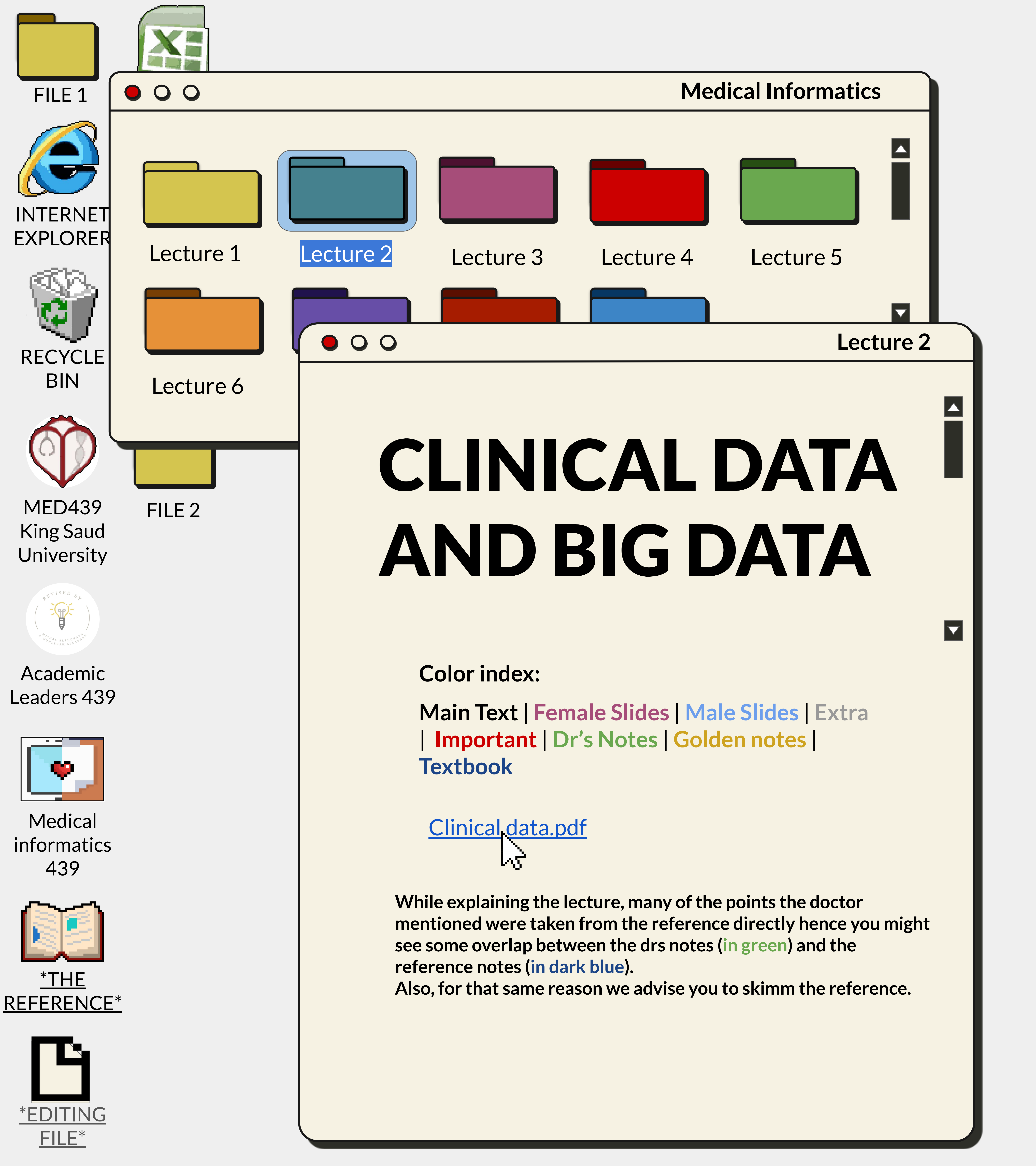


CLINICAL DATA AND BIG DATA

Color index:

Main Text | Female Slides | Male Slides | Extra | Important | Dr's Notes | Golden notes | Textbook

Clinical data.pdf

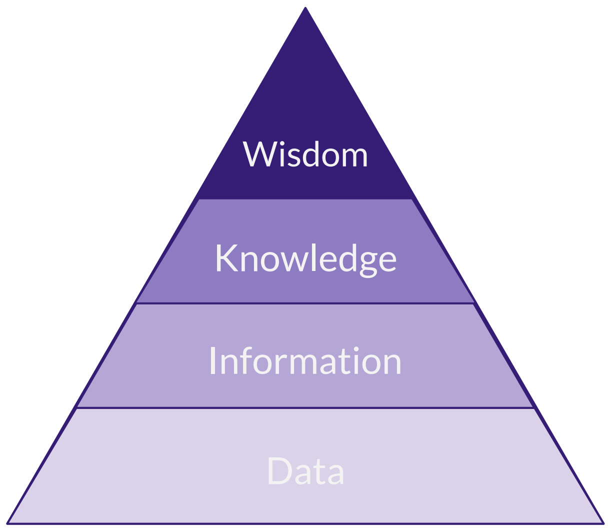
While explaining the lecture, many of the points the doctor mentioned were taken from the reference directly hence you might see some overlap between the drs notes (in green) and the reference notes (in dark blue).
Also, for that same reason we advise you to skimm the reference.

Outlines:

- Define data, information, and knowledge
- Types of clinical data
- Informatics vs. Information Technology and Computer Science
- Data to information
- Information to Knowledge
- Clinical Data Warehouse
- Use of Aggregated Clinical Data
- What Makes Informatics Difficult?
- Big data.

Data:

- **Data:** are symbols or observations reflecting differences in the world. (e.g. 5)
- **Information:** is data with meaning. (If we added the word “fingers” to number 5. “5 fingers”, now it has a meaning)
- **Knowledge:** is information that is justifiably believed to be true. (elevation in FBG level, the likelihood of diabetes is increased. Smokers are likely to develop lung cancer more than non-smokers)
- **Wisdom:** is the critical use of knowledge to make intelligent decisions.



Each zero or one is a bit, each 8 bits equal a byte

Bits can occur as various data types:

- Integers (numbers ex: 14)
- Floating point numbers (decimals)
- Characters (A-Z)
- Character strings (ex: words)

Note that these data types do not define meaning.
A computer does **not** “know” whether 3.14159 is a random number or the ratio of the circumference to the diameter of a circle (known as Pi or π).

File format:

Data are aggregated in many file formats, which makes sharing files possible.

- image files (JPG, GIG, PNG)
- text files
- sound files (WAV, MP3)
- video files (WMV, MP4)

Common or standardized file formats allow sharing of files between computers and between applications. For example, as long as your digital camera stores photos as JPG files, you can use any program that can read JPG files to view your photos.

it is important to recognize that neither data types nor file formats define the meaning of the data.

Clinical Data

Types of clinical data		
Narrative	Numerical measurements	Coded data
recording by clinician- maternity history	blood pressure, temperature , glucose level, heart rate.	selection from a controlled terminology system, anything that has a drop down menu.
Textual data	Recorded signals	Pictures
other results reported as text	EKG, EEG	radiographs, photographs, and other images

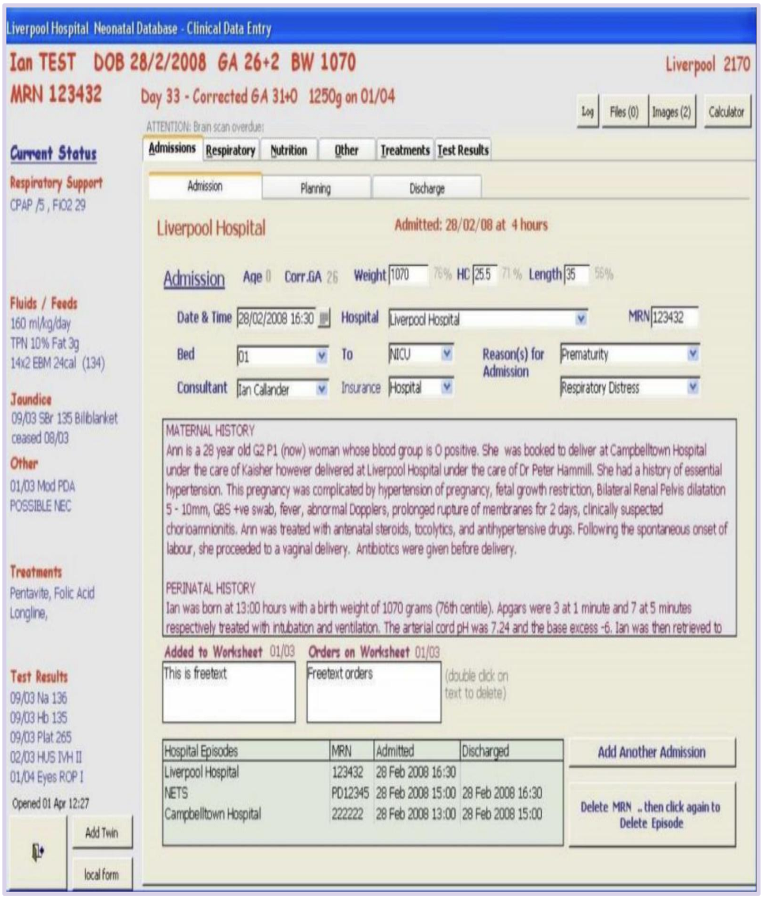
General categories of data entry:

- **Free-form** entry by historical methods:

○ Writing
○ Dictation
○ Typing

- **Structured (menu-driven) data** entry by mouse or pen.

- **Speech recognition** for either of above.



Ian TEST DOB 28/2/2008 GA 26+2 BW 1070 Liverpool 2170
MRN 123432 Day 33 - Corrected GA 31+0 1250g on 01/04

ATTENTION: Brain scan overdue:

Current Status

Respiratory Support
CPAP /5 , FiO2 29

Fluids / Feeds
160 ml/kg/day
TPN 10% Fat 3g
14x2 EBM 24cal (134)

Jaundice
09/03 SBr 135 Bilblanket
ceased 08/03

Other
01/03 Mod PDA
POSSIBLE NEC

Treatments
Pentavite, Folic Acid
Longline,

Test Results
09/03 Na 136
09/03 Hb 135
09/03 Plat 265
02/03 HUS IVH II
01/04 Eyes ROP I

Opened 01 Apr 12:27

Liverpool Hospital Admitted: 28/02/08 at 4 hours

Admission Age 0 Corr.GA 26 Weight 1070 76% HC 25.5 71 % Length 35 56%

Date & Time 28/02/2008 16:30 Hospital Liverpool Hospital MRN 123432
Bed 01 To NICU Reason(s) for Admission Prematurity
Consultant Ian Callander Insurance Hospital Respiratory Distress

MATERNAL HISTORY
Ann is a 28 year old G2 P1 (now) woman whose blood group is O positive. She was booked to deliver at Campbelltown Hospital under the care of Kaisher however delivered at Liverpool Hospital under the care of Dr Peter Hammill. She had a history of essential hypertension. This pregnancy was complicated by hypertension of pregnancy, fetal growth restriction, Bilateral Renal Pelvis dilatation 5 - 10mm, GBS +ve swab, fever, abnormal Dopplers, prolonged rupture of membranes for 2 days, clinically suspected chorioamnionitis. Ann was treated with antenatal steroids, tocolytics, and antihypertensive drugs. Following the spontaneous onset of labour, she proceeded to a vaginal delivery. Antibiotics were given before delivery.

PERINATAL HISTORY
Ian was born at 13:00 hours with a birth weight of 1070 grams (76th centile). Apgars were 3 at 1 minute and 7 at 5 minutes respectively treated with intubation and ventilation. The arterial cord pH was 7.24 and the base excess -6. Ian was then retrieved to

Added to Worksheet 01/03: This is freetext
Orders on Worksheet 01/03: Freetext orders
(double click on text to delete)

Hospital Episodes	MRN	Admitted	Discharged
Liverpool Hospital	123432	28 Feb 2008 16:30	
NETS	PD12345	28 Feb 2008 15:00	28 Feb 2008 16:30
Campbelltown Hospital	222222	28 Feb 2008 13:00	28 Feb 2008 15:00

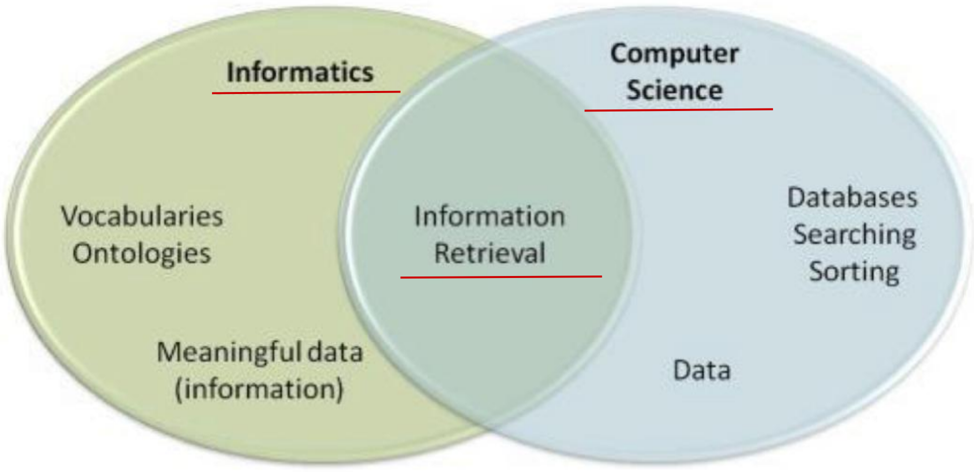
Informatics and Computer Science

Important

What is the domain of computer science? DATA! (Meaningless)
What is the domain of informatics? Information. (Meaningful)

Data are the domain of computer scientists and IT technologist, but information is the domain of informatics and informaticians
(The meaning of the data is of secondary importance to computer scientists).

-so we can say that computer science deals with meaningless data.



Information retrieval:
involves both **computer science** (data) and informatics (information).

-Information retrieval is defined as finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need by retrieving documents from large collections (usually stored on computers).
-example of information retrieval task: find the relationship between heart attacks and aspirin > all records will be retrieved.
-Notice that informaticians are concerned with vocabularies and ontologies as they deal with meaningful data (information).
-To an informatician, computers are tools for manipulating information, like other tools such as pens, papers and cards.

Clinical Data

Artificial Intelligence (AI)

- AI is concerned with the development of systems that can do something that previously required human intelligence. (chess, driving vehicles)
- **Example in medicine:** derma skin lesions categorization. This system was developed by Stanford university and it can categorize images of skin lesions to benign and malignant. This is done by training the system. Large data sets (images) are inserted with labels (benign, malignant,...). And then data sets (images) are added without labels.
- The system tries to learn to be able to identify lesions.

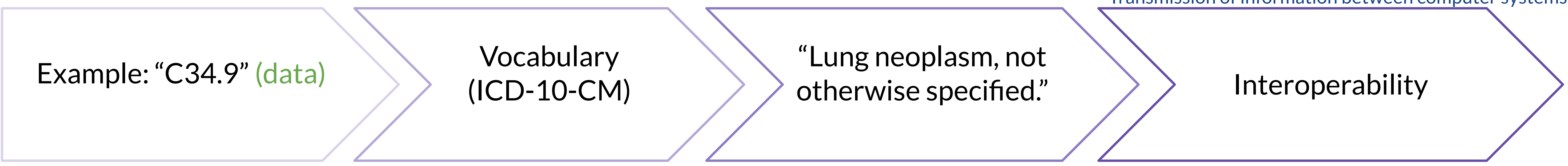
  Limitations:

  1- It requires large sets of labeled data to train the system.

  2-Cannot justify judgment (why did it classify this picture as benign?).

Data to information

Interoperability:
Transmission of information between computer systems.


Example: "C34.9" (data)

Vocabulary (ICD-10-CM)

"Lung neoplasm, not otherwise specified."

Interoperability

Explanation: C34.9 is code for lung cancer in computers. However, this Datum is of no meaning **if we didn't link it to a known vocabulary**. The computer still stores only data, not information

- **ICD:** International Classification of Disease, 10 is the version.
- **Interoperability:** Ability of two or more systems or components to exchange the information and use the information that has been exchanged. (ex: medical record at hospital A, sends information to a medical record at hospital B without losing this information).

Information to knowledge

Two types of data:

- **Unstructured (free text)** **such as discharge summaries or pathology reports.** (simple human language ex: history).
- **Structured data.** **may include billing codes, lab results (e.g., Sodium = 140 mg/dl).** (from *drop down menus* such as; billing codes, lab results, problem nests and medication nests).

- **Advantages and disadvantages :**

(ex: retrieval of all patients medical records that are in ICD-10-CM system with the same disease such as breast cancer).

	Structured Data	Unstructured
Advantages	**Much easier to manage.**	able to express anything
Disadvantages	may not accurately reflect clinical reality	may be difficult to convey with a "one size fits all" vocabulary

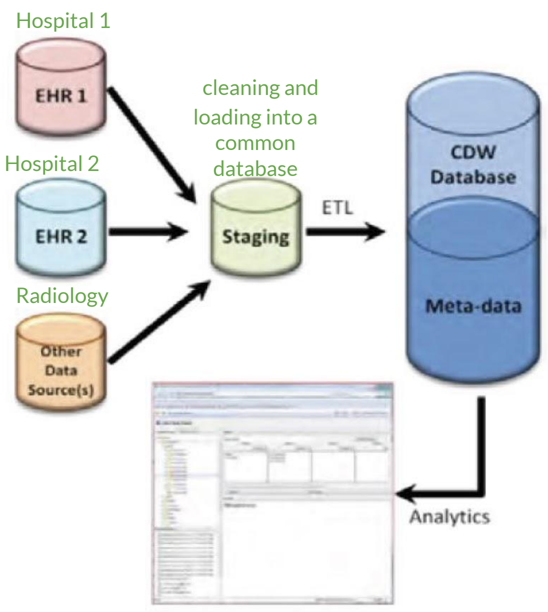
***Natural language processing (NLP):**

It's used to make computers understand unstructured data .

(Takes the natural human language as an input, process it (low level processing: assigns the part of speech to words "verb, noun" while high level processing such as Siri).

Clinical Data Warehouse Important

A modern **way to convert medical information to knowledge** is to use a clinical data warehouse (CDW).	
Function	a database system that collects, integrates and stores clinical data from a variety of sources including electronic health records (**EHR**), radiology and other information systems.
Staging	the process of cleaning the data from any incorrect or missing values.
Meta-Data	"data about data" example: ICD-10-CM
Difference between EHR&CDW	● EHR: are systems implemented in hospitals that focus on individual data for one patient. -Address real time updates regarding patient data ● CDW: support many EHR, focus on group query. - Information update depends on how often it is updated (monthly, weekly,... unlike EHRs, they're designed to support real-time updating and retrieval of individual data



Uses

If you want to retrieve all women who are 40 years or older what will you use? CDWs

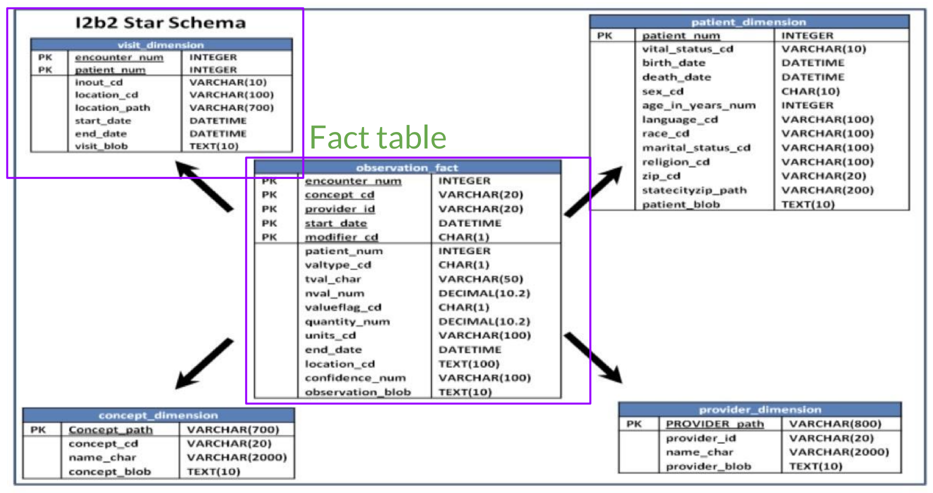
- **Monitor Quality** by allowing users to query for specific quality measures. e.g. retrieve all women who are 40 years or older who have not had a mammogram in the past year
- Identify trends.
- Comparative effective research: practice based research, answers very specific questions. (is the treatment A better than treatment B? We can answer this question by looking for the prognosis of people who were treated with both in the system)

i2b2[1] platform (an example of CDW)

- A harvard project to integrate biology and the bedside used by other institutes.
- Its an open source and modular and incorporate genomic and clinical information for research purposes.
- Database consists of **facts** (diagnoses, lab results, etc.) queried by users and dimensions that describe the fact.
- **Design**: star scheme
  - In the middle there is a fact table (quantitative, information).
  - On the side dimension tables (more information about these facts)
  - Dimensions tables provide qualitative information that answer (where, when and what)

Dimensions table

Fact table



I2b2 Star Schema

visit_dimension		
PK	encounter_num	INTEGER
PK	patient_num	INTEGER
	inout_cd	VARCHAR(10)
	location_cd	VARCHAR(100)
	location_path	VARCHAR(700)
	start_date	DATETIME
	end_date	DATETIME
	visit_blob	TEXT(10)

observation_fact		
PK	encounter_num	INTEGER
PK	concept_cd	VARCHAR(20)
PK	provider_id	VARCHAR(20)
PK	start_date	DATETIME
PK	modifier_cd	CHAR(1)
	patient_num	INTEGER
	valtype_cd	CHAR(1)
	tval_char	VARCHAR(50)
	nval_num	DECIMAL(10.2)
	valueflag_cd	CHAR(1)
	quantity_num	DECIMAL(10.2)
	units_cd	VARCHAR(100)
	end_date	DATETIME
	location_cd	TEXT(100)
	confidence_num	VARCHAR(100)
	observation_blob	TEXT(10)

patient_dimension		
PK	patient_num	INTEGER
	vital_status_cd	VARCHAR(10)
	birth_date	DATETIME
	death_date	DATETIME
	sex_cd	CHAR(10)
	age_in_years_num	INTEGER
	language_cd	VARCHAR(100)
	race_cd	VARCHAR(100)
	marital_status_cd	VARCHAR(100)
	religion_cd	VARCHAR(100)
	zip_cd	VARCHAR(20)
	statecityzip_path	VARCHAR(200)
	patient_blob	TEXT(10)

concept_dimension		
PK	Concept_path	VARCHAR(700)
	concept_cd	VARCHAR(20)
	name_char	VARCHAR(2000)
	concept_blob	TEXT(10)

provider_dimension		
PK	PROVIDER_path	VARCHAR(800)
	provider_id	VARCHAR(20)
	name_char	VARCHAR(2000)
	provider_blob	TEXT(10)

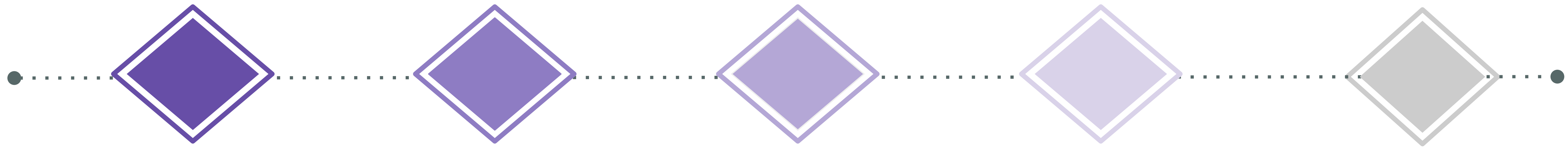
Use of Aggregated Clinical Data

- **Concept extraction**: the problem of identifying concepts within unstructured data, such as discharge summaries or pathology reports. غالبا يكون مربوط ب control vocabulary
  - Usually, these concepts are mapped to a controlled vocabulary.
- **Classification**: the problem of categorizing data into two or more categories.
  - Supervised machine learning. مثل سستم جامعة ستانفورد.

I2B2 stands for "informatics for integrating Biology & Bedside".

What Makes Biomedical Informatics Difficult?

Answer: "semantic gap" between data and information.



Incomplete information.
e.g.
unconscious patient in the ER. we don't know their past history.

Uncertain information.
e.g.
عدد الأطفال بالسعودية
We can only estimate the answer using statistics.

Imprecise information.
e.g.
"pneumonia"
We need to know more
Viral? Bacterial?

Vague information.
e.g.
Tall, big, eldery.

Vague information: information that includes quantifiers that permit boundary cases.

Inconsistent information
Ex: Birthdate: 8/29/66 and 9/17/66.

يعني احنا نعرف الفرق
بين التاريخين بسيط
وممكن نتغاضى عنه بس
الكمبيوتر مايعرف

As illustrated in the example, all these imperfections may be found in healthcare. And humans can deal with these imperfections but computers cannot.

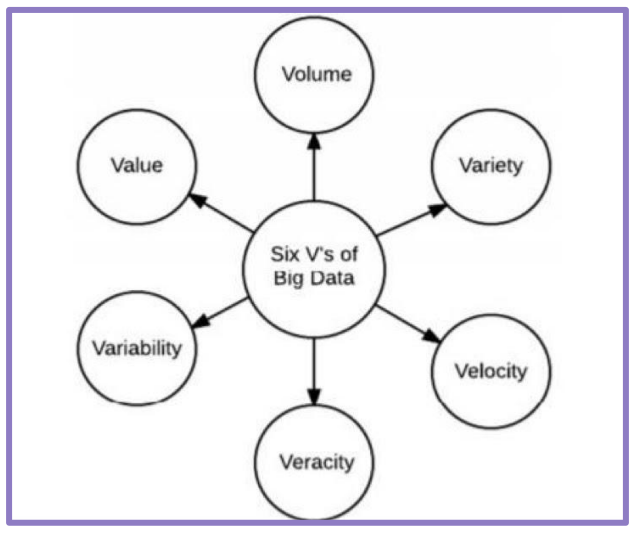
Big Data

Definition: collecting large collections of data from various healthcare foundations followed by storing, managing, analyzing, visualizing, and delivering information for effective decision making.

The Six V's of big data:

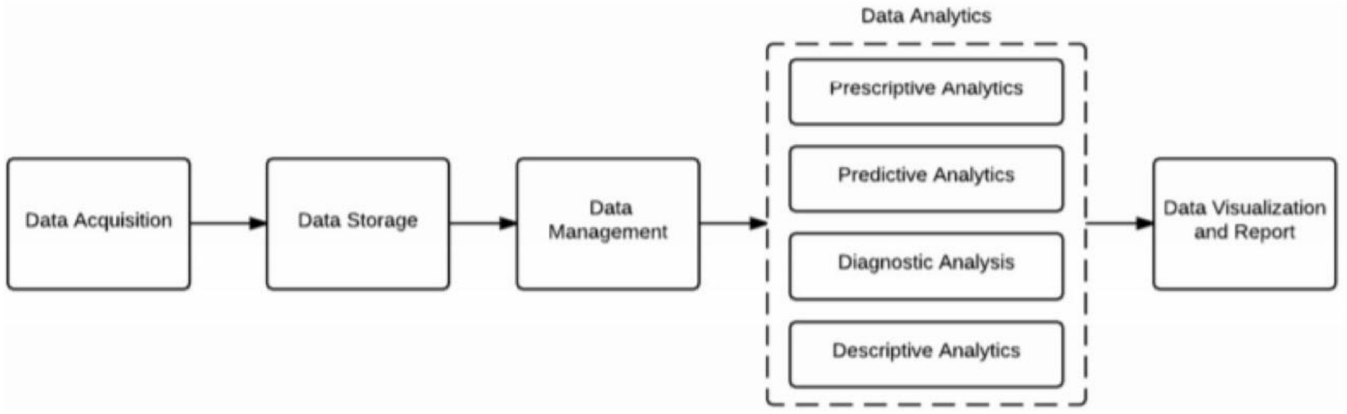
It's important to know the six V's and their definitions

Click here to read more about big data.



- **Volume**: large quantity of data produced by organization.
- **Variety**: a lot of sources in different formats, contribute in big data.
  - **Organized** (structured data: laboratory data, sensors data, data from databases).
  - **Semi-organized**: a combination of organized and unorganized (ex: website data and health records).
  - **Unorganized** "most common" (ex: social media data, medical records that doesn't use medical terminology).
- **Velocity**: massive frequency during the current details created, supplied and managed.
- **Veracity**: refers to accuracy of this data if it's accurate or valid (ex: in big data there is usually low veracity compared to other databases).
- **Variability**: data is fluctuating, changeable data, guidelines are changeable as well and might me updated so data might change during life.
- **Value**: methods of extracting valuable information from these data (big data analytics).

-Velocity includes both equivalent the rapidity of **data manufacture** and the rapidity of **data handling** to meet demand.
-Big data has low veracity, it can never be 100% accurate, and it is difficult to validate. Since most of the data comes from unknown sources.



Analysis: process of transforming raw data into information.

- **Stage 1 Data acquisition:** there are different sources (Electronic record, social media, smart phone, apps, websites… etc) to collect the data.
- **Stage 2 Storage:** store in cloud chambers.
- **Stage 3 Management:** organizing, cleaning and data mining to make sure that the data is valid, no missing data or values.
- **Stage 4 Analytics:**
  - Descriptive analysis: collects historical data, **what happened** in the health care?
  - Diagnostic Analysis: route cause of the problem, **why did it happen**?
  - Predictive Analysis: use both real time data and historical data, it has probabilities, **what will happen**? **what is the future trends.**
  - Prescriptive Analysis: number of different outcomes before the decision, what should we do? And **what is the best outcome**? And how we can make it happen?
- **Stage 5 Data visualization and reporting:** how will I represent these results? (ex: in graphs).

Conclusion

-Users must be able to "make sense" of clinical data; to make clinical data meaningful (data → information) and then learn from aggregated clinical data (information → knowledge)

-Computer scientists focus on data, while informaticists focus on information

-The transformation of information into knowledge is a primary goal of informaticists

-Clinical data warehouses are increasingly used to research clinical questions and generate knowledge from information

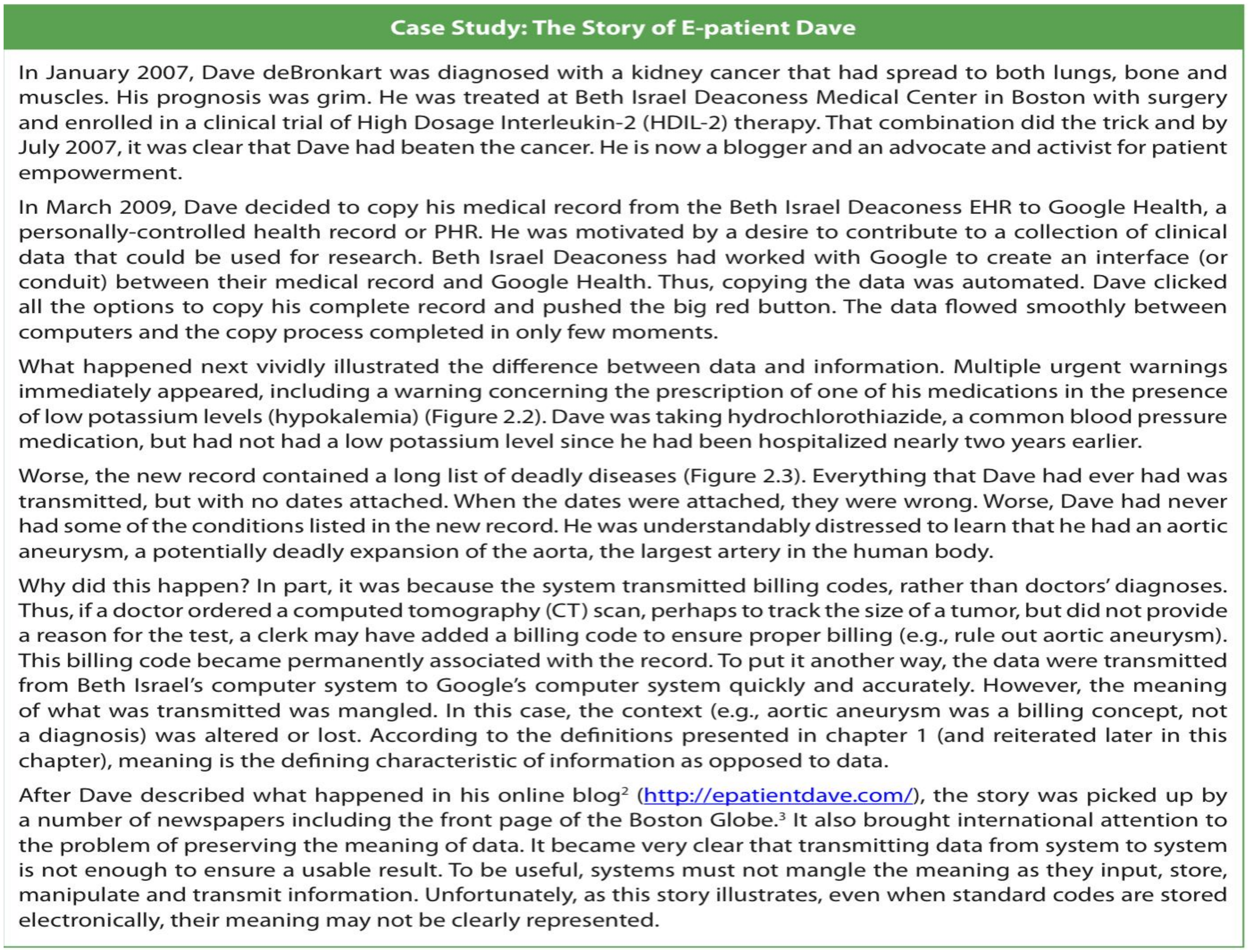
-Sources of big data.

Key points

Extra

- Data are observations reflecting differences in the world (e.g., "C34.9") while information is meaningful data or facts from which conclusions can be drawn and knowledge is information that is justifiably believed to be true
- Data are largely the domain of information technology (IT) professionals and computer scientists; information and knowledge are the domains of informatics and informaticians.
- Vocabularies help convert data into information
- The transformation of data into information and knowledge is a core concern of informaticians.
- When the real world, the conceptual model and the computational model match, we get useful answers from the computer
- Concepts relevant to health are relatively poorly defined compared to e.g. banking concepts
- There is a large "semantic gap" between health data and health information

I encourage you to read this case study to understand the challenges at the information level and to understand the concept of interoperability.



Extra

Case Study: The Story of E-patient Dave

In January 2007, Dave deBronkart was diagnosed with a kidney cancer that had spread to both lungs, bone and muscles. His prognosis was grim. He was treated at Beth Israel Deaconess Medical Center in Boston with surgery and enrolled in a clinical trial of High Dosage Interleukin-2 (HDIL-2) therapy. That combination did the trick and by July 2007, it was clear that Dave had beaten the cancer. He is now a blogger and an advocate and activist for patient empowerment.

In March 2009, Dave decided to copy his medical record from the Beth Israel Deaconess EHR to Google Health, a personally-controlled health record or PHR. He was motivated by a desire to contribute to a collection of clinical data that could be used for research. Beth Israel Deaconess had worked with Google to create an interface (or conduit) between their medical record and Google Health. Thus, copying the data was automated. Dave clicked all the options to copy his complete record and pushed the big red button. The data flowed smoothly between computers and the copy process completed in only few moments.

What happened next vividly illustrated the difference between data and information. Multiple urgent warnings immediately appeared, including a warning concerning the prescription of one of his medications in the presence of low potassium levels (hypokalemia) (Figure 2.2). Dave was taking hydrochlorothiazide, a common blood pressure medication, but had not had a low potassium level since he had been hospitalized nearly two years earlier.

Worse, the new record contained a long list of deadly diseases (Figure 2.3). Everything that Dave had ever had was transmitted, but with no dates attached. When the dates were attached, they were wrong. Worse, Dave had never had some of the conditions listed in the new record. He was understandably distressed to learn that he had an aortic aneurysm, a potentially deadly expansion of the aorta, the largest artery in the human body.

Why did this happen? In part, it was because the system transmitted billing codes, rather than doctors' diagnoses. Thus, if a doctor ordered a computed tomography (CT) scan, perhaps to track the size of a tumor, but did not provide a reason for the test, a clerk may have added a billing code to ensure proper billing (e.g., rule out aortic aneurysm). This billing code became permanently associated with the record. To put it another way, the data were transmitted from Beth Israel's computer system to Google's computer system quickly and accurately. However, the meaning of what was transmitted was mangled. In this case, the context (e.g., aortic aneurysm was a billing concept, not a diagnosis) was altered or lost. According to the definitions presented in chapter 1 (and reiterated later in this chapter), meaning is the defining characteristic of information as opposed to data.

After Dave described what happened in his online blog[2] (http://epatientdave.com/), the story was picked up by a number of newspapers including the front page of the Boston Globe.[3] It also brought international attention to the problem of preserving the meaning of data. It became very clear that transmitting data from system to system is not enough to ensure a usable result. To be useful, systems must not mangle the meaning as they input, store, manipulate and transmit information. Unfortunately, as this story illustrates, even when standard codes are stored electronically, their meaning may not be clearly represented.

Reference excerpts

-Information is meaningful data or facts from which conclusions can be drawn (e.g., ICD-10-CM code C34.9 = “Malignant neoplasm of unspecified part of bronchus or lung”.
-Knowledge is information that is justifiably believed to be true (e.g., “Smokers are more likely to develop lung cancer compared to non-smokers”).

-Why do we aggregate data into file formats?
1-To specify the way the data are organized within the file.
2-Common or standardized file formats allow sharing of files between applications.

-When converting data to information, one must consider the **conceptual model** to convert it to the **computational model.**
Conceptual model: نموذج يهتم بالأشياء التي يريد أن يهتم فيها فقط، مثل نموذج تبخر الماء الى سحاب إلى مطر، ويستثني عوامل أخرى مثل الرياح.
مثاله في الإنفورماتيكس: الاهتمام بالطول والوزن لبيانات أحد المرضى بغض النظر عن عمره. بعد ذلك، يمكن تحويل النموذج هذا إلى نموذج حاسوبي حسب الطلب

-The difference between **computer science** and **informatics** :
Computer science: computer scientists and IT professionals concentrate on **technology**, including computing systems composed of hardware and software as well as the algorithms implemented in such systems. For example, computer scientists develop algorithms to search or sort **data** (meaningless) more efficiently. Note that what is being sorted or searched is largely irrelevant. In other words, the meaning of the data is of **secondary** importance.
Informatics: Information and knowledge (meaningful), are addressed by informatics. To an informatician computers are tools for manipulating information.

-What is **information retrieval**?
Finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need by retrieving documents from large collections (usually stored on computers).

-Information retrieval is concerned with meaningful **information** NOT **data,** **and it involves computer science and informatics.**

-AI or “**machine learning**” have enabled computers to solve problems that have previously **resisted automation.**

-What is **deep learning**?
It’s the use of multi-layer neural networks to learn patterns such as the features of objects in an image.

-Limitations of **deep learning:**
1-It requires large sets of labelled data to “train” the system. 2-The system cannot explain “why” it does something.

-Structured data vs **Unstructured** data
Structured:
-It may include billing codes, lab results (e.g., Sodium = 140 mg/dl), problem lists **(e.g., Problem #1 = ICD-10-CM C34.9 = “Lung Neoplasm, Not Otherwise Specified”),** medication lists.
-Structured data are much easier to manage and are computationally tractable.
Unstructured:
-Free text is simply human language such as English, called **natural language.**
-Key portions of clinical notes are still often dictated and are represented in records as free text.
-90% of data are unstructured.
-Has the advantage of being able to express anything that can be expressed using natural language.
-Difficult for computers to process as it requires NLP.

-CDWs vs **EHRs**
CDWs:
-Variety of analytics can be applied on data, and the results presented to the user via a user interface.
Examples of simple analytics include summary statistics such as counts, means, medians and standard deviations. More sophisticated analytics include associations (e.g., does A co-occur with B) and similarity determinations (e.g., is A similar to B).
-Designed to support queries about groups. -CDWs are used to identify trends.
EHRs:
-Designed to support real-time updating and retrieval of **individual** data.
-Databases that support EHRs are designed for efficient real-time **updating** and retrieval.

-Semantic gap: A wide semantic gap makes informatics difficult because concepts relevant to health are relatively poorly defined. e.g. “sick” can be high BP or low BP or an aortic aneurysm or any kind of illness.

Summary

Data

definitions	**Data:** are symbols or observations reflecting differences in the world. **Information:** is data with meaning. **Knowledge:** is information that is justifiably believed to be true. **Wisdom:** is the critical use of knowledge to make intelligent decisions.

Clinical data

Types	○ **Narrative** ○ **Numerical measurements** ○ **Coded data** ○ **Textual data** ○ **Recorded signals** ○ **Pictures**

General categories of data entry

- **Free-form**
- **Structured (menu-driven) data**
- **Speech recognition**

Artificial intelligence (AI)

- **AI is concerned with the development of systems that can do something that previously required human intelligence.**

Data to information

- **ICD:** International Classification of Disease, 10 is the version.
- **Interoperability:** Ability of two or more systems or components to exchange the information and use the information that has been exchanged.

Clinical Data Warehouse

Definition	A modern **way to convert medical information to knowledge** is to use a clinical data warehouse (CDW).
Function	a database system that collects, integrates and stores clinical data from a variety of sources including electronic health records (**EHR**), radiology and other information systems.
Uses	Monitor Quality by allowing users to query for specific quality measures Identify trends Comparative effective research: practice based research, answers very specific questions

Use of Aggregated Clinical Data

- **Concept extraction:** the problem of identifying concepts within unstructured data, such as discharge summaries or pathology reports.
  - Usually, these concepts are mapped to a controlled vocabulary.
- **Classification**: the problem of categorizing data into two or more categories.
  - Supervised machine learning.

What Makes Biomedical Informatics Difficult?

- Incomplete information.
- Uncertain information.
- Imprecise information.
- Vague information.
- Inconsistent information.

Big data

Definition	collecting large collections of data from various healthcare foundations followed by storing, managing, analyzing, visualizing, and delivering information for effective decision making.

MCQs

1-Finding material of unstructured nature that satisfies an information need by retrieving documents from large collections.

A- Artificial intelligence
B- Information retrieval
C- Health informatics
D-Machine learning

2-Key portions of clinical notes are represented as:

A-Structured data
B-Unstructured data

3-Designed to support queries about groups, and used to identify trends.

A-Clinical Data Warehouse
B-Electronic Health Record

4-Big Data has low

A-Velocity
B-Veracity
C-Variety
D-Value

5-Data that describe other data

A- Meta-Data
B-Big data

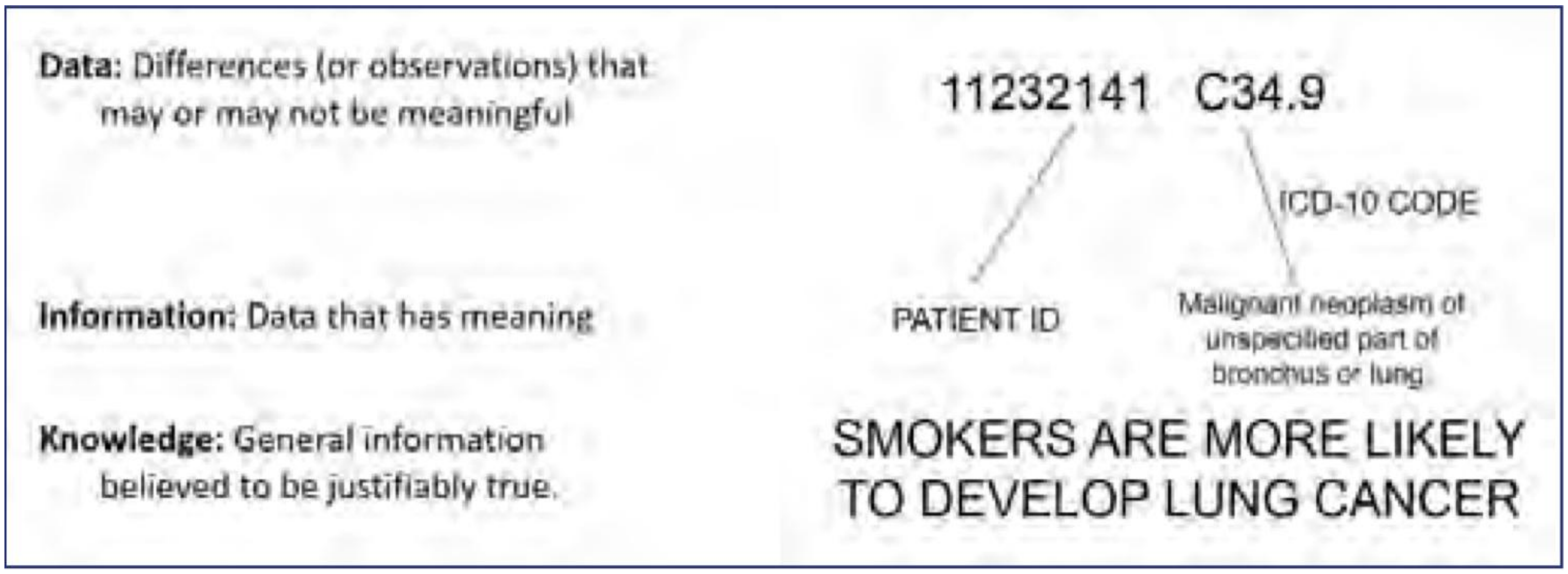
6-Which of the followings is picture data?

A-ECG
B-Blood test
C-X-ray
D-EMG

Answers key

1-B 2-B 3-A 4-B 5-A 6- C

Bonus!



Data: Differences (or observations) that may or may not be meaningful

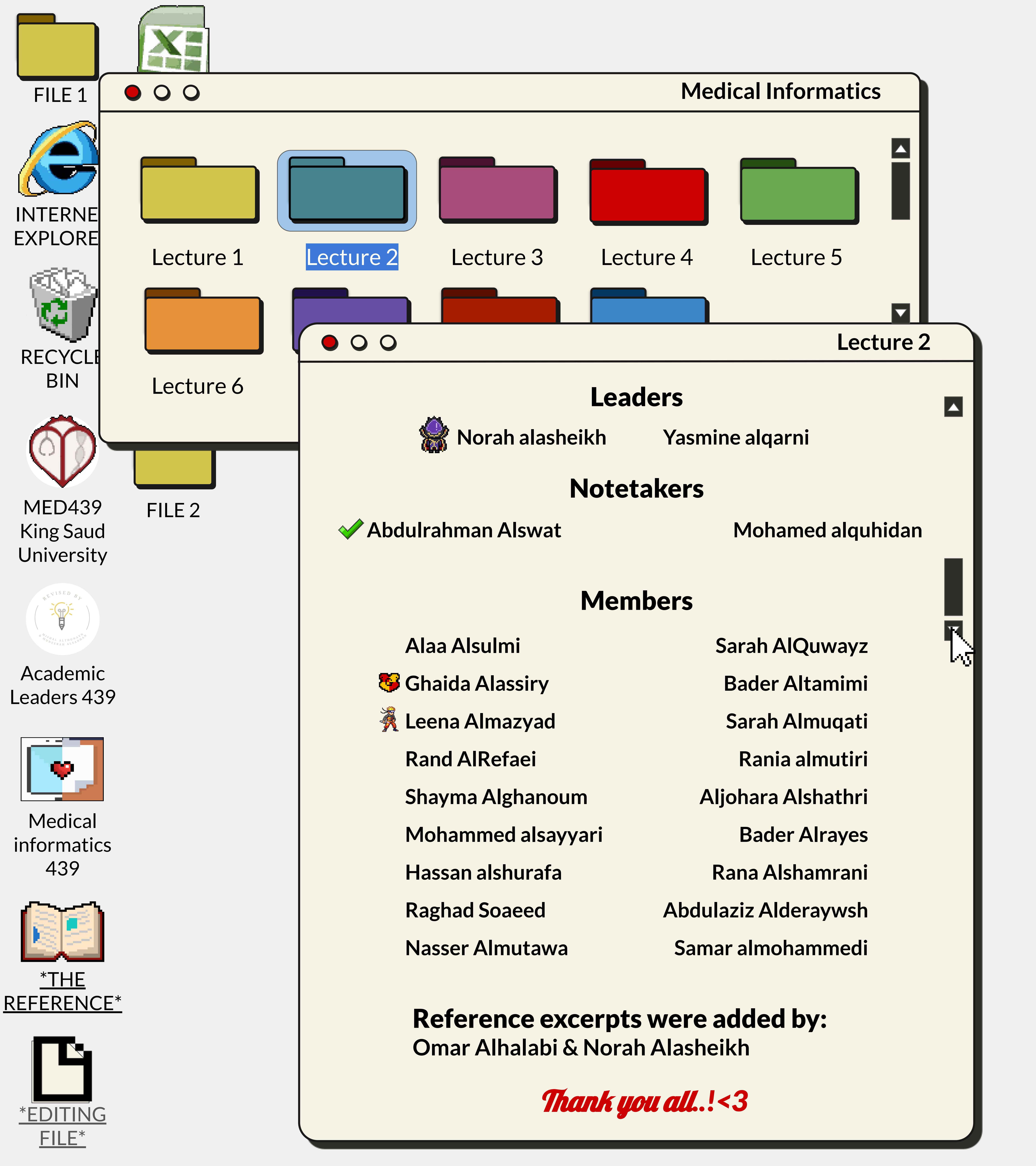
Information: Data that has meaning

Knowledge: General information believed to be justifiably true.

11232141 C34.9

SMOKERS ARE MORE LIKELY TO DEVELOP LUNG CANCER

Excuse the bad quality.



Lecture 2

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Yasmine alqarni

Notetakers

✓ Abdulrahman Alswat

Mohamed alquhidan

Members

- Alaa Alsulmi
- Ghaida Alassiry
- Leena Almazyad
- Rand AlRefaei
- Shayma Alghanoum
- Mohammed alsayyari
- Hassan alshurafa
- Raghad Soaeed
- Nasser Almutawa
- Sarah AlQuwayz
- Bader Altamimi
- Sarah Almuqati
- Rania almutiri
- Aljohara Alshathri
- Bader Alrayes
- Rana Alshamrani
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Reference excerpts were added by:
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Thank you all..!<3