UML Specification by Example: Objects/Data

- With use cases defined, the next specification to look at is the meat and potatoes of the rest of this course — the data model
- In pre-object-oriented days, the conceptual schema was modeled using *entity-relationship (E-R)* notation
- Today's tools and languages allow for a conceptual schema that maps pretty well to an object-oriented code base, which with just a little more work can translate into the relational data model in a straightforward manner

- Just so you don't have to dig up the previous handout again, here is our natural-language write-up for our sample application:

We would like to create a student information and document management system, to augment the student records that are already maintained by the university. With this system, a user can maintain a list of student records. Linked to each student record would be a set of documents. Each document would have a timestamp, and can be bound to any number of keywords, which are also defined in a separate list. The actual document files (such as PDF) can be uploaded to the system and stored on a server; they can then be retrieved by (at least) student, date, and/or keyword. The keyword list can be added to as needed, and functions for adding new students and maintaining existing student data would also be required. The preferred end-user interface would be the Web, although the overall architecture may also accommodate other UIs such as Swing.

Structural Modeling Concepts

Concept	Linguistic Role	E-R Term	UML Term
real-world items stored by the system	nouns	entity set | entity	class | object
connections between items	verbs	relationship set | relationship	association | link
properties that describe items	adjectives	attribute	attribute
properties that describe connections	adverbs	descriptive attribute	relationship class | object
distinguishing/unique properties	proper nouns	key	object identifier

- Nouns and verbs have two "levels" of existence: as the *category* to which they belong (*entity set*; *class*) and as a specific occurrence of that category (*entity*; *object*)

- *Generalization/specialization*: entities may indicate that they are specializations or subclasses of other entities

- *Containment*: entities may "hold" other entities through *aggregation* or *composition* relationships

- *Cardinality*: relationships/associations typically indicate how many entities participate in them — *1-to-1*, *1-to-many*, *many-to-1*, *many-to-many*

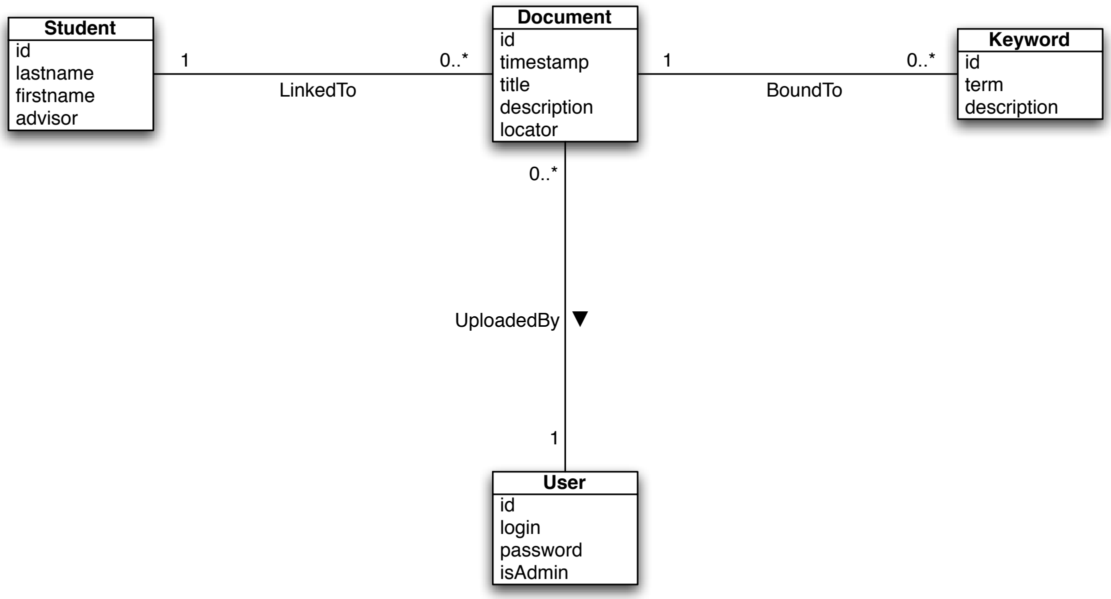
- *Composite/multivalued attributes*: attributes may be broken down into sub-attributes or may hold multiple values in the same "slot"

E-R vs. UML

- E-R (1976) predates UML (version 1.1 in 1997)
- "Pure" E-R has been extended in different ways; collectively these variants are called "extended E-R"
- UML covers broader ground than E-R, covering *structure* (*class*, *use case*, *component* diagrams) and *behavior* (*sequence/collaboration*, *state*, *activity* diagrams)
- UML class notation is a direct descendant of E-R and extended E-R notations, integrating object-oriented constructs that weren't around when E-R was born

Structural Diagram Notation

- Just as with use cases, your data model diagram is the *means*, not the *end*
- Unlike use cases, however, a data model is really primarily about structure, and so a diagram is definitely more compelling than a text write-up — but, it still helps in some situations
- These days, structural diagrams generally have two concrete destinations — an object-oriented environment at runtime (e.g. Java), and a relational database for persistence (e.g. PostgreSQL)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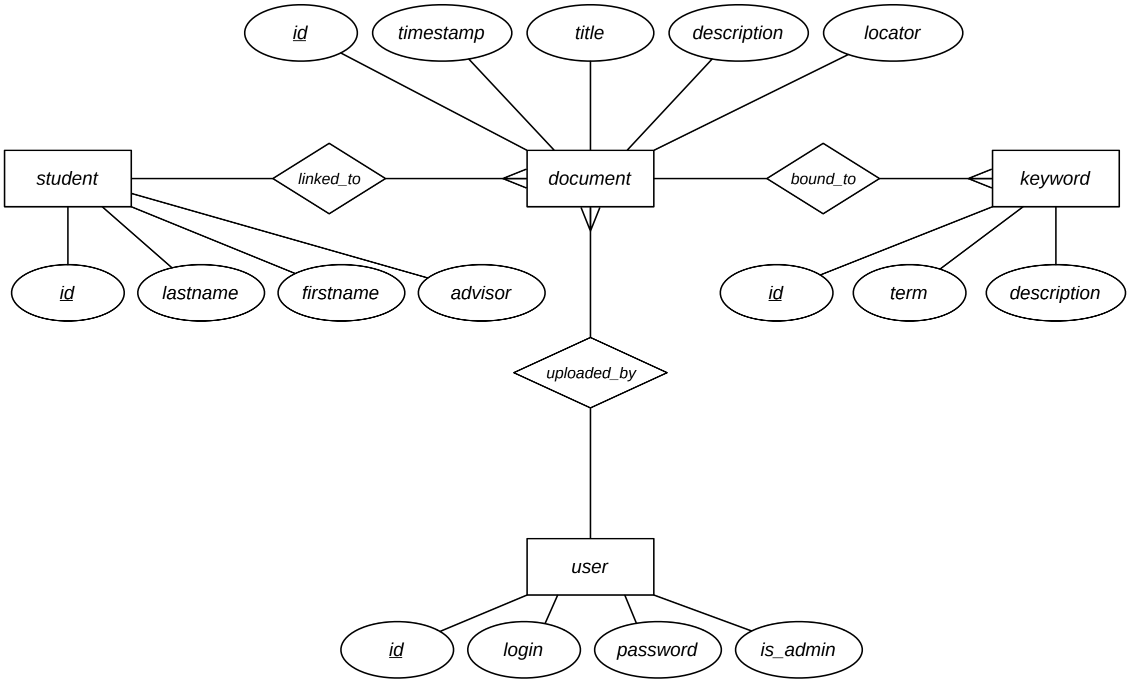
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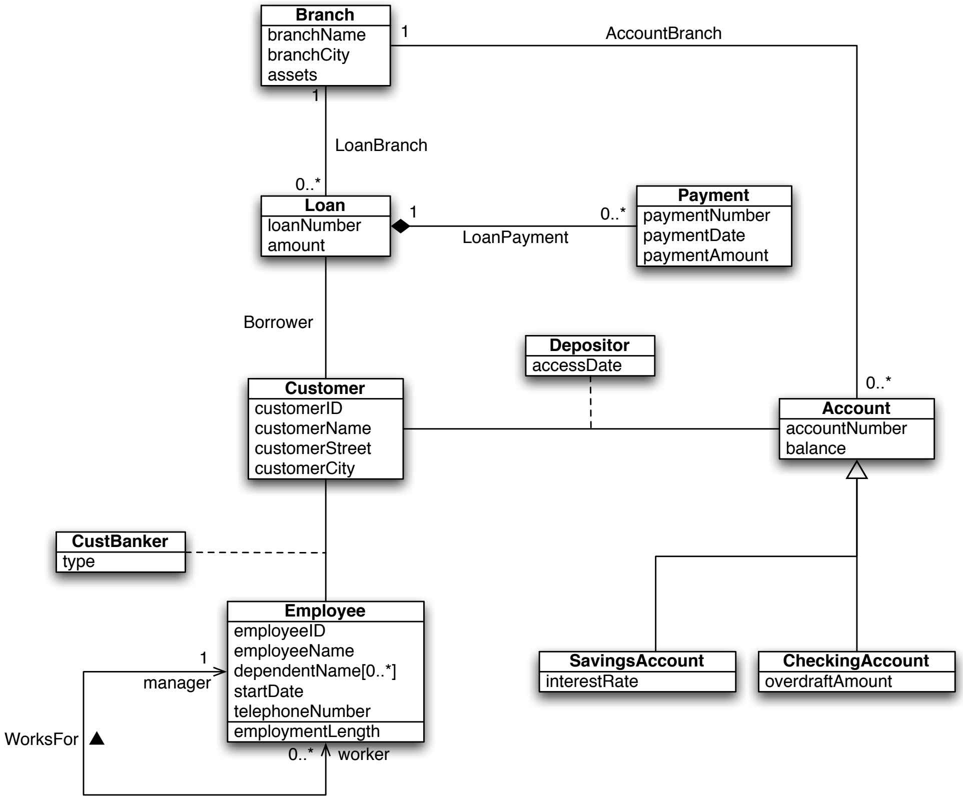

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Payment
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paymentAmount

Borrower

Depositor
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customerStreet
customerCity

Account
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telephoneNumber
employmentLength

1
manager
WorksFor ▲
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worker

SavingsAccount
interestRate

CheckingAccount
overdraftAmount

Depending on the size of the project and/or its development team, these can happen next:

- Dive into further detail:
    - ◇ Add more information to the data model, such as more specific attribute information (types, default values, constraints), defining methods, etc.
    - ◇ Create the other types of diagrams within UML's scope: component, behavioral diagrams
- On the database front, the conceptual model would need to be implemented in terms of the target database's logical model
    - ◇ When the conceptual model is implemented at runtime in an object-oriented environment (e.g., Java) and is persisted in a relational database, this process goes by the specific term "object-relational (OR) mapping"