Applications and Practical Systems for Healthcare

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1. Data Analytics for pervasive health

- Pervasive health refers to the process of tracking medical well-being and providing long-term medical care with the use of advanced technologies such as wearable sensors.
- For example, wearable monitors are often used for measuring the long-term effectiveness of various treatment mechanisms.
- These methods, however, face a number of challenges

1. knowledge extraction from the large volumes of data collected and real-time processing. However, recent advances in both hardware and software technologies (data analytics in particular) have made such systems a reality. These advances have made low cost intelligent health systems embedded within the home and living environments a reality

- A wide variety of sensor modalities can be used when developing intelligent health systems, including wearable and ambient sensors. In the case of wearable sensors, sensors are attached to the body or woven into garments, (smart fabrics).
  For example, 3-axis accelerometers distributed over an individual's body can provide information about the orientation and movement of the corresponding body part. In addition to these advancements in sensing modalities, there has been an increasing interest in applying analytics techniques to data collected from such equipment.

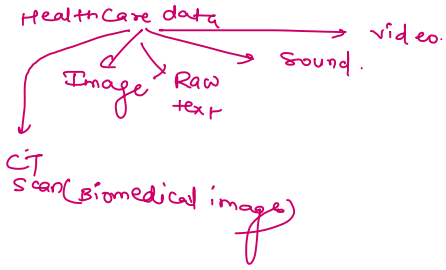
Advantages :-

- Several practical healthcare systems have started using analytical solutions.
  Some examples include cognitive health monitoring systems based on activity recognition, persuasive systems for motivating users to change their health and wellness habits, and abnormal health condition detection systems } uses analytical solutions.

Healthcare Fraud Data

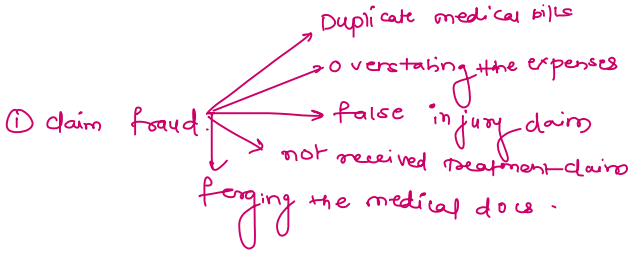
WHAT IS THE CHARACTERISTICS OF HEALTHCARE DOMAIN DATA?

- Complexity and number of fields in these kind of data are tremendous. (many fields are involved).
- The people or organizations attends to make profit to others.
- Data is really BIG and sometimes stream
- Many kinds of data like: Image, Raw Text, Sound, ...
- Data are not labeled and hard to classification
- Concept drifting



SOME FRAUDS THAT TRADITIONAL HEALTHCARE SYSTEMS USED TO FACE WITH

- Changing patient's insurance identification document → (1) claim fraud
- Prescribing some fixed brands of drugs by a Dr
- Prescribing expensive drugs than what is usual for same disease (option for generic medicine)
- getting some kinds of drugs by a patient more than usual
- and many more...



Statistical Methods

- Uses some rules
- Rules are described by a domain expert
- Creating application to initial statistical parameters ex:
  - Count average of drugs in every prescription
  - Total price of every disease
- Then they can be compared with new data. If high difference found, ALARM GOES OFF

examples of statistical parameters.

CONS AND PROS

- It's very simple and easy to implement
- Low computation overhead
- Very easy to use for stream data
- Low flexibility
- Can't be used for data concept drifting
- Adding rules is hard
- Every thing is based on domain expert knowledge
- It's possible that defined solution wouldn't be complete

MACHINE LEARNING ALGORITHMS for fraud detection

- Choosing one or more machine learning algorithm based on the data
- Use them for learning and detecting frauds
- If (data are labeled) classification is perfect idea
- Else clustering
- Or using clustering (1) to labeling (2) and the using classifications (3).

GRAPH BASED FRAUD DETECTION

GRAPH ANALYSIS

ML Algo + Graph analysis ⇒ Fraud detection system.

- It has been going popular since 2015
- It's still just a assistant system to get along with machine learning algorithms
- It can't consider all aspects ← Disadvantage
- But handy ← Advantage of graph analysis.

Data Analytics for Pharmaceutical Discoveries

- The cost of successful novel chemistry-based drug development often reaches millions of dollars, and the time to introduce the drug to market often comes close to a decade.
- The high failure rate of drugs during this process, make the trial phases known as the "valley of death."
- Most new compounds fail during the FDA approval process in clinical trials or cause adverse side effects.
- Interdisciplinary computational approaches that combine statistics, computer science, medicine, chemoinformatics, and biology are becoming highly valuable for drug discovery and development.
- In the context of pharmaceutical discoveries, data analytics can potentially limit the search space and provide recommendations to the domain experts for hypothesis generation and further analysis and experiments.

outcome variable - BP

- Data analytics can be used in several stages of drug discovery and development to achieve different goals. In this domain, one way to categorize data analytical approaches is based on their application to pre-marketing and post-marketing stages of the drug discovery and development process.
- In the pre-marketing stage, data analytics focus on discovery activities such as finding signals that indicate relations between drugs and

targets, drugs and drugs, genes and diseases, protein and diseases, and finding biomarkers. In the post-marketing stage an important application of data analytics is to find indications of adverse side effects for approved drugs.

- These methods provide a list of potential drug side effect associations that can be used for further studies.

Clinical Decision Systems

Definition

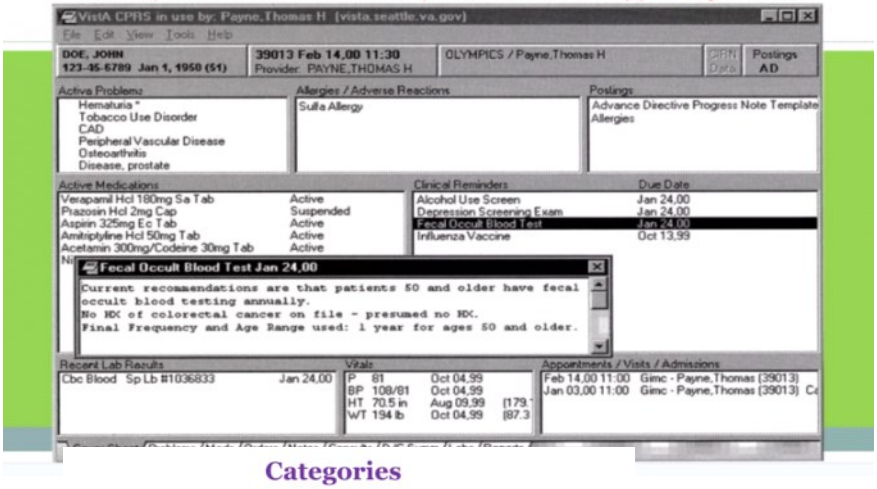
defn for CDS

- A *clinical decision-support system* is a computer program designed to help health professionals make clinical decisions.
- Is *a* computer system that deals with clinical data or medical knowledge is intended to provide decision support.

Definition:

- **an interactive Expert system Computer Software, which is designed to assist physicians and other health professionals with decision making tasks such as diagnosing and designing the treatment plan for a disease** (Prescribing medicine)
- **active knowledge systems in which they use two or more items of patient data to generate case specific advice**

Examples of Successful Computer Decision Support Systems



Categories

- Diagnostic assistance
- Therapy critiquing and planning
- Image recognition and interpretation

Tools for CDS

1- Tools for Information Management

- **Examples:**
  - Hospital information systems
  - Bibliographic retrieval systems (PubMed)
  - Specialized knowledge-management workstations (e.g. electronic textbooks, ...)
- **These tools provide the data and knowledge needed, but they**

2- Tools for Focusing Attention

- **Examples:**
  - Clinical laboratory systems that flag abnormal values or that provide lists of possible explanations for those abnormalities.
  - Pharmacy systems that alert providers to possible

3- Tools for Patient-Specific Consultation

- **Provide customized assessments or advice based on sets of patient-specific data:**

- Hospital information systems
- Bibliographic retrieval systems (PubMed)
- Specialized knowledge-management workstations (e.g. electronic textbooks, ...)

- These tools provide the data and knowledge needed, but they do not help to *apply* that information to a particular decision task (particular patient)

- Examples:
  - Clinical laboratory systems that flag abnormal values or that provide lists of possible explanations for those abnormalities.
  - Pharmacy systems that alert providers to possible drug interactions or incorrect drug dosages.
- Are designed to remind the physician of diagnoses or problems that might be overlooked.

- Provide customized assessments or advice based on sets of patient-specific data:
  - Suggest differential diagnoses
  - Advice about additional tests and examinations
  - Treatment advice (therapy, surgery, ...)

Challenges to Implementation of CDSS

1. Clinical challenges:
   - No clinical database stores all information that is self sufficient or complete
   - Computers can assist but can't replace human
   - Lack in integration of components of CDSS
   - Deficiency in planning for how the clinician will actually use the product in situation
   - CDSSs that are aimed at the diagnostic tasks have found success but are often very limited in utilization and scope

2. Technical challenges:
   - difficulty in incorporating the extensive quantity of clinical research being published on an ongoing basis
   - Biological systems are complicated, and a clinical decision may utilize an enormous data

3. Cost and Evaluation:
   - Different CDSSs serve for different purposes, there is no common method which applies to all such systems

4. Alert fatigue:
   - When clinicians are exposed to too many clinical decision support alerts they may eventually stop responding to them.
   - The alert was not serious, was irrelevant, or was shown repeatedly

Computer-Aided Diagnosis

- Computer-aided diagnosis/detection (CAD) is a procedure in radiology that supports radiologists in reading medical images .
- CAD tools in general refer to fully automated second reader tools designed to assist the radiologist in the detection of lesions.
- There is a growing consensus among clinical experts that the use of CAD tools can improve the performance of the radiologist.

- The radiologist first performs an interpretation of the images as usual, while the CAD algorithms is running in the background or has already been precomputed. Structures identified by the CAD algorithm are then highlighted as regions of interest to the radiologist. The principal value of CAD tools is determined not by its stand-alone performance, but rather by carefully measuring the incremental value of CAD in normal clinical practice, such as the number of additional lesions detected using CAD.

- Secondly, CAD systems must not have a negative impact on patient management (for instance, false positives that cause the radiologist to recommend unnecessary biopsies and follow ups).

- From the data analytics perspective, new CAD algorithms aim at extracting key quantitative features, summarizing vast volumes of data, and/or enhancing the visualization of potentially malignant nodules, tumors, or lesions in medical images. The three important stages in the CAD data processing are candidate generation (identifying suspicious regions of interest), feature extraction (computing descriptive morphological or texture features), and classification (differentiating candidates that are true lesions from the rest of the candidates based on candidate feature vectors).

CAD- Case Study https://www.slideshare.net/slideshow/ct-computer-aided-diagnosis-system/45524220

https://slideplayer.com/slide/4582992/

Mobile Imaging for Biomedical Applications

- Mobile imaging refers to the application of portable computers such as smartphones or tablet
- computers to store, visualize, and process images with and without connections to servers, the Internet, or the cloud.
- Today, portable devices provide sufficient computational power for biomedical image processing and smart devices have been introduced in the operation theater. While many techniques for biomedical image acquisition will always require special equipment, the regular camera is one of the most widely used imaging modality in hospitals.
- Mobile technology and smart devices, especially smartphones, allows new ways of easier imaging at the patient's bedside and possess the possibility to be made into a diagnostic tool that can be used by medical professionals.
- Smartphones usually contain at least one high-resolution camera that can be used for image formation. Several challenges arise during the acquisition, visualization, analysis, and management of images in mobile environments.