SCSA3022	AI for CLINICAL INFORMATION SYSTEM	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES
- The objective of this course is to gain insight and situational experience with clinical information systems.
- To examine the effective use of data and information technology to assist in the migration away from paper-based systems and improve organizational performance.
- To gain insights and understanding of the impacts placed on patients and health care providers.

UNIT 1 9Hrs.
Introduction to clinical information systems – contemporary issues in healthcare – workflow and related tools for workflow design – electronic health records databases – Healthcare IT & portable technology

UNIT II 9Hrs.
Artificial intelligence in health care: Use of AI, The healthcare industry, Electronic medical records,Clinical decision support systems

UNIT III 9Hrs.

Machine learning for natural language, Machine learning for vision, Human-computer interaction

UNIT IV 9Hrs.
Bioethics and challenges to deployment, Grand challenges in clinical decision support

UNIT V 9Hrs.
Data mining in health care, Big data analytics in health care, IBM Watson, Issues in sustainability and interoperability.

COURSE OUTCOMES
On completion of the course, student will be able to

CO1: To understand the basics of clinical information systems.
CO2: To learn how to apply information technology and related tools in workflow design.
CO3: To explore the "benefits and barriers" associated with electronic health records.
CO4: Explain strategies to minimize major barriers to the adoption of electronic health records.
CO5: Explain the principles of health care data exchange and standards.
CO6: Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity**.**

TEXT /REFERENCE BOOKS
1. Sittig&Ash, Clinical Information Systems – Overcoming Adverse Consequences, Jones & Bartlett Learning Publishers, 2009.
2. Edward H. Shortliffe; Leslie E. Perreault, Medical Informatics – Computer Applications in Healthcare and Biomedicine, Springer-Verlag New York Inc.Publishers, 2014.
3. Arnold, M. (2016). Digital health news update: Machine learning meets health search. Decision Resources Group
4. Blenner, S. R., Köllmer, M., Rouse, A. J., Daneshvar, N., Williams, C., Andrews, L. B. (2016) Privacy Policies of Android Diabetes Apps and Sharing of Health Information. JAMA, 315(10), 1051.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**
PART A : 10 Questions of 2 marks each-No choice **20 Marks**
PART B : 2 Questions from each unit with internal choice, each carrying 16 marks **80 Marks**

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Common to: CSE

UNIT I

Introduction to clinical information systems – contemporary issues in healthcare – workflow and related tools for workflow design – electronic health records databases – Healthcare IT & portable technology.

UNIT – I – SCSA3022- AI for Clinical Information System

1.1 INTRODUCTION TO CLINICAL INFORMATION SYSTEM

Clinical Information Systems (CIS) can be defined as the overall set of resources, techniques, devices, and methodologies that are used by different healthcare and medical organizations in order to support the knowledge needs required to reach the clinical goals of the organization themselves.

More particularly, clinical information systems focus explicitly on the informational needs related to clinical activities, as hospitalizations (admission, discharge, transfer), management of patients' follow up, and disease prevention.

A clinical information system is often the part of the wider Hospital Information System (HIS) that specifically focuses on the information needs related to the patient care.

Patient care consists of a set of complex activities usually intertwined and decision-making oriented. CIS have to support the integrated management of both patients' clinical information and clinicians' decision-related information, as diagnoses and prescribed therapies. Moreover, CIS have to store all the information related to the clinical activities performed by healthcare stakeholders.

Collecting big data in healthcare differs from collecting big data in other application domains: highlight that the extension to healthcare of the classical 5 V definition (Volume, Variety, Velocity, Veracity, Value) of big data moves from problem solving to knowledge discovery.

Thus, with respect to more traditional information systems, knowledge- and data-intensive tasks need to be supported by a CIS, even when considering non-alphanumeric data. On the other hand, clinical information systems can be considered as a potential source of (new) clinical knowledge both for the best (evidence-based) clinical tasks, such as identifying care flows, validating guidelines and recommendations, or verifying the compliance of a treatment to a research protocol, and for the identification of specific clinical contexts with respect to a given population of patients, such as extracting sub-cohorts of patients from a wider cohort.

Recently, the term "Artificial Intelligence" (AI) attracted attention in many different and popular domains. Among them, medicine has always been considered as an important application domain for AI-based solutions, both for medical knowledge representation and new knowledge extraction from stored clinical data, and for the support to clinical decision making or reasoning. Artificial intelligence in medicine may be characterized as the scientific discipline pertaining to research studies, projects, and applications that aim at supporting decision-based medical tasks through knowledge- and/or data-intensive computer-based solutions that ultimately support and improve the performance of a human care provider.

1.1.1 NEED OF AI IN CLINICAL INFORMATION SYSTEM

The digitization of pathology has helped address some of these challenges by enhancing clinical lab workflows and enabling more efficient collaboration. However, in order to fully reap the benefits of digital pathology in clinical diagnostic artificial intelligence (AI) must be considered. After all, effective treatment begins with a fast and precise diagnosis.

Adding AI to the clinical workflow is vital in order to:

1. Scale productivity

AI is substantially faster at image analysis and enables the automation of manual, time-consuming tasks. Speeding up case review increases your pathology labs' output allowing for more new patients to be taken in. Additionally with the time saved, pathologists can focus for longer on complex and rare cases.

A study on intraoperative brain tumor diagnosis found that an expert pathologist's diagnosis during surgery, normally about a 40 minute process, can take under 3 minutes with the assistance of an AI model in the operating room.

2. Increase diagnostic accuracy

Pathologists are highly specialized healthcare professionals, however the tools at their disposal for case review and clinical diagnostics are fallible and time-consuming. Artificial intelligence systems improve the accuracy of analysis, reduce bias and standardize sample review therefore democratizing care given to patients. An AI model trained to find metastasized breast cancer tumors was able to detect 92.4% of the tumors, compared to the human pathologist average of 73.2% .

The most beneficial use of AI is the combination of both a pathologist's knowledge and AI's accuracy and efficiency. In a validation study on AI assistance in mitotic count for identifying breast carcinoma, 87.5% of pathologists identified more mitoses with the assistance of an AI model, while 54.2% decreased the quantity of false positives . AI is set not to replace pathologists, but to supercharge them.

3. Reduce costs

Improved diagnostic accuracy is achieved with AI-assistance as bias and subjectivity are eliminated. AI systems analyze cases with 100% consistency. Reducing diagnostic error and misdiagnosis, while improving treatment accuracy with more detailed results, will result in direct cost savings due to greater precision.

Not only does misdiagnosis cost lives, it is a significant financial burden on both patients and hospitals. $386,849 was identified as the average price of cost per claim in cases involving diagnostic error from a 25 year study in the US on malpractice.

According to a report, AI could account for up to $8 billion in annual savings for the U.S. healthcare economy by 2026 through more precise preliminary and automated image diagnosis.

4. **Enhance staff satisfaction**

Better workload distribution can be achieved as pathologists spend less time on manual, repetitive tasks and more on assessing rare or complex cases that require a higher level of expertise and skills. The overall burden of rising caseloads is also alleviated with faster review times while the browser-based Aiforia platform enables flexible working.

In a five-year study on the experience of digital pathology (DP) implementation, 91% of pathologists thought DP reduced turnaround times, helped to decide on repeat ancillary studies, and was useful for prior case review.

5. Improve patient outcomes

The improved diagnostic accuracy and consistency of analysis with AI assistance brings benefits not only to the hospital and pathologists but perhaps more importantly, to the patients as well:

- Enhanced treatment efficacy
- More personalized therapies to be administered
- Reduction of the amount of unnecessary interventions or surgeries
- Democratization of care given to patients
- Enhanced quality of service as patients receive diagnoses faster

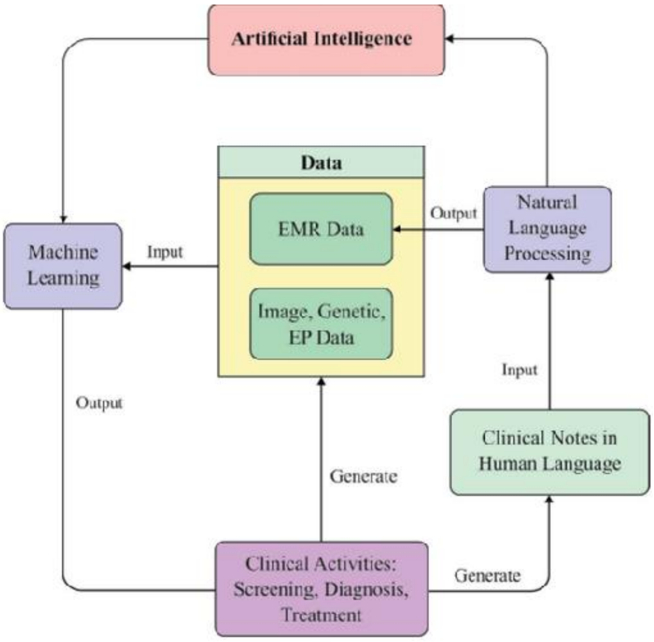


Fig 1 AI in Clinical Information System

1.1.2 TYPES OF CLINICAL INFORMATION SYSTEM

Clinical information systems are available to and accessed by healthcare professionals. These include those who deal directly with patients, clinicians, and public health officials. Healthcare professionals collect data and compile it to make health care decisions for individual patients, client groups, and the general public. Health information systems include:

1. Electronic Medical Record (EMR) and Electronic Health Record (EHR)

EMR and EHR systems replace paper patient records. The medical information on each patient is collected and stored electronically. These records include patient health information, test results, doctor and specialist visits, healthcare treatments.

Many healthcare facilities use cloud-based storage for sensitive data for increased security. However, this may not be an option for Critical Access Hospitals who struggle with basic EHR systems.

2. Practice Management Software

Information systems assist healthcare facilities and personnel with the management of daily operations of the facility. This includes scheduling of patients and medical services billing. Regardless of their size from single practice doctors to huge multi-center hospitals, all healthcare providers utilize practice management systems. The goal is to automate administrative tasks carried out as part of doing business in the facility.

3. Master Patient Index (MPI)

The software of this healthcare information system connects patient records to more than one database. The MPI contains records for any patient registered at a healthcare organization. MPI creates an index on all the records for that patient. MPIs reduce duplicate patient records and avoid inaccurate patient information that could result in patient claim denials.

4. Patient Portals

This information system enables patients to peruse their health data. They can access appointment information, medications they may be receiving, and their lab results via the internet. Some patient portals also facilitate active communication with healthcare professionals, including physicians, pharmacists regarding their prescription refill requests, and scheduling of appointments.

5. Remote Patient Monitoring (RPM)

Also known as tele-health, RPM provides medical sensors that can transmit patient data to healthcare professionals.

RPM can monitor blood glucose levels and blood pressure. It is particularly helpful for patients with chronic conditions such as type 2 diabetes, hypertension, or cardiac disease.

Data collected and transmitted via RPM can be used by a healthcare professional or a healthcare team to detect medical events such as stroke or heart attack that require immediate and aggressive medical intervention. Data collected may be used as part of a research project or a health study. RPM is a life-saving system for patients in remote areas who cannot access face-to-face health care.

6. Clinical Decision Support (CDS)

CDS analyses data from clinical and administrative systems. The aim is to assist healthcare providers in making informed clinical decisions. Data available can provide information to medical professions who are preparing diagnoses or predicting medical conditions like drug interactions and reactions.

CDS tools filter information to assist healthcare professionals in caring for individual clients.

7. Laboratory Information System (LIS)

LIS software allows doctors and lab technicians to coordinate inpatient and outpatient tests for microbiology, hematology, chemistry, and immunology to obtain clinical data. A standard information system for a lab manages patient demographics, check-in information, specimen entry and processing, and results.

2.1 CONTEMPORARY ISSUES IN HEALTHCARE

Contemporary issues are based on strategic, Financial, Human Resource, operations, Healthcare reform and quality maintenance. 10 different types of issues are listed.

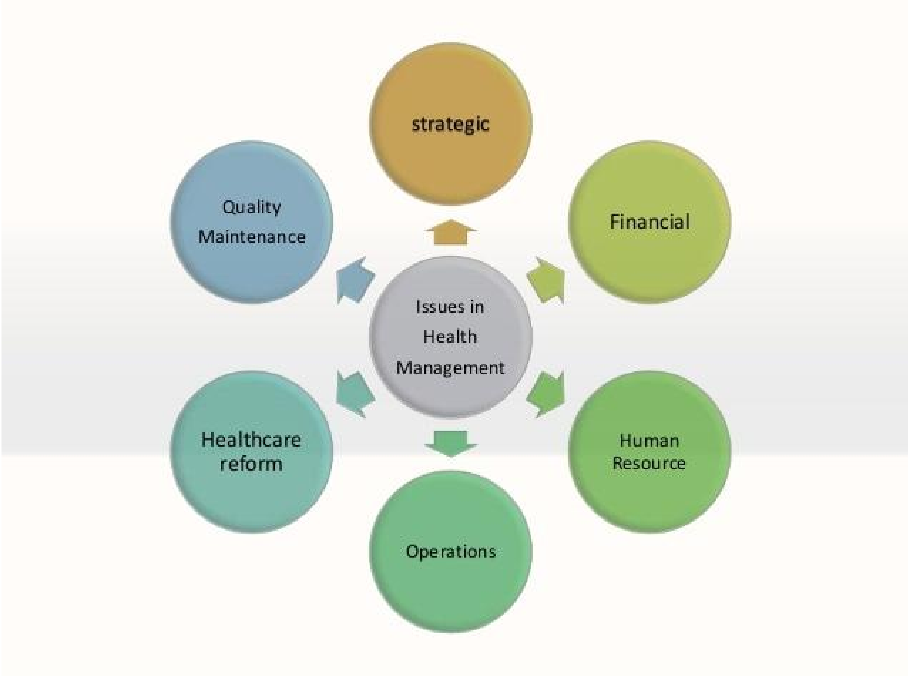


Fig 2 Contemporary issues

Strategic Management

- Rapidly changing environment
- Data availability
- Competition with other healthcare providers
- Problems and challenges of increasing complexity and decisions.
- Find balance between providing outstanding care, quality expectations and reducing operating costs.
- Concentrate on core services to provide well and with more efficiency
- Plans can be redundant to consider for long term objectives
- Evaluation at regular intervals is must
- Set realistic goals
- Provide direction to the entire organization
- Support and concurrence of board is essential

Fig 3 steps in strategic management

Financial Management

- It is the corner stone for successful hospital management
- Budgeting
- Cost cutting through maintenance
- Group buying
- Inventory Control
- Expanding revenues

Fig 4 Steps in Financial Management

Healthcare Reform

- Access to affordable, high-quality healthcare is far from a given for millions of people

Human Resource

- Changes in culture of staff and their expectations
- Shortage of qualified skilled personnel
- Easy to get attached to facts and figures

Fig 5 Steps in HRM

Operations

- New facilities are getting smaller, specialized and dispersed.
- Managing limited Human resources
- Financial constraints
- Patient Satisfaction
- Process flow and improvement reduce wait times

Quality Management

- Dilemma of maintaining high quality of service with cost line
- Demanding Patients
- Ensure patients meet expectations
- Litigations / Legal disputes between patients, insurance providers, healthcare providers
- Patient safety

The common contemporary issues are

1. **Costs and transparency.** Implementing strategies and tactics to address growth of medical and pharmaceutical costs and impacts to access and quality of care.
2. **Consumer experience**. Understanding, addressing, and assuring that all consumer interactions and outcomes are easy, convenient, timely, streamlined, and cohesive so that health fits naturally into the "life flow" of every individual's, families and community's daily activities.
3. **Delivery system transformation.** Operationalizing and scaling coordination and delivery system transformation of medical and non-medical services via partnerships

and collaborations between healthcare and community-based organizations to overcome barriers including social determinants of health to effect better outcomes.

4. **Data and analytics.** Leveraging advanced analytics and new sources of disparate, non-standard, unstructured, highly variable data (history, labs, Rx, sensors, mHealth, IoT, Socioeconomic, geographic, genomic, demographic, lifestyle behaviors) to improve health outcomes, reduce administrative burdens, and support transition from volume to value and facilitate individual/provider/payer effectiveness.
5. **Interoperability/consumer data access**. Integrating and improving the exchange of member, payer, patient, provider data, and workflows to bring value of aggregated data and systems (EHR's, HIE's, financial, admin, and clinical data, etc.) on a near real-time and cost-effective basis to all stakeholders equitably.
6. **Holistic individual health.** Identifying, addressing, and improving the member/patient's overall medical, lifestyle/behavioural, socioeconomic, cultural, financial, educational, geographic, and environmental well-being for a frictionless and connected healthcare experience.
7. **Next-generation payment models.** Developing and integrating technical and operational infrastructure and programs for a more collaborative and equitable approach to manage costs, sharing risk and enhanced quality outcomes in the transition from volume to value (bundled payment, episodes of care, shared savings, risk-sharing, etc.).
8. **Accessible points of care.** Tele-health, mHealth, wearable, digital devices, retail clinics, home-based care, micro-hospitals; and acceptance of these and other initiatives moving care closer to home and office.
9. **Healthcare policy**. Dealing with repeal/replace/modification of current healthcare policy, regulations, political uncertainty/antagonism and lack of a disciplined regulatory process. Medicare-for-All, single payer, Medicare/Medicaid buy-in, block grants, surprise billing, provider directories, association health plans, and short-term policies, FHIR standards, and other mandates.
10. **Privacy/security**. Staying ahead of cyber security threats on the privacy of consumer and other healthcare information to enhance consumer trust in sharing data. Staying current with changing landscape of federal and state privacy laws.

3.1 WORKFLOW AND RELATED TOOLS FOR WORKFLOW DESIGN

3.1.1 WORKFLOW

There are many processes involved, such as managing finances, staff, patients, legal issues, logistics, inventory, and more. It can all get a little overwhelming–especially when each of them are done manually. Healthcare data is so sensitive that many managers think that using automation as a part of healthcare workflow management is not even an option.

There are five common healthcare processes that should be automated to move your healthcare workflow management a notch ahead.

Below are the 5 popular healthcare workflows to boost efficiency:

1. Approvals for Patient Admissions and Discharges
2. Allocating Medication
3. Running Patient Surveys
4. Maintaining Adequate Medical Documentation
5. The Admission Carousel

1. Approvals for Patient Admissions and Discharges

In the average healthcare institution, a number of patients move in and out on any given day. Their physical conditions and other details may vary, but from the hospital's perspective, there's one common, crucial factor: approvals.

Patients are often stuck with unnecessary delays, waiting for the right doctor to receive the paperwork and sign off on an admission or a discharge.

Automated workflows can get approvals done in real-time. This means that doctors can use mobile apps to approve patient discharge requests on the go. Another advantage is that approvals like this can't be easily faked, and hospitals will have a permanent time-stamped record of each approval.

2. Allocating Medication

Medicine reaching the wrong hands simply because of human error is an all-too-common issue at hospitals around the world. Whether it's due to errors in handwritten notes or just dealing with the sheer volume, errors in allocating medication are bound to happen with manual processes.

With an automated process, you can ensure that physicians digitally select the right medication so it is clear to everyone in the workflow, and there is a clear audit of who has seen and approved the medication, ensuring the right medicines reach the right patients, and always on time.

3. Running Patient Surveys

The healthcare industry has grown beyond just performing surgeries and passing out medicine. Bedside manners, extra amenities, and holistic patient care are no longer nice-to-haves, but a core offering of any healthcare workflow.

Patient surveys are the best way of ascertaining that the healthcare you provide was satisfactory. Done the traditional way, these surveys are barely more than a lukewarm, token effort with the surveyor and the patient going through the motions, both looking to complete the formality as soon as possible.

That’s why you need to run these surveys through a healthcare workflow management system, which ensures that a proper survey is carried out at the appropriate time, and the data actually goes to someone who can do something about it!

4. Maintaining Adequate Medical Documentation

Very few healthcare organizations have medical records that are updated comprehensively by every doctor who ever treated you, and understood comprehensively by every subsequent doctor who looks at them.

For the most part, adequate medical documentation is a struggle to achieve.

Take the recent push for mental healthcare to be linked to your primary physician–with both worlds coming together to provide the best care for issues like depression. Medical records need to be impeccable, which is far from the case in real life.

The automation of documentation will mean that medical records are consistently updated, with the doctor’s computer ensuring that they enter treatment details every single time. Coupling that with a cloud database makes all your files safe and accessible from anywhere you need them.

5. The Admission Carousel

Patients at busy hospitals often get turfed from department to department. Admission is often a process that requires the patient to go from desk to desk–this is obviously a painful process for someone who might already be in pain!

Advantages of having workflow:

- Save the hospital precious time
- Improve the patient's experience, and get them treatment quickly
- Make the hospital run smoothly and efficiently

3.1.2 TOOLS FOR WORKFLOW DESIGN

Benchmarking: Benchmarking is a process of evaluating metrics or best practices from other organizations (either related or unrelated to your own) and then applying them to your organization.

Checklist: A checklist is a form that is used for quickly and easily recording data or identifying actions or requirements. It is usually easy to extract data in a useful manner from a checklist. It is particularly effective at registering the occurrence of incidents, events, tasks, or problems.

Flowchart: Flowcharts visually convey the steps in a process.

Interview : Interviews provide a means of eliciting information from a group of individuals regarding their opinions, behaviour, or knowledge. They involve two or more people (interviewer and interviewee). The interviewer is the individual collecting data, and the interviewee is the person providing the data. Interviews can be face-to-face or conducted over the phone or with other electronic communication methods.

Usability Evaluation : A usability evaluation is conducted to determine the extent to which a system is easy to use or "user friendly."

4.1 ELECTRONIC HEALTH RECORDS DATABASES

Healthcare databases are systems into which healthcare providers routinely enter clinical and laboratory data. One of the most commonly used forms of healthcare databases are electronic health records (EHRs). Practitioners enter routine clinical and laboratory data into EHRs during usual practice as a record of the patient’s care. Other healthcare databases include claims databases, which are maintained by payers for reimbursement purposes, pharmacist databases and patient registries. Healthcare databases can be used as data sources for the generation of real-world evidence (RWE).

Need of EHR

- **Real-world data on risks and benefits**: the use of routinely collected data, such as data from EHRs, allows assessment of the benefits and risks of different medical treatments, as well as the relative effectiveness of medicines in the real world.
- **Studies can be carried out quickly**: studies based on real-world data (RWD) are faster to conduct than randomised controlled trials (RCTs).

Examples of initiatives for healthcare databases

The Medicines and Healthcare products Regulatory Agency (MHRA) has published a position paper (*Position Statement and Guidance Electronic Health Records, MHRA 2015*) on compliance issues and user requirements for EHRs. This paper could be used as a basis EHR quality checks. In addition, the following initiatives aim to improve routinely collected data for use in research:

- ***The TRANSFoRm*** *Project* aims to develop a ‘rapid learning healthcare system’ that can improve both patient safety and the conduct and volume of clinical research in Europe.
- ***The Electronic Health Records for Clinical Research (EHR4CR) Project*** of the EU’s Innovative Medicines Initiative (IMI) has developed a technological platform that combines hospital data across countries, to identify sites and patients for trials.
- ***A tool developed by the EHR for Clinical Research Functional Profile Project*** *(EHRCR)* allows doctors to evaluate the quality and security of their EHR systems and provide study teams with this information.
- ***The Sentinel Initiative*** is a system developed by the US Food and Drug Administration (FDA) that links existing healthcare data from multiple databases, to actively monitor the safety of medical products in real time and to help address the heterogeneity of data collection that currently exists.

- **The *EHDEN (European Health Data and Evidence Network) project***, part of the EU's Innovative Medicines Initiative (IMI), is developing a federated network of databases, standardised to a common data model, to improve the ability to study real world health outcomes across diverse healthcare systems and to support open science collaboration in Europe.

Limitations of EHR

- **Data are not collected for research purposes**: practitioners and healthcare professionals are not trained to collect data. The data collection process may not be clear and may result in imprecise, incorrect or incomplete data entry, however this may be avoided or reduced by training staff. There may be interference with the usual care provided to patients, for example by altering treatment decisions, which could result in a decrease in the generalizability of study results.
- **Invalid, inaccurate or incomplete data:** routinely collected data may lack detailed information on indications, patient characteristics, treatments and events, and may be less structured. In addition, data are typically obtained during clinical visits, which may be infrequent or irregular.
- **Quality and completeness of data varies within and among databases:** routinely used healthcare databases are varied and heterogeneous. Data quality checks within the data collection system that detects incorrect or missing data, and specify procedures for correction, may ensure that differences within and among databases are detected and accounted for.
- **Variable quality and completeness:** EHR systems include patient data beyond that needed for a study. Access to these data (rather than study-specific data) raises right-to-privacy concerns.

5.1 HEALTHCARE IT & PORTABLE TECHNOLOGY

New and emerging technologies have transformed healthcare in recent years. Hospitals and physician offices large and small have implemented new technologies to respond to a changing regulatory environment and to improve the overall quality of care for patients. Nowadays medical facilities are high-tech operations that put cutting-edge technologies into the hands of talented professionals. Even still, significant opportunities remain for hospitals and healthcare settings to streamline their implementation and usage of new technologies.

IT services for healthcare have never been more vital. The right IT partner can help for medical facility fully realize the extraordinary benefits of information technology in healthcare.

IT services can help medical facility operate with fewer errors, comply with today's regulations, and recover quickly from unexpected disasters. The electronic health records (EHR) systems can help the staff reliably record crucial patient health data and seamlessly share that data with other healthcare providers. Most importantly, the healthcare IT support provided here at Worldwide Services will help to improve the quality of care that patients receive from your staff.

As medical facilities across the country continue to modernize, the need for robust and responsive healthcare IT support will only increase.

5.1.1 THE OPPORTUNITIES AND CHALLENGES OF HEALTHCARE IT STANDARDS

Today's medical facilities are built on the individual expertise of talented physicians, nurses and staff, but patients receive the best care when all these team members work together. Through legislation like the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, Congress pushed medical facilities to modernize their IT systems, particularly regarding the use of electronic health records. These shared, detailed records allow a patient's medical providers to act as a team and make crucial healthcare decisions based on the totality of a patient's health record.

EHRs are now used across the medical landscape, but there are significant problems that need to be addressed for EHRs to live up to their promise. Over 85% of office-based doctors use an EHR system, but most doctors are calling for change. In a 2016 poll, 63% of doctors agree that EHRs have improved patient care, but 71% think that EHRs are a cause of physician burnout. Even worse, 69% of doctors indicated that they have less time for patients because of the time they spend writing and reading EHRs. Clearly, there's a need for change.

The specific concerns these doctors raise highlight the value of health information technology. In the same poll, doctors called for change in the user interface of EHR systems and improved interoperability between EHR systems. A healthcare IT support partner is vital for implementing both of these changes. EHR user interfaces need to be intuitive, user-centred and easy to use, and Worldwide Services can help build such systems from the ground up. Interoperability is a larger goal that will require reliable networking and carefully constructed systems, along with cooperation of regulatory bodies and other healthcare partners. The 21st Century Cures Act, passed in 2016, charged regulatory agencies with creating standards for interoperable, usable and accessible EHRs. It won't be enough to just have electronic records — you'll have to be able to share and receive records from other providers, even ones outside of your system.

The new era of EHRs will bring many benefits to the medical community. For one, patients will undoubtedly benefit when they can be confident that their chosen medical providers will have immediate access to their health records, no matter where they seek treatment. However, there are many challenges that healthcare providers will face as they adjust to the new healthcare information technology standards. EHRs should be usable and available to all of a patient's healthcare providers, and they need to be highly secure, as well. Privacy and security guidelines established by the Health Insurance Portability and Accountability Act (HIPAA) in 1996 and since refined and expanded hold healthcare providers to a high standard.

It's crucial to have an experienced healthcare IT provider capable of implementing services that follow the required standards. You need a professional partner that can help ensure that your EHRs are easy to record, access and share, while also private and secure.

5.1.2 THE ROLE OF HEALTHCARE IT SUPPORT

At its core, healthcare information technology is all about communication — communication between devices, between team members, between patients and their medical providers, between separate medical facilities. These communication channels are enabled by carefully-selected and installed hardware solutions, and maintained with prompt and effective repair services. These components should be scalable and flexible so that your network can grow along with your facility.

Information technology's role in communications also puts it on the frontlines of your facility's security team. Healthcare IT standards, patient privacy rights and patient well-being all require a trustworthy, secure network that is transparent and easy for your staff to use but opaque and secure against unauthorized users. A healthcare IT services provider can help your facility initiate best practices for network security. Today's patients expect their data to be secure, and we can help establish your reputation as a trustworthy steward of patient data.

Information technology also plays a crucial role in ensuring the efficient operation of your facility. Research indicates that new healthcare technologies **are only effective** when they are designed with ergonomics and human factors in mind, when they have a robust interface with the patient and the environment and when appropriate implementation and maintenance plans are established from the beginning. IT services contribute fundamentally to the role of technology in the healthcare industry. When health information technology is properly integrated into a facility, users aren't slowed down by awkward interfaces or unnecessary roadblocks. The systems just work.

5.2 PORTABLE DEVICES

The modern lifestyle has given rise to a number of ailments and medical science has found a way to combat this. Portable devices play a major role in monitoring and managing healthcare for a wide range of patients. A wide range of portable medical devices are already in the market, while various next-gen devices are under development. The key challenges in terms of technology pertain to hardware, operating systems and device connectivity.

As per Grandview Research, the global wearable medical device market size was valued at USD 10.3 billion in 2018 and expected to witness a CAGR of 26.1% over the forecast period. Increase in health and fitness awareness, coupled with the latest advances in technology, has resulted in the development and adoption of portable healthcare devices and remote patient monitoring. The below chart published by Grandview research indicates the global wearable medical device market share by application.

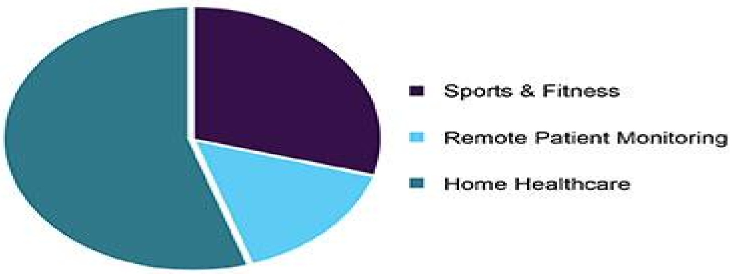


Fig 6: available wearable medical devices

Hectic and stressful lifestyle has resulted in increase in multiple health disorders. In today’s fast-moving world, people prefer to have quick access to monitoring and diagnostics devices. Portable medical devices have revolutionized the way in which people monitor and determine their own health and wellbeing. These devices can’t just provide continuous and non-invasive monitoring of health parameters, but through connectivity they also provide real-time updates to healthcare providers.

Here are a few examples of portable devices that are trending in this domain:

Blood Pressure Monitors

Blood Pressure Monitoring has become a routine for people having the tendency of high/low blood pressure. Wireless BPMs are highly portable and they attach to your upper arm, use smart technology to record, and monitor your blood pressure.

Glucose Monitoring Systems

Smart, portable glucose monitoring systems let you measure the glucose levels in your blood on the go. The smart element is that these little devices can connect to your smartphone in order to monitor your blood sugar levels over time and share them with a doctor.

The benefit of being able to test your glucose levels remotely is that you can do so before and after exercise, meals out, or in any situation that you might need to do so remotely without the usual blood test.

Automated Insulin Pumps

People suffering from type 1 diabetes need to replenish their insulin stock with multiple daily injections or through a catheter. Unlike these manual techniques, the latest automated insulin pump system continuously tracks the glucose levels and then adjusts insulin levels with little or no input from the user.

Portable EKG/ECG Monitors

Portable EKG/ECG monitors assess heart activity used during electrocardiogram tests. While traditional models would display data as graphical lines on paper, the latest compact version includes LCD screens and sensors to let you view results in real time by taking your pulse via your fingers with an accompanying mobile application.

SCHOOL OF COMPUTING

Common to: CSE

UNIT II

Artificial intelligence in health care: Use of AI, The healthcare industry, Electronic medical records, Clinical decision support systems.

UNIT –II – SCSA3022- AI for Clinical Information System

2.1 ARTIFICIAL INTELLIGENCE IN HEALTH CARE

Artificial intelligence (AI) and related technologies are increasingly prevalent in business and society, and are beginning to be applied to healthcare. These technologies have the potential to transform many aspects of patient care, as well as administrative processes within provider, payer and pharmaceutical organisations.

There are already a number of research studies suggesting that AI can perform as well as or better than humans at key healthcare tasks, such as diagnosing disease. Today, algorithms are already outperforming radiologists at spotting malignant tumours, and guiding researchers in how to construct cohorts for costly clinical trials. However, for a variety of reasons, we believe that it will be many years before AI replaces humans for broad medical process domains. In this article, we describe both the potential that AI offers to automate aspects of care and some of the barriers to rapid implementation of AI in healthcare.

The use of artificial intelligence in healthcare has the potential to assist healthcare providers in many aspects of patient care and administrative processes.

Most AI and healthcare technologies have strong relevance to the healthcare field, but the tactics they support can vary significantly.

And while some articles on artificial intelligence in healthcare suggest that the use of artificial intelligence in healthcare can perform just as well or better than humans at certain procedures, such as diagnosing disease, it will be a significant number of years before AI in healthcare replaces humans for a broad range of medical tasks.

What is artificial intelligence in healthcare, and what are the benefits?

Machine Learning

Natural Language Processing

Rule-based Expert Systems

Diagnosis and Treatment Applications

Administrative Applications

Types of AI of relevance to healthcare

Artificial intelligence is not one technology, but rather a collection of them. Most of these technologies have immediate relevance to the healthcare field, but the specific processes and tasks they support vary widely. Some particular AI technologies of high importance to healthcare are defined and described below.

Machine learning – neural networks and deep learning

Machine learning is a statistical technique for fitting models to data and to 'learn' by training models with data. Machine learning is one of the most common forms of AI; in a 2018 Deloitte survey of 1,100 US managers whose organisations were already pursuing AI, 63% of companies surveyed were employing machine learning in their businesses.1 It is a broad technique at the core of many approaches to AI and there are many versions of it.

In healthcare, the most common application of traditional machine learning is precision medicine – predicting what treatment protocols are likely to succeed on a patient based on various patient attributes and the treatment context.2 The great majority of machine learning and precision medicine applications require a training dataset for which the outcome variable (eg onset of disease) is known; this is called supervised learning.

A more complex form of machine learning is the neural network – a technology that has been available since the 1960s has been well established in healthcare research for several decades3 and has been used for categorisation applications like determining whether a patient will acquire a particular disease. It views problems in terms of inputs, outputs and weights of variables or 'features' that associate inputs with outputs. It has been likened to the way that neurons process signals, but the analogy to the brain's function is relatively weak. The most complex forms of machine learning involve deep learning, or neural network models with many levels of features or variables that predict outcomes. There may be thousands of hidden features in such models, which are uncovered by the faster processing of today's graphics processing units and cloud architectures. A common application of deep learning in healthcare is recognition of potentially cancerous lesions in radiology images.4 Deep learning is increasingly being applied to radiomics, or the detection of clinically relevant features in imaging data beyond what can be perceived by the human eye.5 Both radiomics and deep learning are most commonly found in oncology-oriented image analysis. Their combination appears to promise greater accuracy in diagnosis than the previous generation of automated tools for image analysis, known as computer-aided detection or CAD.

Deep learning is also increasingly used for speech recognition and, as such, is a form of natural language processing (NLP), described below. Unlike earlier forms of statistical analysis, each feature in a deep learning model typically has little meaning to a human observer. As a result, the explanation of the model's outcomes may be very difficult or impossible to interpret.

Natural language processing

Making sense of human language has been a goal of AI researchers since the 1950s. This field, NLP, includes applications such as speech recognition, text analysis, translation and other goals related to language. There are two basic approaches to it: statistical and semantic NLP. Statistical NLP is based on machine learning (deep learning neural networks in particular) and has contributed to a recent increase in accuracy of recognition. It requires a large 'corpus' or body of language from which to learn.

In healthcare, the dominant applications of NLP involve the creation, understanding and classification of clinical documentation and published research. NLP systems can analyse unstructured clinical notes on patients, prepare reports (eg on radiology examinations), transcribe patient interactions and conduct conversational AI.

Rule-based expert systems

Expert systems based on collections of 'if-then' rules were the dominant technology for AI in the 1980s and were widely used commercially in that and later periods. In healthcare, they were widely employed for 'clinical decision support' purposes over the last couple of decades5 and are still in wide use today. Many electronic health record (EHR) providers furnish a set of rules with their systems today.

Expert systems require human experts and knowledge engineers to construct a series of rules in a particular knowledge domain. They work well up to a point and are easy to understand. However, when the number of rules is large (usually over several thousand) and the rules begin to conflict with each other, they tend to break down. Moreover, if the knowledge domain changes, changing the rules can be difficult and time-consuming. They are slowly being replaced in healthcare by more approaches based on data and machine learning algorithms.

Physical robots

Physical robots are well known by this point, given that more than 200,000 industrial robots are installed each year around the world. They perform pre-defined tasks like lifting, repositioning, welding or assembling objects in places like factories and warehouses, and delivering supplies in hospitals. More recently, robots have become more collaborative with humans and are more easily trained by moving them through a desired task. They are also becoming more intelligent, as other AI capabilities are being embedded in their 'brains' (really their operating systems). Over time, it seems likely that the same improvements in intelligence that we've seen in other areas of AI would be incorporated into physical robots.

Surgical robots, initially approved in the USA in 2000, provide ‘superpowers’ to surgeons, improving their ability to see, create precise and minimally invasive incisions, stitch wounds and so forth.6 Important decisions are still made by human surgeons, however. Common surgical procedures using robotic surgery include gynaecologic surgery, prostate surgery and head and neck surgery.

Robotic process automation

This technology performs structured digital tasks for administrative purposes, ie those involving information systems, as if they were a human user following a script or rules. Compared to other forms of AI they are inexpensive, easy to program and transparent in their actions. Robotic process automation (RPA) doesn't really involve robots – only computer programs on servers. It relies on a combination of workflow, business rules and ‘presentation layer’ integration with information systems to act like a semi-intelligent user of the systems. In healthcare, they are used for repetitive tasks like prior authorisation, updating patient records or billing. When combined with other technologies like image recognition, they can be used to extract data from, for example, faxed images in order to input it into transactional systems.

Diagnosis and Treatment Applications

- Diagnosis and treatment of disease has been at the core of artificial intelligence AI in healthcare for the last 50 years.
- Early rule-based systems had potential to accurately diagnose and treat disease, but were not totally accepted for clinical practice.
- They were not significantly better at diagnosing than humans, and the integration was less than ideal with clinician workflows and health record systems.

Administrative Applications

- There are a number of administrative applications for artificial intelligence in healthcare.
- The use of artificial intelligence in hospital settings is somewhat less game changing in this area as compared to patient care.
- But artificial intelligence in hospital administrative areas can provide substantial efficiencies.
- AI in healthcare can be used for a variety of applications, including claims processing, clinical documentation, revenue cycle management and medical records management.
- Another use of artificial intelligence in healthcare applicable to claims and payment administration is machine learning, which can be used for pairing data across different databases

2.1.2 IMPORTANCE OF AI IN HEALTHCARE SECTOR

AI and related advancements are progressively playing the role of a disruptor in business and society. The application of AI is also increasing in the healthcare domain. These advances can possibly change numerous parts of patient care, just as regulatory procedures inside supplier, patient experience, and pathology labs. There are as of now various researches recommending that AI can proceed just as or better than people at key human services, for example, diagnosing the ailment.

Nonetheless, for an assortment of reasons, have to accept that it will be numerous prior years AI replaces people for wide clinical procedure areas. In this article, we portray both the potential that AI offers to mechanize parts of care and a portion of the hindrances to the fast execution of AI in social insurance.

How about we talk about how AI has changed the Healthcare segment:

2.1.3 AI in Healthcare

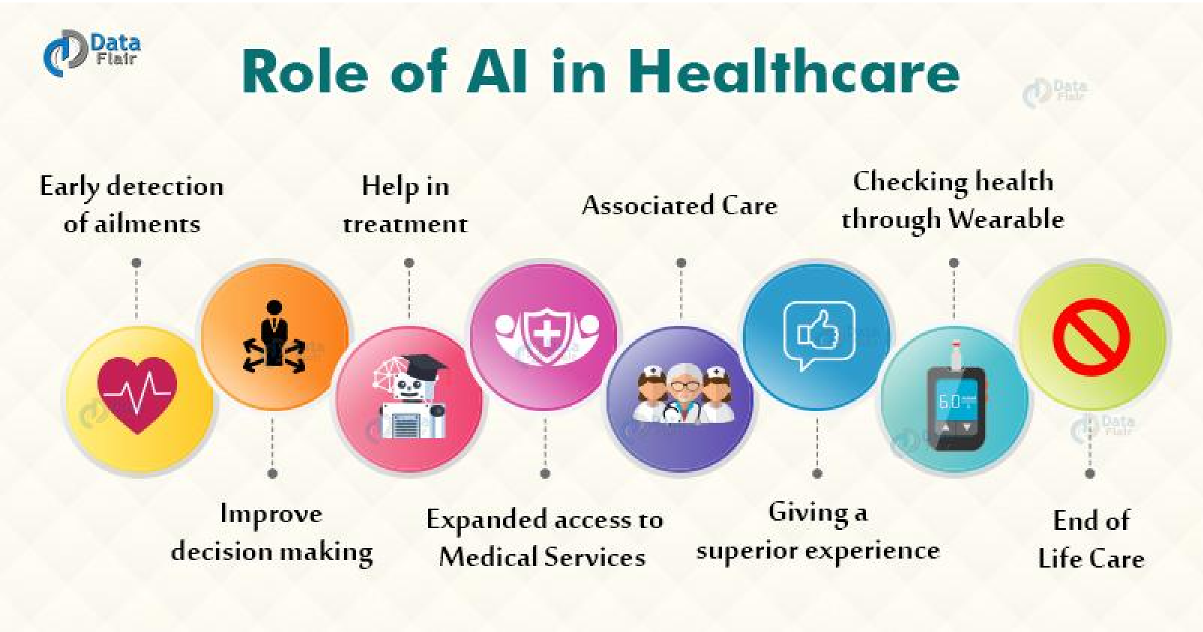


Fig1 Role of AI

1. Early Detection of ailments

AI-based knowledge is now used to recognize illnesses, for instance, tumors, in their starting stage. According to the American Cancer Society, a high degree of mammograms yield counterfeit results. 1 out of 2 sound women was prone to threatening development.

The use of AI is engaging study and understanding of mammograms on different occasions speedier with 99% precision, diminishing the necessity for silly biopsies. The widespread use of wearables like iWatch by Apple and other clinical contraptions got together with AI. This helps in overseeing starting period coronary ailment. In general, the earlier the detection of a disease, the better it can be treated.

2. Improve Decision Making

Improving thought requires the course of action of gigantic prosperity data with reasonable and perfect decisions, and insightful assessment can reinforce clinical elements and exercises similarly as sort out administrative endeavors.

Using past information of patients to recognize patients at risk for a condition is one of the major uses of AI in healthcare. Using this information, AI algorithms can assist in better and improved decision-making processes.

3. Help in Treatment

By looking at the previous medical records of patients, AI can help individuals who are at a greater risk of medical conditions like heart stroke. AI can help clinicians with devising better treatment plans for these patients.

We use Robots in the prescription for more than 30 years. Despite clinical strategies, we use them in crisis facilities and labs for excess tasks, in recuperation, non-nosy treatment, and on those with long stretch conditions.

4. End of Life Care

With time, the future of a normal human has impressively expanded because of better social insurance offices. Presently, as we approach the finish of our lives, our body capitulates to death in a slower way, from conditions like dementia, cardiovascular breakdown, and osteoporosis.

Robots can modify the finish of life care, helping people to remain self-ruling for additional, reducing the necessity for hospitalization and care homes. In this way, AI can help to make the experience better for critically ill or old age patients.

5. Associated Care

Healthcare doesn’t just mean treatment by doctors. It involves a lot of hospital staff, nurses, managers, technicians, and pharmacists to efficiently run this entire healthcare ecosystem. To improve healthcare, this whole ecosystem has to evolve.

These zones rely upon a lone propelled structure. Concentrated war rooms dismember clinical and zone data to screen showcase enthusiasm over the framework persistently. Similarly, as using AI to spot patients at risk for deterioration, this framework can in like manner remove bottlenecks in the system.

6. Giving a superior experience

Similarly, as with some other industry, in the social insurance industry likewise, the client experience, just as the staff understanding, is of most extreme significance for their drawn-out development.

Computer-based and intelligence-based frameworks are being created for helping with decreasing hold up times, improving staff work procedures, and taking on the ever-creating administrative weight.

The more that AI is used in clinical practice, the more clinicians are creating to trust in it to build their aptitudes in zones, for instance, clinical methodology and end.

7. Checking Health Through Wearables

Essentially all clients by and by approach devices with sensors that can accumulate significant data about their prosperity. Devices like FitBit and IWatch by Apple have become an increasingly useful gadget. They help to track our daily calorie count, steps, and even sleeping pattern.

Using this data, analyzing it with the help of AI, can bring a lot of awareness among individuals and help them keep a better track of their fitness. Man-made intelligence frameworks will accept an important activity in isolating huge bits of information from this tremendous and contrasted treasure trove of data.

8. Expanded Access to Medical Services

Lacks of arranged human administration providers, including ultrasound experts and radiologists would altogether be able to limit access to life-saving thought in making nations around the world.

More radiologists work in the around six clinical centers covering the prominent Longwood Avenue in Boston than in all of West Africa, the gathering pointed out.

Modernized thinking could help moderate the impacts of this extraordinary deficiency of qualified clinical staff by accepting authority over a segment of the suggestive commitments usually doled out to individuals.

Future of AI in Healthcare

all must accept that there is a significant role of AI in the healthcare sector in the coming years. Like AI, it is the essential ability behind the improvement of precise medication, broadly consented to be a painfully required development in care.

Albeit early endeavors at giving analysis and treatment proposals have demonstrated testing, we expect that AI will at last ace that area also. Given the fast advances in AI for imaging examination, most radiology and pathology pictures will be analyzed sooner or later by a

machine. Discourse and content acknowledgment is now utilized for errands like patient correspondence and catch of clinical notes, and their use will increment.
The best test to AI in these social insurance spaces isn't whether the advances will be able enough to be helpful, but instead guaranteeing their reception in every day clinical practice. For broad appropriation to occur, AI frameworks must be endorsed by controllers.
They must also incorporate EHR frameworks. Thus, we hope to see constrained utilization of AI in clinical practice inside 5 years and increasingly broad use inside 10 years.
It additionally appears to be progressively certain that AI frameworks won't supplant human clinicians for an enormous scope, yet rather will expand their endeavors to think about patients. After some time, human clinicians may push toward undertakings and employment plans that draw on remarkably human abilities like compassion, influence, and enormous picture joining.

2.2 THE HEALTHCARE INDUSTRY

The purpose of the health care industry is **to promote health, to heal, to provide treatment**, and to increase the quality of life of the individuals that are being served. Each medical professional has chosen to pursue a career to help mankind, in a selfless act and without self-interest.
Healthcare comprises **hospitals, medical devices, clinical trials, outsourcing, telemedicine, medical tourism, health insurance and medical equipment**. The Indian healthcare sector is growing at a brisk pace due to its strengthening coverage, services and increasing expenditure by public as well private players.

Sectors of Healthcare Industry

The healthcare industry provides a variety of services to support the healthcare needs of a community or individuals. A universally agreed-upon classification of sectors does not exist, but the key sectors of the healthcare industry can be broadly classified into four sectors called 'Health care services and facilities', 'Medical devices, equipment, and hospital supplies manufacturers', Medical insurance, medical services and managed care' and 'Pharmaceuticals & Related Segments

Healthcare Industry Sectors:

The healthcare industry provides a variety of services to support the healthcare needs of a community or individuals. The healthcare industry classifies the different products it offers by sector. Hospitals and healthcare systems are continually changing their service offerings and responding to various internal and external forces including reimbursement issues, advances in technology, and shifts in the populations they serve. A universally agreed-upon classification of sectors does not exist, so a non-exhaustive but the inclusive and simplified classification of broad sectors will be used in this exploration.

The key sectors of the healthcare industry can be broadly classified into the following four sub-segments:

1. Health care services and facilities
2. Medical devices, equipment, and hospital supplies manufacturers
3. Medical insurance, medical services, and managed care
4. Pharmaceuticals & Related Segments

Healthcare Segment 1: Health care services and facilities:

Health care services and facilities subsector is comprised of many subsectors. The broad classification includes:

(A) Hospitals:

Hospitals provide medical, diagnostic, and treatment services to inpatients and some outpatient services. This category includes General medical and surgical hospitals, psychiatric and substance abuse hospitals, Specialty hospitals (not including psychiatric and substance abuse facilities), Family Planning & Abortion Clinics, Hospices & Palliative Care Centers, Emergency & Other Outpatient Care Centers, Sleep Disorder Clinics, Dental Laboratories, and Blood & Organ Banks.

Given below are different types of hospitals:

- General medical and surgical hospitals
- Psychiatric and substance abuse hospitals
- Specialty hospitals (not including psychiatric and substance abuse facilities)
- Family Planning & Abortion Clinics
- Hospices & Palliative Care Centers
- Emergency & Other Outpatient Care Centers
- Sleep Disorder Clinics
- Dental Laboratories
- Blood & Organ Banks

- Teaching or University Hospitals

(B) Nursing and residential care facilities:

They provide residential care combined with either nursing, supervisory, or other types of care as needed. This category includes Home health care services, Nursing Care Facilities, Urgent Care Centers, Mental health and residential developmental handicap facilities, In-Home Senior Care, Community care facilities for the elderly, and other residential care facilities.

Given below are different nursing and residential care facilities:

- Home health care services
- Nursing Care Facilities
- Urgent Care Centers
- Mental health and residential developmental handicap facilities
- In-Home Senior Care
- Community care facilities for the elderly
- Other residential care facilities

(C) Ambulatory health care services:

Players provide direct and indirect health care services to ambulatory patients. This category includes Outpatient care centers, medical and diagnostic laboratories, Ambulance Services, and other ambulatory health care services.

Given below are different ambulatory health care services:

- Outpatient care centers
- Medical and diagnostic laboratories
- Ambulance Services
- Other ambulatory health care services

(D) Medical Practitioners & Healthcare Professionals:

This category includes Medical Practitioners, Chiropractors, Homeopaths, Psychologists, Social Workers & Marriage Counselors, Dermatologists, Nutritionists & Dietitians, Optometrists, Physical Therapists, and other alternative Healthcare Providers.

Given below are different types of Medical Practitioners and healthcare professionals:

- Medical Practitioners
- Chiropractors
- Homeopaths
- Psychologists, Social Workers & Marriage Counselors
- Dermatologists
- Nutritionists & Dietitians
- Optometrists
- Physical Therapists
- Alternative Healthcare Providers

Healthcare Segment 2: Medical devices, equipment, and hospital supplies manufacturers:

These are medical companies at the forefront of the latest medical technology offering their products across the whole spectrum of medical equipment, hospital supplies, products, and services, including specialist applications. This sector further consists of many players including In-vitro diagnostic substances, Electro-medical and electrotherapeutic apparatuses , Irradiation apparatuses, Surgical Instrument & Medical Instrument Manufacturing, Surgical appliances and supplies, Dental equipment and supplies, Ophthalmic goods, Vital Signs Monitor Manufacturing, Mammography Machine Manufacturing, TENS Machine Manufacturing, Nebulizer Manufacturing, Hot & Cold Topical Therapy Manufacturing, Optical Coherence Tomography Machine Manufacturing, Medical Laser Machine Manufacturing, Medical Device Manufacturing, Medical Instrument & Supply Manufacturing, Robotic Surgery Equipment Manufacturing, Endoscope Manufacturing, Venous Access Device Manufacturing, Wound Care Product Manufacturing, Toxicology Laboratories, Glucose Meter Manufacturing, Instrument Sterilization Product Manufacturing, Intravenous (IV) Solution Manufacturing, Ultrasonic Cleaning Equipment Manufacturing, Hospital Bed Manufacturing and Hospital Furniture Manufacturing etc.

Given below are different Medical devices, equipment, and hospital supplies manufacturers:

- In-vitro diagnostic substances
- Electro-medical and electrotherapeutic apparatuses
- Irradiation apparatuses
- Surgical Instrument & Medical Instrument Manufacturing
- Surgical appliances and supplies

- Dental equipment and supplies
- Ophthalmic goods
- Vital Signs Monitor Manufacturing
- Mammography Machine Manufacturing
- TENS Machine Manufacturing
- Nebulizer Manufacturing
- Hot & Cold Topical Therapy Manufacturing etc

Healthcare Segment 3: Medical insurance, medical services, and managed care:

This segment deals with the players that provide medical insurance or different types of services to either patients or other medical sector players. The term managed care or managed health care is used to describe a variety of techniques intended to reduce the cost of providing health benefits and improve the quality of care for organizations that use those techniques or provide them as services to other organizations. This sector further consists of many players including Health maintenance organizations (HMOs), Preferred provider organizations, exclusive provider organizations, Medicare, Medicaid, Healthcare Consultants, Medical Patient Financing, Healthcare Staff Recruitment Agencies, Health & Medical Insurance, Surgical Apparel Manufacturing, Medical Supplies Wholesaling, Medical Waste Disposal Services, Dental Insurance, Medical Couriers, Medical Device Cleaning & Recycling, Medical Claims Processing Services, Pharmacy Benefit Management, Corporate Wellness Services, Home Medical Equipment Rentals and Medical Case Management Services, etc.

Given below are different medical insurance, medical services, and managed care providers:

- Health maintenance organizations (HMOs)
- Preferred provider organizations
- Exclusive provider organizations
- Medicare
- Medicaid
- Healthcare Consultants
- Medical Patient Financing
- Healthcare Staff Recruitment Agencies
- Health & Medical Insurance
- Surgical Apparel Manufacturing

- Medical Supplies Wholesaling
- Medical Waste Disposal Services
- Dental Insurance
- Medical Couriers
- Medical Device Cleaning & Recycling
- Medical Claims Processing Services
- Pharmacy Benefit Management
- Corporate Wellness Services
- Home Medical Equipment Rentals
- Medical Case Management Services

Healthcare Segment 4: Pharmaceuticals & Related Segments:

The pharmaceutical industry develops, produces, and markets drugs or pharmaceuticals licensed for use as medications. Pharmaceuticals eliminate the need for inpatient and invasive care services. They are subject to a variety of laws and regulations regarding the patenting, testing, and ensuring the safety and efficacy and marketing of drugs. This sector further consists of many players including Over-the-counter (OTC) drugs & Drug Stores, Prescription drugs, Biopharmaceutical drugs, Generic drugs, Pharmaceuticals Packing & Labeling Services, Dietary Fiber Supplement Manufacturing, Vitamin & Supplement Manufacturing, Cough & Cold Medicine Manufacturing, Health Stores and Eye Glasses & Contact Lens Stores, etc.

Given below are different types of Pharmacy and Medical Stores:

- Over-the-counter (OTC) drugs & Drug Stores
- Prescription drugs
- Biopharmaceutical drugs
- Generic drugs
- Pharmaceuticals Packing & Labeling Services
- Dietary Fiber Supplement Manufacturing
- Vitamin & Supplement Manufacturing
- Cough & Cold Medicine Manufacturing
- Health Stores
- Eye Glasses & Contact Lens Stores

2.3 ELECTRONIC MEDICAL RECORDS

An electronic medical record (EMR) is a digital version of all the information you'd typically find in a provider's paper chart: medical history, diagnoses, medications, immunization dates, allergies, lab results and doctor's notes. EMRs are online medical records of the standard medical and clinical data from one provider's office, mostly used by providers for diagnosis and treatment. Comprehensive and accurate documentation of a patient's medical history, tests, diagnosis and treatment in EMRs ensures appropriate care throughout the provider's clinic.

EMRs are more than just a replacement for paper records. They effectively allow communication and coordination among members of a healthcare team for optimal patient care.

Its natural evolution began in the 1960s when we began to see "problem-oriented" medical records (like we understand them today) instead of just the diagnosis and treatment a doctor provided. This was the first time that third party facilities were able to independently verify the diagnosis.

"With the internet, change became far more visible, and the internet became an essential tool for recording and transferring medical records."

With the dawn of the computer era, many of the earliest computer applications were in use at hospitals but few other places. Computers gained traction in smaller facilities and clinics at the same time computers were gaining traction with the general public. With the internet, change became far more visible, and the internet became an essential tool for recording and transferring medical records.

As a part of the American Recovery and Reinvestment Act, all public and private healthcare providers were required to demonstrate "**meaningful use**" of EMRs by January 1, 2014.

"Meaningful use", as defined by HealthIT.gov, would achieve the following:

- Improve quality, safety, efficiency, and reduces health disparities
- Engage patients and families
- Improve care coordination and public health
- Maintain privacy and security of patient health information

You can learn more about meaningful use in our **What is Meaningful Use** article.

Although patient medical records are more comprehensive and accessible than ever before, refinements and system upgrades are continually enhancing clinic workflow and doctor-patient interactions.

What is the Difference Between an EMR and an EHR?

While an EMR contains comprehensive information and records of the patient's history with one provider, an electronic health record (EHR) contains all of this and it is sharable amongst authorized providers, health organizations and clinics. An EHR goes beyond the information from just one provider and includes a comprehensive patient history which can be shared amongst all providers to help coordinate care for the patient. EMR and EHR systems are both beneficial tools for clinics – below are some of the key differences between EMR and EHR systems.

EMRs	**EHRs**
A digital version of a patient chart	A digital record of all patient health information
Patient record does not easily travel outside the practice and might need to be printed	Allows a patient's medical information to move with them to other health care providers and specialists
Mainly used by a provider for diagnosis, treatment and care	Accessed by any number of providers for decision making, diagnosis and care beyond one provider's office

Both are necessary on the continuum of care for a patient. The EMR provides a comprehensive record of care within a practice and the EHR makes that care accessible to a variety of healthcare providers, even hospitals, if and when needed.

The Advantages of an EMR

Benefits of EMRs for PATIENTS:

- Fewer errors on medical records
- Quicker assessment and care from medical professionals
- Data and results are tracked over time
- Improved health diagnosis, treatment and overall quality of care
- Identify patients who are due for preventive visits and screenings
- Enhanced privacy and security of patient data
- Reduction in patient errors and improved patient care
- Enable evidence-based decisions at point of care

- Follow-up information after a visit such as self-care instructions, reminders for other follow-up care, and links to web resources
- Access to patient's own records to view medications and keep up with lifestyle changes that have improved their health

Benefits of EMRs for CLINICS:

- Save space by eliminating paper records needing to be stored, managed and retrieved
- Optimize workflow and increased number of patients served per day
- Reduce administrative difficulties and operational costs
- Interface easily with hospitals, pharmacies, labs and state health systems
- Customizable and scalable electronic records
- Gather and analyze patient data that enables outreach to discreet populations
- Provide clinical alerts and reminders
- Improve documentation and coding
- Enhance research and monitoring for improvements in clinical quality
- Provide built-in safeguards against prescribing treatments that would result in adverse events
- Track electronic messages to staff, other clinicians, hospitals, labs, etc.
- Links to public health systems such as registries and communicable disease databases

EMRs don't just contain information they "compute" it by beneficially manipulating the information.

For example:

- The EMR automatically checks for problems whenever a new medication is prescribed to a patient and **alerts** potential conflicts with the patient's other medications or health conditions.
- EMRs can help providers quickly and systematically identify and correct operational problems. In a paper-based setting, identifying such problems is much more difficult, and correcting them can take years.

Beyond the improved systems and quality of care for patients, there are also financial advantages to EMRs. A clinic's operational costs and overtime labor expenses are reduced due to the overall efficiency of workflow. Additionally, the ability to more accurately and efficiently process patient billing improves the clinic's bottom line.

Any disadvantages of electronic medical records are not necessarily in the system itself, but in the initial (and natural) challenges of investment, preparation and training in the system.

2.4 CLINICAL DECISION SUPPORT SYSTEM (CDSS)

An average adult makes about 35,000 decisions daily. The majority of them are trivial choices about clothing, food, or other things that — no offense! — don't really matter. But everything changes as we enter the healthcare field where the right decisions save lives while the wrong ones lead to grave consequences.

To pinpoint the best solution for a particular patient or case, health workers have to sift through numerous details and factors — and do it fast, under a great deal of pressure. Luckily, the most routine part of this job can be done by computers — or, to be more specific, by clinical decision support systems. This article explores how these technologies can improve the speed and quality of medical decisions.

CDSS basics: types, tasks, and structure

Broadly speaking, a **clinical decision support system (CDSS)** is a program module that helps medical professionals make decisions at the point of care. The concept is not new to the healthcare sector: The first CDSS called MYCIN was built in the early 1970s at Stanford University. It employed an artificial intelligence model applying over 600 rules to identify infectious diseases and recommend a course of treatment.

Though MYCIN outperformed medical staff in evaluation accuracy, it was never put in practice — partially, because of slow performance, but mainly due to the ethical and legal issues. The very idea of the computer acting as a medical expert was too ahead of its time to be accepted.

MYCIN expert system interface.

Now, hospitals use CDSSs for numerous tasks, from generating alerts to drug control to ordering tests. Decision support solutions come in a number of versions. They can be either standalone tools or integrated parts of larger infrastructures — such as an Electronic Health Record (EHR) or a Computerized Provider Order Entry (CPOE) system, designed to replace a paper-based ordering process. Some of them focus on a single problem and perform simple functions — like sending reminders. Others cover a wide range of processes and include multiple modules.

No matter the size, modern systems benefit from powerful computing engines, cloud technologies, and advanced algorithms. But at the architectural level, they haven't changed much over the last decades, preserving structures similar to early expert solutions.

CDSS architecture

A typical CDSS contains three core elements: a base or data management layer, inference engine or processing layer, and user interface.

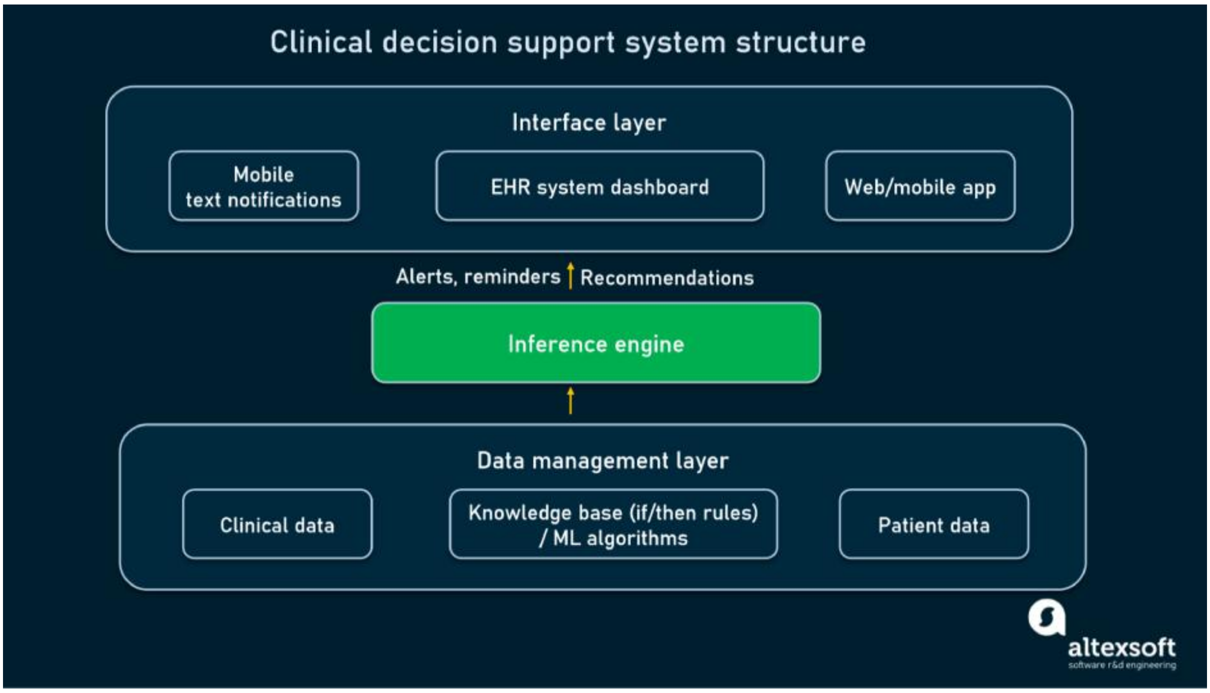


Fig 2 Core modules of a typical clinical decision support system.

A **data management layer** combines

- a clinical database storing information on diseases, diagnoses, and lab findings;
- patient data; and
- a knowledge base in the form of if-then rules or machine learning models.

An **inference engine or processing layer** applies rules or algorithms and datasets from the knowledge base to available patient data. The results are displayed via a **user interface layer** — a mobile, web or desktop application, an EHR system dashboard or mobile text alerts. Preserving the same structure, under the hood CDSSs vary in ways they come to a conclusion, falling into two types — knowledge-based and nonknowledge-based systems.

KNOWLEDGE-BASED CDSS

Systems of this type are built on top of a knowledge base in which every piece of data is structured in the form of if-then rules. For instance, if a new order for a blood test is placed and if the same blood test was made within the past 24 hours, then a duplication is possible.

The inference engine runs the built-in logic to combine the evidence-based rules with the patient's medical history and data on his or her current condition. The results come in the form of alerts, reminders, diagnostic suggestions, a series of treatment options or ranked lists of possible solutions while the final word rests with a human expert.

NON KNOWLEDGE-BASED CDSS

The core difference from the previous group consists of applying machine learning models. Rather than consulting with a library of predefined if-then rules, such a system learns from past experiences and finds patterns in historical data. These are the two techniques most widely used in such CDSSs:

- **genetic algorithms (GA)** reflecting the mechanics of natural selection described by Charles Darwin. Just as species change from generation to generation to better fit their environment, GAs adapt to a new task, producing a number of random solutions and then iteratively evaluating and improving them until the most fitting option is found.
- **artificial neural networks (ANN)** that mimic human thinking. Similar to human brains, ANNs have a set of "neurons" called "neurods." They are linked to each other with weighted connections that act as nerve synapses transmitting signals across the neural network.

Nonknowledge-based systems come with a promise to significantly cut healthcare costs and relieve the pressure on medical experts. However, there are issues preventing their large-scale adoption. They include a compute-intensive and time-consuming training process and the requirement of large datasets needed to improve accuracy of models. But the main obstacle is the lack of interpretability as systems can't explain the reasoning behind generated decisions.
Due to drawbacks mentioned, modern CDSSs are primarily knowledge-based. Now, let's see what decisions they are able to support.

CDSS MAJOR AREAS OF APPLICATION

Human brains are prone to error — especially, when dealing with large volumes of information in a high-stress hospital environment. Computerized systems can take a laboring oar of sifting through tons of data and making countless comparisons to narrow down the number of possible decisions — from hundreds and thousands to just a few .
Drug selection

Statistics show that 7,000 to 9,000 US patients die annually because of medication errors. Besides that, a lot more people suffer from complications caused by inappropriate medicines, ill-judged dosage, or drug incompatibility, increasing treatment costs by over 40 billion a year. The good news is that nearly 50 percent of medication errors happen at the first — ordering or prescribing – stage. So, mistakes can be spotted and prevented before they cause any harm. And that’s where a decision support tool comes in handy, eliminating risks from human factors like distraction that accounts for around 75 percent of medication errors.

Using critical patient data such as weight, age, allergy status, and current prescriptions, CDSSs may automatically deal with the following tasks.

Drug allergy checking. The system matches an ordered medication against a patient’s list of documented allergies, evaluates the probability of unwanted reactions, and generates alerts.

Basic guidance on dosage. Dosing errors account for over 60 percent of all the prescribing mistakes. But this can be improved by a corresponding decision support module. In the simplest scenario, the software component generates a patient-specific list of recommended dosing parameters for a particular medication. It saves a clinician time on selection of the most appropriate dosage and frequency. The CDSS may as well alert experts to exceeding dosing limits.

Checking for duplicate therapy. A duplicate therapy occurs when two or more drugs with the same active ingredient are prescribed simultaneously. It leads to overdose and related adverse effects. The CDSS feature addressing this problem compares a newly added drug with active ingredients of drugs in a patient’s profile. If a match is detected, the system generates an alert.

Drug interactions checking. A drug’s interaction with other substances may change its expected effect. Based on clinical documentation at hand, a CDSS considers interactions of a newly prescribed medication with

- other drugs in a patient’s list (drug-drug interactions or DDI),
- food and beverage (drug-food interactions),
- herbals,
- ethanol,
- testing (if the medication can affect the results of laboratory tests),
- pregnancy and lactation, and
- a patient’s disease that can also affect the drug’s performance (drug-disease interactions).

Today, many Computer Provider Order Entry (CPOE) systems come equipped with drug safety components that perform duplicate therapy, DDI and drug-dose checking. But you may find separate decision support modules to complete existing software as well. The example of a single-task solution is a drug allergy checker by PEPID which can be integrated with any EHR or other healthcare information system.

Diagnostic support

CDSSs for disease identification are called diagnostic decision support systems (DDSSs) or medical diagnosis systems (MDSs). They compare information on a patient's condition with a knowledge base and generate a list of possible diagnoses.

A specific example of a DDSS is a solution utilizing deep learning for diagnostic imaging. It would traditionally focus on a specific problem area — say, lung abnormalities or a particular type of cancer. Similar to other CDS tools, AI-fueled programs work as a second pair of eyes and make suggestions and alerts — rather than come to a final conclusion.

Cost containment

Integrated in a CPOE system, decision support tools may decrease treatment costs by suggesting cheaper drug alternatives or spotting test duplications. Studies revealed that CDSSs save hospital units hundreds of thousands of dollars per year by alerting to cases of excessive medical testing.

Clinical management

Some clinics employ decision support software to enhance adherence to clinical guidance. Similar to information about drugs and diseases, hospital rules can be encoded into a knowledge-based CDSS in the form of IF-THEN-ELSE pieces of information. Such solutions perform various tasks, from prompting nurses to take specific measurements according to a protocol to informing doctors about patients who don't follow their treatment plans.

AUC for Medicare patients

AUC stands for appropriate use criteria that specify when exactly it makes sense to perform a certain medical service. Starting in January 2020, the Protecting Access to Medicare Act (PAMA) obliges American hospitals to comply with Medicare's AUC program for advanced imaging like computer tomography (CT) or magnetic resonance imaging (MRI).

It means that prior to ordering an expensive test for a Medicare patient, a physician must consult a clinical decision support mechanism. Without a verdict made by a CDS tool ("appropriate," "may be appropriate," or "rarely appropriate,"), service providers won't receive reimbursement for their procedures.

SCHOOL OF COMPUTING

Common to: CSE

UNIT –III

UNIT III **9Hrs.**

Machine learning for natural language, Machine learning for vision, Human-computer interaction

UNIT – III – SCSA3022- AI for Clinical Information System

Natural Language Processing (NLP):

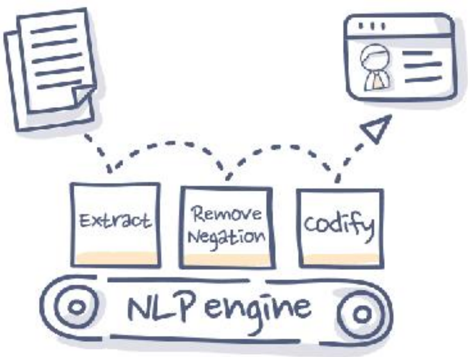
Natural language processing (NLP) is the ability for computers to understand the latest human speech terms and text. It’s used in current technology to support spam email privacy, personal voice assistants and language translation applications.

The adoption of natural language processing in healthcare is rising because of its recognized potential to search, analyze and interpret mammoth amounts of patient datasets. Using advanced medical algorithms, machine learning in healthcare and NLP technology services have the potential to harness relevant insights and concepts from data that was previously considered buried in text form. NLP in healthcare media can accurately give voice to the unstructured data of the healthcare universe, giving incredible insight into understanding quality, improving methods, and better results for patients.

Physicians spend a lot of time inputting the how and the why of what’s happening to their patients into chart notes. These notes aren’t easily extractable in ways the data can be analyzed by a computer. When the doctor sits down with you, and documents your visit in a case note, those narratives go into the electronic health record systems (EHRs) and get stored as free text.

Huge volumes of unstructured patient data is inputted into EHRs on a daily basis, but it’s hard for a computer to help physicians aggregate that critical data. Structured data like claims or CCDAs / FHIR APIs may help determine disease burden, but gives us a limited view of the actual patient record. Big data analytics in healthcare shows that up to 80 percent of healthcare documentation is unstructured, and therefore goes largely unutilized, since mining and extraction of this data is challenging and resource intensive. Without NLP technology, that data is not in a usable format for modern computer-based algorithms to extract.

Healthcare natural language processing uses specialized engines capable of scrubbing large sets of unstructured health data to discover previously missed or improperly coded patient conditions. Natural language processing medical records using machine-learned algorithms can uncover disease that may not have been previously coded, a key feature for making HCC disease discoveries.



EHRs and physicians don't always get along well. The additional data input responsibilities create challenges, and can be frustrating. Researchers conclude, some physicians suffer from EHR burnout and threaten to retire from service early rather than suffer through the many clicks and screens required to navigate their EHR. Medical NLP is steadily proving to be a solution to this challenge since NLP healthcare tools can easily access and accurately interpret clinical documentation. Once the friction of healthcare technology is reduced, we can begin to appreciate more of the benefits of the technology and less of the daily frustrations.

The accuracy of medical natural language processing goes up along with the volume of data available for learning. The more a medical NLP platform is used, the more accurate using artificial intelligence in healthcare gets, since it’s always learning, and in some cases, can be customizable. Some NLP healthcare systems offered by vendors advertise the ability to screen how the medical natural language processing would initially perform with a specific medical group. Then customize it next to the needs of that particular medical group.

A distinct advantage natural language processing medical records offers is the ability for computer assisted coding to synthesize the content of long chart notes into just the important points. Historically, this could take organizations weeks, months, even years, to manually review and process stacks of chart notes from health records, just to identify the pertinent info. Natural language processing software for healthcare can scan clinical text within seconds and identify what needs to be extracted. This frees up physicians and staff resources to focus more on the complex matters and reduces the time spent on redundant administrative policy. When computers can understand physician notation accurately and process that data accordingly, valuable decision support can be obtained. These insights can be of significant use for future drug research and personalized medicine, which is good for patients and providers.

Physicians don’t all “speak the same way”, and should always be aware that their notes and reports will likely be read by their work peers, patients and even computers, according to their organizations privacy policy. Avoiding non-standard language in note creation and management is extremely important. Most natural language processing healthcare engines are built to accommodate a wide variation of medical notation terminology. However, using uncommon acronyms can confuse NLP coding algorithms and other medical note readers.

In 2018 and 2019 the development to improve natural language processing healthcare data has proven challenging. If the NLP output displays too many suggested conclusions, or artificial conclusions that are incorrect, users will learn to ignore the intelligence and end up with a system that can reduce overall business productivity. NLP software for healthcare should center around data conclusions that have the least noise, and the strongest signal about what healthcare providers need to do.

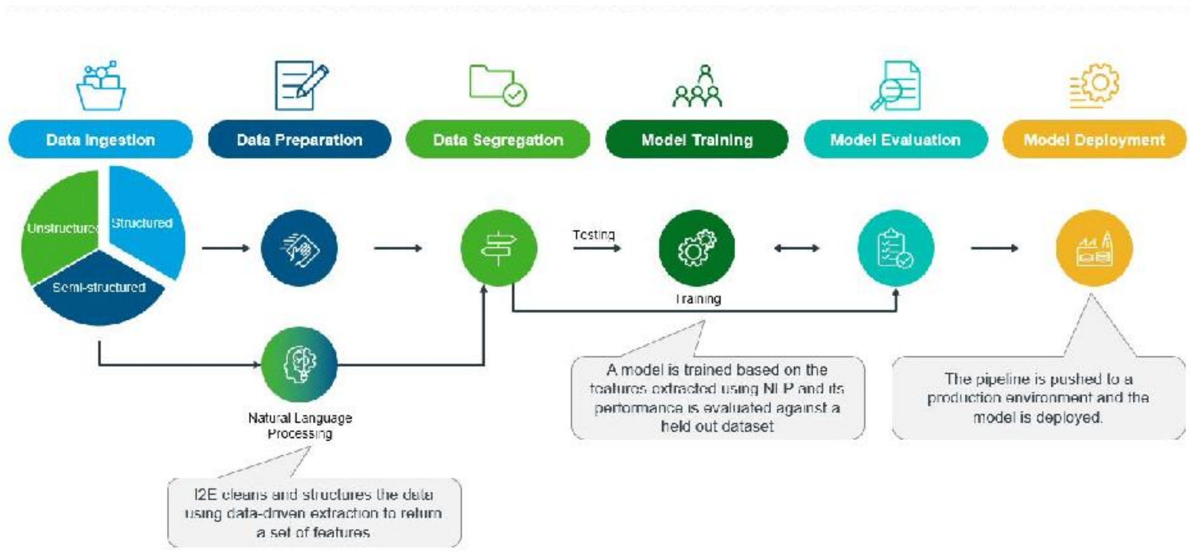
Healthcare natural language processing offers the chance for computers to do the things that computers need to do. To do the analytics, the HCC risk adjustment coding, the back office functions, and the patient set analysis, all without obstructing physician communication.

NLP in healthcare is creating new and exciting opportunities for healthcare delivery and patient experience. It won’t be long before specialized NLP coding recognition enables physicians to spend more time with patients, while helping make insightful conclusions based on precise data. In the years to come, we’ll hear the news, and see the possibilities of this technology, as it empowers providers to positively influence health outcomes.

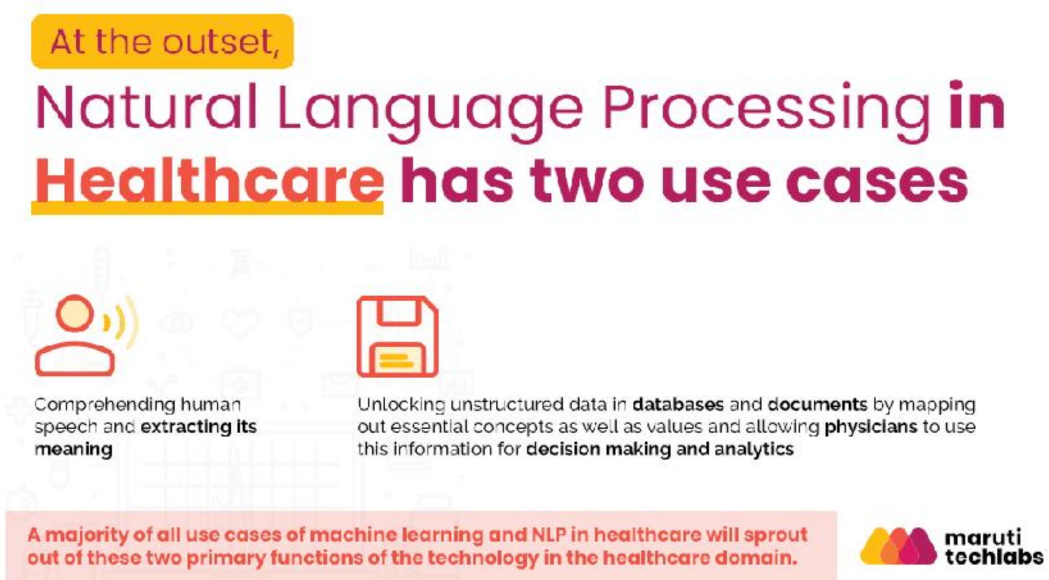
Within Healthcare text (including EMR, claims, clinical notes, lab results, pathology reports, clinical trials and more) there is a huge amount of variation in the ways people express the same concepts or relationships. Data Scientists can use Natural Language Processing (NLP) to capture this variation and create a normalized representation of the text, cleaning the natural language (i.e., documents of text) into a structured, formal representation.

The benefits of this normalization include:

- avoiding data sparsity (enabling language to be modelled more accurately)
- improved document search
- realizing connections across different kinds of notes written by different healthcare professionals



The NLP illustrates the manners in which artificial intelligence policies gather and assess unstructured data from the language of humans to extract patterns, get the meaning and thus compose feedback. This is helping the healthcare industry to make the best use of unstructured data. This technology facilitates providers to automate the managerial job, invest more time in taking care of the patients, and enrich the patient's experience using real-time data.



14 Best Use Cases of NLP in Healthcare

Let us have a look at the 14 use cases associated with Natural Language Processing in Healthcare:

1. Clinical Documentation

The NLP's clinical documentation helps free clinicians from the laborious physical systems of EHRs and permits them to invest more time in the patient; this is how NLP can help doctors. Both speech-to-text dictation and formulated data entry have been a blessing. The Nuance and M*Modal consists of technology that functions in team and speech recognition technologies for getting structured data at the point of care and formalised vocabularies for future use

The NLP technologies bring out relevant data from speech recognition equipment which will considerably modify analytical data used to run VBC and PHM efforts. This has better outcomes for the clinicians. In upcoming times, it will apply NLP tools to various public data sets and social media to determine Social Determinants of Health (SDOH) and the usefulness of wellness-based policies.

2. Speech Recognition

NLP has matured its use case in speech recognition over the years by allowing clinicians to transcribe notes for useful EHR data entry. Front-end speech recognition eliminates the task of physicians to dictate notes instead of having to sit at a point of care, while back-end technology

works to detect and correct any errors in the transcription before passing it on for human proofing.
The market is almost saturated with speech recognition technologies, but a few startups are disrupting the space with deep learning algorithms in mining applications, uncovering more extensive possibilities.

3. Computer-Assisted Coding (CAC)

CAC captures data of procedures and treatments to grasp each possible code to maximise claims. It is one of the most popular uses of NLP, but unfortunately, its adoption rate is just 30%. It has enriched the speed of coding but fell short at accuracy.

4. Data Mining Research

The integration of data mining in healthcare systems allows organizations to reduce the levels of subjectivity in decision-making and provide useful medical know-how. Once started, data mining can become a cyclic technology for knowledge discovery, which can help any HCO create a good business strategy to deliver better care to patients.

5. Automated Registry Reporting

An NLP use case is to extract values as needed by each use case. Many health IT systems are burdened by regulatory reporting when measures such as ejection fraction are not stored as discrete values. For automated reporting, health systems will have to identify when an ejection fraction is documented as part of a note, and also save each value in a form that can be utilized by the organization's analytics platform for automated registry reporting.

6. Clinical Decision Support

The presence of NLP in Healthcare will strengthen clinical decision support. Nonetheless, solutions are formulated to bolster clinical decisions more acutely. There are some areas of processes, which require better strategies of supervision, e.g., medical errors.
According to a report, recent research has indicated the beneficial use of NLP for computerised infection detection. Some leading vendors are M*Modal and IBM Watson Health for NLP-powered CDS. In addition, with the help of Isabel Healthcare, NLP is aiding clinicians in diagnosis and symptom checking.

7. Clinical Trial Matching

Using NLP and machines in healthcare for recognising patients for a clinical trial is a significant use case. Some companies are striving to answer the challenges in this area using Natural Language Processing in Healthcare engines for trial matching. With the latest growth, NLP can automate trial matching and make it a seamless procedure.
One of the use cases of clinical trial matching is IBM Watson Health and Inspirata, which have devoted enormous resources to utilise NLP while supporting oncology trials.

8. Prior Authorization

Analysis has demonstrated that payer prior authorisation requirements on medical personnel are just increasing. These demands increase practice overhead and holdup care delivery. The problem of whether payers will approve and enact compensation might not be around after a while, thanks to NLP. IBM Watson and Anthem are already up with an NLP module used by the payer's network for deducing prior authorisation promptly.

9. AI Chatbots and Virtual Scribe

Although no such solution exists presently, the chances are high that speech recognition apps would help humans modify clinical documentation. The perfect device for this will be something like Amazon's Alexa or Google's Assistant. Microsoft and Google have tied up for the pursuit of this particular objective. Well, thus, it is safe to determine that Amazon and IBM will follow suit.

Chatbots or Virtual Private assistants exist in a wide range in the current digital world, and the healthcare industry is not out of this. Presently, these assistants can capture symptoms and triage patients to the most suitable provider. New startups formulating chatbots comprise BRIGHT.MD, which has generated Smart Exam, “a virtual physician assistant” that utilises conversational NLP to gather personal health data and compare the information to evidence-based guidelines along with diagnostic suggestions for the provider.

Another “virtual therapist” started by Woebot connects patients through Facebook messenger. According to a trial, it has gained success in lowering anxiety and depression in 82% of the college students who joined in.

10. Risk Adjustment and Hierarchical Condition Categories

Hierarchical Condition Category coding, a risk adjustment model, was initially designed to predict the future care costs for patients. In value-based payment models, HCC coding will become increasingly prevalent. HCC relies on ICD-10 coding to assign risk scores to each patient. Natural language processing can help assign patients a risk factor and use their score to predict the costs of healthcare.

11. Computational Phenotyping

In many ways, the NLP is altering clinical trial matching; it even had the possible chances to help clinicians with the complicatedness of phenotyping patients for examination. For example, NLP will permit phenotypes to be defined by the patients’ current conditions instead of the knowledge of professionals.

To assess speech patterns, it may use NLP that could validate to have diagnostic potential when it comes to neurocognitive damages, for example, Alzheimer’s, dementia, or other cardiovascular or psychological disorders. Many new companies are ensuing around this case, including BeyondVerbal, which united with Mayo Clinic for recognising vocal biomarkers for coronary artery disorders. In addition, Winterlight Labs is discovering unique linguistic patterns in the language of Alzheimer’s patients.

12. Review Management & Sentiment Analysis

NLP can also help healthcare organisations manage online reviews. It can gather and evaluate thousands of reviews on healthcare each day on 3rd party listings. In addition, NLP finds out PHI or Protected Health Information, profanity or further data related to HIPPA compliance. It can even rapidly examine human sentiments along with the context of their usage.

Some systems can even monitor the voice of the customer in reviews; this helps the physician get a knowledge of how patients speak about their care and can better articulate with the use of shared vocabulary. Similarly, NLP can track customers’ attitudes by understanding positive and negative terms within the review.

13. Dictation and EMR Implications

On average, EMR lists between 50 and 150 MB per million records, whereas the average clinical note record is almost 150 times extensive. For this, many physicians are shifting from handwritten notes to voice notes that NLP systems can quickly analyse and add to EMR systems. By doing this, the physicians can commit more time to the quality of care.

Much of the clinical notes are in amorphous form, but NLP can automatically examine those. In addition, it can extract details from diagnostic reports and physicians’ letters, ensuring that each critical information has been uploaded to the patient’s health profile.

14. Root Cause Analysis

Another exciting benefit of NLP is how predictive analysis can give the solution to prevalent health problems. Applied to NLP, vast caches of digital medical records can assist in recognising subsets of geographic regions, racial groups, or other various population sectors which confront different types of health discrepancies. The current administrative database cannot analyse socio-cultural impacts on health at such a large scale, but NLP has given way to additional exploration.

In the same way, NLP systems are used to assess unstructured response and know the root cause of patients' difficulties or poor outcomes.

Machine Learning for Computer Vision

You can say computer vision is used for deep learning to analyze the different types of data sets through annotated images showing the object of interest in an image. It can recognize the patterns to understand the visual data feeding thousands or millions of images that have been labeled for supervised machine learning algorithms training. This process depends subject to use of various software techniques and algorithms, that are allowing the computers to recognize the patterns in all the elements that relate to those labels and make the model predictions accurately in the future.

Computer vision is a field of study focused on the problem of helping computers to see. Computer vision can be only utilized only with image processing through machine learning. Both are the part of AI technology used while processing the data and creating a model. The difference between computer vision and image processing in Computer vision helps to gain high-level of understanding from images or videos. For instance, object recognition, which is the process of identifying the type of objects in an image, is a computer vision problem. In computer vision, you receive an image as input, and you can produce an image as output or some other type of information. Whereas, image processing doesn't need such a high level of understanding of image. In fact, it is the sub-field of signal processing but also applied to images. For example, if you have noisy or blurred images, then under image processing the deblurring or denoising is done to make the object in the image clearly visible to machines.

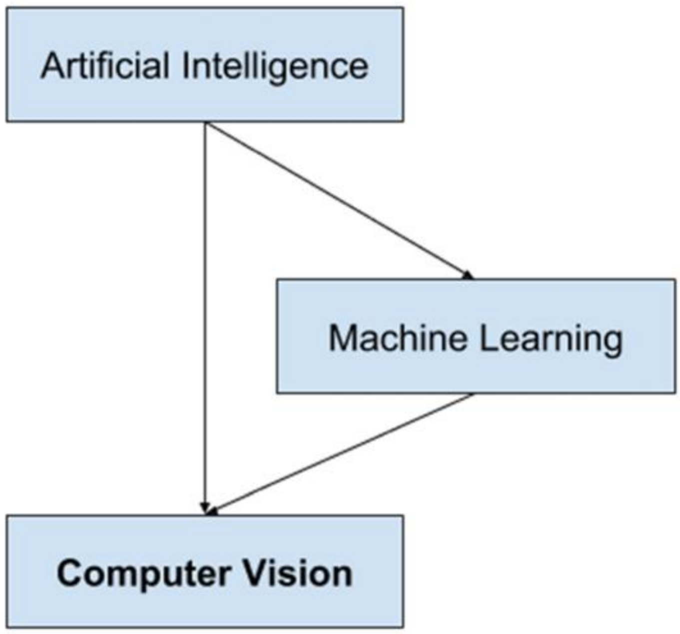


Image process task involves filtering, noise removal, edge detection, and color processing. In entire processing, you receive an image as input and produce another image as an output that can be used to train the machine through computer vision.
The main difference between computer vision and image processing are the goals (not the methods used). For example, if the goal is to enhance the image quality for later use, which is

called image processing. If the goal is to visualize like humans, like object recognition, defect detection or automatic driving, then it is called computer vision.

Machine learning in Computer Vision is a coupled breakthrough that continues to fuel the curiosity of startup founders, computer scientists, and engineers for decades. It targets different application domains to solve critical real-life problems basing its algorithm from the human biological vision. The goal of computer vision is to understand the content of digital images. Typically, this involves developing methods that attempt to reproduce the capability of human vision. Understanding the content of digital images may involve extracting a description from the image, which may be an object, a text description, a three-dimensional model, and so on.

These real-life problems keep us at bay as it aims to provide solutions using computer vision. However, computer vision alone is already a complex field. For example, the certainty of algorithms to use is already a huge challenge and so is finding the right computer vision resources.

Computer vision works with a device using a camera to take pictures or videos, then perform analysis. The goal of computer vision is to understand the content of digital images and videos. Furthermore, extract something useful and meaningful from these images and videos to solve varied problems. Such examples are systems that can check if there is any food inside the refrigerator, checking the health status of ornamental plants, and complex processes such as disaster retrieval operation.

Computer vision is the process of understanding digital images and videos using computers. It seeks to automate tasks that human vision can achieve. This involves methods of acquiring, processing, analyzing, and understanding digital images, and extraction of data from the real world to produce information. It also has sub-domains such as object recognition, video tracking, and motion estimation, thus having applications in medicine, navigation, and object modeling.

Machine learning is currently the only known way to develop computer vision systems that are robust and easily reusable in different environments. However, the application of ML techniques to CV is neither straightforward nor well understood.

Relationship between Machine Learning and Computer Vision

- Technology never ceases to mimic the human brain, thus AI gains a lot of interest for decades. To show the roadmap of these breakthroughs, let’s discuss the relationship between AI, machine learning, and computer vision. AI is the umbrella of these fields, machine learning is a subset of AI, wherein computer vision is also the subset of machine learning. However, computer vision can be considered as a direct subset of AI.

- Machine learning and computer vision are two fields that have become closely related to one another. Machine learning has improved computer vision about recognition and tracking. It offers effective methods for acquisition, image processing, and object focus which are used in computer vision. In turn, computer vision has broadened the scope of machine learning. It involves a digital image or video, a sensing device, an interpreting device, and the interpretation stage. Machine learning is used in computer vision in the interpreting device and interpretation stage.

- Relatively, machine learning is the broader field, and this is evident in the algorithms that can be applied to other fields. An example is the analysis of a digital recording, which is done with the use of machine learning principles. Computer vision, on the other hand, primarily deals with digital images and videos. Also, it has relationships in the fields of information engineering, physics, neurobiology, and signal processing.

- The obstacle faced by developers and entrepreneurs is the huge gap between computer vision and biological vision. The fields most closely related to computer vision are image processing and image analysis. However, it deserves another interesting article to cite its relationship and differences. Also, the lack of knowledge about the main goal of machine learning in a particular project is a huge disruption among entrepreneurs.

Applications of Computer Vision

The application of computer vision in artificial intelligence is becoming unlimited and now expanding into the emerging fields like automotive, healthcare, retail, robotics, agriculture, autonomous flying like drones and manufacturing etc.

To create the computer vision-based models the labeled data is required for supervised machine learning. Image Annotation is the data labeling technique used for creating such labeled images for computer vision.

- Video tracking – is a process of locating a moving object over time. Object recognition is used to aid in video tracking. Video tracking can be used in sports. Sports involve a lot of movement, and these technologies are ideal for tracking the movement of players.
- **Autonomous vehicles –** computer vision is used in autonomous vehicles such as a self-driving car. Cameras are placed on top of the car providing 360 degrees field of vision up to 250 meters of range. The cameras aid in lane finding, road curvature estimation, obstacle detection, traffic sign detection, and many more. Computer vision has to implement object detection and classification.
- **Sports –** computer vision is used in sports to improve the broadcast experience, athlete training, analysis and interpretation, and decision making. Sports biomechanics is a quantitative study and analysis of athletes and sports. For broadcast improvement, virtual markers can be drawn across the field or court. As for athlete training, creating a skeleton model of an acrobat and estimating the center of mass allows for improvement in form and posture. Finally, for sports analysis and interpretation, players are tracked in live games allowing for real-time information.

How is ML used in Computer Vision Systems?

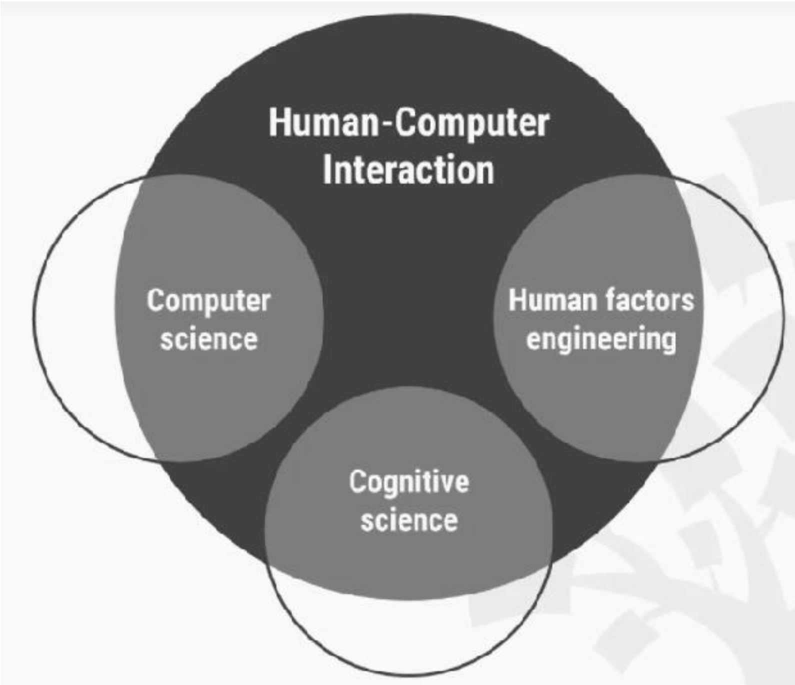
Machine-learning algorithms can be applied in at least two different ways in computer vision systems: First, to improve perception of the surrounding environment, which improves the transformation of sensed signals into internal representations; second, to bridge the gap between the internal representations of the environment and the representation of the knowledge needed by the system to perform its task. The latter is by far the most common use. For instance, in an application to flaw detection, rules are generated by means of a decision-tree learning system so that flaws can be detected in pipe images once these are described by a set of features. Only recently, the related issues of feature selection and, more generally, data preprocessing have been more systematically investigated in ML. Data preprocessing is still considered a step of the knowledge discovery process and concerned to data cleaning, simple data transformations and validation. On the contrary, many studies in computer vision and pattern recognition focused on the problems of feature extraction and selection. Hough transform, Fast Fourier transform (FFT) and textural features, just to cite some, are all examples of features widely applied in image classification and scene understanding tasks. Their properties have been well investigated and available tools make their use simple and efficient. In benchmarking computer vision systems, estimates of the predictive accuracy, recall, and precision are considered the main parameters to evaluate the success of a learning algorithm. However, the comprehensibility of learned models is also deemed an important criterion, especially when domain experts have strong expectations on the properties of visual models (e.g., the size or shape of a piece on a conveyer belt) or when an understanding of system failures is important (e.g., a logical component in a document image is not recognized because its corresponding layout component is a few pixels wider than the expected maximum).

Human Computer Interaction

HCI (human-computer interaction) is the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings. A significant number of major corporations and academic institutions now study HCI. Historically and with some exceptions, computer system developers have not paid much attention to computer ease-of-use. Many computer users today would argue that computer makers are still not paying enough attention to making their products "user-friendly." However, computer system developers might argue that computers are extremely complex products to design and make and that the demand for the services that computers can provide has always outdriven the demand for ease-of-use.

One important HCI factor is that different users form different conceptions or mental models about their interactions and have different ways of learning and keeping knowledge and skills (different "cognitive styles" as in, for example, "left-brained" and "right-brained" people). In addition, cultural and national differences play a part. Another consideration in studying or designing HCI is that user interface technology changes rapidly, offering new interaction possibilities to which previous research findings may not apply. Finally, user preferences change as they gradually master new interfaces.

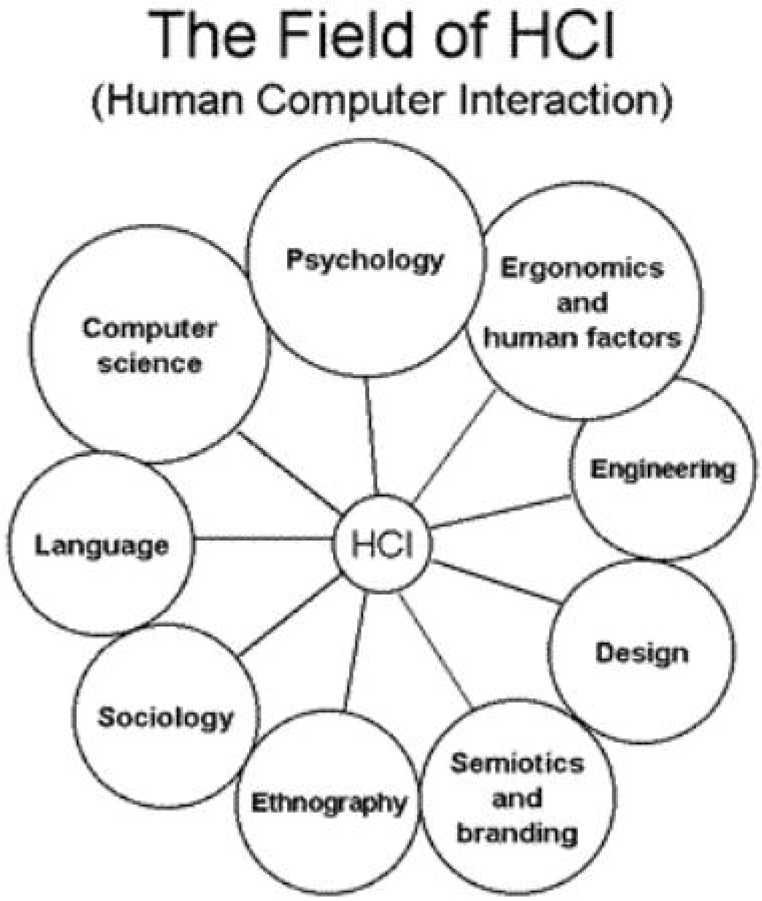
Human-computer interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers. While initially concerned with computers, HCI has since expanded to cover almost all forms of information technology design.



- The need for people to communicate with each other has existed since we first walked upon this planet.
- The lowest and most common level of communication modes we share are movements and gestures.
- Movements and gestures are language independent, that is, they permit people who do not speak the same language to deal with one another.
- The next higher level, in terms of universality and complexity, is spoken language.
- Most people can speak one language, some two or more. A spoken language is a very efficient mode of communication if both parties to the communication understand it.
- At the third and highest level of complexity is written language. While most people speak, not all can write.
- But for those who can, writing is still nowhere near as efficient a means of communication as speaking.
- In modem times, we have the typewriter, another step upward in communication complexity.
- Significantly fewer people type than write. (While a practiced typist can find typing faster and more efficient than handwriting, the unskilled may not find this the case.)
- Spoken language, however, is still more efficient than typing, regardless' of typing skill level.

- Through its first few decades, a computer's ability to deal with human communication was inversely related to what was easy for people to do.
    - The computer demanded rigid, typed input through a keyboard; people responded slowly using this device and with varying degrees of skill.
    - The human-computer dialog reflected the computer's preferences, consisting of one style or a combination of styles using keyboards, commonly referred to as Command Language, Question and Answer, Menu selection, Function Key Selection, and Form Fill-In.
- Throughout the computer's history, designers have been developing, with varying degrees of success, other human-computer interaction methods that utilize more general, widespread, and easier-to-learn capabilities: voice and handwriting.

    ®Systems that recognize human speech and handwriting now exist, although they still lack the universality and richness of typed input.



Human–computer interaction (HCI), alternatively man–machine interaction (MMI) or computer–human interaction (CHI) is the study of interaction between people (users) and computers.

• With today’s technology and tools, and our motivation to create really effective and usable interfaces and screens, why do we continue to produce systems that are inefficient and confusing or, at worst, just plain unusable? Is it because:

1. We don't care?
2. We don't possess common sense?
3. We don't have the time?
4. We still don't know what really makes good design?

DEFINITION

• "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."

GOALS

• A basic goal of HCI is – to improve the interactions between users and computers – by making computers more usable and receptive to the user's needs.

• A long term goal of HCI is – to design systems that minimize the barrier between the human's cognitive model of what they want – to accomplish and the computer's understanding of the user's task

WHY IS HCI IMPORTANT

• User-centered design is getting a crucial role!
• It is getting more important today to increase competitiveness via HCI studies (Norman, 1990)
• High-cost e-transformation investments
• Users lose time with badly designed products and services
• Users even give up using bad interface – Ineffective allocation of resources

New methods of human-computer interaction - touch screens, voice input, handwritten input, multiple active windows, interactive graphics - now allow the physician to maintain a direct dialog with the computer, moving it beyond the programmer's hands and integrating it as a tool into the physician's environment. But the capacity of the physician to interact directly with elegant computer based clinical aids can only be fully realized when the physician also interacts directly with the system for capture of the primary clinical data that s/he generates, which is then electronically available on-line for analysis and decision support. Development of systems for direct physician entry of patient medical data has proven very difficult, as demonstrated by the paucity of commercially available systems that do not rely on the intervention of a data entry clerk; the physician is thus deprived of the opportunity to interact directly with the data s/he has generated and to verify its appropriateness in the context of the record. The major problems lie in the need for physicians to communicate at a professional level with the computer. This suggests a user interface that organizes findings and anticipates the observations that physician intends to record. Computer-based systems have been developed over the last two decades in order to help replace pen and paper in the examining room. The goals of these systems have been to help with the recording of patient records, assist in diagnosis, and provide for fully legible summaries of findings. One of the major problems with these computerized medical systems is that the physician/user must often adapt significantly to the system rather than the system adapt to the user. The issues that deal with how the human user needs to interact with the computer is commonly referred to as Human-Computer Interaction (HCI). An important concept of Human-Computer Interaction is to better understand how people work and to examine how to support them before the development of an interface begins. This will allow for better tools for automating these methods, more powerful building blocks for software implementation, better techniques for software quality assurance, and an overiding philosophy for coordination, control, and management of software development. These building blocks have been developed over time as software engineering techniques that prompt for the high level design through the development of requirement analysis. They focus more on what the user wants and how the user operates rather than on how the system will be developed.

SCHOOL OF COMPUTING

Common to: CSE

Unit- IV

UNIT IV

Bioethics and challenges to deployment, Grand challenges in clinical decision support

UNIT –IV – SCSA3022- AI for Clinical Information System

4.1 BIOETHICS

“Bioethics” is a term with two parts, and each needs some explanation. Here, “ethics” refers to the identification, study, and resolution or mitigation of conflicts among competing values or goals. The ethical question is, “What should we do, all things considered?” The “bio” puts the ethical question into a particular context.

Bioethics is commonly understood to refer to the ethical implications and applications of the health-related life sciences. These implications can run the entire length of the bench-to-bedside “translational pipeline.” Dilemmas can arise for the basic scientist who wants to develop synthetic embryos to better study embryonic and fetal development, but is not sure just how real the embryos can be without running into moral limits on their later destruction. How much should the scientist worry about their potential uses?

Once treatments or drugs are in clinical trials involving human subjects, a new set of challenges arise, from ensuring informed consent, to protecting vulnerable research participants to guarantee their participation is voluntary and informed. Eventually, some of these new approaches exit the pipeline and are put into practice, where providers, patients, and families struggle with how to best align the risks and benefits of treatment with the patient’s best interest and goals. The added costs of new therapies inevitably strain available resources, forcing hard choices about how to fairly serve the needs of all, especially those already underserved by the health care system.

Questions in bioethics aren’t just for “experts.” Discussions of bioethical challenges take place in the media, in the academy, in classrooms, but also in labs, offices, and hospital wards. They involve not just doctors, but patients, not just scientists and politicians, but the general public.

Clinical Ethics

Clinical ethics is a practical discipline that aims to resolve ethical questions or disagreements that emerge in the practice of health care. Clinical ethicists work to identify, analyse, and resolve value conflicts that arise when providers, patients, families, surrogates, and other stakeholders disagree or are uncertain about the ethically best course of action. For example, patients or their surrogates may refuse recommended treatments or demand non-beneficial treatments, which puts their requests at odds with providers’ medical judgment. Clinical ethicists help to identify and clarify ethical questions, find ethically acceptable courses of action, encourage honest and respectful communication between all parties, and recommend ethically acceptable solutions for the case at hand. Clinical ethics also works to improve institutional responses to ethical dilemmas through education and policy formation.

Health Policy

Health policy is about governmental efforts to manage health care as a public good. Government must assure access to needed health care for all, incentivize curative research, protect health quality, and control health care costs. Justice is the moral value most pertinent to health policy, given large public investments in creating our health care system. Consequently, bioethicists ask whether it is just that an individual's access to needed, costly and effective care should depend upon an individual's ability to pay, or the willingness of a state legislature to adequately fund the Medicaid program for the poor? Should the genetically healthy and fortunate help pay the health care costs of the genetically unhealthy and unfortunate? A just and caring society must address these questions through thoughtful bioethical inquiry and respectful democratic deliberation.

Genetics

Much of medicine today is about genetics, whether for disease prevention, diagnosis, treatment, or reproductive decision-making. Emerging genetic technologies and knowledge generate numerous value conflicts. Consequently, bioethicists ask what is ethically appropriate if individuals have a mutation for a serious and now untreatable genetic disorder. Are those individuals ethically obligated to sacrifice their privacy rights to inform at-risk relatives? What are the ethical obligations for the best interests of future possible children on the part of parents considering whether and how to have children, when whole genome sequencing indicates serious potential risks associated with conceiving those children? Should social policies govern such decisions? Should those policies protect parental procreative liberty or enhance social responsibility for the best interests of those future possible children? This is bioethics in the age of genomics.

Neuroethics

As our ability to understand, measure, and manipulate the functioning of the human brain and nervous system rapidly advances, so too does our need to grapple with the ethical, social, and legal implications of these tools and neuroscientific knowledge. Neuroethics is an interdisciplinary research area that involves systematizing, defending, and recommending paths to action to address those issues. Neuroethics is also a platform for engaging different stakeholders to interact and discuss the future of neuroscience and neurotechnologies. That platform can take theoretical but also empirical and pragmatic approaches to the issues it covers, including the use of neuroenhancement drugs, memory dampening techniques, neural prostheses, the clinical and non-clinical uses of neuroimaging, and policy issues around neurotechologies. Neuroethics brings to light theoretical and reflective issues regarding how we think about and treat each other.

Clinical Neuroethics

Clinical neuroethics is a field at the intersection of neuroethics and clinical ethics, two dynamic and exciting disciplines. While neuroethics has developed at a time that neuroscience is making significant discoveries and developments at a rapid pace, clinical ethical questions have been on the table since the beginning of medicine. Clinical neuroethics combines these well-established issues with issues raised by interventions, drugs, and treatments that impact mental and neurological states. For example, the use of ventilators generated questions about who is alive and who is dead, as ventilators could keep blood circulating and oxygen flowing. Now, imaging tools can detect brain functions in those who appear clinically dead, and these questions arise anew. Clinical neuroethics addresses topics such as consciousness, death, deep brain stimulation, pain, and enhancement in the clinical setting.

Precision Medicine

Precision medicine is often ethically ambiguous. Precision medicine is about very expensive cancer drugs designed to target the genetic "drivers" of a metastatic cancer. In the U.S., ninety of these drugs have FDA approval and costs of $100,000 or more per year, with some therapies (CAR-T cell therapies) priced at $475,000. Some of these drugs are very effective. Imatinib (Gleevec) for chronic myeloid leukemia will yield more than ten extra years of life for 70% of these patients, but at $135,000 per year. Most, however, yield only extra months of life at very high cost. One goal of precision medicine is identify biomarkers that predict effectiveness in individuals. What then? Do we deny the drugs to patients who very likely (not certainly) will gain no more than three extra months of life? Is that limitation either just or caring? Therein lies the ethical ambigui

Reproductive Ethics

Reproductive ethics addresses topics that commonly provoke social and legal controversy, and intimately connect to concerns over reproductive justice. The field looks at issues related to assisting fertility (assisted reproduction, surrogacy, genetic manipulation of offspring), restricting fertility (contraception and sterilization), terminating a pregnancy (abortion), minors and access, and concerns that are more general over maternal and fetal best interests. Reproductive ethics examines perplexing questions: Should we enable people to reproduce after they die? Should we keep a brain-dead pregnant person on life support to allow for the birth of their child, or harvest a dead person's sperm? Should we manipulate the DNA of our offspring, not only to eliminate entire genetic disorders, but perhaps also to select superficial traits such as intelligence or athletic ability? Reproductive ethics focuses on these questions, and more.

Research Ethics

Research ethics addresses a variety of ethical challenges or questions that arise in the conduct of research, human or animal, clinical or basic science, many of which are not answered by regulations. For example, the distinction between "identifiable" and "non-identifiable" is a critical boundary in human subjects research. Research using data whose human sources are not identifiable is not subject to the requirement of informed consent. But as the amount and variety of data (including genetic data) assembled around one individual increases—as happens in "Big Data" research—the less possible it is to guarantee anonymity to the sources. Then the question is whether the data is "non-identifiable" enough. That requires balancing the nature and magnitude of the risks against the research benefits.

Shared Decision-Making

Effective clinical encounters depend on good communication. With the goal of arriving at the best possible decision for the individual patient, shared decision-making is the process whereby a healthcare decision is presented, discussed, deliberated, and negotiated between the provider and patient. In shared decision-making, a physician taps their knowledge about the available evidence and combines it with their experienced clinical judgment to provide balanced information regarding treatment choices. That information then is communicated to the patient – allowing them to clarify and determine their healthcare options in light of their own values and preferences. Shared decision-making evolved from the recognition of a patient's right to autonomy and reflects ethical medical practice. Recognizing that there are two experts in the room, shared decision-making is the pinnacle of patient-centered care.

Social Determinants of Health

In the clinical encounter, patients bring complex social circumstances that are a consequence of their physical and social environment and access to resources. Limitations on those resources determine a patient's ability to prevent illness, maintain health, and recover when illness occurs. Social justice draws our attention to disparities in health and asks not only that we recognize such disparities – it also requires us to actively work toward solutions both for the individual and the population as a whole. Learning about and respecting a patient’s socially-circumscribed access to resources can enhance the patient-doctor relationship. Even with the expanding emphasis on genetics and precision medicine, it remains the case that "it’s zip code not genetic code” – where a person lives as well as their related social experiences have a profound impact on their health.

4.2 <u>CHALLENGES TO DEPLOY BIOETHICS</u>

High ethical standards are necessary for healthcare. These standards fall under the umbrella of health or medical ethics, the field of applied ethics that is concerned with moral decision-making applied to medical practices and policies.

A standard approach to health ethics, developed by Tom L. Beauchamp and James F. Childress, often refers to the following four basic principles when evaluating the merits and difficulty of a medical procedure:

- Autonomy: Determine the wishes of the patient to protect their autonomy.
- Justice: Follow the due process to determine limits on healthcare and treat patients alike.
- Beneficence: Seek the patient’s best interest and assess what counts as goods to be pursued
- Non-maleficence: Determine what counts as harms to avoid.

These principles can help healthcare professionals identify ethical dilemmas and find solutions by having conversations with patients about their needs and desires.

Examples of Ethical Issues in Healthcare

When a healthcare provider oversees a patient's health, disagreements about treatment decisions, waiting lists, and access to resources can be some of the challenges that pose ethical dilemmas.

Ethical decisions don't have the same consequences as unlawful practices. If a healthcare administrator faces the challenge of a busy emergency room, they are not *lawfully* required to promise people that the process will speed up. But it can be ethically responsible for them to raise the concern with the board of administrators.

Healthcare institutions may create ethical committees to facilitate reasonable decision making that respects value and concerns of patients, their families and healthcare providers.

5 Ethical Issues in Healthcare

1. Do-Not-Resuscitate Orders

A Do-Not-Resuscitate (DNR) order is written by a doctor and it instructs healthcare providers not to perform cardiopulmonary resuscitation (CPR) if a patient stops breathing or if their heart stops beating. The DNR doesn't have instructions for any other treatment and can only be permitted after a physician speaks with the patient.

Ethical concerns can arise when it's not clear if a patient was capacitated to choose a DNR. In 2017, the case of a Florida man who was rushed to the hospital unconsciously with a "do-not-resuscitate" tattoo across his chest rose questions amongst the hospital staff.

After questioning the seriousness of the tattoo and his critical existing medical conditions, the ICU unit decided to honor the message expressed in the tattoo, despite the man's inability to talk. According to the ethics consultation on the case, "…the law is sometimes not nimble enough to support patient-centred care and respect for patient's best interests."

Hospital administrators should consider that CPR can sometimes worsen pre-existing conditions. In such cases, questioning if the degree of pain is worth the benefits can help professionals navigate severe situations that involve life or death.

2. Doctor and Patient Confidentiality

Violating a patient's confidentiality can have legal and ethical consequences for healthcare providers, according to the Health Insurance Portability and Accountability Act (HIPPA). The act requires physicians to protect the privacy and security of a patient's medical records. HIPPA also sets forth who can see the confidential information and who cannot. Despite the law's straightforwardness, there are some Gray areas.

For example, withholding information about a patient's condition could be unethical because it could harm the patient or someone else. The opposite can be harmful too. A health practitioner could be suspended or, in some cases, fired for posting information about cases on social media. Despite how unintentional a practice like that can be, HIPPA laws prohibit any disclosure of health information on social media channels, arguing that a patient loses their privacy immediately after the fact.

3. Malpractice and Negligence

Medical errors are the third leading cause of death in the U.S., according to a study published in the BMJ journal. Despite the decreasing rate of malpractice suits, patients who are affected by it may never recover. For others, it may take years.

The high-risk nature of the healthcare atmosphere can increase the likelihood of malpractice. Administrators, as well as physicians and nurses, must cover the essential responsibilities of patient care to avoid litigation. In the case of hospitals, ordinary negligence can be due to defective medical equipment, a misdiagnosis, or a delayed diagnosis.

Sometimes conditions can come up in unusual ways that wouldn't make sense unless a doctor was looking for the symptoms. Lines can be blurred when doctors disagree about procedures or necessary tests to provide accurate treatment. In cancer cases, a diagnosis can be challenging to prove, as there is a possibility that cancer would have progressed the same way regardless of when doctors started a treatment.

4. Access to Care

In 2017, the number of people with health insurance coverage increased by 2.3 million, up to 294.6 million, according to the United States Census Bureau. Despite peak access to healthcare insurance, Americans without coverage face difficulties when accessing medical services.

A Kaiser report informs that one in five uninsured adults in 2017 did not seek medical care due to costs. With the increase in healthcare resource demands, financial costs that cover the resources are very high, and hospitals weigh down the price.

Emergency departments across the U.S. can charge a patient up to $900 for a routine medical service that doesn't require complex treatment, according to a year-long project focused on American healthcare prices published by Vox.

The report found that insured patients can be affected too. Health administrators justify bill increases based on the need for a high quality of healthcare. But a recent JAMA article emphasizes that the "U.S. citizen is not getting good care for the money spent on healthcare." The World Health Organization (WHO) argues that despite the demand for service, healthcare institutions should prioritize efforts to reduce prices and administrative costs if the benefits are not worth the burden.

The WHO recommends that it's justified to shield people from health-related financial risks, too. This recommendation, as well as the debate of affordability and access, sparks difficult questions that institutions and healthcare providers must navigate.

5. Physician-Assisted Suicide

Physician-assisted suicide is the act of intentionally killing oneself with the aid of someone who has the knowledge to do so. In the most basic sense, the only person fully qualified to participate in the process is a physician. PAS is subject to criminalization by the state only. According to federal law, legalizing PAS is a matter of states' rights.

In states where PAS is allowed, a patient who qualifies must be terminally ill, can take the assisted drug themselves, and is mentally capacitated to understand what they're doing. Actions to legalize PAS are increasing despite its ethical prohibitions, according to the American College of Physicians (ACP). PAS is currently legal in seven states and the District of Columbia. In Montana and California, assistance is an option given to patients via court decisions.

States that oppose the practice raise the following concerns:

- Legalizing PAS can cause pressure on terminal patients who fear their illness is a burden to their families
- PAS is incompatible with a physician's roles as a healer and the American Medical Association's Code of Ethics.

The dilemma leaves the states to reason with residents' rights to autonomy and healthcare providers' beliefs of what they ought to do, based on their code of ethics. Since reforms and policies may change often, ethical applications can help set the pillars for a successful transformation in the healthcare industry. clinical decision support systems can help organizations manage large volumes of data while enabling them to deliver quality, value-based care.

Some other challenges with clinical decision support implementation and use, and how can developers and provider organizations overcome these barriers?

INTRUSIVE ALERTS, EXHAUSTED CLINICIANS

Clinical decision support systems embedded into the EHR have the potential to reduce care errors and improve adherence to evidence-based medicine.

But these tools can also contribute to clinician frustration and burnout. In a 2020 **study** conducted by researchers at Stanford University School of Medicine, the group stated that an estimated 35 to 60 percent of clinicians experience symptoms of burnout.

"Burnout affects not only the health of clinicians but also that of patients and the healthcare system overall. As studied in physicians, burnout is associated with increased risks of depression, substance abuse, occupational injury, and suicide," the researchers noted.

"Patients also suffer when clinicians are burned out. Increases in medical errors, recovery times, and patient mortality, as well as decreased patient satisfaction, have been associated with healthcare team burnout."

The team said that several key factors should be considered when designing and implementing clinical decision support to minimize clinician burnout.

"End-users should be involved in all aspects of design, pre-testing, and implementation. CDS requires ongoing maintenance based on feedback and outcomes, as well as updates to clinical practice standards," the group said.

Previous research has highlighted the importance of user feedback and involvement in clinical decision support development. A 2019 **study** published in *JAMIA* showed that using natural language processing techniques to analyze user feedback and override comments in clinical decision support systems could help organizations identify malfunctioning or broken alerts.

This could help eliminate unnecessary notifications, reducing clinician burnout and fatigue.

"Our results suggest that user feedback provided through override comments has been an underutilized but valuable data source for improving CDS," the team stated. "For organizations that can afford to do so, reading all the override comments may be worthwhile."

THE GROWING INFLUENCE – AND POTENTIAL RISK – OF AI

With the rise of artificial intelligence and machine learning in healthcare, it makes sense that researchers and provider organizations would **begin to apply** these technologies to clinical decision support tools.

However, combining these systems with advanced analytics often introduces its own set of challenges.

"One of my fears is that physicians will blindly accept the outputs of these systems going forward, and that's not what you want," Katherine Andriole PhD, director of research strategy and operations at the MGH & BWH Center for Clinical Data Science, **said** during an episode of *Healthcare Strategies*, an Xtelligent Healthcare Media podcast.

"Organizations will also need to have a clinical champion involved in this process, working with the vendor or the researcher who is developing the model. Clinicians can offer possible reasons why a model isn't working in a particular case, and can help modify the algorithm based on their clinical expertise."

Developing AI algorithms on-site can actively involve clinicians in the process, leading to more accurate, effective care delivery.

It is using machine learning and natural language processing to have a real-time listener operating at the same time that our radiologists are dictating the report.

By comparing the algorithm's results to the actual provider recommendation, organizations can ensure suggestions are aligned with clinical practice.

"We have human receives flag cases that we didn't correctly act upon. We retrain the models based on that feedback," Denny said.

"We don't want our radiologists to automatically do whatever the tool says. Before our radiologists are allowed to use the tool, they actually have to go through educational training and be very familiar with what all of the best practices are for the different cases. They are also educated on what the truth should be."

DIAGNOSTIC ERRORS, MISSED INFORMATION

Diagnostic errors are a massive patient safety hazard, resulting in care gaps, unnecessary procedures, and patient harm.

Sometimes, these errors can be attributed to information missed by clinical decision support systems.

"Diagnostic errors are not only common, but they can have serious consequences. A lot of hospital deaths that were attributed to the normal course of disease may have been the result of diagnostic error," **said** Gail M. Horvath, MSN, RN, CNOR, CRCST, patient safety analyst, ECRI.

"Clinical decision support interventions can help combat diagnostic errors by identifying ordered tests that haven't been done or by flagging incidental findings that require follow-up."

Clinical decision support tools that incorporate hard stops – in which a response is required before a user can move forward with a task – are associated with higher performance on both process and outcomes measures.

However, more study is needed to identify the ideal deployment of interruptive alerts.

"Because hard stops can be such powerful tools, effectively prohibiting specific actions on the part of the provider, they need to be carefully implemented with diligent assessment of possible harms and continuous user involvement in the design and implementation process," researchers stated in a **study** published in *JAMIA*.

"A lack of user testing and iterative design is more likely to lead to unintended consequences and error-prone systems and must be addressed in accordance with the growing body of literature on this topic. It is imperative that we approach the study of CDS with the same rigor with which we approach more traditional healthcare interventions."

SCHOOL OF COMPUTING

Common to: CSE

UNIT –V

UNIT V **9Hrs.**

Data mining in health care, Big data analytics in health care, IBM Watson, Issues in sustainability and interoperability.

UNIT – V – SCSA3022- AI for Clinical Information System

WHAT IS DATA MINING?

The purpose of data mining, whether it's being used in healthcare or business, is to identify useful and understandable patterns by analyzing large sets of data. These data patterns help predict industry or information trends, and then determine what to do about them. In the healthcare industry specifically, data mining can be used to decrease costs by increasing efficiencies, improve patient quality of life, and perhaps most importantly, save the lives of more patients.

The term's meaning differs when used in different industries. The most common definition, as provided by Techtarget, is "the process of sorting through large data sets to identify patterns and establish relationships to solve problems through data analysis."

Data Mining is useful in database analysis and decision support that includes market analysis and management by finding patterns helpful in target marketing, risk analysis, improved underwriting, quality control, competitive analysis, and fraud detection. Data Mining is applied for text mining, web analysis, provide summary information, and resource planning. It can summarize and compare the resources and their expenditure. Data mining in healthcare provides efficiency, consistency, and quality. Data mining has assisted in business. It has shown its potential in health service in segments like predictive medicines for a fatal disease, management of health care, resource allocation, and analyzing the effectiveness of the treatments undertaken. It has led to an increase in the importance of data mining in healthcare industry.

Data mining tools allow you to discover patterns and to use those patterns to predict future trends or the likelihood of future events. Typically data mining is applied to structured data.

Data mining holds incredible potential for healthcare services due to the exponential growth in the number of electronic health records. Previously Doctors and physicians hold patient information in the paper where the data was quite difficult to hold. Digitalization and innovation of new techniques reduce human efforts and make data easily assessable. For example, the computer keeps a massive amount of patient data with accuracy, and it improves the quality of the whole data management system. Still, the major challenge is what should healthcare services providers do to filter all the data efficiently? This is the place where data mining has proven to be extremely useful.

HOW DOES DATA MINING WORK?

To perform data mining, you need two things:

- the data itself (lots of data indeed)
- and the computing power capable to deal with the data (petabytes of data to be more precise).

The more organized the data is, the easier it is to mine it and get useful information for analysis.

Data mining is commonly used for marketing purposes. For example, online services such as Facebook, Google, and many others, mine myriads of data to provide users with targeted content. E-commerce companies, such as Amazon, use data mining to offer cross-sells and up-sells. When you see a box "People who viewed this product, also liked this", you see the results of very sophisticated data mining.

WHAT IS DATA MINING IN HEALTHCARE?

The medical industry collects a dazzling array of data, most of which is electronic health records (EHRs) collected by HIPAA covered healthcare facilities. According to a survey by PubMed, data mining is becoming increasingly popular in healthcare, if not increasingly essential. The huge amounts of data generated by healthcare EDI transactions cannot be processed and analyzed using traditional methods because of the complexity and volume of the data.

Data mining provides the methodology and technology for healthcare organizations to:

- evaluate treatment effectiveness,
- save lives of patients using predictive medicine,
- manage healthcare at different levels,
- manage customer relationship,
- detect waste, fraud and abuse.

HOW DOES DATA MINING WORK IN HEALTHCARE?

To sift through the collected medical data and to extract the useful knowledge hidden there, data mining is used as a part of the Knowledge Discovery in Databases (KDD) process.

The whole process includes the following main steps, which can be performed in an iterative and interactive sequence:

Data selection. The main goal of this step is to create a target data set from the original data, on which knowledge discovery has to be performed.

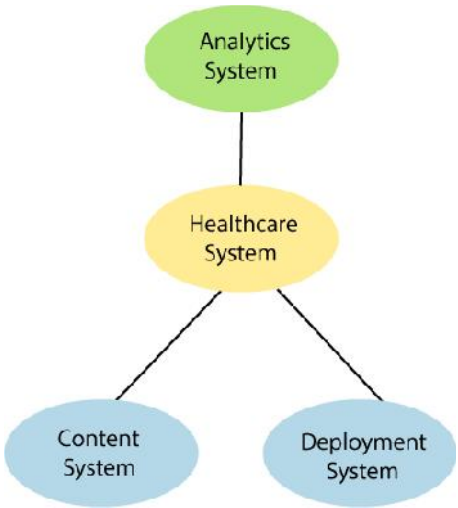
Data preprocessing is the step where the data is "cleaned" to define strategies for handling missing data fields and accounting for time-sequence information.

Data transformation. This step reduces and projects the data using transformation techniques or methods to find invariant aspects of the data.

Data mining. This step deals with extracting interesting patterns by choosing methods, tasks, and algorithms and presents the output results appropriately.

Data interpretation or evaluation. This step is performed by the user to interpret and extract knowledge from the mined patterns.

Healthcare organizations execute all three of these systems. These are the following three systems:



The analytics system:
The analytics system incorporates the technology and expertise to accumulate information, comprehend it, and standardize measurements. Aggregating clinical, patient satisfaction, financial, and other data into an enterprise data warehouse (EDW) is the foundation of the system.

The content system:
The content system includes standardizing knowledge work. It applies evidence-based best practices to care delivery. Scientists make significant discoveries each year about clinical best practice, but it mentioned previously, it takes a long time for these discoveries to be incorporated into clinical practice. A strong content system enables organizations to put the latest medical conformation into practice quickly.

The deployment system:
The deployment system involves driving change management over new hierarchical structures. Particularly, it includes implementing group structures that empower consistently, enterprise-wide deployment of best practices. It requires a real hierarchical change to drive the adoption of best practices throughout an organization.

DATA MINING IN HEALTHCARE EXAMPLES

Data mining has been used in many industries to improve customer experience and satisfaction, and increase product safety and usability. Data mining in healthcare has proven effective in areas such as predictive medicine, customer relationship management, detection of fraud and abuse, management of healthcare and measuring the effectiveness of certain treatments. Data mining has been used intensively and widely by numerous industries. In healthcare, data mining is becoming more popular nowadays. Data mining applications can incredibly benefit all parties who are involved in the healthcare industry. For example, data mining can help the healthcare industry in fraud detection and abuse, customer relationship management, effective patient care, and best practices, affordable healthcare services. The large amounts of data generated by healthcare transactions are too complex and huge to be processed and analyzed by conventional methods. Data mining provides the framework and techniques to transform these data into useful information for data-driven decision purposes.

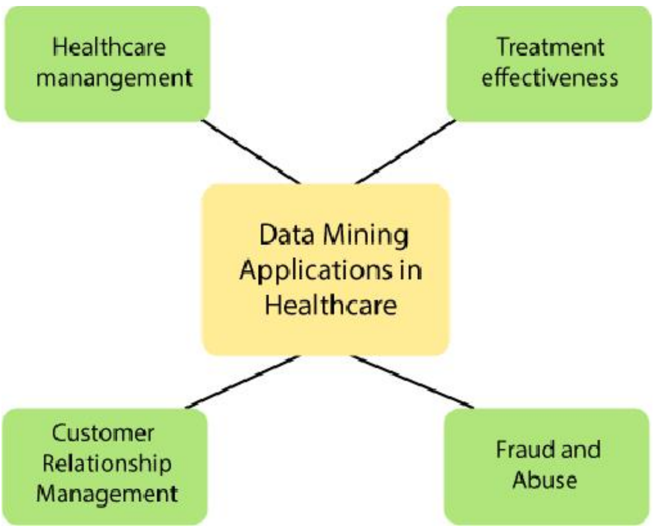
Here is a short breakdown of two healthcare data mining applications with real-world examples of their use.

Measuring Treatment Effectiveness

This application of healthcare data mining involves comparing and contrasting symptoms, causes and courses of treatment to find the most effective course of action for a certain illness or condition. For example, patient groups who are treated with different drug regimens can be compared to determine which treatment plans work best and save the most money. Furthermore, the continued use of this data mining application could help standardize a method of treatment for specific diseases, thus making the diagnosis and treatment process quicker and easier.

Detecting Fraud and Abuse

This application of data mining in healthcare involves establishing normal patterns, then identifying unusual patterns of medical claims by clinics, physicians, labs, or others. This application can also be used to identify inappropriate referrals or prescriptions and insurance fraud and fraudulent medical claims. The Texas Medicaid Fraud and Abuse Detection System is a good example of a business using data mining to detect fraud. In 1998, the organization recovered \$2.2 million in stolen funds and identified 1,400 suspects for investigation. To recognize its success, the Texas system received a national award for its innovative use of technology.



Treatment effectiveness:
Data Mining applications can be used to assess the effectiveness of medical treatments. Data mining can convey analysis of which course of action demonstrates effective by comparing and differentiating causes, symptoms, and courses of treatments.

Healthcare management:
Data mining applications can be used to identify and track chronic illness states and incentive care unit patients, decrease the number of hospital admissions, and supports healthcare management. Data mining used to analyze massive data sets and statistics to search for patterns that may demonstrate an assault by bio-terrorists.

Customer relationship management:
Customer and management interactions are very crucial for any organization to achieve business goals. Customer relationship management is the primary approach to managing interactions between commercial organizations normally retail sectors and banks, with their customers. Similarly, it is important in the healthcare context. Customer interactions may happen through call centers, billing departments, and ambulatory care settings.

Fraud and abuse:
Data mining fraud and abuse applications can focus on inappropriate or wrong prescriptions and fraud insurance and medical claims.

Advantages of data mining in healthcare
Data mining in Healthcare can improve decision-making by discovering sequences and tendencies in large amounts of complex data. Such analysis has become widely essential as financial pressures have profounded the need for health care organizations to make decisions based on the analysis of clinical and financial data. Insights gained from data mining can influence cost, revenue, and operating efficiency while maintaining a high level of care. Data Mining provides various methodologies for decision making, solving problems, analysis, planning, diagnosis, identification, integration, prevention, learning, and developing treatments.

Challenges in healthcare data mining
Data Mining applications are highly beneficial to the health care industry. The importance of Data mining in the health care industry can never get neglected. However, one can’t ignore the disadvantages of data mining in healthcare. There are certain limitations like data accessibility, as the unprocessed inputs for data mining often exist in different settings and systems. These systems include administration, management, clinics, diagnostics, and more. Therefore, Before the data mining gets executed, there is a requirement to collect and integrate the data.

The future of data mining in healthcare

The shift from written to electronic health records has played a huge part in the push to use patient data to improve areas of the healthcare industry. The adoption of electronic health records have allowed healthcare professionals to distribute the knowledge across all sectors of healthcare, which in turn, helps reduce medical errors and improve patient care and satisfaction.

The future of healthcare may well depend on using data mining to decrease healthcare costs, identify treatment plans and best practices, measure effectiveness, detect fraudulent insurance and medical claims, and ultimately, improve the standard of patient care.

BIG DATA ANALYTICS IN HEALTHCARE

Big data is a massive amount of information on a given topic. Big data includes information that is generated, stored, and analyzed on a vast scale — too vast to manage with traditional information storage systems. In health care, the move to digitize records and the rapid improvement of medical technologies have paved the way for big data to have a big impact in the field. Many industries use big data to learn about their customers and tailor their products or services accordingly. In health care, big data sources include patient medical records, hospital records, medical exam results, and information collected by healthcare testing machines (such as those used to perform electrocardiograms, also known as EKGs).

Biomedical research on public health also provides a large portion of the big data that, if properly managed and analyzed, can serve as meaningful information for patients, doctors, administrators, and researchers alike. For example, public health researchers can generate big data to predict and prepare for future pandemics.

Why Collecting Data in Health Care Is Important

Big data collection and analysis enable doctors and health administrators to make more informed decisions about treatment and services. For example, doctors who have big data samples to draw from may be able to identify the warning signs of a serious illness before it arises. Treating disease at an early stage can be simpler and costs less overall than treating it once it has progressed.

In other areas of the healthcare industry, administrators can use key performance indicators and data analytics to make a number of funding and resource allocation decisions. Big data amassed from health records and Google maps have been used to create critical health maps that highlight underserved locations, for example. Administrators and providers can use such information to determine where to deploy mobile health clinics and other resources.

Hospitals and other large care facilities can use big data to capture a comprehensive picture of patient experience. Big data tools allow care teams to merge data that would otherwise be archived in separate clinics, hospitals, and specialist offices and remain underutilized. Big data holds the promise of consolidating patient data, allowing for rapid and accurate communication between patients and providers that draws from a patient's entire health history.

How Big Data Improves Patient Outcomes

For years, amassing big data for medical use has been expensive and time-consuming. Today, innovative technologies can collect data electronically and convert it into an easily readable form. Health professionals can now generate data-driven healthcare solutions to improve patient outcomes in many ways:

Empowering patients to engage with their own health histories with easy-to-access medical records. Informing providers of patients' ongoing health status so they can in turn assess treatment methods faster. Saving patients time and money

Improving access to quality health care by streamlining administrative processes and helping administrators make informed decisions about allocating funds and resources both within and between health institutions. Harnessing data-driven findings to predict and solve medical issues earlier than ever before

Types of Healthcare Data

Medical records are just one type of healthcare data generated by our complex medical systems. Researchers with the Centers for Disease Control and Prevention (CDC) estimate that over 883.7 million office-based physician visits take place annually in the United States. According to the National Center for Health Statistics within the CDC, over 85 percent of office-based physicians use electronic medical record systems.

Types of patient-centered healthcare data also include:

Medical records

Dental records

Surgical records

Behavioral data (for example, a patient's diet)

Biometrics (for example, a patient's blood pressure)

Living conditions

Big data collection tools in health care can generate insights at the institutional level as well. Hospitals, clinics, and independent providers may track other forms of healthcare delivery data:

Staffing schedules (for example, to determine how many medical workers to put on staff in a given time period to care for patients)

Patient waiting room time

Insurance claim data

Medical referrals

Employee performance metrics (for example, number of patients cared for per hour)

Supply chain metrics (for example, for ordering the correct amounts of personal protective equipment)

Collecting High-Quality Healthcare Data with Big Data Tools

Big data allows healthcare providers and health administrators to drill down and learn more about their patients and the care they provide to them. Collecting high-quality data requires optimization of data collection tools in health care and proper use of such tools by patients and providers alike.

Improving Patient Engagement with Wearable Technology. Smart devices can record a patient's activity levels, heart rates, sleeping habits, and many other biometrics in real time. Coupled with big data, patients' vital information can supply doctors with more accurate medical data than patient-provided questionnaire responses alone. Wearable technologies, then, can facilitate rapid communication between doctors, patients, and their data, which could cut down on expensive hospital visits.

Getting Everyone on the Same (Electronic) Page

Questionnaire data from patients provides just one side of a patient's health. Patients and providers alike may benefit from a holistic view supplied by standardized information from big data. For example, doctors with patients at risk for heart disease who need to monitor their blood pressure may recommend that their patients reduce their sodium intake. In a traditional model, providers may question patients about their lifestyle and dietary habits ("How often do you add salt to the food you eat?") and take vitals (blood pressure, blood glucose levels, etc.) to keep track of their patient's progress.

Today, smart interactive questionnaires synced with real-time biometric technology allows providers to record information faster and in a more standardized form, leading to faster responses and individualized treatment plans.

Increasing Access to Primary and Preventive Care

Big data allows doctors to serve patients in rural areas and other locations where a robust medical infrastructure may not exist. For example, patients can use smart devices in their homes to communicate with a medical provider.

Big data also can build on and improve existing telehealth systems through automation. For example, patient questionnaire responses can be compared to a vast pool of population data and treatment plans can be automatically suggested to physicians, who can then approve outbound recommendation messages to patients, rather than write each one manually.

Addressing Concerns with Big Data in Healthcare

Privacy of patient data is crucial to protect as big data infrastructures emerge and develop in healthcare. In light of ongoing cybersecurity breaches, healthcare organizations must prioritize security. From malware to phishing attacks, healthcare data has vulnerabilities like any other collection of confidential information.

The HIPAA Security Rule offers a list of safeguards for healthcare organizations storing protected health information (PHI). These data practices include:

Ensuring transmission security

Adopting authentication protocols

Managing controls over data access and integrity

Scheduling regular data security audits

In more concrete terms, these safeguards may involve encrypting sensitive data, enabling firewalls, implementing multi-factor authentication, and ensuring anti-virus software is up-to-date.

Healthcare organizations must also remind their staff frequently that data security is critical. Staff must be willing to prioritize data security, which may mean complying with software updates, security checks, and constraints on access to data. Organizations must also consistently follow data security protocols, including reviewing who may have access to confidential data.

The healthcare industry has come a long way to reach the point where it is right now - telemedicine, medical imaging, electronic health records, robots, and more. All this has become possible with the help of technology. And big data is one of those disruptors that have revolutionized the healthcare industry. Big data in the healthcare industry help save lives, decrease costs, and improve the efficiency of operations.

The outbreak of the global pandemic has accelerated innovation and the adoption of digital technology, especially big data and big data analytics. But also it has exposed many weaknesses of the healthcare industry. Here we outline the benefits of big data and data analytics in healthcare as well as give an overview of key applications of big data in the healthcare sector. So let's take a look at how big data and data analytics can help solve many well-known as well as emerging problems in healthcare.

OVERVIEW OF BIG DATA IN HEALTHCARE

According to the IDC report, big data is expected to grow faster in healthcare than in other industries like manufacturing, financial services, or media. It is projected that the healthcare data will see a compound annual growth rate (CAGR) of 36% through 2025.

Sources of big data in healthcare

Big data in healthcare comes from a variety of sources - starting from electronic health records to server logs of search engines and wearable devices. This is the endless sea of data that offers an endless list of opportunities. The main thing is to know how to put this data to good use.

With proper storage and analytical tools in hand, all the players in the healthcare system including healthcare organizations (HCOs), patients, medical staff, pharmaceutical manufacturers, etc. can reap a number of benefits. In broad terms, patients become more healthy, doctors can significantly enhance medical outcomes, HCOs can save costs and improve the efficiency of operations, pharmaceutical manufacturers and other healthcare providers can make more informed decisions.

Benefits of big data and big data analytics in healthcare:

Reducing medical errors

Preventing mass diseases

Preventative care

Modeling the spread of diseases

Detecting diseases at their early stage

More accurate treatment

Real-time alerting

Patients personalization care

Predicting the cost of treatment

Forecasting the risks of treatment

Identifying and assisting high-risk patients

Suicide & self-harm prevention

New therapy and drug discovery

Prevention of unneeded emergency room visits

Improved staff management

Streamlined hospital operations

Better customer service

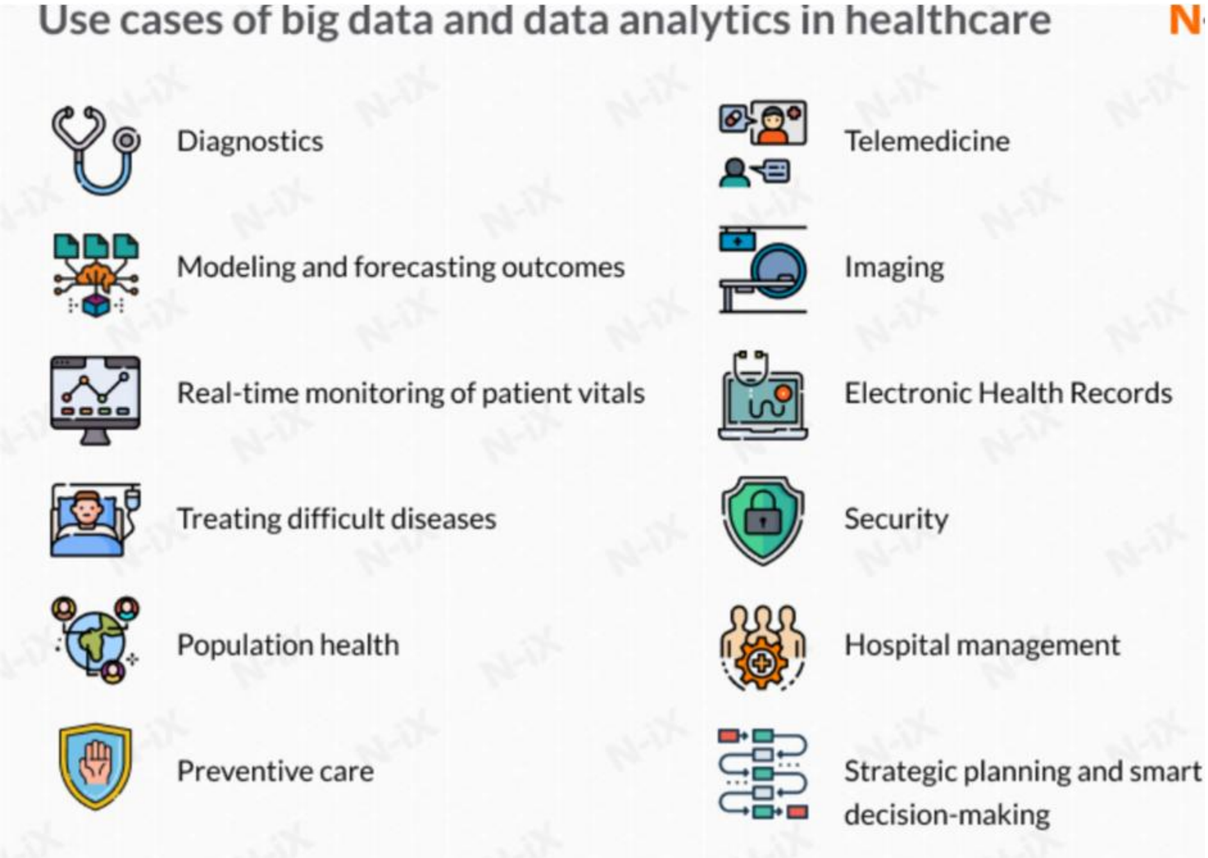
Cost reduction

"Data builds on data. Patient-generated data, from a clinical perspective, improves outcomes by creating a more complete picture of the patient outside of the exam room. In addition, as HCOs collect more data, machine learning will get better and enable more proactive outreach. As we gain deeper insights on individuals through data and AI, HCOs will create richer, individualized experiences that yield higher customer loyalty." - Healthcare 2020: The State Of The Doctor-Patient Relationship In The US, Forrester Research Inc., March 10, 2020

Use cases of big data and data analytics in healthcare:

Knowledge derived from big data analysis gives healthcare specialists insights that were not available before. Big data in healthcare is applied at every step of the healthcare cycle: from medical research to patient experience and outcome.

use cases of big data in healthcare



Diagnostics

With the help of Big data and data analytics, it is possible to diagnose a disease quickly and accurately. Usually, doctors examine patients, talk to them about their ailments, and compare their symptoms to disease pictures they know. In complex cases, they research the literature and consult with colleagues. But big data presents a smarter way to diagnosing patients. Physicians can simply collect the patient data and feed it into an algorithm that will suggest the most likely diagnoses. Algorithms will also propose high-value tests and reduce the overuse of unnecessary tests. Also, computer vision (CV) is widely used in diagnostics. For example, this technology helps examine the retina with the aim to detect anomalies at an early stage and prevent diseases.

Modeling and forecasting outcomes

Big data and predictive analytics assist healthcare specialists with clinical decision-making. Prognostic modeling is widely used in healthcare for different purposes. Some models are aimed at predicting future outcomes of diseases and/or treatments. Others focus on identifying patients who may be at risk for the development of a particular condition. There also models that forecast the spread of diseases among the population. For example, predictive modeling has been successfully applied in many countries to identify undiagnosed diabetes, predict survival after in-hospital cardiopulmonary resuscitation, and forecast the spread of the COVID-19 pandemic.

Real-time monitoring of patient vitals

The use of wearables and other IoT devices, which healthcare technology companies now produce quite enough, is among key healthcare technology trends. They can automatically collect health metrics like heart rate, pulse, blood pressure, temperature, oxygen concentration, blood sugar level, and more. Thus, they eliminate the need for patients to travel to the providers, or for patients to collect it themselves. These devices generate tons of valuable data that can further help doctors with diagnostics and treatment.

Treating difficult diseases

Data collected from patients on different treatment plans can be analyzed for trends and patterns to find those with the highest rates of success. This is specifically important for fighting such severe illnesses as cancer, AIDS, multiple sclerosis, etc.

Population health

Big data helps improve the quality of people’s lives. It has the potential to predict and prevent the outbreaks and spread of infectious diseases. Big data tools were not available during previous pandemics. In case of the coronavirus, big data helps improve epidemic surveillance and response. Countries around the world are using big data and data analytics to provide real-time stats, track the spread of the virus, and predict the impact of this outbreak.

Preventive care

Preventing diseases is better than curing them for patients, hospitals as well as insurance providers. Doctors want patients to be healthy and stay away from hospitals. And this where big data comes into play. Thanks to big data, it is possible to predict the chances of someone getting ill based on their behaviors and identify warning signs of serious illness at an early stage.

Telemedicine

Big data has huge relevance in telemedicine. With the use of robots and high-speed real-time data, for example, doctors can perform operations while physically being miles away from the patient. Big data plays a crucial role not only in robot-assisted surgery but also in initial diagnosis, remote patient monitoring, and virtual nursing assistance. Thanks to telemedicine and big data, which makes it all possible, the lives of doctors and patients become easier:

Patients can avoid waiting in lines

Doctors don’t waste time on unnecessary consultations and paperwork

Patients can be monitored and consulted anywhere and anytime.

Prevention hospitalization or re-admission;

Clinicians can predict acute medical events in advance and prevent deterioration of patient’s conditions;

Telemedicine helps reduce costs and improve the quality of service.

Imaging

Analyzing imaging data such as CT, MRI or PET is challenging. But Big data analytics can streamline the way radiologists read images. Algorithms can identify specific patterns in the pixels and convert it into a number to help healthcare specialists with the diagnosis. So doctors have the possibility to build history catalogues of images and use computer vision and data science techniques for their quick analysis.

Electronic Health Records

Electronic Health Records (EHRs) are one of the biggest sources of big data in healthcare. Many HCOs have already implemented them. According to the HITECH research, 94% of US hospitals have adopted EHRs. EHRs give patients and doctors a complete picture of a patient's medical history. Records are shared via secure information systems and are available for providers from both the public and private sectors. Doctors can implement changes over time with no paperwork and no danger of data replication. EHRs can also trigger warnings and reminders when a patient should get a new lab test or track prescriptions to see if a patient has been following doctors' orders.

Security

Big data and data analytics can help with fraud prevention and detection. It is possible to identify changes in network traffic or any other behavior that reflects a cyber-attack and take measures to block harmful activities.

Hospital management

Big data is a key to hospital management. It can improve hospital operations and significantly reduce costs. For example, through data-driven analytics, it's possible to predict when you might need staff in particular departments at peak times while distributing skilled personnel to other areas during quiet periods. Also, by keeping track of employee performance across the board, you can use healthcare data analysis to gain insight on who needs support or training and when.

However, implementing a big data solution in healthcare requires a thorough strategy. You can develop your own solution or purchase a ready-made product. The main thing is to have a clear idea of what your requirement and goals are.

Strategic planning and smart decision-making

Bid data and data analytics allow healthcare specialists to better understand and spot problems and opportunities which derive from them. For instance, it is possible to identify which areas are suffering the most and more care units to those places. Also, big data analysis in healthcare assists in new therapy and drug discoveries. By using a mix of historical, real-time, predictive analytics and data visualization techniques, healthcare experts can identify potential strengths and weaknesses in trials or processes and discover new drugs.

Key challenges of big data and big data analytics in healthcare

Big Data has great potential to change the healthcare landscape. It can save people's lives by preventing diseases, forecasting medical outcomes, and reducing medical errors. Also, it can improve the quality and cost of care. However, not every healthcare organization has incorporated big data into everyday operations. According to a recent PwC survey, 95% of healthcare CEOs are exploring better ways of using and managing big data; but only 36% have made any headway in getting to grips with big data. So what are the main obstacles to the mass adoption of big data in healthcare? Let's take a look at some of the most pressing issues:

Data integration and storage

The big data ecosystem was created exactly to solve problems of ingesting and storing not only big amount of data, but also extremely diverse data. Such concept as a data lake provide the possibility to solve the problem of storing a variety of healthcare data like images, document files, exports from old RDBMS systems, and so on.

Data standardization

Healthcare is known for a series of standards applied to the data, however it is possible to standardize a variety of data from data lakes into some structured form as data warehouses.

Data quality

To drive trustworthy insights, AI and ML algorithms need reliable input data without duplications and inaccuracies. If the quality is poor, doctors may misidentify a patient or prescribe the wrong treatment. Thus, HCOs should work on data governance and master data management solutions to improve the quality of the data. They should implement automated checks for all incremental pipelines and pay special attention to data preparation and cleaning.

Data mining

Data exploration tools from the big data ecosystem that are regularly used in Business Intelligence are extremely useful when it comes to data mining problems. And data engineers and data scientists could help with data mining for healthcare too.

Data sharing

Due to the lack of standardization, sharing healthcare data between different organizations is one of the main pain points. Moreover, such sensitive information requires robust privacy protections. Under public health emergencies, and particularly the COVID-19 pandemic, it is crucial that data is shared in a timely and an accurate manner.

Data visualization

Big data healthcare projects call for high visibility. Thus, real-time monitoring, operational dashboards and periodic business/report dashboards are essential. In the healthcare industry, however, there is a problem with visualizing health data as it requires specific tools and expertise.

Scalability

Some enterprise data warehouse systems that are commonly used in the healthcare sphere lack horizontal scalability and support only vertical one. Migration to massively parallel processing (MPP) data warehouse or the big data ecosystem can resolve such scalability issues.

Security and privacy of data

Security is a top concern in healthcare. Healthcare is a highly regulated industry that has strict laws regarding storing and sharing sensitive data. Nonetheless, there are a lot of examples of breaches and leaks of confidential data. Thus, it is fundamental to set up necessary configurations, conduct regular audits, perform risk assessment, and train employees on security best practices.

Integrating legacy systems with the big data ecosystem

It is important to identify if legacy systems can be integrated into the new pipeline and continue to do some job or should be rewritten to suit the big data ecosystem totally for gaining cost and performance benefits in the future. In case rewrite is not an option which is quite common in healthcare due to regulations and certifications of a software, common practices like middleware buses are used.

Lack of big data skills

Big data in healthcare is really ‘big’ and diverse. Collecting, cleaning, processing, managing, and analyzing such huge volumes of data is challenging. However, with a reliable partner by your side, you can easily overcome these and many other issues with big data and big data analytics in healthcare.

IBM Watson

IBM Watson Health is committed to helping build smarter health ecosystems. The combination of our core strengths—our deep industry experience in health, our advanced technology solutions including options for AI, blockchain, and data and analytics, and our reputation for trust and security—enables Watson Health to support our clients' digital transformations. Through a combination of technology solutions and experienced consulting, we're helping organizations become more efficient, resilient and robust institutions that can deliver on their mission to their communities.

Watson Analytics, which was initially developed as a pure question and answer (QA) computing system, has evolved dramatically with the advantage of cloud technology, improved machine learning and hardware capabilities. Implementation of Watson Analytics in healthcare has significantly revolutionised the sector by assisting both patients and healthcare professionals. Even though across industries consequential uncertainty of artificial intelligence prevails, the healthcare industry can exploit Watson to resolve the ever-growing pile of data.
Healthcare being a patient-intensive industry, its success relies on real-time, quick diagnosis and treatment decisions. Rising global disease burden, growing traffic of patients, mismanagement of medical prescriptions, challenges of rare diseases, lack of connectivity for collaborative treatment, and growing load of patient data are vital challenges to be addressed in the healthcare sector.

Although Watson hasn’t been able to fully showcase its purported potential, it can rescue the healthcare sector from severe failures by systematically addressing the aforementioned challenges. Improved organisational performance, effective diabetes management, advanced oncology care, and ameliorated drug discovery are prominent trends of Watson that are transforming the healthcare sector.

1. Improved Organisational Performance
Growing pool of patients in the healthcare sector has intensified chaos and failure of appropriate care delivery. As the sector faces a shortage of workforce, data-driven AI, cloud-technology, and machine learning can mitigate the effects of disorders in the management.
Implementation of Watson-based solutions in the healthcare sector can help organisations to integrate a large pool of information from multiple systems and care providers, and device an automated management workflow for effective healthcare delivery.

The automated platform works smarter in terms of creating individualised care plans, health summarisation, use of cognitive computing for holistic care management, an intuitive user interface for role-based access and much more. The smooth workflow saves time as well as expenditure. Such an administrative workflow can effectively address dose error detection, preliminary diagnosis, faster clinical trial participant identifier, fraud detection and cyber-security among other issues in healthcare.

2. Effective Diabetes Management

IBM Watson Health, in partnership with Medtronic, has recently launched Sugar.IQ - an application which addresses data-driven obstacles of diabetes and assists patients to manage their diabetes. Diabetic patients are subjected to daily challenges of blood sugar level maintenance and optimum sugar intake.

As IBM Watson Health can predict alterations in glucose levels up to three hours in advance of the onset, it can prove disruptive for diabetes management. The app was presented at the American Diabetes Association (ADA) with study results of its real-world application where people with diabetes could spend 36 minutes more per day in healthy glucose range using the app.
In this regard, a total of nine days with healthy glucose range is added per year in the life of a diabetic patient. With the growing prevalence of diabetes and associated mortality rates, effective diabetes management through AI platform such as Watson can significantly relieve the disease burden.

3. Advanced Oncology Care

Cancer, being the second leading cause of death, has taken lives of 8.8 million globally in 2015, as per WHO data. According to the American Cancer Society, advances in healthcare has significantly reduced the mortality rate by 25% in the past two decades. However, new cancer cases are expected to rise by 70% over the next two decades amidst the shortage of oncologists worldwide. With the implementation of cognitive computing, Watson is capable of analysing tens of millions of pieces of data in a matter of a few seconds and identifying 300 alternative therapies, which can seem challenging for a team of physicians.

Watson oncology offerings are available to support at least 12 cancer types, representing 80% of the global cancer incidences. In addition, Watson for Genomics is empowering precision cancer care on the backdrop of collaborations with Quest Diagnostics, Illumina, and Baheal Pharmaceutical Group among others. Further, the use of Watson Clinical Trial Matching prominently reduces the time required to screen patients for eligibility of clinical trials by 78%.

4. Ameliorated Drug Discovery

Watson for Drug Discovery is a comprehensive drug discovery assistant for pharmaceutical companies, medical device companies, and academic institutions. It is a cloud-based platform enabling researchers to identify new drug target and repurpose their drug discoveries. With the help of natural language processing trained in the life sciences domain, evidence-backed predictions and dynamic visualisations, researchers can generate a new hypothesis. The platform can synthesize a comprehensive dataset in tabular as well as unstructured formats to derive insights at levels which seem impossible by manual operations. By leveraging machine learning, predictive analytics evaluate and learn through reasoning algorithms and ultimately novel hypothesis for future analysis.

Dynamic visualisation enhances the data visibility by enabling researchers to visualise connections, identify properties of interest, and quickly screen to supporting evidence. Such accelerated identification of novel drugs through Watson can transform traditional ways of drug discovery by delivering novel therapies in lesser time. By addressing management of diabetes and cancer, leading causes of mortality, improving administrative operations, and better drug discovery, Watson Analytics holds significant potential to transform the future efficiency of healthcare sector.

IBM’s Watson boasts an impressive list of achievements, in which the supercomputer routinely dwarfs human intelligence. So far, the computer has defeated several geniuses on Jeopardy and cooked a slew of exotic dishes.

Realizing that Watson’s computing power could work wonders for healthcare, it has been enlisted for a number of life-saving ventures. In February 2013, IBM and American healthcare provider WellPoint launched Watson’s first commercial application, providing utilization management decisions for lung cancer treatment at Memorial Sloan-Kettering Cancer Center. IBM Watson Health launched in April 2015, in order to leverage its formidable cognitive computing power as an open platform for physicians, researchers, insurers, and medical companies. This endeavor has thus far drawn in a number of organizations partnering with IBM to optimize personal health, through data collection from consumer and medical devices. The list is pretty star-studded, including Apple, Johnson & Johnson, and Medtronic.

Now, Watson has taunted human intelligence once again—this time by diagnosing a rare disease that had long stumped human doctors. This achievement marks a significant advance in the diagnostic capabilities of data analysis and artificial intelligence. No longer may doctors have to waste time combing through hundred of pages of research to diagnose a cryptic disease. But that’s not all: with adequate genetic data and a handy set of algorithms, Watson could greatly advance the personalized medicine initiative by prescribing customized dosages of medicine tailored to each patient’s genetic makeup.

However, collecting that much genetic information from patients comes with a set of problems of its own. Watson’s database of intimate health information is going to need extremely high-level security protocols, especially if prominent figures submit their information to be archived. Some may be uneasy about their personal health data out there in the cloud—Watson would likely also contain information on patients’ physical traits and ethnic background.

ISSUES IN SUSTAINABILITY AND INTEROPERABILITY

Sustainability is the capacity to maintain program services after the end of financial, managerial, and technical assistance from external donors. Table presents factors hypothesized to affect sustainability, as described in the literature, and this was the conceptual framework for this study. Program-specific factors include the degree to which project goals are clearly specified and able to show results, the perceived effectiveness of the program in achieving these results, the availability of financing for the program, and the emphasis on training within the program. Relevant organizational factors include the flexibility to modify implementation to meet local needs and conditions, the participatory nature of donor-client and donor-community interactions, the existence of an effective project champion, the extent to which the program is integrated into the host institution and activities, and the institutional strength of the implementing agency. Contextual factors include the presence or absence of concurrent donor projects (either those that compete with the program or those that complement it), the receptivity of the community to participation, and the political, economic and cultural characteristics surrounding the project. Similar determinants have emerged as important for EHIS – for example, political commitment to the system, human resource and infrastructural constraints, physical and socioeconomic environment, alongside global determinants such as donor role, the technological environment, and institutional issues such as the project environment and knowledge management practices.

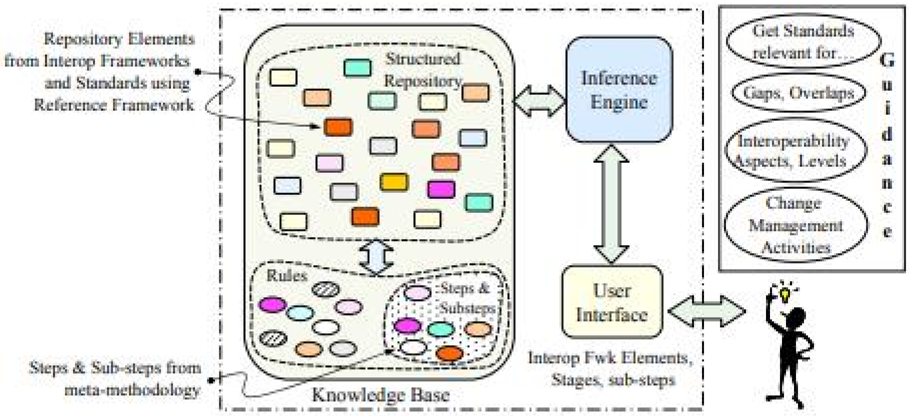
Sustainability framework: determinants of sustainability

Factor	Conditions hypothesized to result in greater sustainability
Program/project-specific factors	
Type/goal(s)	Programs/projects that are better able to demonstrate results, often by being more narrowly focused
Perceived effectiveness	Higher degree
Financing	Ability to secure multiple sources of non-donor financing, particularly from national sources (during or by end of program/project)
Training	Greater emphasis
Organizational factors	
Local-level modifiability	Greater local-level ability to modify implementation to local needs and conditions
Donor-client interactions	Characterized by joint participation/consensus-building
Donor-community interactions	Characterized by joint participation/consensus-building
Project champion	Existing and effective
Integration	Higher degree of integration within host institution, national health authority institution or activities, and/or recipient community needs/priorities
Institutional strength/capacities	Stronger
Contextual factors	
Concurrent projects/donor-supported activities	Fewer similar other programs/projects and/or minimization of competing health problems
Community characteristics	Higher receptivity to participation
Political, economic and cultural characteristics	Socio-political stability, economic stability/growth, higher governmental institutional capacity

Interoperability is typically defined as the ability of systems or components to exchange and use information. ISO 16100 defines manufacturing software interoperability as "the ability to share and exchange information using common syntax and semantics to meet an application-specific functional relationship". Thus, generally speaking, interoperability is the ability to work together effectively and to exchange information in a useful and meaningful way. While the term 'sustainability' is nowadays encompassing ecological, economical and ethical concerns, the focus in on the results, rather than on the means to achieve them. Thus, the main question is: Can one improve the sustainability of a given system by enhancing its capability to interoperate with its environment? The difference between integration and interoperability has been explained in ISO 14258, who describes three ways in which models could be related: (1) integration, with a standard or pivotal format to represent these models; (2) unification, with a common meta-level structure for semantic equivalence between these models; and (3) federation, when each model exists per se, with the mapping between concepts done at an ontology level to formalise interoperability semantics. Integration is generally considered to involve a degree of functional dependence and hence less flexibility. Integration also deals with organisational issues, albeit in a less formal manner owing to the human factor. Compatibility is something less than interoperability, where systems/units do not interfere with each other's functioning but are not able to exchange services. To conclude, interoperability lies in the middle of an ‘Integration Continuum’ between compatibility and full integration. It is important to distinguish between compatibility, interoperability and integration in order to have a meaningful debate on how to achieve them. The question is: is one able to make a similar analysis and demonstration relating to the three main facets of sustainability, i.e. Economic, Ecologic, Ethical / Social? From an Economical perspective, interoperability is an a priori property for the socalled ‘Network effect’. For larger networks, interoperability is a competitive weapon; they have nothing to gain by interoperating and thus their best strategy is to drive organic growth while waiting for smaller networks to ‘wither on the vine’. However, the mid-sized networks can gain market leadership by interoperating with each other; so the risk of this happening has to be weighed by the market leaders. In order for a market leader to establish an insurmountable lead, they would have to create interoperability with a smaller network (ideally the number 2 network) such that the combined value of all remaining competing networks would not be a threat. In this way, interoperability is contributing to the sustainability of the systems that need a capacity to interoperate by improving their economic competitiveness. From an Ecological perspective, interoperability is contributing to the so-called ‘Green Information Technology (IT) ’, which is a complex and still ‘fuzzy’ concept, partly due to the complexity and diversity of the IT applications and development. The goal of the IT-related economic development is differs regionally; for example, the European Union countries have devised a plan of ‘Green Knowledge Society’ to help promoting the application of the Green IT, since knowledge is the dominant element in the economic structure of EU. Green IT is especially useful for the improvement of the green production mode and the supervisory control in traditional industries, the reduction of the pollution emissions and the energy utilization. Recent research results suggest that when ICT is applied in other industries the amount of the energy saving is 5 times that of its own. Reducing the heterogeneity, improving the quality of data stored by IS and assessing the risks of poor interoperability can help ecological sustainability of those interoperable systems. From an Ethical perspective, interoperability is concerned with data privacy, information protection, trust and access control. Policy makers recognize the need for robust, protected data flows if the benefits of an information economy are to be realized. While the global flow of data is essential for innovation and economic growth, companies face significant challenges when attempting to comply with often conflicting requirements of diverse national and regional data protection laws and regulations. Emerging policies stress the need to create a streamlined system which allows for the smooth movement of data across regimes, in a manner that ensures that individuals and enterprises enjoy the protection afforded by local laws and regulations. That is the conundrum of sharing information: the information is essential to improve collaboration towards an economical benefit; however, on the other hand, sharing it presents the risk of possible loss, knowledge theft and protection rights.

Rules can then be added to enable querying the Structured Repository (SR) and thus transforming it into a knowledge base, as part of an expert system guiding standards creation and review in an integrated, collaborative and synergistic manner.

Standards interoperability is essential in promoting user acceptance, usability and efficient administration and maintenance; however, it is also a complex undertaking involving a multitude of aspects and levels, from infrastructure to politics and organisational culture of the custodian work groups. The proposed system provides a foundation towards a sustainable interoperability of standards – a benefit that will propagate to the enterprises and collaborative networks using the standards.



Sustaining Interoperability of Electronic Healthcare Records

The current fragmentation of health science along traditional boundaries is considered as inefficient, particularly when considered in the contemporary patient management context. The Virtual Physiological Human (VPH) is intended to address this issue by providing a framework that enables the integration of data and observations about human's biology. Today, VPH can be specialized to a subset of data, which is manageable in current healthcare settings. This subset of VPH data is an Electronic Health Record (EHR), defined as a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Sustainability of EHR is directly related to sustaining their interoperability, namely towards exhibiting the robustness to a change of environment in which EHR is used. That is, EHR is sustainable as long as different clinical IS can operate in the same way (or draw the identical conclusions) based on a single EHR; or, EHR is sustainable as long as the same clinical IS can operate in the same way on basis of the different representations of same EHR data. One of the related problems is that terminologies are not bound to EHR standards. Rector et al used ontology to bind HL7 messages to SNOMED-CT (Systematized Nomenclature of Medicine - Clinical Terms) codes; however, the semantic interoperability between the systems using the above standards is still an issue. The diversity of medical ontologies based on various conceptualization approaches makes mapping difficult. Two development approaches are 1) bottom-up formalization of the vocabularies and 2) semantic analysis of the clinical care and development of facilitating ontologies. Although the first approach is dominant in the research community, Beale and Heard argue that the starting point for a successful model is an ontological analysis of the healthcare delivery process. In fact, the diversity of conceptualization choices is not necessarily an issue. Bottom-up approaches and narrow scopes are characterized by decreased development time and thus, they contribute to the commoditization of the semantic technologies in a medical sector. The difficulties of integrating such ontologies (caused by implicitness) can be resolved by using upper ontologies. Schulz et al addressed logical and ontological issues of SNOMED; the well-known Ontology of Biomedical reality was developed as a result of the process of vertical integration of upper ontology (Basic Formal Ontology - BFO) and domain ontology. Although this approach introduces new artefacts into the context, the sustainability of an integrated knowledge is actually being increased. Due to its general approach in describing the world, one of the key features of the upper ontologies is the resilience to change. When formal models are considered, this resilience decreases with the used level of abstraction in their development. Similar conclusion can be drawn for the increase of the implicitness level, which is notable for more specialized ontologies. When upper ontologies are used in correlating different standards, the total number of mappings decreases. Hence, the effort needed for their maintenance is reduced. Partitioning can also help the maintainability of the ontological framework. Besides the computational performance benefits, this decoupling allows developers to compensate for these failings without compromising the underlying models. Clearly, one approach to achieve sustainability would be to identify and maintain the mappings between the concepts of the different EHR standards in their native forms. However, this approach itself would not be sustainable because of decreased scalability of such mappings and high maintenance effort required. Another approach is related to defining and associating the formally defined meanings to the EHR concepts. Hence, the robustness of EHR would be drawn from the capability of systems to interpret the semantic similarities or differences of the EHR concepts, based on their formal representations. The inference capability of these systems would allow the logical correspondences between two representations to be computed on the basis of the relationships between the concepts of the respective representations and the concepts of formal ontologies.

Virtualisation: addressing Interoperability and Sustainability in Distributed Manufacturing

Manufacturing can be defined as a process composed of activities performed using various resources and aimed at transforming a form of matter into another for a given scope (typically responding to a set of customer requirements). There is significant scientific interest in making manufacturing sustainable, as unfortunately it is currently one of the most important causes of global resource depletion. This challenge is compounded by the current distribution of activities and processes; this requires interoperability of the activities along the distributed manufacturing chain. As a reaction to this challenge, the new paradigm of Virtual Manufacturing (VM) has emerged in the last decades as an improved capability of sharing and managing knowledge and synchronizing cooperation activities in a form useful to the human decision factors. The improvements in sensor technologies (hardware) as well as in simulation facilities (software) have been the key driver of this 'soft revolution', making the use of IT and computer simulation more effective in modelling real world manufacturing processes for the purpose of understanding and controlling them. The origins of virtual reality can be traced as far back at least as 'the ultimate display', allowing a user to 'step through' the computer screen into a three dimensional (3D) world. Thus, with the advance of computer technology, VM turned into a way to reduce the time and cost involved in decision making and simulation (and thus covering the entire product lifecycle, from conceptualization to production). The user can look at, move around, and interact with the virtual world as if they were real. An essential question is how and to what extent could VM (as a breakthrough technology to support interoperability in manufacturing) contribute towards achieving sustainability along the manufacturing chain? Given the scarcity of bibliographical references, a possible viewpoint to address this new question is to refer to the very nature of VM, which is in fact synonymous to simulation of the manufacturing processes. Simulation is defined as experimentation (using some model) on a system of interest, whether existing or not. Simulation helps reduce uncertainty in the decision making process by allowing to explore several alternatives with relatively low costs and by presenting knowledge about projected artefacts on various levels of abstraction. In other words, when dealing with VM one adopts a computer system to generate information about the structure, status, and behaviour of a manufacturing system (whether existing or not) as if it was in a real setting, i.e. to provide a capability to 'manufacture in the computer'. In this context, the VM connection to sustainability becomes obvious; VM has the potential to provide a modelling and simulation environment allowing the sustainability of fabrication/assembly of any product, including the related manufacturing processes, to be assessed by computer simulation. For example, one can in measure the energy required to manufacture, or can estimate the amount of material and its footprint from well-known databases, or even foresee potential improvements by adopting different materials. Furthermore, it can be shared with other suppliers along the distributed manufacturing chain, even in absence of a predetermined standard. In this context, a new concept can be introduced, Virtual Sustainability (VS) that can be defined as feature of a product/process obtained by the grace of the above-said virtual paradigm. Provided adequate tools are available, one can assess the sustainability of processes or products before any concrete action is taken, in a preconceptual stage and independently of the manufacturing chain stage. It is only a matter of the quality and power of modelling and simulation tools, techniques and applications to offer new opportunities to evaluate the impact on resource consumption and environment because of these features. Virtual sustainability then reflects into 'real sustainability' as products or processes implemented in the real world can be improved to address economical, environmental or even social pillars, since VM application can encompass the entire life cycle of a product or process. In order to clarify the VS concept, one can refer to three stages of representation of knowledge and information of an entity as: digital, virtual and real. A digital entity is the representation of the digital information, such as a knowledge model of the entity. The virtual representation of an entity is its representation within a domain for validation purposes, where the link between digital and virtual can be a reference architecture. Finally, the real entity is the implemented actual test scenario and thus reflects the former stages. Whatever the entity we are reasoning about (be a manufacturing system, a process, a product) or its features related to sustainability, it is quite clear that virtualisation is simply a indissoluble part of the same continuum formed by interoperability and sustainability before recalled.

Control Systems for Sustainability, Sustainable Control Systems

In the context of the fundamental changes to environmental, social and lifecycle requirements we currently have to deal with, the legacy isolated control system concepts have to be overlapped in order to create better systems where the concept of boundaries disappear. The following shows the control techniques basic laws that are used in Control Systems for Sustainability and Sustainable Control Systems. Thus, Intelligent control uses various Artificial Intelligence computing approaches; Optimal control is a particular control technique in which the control signal optimizes a certain cost index; Robust control deals with uncertainty in its approach to controller design; Adaptive control uses on-line identification of the process parameters, or modification of controller gains; Hierarchical control arranges a set of devices and governing software in a hierarchical tree; Stochastic control deals with control design with uncertainty in the model and Energy-shaping control views the plant and the controller as energy-transformation devices. The basic considerations for defining Control Systems for Sustainability and Sustainable Control Systems are presented in a new control system concept named Sustainable Control System for Sustainability (SCSFS). This design has to include the primary and secondary factors that are presented below:

1. Defining the control systems limits by the carrying capacity of the environment.

2. Taking account the effect o the social necessities

3. Respecting life forms and supports biodiversity in the design; accidents leading to environmental concerns are key focus areas for governments and public alike;

4. Employing ecological decision-making systems inside the control laws;

5. Creating balanced, open and flexible control laws that incorporate the social, economic and environmental factors as a unique solution;

6. Using global control efforts and natural resources;

7. Appling renewable and reliable sources of energy in the control system;

8. Eliminating harm to the environment from the controller;

9. Designing control systems that use long lifetime cycles;

10. Guarantee the sustainability of the controller during a long period of time for future control systems developments;

11. Employing economical decision-making systems inside the control system;

12. Developing a self-categorization control system, including methodologies for lifetime cycle stages;

13. Utilizing the lifetime cycle stages as a dependent variable in the controller;

14. Generating a positive impact on the life cycle during early control design stage;

15. Developing an integrated control system that includes a cost management function. This is because non-common operating point and maintenance controller strategies are rarely planned at the design phase, so those could affect the lifetime.

16. Adopting new controller technologies to maintain competitive advantage.

The concept of life cycle is a key factor for designing Control Systems for Sustainability and Sustainable Control Systems. It is important to include all the aspects of life cycle: economical, environmental, social, and society, but also controller performance, scalability, reconfiguration and integration. The intention of controls systems for sustainability is to eliminate negative environmental impact completely through skilful, sensitive and sustainable control design and minimum impact on the environment during system operation. The control system concepts are included in the process design for improving the overall performance of the system. It is expected that the proposed SCSFS based on the above-mentioned principles and concepts will provide suitable solutions for the challenges posed by the next generation of control systems.

Sustainability and Interoperability of Negotiation Processes

In a globalised and networked market, businesses face the struggle to perform better and faster, using new approaches and techniques and optimising their way in order to stay in business. In the light of this highly competitive and demanding environment, the establishment of strategic partnerships and outsourcing are common practices that frequently compete with in-house development. To reach a sustainable operation, companies need to continuously negotiate to create and maintain interoperability supported by an appropriate knowledge management framework. Negotiation of tasks and jobs implementation is therefore a task that plays a crucial part on its business evolution. Negotiations often involve several heterogeneous parties, external and internal, using different tools, languages, platforms and Information and Communication Technologies (ICT); hence, several internal company areas compete or collaborate with external parties for the development of a project, or outsource parts of it. Best practices specify that decision analysis must convey a thorough documentation, evaluation and analysis of the alternative solutions in order to reach the best solution and learn from it. On the other hand, the various parties involved in the negotiation need to be interoperable, sharing business, technical data and information seamlessly. This requires a framework for sustainable interoperability of negotiation processes, using formal description (modelling) to support the coordination of multiple parallel negotiations occurring in business-to-business interactions and offering mechanisms to support negotiations in a distributed environment. This includes a set of hierarchically layered and distributed components that implement the rules of the modelled negotiation and also handle the interoperability aspects of the negotiation. A sustainable, flexible and generic approach towards the implementation of the underlying infrastructure can be provided by a Cloud web-service-based platform (e.g. Software as a Service, SaaS). Such infrastructures and service provider platforms allow subscribing to processing that matches the negotiation environment needs. The framework's top layer (Negotiation Manager) is targeted to the Manager of each negotiation party. It handles all business decisions that need to be taken (e.g. proposal, acceptance of proposal, rejection of proposal, invite of another party to take part in the negotiation) and analyses and manages the negotiated parameters, communicating with the lower layers using web-services. A second layer is dedicated to the Coordination Services (CS) which assist the negotiations at a global level (negotiations with different participants on different jobs) and at a specific level (negotiation on the same job with different participants) handling all issues regarding communication at this layer level. The CS shall also handle the on-going transactions and manage the persistence for the status of the negotiation sequences. To improve the interoperability, data shall be exchanged using the standard protocol ISO10303 STEP. This layer is also responsible for handling semantic discrepancies between the negotiating parties via the use of one or more ontologies and may include an agent-based architecture to support the complexities of the negotiation operations through the Middleware layer. These middleware services shall provide support for performing all aspects related with basic infrastructure, and handling the heterogeneity related with multiple negotiation players; it may also include publication of the job requirements and characteristics, in order to allow potential companies interested in participating to 'subscribe' to it and be able to enter the negotiation. Each negotiation is organised in three main steps: initialisation; refinement of the job under negotiation; and closure. The initialisation step allows to define what has to be negotiated (Negotiation Object) and how (Negotiation Framework). In the refinement step, participants exchange proposals on the negotiation object trying to satisfy their constraints. Closure concludes the negotiation. To manage all issues regarding semantics between the negotiating parties, an ontology can handle generic negotiation terms not bound to any specific business, as well as using dedicated ontologies to handle semantics related to negotiated items. To foster a higher independence of external factors, the services and infrastructure are modelled in a Model-Driven Architecture (MDA) Platform-Independent Model (PIM) defining the basic foundations of the framework, which is then transformed into the final Platform-Specific Model (PSM) set of services.