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Data Types

COMP3211 Advanced Databases

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Overview

- Data types and operations
- Temporal data
- Spatial data
- Multimedia data

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Data Types and Operations

Data Types

- Numeric
- Character
- Temporal
- Spatial
- Image
- Text
- Audio and Video

Operations on Data

- Comparison
- Arithmetic
- Fuzzy searches
- Retrieve all documents that contain a given word
- Find a picture that contains blue sky

Which operations are meaningful?

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Can you add two weights together?

- 2kg + 2kg = ?

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Can you add a weight to a quantity?

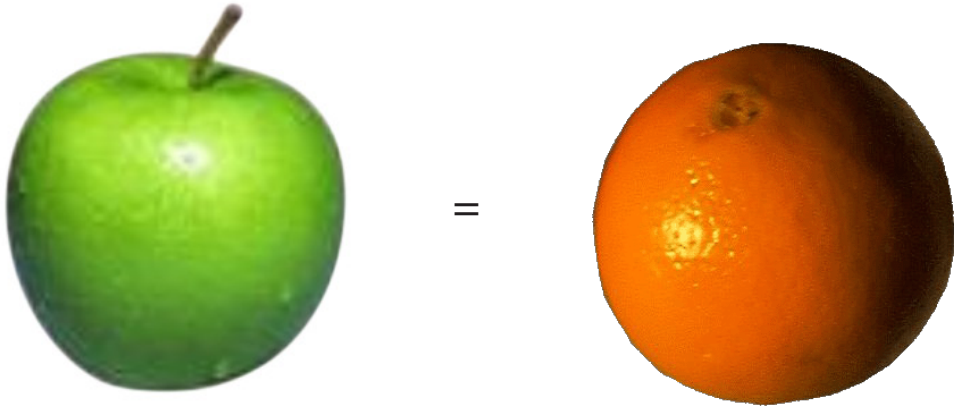
- 13 + 2kg = ?

Can you multiply a weight by a quantity?

- 13 * 2 kg = ?

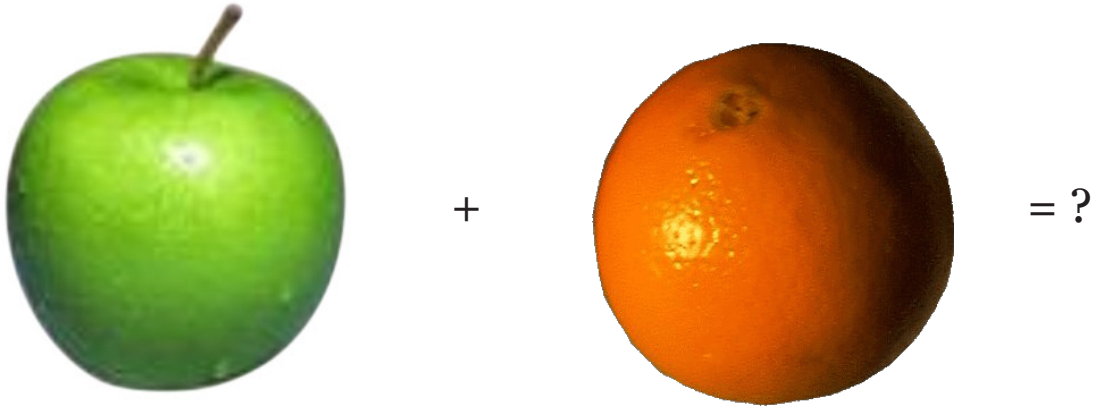
Which operations are meaningful?

Can you compare two images?



Which operations are meaningful?

Can you add two images?



Further Questions

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Is the data ordered in any sense?

- Total order vs. partial order

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Is the data ordered in any sense?

- Total order vs. partial order

Does the order actually have any meaning, or is it just a convenience?

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Temporal Data

Temporal Data

The dimension of time is needed to answer such questions as:

- What was the average price of product X during 1995?
- In which month did we sell the most copies of video Y?
- What was the treatment history for patient Z?

Characteristics of Time

Time structure

- Linear
- Branching time, possible futures
- Directed acyclic graph
- Periodic/cyclic

Boundedness of time

- Unbounded
- Time origin exists
- Bounded at both ends

Time Density: Discrete

Timeline is isomorphic to the integers

- Integers have a total order

Timeline is composed of fixed periods, termed *chronons*

Between each pair of chronons is a finite number of other chronons

Time Density: Dense

Timeline is isomorphic to the rational numbers

- Rational numbers have a partial order

Between each pair of chronons is an infinite number of other chronons

Time Density: Continuous

Timeline is isomorphic to the real numbers

- Real numbers have a total order

Between each pair of chronons is an infinite number of other chronons

Characteristics of Time

Granularity is important

- Event A occurs at 11.00am
- Event B occurs at 3.00pm the same day
- Does event A precede event B?
- The answer is different if
  - Granularity is one day
  - Granularity is one minute

There is also a distinction between sequence and time

Storing Times in a Database

Various times may be associated with an event that appears in a database

We may wish to record

- The Valid Time of a fact – when the fact is true in reality
- The Transaction Time of a fact – when the fact is current in the database, and can be retrieved
- Both of these (*bitemporal*)

SQL Extensions

TSQL includes:

- A WHEN clause (see next slide)
- Retrieval of timestamps
- Retrieval of temporally ordered information
- Using the TIME-SLICE clause to specify a time domain
- Using the GROUP BY clause for modified aggregate functions

TSQL WHEN Clause

Format of the SELECT … WHEN statement

- SELECT { select-list }
  FROM { list of relations }
  WHERE { where-clause }
  WHEN { temporal clause }

Temporal comparison operators include:

- BEFORE/AFTER, FOLLOWS/PRECEDES
  DURING, EQUIVALENT, ADJACENT, OVERLAPS
- (compare with Allen's Interval Calculus)

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Spatial Data

Spatial Data

Data Types include:

- Points
- Regions
  - Boxes
  - Quadrangles
  - Polynomial surfaces
- Vectors

Operations include:

- Length
- Intersect
- Containment
- Overlap
- Centre

Spatial Data Applications

Computer Aided Design (CAD)

Computer generated graphics

Geographic Information Systems (GIS

For these systems, the properties of interest would include:

- Connectivity
- Adjacency
- Order
- Metric relations

Spatial Data Characteristics

In systems dealing with space:

- Data objects may be highly complex
- Data volumes may be very large
- Data may be held in real time
- Performance is not easy to achieve
- Access is likely to be through specialised graphical front ends; operator skills are key
- Query processing will (probably) not be performed using SQL

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Multimedia Data

Textual Data

Text data may be

- Already in machine-readable form, from a word-processor, spreadsheet or other source
- Read using OCR techniques

Text data is essentially unstructured, and an index of some kind needs to be built

- By a human operator
- Automatically by building a inverted list of every significant word in the database

Textual Data

Markup languages do give some structure to a document

- HTML is a markup language for the Web

XML (and its predecessor SGML) allows a programmer to create portable documents that contain structured data

- Can also create new markup languages

Character Large Objects (CLOBs) are now commonly supported by vendors

- Able to store and handle text documents in addition to standard data
- Provision of text search and retrieval facilities

Text and Documents

Much data is stored in the form of text

It would be very useful to be able to ask queries such as:

- Find all the legal documents concerning client ‘Jones’
- Find all the suspects with false teeth who have been interviewed
- Find all the articles on ‘databases’

Image Data

Examples of still images include:

- X-Rays
- Maps
- Photographs

These are all classified as binary large objects (BLOBs)

- No attached semantics

Image Databases

An image database needs to provide support for:

- Image analysis and pattern recognition
- Image structuring and understanding
- Spatial reasoning and image information retrieval

Mainstream DB vendors now adding

- Support for BLOBs
- Access using QBIC (Query by Image Content)

Audio Data

Digitised sound

- Stored in various formats, such as WAV or MP3
- Consumes large amounts of storage
- Compression techniques normally used

MIDI (Musical Instrument Digital Interface)

- More compact than digitised audio
- Consists of a sequence of instructions:
  Note_On, Note_Off, Increase_Volume
- Interpreted by a synthesiser

Video Data

One of the most space hungry formats of all

- Images stored as a sequence of frames
- Each frame can consume over a megabyte
- Frames typically played back at 24-30 fps

To integrate video and audio, interleaved file structures incorporate times sequencing of audio/video playback

- Microsoft AVI
- Apple Quicktime

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Next Lecture: DBMS Architecture