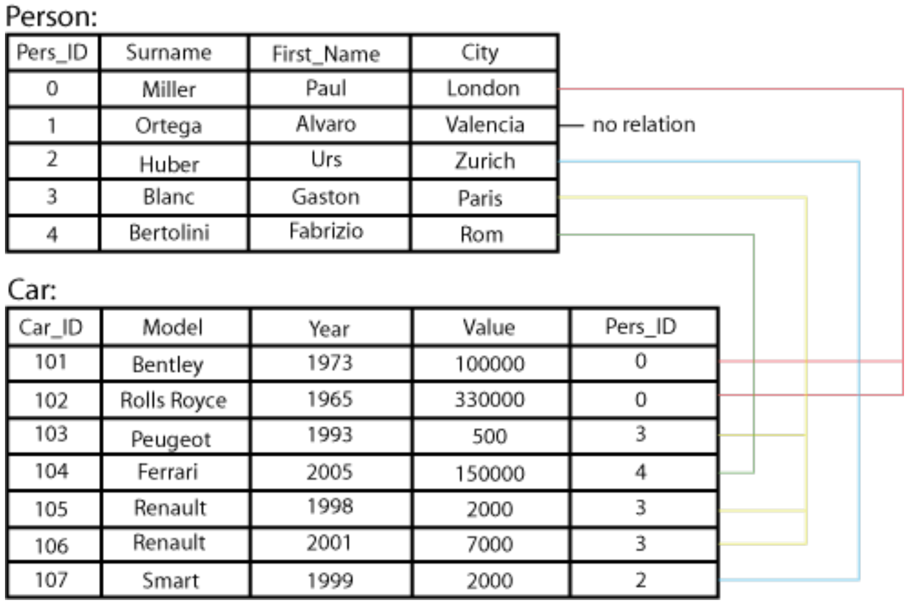
Types of data

Types of data, data objects, and attribute types

Types of Data Sets: (1) Record Data

- Relational records
  - Relational tables, highly structured
- Data matrix, e.g., numerical matrix, crosstabs
- Transaction data
- Document data: Term-frequency vector (matrix) of text documents

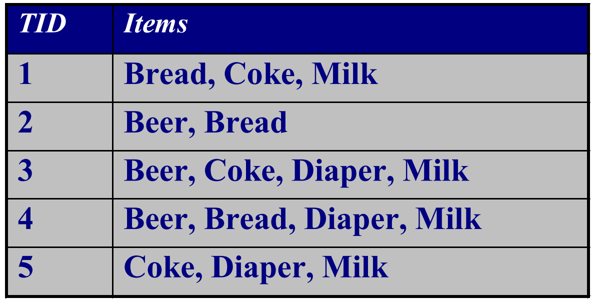


Person:

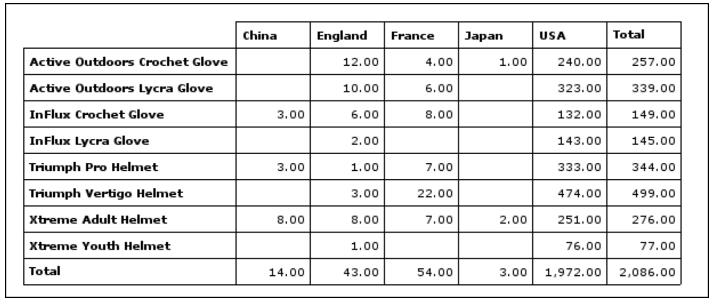
Pers_ID	Surname	First_Name	City
0	Miller	Paul	London
1	Ortega	Alvaro	Valencia
2	Huber	Urs	Zurich
3	Blanc	Gaston	Paris
4	Bertolini	Fabrizio	Rom

Car:

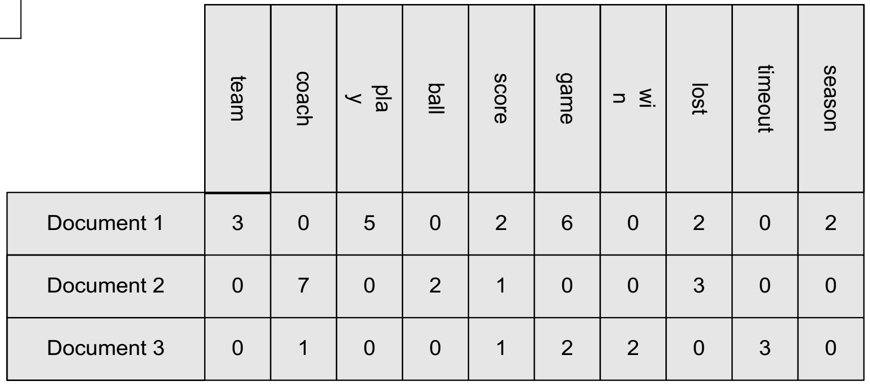
Car_ID	Model	Year	Value	Pers_ID
101	Bentley	1973	100000	0
102	Rolls Royce	1965	330000	0
103	Peugeot	1993	500	3
104	Ferrari	2005	150000	4
105	Renault	1998	2000	3
106	Renault	2001	7000	3
107	Smart	1999	2000	2



TID	*Items*
1	Bread, Coke, Milk
2	Beer, Bread
3	Beer, Coke, Diaper, Milk
4	Beer, Bread, Diaper, Milk
5	Coke, Diaper, Milk



	China	England	France	Japan	USA	Total
Active Outdoors Crochet Glove		12.00	4.00	1.00	240.00	257.00
Active Outdoors Lycra Glove		10.00	6.00		323.00	339.00
InFlux Crochet Glove	3.00	6.00	8.00		132.00	149.00
InFlux Lycra Glove		2.00			143.00	145.00
Triumph Pro Helmet	3.00	1.00	7.00		333.00	344.00
Triumph Vertigo Helmet		3.00	22.00		474.00	499.00
Xtreme Adult Helmet	8.00	8.00	7.00	2.00	251.00	276.00
Xtreme Youth Helmet		1.00			76.00	77.00
Total	14.00	43.00	54.00	3.00	1,972.00	2,086.00

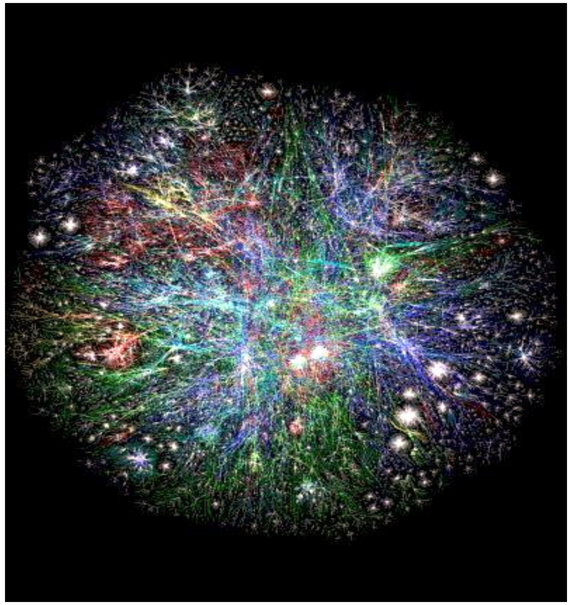


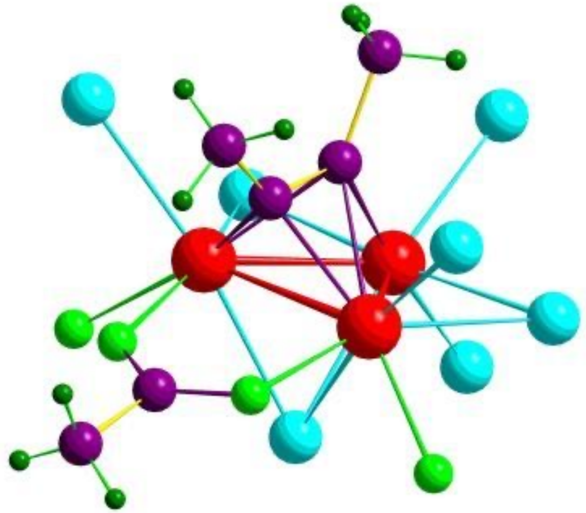
	team	coach	play	ball	score	game	win	lost	timeout	season
Document 1	3	0	5	0	2	6	0	2	0	2
Document 2	0	7	0	2	1	0	0	3	0	0
Document 3	0	1	0	0	1	2	2	0	3	0

Types of Data Sets: (2) Graphs and Networks

- Transportation network

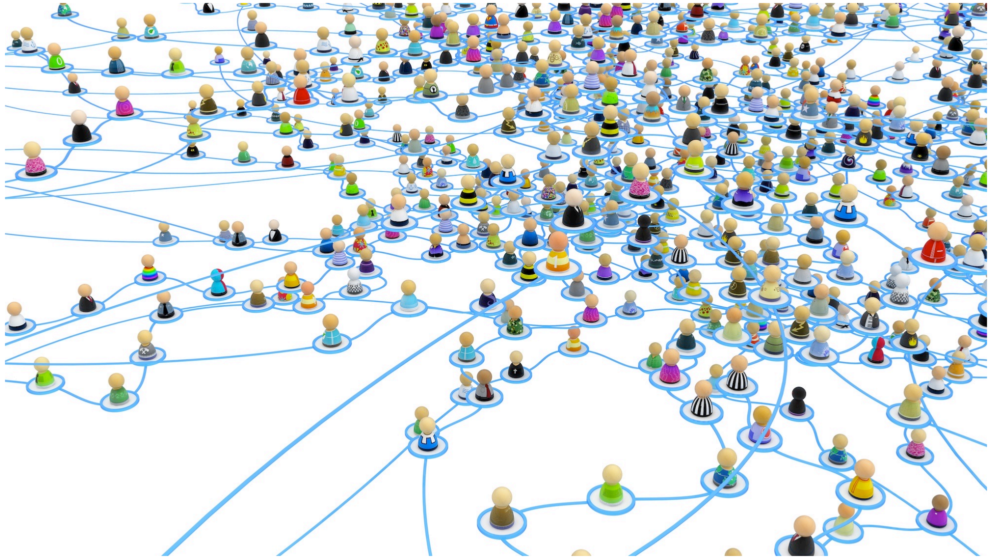
- World Wide Web





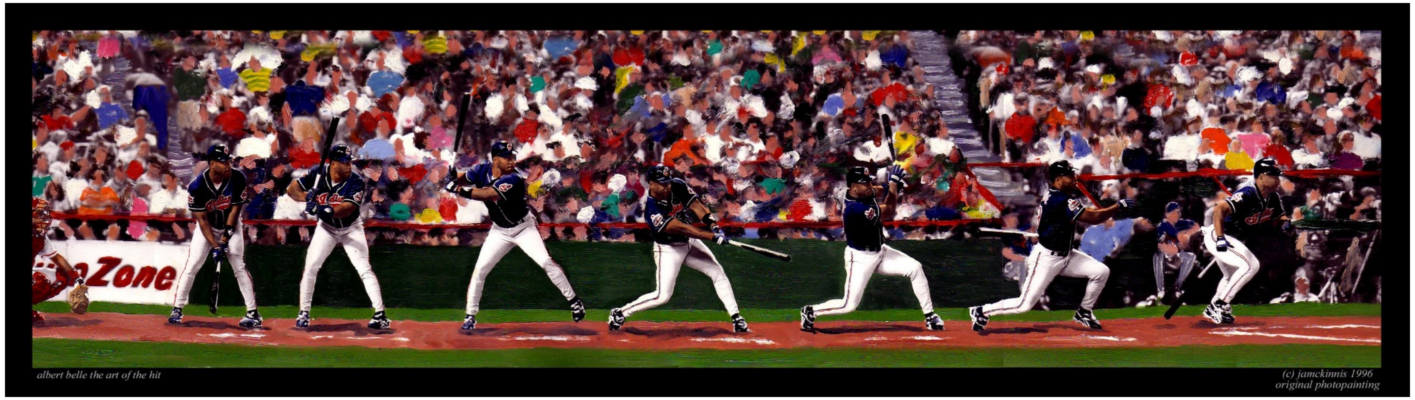
- ❑ Molecular Structures

- ❑ Social or information networks

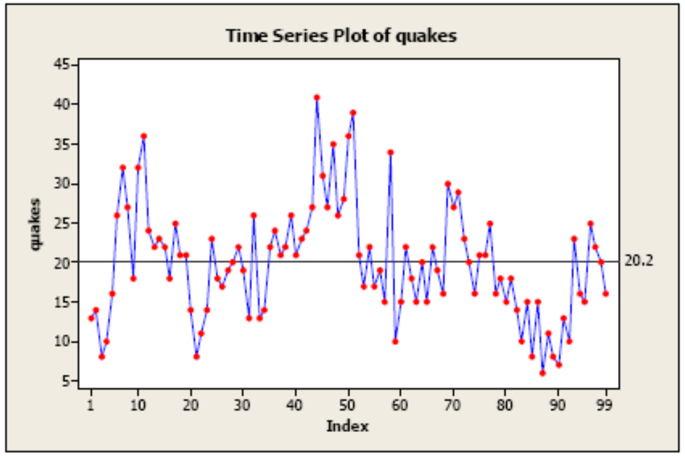


Types of Data Sets: (3) Ordered Data

- Video data: sequence of images

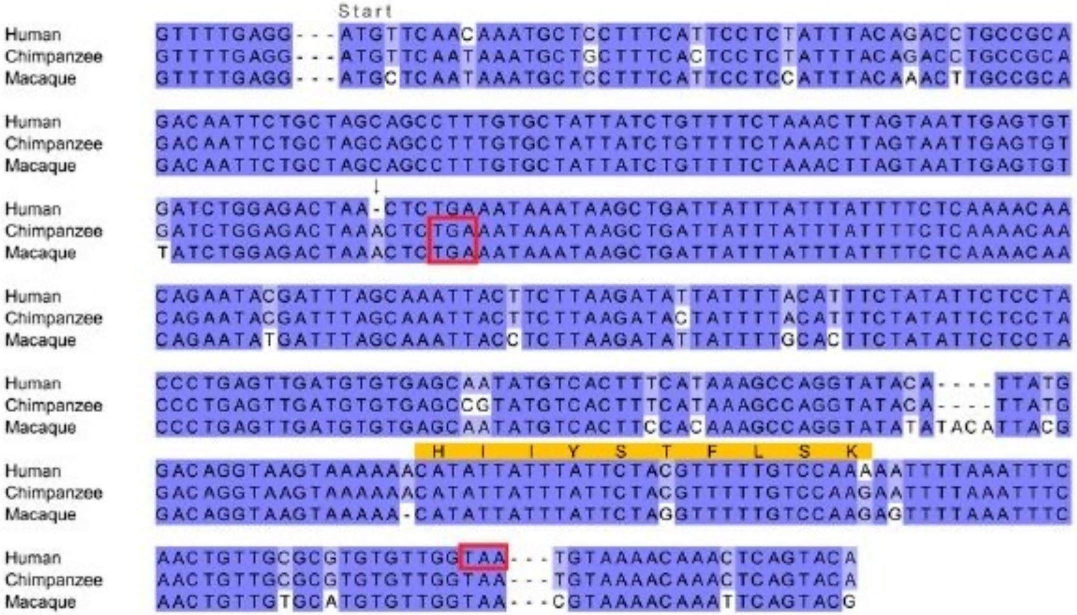


- Temporal data: time-series



- Sequential Data: transaction sequences

- Genetic sequence data



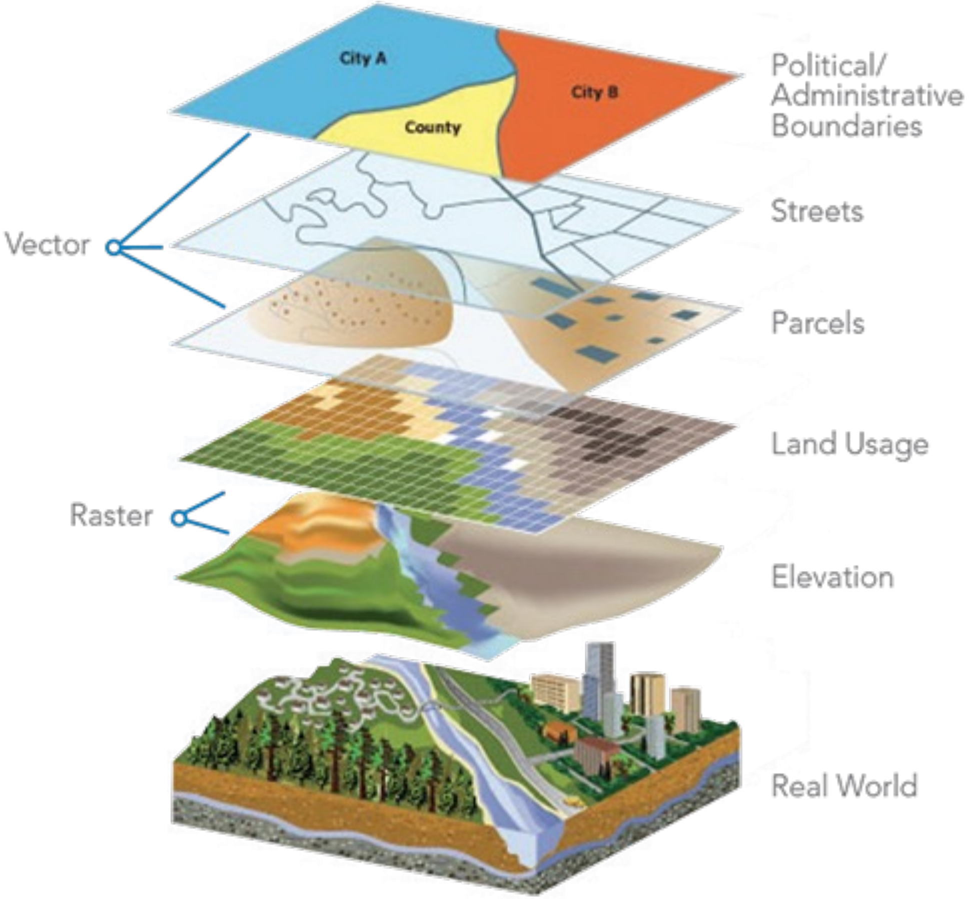
```
Human       GTTTTGAGG---ATGTTCAACAAATGCTCCTTTCATTCCTCTATTTACAGACCTGCCGCA
Chimpanzee  GTTTTGAGG---ATGTTCAATAAATGCTGCTTTCACTCCTCTATTTACAGACCTGCCGCA
Macaque     GTTTTGAGG---ATGCTCAATAAATGCTCCTTTCATTCCTCCATTTACAAACTTGCCGCA

Human       GACAATTCTGCTAGCAGCCTTTGTGCTATTATCTGTTTTCTAAACTTAGTAATTGAGTGT
Chimpanzee  GACAATTCTGCTAGCAGCCTTTGTGCTATTATCTGTTTTCTAAACTTAGTAATTGAGTGT
Macaque     GACAATTCTGCTAGCAGCCTTTGTGCTATTATCTGTTTTCTAAACTTAGTAATTGAGTGT

Human       GATCTGGAGACTAA-CTCTGAAATAAATAAGCTGATTATTTATTTATTTTCTCAAAACAA
Chimpanzee  GATCTGGAGACTAAACTCTGAAATAAATAAGCTGATTATTTATTTATTTTCTCAAAACAA
Macaque     TATCTGGAGACTAAACTCTGAAATAAATAAGCTGATTATTTATTTATTTTCTCAAAACAA

Human       CAGAATACGATTTAGCAAATTACTTCTTAAGATATTATTTTACATTTCTATATTCTCCTA
Chimpanzee  CAGAATACGATTTAGCAAATTACTTCTTAAGATACTATTTTACATTTCTATATTCTCCTA
Macaque     CAGAATATGATTTAGCAAATTACCTCTTAAGATATTATTTTGCACTTCTATATTCTCCTA

Human       CCCTGAGTTGATGTGTGAGCAATATGTCACTTTCATAAAGCCAGGTATACA----TTATG
Chimpanzee  CCCTGAGTTGATGTGTGAGCCGTATGTCACTTTCATAAAGCCAGGTATACA----TTATG
Macaque     CCCTGAGTTGATGTGTGAGCAATATGTCACTTCCACAAAGCCAGGTATATATACATTACG

Human       GACAGGTAAGTAAAAAACATATTATTTATTCTACGTTTTTGTCCAAAAATTTTAAATTTC
Chimpanzee  GACAGGTAAGTAAAAAACATATTATTTATTCTACGTTTTTGTCCAAGAATTTTAAATTTC
Macaque     GACAGGTAAGTAAAAA-CATATTATTTATTCTAGGTTTTTGTCCAAGAGTTTTAAATTTC

Human       AACTGTTGCGCGTGTGTTGGTAA---TGTAAAACAAACTCAGTACA
Chimpanzee  AACTGTTGCGCGTGTGTTGGTAA---TGTAAAACAAACTCAGTACA
Macaque     AACTGTTGTGCATGTGTTGGTAA---CGTAAAACAAATTCAGTACG
```

Types of Data Sets: (4) Spatial, image and multimedia Data

- Spatial data: maps

- Image data:

- Video data:



Data Objects

- Data sets are made up of data objects
- A **data object** represents an entity
- Examples:
  - sales database: customers, store items, sales
  - medical database: patients, treatments
  - university database: students, professors, courses
- Also called *samples , examples, instances, data points, objects, tuples*
- Data objects are described by **attributes**
- Database rows → data objects; columns → attributes

Attributes

- **Attribute (**or **dimensions, features, variables**)
  - A data field, representing a characteristic or feature of a data object.
  - *E.g., customer _ID, name, address*
- Types:
  - Nominal (e.g., red, blue)
  - Binary (e.g., {true, false})
  - Ordinal (e.g., {freshman, sophomore, junior, senior})
  - Numeric: quantitative
    - Interval-scaled: 100°C is interval scales
    - Ratio-scaled: 100°K is ratio scaled since it is twice as high as 50 $^{\circ}$K
  - Discrete vs. Continuous Attributes

Attribute Types

- **Nominal:** categories, states, or "names of things"
  - *Hair_color* = {*auburn, black, blond, brown, grey, red, white*}
  - marital status, occupation, ID numbers, zip codes
- **Binary**
  - Nominal attribute with only 2 states (0 and 1)
  - Symmetric binary: both outcomes equally important
    - e.g., gender
  - Asymmetric binary: outcomes not equally important.
    - e.g., medical test (positive vs. negative)
    - Convention: assign 1 to most important outcome (e.g., HIV positive)
- **Ordinal**
  - Values have a meaningful order (ranking) but magnitude between successive values is not known
  - *Size* = {*small, medium, large*}, grades, army rankings

Numeric Attribute Types

- Quantity (integer or real-valued)
- **Interval**
  - Measured on a scale of **equal-sized units**
  - Values have order
    - E.g., *temperature in C˚ or F˚, calendar dates*
  - No true zero-point
- **Ratio**
  - Inherent **zero-point**
  - We can speak of values as being an order of magnitude larger than the unit of measurement (10 K˚ is twice as high as 5 K˚).
    - e.g., *temperature in Kelvin, length, counts, monetary quantities*

Discrete vs. Continuous Attributes

- **Discrete Attribute**
  - Has only a finite or countably infinite set of values
    - E.g., zip codes, profession, or the set of words in a collection of documents
  - Sometimes, represented as integer variables
  - Note: Binary attributes are a special case of discrete attributes
- **Continuous Attribute**
  - Has real numbers as attribute values
    - E.g., temperature, height, or weight
  - Practically, real values can only be measured and represented using a finite number of digits
  - Continuous attributes are typically represented as floating-point variables