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Editorial

Biomedinformatics: A New Journal for the New Decade to Publish Biomedical Informatics Research

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With this volume, the peer-reviewed open access journal *Biomedinformatics* published online on the website https://www.mdpi.com/journal/biomedinformatics, and bearing the current International Standard Serial Number ISSN 2673-7426 enters the scientific community.

At the beginning of the 3rd decade of the 21st century, this new journal is dedicated to research reports in the field of biomedical informatics. *Biomedinformatics* appears at a time when computational methods have reached clinical practice and the transformation to digital medicine is accelerating. Both digitized healthcare and bioinformatics-based research is producing and benefiting from increasingly complex data. This requires the development of tools and methods to extract information from these data and translate it into new knowledge. While biomedical research continues to require clinical and experimental data collection, digital healthcare research has clearly evolved from a collection of supporting methods to an equivalent scientific approach, enabling a paradigm shift from almost exclusively hypothesis-driven approaches to increasingly data-driven biomedical research. Indeed, computational science is a rapidly growing multidisciplinary field that uses advanced computational capabilities to understand and solve complex problems by applying new methods of computational intelligence, machine learning, and advanced statistics [1].

Biomedical research is currently confronted with the emergence of a plethora of new journals, of which only those with peer-review and as soon as possible PubMed listing deserve serious attention. This leads to the dilution of the sources of scientific information as evidenced by a scientometric study that found that the relationship between impact factor and citations has weakened since 1990 [2]. A greater proportion of the 5% and 10% most cited papers were published outside of journals with top 5% and top 10% impact factors, respectively. As research activity increases and the number of papers that can be published in a journal is limited, either the rejection rate must increase or the number of journals must increase, which is what is happening. As a result, new journals are increasingly publishing highly cited reports.

In particular, the proportion of bioinformatics-related topics among biomedical research papers is steadily increasing (Figure 1). A search of the PubMed database at https://pubmed.ncbi.nlm.nih.gov on 12 December 2020, using the search string "((((bioinformatics) OR (biomedinformatics) OR (medical informatics) OR (biomedical informatics) OR (data science[TIAB]) OR (data-science[TIAB]))) NOT (review[PT]))" and the R library "RISmed" (https://cran.r-project.org/package=RISmed [3]) returned 35 hits of papers published in 1950 and 57,368 hits of papers published in 2019. The total number of publications listed in PubMed that were queried using only the year as the search string (YEAR[EDAT]: YEAR[EDAT]) was 85,787 in 1950 and 1,229,451 in 2020. These figures show an absolute increase in the number of bioinformatics-related publications; however, their relative share of all the publications listed in PubMed also increased from 0.041% in 1950 to 4.7% in

2019. Although this editorial is written at a time when everyone is looking at the exponential growth of medical indicators, the evolution of biomedical publications, including the absolute and relative proportions of bioinformatics-related papers, is better described by bilinear growth when trying sliding breakpoints and judging goodness-of-fit by the Akaike information criterion [4]. The relative share of bioinformatics-related publications in all publications already shows an accelerated increase from 1990 onwards, and from 1998 onwards this topic also shows an absolute acceleration of publication activities.

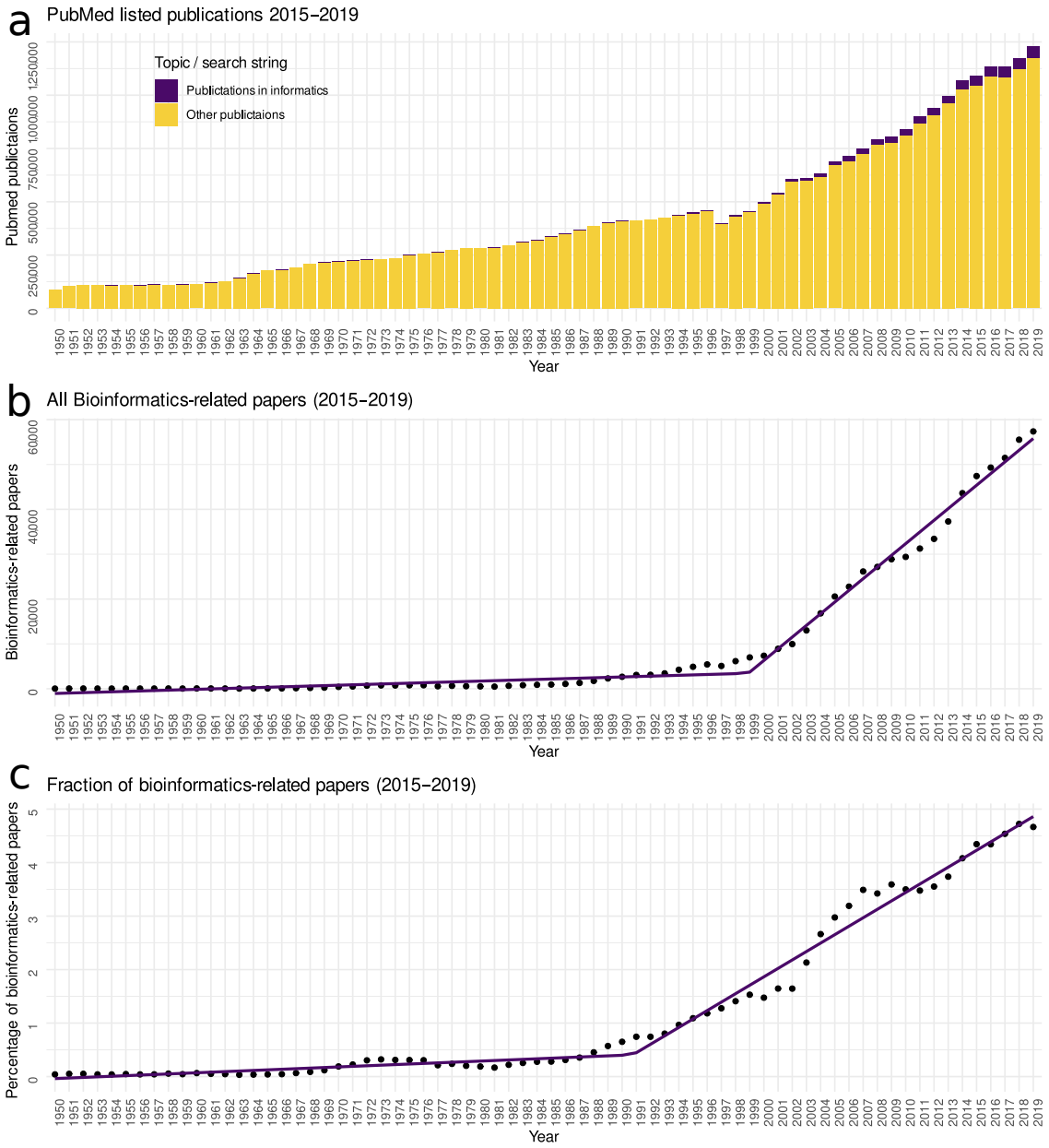

Figure 1. Publications listed in the PubMed database that are annotated with bioinformatics-related topics, based on the year of publication and the total number of biomedical publications listed. (**a**): stacked bar chart of all publications listed in PubMed per year with special focus on the publications found with the search string "((((bioinformatics) OR (biomedinformatics) OR (medical informatics) OR (biomedical informatics) OR (data science[TIAB]) OR (data-science[TIAB]))). NOT (review[PT]))". (**b**): scatterplot of publications on biomedical topics. The line shows the bilinear trend in the number of publications with acceleration from the late 1990s. (**c**): scatterplot of the relative number of publications on biomedical topics from all PubMed publications, also showing a bilinear trend. The figure was created using the R software package (version 4.0.3 for Linux; http://CRAN.R-project.org/ [5]) and the library "ggplot2" (https://cran.r-project.org/package=ggplot2 [6]).

Over the last 70 years, the above search provided 77 countries of origin for biomedinformatics-related papers in the PubMed database (Figure 2); however, only the affiliation of the first author was considered, which may underestimate collaborative contributions from other countries, with the United States of America being both the country with the most publications and the top country for collaborative publications [7]. The US occupies indeed the largest spot in a cartogram of the world's bioinformatics-related publications (Figure 3a), i.e., in a thematic map, in which distortion is used to convey information, for example, by distorting the outline polygons of all countries in such a way that the areas are proportional to the number of publications [8].

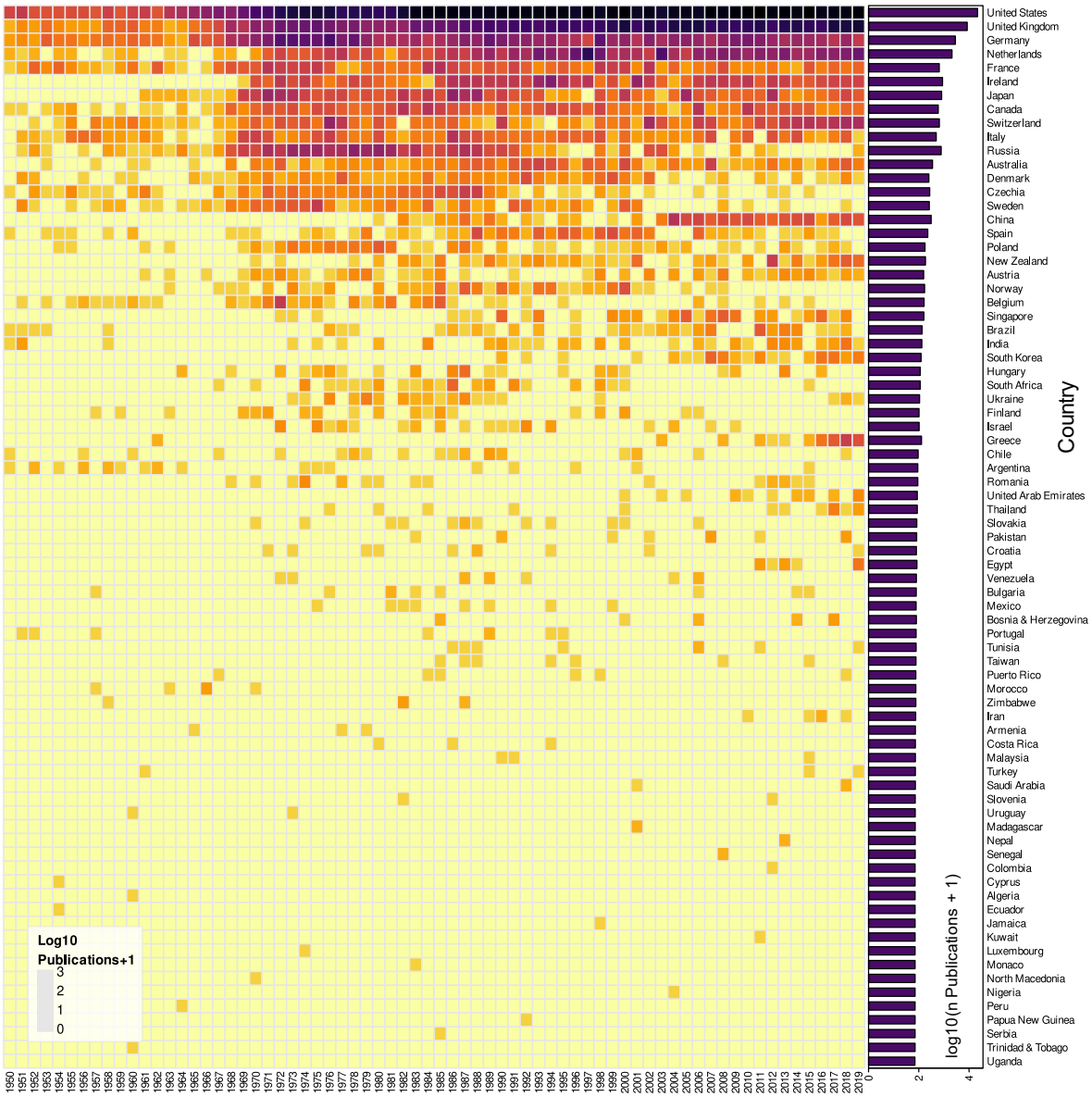

Figure 2. Publications listed in the PubMed database and annotated with bioinformatics-related topics, based on the year of publication and the country of work of the first author. The matrix plot shows the number of publications color-coded after zero-invariant log transformation. A darker color indicates more publications. On the right, the sum of publications per country over the last 70 years is shown as a bar chart. The figure was created using the R software package (version 4.0.3 for Linux; http://CRAN.R-project.org/ [5]), and the R library "Complex Heatmap" (https://bioconductor.org/packages/release/bioc/html/ComplexHeatmap.html [9]).

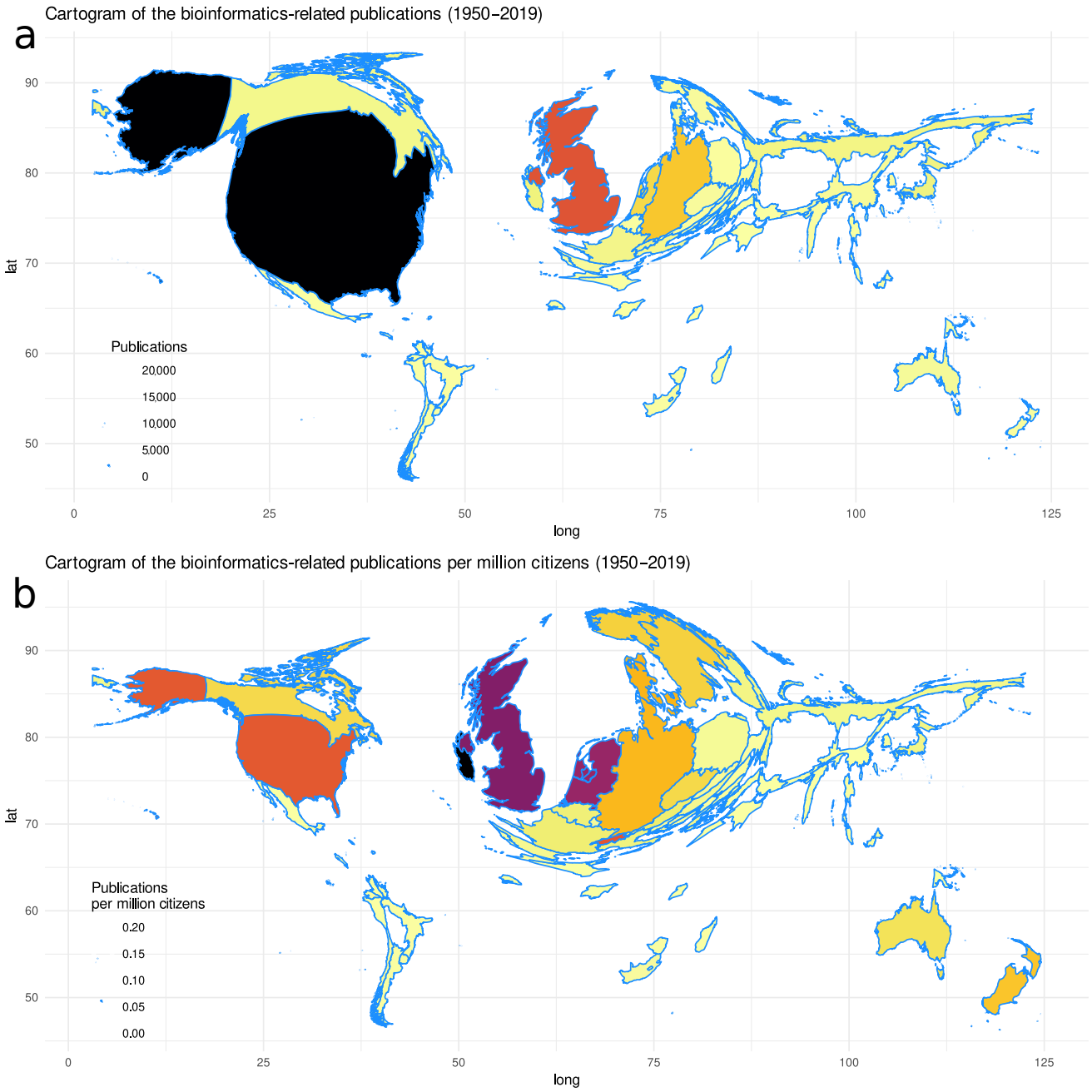

Figure 3. Cartograms [8] showing publication activity on biomedical informatics-related topics listed in the PubMed database between 1950 and 2019. (**a**): publication activity per county plotted with Gaussian blur as described in [8] spatial plots, with the boundaries of the regions transformed to be proportional to the publication numbers. (**b**): the same type of mapping, but plotting publications per million inhabitants. The figure was created using the R software package (version 4.0.3 for Linux; http://CRAN.R-project.org/ (R Development Core Team, 2008)) and the libraries "ggplot2" (https://cran.r-project.org/package=ggplot2 [6]) and "Rcartogram" (https://github.com/omegahat/Rcartogram [10]).

Indeed, the raw number of bioinformatics publications is significant for the impact on the world's knowledge. But the figure also shows the trend toward globalization. When the number of publications per year is standardized to the respective country's population in that year according to the United Nations Department of Economic and Social Affairs, Population Division (World Population Prospects 2019, Online Edition. Rev. 1, downloaded on December 14 from https://population.un.org/wpp/Download/Standard/Population/), the weight shifts toward Western Europe, with Ireland and the Benelux countries having the largest share of biomedical informatics-related publications

per capita (Figure 3b). Using only the last five full years does not yet significantly change this picture, but it is likely that the weights will continue to shift. This is reflected in the diverse editorial board with broad expertise in biomedical informatics and computational biology and medicine from many countries on three continents so far, including North America, Europe, and Asia, and a completion of this list should be a matter of only a short term.

The *Biomedinformatics* journal has just started its online presence with a first article and the next goal will be to establish the journal as a visible publication platform, implying its inclusion in the PubMed database as the primary collection of references and abstracts on life science and biomedical topics. The journal aims to produce truly multidisciplinary publications that meet a high international standard, based on a competitive peer review process that has been established from the beginning. The editors are committed to making it a success. The next immediate goal is inclusion in the PubMed database as the standard collection for scientific papers in the biomedical research field.

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Short Biography of Author

Jörn Lötsch is a Full Professor at the Medical Faculty of the Goethe-University Frankfurt am Main, Germany. He holds an M.D. degree from the (now) Technical University of Dresden, Germany, and a Ph.D. degree in Data Science from the Goethe-University. His past and present academic affiliations have included institutions in Halle/Saale, Germany; Cluj-Napoca, Romania; Dresden, Germany; Erlangen, Germany; Stanford, USA; and Frankfurt am Main, Germany. His research areas are data science, pain, and clinical pharmacology, with the goal of combining artificial and human intelligence in these areas. Active research topics include acquisition and computational analysis of data related to pain and analgesia in humans (biometrics), including drug effects (pharmacometrics), computational functional genomics, and next-generation gene sequencing approaches. He has published in *Bioinformatics*, *Scientific Reports*, *PLoS ONE*, *Journal of Biomedical Informatics*, *Data*, *Big Data Analytics*, *CPT Pharmacometrics Systems Pharmacology*, among many others.