

# Data Modeling



# After this module you will be able to...

- Describe at least 5 different types in which Big Data may appear in an application problem
- Identify the genre of the data you encounter in an analytics application



# What is a Data Model?



# After this video you will be able to...

- Distinguish between structured and unstructured data
- Describe four basic data operations, namely, selection, projection, union, join
- Enumerate different types of data constraints like type, value and structural constraints
- Explain why constraints are useful to specify the semantics of data

# Data Models Describe Data Characteristics

```
Person {  
  firstName: string,  
  lastName: string,  
  DOB: date  
}
```

## Structure

# Data Models Describe Data Characteristics

All DOB before 1990.

## Operations

# Data Models Describe Data Characteristics

Today's Date 'minus'  
DOB must be greater  
than 18 years.

## Constraints

**pause**



# Structure

File 1

(John, Smith, 10-12-1989)  
(Liz, Spencer, 09-29-1980)  
(Marie, Bishop, 11-07-1992)

File 2

(John, Smith, 10-12-1989, Mechanical, 70000)  
(Liz, Spencer, 09-29-1980, Electrical, 65000)  
(Marie, Bishop, 11-07-1992, Driver, )  
(Steve, Richards, 04-16-1958, 140000)

structure

$A_1, A_2, \dots, A_k$

$B_1, B_2, \dots, B_k$

$\dots$

$\dots$

$X_1, X_2, \dots, X_k$

# Unstructured Data

&#2453;&#2494;&#2480; &#2453;&#2507;&#2469;&#2494;&#2527;&#2469;&#2494;&#2453;&#2494;  
&#2441;&#2458;&#2495;&#2468;&#2476;&#2507;&#2461;&#2494;&#2479;&#2494;&#2458;&#2509;&#2459;&#2503;  
&#2472;&#2494; &#2439;&#2470;&#2494;&#24#2472;&#2496;&#2434;! &#2456;&#2480;&#2503;  
&#2469;&#2494;&#2453;&#2476;&#2503; &#2453;&#2503;,,  
&#2438;&#2480;&#2476;&#2494;&#2439;&#2480;&#2503;&#2439; &#2476;&#2494; &#2453;&#2503;,,  
&#2476;&#2480;&#2509;&#2471;&#2478;&#2494;&#2472;&#2503; &#2453;&#2494;&#2480;  
&#2469;&#2494;&#2453;&#2494; &#2470;&#2480;&#2453;&#2494;&#2480;,, &#2453;&#2494;&#2480;  
&#2458;&#2482;&#2503; &#2479;&#2494;&#2451;&#2527;&#2494; &#2470;&#2480;&#2453;&#2494;&#2480;  
&#2478;&#2494;&#2482;&#2470;&#2489; &#2469;&#2503;&#2453;&#2503;&mdash; &#2488;&#2476;  
&#2453;&#2503;&#2478;&#2472; &#2455;&#2497;&#2482;&#2495;&#2527;&#2503;  
&#2479;&#2494;&#2458;&#2509;&#2459;&#2503;&#2404; &#2488;&#2480;&#2453;&#2494;&#2480;  
&#2479;&#2494;&#2433;&#2453;&#2503; &#2456;&#2480;&#2503;&#2480; &#2438;&#2488;&#2472;&#2503;  
&#2476;&#2488;&#2495;&#2527;&#2503; &#2480;&#2494;&#2454;&#2503;,,  
&#2472;&#2495;&#2480;&#2509;&#2476;&#2494;&#2458;&#2472; &#2453;&#2478;&#2495;&#2486;&#2472;  
&#2468;&#2494;&#2453;&#2503;&#2439; &#2476;&#2494;&#2439;&#2480;&#2503;&#2480;  
&#2470;&#2480;&#2460;&#2494; &#2470;&#2503;&#2454;&#2494;&#2527;&#2404;  
&#2437;&#2468;&#2447;&#2476;&#2474;&#2509;&#2480;&#2468;&#2509;&#2479;&#2494;&#2456;&#2494;&#2468;  
&#2503; #2478;&#2497;&#2454;&#2509;&#2479;&#2478;&#2472;&#2509;&#2468;&#2509;&#2480;&#2496;&#2480;  
&#2478;&#2497;&#2454; &#2469;&#2503;&#2453;&#2503; &#2476;&#2503;&#2480;&#2507;&#2527;,,  
&#2456;&#2480;&#2503; &#2475;&#2503;&#2480;&#2494;&#2472;&#2507;&#2480;  
&#2472;&#2495;&#2486;&#2509;&#2458;&#2495;&#2468; &#2438;&#2486;&#2509;&#2476;&#2494;&#2488;&#2404;

**pause**

# Operations

- **“Subsetting”**
  - Example: Given a collection of data, and a condition
    - Find a subset of data from the collection so that each element in the subset satisfied

# Operations

- “Subsetting”

(John, Smith, 10-12-1989, Mechanical, 70000)  
(Liz, Spencer, 09-29-1980, Electrical, 65000)  
(Marie, Bishop, 11-07-1992, Driver, )  
(Steve, Richards, 04-16-1958, 140000)



field 5 > 100000

(Steve, Richards, 04-16-1958, 140000)



# Operations

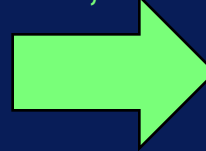
- **“Substructure extraction”**
  - Given a data collection with some structure, extract from each data item a part of the structure as specified by a condition

# Operations

- “Substructure extraction”

(John, Smith, 10-12-1989, Mechanical, 70000)  
(Liz, Spencer, 09-29-1980, Electrical, 65000)  
(Marie, Bishop, 11-07-1992, Driver, )  
(Steve, Richards, 04-16-1958, 140000)

field 1, field 2



(John, Smith)  
(Liz, Spencer)  
(Marie, Bishop)  
(Steve, Richards)

# Operations

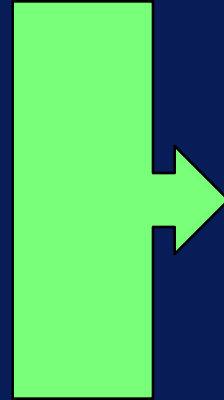
- **“Union”**
  - Given two data collections, create a new one with elements of the two input collections
  - Duplicate elimination

# Operations

- “Union”

(John, Smith, 10-12-1989)  
(Liz, Spencer, 09-29-1980)  
(Marie, Bishop, 11-07-1992)

(Lance, Holt, 04-02-1976)  
(Liz, Spencer, 09-29-1980)



(John, Smith, 10-12-1989)  
(Liz, Spencer, 09-29-1980)  
(Marie, Bishop, 11-07-1992)  
(Lance, Holt, 04-02-1976)

# Operations

- **“Join”**
  - Given two data collections, create a new one with elements of the two input collections
  - Duplicate elimination




# Operations

- “Join”



(12, John, Smith, 10-12-1989)  
(14, Liz, Spencer, 09-29-1980)  
(18, Marie, Bishop, 11-07-1992)  
(20, Sue, Daveson, 03-16-1986)



(12, Mechanical, 70k)  
(14, Electrical, 65k)  
(18, Driver, 45k)  
(23, Student, 30k)



(12, John, Smith, 10-12-1989, Mechanical, 70k)  
(14, Liz, Spencer, 09-29-1980, Electrical, 65k)  
(18, Marie, Bishop, 11-07-1992, Driver, 45k)

**pause**

# Constraints

- Constraints are logical statements that must hold for data

A movie has only one title

# Constraints

- Constraints are logical statements that must hold for data

A movie has only one title

- Different data models have different ways to express constraints

# Types of Constraints

- Value constraint
  - Age is never negative
- Uniqueness constraint
  - A movie can have only one title
- Cardinality constraint
  - A person can take between 0 and 3 blood pressure medications at a time



# Types of Constraints

- Type constraint

Last Name is alphabetical

Lname:string, not(isNumeric(Lname))

# Types of Constraints

- Type constraint

Last Name is alphabetical

Lname:string, not(isNumeric(Lname))

- Domain constraint

Day in (1 ... 31)

Month in (1 ... 12) or Month in ('Jan', 'Feb', ... 'Dec')

# Structural Constraints

- **A structural constraint puts restrictions on the structure of the data rather than the data values themselves**

# Structural Constraints

|    |     |    |     |
|----|-----|----|-----|
| 10 | 3   | 23 | -3  |
| 43 | 9   | 86 | 5   |
| 20 | -56 | 0  | -16 |
| 65 | 38  | 36 | 29  |

| i   | j   | value |
|-----|-----|-------|
| 1   | 1   | 10    |
| 1   | 2   | 3     |
| 1   | 3   | 23    |
| 1   | 4   | -3    |
| 2   | 1   | 43    |
| 2   | 2   | 9     |
| ... | ... | ...   |