Biomedical Informatics Publications: a Global Perspective

Part I: Conferences*

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Summary
Background: In the past decade, Medical Informatics (MI) and Bioinformatics (BI) have converged towards a new discipline, called Biomedical Informatics (BMI) bridging informatics methods across the spectrum from genomic research to personalized medicine and global healthcare. This convergence still raises challenging research questions which are being addressed by researchers internationally, which in turn raises the question of how biomedical informatics publications reflect the contributions from around the world in documenting the research.
Objectives: To analyse the worldwide participation of biomedical informatics researchers from professional groups and societies in the best-known scientific conferences in the field. The analysis is focused on their geographical affiliation, but also includes other features, such as the impact and recognition of the conferences.
Methods: We manually collected data about authors of papers presented at three major MI conferences: Medinfo, MIE and the AMIA symposium. In addition, we collected data from a BI conference, ISMB, as a comparison. Finally, we analyzed the impact and recognition of these conferences within their scientific contexts.
Results: Data indicate a predominance of local authors at the regional conferences (AMIA and MIE), whereas other conferences with a worldwide scope (Medinfo and ISMB) had broader participation. Our analysis shows that the influence of these conferences beyond the discipline remains somewhat limited.
Conclusions: Our results suggest that for BMI to be recognized as a broad discipline, both in the geographical and scientific sense, it will need to extend the scope of collaborations and their interdisciplinary impacts worldwide.

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1. Introduction

Over the past decade, Medical Informatics and Bioinformatics have converged into a new discipline, called "Biomedical Informatics" (BMI). Originally, Medical Informatics (MI) and Bioinformatics (BI) were largely independent academic disciplines with different histories, backgrounds, educational curricula, research interests and goals. While both disciplines were focused on rather different scientific and engineering issues, topics of common interest emerged in the context of genomic research and personalized medicine. Collaborative research bridging MI and BI led to an increasing number of publications under the heading of "Biomedical Informatics". Existing MI and BI academic programs were redesigned to include content and lessons learned from both disciplines, integrated into academic curricula which emphasized a common BMI perspective. Reviews of the origins of the disciplines and their convergence can be found in [1–6]. Similarly, major MI conferences and journals have been redesigned to incorporate BMI-focused research and professional topics. However, there is still discussion about BMI being a new discipline at the intersection or the union of the two older, classical disciplines – MI and BI. That BMI is at "the confluence of multiple disciplines" was the central topic of a meeting held in Heidelberg, Germany, in May 2011, celebrating the 50th anniversary of the *Methods of Information in Medicine* journal. At the time of writing, a number of papers are planned to be published incorporating the results of this scientific meeting. They should contribute to elucidate the current status of BMI a decade since it was proposed as a new discipline [1–6].

Currently there is broad consensus that interactions under the BMI umbrella are maturing, leading to the consolidation of the field, with extensive educational opportunities [7, 8]. Likewise, there appears to be, too, a widespread perception of inter-

* Part II of this article will be published in one of the next issues of this journal.

national collaboration among BMI researchers [9, 10]. The completion of the Human Genome and other -omics projects were the result of collaborative efforts carried out between many groups and professions, and in many countries [11, 12]. To achieve its objectives, open exchange of data and informatics resources was strongly emphasized in these projects. International collaboration is required for European Union (EU) projects, where funding is awarded to international consortia involving partners from the EU members – 27 countries – through the European Commission. A "global" context is frequently suggested as a new framework for the world's economy, science and society, with the tremendous boost of the web 2.0, where hundreds of millions of citizens are connected in social networks all over the world [13]. Such global networking is changing the world in ways that are difficult to anticipate, modifying the way people communicate and socialize – extending to even how are papers reviewed and published [14].

An analysis of BMI, as a scientific and technological field, was carried out and reported by Malin and Carley by analyzing one important aspect influencing the field: membership on the boards of various BMI journals and their overlaps/interactions [15]. Similarly, other reports have analyzed publications from two main BMI journals – *Methods of Information in Medicine* (*MIM*) and the International Journal of Medical Informatics (IJMI) –, carrying out a comparison of the main topics of the manuscripts published in these two journals in the period 2004–2005 [16, 17]. Schuemie et al have also carried out an analysis of MI journals, suggesting a possible clustering of papers published in these journals according to various categories [18]. Similarly, various special issues of MIM have been devoted to comparable analyses of the disciplines from a number of perspectives [19–22].

We present here an analysis of the participation of BMI researchers from different geographical areas in various relevant BMI scientific conferences, carried out at an international level. In addition, we also investigate issues related to the scientific recognition and current rankings of conferences, within the context of the literature. In a second part of this paper, we extend such analyses to include BMI journals, thus providing a broader perspective. To our knowledge, this kind of analysis of BMI conferences and journals has not been undertaken until now.

In the present paper, part I, we focus our efforts on the three most significant scientific conferences in the field of medical informatics, which have been already running for several decades: the (triennial) World Conference on Medical Informatics (Medinfo) – which rotates to different venues around the world every three years –, Medical Informatics Europe (MIE) and the American Medical Informatics Association (AMIA) Symposium – in the USA. In addition, we use information about a major BI conference, ISMB, as part of our comparative analysis. To facilitate the reading of both papers and avoid further discussion on the limits and scope of both MI and BI, which is beyond the scope of these two papers, we will consider BMI, in general, as a discipline with a broader scope than MI and BI, incorporating both MI and BI topics and issues under its umbrella. Then, when we refer to generic aspects of both areas together (MI and BI), we may use the acronym "BMI". When we refer to specific conferences or journals, we will use the acronyms "MI" or "BI".

2. Background: Historical Retrospective of Major BMI Conferences

We present below a brief historical overview on the origins of three major BMI conferences (Medinfo, MIE and AMIA) and their relation to their respective societies or organizations.

2.1 Medinfo and IMIA

The International Medical Informatics Association (IMIA) is an independent organization established under Swiss law in 1989. IMIA's origins can be traced back at least to 1967 as Technical Committee 4 of the International Federation for Information Processing (IFIP). In 1979, it started to evolve from a Special Interest Group within IFIP to its current status as a separate organization, composed of national and regional member societies and affiliates from around the world. IMIA continues to maintain its relationship with IFIP as an affiliate organization [23].

IMIA organizes the triennial World Congress on Medical Informatics – known as Medinfo – in order to broaden the participation of professionals from all the biomedical informatics societies worldwide. In addition to its scientific programme, it provides an opportunity for formal meetings and informal networking among IMIA's members. The event is jointly hosted by IMIA and one of its (National) Member societies. The first official Medinfo took place in Toronto, Canada, in 1977 even though the IFIP-TC4 meeting in Stockholm in 1974 is widely recognized as the first, or precursor of Medinfo. Since then, the conference has been held in Tokyo, Amsterdam, Washington, Beijing/Singapore, Geneva, Vancouver, Seoul, London, San Francisco, Brisbane and Cape Town, with Copenhagen scheduled for Medinfo 2013.

2.2 MIE and EFMI

The European Federation for Medical Informatics (EFMI) was proposed at a meeting, assisted by the Regional Office for Europe of the World Health Organization (WHO), in Copenhagen in September 1976 [24], with the result that a Medical Informatics Europe (MIE) conference has taken place annually (except on the years when Medinfo is held) since 1978. It has met in Cambridge (UK), Berlin, Toulouse, Dublin, Brussels, Helsinki, Rome, Oslo, Glasgow, Vienna, Jerusalem, Lisbon, Copenhagen, Thessalonica, Ljubljana, Hannover, Budapest, Saint Malo, Geneva, Maastricht, Gothenburg and Sarajevo. A selection of the best papers from the MIE conferences is usually published in special issues of the journal *Methods of Information in Medicine.*

2.3 SCAMC and AMIA

SCAMC – the annual Symposium on Computer Applications in Medical Care – was started in the US in 1976 [25]. In 1981, a proposed merger of US medical informatics organizations failed to go through, but in 1988, SCAMC, the American College of Medical Informatics (ACMI), and the American Association of Medical Systems and Informatics (AAMSI) merged into the American Medical Informatics Association (AMIA). Since 1977, this conference has been successfully held every year, with various changes of names: the Annual Symposium on Computer Applications in Medical Care (SCAMC): from 1977 to 1995; AMIA Annual Fall Symposium: from 1996 to 1997; the AMIA Symposium: from 1998 to 2002 and the AMIA Annual Symposium: from 2003 to the present [26]. About two thirds of the AMIA conferences are held in Washington – as it facilitates the active participation of various US federal funding agencies, institutions and their members. There has been a traditional link between AMIA and the Journal of the American Medical Informatics Association (JAMIA), which, for several years, published the proceedings of the conference as a special supplement of the journal.

3. Methods

We have compiled data from PubMed sources and conference proceedings on the participation of researchers in the three major MI conferences (international, European, and US) over the past seven years: 2004 to 2010. We also extracted logistical information – e.g., call for papers, venues, history, background – from the conference websites and their corresponding scientific societies. We classified the papers according to the country of the first author of each publication. While recording the affiliation of all the authors of each paper, we finally left this data out of the present analysis, since, although it provided interesting additional information about international collaborative efforts and networks involved in the research and preparation of each paper, it was not directly interpretable without considerably more analysis and underlying assumptions and input from the publications themselves (i.e, collaborations between European researchers with funding from the European Commission are frequent and might be seen as somewhat equivalent to collaborations between researchers from different US institutions funded by the US National Institutes of Health – but not always). To expand the scope of our analysis to bioinformatics we have chosen the Intelligent Systems for Molecular Biology (ISMB) conference as a comparative instance. With such an approach, we aimed to: a) analyze the geographical distribution of authors in major well-established MI and BI conferences, b) compare patterns of participation between MI and BI conferences, which can be also of interest for future combined approaches in the broader framework of BMI, and c) demonstrate the pertinence of these kinds of studies for further, deeper analyses of MI and BI publications, comparing other issues, as discussed below.

In short, we have analyzed data for the following conferences for the years listed below:

- Medinfo: 2004, 2007 and 2010
- MIE: 2005, 2006, 2008, 2009 (MIE is not held in those years where there is a Medinfo conference)
- AMIA: 2005–2009 (2004 was not held, since there was a Medinfo conference in San Francisco organized by AMIA and the 2010 information was not available at the time of collecting the data for this work)
- ISMB: 2006–2010

For this analysis we deliberately considered articles published after 2003, when the Human Genome Project was completed and BMI was proposed and started to evolve within the context of genomic and post-genomic research.

From a statistical point of view, we have followed an approach paralleling that in [16, 17], collecting data from the whole sample of publications in the years that we considered. We analyzed data using *p*-values, realizing that no additional statistical analyses were necessary for our objective, which was to compare the entire set of publications for each conference over the selected time-periods.

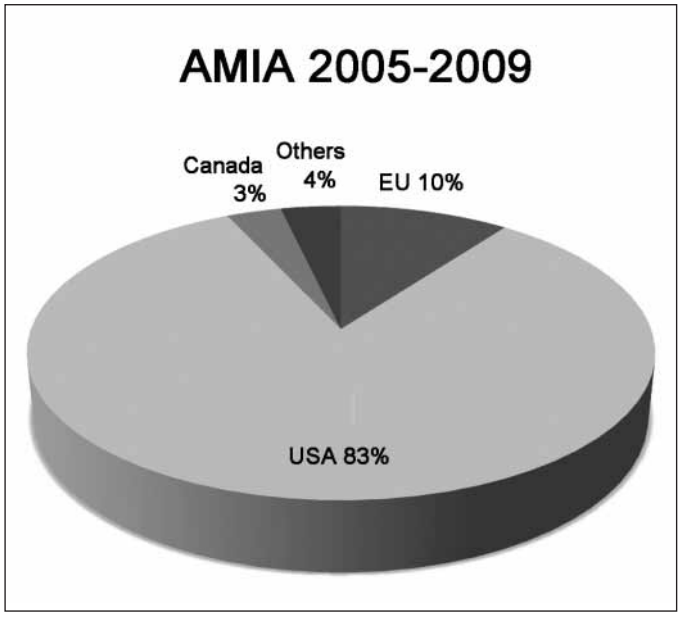

Fig. 1 Pie charts showing the distribution of first authors from AMIA, taken from Table 1 in the Appendix

4. Results

4.1 Conferences

We have collected information from the three main MI conferences, as shown in the tables (▶Appendix). We have carried out a preliminary descriptive statistical analysis illustrated by the pie charts for these data for each conference. We have focused on

the participation of US and EU researchers, who were the main participants, while listing information from a number of additional countries with significant participation in these meetings.

▶Figures 1–3 show three pie charts, graphically illustrating the overall participation in all years counted (the sum column from the tables in the appendix) of first authors according to their geographical affiliation listed for these three conferences.

It can be seen from the above that national or regional researchers comprise the bulk of participants for both AMIA and MIE. For AMIA, the participation of USA researchers (as first authors) was 82.88% of the total number of participants, while the participation of EU researchers was only 10.20%. The opposite occurs for MIE, where participation of EU researchers as first authors was 74.67%, vs only 3.33% for USA researchers. In stark contrast to this imbalance, the last three Medinfos have shown, on average, 33.75% participation from EU first authors, and 36.78% from US first authors.

We also wanted to compare participation in these MI conferences with that in a well-known BI conference – the Annual International Conference on Intelligent Systems for Molecular Biology (ISMB). This conference started in 1993, in Washington DC, bringing together researchers interested in applying AI-related computational approaches to biological investigation. In 2004 ISMB and the European Conference on Computational Biology (ECCB) joined forces and agreed to share their main meetings whenever ISMB meets in Europe, which is currently planned to be every other year (odd numbered years) [27]. For these meetings we considered five years, from 2006 to 2010, with conferences held in Fortaleza (Brazil), Vienna, Toronto, Stockholm and Boston.

Results appear in ▶Table 4 (▶Appendix) and ▶Figure 4 shows the corresponding pie chart to ISMB. As shown in ▶Table 4, ISMB has typically more US than EU participants (47.81% vs 25.55% total in the years analyzed), but is more balanced than the main regional MI conferences.

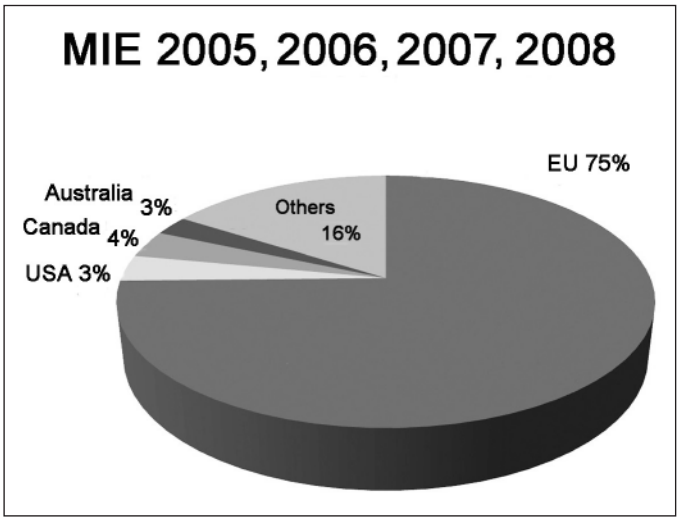

Fig. 2 Pie chart showing the distribution of first authors from MIE, taken from Table 2 in the Appendix

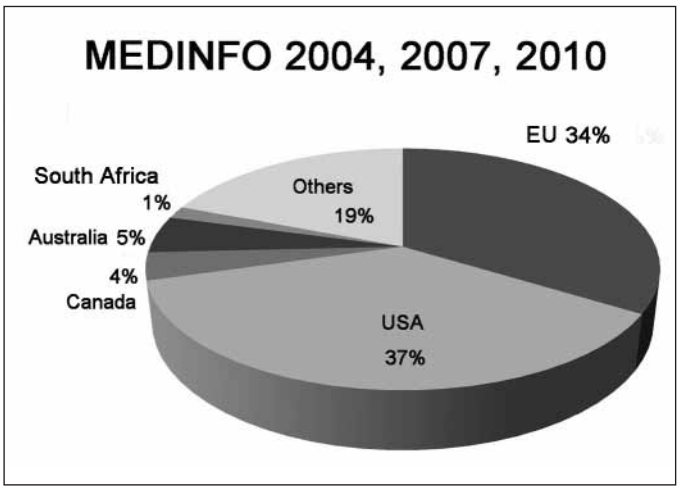

Fig. 3 Pie chart showing the distribution of first authors from Medinfo, taken from Table 3 in the Appendix

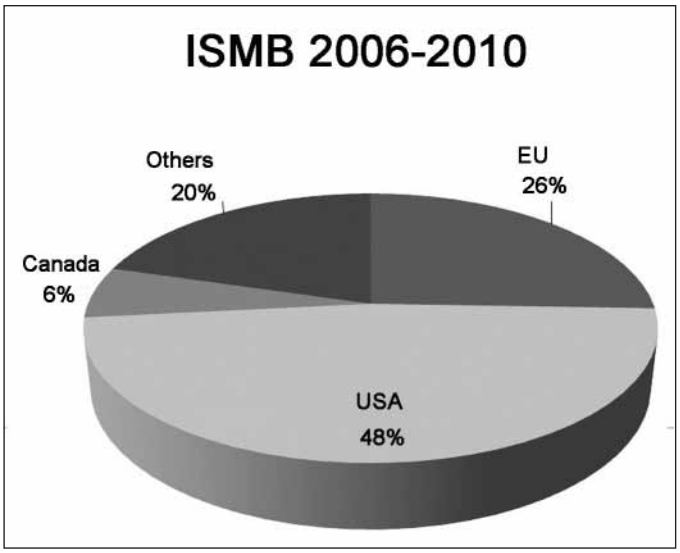

Fig. 4 Pie chart showing the distribution of the first authors from ISMB conference, taken from Table 4 in the Appendix

5. Discussion

In this section, we discuss the above results by considering various aspects of participation in the three main MI conferences: Medinfo, MIE and AMIA. These aspects include: a) origins, b) collection of data and analysis, c) main areas included in the different calls for papers of the conferences, d) rankings of these conferences, e) geographical affiliation of the first authors of the papers presented in these three conferences, and f) a comparison with a relevant BI conference (ISMB).

5.1 Origins

The three MI conferences selected for this analysis are linked to different MI professional associations. Medinfo was associated with IMIA, whereas MIE has been associated with EFMI and the AMIA symposium (previously SCAMC) with AMIA. In addition, the three conferences emerged within a narrow span of time: Medinfo and SCAMC in 1977 and MIE in 1978.

5.2 Collection of Data and Analysis

Data for this analysis were manually extracted from various sources, such as Medline and conference proceedings. Due to personnel changes during the project, modifications were made in the data collection process, which, however, do not affect the estimation of overall trends from an international perspective since concentrating on first authors should provide a good indication of the contributions of each region, and can be subsequently refined with further statistical analyses with additional data provided by the journals and conferences' editors. We have earlier carried out extensive research, and reported on, automatic methods for extracting information from the scientific literature, based on text mining techniques [28–33]. For the present study, we preferred a manual approach because the information was quite disparate, with different structures of information within the various sources used, and, most importantly from an attribution perspective, with information about affiliations being frequently inconsistently and incompletely recorded. Thus, this work required a manual review of all the data to confirm the affiliations and countries just for first authors. A fully automated approach to data collection for all authors and their patterns of collaboration would have required its own research methodology, which was not the goal of our work. Standardisation and structuring of the information published and reported in scientific papers is yet-to-be-accomplished in BMI, although there have been some suggestions made for BI journals [34].

We have also analysed poster papers from the AMIA conference to compare the distribution of participation of authors from different countries against the distribution for regular papers. Results were quite similar. However, we did not perform further analyses of these data, since posters are not comparable to regular papers. Both categories – papers and posters, as well as panel sessions, demonstrations, keynote speeches, etc. – usually represent different degrees of quality and peer-review and cannot be directly merged within the same sample. Information about participation from specific US states and EU countries and specific institutions was also recorded, but a detailed analysis goes beyond the international-breakdown focus of the present paper. Finally, we concentrated our analysis on the most stringently reviewed regular papers, so neither posters, in the case of conferences, nor other reports – letters to the editor, corrections, notes – in journals (in part II), are included, since they cover very different types of information for which quality judgements differ even more.

A related analysis comparing two US and European conferences has been reported in a major medical specialty journal (Dermatitis) showing significant differences between US and EU researcher participation in conferences of the American Contact Dermatitis Society (ACDS) – using data from 2005 and 2006 – and the European Society of Contact Dermatitis (ESCD) – with data only from 2006 [35]. In addition, another analysis reported earlier [15] presented a social network analysis of the editorial boards of MI and BI journals (2000–2005), in the context of the emergence of BMI. This analysis described a small – although increasing – number of professionals working at the intersection of MI and BI and their relationships.

5.3 Main Fields Included in the Different Calls for Papers

An analysis of the most recent calls for papers for the three conferences (Medinfo, MIE and the AMIA Symposium) found overall similarities. An analysis of the last set of calls available at the time of preparing this manuscript (Medinfo 2010, MIE 2011, AMIA 2010), suggests very similar ways of defining the research fields covered by all three of the conferences. Examples include topics such as "information storage and retrieval (text and images)", "advanced algorithms, languages, and computational methods", "cognitive studies (including experiments emphasizing verbal protocol analysis and usability)", "system implementation and management issues, delivering health information and knowledge to the public", "personal health records and self-care systems" or "providing just-in-time access to the biomedical literature & other health information". AMIA and MIE in particular, significantly overlap in their topics, suggesting a shared conceptualization of the field.

5.4 Ranking of the Three Conferences within the Scientific Community

Publications are a significant indicator in evaluating and ranking academic merit for individual researchers and institutions. Contributions to BMI, as an interdisciplinary field between two very contrasting large fields – biomedicine and informatics/computer science – face many challenges in being ranked. Most research groups are either located in medical institutions – especially in the US – or computer science departments – especially in many locations in Europe. For instance, some of the authors of the present paper belong to computer science departments at the UPM (EU) and Rutgers University (USA), which happen

to be both universities without medical schools. When comparing biomedical and computing academic publications and results, the evaluation of merit often follows very different criteria. In the biomedical area, journal papers are typically given much greater weight in relation to conference papers. In contrast, in many departments of computer science or informatics, conference papers have become much more heavily weighted, often with a predominant – or, at least, comparable – level of credit compared to journal papers. This can be a contentious issue, where some argue that computer science could be the driving force reflecting novel technological contributions – in contrast to the practices of more traditional scientific disciplines [36]. Similarly, many medical schools do not consider conference papers at the same level than journal papers. So, how to assess what happens, world-wide, across BMI, which is located at the intersection between biomedicine and informatics and computing? Compared to the established approaches for scientific journals, what is the gold standard for ranking conferences? Are there similar measures to evaluate the quality and impact of conference papers? And how is consensus reached for them? The direct answer is that as yet, there is neither a gold standard nor a consensus. We expand on this issue next.

There are several conference classifications and rankings currently being used to rank the impact of conference publications, many frequently used in computer science. We show below various significant examples, without any special ordering.

1. ISI proceedings: At the time of writing, conferences – and their citations – are included in the ISI databases, but no formal ranking is given [37].
2. DBLP: A database widely used in computer science, does not include an associated impact-based ranking [38].
3. CORE: This is a ranking developed by Australian computer scientists from various organizations, which is seeing increasing use [39]. It was primarily based on the personal experiences of Australian faculty attending national and international conferences. It has been improved by taking into account rankings from other organizations and citation analyses, such as Citeseer (public) and the ISI database (private). They also refer to the "number of publications reported by Australian universities" as a criterion for the preliminary creation of this ranking. Then, "a workshop of approximately 20 ICT researchers from a number of universities and across a range of disciplines was convened in Canberra in mid-March 2006 to continue the ranking process" – as kept in a mirror site [40]. This ranking has evolved over the years. First, there were four classes, C (lowest), B, A and A+ (top), which were later reduced to three, from C to A. From a rapid examination of past yearly rankings of conferences (not officially available now, but they can be found in mirror sites by using advanced Web search engines, such as in [40]), it can be seen how conferences appear and disappear without further explanation. For instance, AMIA, which was earlier a CORE A – this information is not now officially available – has now disappeared, at the time of writing. Medinfo appears now as CORE B – and, coincidence or not, we have to remind that Medinfo 2007 was held in Australia – and it seems that MIE has never appeared. Conversely, twenty conferences appear with the term "bio", including prestigious conferences such as ISMB (CORE A) or the International Conference on REsearch in COmputational Molecular Biology (RECOMB, CORE B). CORE is now the basic reference for conferences in computer science in Spain, for both the Ministry of Education and the Ministry of Science and Innovation, and therefore for many universities, in Spain – and also in other places in Europe. However, as we suggest here, large variations can appear at any time, with no apparent justification.
4. Citeseer X (Scientific Literature Digital Library and Search Engine): A search engine, with some support from the US National Science Foundation, NEC and Penn State University, mainly shows citations [41]. Citations to papers published in Medinfo (437), MIE (19) and AMIA (193) are included. Citeseer X includes a ranked list of conferences, but none of the three BMI conferences are listed. Only venues contained in DBLP are included. Venue impact factors are generated from documents in the Citeseer X database as of March 20, 2008 and they are estimated based on the Garfield's traditional impact factor. As stated in their website, "the list may contain errors" [41]. Interestingly, the Journal of Biomedical Informatics appears here as a conference venue (!), at the time of writing [41].
5. CS Conference Ranking: Under this name, various informal rankings appear in the Web, with different scores for these three BMI conferences. Thus, in [42], Medinfo and AMIA appear in the second order rank. Another widely mentioned reference appears in [43]. Other related websites, with no information at all about the underlying methodology, present different rankings under this name, and none of them include the three main BMI conferences. In this regard, it seems that this cannot be considered as a trusted reference from a methodological perspective – but it seems to be actually used!
6. Conference-ranking.org: The conference ranking, accessible at [44], is produced with a collection of information from different Internet sources for the reference of research scientists. The listings of the quality conferences have been based on different academic sources but may not be yet complete [44]. Neither Medinfo, AMIA nor MIE appear.
7. Arnetminer: This is a conference ranking which uses an impact factor based on citations, with a method described elsewhere [45]. It was discontinued in 2008. ISMB and RECOMB appear in the list, but not the three medical informatics conferences. Interestingly, the Journal of Biomedical Informatics appears as a conference venue (!, again), at the time of writing, although the ranked list is different to Citeseer X.
8. PubMed/Medline: No conference rankings are provided [46].
9. Other citations sites – e.g., Publish or Perish [47], Google scholar [48] – include numbers of citations made to publications in conferences – including

from BMI – but contain no conference rankings.

In most university departments, journals are usually ranked following ISI impact factors [49], but for conferences the differences can be substantial. Frequently, each department creates its own rankings, based on different criteria. However, whereas there is some informal consensus in large BMI departments, particularly within medical institutions, those groups working in different contexts – such as computer science departments – face different situations. In fact, it sometimes happens that the number of conferences in some areas – for instance, programming or databases – is quite large, whereas the number of BMI conferences appearing in these public rankings is small – if any. In this current situation, competition between biomedical informaticians and other computer scientists can lead to evaluation inequities within academic computing environments, and may have a negative influence on computer scientists who might otherwise consider publishing in a BMI venue if they know their contributions will not count in their discipline. A different analysis would be needed for the many biomedical informatics departments located within medical schools.

The low profile of Medinfo, MIE and AMIA in these rankings – in contrast, at least, with BI conferences – seems to indicate low recognition outside of BMI, at least in terms of measurable outcomes. Efforts to increase such recognition – for instance, by developing more objective rankings – would be most useful.

5.5 Geographical Affiliation of the First Authors of the Papers Presented in the Three Conferences

We had sometimes observed differences of participation, and geographical affiliations, between the several major MI and BI conferences that we attended in the past. This motivated us to carry out a deeper analysis, beyond generic informal observations, regarding such participation. The results of such an analysis may provide new insights for enhancing future exchanges and synergies between people from different locations and areas of expertise. In this regard, our data present a low participation of EU researchers in the US conference (AMIA), and vice-versa (for MIE), whereas participation of researchers from both locations is more balanced in the Medinfo conferences – covering the most recent venues of San Francisco (2004), Australia (2007) and South Africa (2010). Since the last two venues were located in very different and distant places from the perspective of the majority of North American and European participants in MI conferences, this apparently suggests that reluctance to travel long distances or limited funding might not be in itself, a significant argument. However, we can also observe – if we analyse each Medinfo conference individually – that participation of US researchers was much higher in 2004 (USA), EU participation was higher in 2010 (South Africa) and both were similar in 2007 (Australia). In all these cases, participation of local researchers was considerably higher than in conferences held at other venues, as might be expected. Other reasons might be studied (for instance, acceptance rates for geographical areas, papers presenting international collaborations, quality of the conferences, networks of researchers or participant satisfaction), with additional and comprehensive data – some of which are not available, at least publicly – but these fall outside the purview of the present paper. In our opinion, our results suggest that there is a need for more external participation in MI conferences organized by national MI societies. To achieve this goal, various approaches may be needed, such as increasing the scientific quality of submissions or stimulating travel to distant conferences . While Medinfo has such a broader, and not locally-circumscribed participation, because it is only held every three years, it does not support an ongoing, regular interaction between MI professionals coming from different geographical locations. Such interactions could contribute, for instance, in avoiding duplication of research efforts at different sites and increasing the benefits coming from the advantages of professional synergies and collaborative efforts between people working in separate locations and areas.

5.6 A Comparison with a Relevant BI Conference (ISMB)

As we can see, results were quite similar in all the years where data were collected for the ISMB conference (showing a predominance of USA participants as opposed to EU participants), independently of their locations. In this case, we have to consider that ISMB is the official conference for the most significant BI society, the ISCB. As indicated by its name, this is an international society, not linked to a specific national society, country or geographical region. Without further data and information it is difficult to interpret, though we can say that the locations of these BI conferences did not appear to lead to the large differences in first author participation that we found when analyzing the MI conferences.

6. Further Analysis

Over the last few years, there has been some discussion about differences in procedures used by some MI conferences. Authors of this paper have been involved in program committees of a number of the three MI conferences, and seen recurrent proposals to improve their quality, responding to critiques from participants. For instance, the chair of the 2010 AMIA symposium and other AMIA leaders stated their position in a letter to AMIA members, after receiving comments from researchers, suggesting that "it had become increasingly difficult for the best methodological research to be accepted for presentation at the AMIA Annual Symposium, with a further concern that the quality of reviewing for such papers was suboptimal" [50]. As result, actions were taken to overcome these shortcomings. This and other perceptions suggest that there is room for improvement, both from a quality perspective and also from that of stimulating open, collaborative work that will attract more intense international participation, regardless of venue – as is suggested by our data. Finally, although we have focused our discussion in this paper on BMI in the USA and the EU, we also collected data on countries such as Canada, Australia, China, Japan, South Africa and other countries, which might af-

ford a more complete analysis of global trends in the impact of conference publications. In some cases, data – for instance, papers published by Australians at Medinfo 2007 or South Africans at Medinfo 2010 – also suggest the strong influence that holding a conference in a place has on the participation of local researchers. However, a full discussion of the global pattern of distribution of research across BMI will require more data, and deeper analysis, beyond the scope of this paper – though it is of great relevance for IMIA in its international scientific dissemination and coordination efforts.

7. Conclusions

Over the past decade the perception that BMI is progressively widening its scope has taken hold in the discipline. This includes extensions of its scientific purview, from the micro to the macro spectrum [51], from public health to molecular biology [5] and even nanomedicine [29, 52], linking MI and BI [1–4, 53] and integrating people from around the world in collaborative projects, committees and globally-focused multinational companies. For instance, AMIA states, in its website, that its members include individuals and organizations from 65 countries [54]. EFMI includes most European countries in its organization and links with many other organizations and individuals from beyond the continent. Finally, IMIA integrates MI societies at a world-wide level. With the scope of science and its social exchanges becoming increasingly global, this preliminary analysis of geographical distribution of first authors from recent publications in BMI scientific conferences – and journals, presented in part II of this manuscript –, shows that there are still many locally-determined patterns of participation. While this analysis has been focused on just a few forums and journals, and covers a relatively limited time-span, these preliminary results seem to suggest that efforts for creating a more expansive, world-wide view of BMI need reinforcement – particularly if we analyse MI in contrast to BI. This situation may have some influence on the degree of recognition for the MI conferences – as shown through conference rankings, or the lack of them. However, current ways of measuring conference rankings, as mentioned above, strongly suggest the need for further, methodologically sound, efforts to build rankings where BMI conferences are fairly measured and ranked. It appears that this is not the case at present. Such efforts would be most useful for increasing the recognition of BMI conferences, and may also prove helpful for the professional and academic careers of biomedical informaticians.

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Appendix

Table 1 Results from AMIA (2005–2009)

	2005	2006	2007	2008	2009	Σ	Percentage
EU	18	24	18	16	11	87	10.20%
USA	144	138	144	162	119	707	82.88%
Canada	4	7	5	8	4	28	3.28%
Others	10	4	7	4	6	31	3.63%
TOTAL	**176**	**173**	**174**	**190**	**140**	**853**	**100 %**

Table 2 Results from MIE (2005–2009)

	2005	2006	2007	2008	2009	Σ	Percentage
EU	73	118	0	107	150	448	74.67%
USA	3	7	0	4	6	20	3.33%
Canada	4	3	0	4	10	21	3.50%
Australia	2	2	0	6	5	15	2.50%
Others	17	14	0	23	42	96	16.00%
TOTAL	**99**	**144**	**0**	**144**	**213**	**600**	**100 %**

Table 3 Results from Medinfo (2004–2010)

	2004	2007	2010	Σ	Percentage
European Union	89	98	58	245	33.75%
USA	158	82	27	267	36.78%
Canada	8	12	7	27	3.72%
Australia	4	26	6	36	4.96%
South Africa	1	1	10	12	1.65%
Others	41	69	29	139	19.15%
Total	**301**	**288**	**137**	**726**	**100 %**

Table 4 Results from ISMB (2006–2010)

ISMB	2006	2007	2008	2009	2010	Σ	Percentage
EU	19	18	12	10	11	70	25.55%
USA	34	31	22	20	24	131	47.81%
Canada	4	7	4	4	2	21	7.66%
Others	10	10	9	12	11	52	18.98%
TOTAL	**67**	**66**	**47**	**46**	**48**	**274**	**100 %**