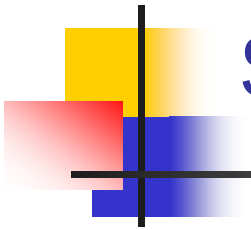
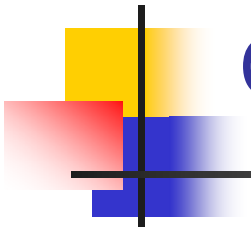
Logical E/R Modeling: the Definition of 'Truth' for Data

Jeff Jacobs
Jeffrey Jacobs & Associates
Belmont, CA
phone: 650.571.7092
email: jeff@jeffreyjacobs.com
http://www.jeffreyjacobs.com



Survey

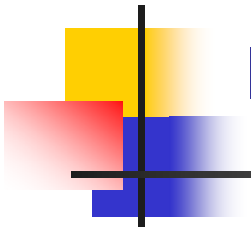
- Do you plan to use Designer?
- Do you plan to use ERWIN?
- Do you plan to use another tool?
- Are you using UML?
- Does your organization have a methodology or process, such as RUP?



Objective

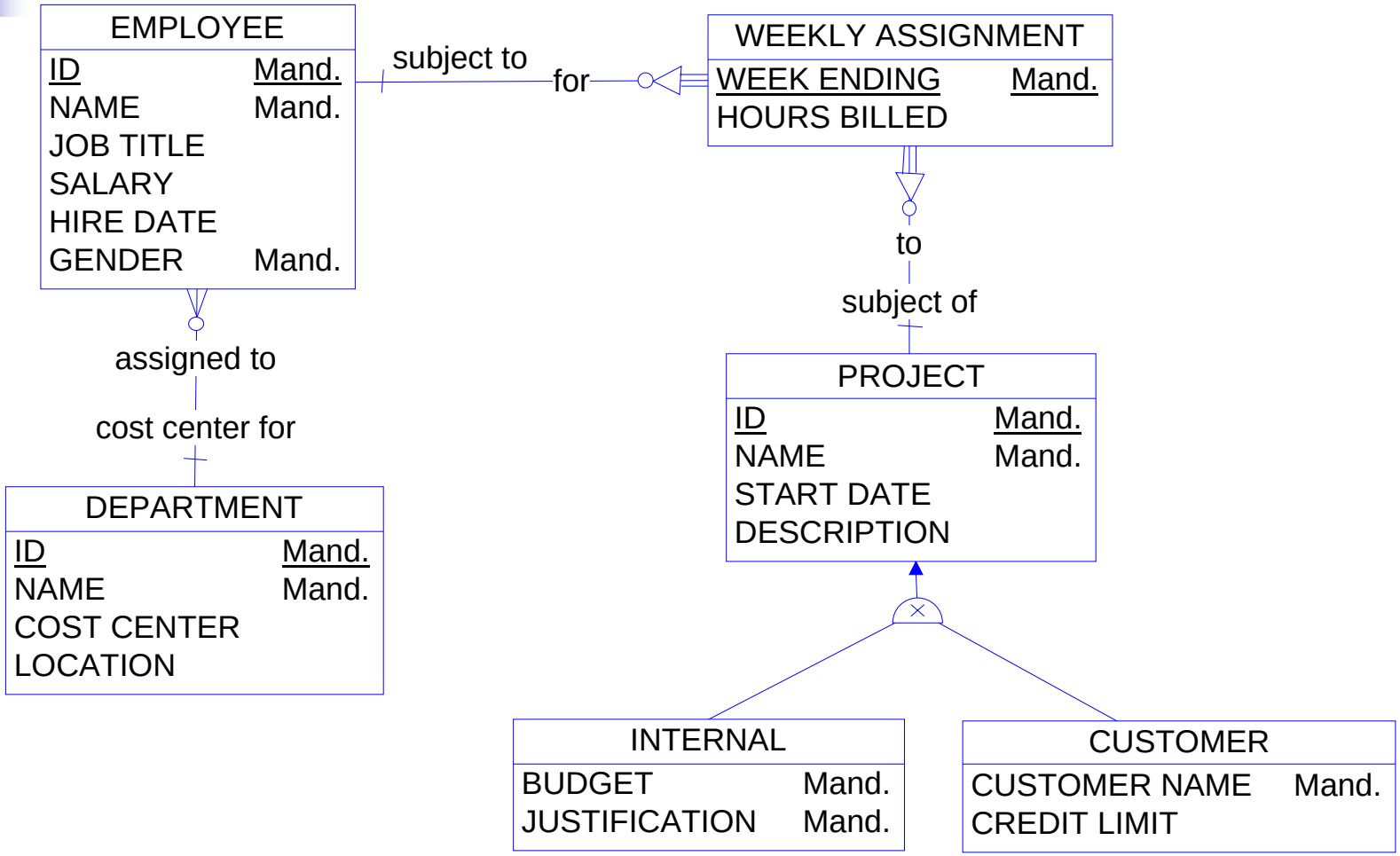
- Learn the fundamentals of Entity Relationship modeling
- Why?
  - Improve overall quality of product requirements
  - Ensure that all necessary data is present for all areas of products, including reporting
  - Understand the business requirements
  - Provide basis for implementation
  - Provide basis for UML class model

Introduction to Entity Relationship Modeling

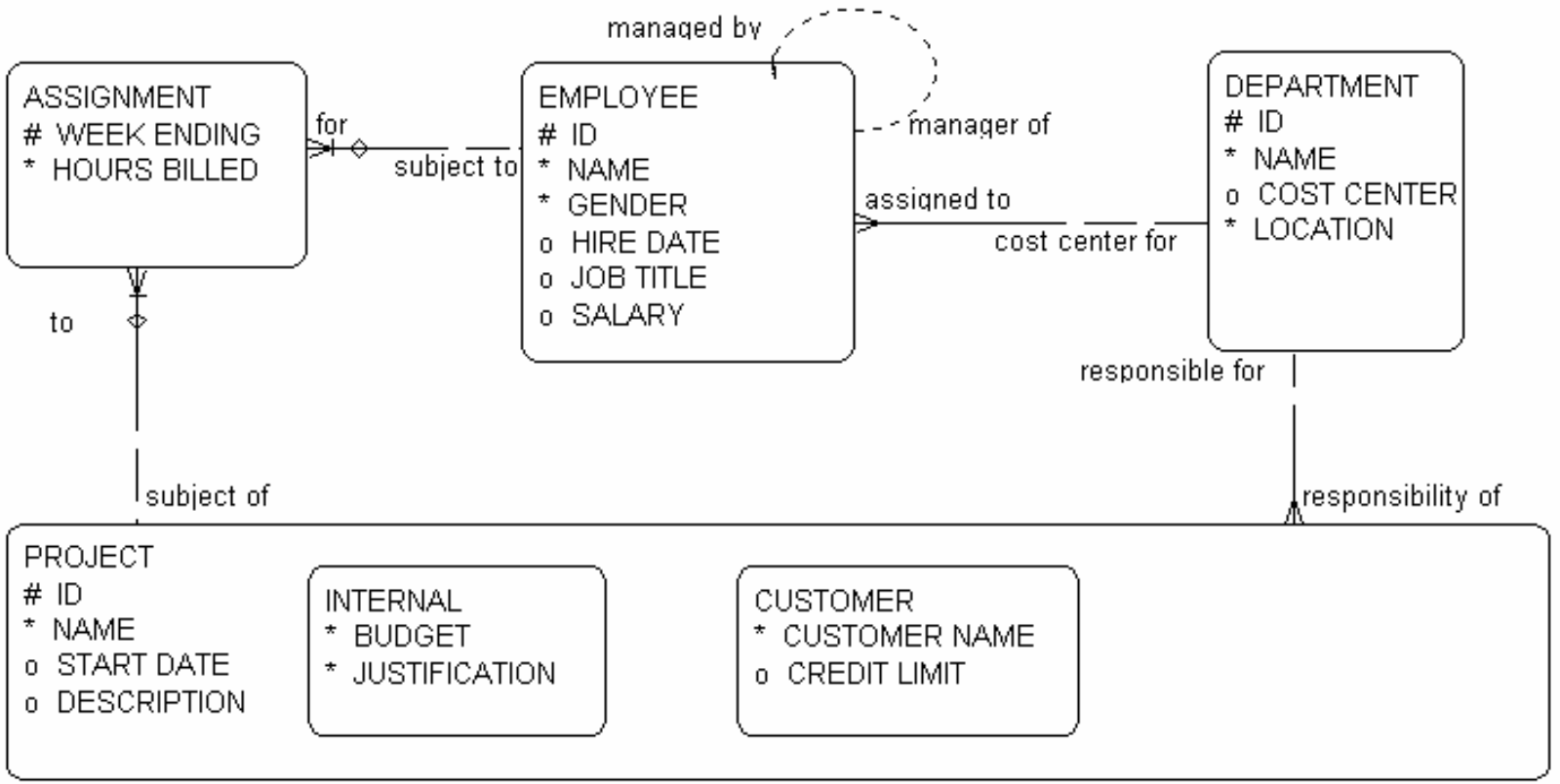


- ER modeling establishes the “information requirements” of the business, e.g. *What information must be kept to meet the functional requirements*
- An ER model consists of definitions of *entities*, *attributes*, *relationships*, *domains* and supporting detailed information
- An ER Diagram (ERD) is a “picture” of the model
- Numerous notations including Oracle, “Information Engineering”, IDEF1X
- Many tools have their own notation(s)

ERD Example (PowerDesigner “IE”)



ERD Example (Oracle)



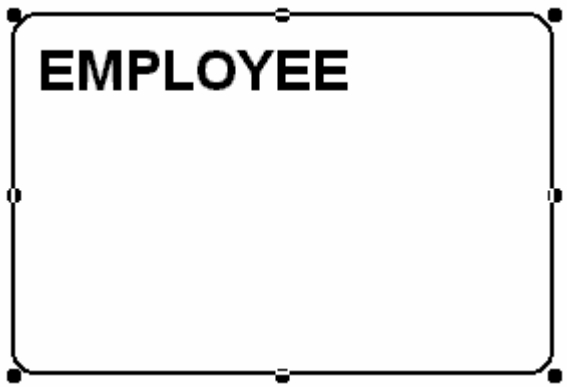
ER Modeling is “Semantic”

- ER modeling establishes information and data requirements, without regard to the eventual implementation
  - implementation may be relational database, object stores, in-memory data or even paper
  - typical implementation is relational database
- Also called “Semantic Data Model”
- Sometime called “Conceptual”
- “Physical Data Model” (PDM) has additional information for generating relational database; diagrams are similar
- Disagreement over “Logical Data Model”…

Entities

- "A thing of significance in the business about which information must be kept and maintained"
- Entity name is always singular
- Entity name is meaningful to the business, part of common vocabulary
- 2 categories of information
  - 1) Attributes
  - 2) Relationships with other entities
- Drawn as square box

Entity Example



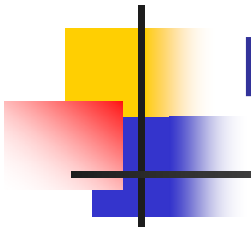
Instances and Occurrences

- Entity definition is a “type” or “class” description, e.g. EMPLOYEE
- Don’t confuse entity “type” with “occurrence/instance” of an entity, e.g. Joan Smith is an occurrence of the entity type EMPLOYEE

Attributes

- "Individual, atomic pieces of data *about* an entity"
- Never used to refer to another entity. (Attributes are *not* foreign keys in ER)
  - Some notations show "foreign keys"
- Attributes may be mandatory or optional
- Mandatory means "*every instance of the entity must, at all times, with no exceptions of any duration, have a valid, non-NULL value for the attribute*"
- Optional means "*value may sometimes by undefined or unknown*", NULL
- In Oracle, "*" means mandatory, "o" means optional
- Other notations/tools differ

Entity Example with Attributes



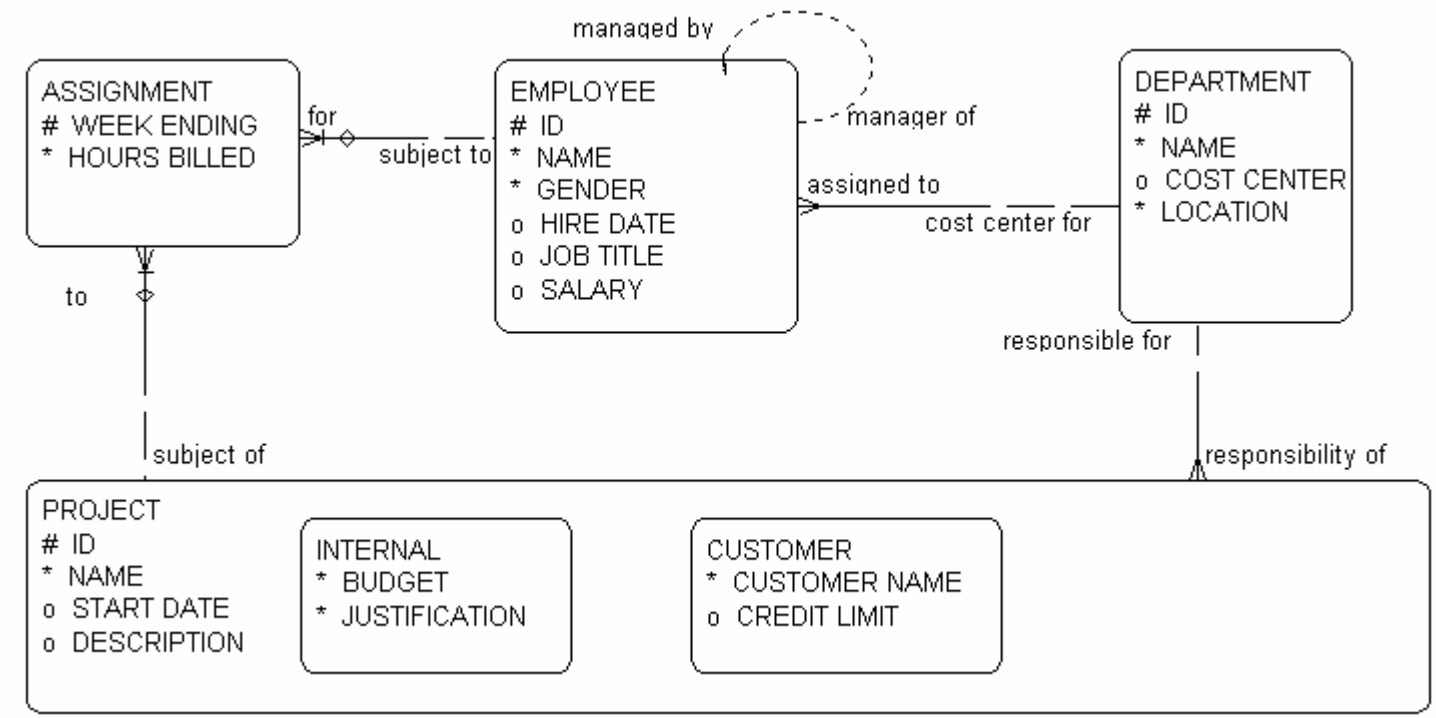
Domains

- Domain is a centralized definition of valid values and datatype information for attributes (and columns)
- Attributes that “belong” to a domain inherit the characteristics of the domain, e.g. datatype information and allowable values
- Example: “Gender” domain has datatype of VARCHAR2(1) and valid values of [M|F|U] with meanings of “Male”, “Female”, “Unknown”
- Attributes can have the same name as the domain to which they belong
- Domains can be “nested”, providing levels of validation, e.g. the SALARY domain belongs to the MONEY domain
- No ”diagramming” technique for domains
- Domains usually result in column constraints or reference tables/classes

Relationships (not Relations)

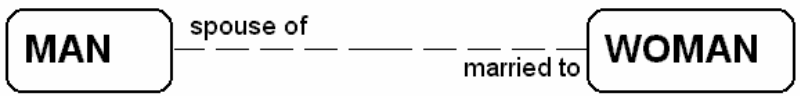
- “A named/labeled association between two entities” (drawn as a line)
- Two names for a relationship, one for each direction
- Naming is very important
  - critical to understanding
  - defines *semantics* in resulting implementation in business terms

Entities with Relationships Example



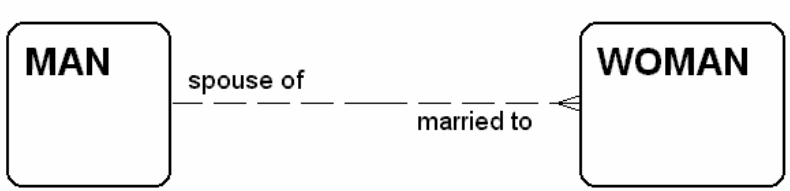
Optionality

- Relationships have *optionality* expressed as either *mandatory* or *optional* in each direction
- "Mandatory" means "*every occurrence of the entity must always, at all times, with no exceptions of any duration, be associated with an instance of the entity at the other end"*
- "Optional" means "need not always be associated..."



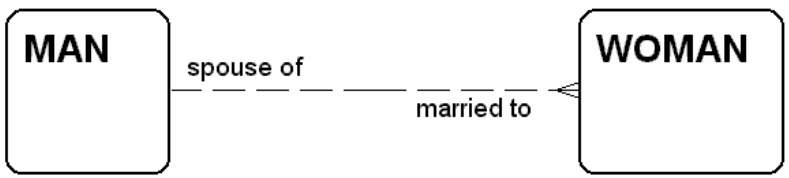
Cardinality

- (Maximum) Cardinality comes in two flavors
  - 1) "*One and only one*", e.g. each occurrence of an entity may be associated with at most one occurrence at the other end; optionality determines if such an association must exist
  - 2) "*One or more*", e.g. each occurrence may be associated with zero (depending on optionality), one or more occurrences at the other end



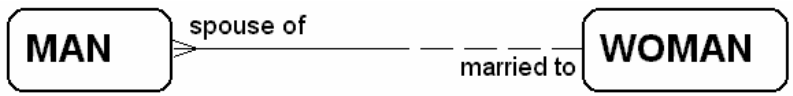
Reading Relationships

- Proper reading of relationship contributes to reliability and confidence
- Relationships should be understandable in both directions
- Reading starts with <entity1>
- EACH <entity1> [MAY BE | MUST BE] <rel1> [ONE OR MORE | ONE AND ONLY ONE] <entity2>
- “EACH” reminds us that we are talking about instance/occurrences of entities



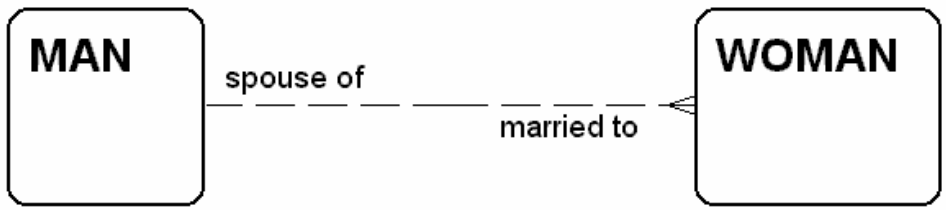
Optionality (Oracle Notation)

- [MAY BE | MUST BE] expresses optionality; more understandable than “zero”
  - dotted/dashed line is “MAY BE”
  - solid line is “MUST BE”
- [ONE OR MORE | ONE AND ONLY ONE] expresses maximum cardinality
  - *presence* of crow’s foot at end opposite <entity1> is “ONE OR MORE”
  - *absence* of crow’s foot at end opposite <entity1> is “ONE AND ONLY ONE”



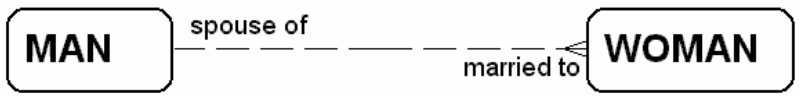
Relationship

- Read relationship name *adjacent to entity1*
- Example: EACH ENTITY1 MUST BE <rel1> ...



Cardinality

- Look at symbols on line adjacent to <entity2> to determine cardinality
- [ONE OR MORE | ONE AND ONLY ONE] expresses maximum cardinality
  - 1) presence of crow's foot at end adjacent to <entity2> is "ONE OR MORE"



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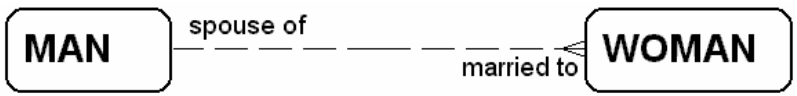
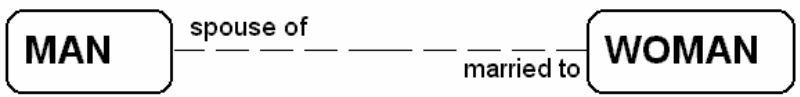
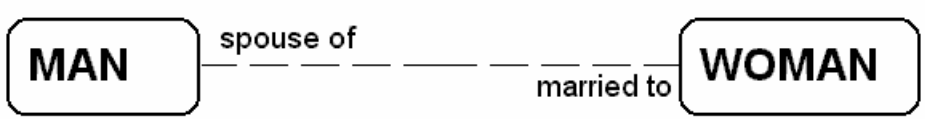
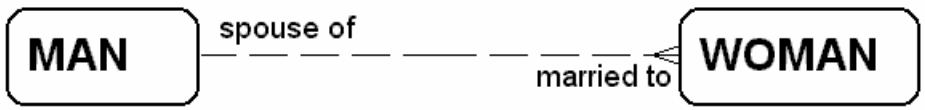


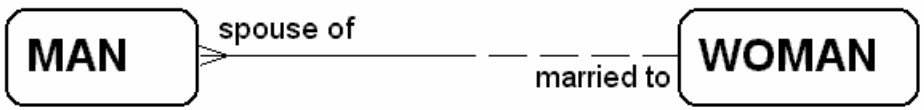
  - 2) absence of crow's foot at end adjacent to <entity2> is "ONE AND ONLY ONE"



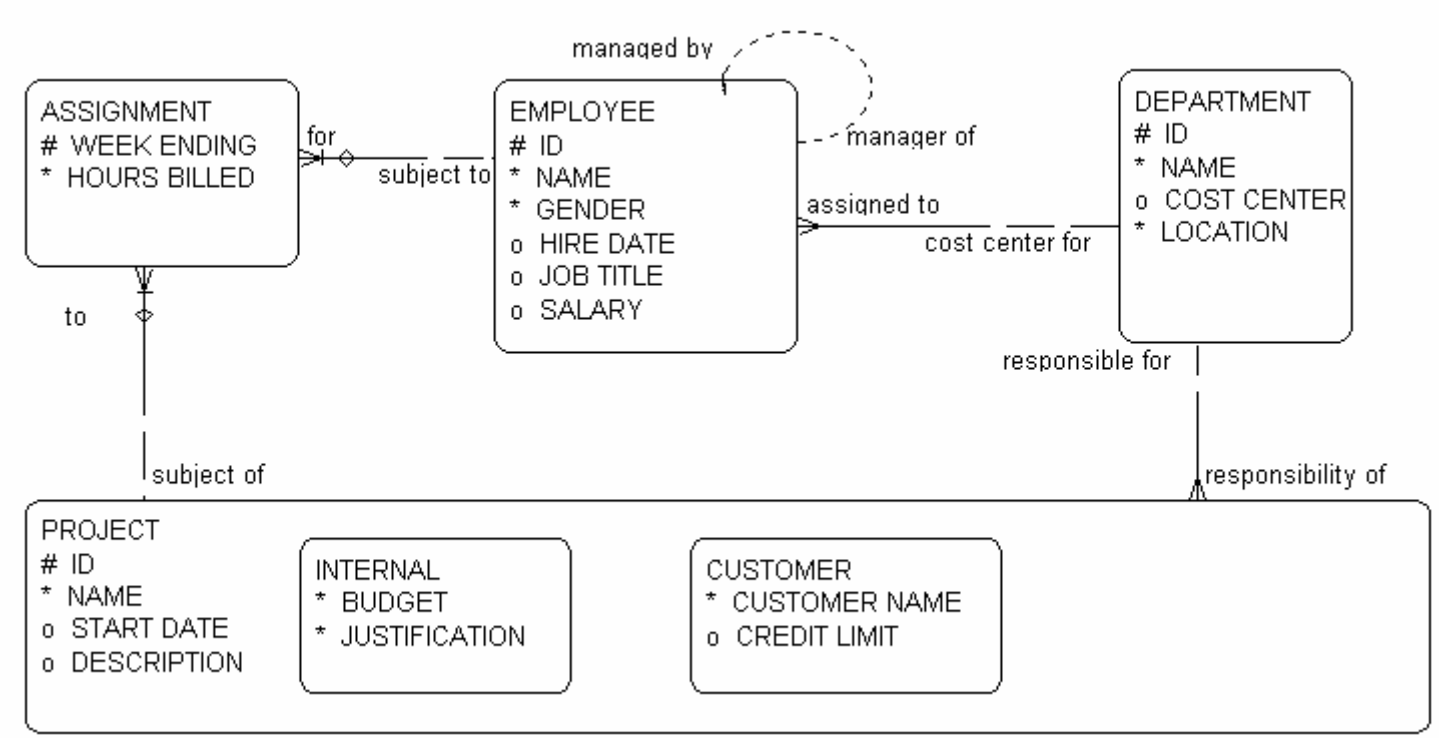
Anthropological Examples





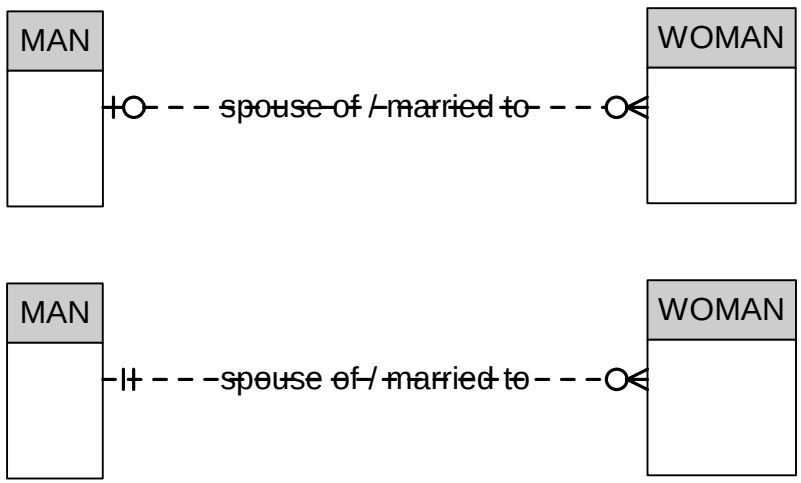


Relationship Reading Exercises



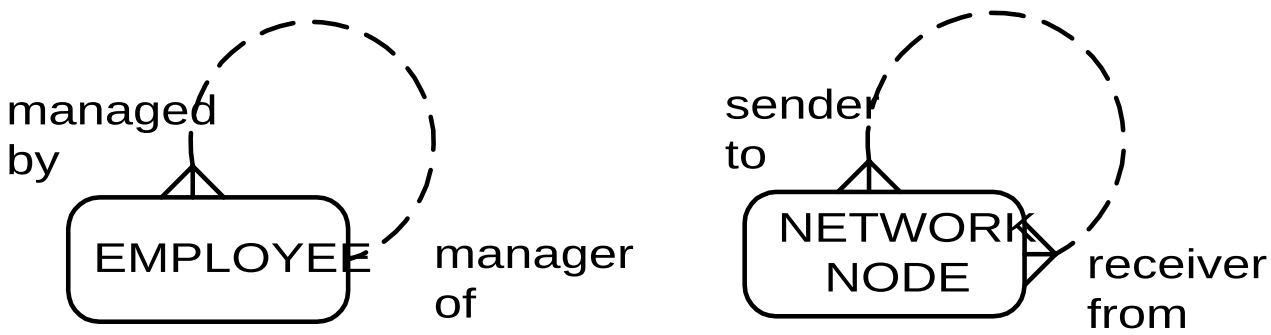
Optionality/Cardinality in IE and Others

- In Oracle, absence of crow's foot means "one"
- In Information Engineering notation, presence of "|" means "one"
- Presence of "0" (or "o") indicates "zero', i.e. optional
  - Occurs at *opposite end, not adjacent to starting entity*
- Examples:



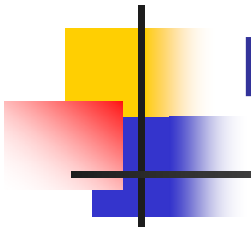
Reflexive/Recursive Relationships

- Relationships may exist between occurrences of the same entity type
- Recursive relationships are used for hierarchies and networks
- Must be optional in both directions



Unique Identifiers (UID)

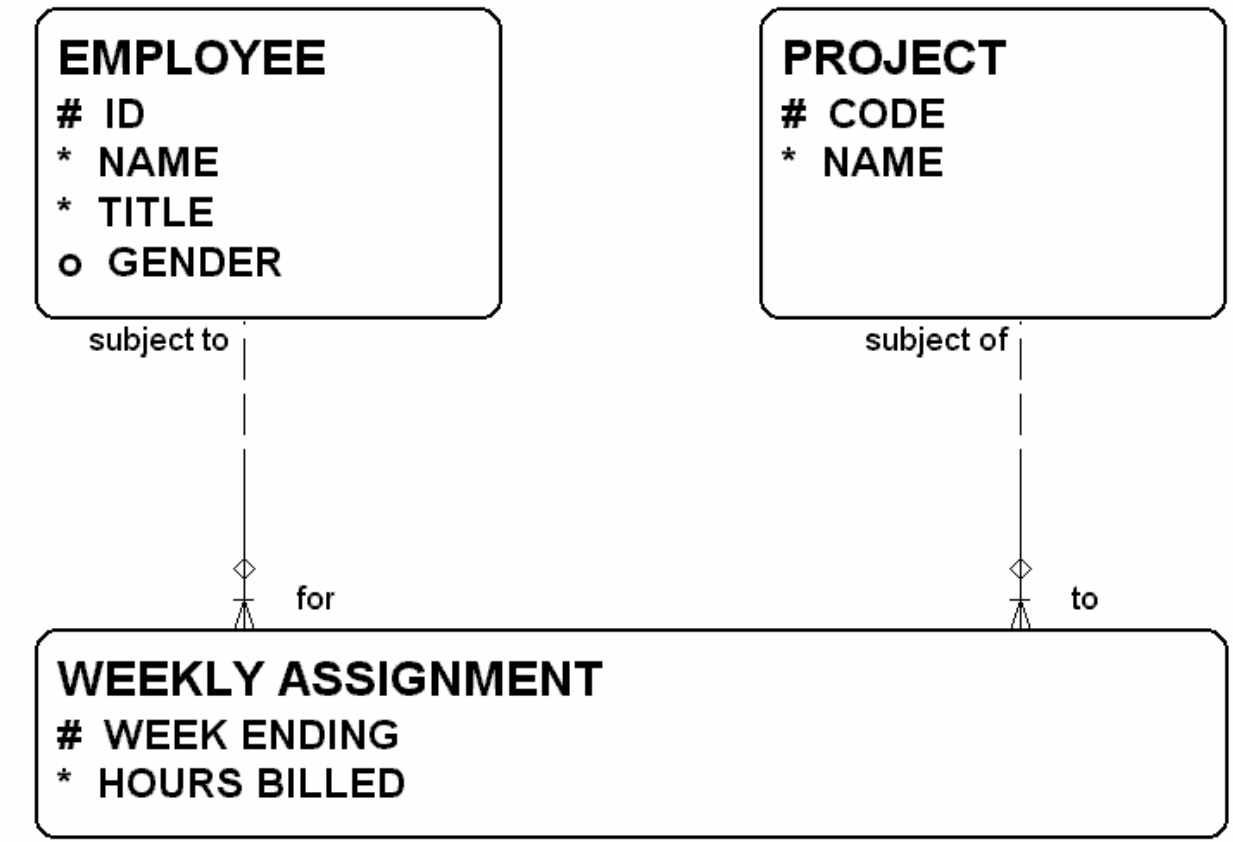
- A combination of attributes and/or relationships used to uniquely identify and distinguish each occurrence of an entity from all others
- No two occurrences may have the same set of values for all parts of the UID
- UID may consist of
  - 1) single attribute
  - 2) multiple attributes
  - 3) multiple relationships
  - 4) combination of attribute(s) and relationship(s)



More UID

- All parts of UID must be mandatory
- Attributes that are part of UID have a # in front of them (Oracle)
- Relationships in a UID have a "|" (Oracle) on the relationship line; opposite end must be singular, without crow's foot
- Terminology note: relationships in a UID are also referred to as "dependent" relationships
- *Note that the "*|" is used differently in other notations, typically representing "one"; other notations use dashed/solid lines for UID

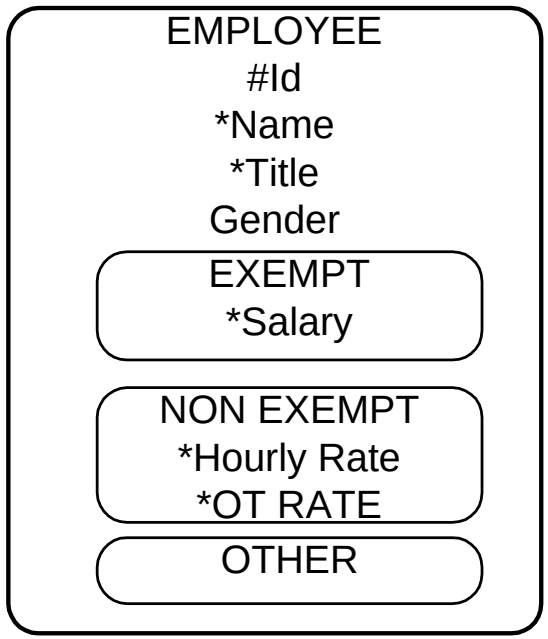
UID Examples



Super/subtype Entity Structure (Oracle)

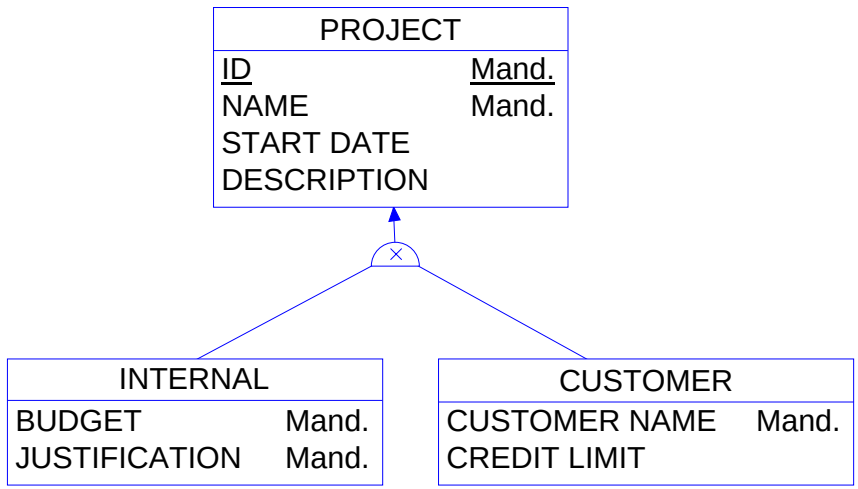
- Subtype entities are “specializations” of supertype entity
- Subtype inherits all attributes and relationships of supertype entity
- Subtypes are drawn nested inside their supertype (Oracle)
- Occurrence of subtype is also occurrence of supertype; UID is always at the outermost supertype
- Each subtype should (eventually) have its own attributes and/or relationships
- Subtypes are “exhaustive”; all occurrences of the supertype must also be occurrence of a subtype
- Subtypes are “exclusive and non-overlapping”; no occurrence can belong to more than one subtype (except via “nesting”)

Oracle Subtype



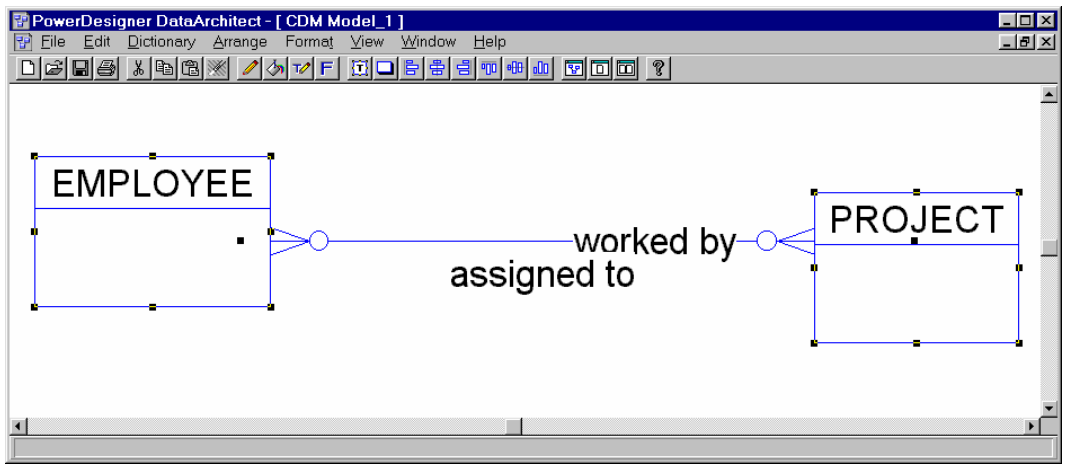
Other Notations

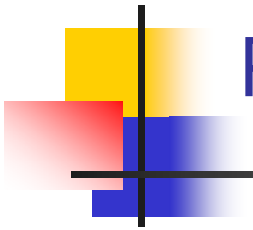
- Use special connectors instead of “nesting”
- May allow specification of exclusive/non-exclusive (aka overlapping/non-overlapping)
- May allow specification of exhaustive/non-exhaustive



Many to Many (M:M) Relationships

- The start of “conceptual modeling”
- M:M relationships “hide” important detail that must be discovered
- M:M relationships should be eliminated by end of detailed requirements analysis
- Iterative process of refinement

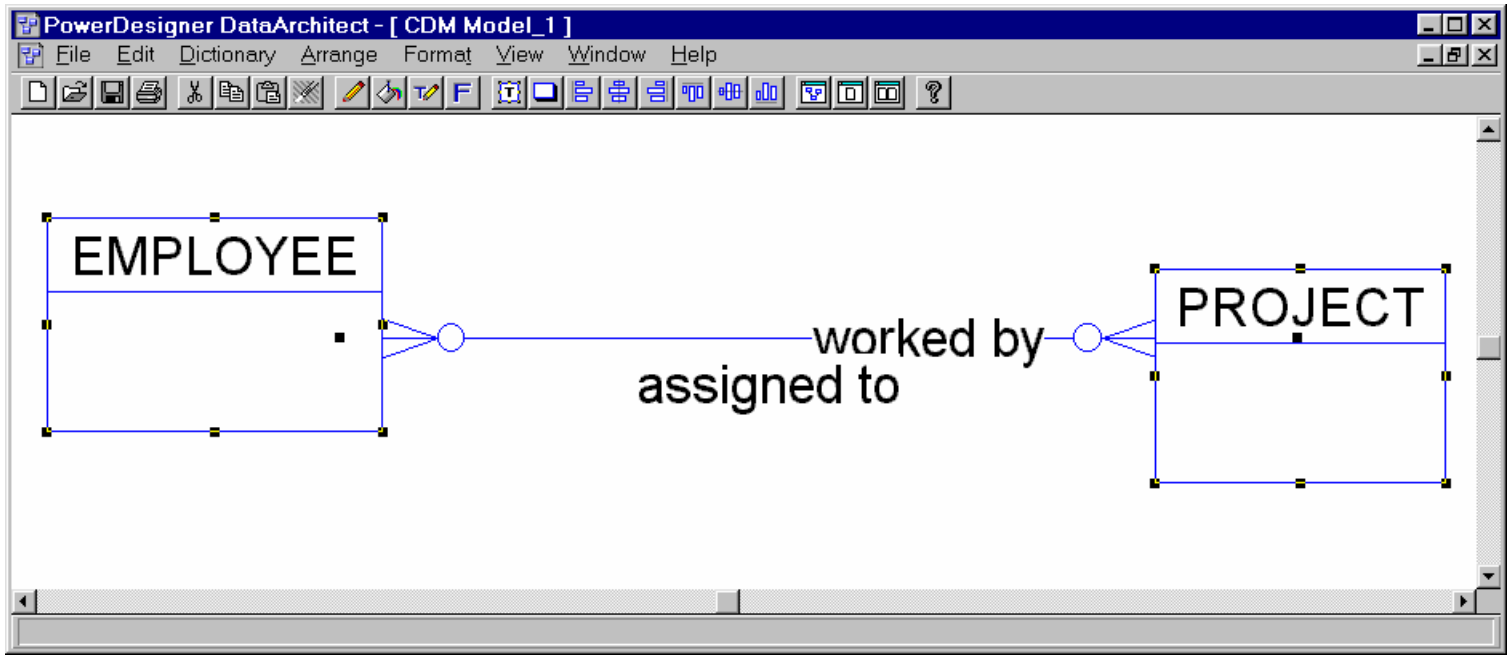




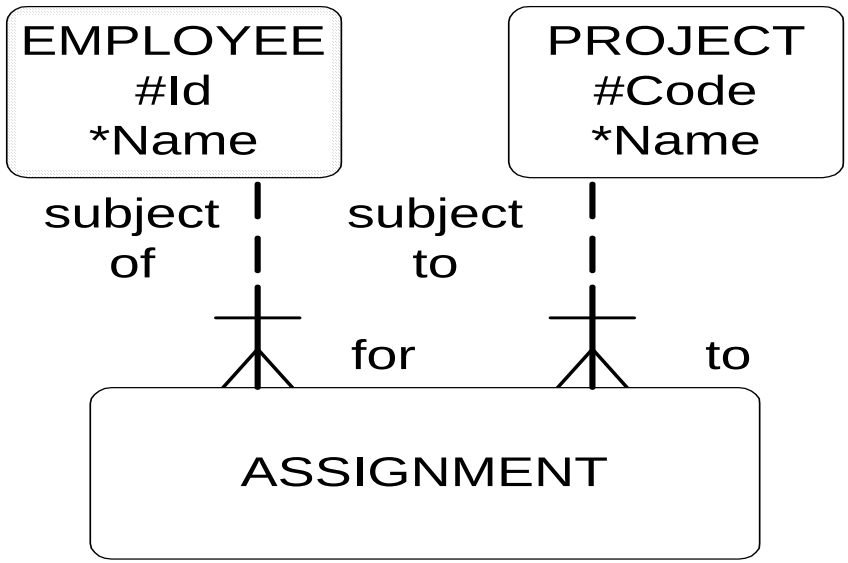
Resolving

- To resolve a M:M relationship:
  - 1) Create new entity
  - 2) Create relationships back to original entities
  - 3) Include relationships as part of new entity's UID
  - 4) Use meaningful names for new entity and relationships
  - 5) Examine new entity for attributes and relationships
- *Major "flaw" in UML modeling techniques*

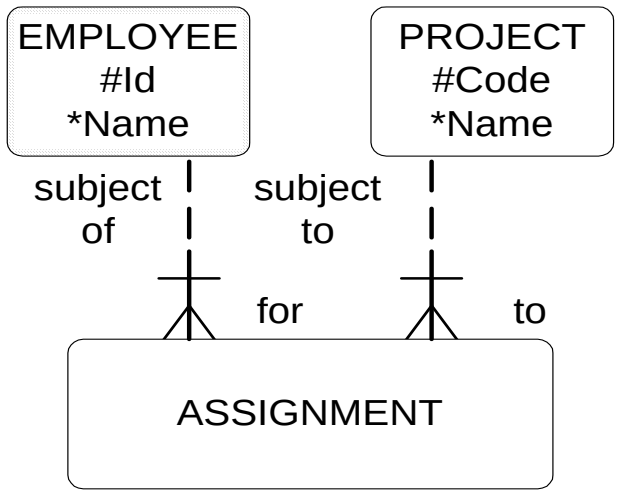
Resolving M:M



- Create new entity with UID/dependant relationships
- New name is important!



- Re-examine for new attributes and relationships



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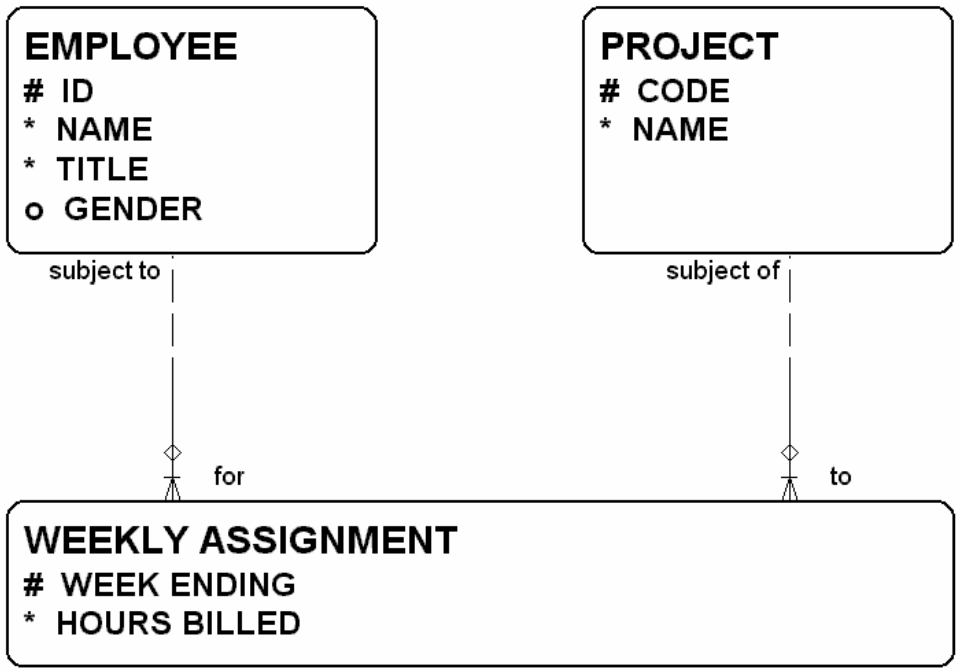
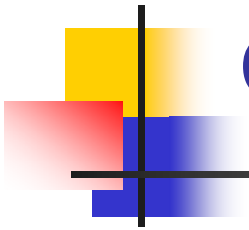


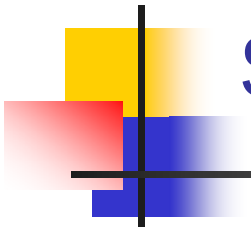


QA'ing ERDs

- For each entity:
  - Is the name precise?
  - Is the name a recognized business term?
  - Is the name singular?
  - Can the name be improved?
- For each attribute:
  - Is the attribute name precise?
  - Is the attribute name understandable?
  - Is the name a a recognized business term?
  - Is the optionality correct?
  - Can the name be improved?

QA of Relationships

- For each relationship:
  - Is the optionality correct? (If it's mandatory, are there any exceptions?)
  - Is the cardinality correct?
  - Is the name precise and meaningful? (*Very important!!!)*
  - Is the name a recognizable business term?
- *Can you find all of the information you need for your development area?*



Summary

- ERD captures information requirements
- Proper reading eliminates ambiguity
- ERD should be understood by all interested parties
- Wording and terminology is critical