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Bioinformatics in Action : A Comprehensive Review of Bioinformatics Applications in Varied Disciplines

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Abstract

Studies have been carried out related to the application of bioinformatics which includes genomics, proteomics and metabolomics in everyday life, such as in the fields of health, agriculture, environment, renewable energy and food. Evaluation of the quality of the papers used is based on papers available in each journal on platforms such as Scopus, Google Scholar, as well as articles published by Elsivier, Springer Nature, etc. The stages carried out in this research include journal data collection, journal renewal, journal grouping, and journal comparison. Based on this application, it has been proven that bioinformatics has achieved success in understanding various biological aspects. Thus, it is hoped that this research can provide deeper insight regarding the use of bioinformatics in various other fields.

A. Introduction

Technological developments are currently progressing so rapidly that combining the fields of biology, computer science and technology into one scientific discipline will help scientists find out what advances are happening around them related to Bioinformatics. The application of computational techniques to manage and analyze biological information includes DNA sequences, amino acids [1][2][3], as well as related information requires bioinformatics to use computer technology [4][5][6], in addition to components of mathematics, statistics and computational methods [7][5][8][9] is needed to process the biological database. The basics of bioinformatics began in the 1960s through the application of computational methods to protein sequence analysis such as biological sequence databases and substitutions [10][11][12][13][14].

This historical milestone that started with the discovery of the alpha helix that can be adopted by proteins in space has led to the development of studies related to genomics, proteomics and metabolomics which then developed into bioinformatic applications. A genome is information about an organism that contains millions or even billions of DNA letters which will be a source of information regarding the inheritance of the characteristics of the organism [15][16][17][18]. Several areas of research and study that emerged related to genetic complementation came to be known as Genomics. The method used to sequence, assemble and analyze the structure and function of the genome can be recombinant DNA [19][20], DNA sequencing [21][22], and Bioinformatics [23]. Complete evaluation of the function, structure, interactions, composition and cellular activity of proteins to understand the nature of an organism is also called proteomics [24][25][26]. This area of research is concerned with the study of proteomes which is used to describe techniques for determining a series of proteins of an organism [27][28] or systems such as protein purification [29][30] and mass spectrometry [31][32] namely proteomics. Metabolomics is a comprehensive analysis of metabolites in biological specimens [33][34][35] which can provide information regarding the work of small-scale metabolite systems to diagnose more complex metabolic diseases [36][37], discovery of therapeutic targets [38][39], and the discovery of biomarkers in monitoring therapeutic activity [40][41]

Almost every year there are new discoveries made by researchers related to bioinformatics applications by developing studies related to genomics, proteomics and metabolomics. According to Oulas in 2019, Bioinformatics can improve therapy and computational diagnosis so that doctors can carry out precision treatment. This is also reinforced by research conducted by Sunil 2021 that the administration of drugs to patients must and needs to be adjusted to relevant clinical considerations and the patient's history [42], apart from that there is research related to the above topic conducted by [43][44][45][46]. Through this article, the author presents several uses in the field of bioinformatics which can include genomics, proteomics and metabolomics in everyday life to solve several biological problems such as health, agriculture, environment, renewable energy, food, etc.

B. Research Method

The use of bioinformatics in everyday life through genomics, proteomics and metabolomics studies is presented in this paper. The research method used involves

an evaluation system of the quality of a methodology in articles available in each journal on platforms such as Scopus, Google Scholar, as well as several articles published in Elseiver and Springer Nature. A comprehensive analysis of the methods used in this research will help in plotting the use of bioinformatics in the context of health, agriculture, environment, renewable energy and food as well as highlighting the potential and challenges that may be faced in future research development. The stages carried out and considered in this research are:

1. Journal Data Collection

The journals used in this research were searched on platforms such as Scopus, Google Scholar, as well as several articles published in Elseiver and Springer Nature using keywords that were appropriate and relevant to the topic to be studied, in this case related to the field of bioinformatics.

2. Journal Update

The journals whose topics are used and studied in this research are journals that have been published or published in the last 5 years and have excellent quality and reputation in the scientific community.

3. Journal Grouping

Journals - The journals that have been selected and collected will then be grouped according to the type of data to be analyzed. The analysis is based on categories in the bioinformatics field such as health, agriculture, environment, renewable energy, food, etc.

4. Journal Comparison

Journals that have gone through the process of data collection, updating, and grouping according to the field of food studies, the next stage is to make comparisons and carry out evaluations regarding the strengths and weaknesses of each journal used.

Thus, it is hoped that this research can provide deeper insight into the use of bioinformatics in the fields of health, agriculture, environment, renewable energy and food and contribute to the development of science and technology in the future.

C. Result and Discussion

The use of Bioinformatics in various fields (health, agriculture, environment, renewable energy, food, etc.) which has been obtained from the analysis of various scientific journals is identified based on field groups, then presented in table form which can be seen in table 1. Journals used in each field namely journals with details of the maximum year the journal was published in the last 5 years.

Table 1. Use of Bioinformatics in Various Fields

No	Category	Utilization of Bioinformatics
1.	Health	Omics-based analysis [47] [48], drug design [49][50][51], drug discovery [12][52], drug innovation [53][54], more accurate detection or diagnosis of disease [55][56][23], network biology [57][33], immunology [58][59], etc.
2.	Agriculture	Pest management [60][61], improving crop quality and productivity [62][63][64], improved nutrition [65][66], biotic stress and antibiotic tolerance [67][68], plant breeding [69][70], development of special servers for various segments

		of flowers and medicinal plants as well as horticultural plants [71][72], etc
3.	Environment	Environmental monitoring with the use of automatic sensors [73][74][75], environmental data analysis relating to environmental factors and biological communities [76][1], development of environmental biotechnology using genetically modified microbes to decompose organic waste [64][77], conservation of biological resources to understand genetic diversity in certain species [78], etc
4.	Renewable Energy	Renewable energy storage systems [79], metagenomic data of biogas producing microbial communities [76], Bioenergy (understanding of microorganisms involved in biogas production both in terms of productivity or efficiency)[80], Biomass and Bioconversion (related to the conversion of biomass into energy including fermentation, photosynthesis, and biomass degradation enzyme products [81][82], Biodiversity and Ecosystems (understanding the genetic diversity and functionality of natural ecosystems which play a role in the nutrient cycle and biomass production where this habitat conversion will contribute to biomass production for renewable energy)[83][84], etc.
5.	Food	Plant breeding to increase resistance to pests, disease and extreme environmental conditions [85][69], understanding food quality in relation to taste, texture, nutrition and disease resistance [86][87], monitoring pathogen detection and potential contamination in the food supply chain [88][89], optimizing food production through understanding plant, livestock and microbial populations [90][91], environmental monitoring and agricultural management precision to optimize resource use [90][92], development of advanced and sensitive analytical methods of food analysis such as allergy and molecular imaging for food quality and integrity [93][94], etc.

Based on the grouping of bioinformatics utilization in the tables above, we can see the differences and similarities in the methodological approaches used in utilizing bioinformatics itself. Presenting in-depth views and exploration regarding the use of bioinformatics will be a very effective tool in overcoming the challenges that exist in these fields.

D. Conclusion

Several applications of Bioinformatics in everyday life have been described in this article. Starting from the fields of health, agriculture, environment, renewable energy and food. Based on this application, it has been proven that bioinformatics has achieved success in understanding various biological and environmental aspects. Through the development of effective and efficient solutions using genomic analysis, proteomics and environmental modeling, it is possible for bioinformatics to better understand biological complexity and accelerate innovation in other fields.

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