Announcements

- Subscribe to the mailing list: cs23500
  - Details are on the course web page
- Office hours
  - Svetlozar: by appointment
  - Xuehai: 2-4pm Fridays
- As always, details are on the web!

The Big Picture

- Stages of building DB application:
  - Real-world domain.
    - understand client needs.
- Design data model:
  - using entity-relationship (E/R) model
- Database data model:
  - using relational model
- Create schema in DBMS, load data.
- Open for business!
- Maintenance

Last Time

- Entity-Relationship Model

Subclasses

- Subclass:
  - special case
  - fewer entities
  - more properties.
- Example: Ales are a kind of beer.
  - In addition to the properties (= attributes and relationships) of beers, there is a color attribute for ales.

Outline

- More design issues:
  - Subclasses,
  - Keys,
  - Weak entity sets.
- Exercise problems
E/R Subclasses
- *isa* triangles indicate the subclass relation.

<table>
<thead>
<tr>
<th>Color</th>
<th>Ales</th>
</tr>
</thead>
</table>
| name  | Beers

Different Subclass Viewpoints
- *E/R viewpoint*: An entity has a *component* in each entity set to which it logically belongs.
  - Its properties are the union of the properties of these E.S.
- *Object-oriented viewpoint*: An object (entity) belongs to exactly one class.
  - It *inherits* properties of its superclasses.

Subclasses Example
- *isa* relation between Beers and Goose Island India Pale Ale

Multiple Inheritance
- Theoretically, an E.S. could be a subclass of several other entity sets.

Problems
- How should conflicts be resolved?
- Example: *manf* means grower for wines, bottler for beers. What does *manf* mean for "grape beers"?
- Need ad-hoc notation to resolve meanings.
- In practice, we shall assume a tree of entity sets connected by *isa*, with all "isas" pointing from child to parent.

Keys
- A *key* is a set of attributes whose values can belong to at most one entity.
  - The value of a key is *unique*.
- In E/R model, every E.S. must have a key.
  - It could have more than one key, but one set of attributes is the *designated key*.
- In E/R diagrams, you should underline all attributes of the designated key.
Example

- Suppose \textit{name} is key for Beers.

- Beer \textit{name} is also key for ales.
  - In general, key at root is key for all.

Example: A Multiattribute Key

- What is the key?

Weak Entity Sets

- Sometimes an E.S. \(E\)'s key comes not (completely) from its own attributes, but from the keys of one or more E.S.'s to which \(E\) is linked by a \textit{supporting} many-one relationship.
- Called a \textit{weak} E.S.
- Represented by putting double rectangle around \(E\) and a double diamond around each supporting relationship.
- Many-one-ness of supporting relationship (includes 1-1) essential.
  - With many-many, we wouldn't know which entity provided the key value.

Example: Email Addresses

- Email address = user name + host name, e.g., evtimov@cs.uchicago.edu.
- Email address corresponds to a user name on a particular host.
- Once on a host, you only need user name, e.g., evtimov
- Key for an email = the user name at the host (which is unique for that host only) + the IP address of the host (which is unique globally).

Example: Chain of \textit{Weakness}

- Consider IP addresses consisting of a primary domain (e.g., \textit{edu}), subdomain (e.g., \textit{uchicago}), and host (e.g., \textit{cs}).
Chain of Keys

- Key for primary domain = its name.
- Key for sub-domain = its name + name of primary domain.
- Key for host = its name + key of sub-domain = its name + name of sub-domain + name of primary domain.

All Connecting Entity Sets Are Weak

- In this special case, where bar and beer determine a price, we can omit price from the key, and remove the double diamond from ThePrice.
- Better: price is an attribute of BBP.

Design Principles

- Faithfulness to requirements.
  - Remember the design schema should enforce as many constraints as possible. Don't rely on future data to follow assumptions.
  - Example: If registrar wants to associate only one instructor with a course, don't allow sets of instructors and count on departments to enter only one instructor per course.

Good and Bad Design
Good and Bad Design

Bad?

- Question: Why is it OK to have *Beers* with just its key as attribute? Why not make set of beers an attribute of manufacturers?

Exercise Problem 1

- Multiway relationships

Exercise Problem 2

- E/R diagrams