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Review Article

Application of Informatics in Medicine

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Abstract

Healthcare professionals are witnessing numerous innovations and technologies that have enabled the performance of more complex diagnostic procedures, treatments and numerous multidisciplinary research. The amount of current patient data as well as their complexity make clinical decision making more challenging than ever for physicians and other carers. This situation requires the use of biomedical IT data processing methods and recommendation and / or forecasting forms to assist such decision makers. The design, application and use of biomedical information systems in the form of computer-aided decision making have become crucial and widely used in the last two decades. This paper provides a brief overview of such systems, their protocols and application methodologies, as well as the future challenges and guidelines they propose.

Keywords: medical informatics; information system; bioinformatics methods; pacs system

1. INTRODUCTION

Medical informatics is a scientific discipline that deals with the theory and practice of information processes in medical work, where information processes include capturing, transmitting, storing and converting data, or data processing in the broadest sense. Since knowledge is an important factor in solving medical problems, it can be said that medical informatics deals with procedures for handling medical data, notifications (information) and knowledge for the purpose of solving medical problems and making decisions in health care. Medical informatics is developing methods that can more efficiently, reliably and cost-effectively handle medical data, information and knowledge, and can be accessed by a wide range of users and providers of medical services via computer networks. Therefore, information technologies, which include computer and telecommunication technology, are an important means of medical informatics[1].

The quality of health care is defined as the degree to which health services for individuals and the population increase the likelihood of the desired health outcome and are in line with current scientific views and knowledge. The quality of health care refers to promotion, prevention, treatment, rehabilitation and palliative care. The new, more advanced model of health care delivery, in response to the health challenges of the 21st century, implies the provision of health care in the community, ie outside the walls of hospitals and a greater degree of integration of primary, specialist health care and social services. It is expected that the health care system will respond to the needs of citizens for health care in a quality and up-to-date manner. Therefore, in a sustainable health care system, high efficiency is expected in providing the highest quality and safest health services: achieving the best results in improving health results with optimally invested funds[2].

The health policy strategy presented in this paper is based on raising the quality of health of the population, with the adjustment and improvement of the health system in accordance with the financial possibilities. Quality health care is defined as health care that efficiently uses available and appropriate resources to contribute equally to improving the health of the population and patients. This means that the provision of health care in accordance with current expertise, focused on the needs and goals of individuals, their families and the community as a whole, prevents and avoids harm associated with treatment, and includes citizens and patients as key partners in the treatment process. The most commonly used quality dimensions include: efficiency, availability, safety, fairness, appropriateness, timeliness, acceptability, patient focus, satisfaction, health improvement, and continuity of health care. The criteria for evaluating health services are:

1. Efficiency (improvement of health outcomes).
2. Safety (prevention of care-related damage).
3. Convenience (meet standards in line with current expertise).
4. Focus on people / patients (look at patients / citizens as key partners in the treatment process).
5. Efficiency and equality (optimal use of available resources without differences, variations and differences in the health achievements of individuals and groups).

Better informed and empowered patients will be able to maintain optimal well-being and manage their health more efficiently in the context of everyday life, with appropriate support from health professionals working in a well-funded and structured health system. It may also mean the possibility of not applying the proposed treatment. The patient may choose not to participate (to be included) by leaving the decisions to healthcare professionals, but may also choose the “no treatment” option (provided conditions allow). Quality health service as a strategic goal with the support of the management of health institutions will basically transform the system step by step. The assessment of the quality of health services, and thus of patient safety, is based on pre-defined quality standards, which determine what exactly needs to be done to achieve the expected quality of health services. The center and purpose of every health care system is the patient[3].

With the advancement of technologies related to the collection of medical signals and images, it can be seen that the complexity of the collected medical data has escalated. In addition to naturally more complex medical data, the simple coverage of such data per patient is growing rapidly. Currently, wide-range medical devices and systems produce thousands of images and large amounts of other data per patient per second, making it difficult for physicians to analyze information while providing timely diagnoses and prognoses. There is a significant need to develop and improve computer-assisted decision support systems in medicine, with expected reinforcements in the future.

This paper provides an overview of applications and methodologies in biomedical informatics that are applied as computer-aided decision support systems and discusses the challenges that arise, for example, in the validation of such systems and at the level of end-user adoption.

2. DEVELOPMENT OF INFORMATION SYSTEM

Management information system is a system comprising of personcomputer used for collection, transfer, storage, maintenance and application of information.The development method of MIS in enterprises mainly has the three ones of Structured System Development Methodology, Prototyping Approach and Object Oriented Design Method. Each development method has its own limitations. In actual application, the optimal development method is to select an appropriate development method in accordance with the comprehensive scale, degree of complexity and development instrument [4].

An information system (IS) is an organized and organized system of procedures and methods for collection, processing, storage and exchange of information for management purposes (supervision, reporting, decision-making and planning) by some other system. Represents and compatible synthesis of hardware, software, life, hardware and corsair.

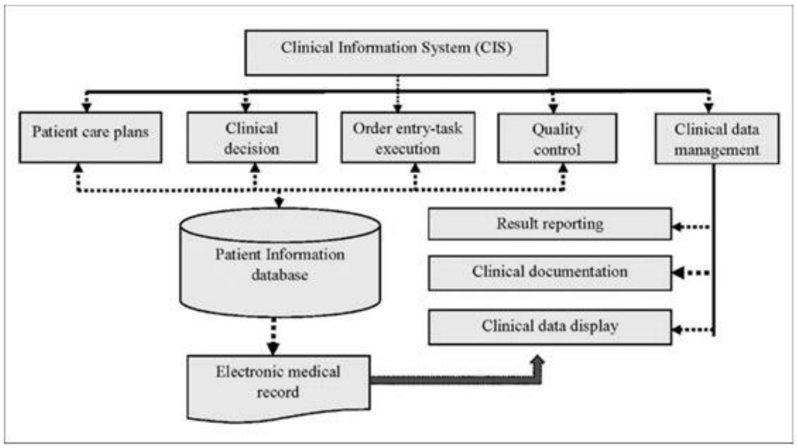

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Diagram 1. *Infrastructure and flows in clinical information systems.*

Hardware (technical basis of computer system, equipment) is a physical part (mechanical and electronic) computer system, which includes the central unit, devices for storage, input and output devices and means for remote data exchange and transmission.

Software (computer system programs, programs) are programs, routines and methods performed by a computer system related to organization, management, processing and using the results of data and information processing.

System software (operating system and compilers) is an essential companion to hardware and software ensures the efficiency of the entire computer system, application programs and user programs are widely used in a variety of environments[5].

User programs are sets of utilities that are part of each computer system, and provide a variety of public functions (programs for copying and deleting files, programs for preparing or processing text and images, etc., e.g.).

Application programs, computer programs, are designed to fulfill requirements users or groups of users. They can be horizontal (widely applicable in different areas, databases, e.g.) and vertical (applicable in very specific, specific areas). Thus, e.g. a statistical program package is a set of programs that uses statistical methods for data analysis and reporting of results. Most commonly used statistically packages of programs in medicine are: SAS (Statistical Analysis System), SPSS ("espieses") (Statistical Package for Social Sciences) and BMDP (“biemdipi”) (Biomedical DataAnalysis Package).

Life (staff), a team of experts who create and maintain an information system and set information system user.

Orgver (organizational procedures, organization), a set of procedures, methods and ways synchronizing and connecting hardware, software, and life into a coherent and efficient whole.

Corsaver is a multimedia set of programs for computer - based education and training.

Each information system has its own life cycle, total duration ("life") of one system, from its inception to obsolescence. Phases, through which the system passes computer-based, are: initial conception, definition of requirements, design of major drawing, detailed design, programming, testing, implementation, maintenance and modification. System design is an activity, which is based on the identified expensive set, designs the appropriate system. Implementation is an activity transforming a given system design into its working version, and evaluating the evaluation the outcome of the application of that system. Basic principle in designing information systems, today, it is their openness (OSI - open system interconnection). That means easy establishing an interface, a connection between a system, device, or program a in order mutual communications.

Information systems are classified by scope, scope, type of data and degree of complexity. For us, the most important is the Health Information System (HIS), integrated communication computer system for information exchange in the process health care, whose users are (all) health workers and (all) health users protection. By scope it can be local, institutional, regional, national and international, and by structures centralized and distributed[6].

The basic functions of the health information system are: collection medical and administrative data (automated collection of medical data directly from medical instruments, aids or structured questionnaires), storing and storing medical records (data processing operations, tabulation data, formatting and production of various reports), communication and integration (communication between members of the same and different teams and integration of similar data from different sources), supervision (directing attention to significant events, vaccination e.g. or potentially dangerous situations, allergy to a particular substance e.g.), search information (availability of all patient data or search of medical literature), data analysis (graphical or descriptive presentation of data, performed survival analysis eg), decision support, clinical consultation systems based on population health statistics and coded expertise provide support to the physician in diagnostic process or when planning treatment) and education (acquisition of new knowledge and skills, and the renewal of the old).

The development of any health information system today relies on modular and distributed approach. Namely, they are designed, tested and implemented information systems that support, or only some health functions, or the work of typical health institutions. Compatible synthesis of such health subsystems information system, is the health information system itself. They are usually you subsystems: medical documentation system, hospital information system, care system, laboratory information system, radiological information system, pharmacological information system, patient monitoring system, practice information system, bibliographic search system, medical decision support system, medical research information system, medical education information system and health assessment system[7].

The information system of medical documentation is a system that enables management of all types of medical and administrative data, ie, medical records - medical records or medical history, e.g. Use Computerized medical records have advantages over paper documents (accessibility, durability) but also some disadvantages (large initial material investments, special type of education or failures of the computer system itself). Today, POMR is most commonly used (Problem-oriented Medical Record) Lawrence Weed (1969), problematic oriented medical history, which has already been discussed, AAMRS (Automated Ambulatory Medical - record System), COSTAR or TMR (The Medical Record).

The laboratory information system supports basic processing functions and data management. At the same time, laboratory equipment is an integral part of the system, so that data is automatically collected, analyzed, stored and distributed, the quality of work is monitored laboratories and provide the necessary data on the inventory, the work process - it is estimated productivity of laboratory work[8].

The radiological information system supports the basic function of every radiological departments, generation, collection and analysis of medical images. Generation modalities images can be different, X-rays, computed tomography, ultrasound imaging or magnetic resonance imaging, while image analysis uses visual shape recognition. Storage, search and use of medical images is enabled by the development of PACS-a, Picture Archiving and Communication Systems Communication System).

The Pharmacological Information System manages information related to properties, use and effects of drugs in the treatment process, MENTOR system e.g.[9].

3. COMMUNICATION WITH HEALTH DATA AND INFORMATION

In order for data and information to be exchanged and understood by different systems and different users, and in order to be able to compare and analyze, they must have a certain prescribed (usually agreed) form. This form is called the standard form, and it is prescribed by certain rules on the basis of an agreement. Standards gained great importance during the Industrial Revolution during the 18th and 19th centuries. Since then, they have found their place in various fields of human activity, including informatics.

The basic principle of standardization is consensus - the agreement of all stakeholders on the standardization of something [10]. In health care systems or for medical research, it is necessary to ensure the transfer of data between the computer systems of laboratories, hospitals or different health care institutions. In health care facilities, patients are routinely given various diagnostic tests from radiological, biochemical and hematological; different treatments ... The data thus obtained should be available to other subjects in the system. As the complexity and growth of digitized data grows, the problem of standardization of the presented digitized data arises. At today's stage of development of information technologies and in times of communication needs among health systems at the local, national or global level, there is a need to standardize communication protocols that present, archive or transmit health data. This need is even more pronounced due to the emergence of different isolated health information systems and the need for these systems to work together[11]. Standardization brings many advantages in health informatics:

- Standards increase opportunities and reduce cost;
- A standardized product can be easily replaced or upgraded;
- Standardized products from different manufacturers can easily modify medical information;

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- Health care institutions can constantly extend their capabilities;
- Standardized products reduce the possibility of error and make the health system safer.

In the late 1980s, standardization of messages in health care was introduced. Communication standards (also called syntactic standards) ensure the correct transfer of health and administrative data between different information systems [12]. Many standardized protocols for health data transmission have been developed, the most important of which are HL7 (Health Level 7), DICOM (Digital Imaging and Communications in Medicine), EDI-FACT (Electronic Data Interchange for Administration, Commerce and Transport), CEN / TC 251, IEEE 1073; and profiles and recommendations: ISO / TC 215, IHE, and others. Dva najznačajnija protokola koja ćemo ovdje opisati su intimno vezana za dvije velike komponente zdravstvenog informacijskog sistema: elektronski medicinski zapis (EMR – electronic medical record) i uskladišteni medicinski slikovni podaci poznati kao PACS – Picture Archiving and Communications Systems.

3.1. EMZ (electronic medical record - elektronski medicinski zapis) SISTEM

Kompjuterizacija i uvođenje internih informacionih sistema u zdravstvene ustanove otvorili su put za stvaranje koncepta računarskog medicinskog kartona (Computeri-zed Medical Record), a potom i elektronske zdravstvene evidencije (Electronic Health Record System), kojim je omogućeno da svi podaci o pacijentu budu u elektronskoj formi i da se nalaze na lokalnom informacionom sistemu (mreži) jedne ustanove [13,14]. Posljedica takvog načina evidentiranja bila je pojava elektronskog medicinskog kartona pacijenta (EMKP), koji se kreira na računaru i u koga se informacije unose putem odgovara-jućih uređaja (tastature, miša, sistema za prepoznavanje glasa, skenera i drugih).

The functions required for electronic medical records and the roles expected of them are increasing on a daily basis. Since the period before the “three principles” were proposed, academic societies and forums including JAMI (Japan Association for Medical Information) have been studying and actively discussing optional formats for electronic medical records. As accumulated experience and social contexts have changed, the format has gradually changed and begun to take on a more concrete shape. What had not been possible before has now become a matter of course, and we are now at the stage of making another leap forward to the next stage.

Currently, there are the following three requirements for the new functions.

1) A function for improving the quality and efficiency of hospital jobs.

2) A function for improving safety by preventing incidents, etc.

3) A function for improving security in relation to the personal information protection law, etc.

Elektronski medicinski zapis je nastao uvođenjem računara u širu upotrebu u zdravstvu. Naime, prva raspostranjenija upotreba računara u zdravstvenom sistemu je bila u upravljanju i računovodstvu. Prvo je dakle, trebalo zadovoljiti potrebe biznisa[15]. Kasnije razvojem specijaliziranih aktivnosti i usložnjavanjem zdravstvene službe u medicinskim centrima, nije se moglo upravljati sve većim brojem različitih podataka i informacija, te je bilo potrebno razviti elektronsko bilježenje medicinskih podataka. Ta praksa se naročito razvija od 90-tih godina prošlog vijeka kada se nastoji olakšati arhiviranje i upotreba podataka. Jedan od najvećih problema pohrane podataka i njihova korištenja jeste što su većina medicinskih bilješki u obliku slobodnog teksta. Tako se javila potreba ekstrakcije teksta u više sistematičnu, simboličnu formu prikladnu za računarsku obradu. Elektronski medicinski zapis možemo defnirati kao računarski pravno valjani medicinski zapis stvoren u zdravstvenoj organizaciji koja pruža zdravstvenu zaštitu, poput bolnica, domova zdravlja ili drugih zdravstvenih ustanova. Oni su dio lokalnog zdravstvenog informacijskog sistema, koji omogućuje njihovu pohranu, dohvat i manipulaciju [16].

3.2. Potential Benefits of PACS

Managing and displaying images to clinicians in a timely manner are some of the biggest challenges in maintaining a modern clinical imaging suite. An integrated PACS can assist in the endeavor, offering many potential benefits, including:

- Direct cost savings associated with decreased consumption of radiographic film and chemistry, decreased processor workload/maintenance, less requirement for hard copy storage space, and decreased labor cost associated with film handling and distribution.
- Increased connectivity and integration between facilities and departments.
- Productivity improvements (less time spent looking for misplaced radiographs or ultrasound images, less time spent hanging/removing films, less time distributing films).
- Simultaneous viewing of the same images in multiple locations.
- Increased revenues through eliminating lost examinations and increasing effective capacity.
- Better image quality than analog film or thermal prints.
- Decreased time to interpret and communicate diagnoses.
- Provides an avenue for rapid consultation with specialists.

PACS is a combination of hardware and software designed for short-term and long-term archiving, retrieval, management, distribution and display of images. Electronic images and reports are transmitted via PACS, which eliminates the need for manual management of such data [17]. Medical images stored in PACS are generated by computed tomography, magnetic resonance imaging, ultrasound, and many other computer-controlled devices. These images are used in a variety of situations and places, from radiotherapy planning, to emergency centers or other dispensaries, and in the case of electronic image transport it was necessary to develop a complex environment.

Figure 1. *PACS allows image data manipulation*

PACS consists of four main components: image production modules such as CT or MRI, patient data transmission networks, image review and interpretation workstations, and image storage and retrieval archives. The number and variations of computer applications in support of imaging techniques grew rapidly, and the problem became more severe on a daily basis. Thus, the idea matured to create a protocol that would enable standardized manipulation of image medical data, and DICOM was created, about which we will say more later. For the transfer of data from the place of origin to the place of use or archiving, whether it is in the same health institution or on the other side of the world (telemedicine), it was necessary to develop protocols that will transfer a standard form of data.

3.3. PACS (Picture Archiving And Communication System)

PACS (Picture Archiving And Communication System) is not a precisely defined standard, but there are recommendations of what each PACS Viewer must contain from user tools, in addition to searching DICOM databases and displaying DICOM images and related additional information such as are annotations. It is a client-server application. Initially, PACS systems had very limited capabilities and were reduced to a computer that also downloads relevant scan data from the device and stores it in its local database.

Systems that are designed to store images for multiple departments, ie with multiple devices from which information would flow into a central database, are called multimodal and represent a major step forward in usability. With them, reviewing information from previously performed examinations from several departments (X-ray, ultrasound, laboratories

...) is no longer a problem. The prices of medical equipment are extremely high, so such systems cost several hundred thousand dollars.

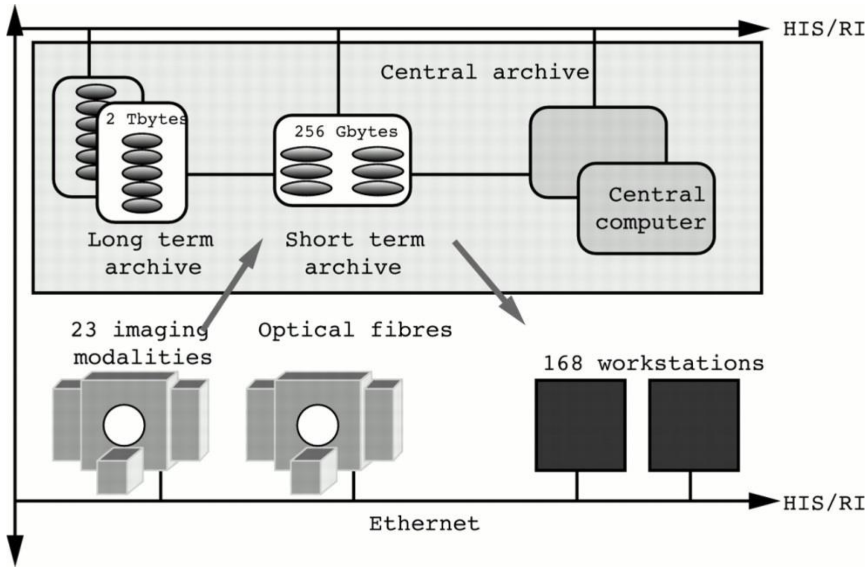

Figure 2. PACS picture archiving and communication systems

It is known that every specialty (radiology, pathology, cardiology ...) has special needs and requirements. For example, a moving ultrasound image of the heart that is synchronized with the ECG of its work provides a better basis for diagnosis than their separate examination. Or, the orthopedist who monitors the patient's recovery, in addition to X-rays, can also see a video of the patient's movement, which was recorded anywhere, and then entered into the system. To meet such requirements, the current global trend is to abandon the complete idea of a universal PACS viewer for all users and create special modules with tools tailored to various specialists. PACS can be implemented in many ways and on different operating systems. In the past, these were mostly graphics workstations and minicomputers, but with the increase in power in the last few years, the PC is successfully coping with this purpose. It is significant that, thanks to the strong penetration of Web technologies, every modern PACS system must be Web-oriented or at least have the ability to convert data through an appropriate Web server into a form that can be seen in a Web browser.

3.4. Specific advantages of PACS in paediatrics

It is particularly in the NNU/special care baby unit setting that the advantages of PACS are most evident. These mainly premature babies are usually acutely unwell and the changing radiographic findings are often the key factor determining management. As soon as a digital image is acquired onto the PACS it is immediately visible by the clinician on the NNU. Valuable time is saved in not having to go to the Imaging Department to retrieve the image or having to wait for it to be returned to the ward. Patient management decisions can be made immediately at this time, day or night. If a radiologist's opinion is desired before the formal report is issued, it can be sought by telephone with both paediatrician and radiologist looking at the same image at the same time on different PACS monitors at different locations in the hospital (or at different hospitals or from a home workstation if teleradiology has been implemented).
Once an image has been acquired onto the PACS archive it can never be lost and is always accessible. Even if the image is not on the short term server, it will still be accessible when fetched from the long term archive within minutes, and available for viewing on the ward workstation. In the neonatal and paediatric age range it is even less acceptable than in the adult for a repeat radiograph to be taken simply because the relevant image is missing when needed diagnostically. On the NNU, or in paediatric patients with chronic diseases, comparative viewing of a sequential series of radiographs/scans is integral to assessment of progress.

3.5. The advantages of PACS

A picture archiving and communication system (PACS) is an electronic and ideally filmless information system for acquiring, sorting, transporting, storing, and electronically displaying medical images.The main advantage a PACS offers is the improvement in efficiency resulting from electronic data handling:

- Once an image has been acquired onto PACS it cannot be lost, stolen, or misfiled. (Many hospitals report that 20% of films are missing when required, creating a serious practical problem.) Thus, images are always available after a PACS has been installed, so no patient appointment is cancelled, no clinical decision deferred, no images are repeated because they are missing, and no time is wasted by doctors or other healthcare workers looking for missing films. All images are available day and night for viewing anywhere in the hospital (and outside the hospital if there is a teleradiology facility).
- The numerous PACS terminals throughout the hospital allow simultaneous multilocation viewing of the same image, if desired, whereas conventional film can only physically exist in one place at any one time. This means, for example, that a doctor in the accident and emergency department can discuss a patient's images with the radiologist, with both clinicians viewing the images yet neither having left their department. Similarly, by the time a patient has returned to the outpatient department after being sent for an urgent radiological examination, the images will be available on PACS for viewing by the referring doctor.

3.6. Structure of Web Browser

The web browser is inarguably the most common portal for users to access the internet for any given array of consumer or business purposes. Innovative advances have allowed many traditional "thick client" apps to be replaced by the browser, enhancing its usability and ubiquity. User-friendly features such as recording browsing history, saving credentials and enhancing visitor engagement through the use of cookies have all helped the browser become a "one stop shopping" experience.

Browser, software that allows a computer user to find and view information on the Internet. Web browsers interpret the HTML tags in downloaded documents and format the displayed data according to a set of standard style rules.

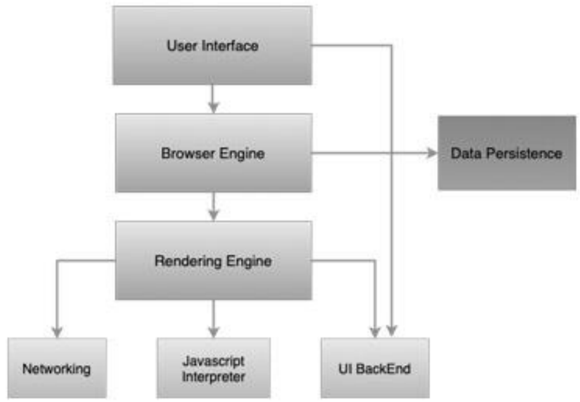

Diagram 2. *Structure of Web Browser*

The Web Browser is inarguably the most common portal for users to access the web. The advancement of the web browsers (through the series of history) has led many traditional "thick clients" to be replaced by browser enhancing its usability and ubiquity. The web browser is an application that provides access to the webserver, sends a network request to URL, obtain resources, and interactively represent them. Common Browsers today include Firefox, Google Chrome, Safari, Internet Explorer and Opera.

1. User Interface

It is a space where interaction between user and browser (application) occurs via the control presented in the browser. No specific standards are imposed on how web browsers should look and feel. The HTML5 specification doesn't define UI elements but lists some common elements: location bar, personal bar, scrollbars, status bar, and toolbar.

2. Browser Engine

It provides a high-level interface between UI and the underlying rendering engine. It makes a query and manipulates the rendering engine based upon the user interaction. It provides a method to initiate loading the URL, takes care of reloading, back, and forward browsing action.

3. Rendering Engine

The Rendering Engine is responsible for displaying the content of the web page on the screen. The primary operation of a Rendering engine is to parse HTML. By default, it displays HTML, XML, and images and supports other data types via plugin or extension.

4. DEFINITION OF BIOINFORMATICS

Computational biology is a discipline closely related to bioinformatics. They are very similar and there are significant overlaps, but they are still two separate disciplines. The BISTIC committee (Biomedical Information Science and Technology Initiative Consortium) of the American National Institutes of Health (NIH), which was specially formed to define the term bioinformatics and computational biology, gave the following definition [18]: rooted in biosciences (science of living systems), just like computer and information science and technology. Both of these interdisciplinary approaches have emerged from specific disciplines such as mathematics, physics, computing, biology, and behavioral sciences. Bioinformatics and computer biology, each individually, have close interactions with the biosciences, in order to develop their full potential. Bioinformatics uses the principles of information science and technology to make broad and complex bioscience data understandable and useful. Computational biology uses mathematical and computational approaches to point out certain theoretical and experimental questions in biology. Although bioinformatics and computer biology are separate, there are significant overlaps within their activities. Although no definition can completely eliminate overlaps in activities or exclude variations in interpretations of different individuals or organizations, the definitions of bioinformatics and computational biology are:

Bioinformatics is a scientific discipline that deals with the research, development or application of computer tools and approaches for the wider application of biological, medical, behavioral or health data, and which includes methods for collecting, storing, organizing, archiving, analyzing and visualizing data.

Computer biology is a scientific discipline that includes the development and application of theoretical methods and methods for data analysis, techniques for mathematical modeling and computer simulation, as well as for use in the study of biological, behavioral and social systems.

4.1. Subfields of bioinformatics

The basic branches of bioinformatics are [19]:

- Genomics Genomics is a subdiscipline in which sequencing, assembly and analysis of the functions and structure of the genome is performed (the genome is a complete set of DNA sequences in one cell of an organism). The basic tasks of genomics are: gene prediction, alignment of two or more sequences, identification of transcription factors, genome examination.

- Proteomics Proteomics deals with the analysis of the functions and structures of proteomes (a proteome is a complete set of protein sequences expressed by a specific genome, cell, tissue or organism). The basic tasks of proteomics are: alignment of two or more sequences, study of the functional conformation of the protein, determination of the active site, analysis of the protein-protein interaction, subcellular localization of the protein and sorting of the protein.

- Rational drug design Various computer techniques are used to search for molecules as potential drugs and to design new drugs. This shortens the time and reduces the costs of the disease identification process and the release of an effective drug on the market.

- Biological Bases and Data Mining

With huge amounts of data in nucleotide and protein sequence databases and 3D protein structures, there is a need to develop new methods for analyzing this data, which use the principles of data mining methods.

Molecular phylogeny

Molecular phylogeny determines a quantitative criterion for the classification of organisms through molecular or bioinformatics analysis of protein and nucleotide sequences.

Microread Informatics

A microarray is a set of chips used to analyze gene expression. As not all genes in a cell are active all the time, gene expression determines which genes are active in a cell and when. The microarray of chips consists of a matrix of samples of DNA fragments taken at different times (cell states) that are stained with different colors according to the times. The result is an image of a certain resolution, which needs to be processed, preprocessed, analyzed by classification methods and statistically valid conclusions.

Systems biology

Systems biology deals with the modeling of biological processes at the cellular level. By identifying basic components, parameters and variables, through modeling equations, she explains basic issues in biology. In short, systems biology represents an in silico reconstruction of biological phenomena.

4.2. Bioinformatics methods

The basic tasks of bioinformatics (in research) are [19, 20]:

Sequence alignment - arrangement or alignment of two or more nucleotide or protein sequences to identify similar regions by homology, which may be due to functional, structural or evolutionary linking of sequences;

Gene finding - identification of DNA regions that encode genes;

Genome assembly - reassembly of a large number of short DNA sequences into the original chromosome from which they originate;

Computer aided drug design (rational drug design) - an inventive process of discovering new medical drugs based on knowledge of the biological target;

Drug discovery - a process by which drugs are discovered or designed, which includes: candidate identification, high-throughput screening, drug development, synthesis, characterization, clinical trials, and therapeutic efficacy testing;

Structural alignment of proteins - establishing homology between two or more polymer structures, based on their shapes and three-dimensional conformation, and is most commonly used for protein tertiary structures, especially when proteins have little sequence similarity and their evolutionary or functional relationship cannot be detected using sequence alignment methods.;

Prediction of protein structure (protein bending) - prediction of three-dimensional, ie secondary, tertiary and quaternary structure based on the primary structure of protein, is one of the most important goals in medicine (drug design) and biotechnology (design of new enzymes);

Prediction of gene expression (gene expression is a process in which a functional gene product, ie protein or RNA) is synthesized based on information from genes;

Protein-protein interactions - analysis of the interaction between proteins (interaction between proteins occurs when proteins bind to perform their biological function);

Transcription factor binding site identification - identification of the site on a particular DNA sequence where binding to a transcription factor (protein) takes place;

Sub-cellular localization of protein (Protein sub-cellular localization) and protein sorting (protein sorting) - determining the part of the cell in which a particular protein exists and locating the position where the protein is transported in the cell;

Genome-wide association study (GWAS) - analysis of common genetic variants in several persons to determine the variant related to a given trait, and is specifically used to link the disease and single-nucleotide polymorphism (Single-nucleotide polymorphism, SNP);

Genome browsing - development of methods for compression and clear visualization of DNA sequences; Active site determination - determining the region of the protein that is most chemically active;

Modeling of evolution - generating a model of evolution (evolution is the change of inherited characteristics of populations through successive generations).

5. ACHIEVEMENTS IN MEDICAL INFORMATICS

Recent advances in medical informatics research have provided opportunities for great advances in health care delivery. These exciting opportunities also present enormous challenges for the application and integration of technologies in the workplace. As in most domains, there is a gap between technology artifacts and end users. Since medical practice is a human endeavor, there is a need to bridge disciplines that will enable clinicians to benefit from rapid technological advancement. This in turn requires expanding disciplinary boundaries to take into account cognitive and social factors related to the design and use of technology. The authors advocate for the place of prominence of cognitive science. Cognitive science provides a framework for the analysis and modeling of complex human performance and has significant applicability to a range of computer science problems. His methods have been used to illuminate various aspects of design and application. This approach also provided insight into the mechanisms and processes involved in joint design. Cognitive scientific methods and theories are illustrated in the context of two examples that examine human-computer interaction in a medical context and computer-mediated collaborative processes. The framework outlined in this paper can be used to refine the process of iterative design, end-user training, and productive practice.

6. CONCLUSION

Medical informatics is an emerging discipline characterized by rapid development and exciting new initiatives that promise to have a significant impact on medical practice. In this paper, we have argued that cognitive and social sciences can shed light on various aspects of design and application. Dramatic technological changes, like those happening today, always go hand in hand with profound social and cultural changes. Tension and quarrel result when the latter do not receive adequate attention. It is well documented that technological development often outweighs its productive use in the community of practitioners. The improved functionality and efficiency provided by new machines must be balanced with concerns about usability, learning and adaptability to the needs of the environment. Since lasting change is one of the few certainties, the challenge is to adapt to the ever-changing balance between recognizing and promoting these technological changes and understanding social consequences. Stable paradigms for clinical computing remain somewhat elusive for the time being. As long as there is complementarity between the social and the cognitive, on the one hand, and the technological, on the other, a satisfactory balance can be more easily achieved.

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