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Bioinformatics Biostatistics and Biometrics: A Statistical Journey

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Abstract

Although bioinformatics, biometrics, and biostatistics all sound similar, each field has its own set of peculiarities. Even within a field, what separates one field from another might be a source of confusion. That's hardly unexpected, given how subtle the distinction might be and how the meaning of a term changes over time. It's also not difficult for people to switch labels. A biostatistician may refer to themselves as a bioinformatician, and vice versa. I imagine that others outside the field are perplexed by the lack of consistency.

Introduction

Bioinformatics, Biometrics, and Biostatistics are well-known broad concepts in the field of analytics for life sciences. Bioinformatics is frequently linked to Quantitative Biology or Computational Biology [1]. Bioinformatics is the journal of the International Society of Computational Biology, which demonstrates the former link. Because of the interdisciplinary nature of bioinformatics, it is frequently made up of people from varied backgrounds. A major influence of computer science and biology can be seen in certain cultures, such as conference publications and a rapid reviewer process, which are markedly different from traditional mathematical and statistical journals [2].

Since the early twentieth century, the phrases "biometrics" and "biometry" have been used to refer to the discipline of developing statistical and mathematical approaches for data processing problems in the biological sciences [3]. Statistical methods for analyzing data from agricultural field experiments to compare yields of different wheat varieties, for analyzing data from human clinical trials evaluating the relative effectiveness of competing therapies for disease, or for analyzing data from environmental studies on the effects of air or water pollution on the appearance of human disease in a region or country are all examples of problems that would fall under the umbrella of this category [4].

Biostatistics is a discipline of statistics that deals with information on living creatures. The purpose of biostatistics is to enhance statistical science and its application to human health and disease problems, with the goal of improving public health [5].

Development of the Field

The terms "statistics," "statistician," and "statistical" are only a century old in their current use. They have, however, been in use for far longer, and it is fascinating to trace the origins of their current meaning [6]. They are all derived indirectly from the Latin status of a political state, in the sense obtained in mediaeval Latin. During the 18th century, the word "statistics" simply meant the presentation of notable characteristics of a state, with the mode of expression almost exclusively verbal; however, as official data became increasingly numerical, the word insensibly acquired a narrower meaning, namely the presentation of state characteristics using numerical methods [7]. It was then extended to numerical data in other areas, including as anthropology and meteorology, with comparable results. As a result, the word statistics has come to have two meanings: when used as a plural noun, it refers to a collection of numerical data, and when used singularly, it refers to statistical methods [8]. Statistics theory is a relatively new development [9]. Its origins can be traced back to Laplace and Gauss' work on the theory of observational mistakes, but the research did not really take off until the latter quarter of the nineteenth century, thanks to the impact of Galton and Karl Pearson (1857-1936), who refined the theories of Gosset established methods for analyzing data gained through sampling in the early twentieth century, which were later popularized in England by R. A. Fisher (1890-1962) and his colleagues, who considerably expanded the theory and application domains, particularly in agriculture, biology, and genetics [10].

Biometrics is a topic that arose from the application of quantitative statistics principles and methodologies to biological problems [11]. The biometrician must not only be able to evaluate the results he produces, but he must also comprehend the assumptions that underpin the mathematics used, as these influence the theory's application to the circumstance. When no theory matches your situation, a mathematical model must be created from scratch, which you should delegate to a professional [12].

Technological Challenge

Bioinformatics is an interdisciplinary area that includes computational biologists, computer scientists, mathematical modelers, systems biologists, and statisticians who study various aspects of data, such as storing, retrieving, organizing, and analyzing biological data. Given the numerous challenges that this complex field presents, bioinformatics is inherently interdisciplinary, as no single researcher can possibly possess all the clinical, biological, computational, data management, mathematical modeling, and statistical knowledge and skills required to optimally discover and validate the vast scientific knowledge contained in the outputs from these technologies.

Biostatistics, or the application of statistics in the realm of health and biology, provides powerful tools for generating questions, conducting research, constructing measurements, and analyzing data, and is critical in determining the efficacy and safety of goods like medications and vaccinations. Statistical sciences have seen a tremendous expansion in their impact on medical and biological sciences during the last few decades. Clinicians must be statistically literate to follow up on and evaluate empirical studies that offer a foundation for therapeutic practice. Recent breakthroughs in biomedical research have presented statisticians and data scientists with new difficulties as well as opportunities. Data scientists are inspired to develop modern statistical methods and innovative inference procedures by big data analytics, precision medicine, artificial intelligence, causal inference, and other new research resources. As a result, new philosophies such as causal models and prediction are required, as well as new models such as graphical chain models and random effects models, faster computers, and more intelligent algorithms for integration and maximizing.

All medical research is at risk of "drowning in data but hungry for knowledge" unless enough investment in biostatistics is made. Biometrics is becoming a more important part of personal, national, and global security. Any biometrics technology supplier, developer, or researcher will need to benchmark feasible system performance to track development. Although there have been various challenges, competitions, and other initiatives in the past to achieve benchmarking, statistical tools, procedures, and methodologies for measuring biometric performance have arguably not kept up. This special issue brings together four new research papers on biometric benchmarking and performance evaluation, with a focus on evaluation methodology and statistical methods that make performance measures more generalizable and dependable. Any biometric modality is irrelevant to the questions mentioned above. This discipline is closely related to statistics, but it is driven by the desire to help people.

Conclusions and Future Direction

In Bioinformatics, Biostatistics, and Biometrics, statisticians have played a key role in developing rigorous design and analysis methods that researchers can use to extract useful biological data. Their in-depth knowledge of the scientific process, as well as unpredictability and uncertainty, has uniquely qualified them to play a key role in this endeavor. We tried to encapsulate this contribution in this paper by focusing on three major areas of bioinformatics, biostatistics, and biometrics. The success and benefit of these statistician-derived procedures are driven by the important statistical principles inspiring and underlying them, and there has been a lot of high-impact work done in these areas.

Acknowledgment

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Conflict of Interest

No conflict of interest.

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