Understanding RDBMS

IT4GIS

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FUNDAMENTALS

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RDBMS

- Relational Database Management System
- The "I" in GIS (*Information*)

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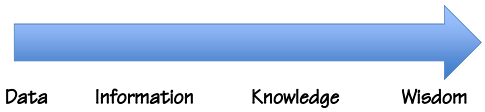
BTW

- The Data-to-Wisdom Pathway



cf., https://en.wikipedia.org/wiki/DIKW_pyramid

Database software...

- Light Duty
- Medium Duty
- Heavy Duty

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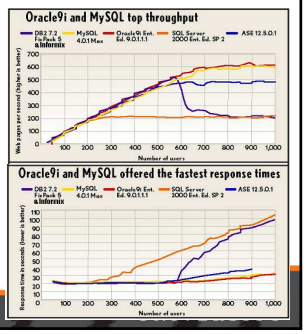
Relational Databases

- Why are databases important?
  - Drive many business processes
  - Store large amounts of data
  - Retrieve data quickly



Spreadsheets vs. Databases

- **Integrity!**
- **Structure**

RDBMS CONCEPTS AND TERMS

Independence

- Physical
- Logical

Logical Consistency Example

- Character based database design
  - FirstName (1-4)
  - LastName (5-10)
  - Address (11-46)

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
P a u l B u n y u n 1 0 0 M a i n   S t r e e t     P o c a t e l l o   I D 8 3 2 0 1
J o h n H e n r y   1 5 0 M a i n   S t r e e t     P o c a t e l l o   I D 8 3 2 0 1
```

- Record #1: Paul Bunyun, 100 Main Street, Pocatello, ID 83201

NOTE: Record #2 starts at character #47

What Happens When We Add a New Field?

- New Field = ZIP+4 (47-50)
  - Example, Paul's ZIP+4 = 1234
- Scripts written and referring to the original design will fail
- Record #1: Paul Bunyun, 100 Main Street, Pocatello, ID 83201
- Record #2: 1234 Johnhe, nry 150 Main Street, Pocatello, ID 8

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
P a u l B u n y u n 1 0 0 M a i n   S t r e e t     P o c a t e l l o   I D 8 3 2 0 1
      J o h n H e n r y   1 5 0 M a i n   S t r e e t     P o c a t e l l o   I D 8
```

Integrity

- Important for consistency and transaction management.
- Types:
  - Domain: all values come from predefined domains or are null
  - Redundancy: problems can occur as a result of repetitive storage that is not consistently updated and from stored data that is derived from other stored data. Redundant data must be consistent.

Integrity Types (cont'd)

- Constraint: Business integrity. Stored data must not violate business rules.
- Entity: Every record must be uniquely identifiable (index field or ObjectID)
- Referential: Relationships must not be ambiguous. Two types…

  Cascading or non-cascading

Enforcing Integrity Rules

- Programmatic
- Systematic

Key Fields versus Index fields

- Unique Identifiers are Index fields
- Relate fields are Key fields
  - –Primary key
  - –Foreign key

RDBMS STRUCTURE

Database Tables

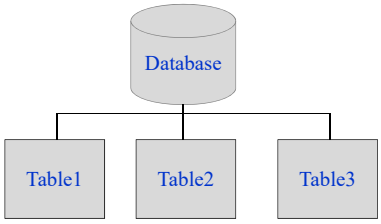


Table Structure

	COLUMN 1 (FIELD OR ATTRIBUTE)	COLUMN 2
ROW 1 (RECORD OR ENTITY)	VALUE	
ROW 2		

Data Value Types

Type Name	Storage Occupied/ data value	Valid Domain Range
Short Integer	2 bytes	-35768 to 32767
Long Integer	4 bytes	-2147483648 to 2147483647
Float	4 bytes	Any number from n^{-45} to n^{38}
Double	8 bytes	Any number from n^{-324} to n^{308}
Text (string)	10 + max. length = bytes	Any alphanumeric characters
Date	8 bytes	Jan 1, 100 to Dec. 31 9999
LOB (variant)	22 + max. length = bytes	Any alphanumeric characters

(BTW) Raster Data Types Worth Knowing

- **1_BIT**—A 1-bit unsigned integer. The values can be 0 or 1.
- **2_BIT**—A 2-bit unsigned integer. The values supported can be from 0 to 3.
- **4_BIT**—A 4-bit unsigned integer. The values supported can be from 0 to 15.
- **8_BIT_UNSIGNED**—An unsigned 8-bit data type. The values supported can be from 0 to 255.
- **8_BIT_SIGNED**—A signed 8-bit data type. The values supported can be from -128 to 127.
- **16_BIT_UNSIGNED**—A 16-bit unsigned data type. The values can range from 0 to 65,535.
- **16_BIT_SIGNED**—A 16-bit signed data type. The values can range from -32,768 to 32,767.
- **32_BIT_UNSIGNED**—A 32-bit unsigned data type. The values can range from 0 to 4,294,967,295.
- **32_BIT_SIGNED**—A 32-bit signed data type. The values can range from -2,147,483,648 to 2,147,483,647.
- **32_BIT_FLOAT**—A 32-bit data type supporting decimals.
- **64_BIT**—A 64-bit data type supporting decimals.

Making Sense of all this…

- Recall, there are 8 bits in 1 byte
- Cross-reference
  - 8-bit is byte data
  - 16-bit is short integer (2 bytes)
  - 32-bit (signed or unsigned) is long integer (4 bytes)
  - 32-bit (float) is single-precision floating point (4 bytes)
  - 64-bit is double-precision floating point (8 bytes)

DATABASE DESIGN

Basic Steps in Database Design

- Understand and document the business' needs.
  - Problem statement
  - Business object types
  - Business relationships
  - Business constraints
- Create an ERM
- Data and process inventory
- Develop tuple types
- Tuple types to tables
- Integrity
- Populate the database

READING A BUSINESS STATEMENT

Identify Candidate Classes

- A *candidate* class may or may not remain a class throughout the design process
  - A *candidate* class may or may not become a table
- Try not to think about tables when reading the business statement at this point

Think Object-Oriented

- Classes are nouns
- A noun is a "person, places, and things"

SCHOOLHOUSE ROCK

Methods

- Identifying *candidate* methods allows us to better understand how the business operates and how the Enterprise uses GIS data.
- A method is a behavior…a relationship between classes
- Ultimately, a connection between two tables
- The candidate methods will describe an inheritance, aggregation, or dependency relationship

And now…Verbs

- *Candidate* methods are verbs
  - They show action
  - They are behaviors

Create an Entity Relationship Model (ERM)

- Symbolized.
  - Standard Representation
  - Attribute Representation
  - Entity Instance Representation

BUILDINGS
K BldgNum: 126 Name: Graveley Hall Type: Education

Relationships

- Determine the **Relationship** between **Entity Types**.
- Add these to the **ERM**

(more about database relationship classes later in the semester)

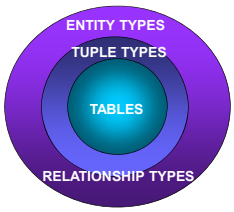
Data and Process Inventory

- Database Dictionary
  - BldgName
    - The name of the building
  - Type
    - Primary use of the building (e.g., 0 = Unknown or n/a; 1 = Education, 2 = Offices, etc.)
  - Floors
    - The total number of floors

Develop Tuple Types

- Use your ERM with relationships
- Perform a "Walk-through" exercise
  - Simulate data is being added/retrieved in your database.
- Create another, more matjure ERM using Attribute Representation

Tuple Types to Tables



Normalization

- First-Fifth Form Normal (**1FN , 2FN ,…5FN**)
- Academic
- Applied

1FN

- "All values are atomic"
  - Each cell in the table contains only a single data value
- Eliminate repeating groups
  - Puppy_Trick1, Puppy_Trick2, …

.

Check this (1FN)…

Field Name	Data Type	Length	Description	Examples
OWNER1	Text	100	Owner of Parcel	John Smith
OWNER2	Text	100	Additional owner of parcel	Mary Smith
MAIL_ADD1	Text	100	Mailing address of owner	1234 S Paper Rd
MAIL_ADD2	Text	100	Additional mailing address of owner	Apt 5C
MAIL_CITY	Text	100	Mailing city of owner	Anaktuvuk Pass
MAIL_STATE	Text	2	Mailing state of Owner	AK
MAIL_ZIP	Text	10	Mailing U.S. zip code of owner	99721-0000
MAIL_CNTRY	Text	100	Mailing country of owner	USA
SITE_ADD	Text	100	Site address of property	6769 W Stapley Ave
SITL_CITY	Text	100	City of property	Nampa
SITL_ZIP	Text	10	Zip code of property	83653-0000
CATEGORY1	Text	2	Assessed land use	01
CATEGORY2	Text	2	Assessed land use	02
CATEGORY3	Text	2	Assessed land use	03
CATEGORY4	Text	2	Assessed land use	04
CATEGORY5	Text	2	Assessed land use	05
CATEGORY6	Text	2	Assessed land use	06
CATEGORY7	Text	2	Assessed land use	07
IRR_ACRES	Double	TBD	Irrigated acreage by land use category	7.560
DRY_ACRES	Double	TBD	Dryland agricultural acreage by land use category	1.648
ZONING	Text	TBD	Zoning category	RSW
DESC1	Text	TBD	Property description	PAR #9500 of S2SE4
DESC2	Text	TBD	Property description	SEC26 3N 1E
DESC3	Text	TBD	Property description	#449100-S
DESC4	Text	TBD	Property description	
DESC5	Text	TBD	Property description	
SUBDIV	Text	TBD	Subdivision name	Happy Valley
VALUATION	Integer	TBD	Net assessed value of property	100.000

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2FN

- Satisfy 1FN and…
- Redundant **data** must be eliminated
  - How?
  - Example: Puppy_ID, Trick_ID, Trick_Name

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Check this (2FN)…

Field Name	Data Type	Length	Description	Examples
OWNER1	Text	100	Owner of Parcel	John Smith
OWNER2	Text	100	Additional owner of parcel	Mary Smith
MAIL_ADD1	Text	100	Mailing address of owner	1234 S Paper Rd
MAIL_ADD2	Text	100	Additional mailing address of owner	Apt 5C
MAIL_CITY	Text	100	Mailing city of owner	Anaktuvuk Pass
MAIL_STATE	Text	2	Mailing state of Owner	AK
MAIL_ZIP	Text	10	Mailing U.S. zip code of owner	99721-0000
MAIL_CNTRY	Text	100	Mailing country of owner	USA
SITE_ADD	Text	100	Site address of property	6769 W Stapley Ave
SITL_CITY	Text	100	City of property	Nampa
SITL_ZIP	Text	10	Zip code of property	83653-0000
CATEGORY1	Text	2	Assessed land use	01
CATEGORY2	Text	2	Assessed land use	02
CATEGORY3	Text	2	Assessed land use	03
CATEGORY4	Text	2	Assessed land use	04
CATEGORY5	Text	2	Assessed land use	05
CATEGORY6	Text	2	Assessed land use	06
CATEGORY7	Text	2	Assessed land use	07
IRR_ACRES	Double	TBD	Irrigated acreage by land use category	7.560
DRY_ACRES	Double	TBD	Dryland agricultural acreage by land use category	1.648
ZONING	Text	TBD	Zoning category	RSW
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DESC3	Text	TBD	Property description	#449100-S
DESC4	Text	TBD	Property description	
DESC5	Text	TBD	Property description	
SUBDIV	Text	TBD	Subdivision name	Happy Valley
VALUATION	Integer	TBD	Net assessed value of property	100.000

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3FN

- Satisfy 1NF and 2FN and…
- No non-key attributes are dependent on other non-key attributes.
  - Example: Appointment_ID, Name, Date, Time, Species

After Normalization

- New **tuple types** will be created.
- New **tables** will be planned.
- Many-many relationships will be handled using associative tables (bridge tables).

De-Normalization

- What? Is this heresy?

Designing the Actual RDBMS

- Visual modeling based upon your **ERM** and **Tuple type** model.
- Implementation of integrity rules based upon your business constraints.

Populate the Database

- Questions and concerns to revisit
  - –Null data
  - –Reporting discrepancies and variations
  - –Measuring or estimating methods
  - –Client utility/efficiency

The Last Step?

Professional Hints and Tips

- Using Google drive, sharing files/folders and communicating this in email

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Questions?

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