Biomedical Informatics and Computational Biology

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Abstract- **Biomedical informatics and computational biology are some of the fields emerged with the introduction of computers. Biomedical informatics involves the effective use of biomedical data, computer models, and problem-solving techniques to solve health challenges. On the other hand, computational biology involves statistical, mathematical and computer knowledge to understand biology-based issues. The paper presents a discussion of these two disciplines, their deeper definitions and their applications in day-to-day operations. In addition, the algorithms of computational biology and importance of biomedical informatics have been highlighted.**

Keywords: **Biomedical informatics, computational biology, data, algorithm, healthcare**

1. INTRODUCTION

Biomedical informatics and computational biology are two distinct fields that have emerged with the emergence of computers and have continued to evolve helping researchers and clinicians solve complex biological and health problems easier [2]. The two disciplines are joined together by the use of computers and information technologies in core functions to solve challenges and develop models but have distinct application. Biomedical engineering is a synergy of bioinformatics and medical information which brings the use of computation applications in implementing healthcare models and using the large amounts of data that is generated in the medical field [2]. While computational biology deals with a wider scope, the bioinformatics is specific to the goals of improving human health.

II. BIOMEDICAL INFORMATICS

Biomedical informatics (BMI) refers to an interdisciplinary field which deals with the effective use of biomedical data and medical information, as wells as problem-solving, scientific inquiry knowledge which is motivated by the efforts geared to improve human health. Biomedical informatics branches from health informatics to deal with data aimed at helping researchers, clinicians as well as scientists to improve human health through the provision of quality healthcare. This is an evolving discipline that has continued to grow with the advancements in biomedicine [10]. Though the field does not solely rely on information technology and computers, biomedical informatics uses lots of software, cloud computing, and artificial intelligence in addition to the knowledge from the biotechnology industry and the digitization of data on personal health. The field studies develop and apply methods and processes, as well as theories for generating, storing, retrieving, using and the sharing of biomedical data, knowledge, and information [10]. It mainly builds on the subject of computing, communication and information technologies and sciences and their use in biomedicine.

III. COMPUTATIONAL BIOLOGY

Computational biology involves the application of mathematics, statistics, and computer science to solve biology-based issues. It involves a range of topics that include evolution, genetics, biophysics, biochemistry, and cell biology [9]. The branch leverages on various quantitative tools such as statistical physics, machine learning, frequency statistics, and algorithm design. The scientists in computational biology are tasked with the development and application of theoretical

methods, data-analytical tools, mathematical modeling and use of techniques in software simulation to study the biological systems [9]. In the modern science, computational biology forms part of research projects in biology such as genome databases, protein data banks and brain magnetic resonance imaging (MRI) images that contain large amounts of raw data that can be studied to bring important information in the development of the field of biology [8]. The computational biologists use the techniques in mathematics and computation to translate the biological process and procedures into computational models. They work in a different range of fields to add knowledge in the systems biology, molecular networks, population genetics as wells as in comparative, agricultural and medical genomics.

IV. COMPUTATIONAL BIOLOGY ALGORITHMS

The knowledge in computation biology is useful in constructing methods and descriptions on how to approach the specific problem in the field of biology. Algorithms are utilized in the construction of computer programs that are used to help if utilizing the capacities of computers [1]. The following are some of the basic computation biology algorithms:

1) **Global and Local Alignment**: In the local alignment two sequences that may or may not be related are treated to check whether a substring in one sequence aligns well with a substring of another, a process which is used in checking local similarities in large sequences [3]. On the other hand, two sequences are treated as potentially equal in global alignment and are used comparing functions of two genes by identifying the differences and conserved regions. These two apply the use of proteins to make the procedures possible.
2) **Hidden Markov Models**: These models have been used extensively in the analysis of the biological sequence. The statistical model is used to describe the evolution of events that are observable which depend on the internal factors which cannot be observed directly [3]. The model consists of two stochastic processes; invisible and visible process, which depict the hidden states and the observable states, respectively.
3) **Population genetics**: This involves the genetic composition of populations focusing on genetic variations within as well as among populations [3]. Population genetics also seeks to understand why and how the frequencies of genotypes and alleles change with time, thus understanding how evolution occurs.
4) **Evolutionary trees**: This is an algorithm that involves the evolutionary relationships among organisms. The trees show have various species or trees evolved from a common ancestor.
5) **Gene Regulation networks**: The algorithm explains the formation of different proteins in an organism and their interactions within the cell [3].
6) **Chemical Equations**: They are used to describe the mechanics behind the networks of gene regulations.

IV. APPLICATIONS OF BIOMEDICAL INFORMATICS AND COMPUTATIONAL BIOLOGY HEALTHCARE

Biomedical Informatics

The biomedical informatics is one of the disciplines that has become a point of focus in the academic centers and medical and biological research centers due to processing of tonnes of information generated by the medical and biological fields today [11]. The following are some of the important applications of the field which have ushered a completely new era in the field of human health.

1) **Substantial Volumes of Data**: in the modern world of healthcare, there has emerged lots of data which has risen from the large volumes of measurements that are available today especially from sophisticated technology measurements such as throughput DNA sequencing and other devices that are being used to capture physiological signals in real-time [11]. There are also enormous sources of medical information in the world today and every medical personnel from emergency room healthcare providers to biochemists are avalanched by tons of information which they need to process. Biomedical informatics is therefore uniquely positioned to help in the processing, retrieving, managing, retrieving, and interpreting the large volumes of data from the basic and clinical scientific fields.
2) **High-performance computing (HPC) technology**: The high-performance computing technology is currently available and inexpensive which has enabled the enabled the sophisticated computational analysis of large volumes of data. The processes of local resources, for example, parallel computing clusters, computing have also turned out to be less expensive to set up and also consume smaller footprints in data centers [11]. Graphics processing units (GPU), which have thousands of cores have become more and more popular led to adapting codes to harness HPC resources developing deter libraries.
3) **Artificial intelligence and machine learning**: The field has today developed and machine learning and artificial intelligence has recorded better performance than human capacities. The success of these intelligent algorithms has been mainly facilitated by the research that has been done over the years [11]. Biomedical informatics has been a crucial element in the integration of medical data into computer systems that are used in machine learning and artificial intelligence.
4) **Knowledge Integrations**: The biomedical informatics has the capabilities to integrate various sources of knowledge which helps the information to be more useful than the information that has been generated from a single source of discipline.
5) **Collaborative research**: The biomedical informaticists have become important assets in the field research. The fields in an important position in developing computational models of data, management of data sources and the use of information technology techniques in the mining of data from the vast amount of resources available in the world today [11]. Many research projects today have taken an interdisciplinary approach due to the availability of lots of information and the use of approaches such as NBT (no-boundary-thinking).

Computational Biology

The great improvements in technology have contributed much in easing researches done through science [4]. In the 21st century, science has taken advantage of the new power Tianhe-2 supercomputer in computing and analyzing data. Additional support has been provided by the NSCC-GZ platform through which biological computing and personalized medicine uses to accelerate and improve medical science researches [4]. Through this platform, life science, as well as medical science researches data, can easily be analyzed and processed. In computational biology, NSCC-GZ is known for its support in enabling researchers to cover vast areas of both medical science and life science researches. Users of the platform have been able to find solutions for multi-model issues, multi-scale as well as solving coupling computations. The platform also helps in bio-information analysis, medical wide data analysis, designing and screening of drugs as well as medical simulation.

Analysis of medical data, biological data and screening and designing drugs creates the biological computing and personalized medicine platform. Users of this platform gather both biological and medical data from various areas and analyze it in the aim of providing improved public health care and improved personalized medicine care and services [4]. Analysis of bio-information data has also been improved through the availability of galaxy sub-platform in the biological computing and personalized medicine platform. The sub-platform through its web-based applications provides a wide range of tools that have interfaces which ease the process of bio-information analysis.

Several types of research and analysis are performed in computational biology and personalized medicine Tianhe-2 platform such as protein structure prediction, biological molecular structure, drug designing, analysis of protein sequence mining of big data in medicine, macromolecular structure simulation as well as genome sequence analysis [5]. The methodologies used in the analysis include string handling, Bayesian model, mathematical statistics, data mining, graph theory, Gaussian prediction, and molecular dynamics among others.

V. IMPORTANCE OF BIOMEDICAL INFORMATICS

Academic medical centers, as well as universities, have placed their focus on biomedical informatics mainly due to its support in their biomedical researches. It increased support in processing, analyzing and interpretation of large data especially in this era where big data is being used has made biomedical informatics vital in these areas of study [6]. It has been termed as the main solution to challenges facing the great efforts put in the improvement of health care systems. Some of the uses include:

1. With the current use of big data, biomedical informatics has the required skills and technology useful unlocking sets of unstructured data. The availability of the open data allows accessibility of various useful sources of big data [7]. This is a relief to persons working in biomedical informatics as they can now be able to handle challenges due to easy simplified ways of accessing data.
2. Through biomedical informatics, different sources of knowledge are being integrated to provide scientific information that is useful in improving human health care services [7]. A good example is the use of genomic medicine in the measurement of variations across the human genome.
3. Biomedical informatics has also enabled the integration of visual analytics through the use of hardware tools such as D3, JavaScript packages used in providing visualized data, especially in web browsers [7]. Additionally, through the improved technology and use of new hardware for touch computing and other soft wares facilitates the improvement of human health care.

VI. CONCLUSION

In conclusion, the emergence of computer science has unleashed lots of new fields in the field of medical and biological studies. Computational biology and biomedical informatics represent some of these fields that emerged and continue to grow. New possibilities in the medical and biological fields have been opened by these fields. Biomedical informatics has helped in solving medical issues improving the lives of populations while computational biology has helped in understanding populations and solving biology-related issues.

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