES)* was examined for the years 2006-2015. For ICMA, female membership percentage rates were consistently below 20%. Although there had been a slight increase in female membership, the actual rates ranged from 14.5% to 19.6%. However, rates for AES were even lower: female membership (worldwide) was lower than 10%. For the preparation of the current publication, the author contacted ICMA and AES to get updated figures on membership rates for year 2016. For ICMA, the percentage rate of female members was 17.0%. For AES, the only figures that could be obtained were rates calculated before the end of the year (the final membership numbers were not available). These preliminary figures indicated 7.5% female members, and 11.6% members with no gender indicated. A new committee focusing on diversity and inclusion issues has recently been formed within AES in order to address these issues.

While it is of course important to recognize the current gender imbalance in the field of computer music, it is also relevant to mention attempts being made to address these issues. There are several examples of non-profit organizations working on gender-related issues in music¹ and numerous examples of initiatives taken to promote a change and empower women, and young girls, in the field. Examples include everything from organizing conference panel discussions [21, 22, 23], symposiums², workshops³ to hackathons⁴.

The main purpose of the study presented in this paper was to estimate the number of female authors in publications from three of the most important conferences in the field of computer music and music technology: *International*

¹ See e.g. <http://womensaudiomission.org/>, <http://iawm.org/> and <http://www.womeninmusic.org/>.

² See e.g. <http://music.arts.uci.edu/icit/symposium16/>

³ See e.g. <https://technesound.org/>

⁴ See e.g. <http://monthlymusicchackathon.org/post/>

Conference on Computer Music (ICMC), Sound and Music Computing Conference (SMC) and International Conference on New Interfaces for Musical Expression (NIME). The author has chosen to use the umbrella term “Sound and Music Computing”⁵ to define research presented in these three conference proceedings. The ambition is that that the presented figures, together with corresponding sonifications, could be used as a starting point for discussions on future initiatives and efforts towards improving the gender imbalance in the field.

2. METHODOLOGY

2.1 Procedure

A database of publication information (title, author names, year and conference location) for proceedings from three conferences ICMC, SMC and NIME was compiled. A more detailed description of the data collection can be found in Sec. 2.1.1. Gender was predicted based on the first name of respective author (see Sec. 2.1.2). This type of categorization is blind for cases where binary gender definitions do not apply, such as for transgender or transsexual identities. The author would like to acknowledge that a binary assumption of gender is problematic and that she does not advocate for binary categorization. As stated in [24], genders should not be considered as categories existing before a discourse; they are but brought into being through repeated “performative” acts. In this publication, the binary categorization into “male” and “female” should be considered merely a statistics on first names. Asking the authors if and how they identified themselves with a specific gender would of course have been a better method to be applied in this context. However, such an approach was not possible in this case, due to the limited time-frame of the study.

After gender prediction, proceedings data was reformatted to include predicted genders of all authors. The data was then converted into a readable format for the sonification software. A detailed description of the sound synthesis is presented in Sec. 2.1.3. Sonification can be particularly useful for data exploration of large data sets such as the one described in this paper, especially when the purpose is to investigate how the figures change over time.

2.1.1 Data Collection

The publication data was obtained from the web pages of respective conference^{6,7,8}. For ICMC, the publication lists for years 1974 and 1976 were not available and could therefore not be included in the analysis. Different approaches were used to parse the data to a consistently formatted database (for NIME, data was provided as a bib-file; for ICMC and SMC, data was formatted as lists of publications). For SMC, the list provided on the web page only included initials of the authors. Thus, all of the SMC publications had to be manually updated to in-

clude authors’ first names. These first names were obtained by searching for the author details online⁹ and by parsing meta-data from PDFs of respective publication. Also for the ICMC proceedings some publications only listed author initials (this was mostly the case for older papers) and manual search had to be carried out to identify the author’s first names. Unfortunately, for both the ICMC and SMC proceedings, some of the authors could not be identified from the initials and contact information provided in the publication headings.

2.1.2 Gender Prediction

Gender prediction was achieved using the Python library *genderize*¹⁰, a client for the web service Genderize.io¹¹. This library allowed for gender prediction with output into the following categories: “male”, “female” and “none” (unknown gender). The male and female outcomes were provided together with a probability of gender, given the first name (a value from 0 to 1). A threshold for probability was set to 0.8; names with lower probability than this threshold were not considered to have been reliably categorized and were therefore added to the batch of names classified as unknowns. All unknown author names (including those with a probability below 0.8) were subsequently manually searched for online¹² for gender classification. The above described two-step approach of identifying authors with no predicted gender or ambiguous gender classification helped reducing the total number of unknowns, as well as ensuring the reliability of the gender classification results. The gender prediction results were parsed into a suitable format for sound synthesis; a CSV file including all publication details together with the predicted gender info¹³.

2.1.3 Sonification

Sounds were synthesized using SuperCollider¹⁴. Two different sonification models were defined. The idea was to define models that could generate ambient soundscapes that could portray the changes between years in a rather subtle way, allowing the listener to reflect upon the number of female authors simply by listening to sonic pieces. The data was sonified separately for each conference. The sonifications are presented together with videos in which the current sonified year is displayed, enabling the listener to easily scroll through data from different years¹⁵. For both sound models, the selection of sounds was based on the idea that the male majority would be represented with a generic background noise, whereas female authors would be represented with more discrete sounds that stood out from the background soundscape.

⁹ The search focused on identifying the authors on ResearchGate, LinkedIn, Google Scholar author search, dblp computer science bibliography and CiteSeerx.

¹⁰ <https://bat-country.us/#genderize>

¹¹ <https://store.genderize.io/>

¹² Search was done on name, email and affiliation on Google, ResearchGate, LinkedIn and Google Scholar author search.

¹³ The data is available from: https://drive.google.com/drive/folders/1WN9HALk9y_FQeDeqf2pGSv8Ac7f_uWT?usp=sharing

¹⁴ <http://supercollider.github.io/>

¹⁵ The sonifications can be found at: https://www.youtube.com/playlist?list=PLdmT_JtSFH2gghEI3PtKMo-OeVyDodYk



Figure 1. Schematic representation of the sonification and time deltas between streams. In our case, $N = 17$. The time difference between subsequent publications was equal to 10k, so that time differences between sounds originating from the same publication never exceeded the time difference to the next publication.

For both sonification models, the data was read as a list of publication entries sorted from first to last year (one row corresponded to one publication). Within each year, the publication entries were sorted in alphabetical order, based on first name of the first author. The gender data (classified gender of respective author name) was converted into a continuous stream of numbers that was translated into sounds. The structure of the data is explained in Fig. 1. As seen in the figure, each publication was presented on a separate row, with a set of columns containing the gender of respective author number (first author gender, second author gender, and so on). For each author gender column, a stream of sounds was generated. Data was read from top to bottom, and each gender entry was represented with a short sound. The sounds were different for female versus male authors. Each column was presented with a particular delay depending on author number. There were up to 17 authors in the data set. Delays were set so that the first author’s sounds were presented with zero delay and sounds for author numbers 2-17 were presented with delays of various duration, as shown in Fig. 1. The delays within one publication were defined so that they never exceeded the delay to the next publication. This structure of embedding up to 17 event streams of sounds according to a specific temporal order was achieved using the SuperCollider list pattern *Ptpar*. The total length of each sonification depended on the total number of publications for that conference. Authors with unidentified genders were not sonified, and panning was randomized for all produced sounds.

Sonification model 1 was designed to produce a rather minimalistic sound. Male authors were represented using low frequency sounds produced by simple sine wave oscillators. The sounds of several male authors were superimposed for a single publication, resulting in a somewhat oscillating drone-like sound. The amplitudes of the male author sounds were reduced for increasing author number (sounds from the first author gender column were the loudest). The frequencies for male sounds were randomized based on a just intonation tuning of a Todi scale (frequencies between 32.7 and 104.7 Hz). For female authors, a resonator filter was excited by random impulses, resulting in a short percussive sound. The frequencies of the female sounds were also randomized based on a just intonation tuning of a Todi scale, but with a different root frequency (frequencies ranging between 523.5 and 1674.4 Hz). Finally, a reverb was applied to the mixed output sound.

For comparative purposes, a second sonification model was defined. Sonification model 2 was a simple granular synthesis model in which male authors were represented

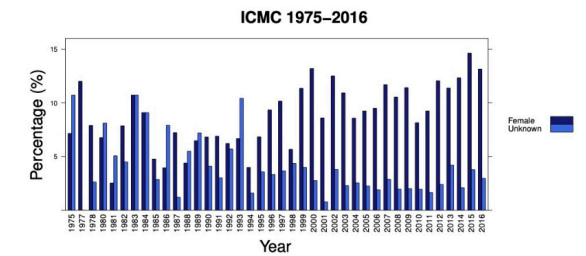


Figure 2. Percentage of female vs. unknown author names in ICMC proceedings from 1975 to 2016 (excluding year 1974 and 1976).

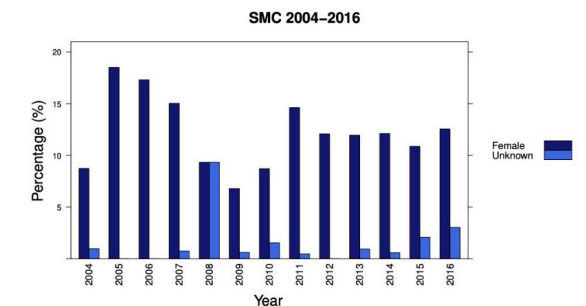


Figure 3. Percentage of female vs. unknown author names in SMC proceedings from 2004 to 2016.

by grains of a recorded sample of rain hitting a window¹⁶. For female authors, grains of a recorded sample of chimes¹⁷ were used. The amplitudes of the sounds decreased for increasing author number (sounds from the first author gender column were the loudest). The starting point for each sound grain was randomized, and a reverb was applied to the mixed output sound.

As seen in Fig. 2, 3 and 4, no dramatic changes in number of female authors could be observed throughout the years, however, the sonifications illustrate the distribution of female versus male authors for each publication and year in a manner that descriptive statistics can not. For comparative purposes, the mapping was reversed for sonification model 1, so that sounds that were originally triggered by the female author entries were set to be triggered by male author entries¹⁸. The reader is encouraged to compare the original version of the sonifications with the reversed one, to further deepen the understanding of the data (as well as the effect of mapping strategies). The sounds of the reversed mapping could be considered as a portrayal of what the data would have sounded like if the gender-balance was completely reversed.

¹⁶ A trimmed excerpt from the following sound sample by InspectorJ of Freesound.org: <https://freesound.org/people/InspectorJ/sounds/346642/>

¹⁷ A trimmed excerpt from the following sound sample by InspectorJ of Freesound.org: <https://freesound.org/people/InspectorJ/sounds/353194/>

¹⁸ These sonifications can be found at: <https://drive.google.com/drive/folders/ThlRm59H5aYZnit785c2Sd4Sc3f2mQ1IH?usp=sharing>

⁵ The formal definition of “Sound and Music Computing” can be found at: <http://smcnetwork.org/roadmap/definition>

⁶ <https://quod.lib.umich.edu/i/icmc/>

⁷ http://smcnetwork.org/resources/smc_papers

⁸ <http://www.nime.org/archives/>

3. RESULTS

The following section provides a detailed description of the sonified data, i.e. the gender classification per publication and year for respective conference.

3.1 ICMC

The ICMC publication list for years 1975-2016 (excluding years 1974 and 1976) included 4417 publications, with 9169 author entries that should be classified. Out of all author names to be classified by gender, 570 (6.2%) were initially classified as unknown, 1026 were classified as “female”, and 7573 as “male”. A total of 463 names (5.0%) received probability values lower than 0.8. Names that could not be assigned to gender (unknowns) and names with a probability lower than 0.8 were manually searched for online for gender identification. The total number of author names that were still unknown after this manual search was 304 (3.3% of all names). The total number of female names was 868 (9.5%) and the total number of male names 7997 (87.2%). For first authors, 10.3% names were classified as female. The percentage of author names classified as female per year is shown in Fig. 2. Percentage female names ranged from 2.5 to 14.6% ($M = 8.8\%$, median = 8.8%) for the different years.

3.2 SMC

The SMC publication list for years 2004-2016 included 1036 publications, with 2668 author entries that should be classified. Out of all author names to be classified by gender, 164 (6.3%) were initially classified as unknown, 378 were classified as “female”, and 2126 as “male”. A total of 158 names (5.9%) received probability values lower than 0.8. Names that could not be assigned to gender (unknowns) and names with a probability lower than 0.8 were manually searched for online for gender identification. The total number of author names that were still unknown after this manual search was 33 (1.2% of all names). The total number of female names was 317 (11.9%) and the total number of male names 2318 (86.9%). For first authors, 12.6% names were classified as female. The percentage of author names classified as female per year is shown in Fig. 3. Percentage female names ranged from 6.8 to 18.5% ($M = 12.2\%$, median = 12.1%) for the different years.

3.3 NIME

The NIME publication list for years 2001-2016 included 1458 publications, with 3570 author entries that should be classified. Out of all author names to be classified by gender, 263 (7.4%) were initially classified as unknown, 440 were classified as “female”, and 2867 as “male”. A total of 200 names (5.6%) received probability values lower than 0.8. Names that could not be assigned to gender (unknowns) and names with a classification probability below 0.8 were manually searched for online for gender identification. The total number of author names that were still unknown after this manual search was 71 (2.0% of all names). The total number of female names was 426 (11.9%) and the total number of male names 3073 (86.1%). For first

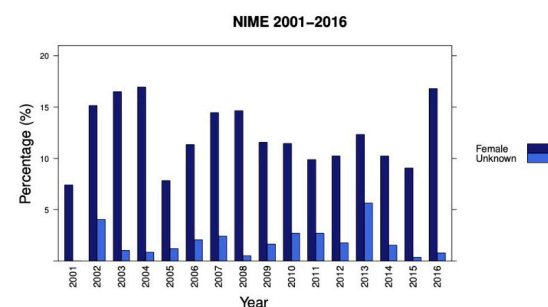


Figure 4. Percentage of female vs. unknown author names in NIME proceedings from 2001 to 2016.

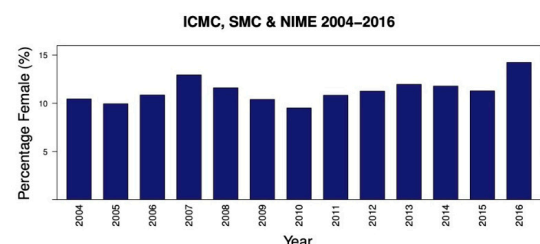


Figure 5. Percentage female author names in ICMC, SMC and NIME proceedings from 2004 to 2016.

authors, 12.7% names were classified as female. The percentage of author names classified as female per year is shown in Fig. 4. Percentage female names ranged from 7.4 to 17.0% ($M = 12.2\%$, median = 11.5%) for the different years.

3.4 Summarized Results from the three Conferences

Results obtained when summarizing classified female, male versus unknown author names for the three conferences for the common years 2004 to 2016 are shown in Fig. 5. Percentage identified female author names ranged from 9.5 to 14.3% ($M = 11.3\%$, median = 11.3%). Interestingly, the highest observed value was found for year 2016. Another year that stands out is 2010, with a particularly low percentage of female authors.

4. DISCUSSION

This paper presents a study on the percentage of female authors in ICMC, SMC and NIME conference proceedings. The figures presented in this paper should be considered exactly for what they are, i.e. predictions based on first names. These numbers are not actual statistics of the number of female authors in the field. Nevertheless, as seen in Sec. 3, the approaches used in this study did result in a rather low percentage of unidentified author names (values ranging from 1.2 to 3.3% for respective conference). Thus, the results could be considered to be a somewhat accurate representation of the actual figures of female authors, at least to a certain extent.

The performance of gender prediction from names may be more or less dependent on which country the name originates from. Some names are female in certain countries

but male in others. Results would of course have been more reliable if the gender prediction algorithm used had taken country of origin into account (some other libraries providing this feature were tested, but the resulting gender classifications proved to be less reliable compared to the results obtained using the *genderize* library). In this particular study, the author addressed the issue of uncertainty in gender prediction from names by manually searching through names with ambiguous gender classification (probabilities below 0.8).

Despite the methodological concerns described above, the result obtained in this study do give a hint about the distribution of men versus women in the field of Sound and Music Computing. The fact that the data from the different conferences spans through different periods (the ICMC dataset had data from 1975, SMC from 2004 and NIME from 2001) complicates the comparison between respective conference. Nevertheless, one could observe that the total percentage of female author names was below 15% for all three conferences (10.3% for ICMC, 11.9% for SMC and 11.9% for NIME). Mean percentage of female names throughout the years was 8.8% for ICMC, 12.1% for SMC and 12.2% for NIME. In this data set, years in which the percentage of female authors was as low as 2.5% could be observed (ICMC), but also years in which this value ranged up to 18.5% (SMC).

As for the broader picture, i.e. the summarized results from the three conferences for the years 2004-2016, no clear general trend for the three conferences could be observed. However, the highest percentage of female authors was found for year 2016. In general, the percentages ranged from 9.5 to 14.3% (mean and median values were both 11.3%). These results suggest that men still widely outnumber women in the field, at least in terms of authorship in conference proceedings.

In the current study, the objective was to create sonifications in the form of longer ambient soundscapes. In order to get an idea of changes in the data throughout the years, the listener had to actively scroll through different years and compare the sonic representations. Of course, the sonifications could have been designed to portray the summarized data portrayed in Fig. 5 in a more direct manner, in order to highlight the actual increases versus decreases in female participation over the years.

Finally, the author would like to stress that although this study focused on quantitative measures based on binary categorizations of gender (since it was based on gender prediction from names), it would of course make much more sense to discuss gender balance in the field of Sound and Music Computing from a non-binary perspective.

5. CONCLUSIONS

Binary representations of gender are problematic and statistics is only one way of illustrating diversity issues in the field of Sound and Music Computing. Promoting a change in the field involves more than just balancing demographic profiles. Nevertheless, some conclusions can be drawn from this study. The ratios of female versus male author names in the proceedings of the three conferences ICMC, SMC and NIME suggest that the field of Sound and Music Computing is still far from being gender-balanced. The estimated figures presented in this paper should ideally be

used to encourage a discussion about social structures that discourage increased participation in the field of Sound and Music Computing, focusing on creating awareness of the challenges women face in their daily work within our field. Clearly, there is a need for analysis of existing environments and social relations surrounding music technology and computer music. If we identify the challenges that women are facing in our research community, we will be able to create more initiatives towards changing practices.

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