

Week 2: Clinical Data and Big Data

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Acknowledgment:

Book: Health Informatics Practical Guide

Chapter 2: Healthcare Data, Information and Knowledge

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Big data : Senthilkumar, S. A., Rai, B. K., Meshram, A. A., Gunasekaran, A., & Chandrakumarmangalam, S. (2018). Big data in healthcare management: A review of literature. *American Journal of Theoretical and Applied Business*, 4(2), 57-69.

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, Information, and Knowledge

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.



Data

- Each zero or one is a bit.
- Byte : ; a series of 8 bits .
- * **Bits can occur as various data types**
 - * Integers
 - * Floating point numbers
 - * Characters
 - * Character strings
- * **File format:**
 - * image files (JPG, GIF, PNG),
 - * text files,
 - * sound files (WAV, MP3)
 - * video files (WMV, MP4)



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

Types of clinical data

- ❖ Narrative: recording by clinician- maternity history
- ❖ Numerical measurements: blood pressure, temperature
- ❖ Coded data: selection from a controlled terminology system
- ❖ Textual data: other results reported as text
- ❖ Recorded signals: EKG, EEG
- ❖ Pictures: radiographs, photographs, and other images



Data entry

❖ General categories of data entry:

❖ Free-form entry by historical methods:

- ❖ writing
- ❖ dictation
- ❖ typing

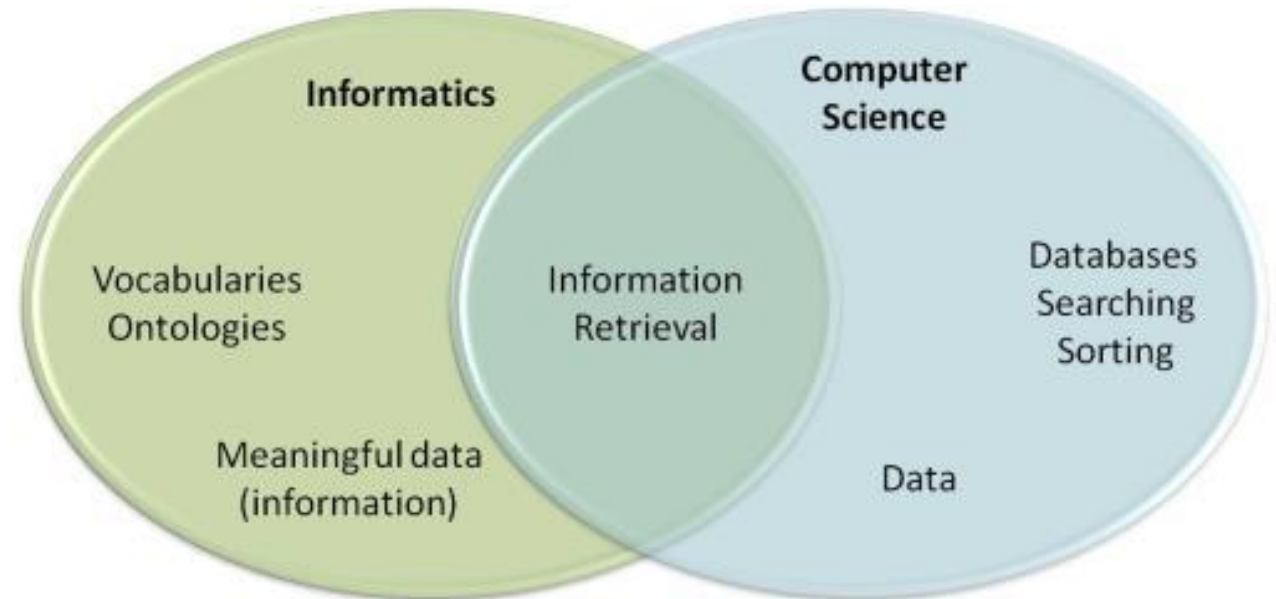
❖ Structured (menu-driven) data entry by mouse or pen

❖ Speech recognition for either of above



Informatics and Computer Science

- Data are the domain of computer scientists, but information is the domain of informatics and informaticians
- Information retrieval involves both computer science (data) and informatics (information).



Artificial Intelligence (AI)



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



Dermatologic (skin) lesion categorization

Data to information



Example: "C34.9"



Vocabulary (ICD-10-CM)



"Lung neoplasm, not otherwise specified."



Interoperability

Information to Knowledge

- Two types of data:
 - Structured data
 - Unstructured (free text)
- Advantages and disadvantages
- Natural language processing (NLP)

Liverpool Hospital Neonatal Database - Clinical Data Entry

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

Log Files (0) Images (2) Calculator

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 Billblanket
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 JVH II
01/04 Eyes ROP I
Opened 01 Apr 12:27

Admissions Respiratory Nutrition Other Treatments Test Results

Admission Planning Discharge

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 Orders on Worksheet 01/03

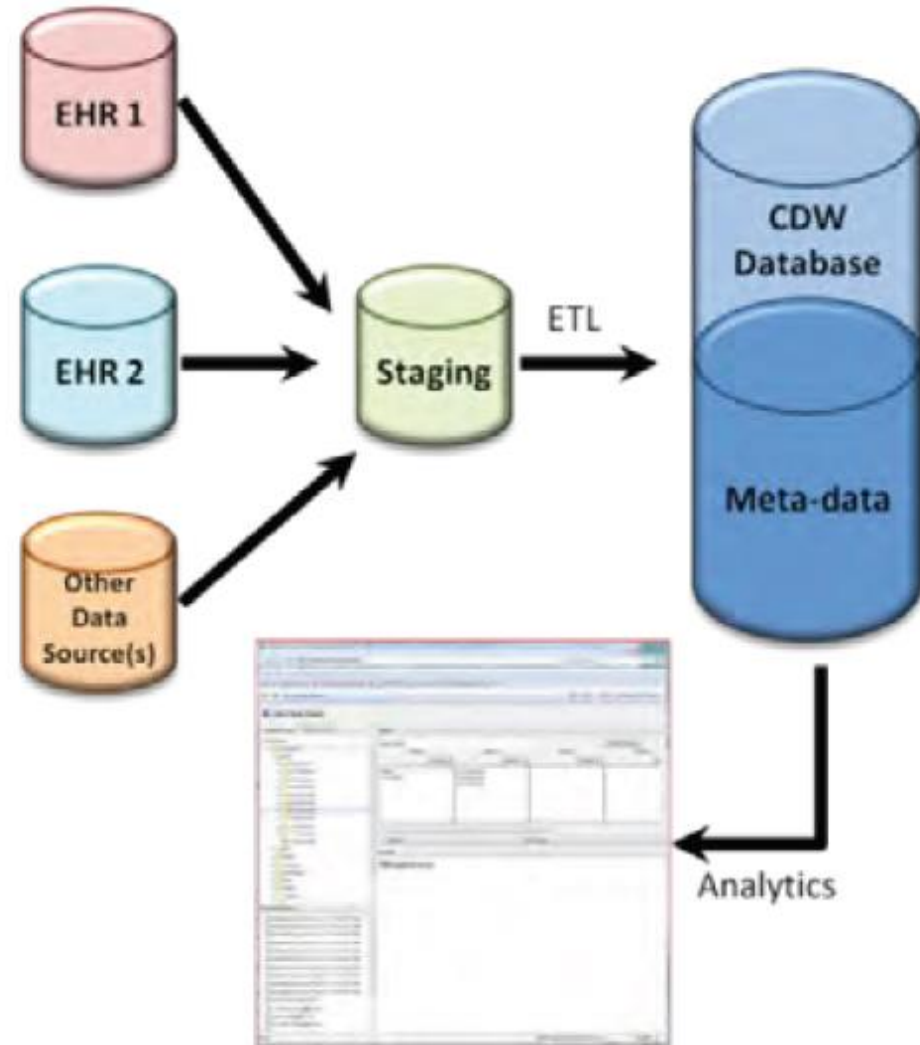
This is freetext Freetext orders (double click on text to delete)

Hospital Episodes	MRN	Admitted	Discharged		
Liverpool Hospital	123432	28 Feb 2008 16:30		Add Another Admission	
NETS	PD12345	28 Feb 2008 15:00	28 Feb 2008 16:30		Delete MRN .. then click again to Delete Episode
Campbelltown Hospital	222222	28 Feb 2008 13:00	28 Feb 2008 15:00		

Add Twin local form

Clinical Data Warehouse

- A modern way to convert medical information to knowledge is to use a clinical data warehouse (CDW).
- A clinical data warehouse is a database system that collects, integrates and stores clinical data from a variety of sources including electronic health records, radiology and other information systems.
- Differences between EHR and CDW.



Clinical Data Warehouse

- **Uses:**

- 1- monitor quality by allowing users to query for specific quality measures
- 2- identify trends.
- 3- Comparative effectiveness research (CER)

i2b2 platform

<https://www.i2b2.org>

- * Informatics for Integrating Biology and the Bedside (i2b2) is a Harvard project used by many other academic institutions in the US
- * The program is open source and modular and incorporates genomic and clinical information for research purposes
- * Database consists of **facts** (diagnoses, lab results, etc.) queried by users and **dimensions** that describe the facts

I2b2 Star Schema

visit_dimension		
PK	<u>encounter_num</u>	INTEGER
PK	<u>patient_num</u>	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	<u>encounter_num</u>	INTEGER
PK	<u>concept_cd</u>	VARCHAR(20)
PK	<u>provider_id</u>	VARCHAR(20)
PK	<u>start_date</u>	DATETIME
PK	<u>modifier_cd</u>	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	<u>patient_num</u>	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	<u>Concept_path</u>	VARCHAR(700)
	concept_cd	VARCHAR(20)
	name_char	VARCHAR(2000)
	concept_blob	TEXT(10)

provider_dimension		
PK	<u>PROVIDER_path</u>	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.
 - 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 Informatics Difficult?

- Biomedical informatics is difficult:

1- Incomplete information.

2- Uncertain information.

3- Imprecise information.

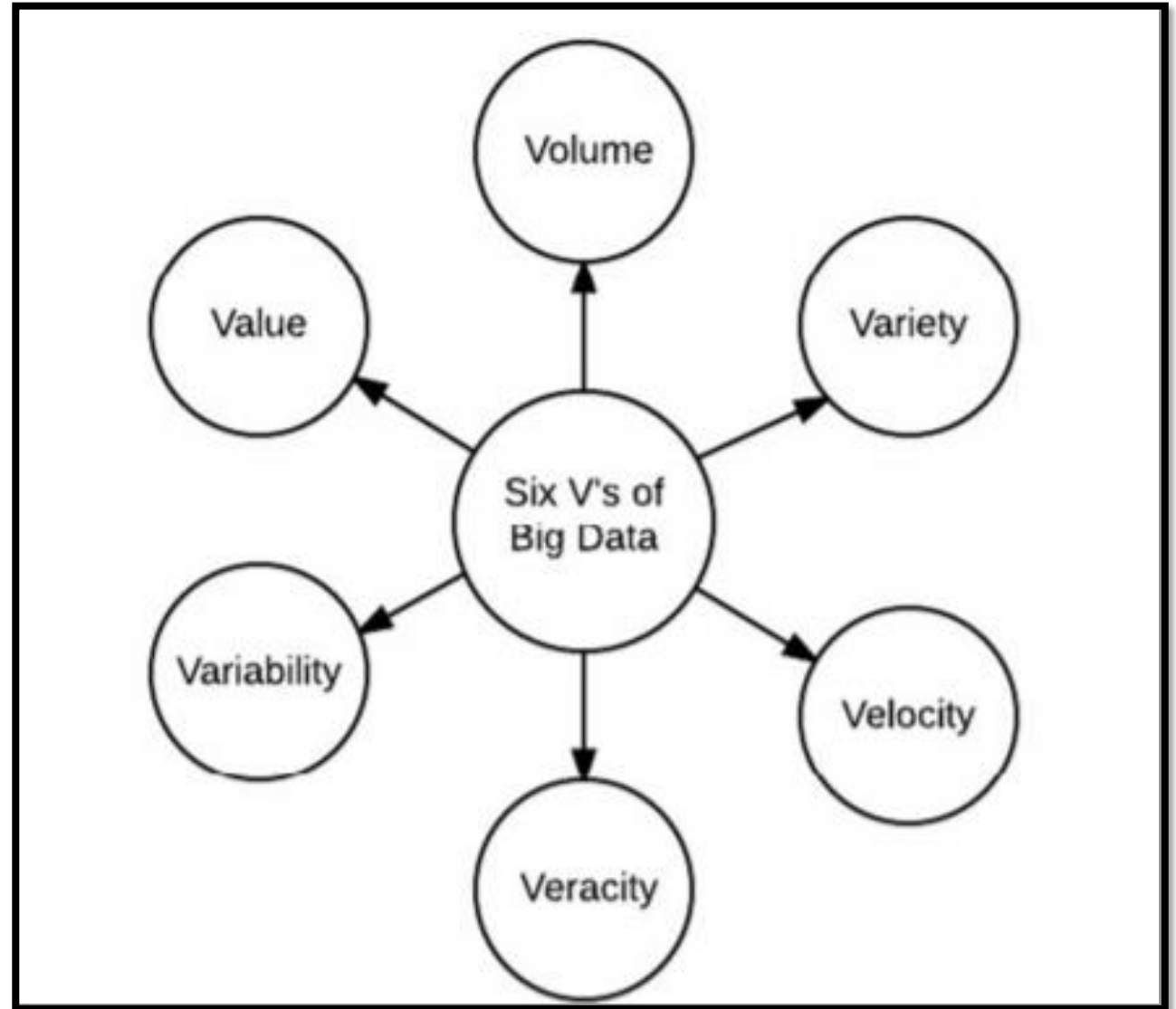
4- Vague information.

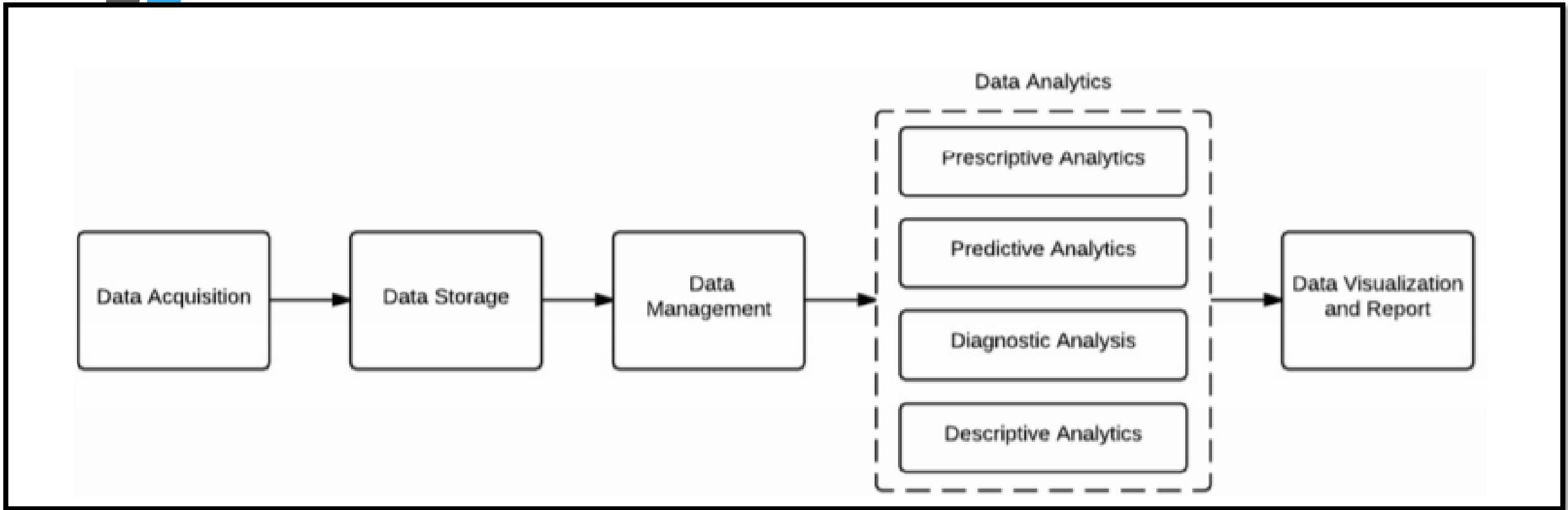
5- Inconsistent information.

e.g Birthdate: 8/29/66 and 9/17/66.

Big data:

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






Big data analysis

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



Thank you for listening
Any questions