Program	:B.Sc
Course Code	:BSCS3570
Course Name	:Advances in Databases
Faculty	:Dr Satheesh A

The Enhanced Entity-Relationship (EER) Model

Generalization, Specialization and Aggregation

Specialization

- An entity-set might contain distinct subgroups of entities
  - Subgroups have some different attributes, not shared by entire entity-set
- E-R model provides specialization to represent such entity-sets
- Example: bank account categories
  - Checking accounts
  - Savings accounts
  - Have common features, but also unique attributes

Generalization and Specialization

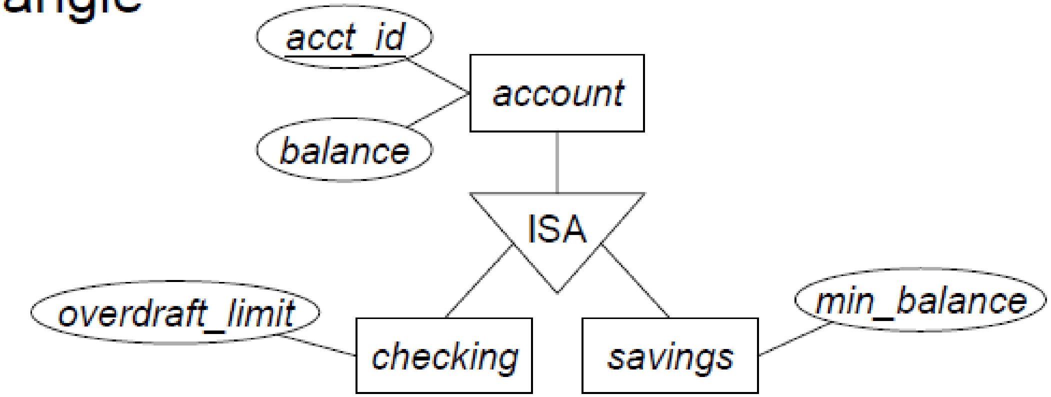
- Generalization: a “bottom up” approach
  - Taking similar entity-sets and unifying their common features
  - Start with specific entities, then create generalizations from them
- Specialization: a “top down” approach
  - Creating general purpose entity-sets, then providing specializations of the general idea
  - Start with general notion, then refine it
- Terms are basically equivalent
  - Book refers to generalization as overarching concept

Bank Account Example

- Checking and savings accounts have:
  - account number
  - balance
  - owner(s)
- Checking accounts also have:
  - overdraft limit and associated account
  - check transactions
- Savings accounts also have:
  - minimum balance

Bank Account Example (2)

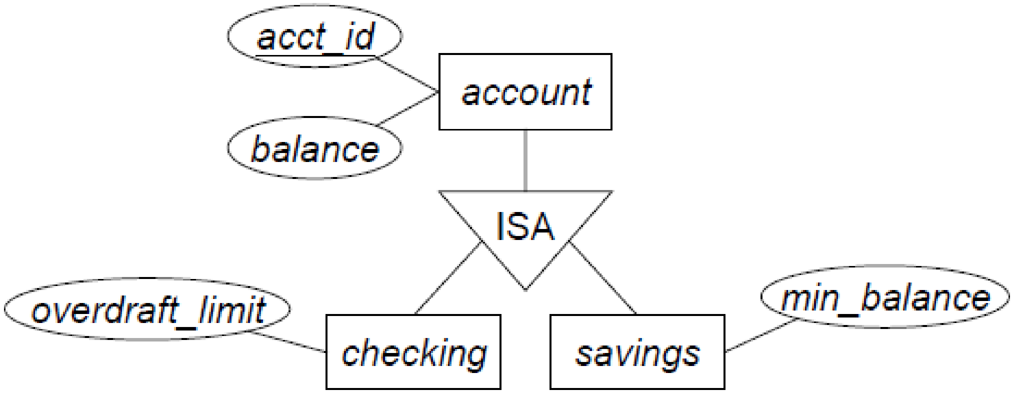
- Create entity-set to represent common attributes
  - Called the superclass, or higher-level entity-set
- Create entity-sets to represent specializations
  - Called subclasses, or lower-level entity-sets
- Join superclass to subclasses using "ISA" triangle



Inheritance

- Attributes of higher-level entity-sets are inherited by lower-level entity-sets
- Relationships involving higher-level entity-sets are also inherited by lower-level entity-sets!
  - A lower-level entity-set can participate in its own relationship-sets, too
- Usually, entity-sets inherit from one superclass
  - Entity-sets form a hierarchy
- Can also inherit from multiple superclasses
  - Entity-sets form a lattice
  - Introduces many subtle issues, of course

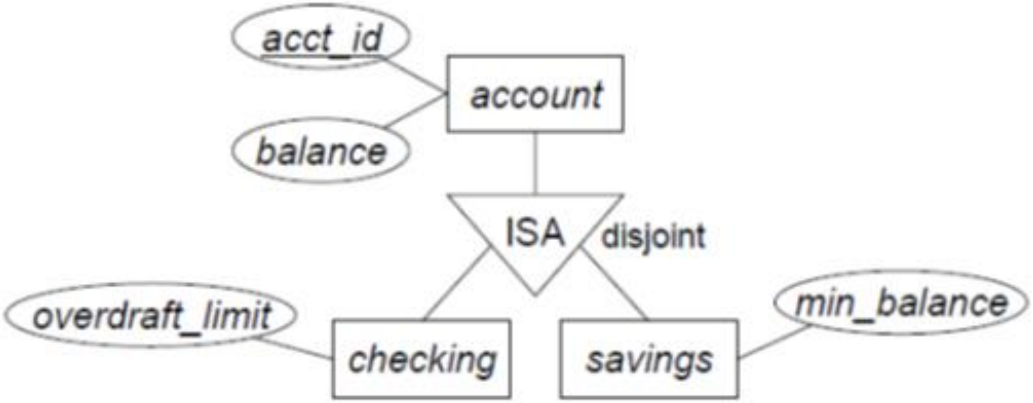
Specialization Constraints



- Can an account be both a savings account and a checking account?
- Can an account be neither a savings account or a checking account?
- Can specify constraints on specialization
  - Enforce what "makes sense" for the enterprise

Disjointness Constraints

- Default constraint is overlapping!
- Indicate disjoint specialization with word “disjoint” next to triangle
- Updated bank account diagram:



Disjointness Constraints (2)

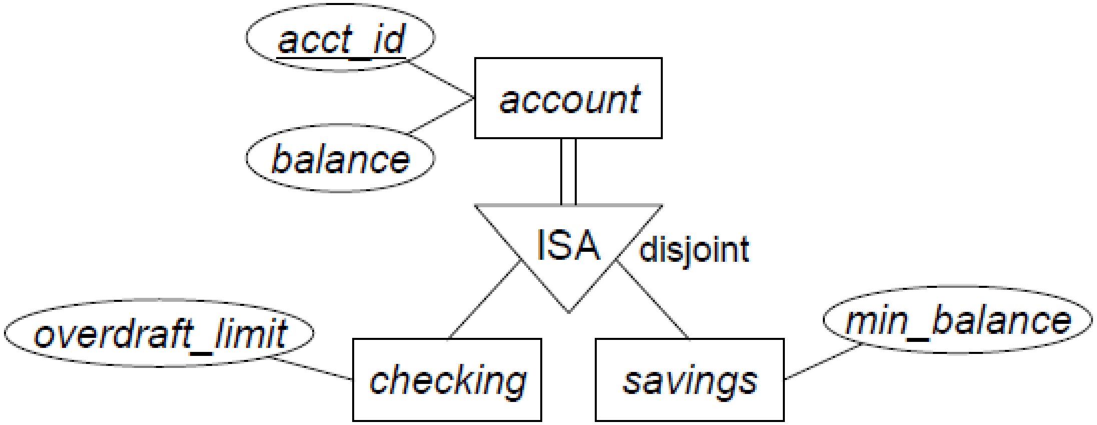
- "An account must be either a checking account, or a savings account, but not both."
- An entity may belong to only one of the lower-level entity-sets
  - Must be a member of *checking*, or a member of *savings*, but not both!
  - Called a "disjointness constraint"
  - A better way to state it: a disjoint specialization
- If an entity can be a member of multiple lower-level entity-sets:
  - Called an overlapping specialization

Completeness Constraints

- “An account must be a checking account or a savings account.”
- Every entity in higher-level entity-set must also be a member of at least one lower-level entity-set
  - Called total specialization
- If entities in higher-level entity-set aren’t required to be members of lower-level entity-sets:
  - Called partial specialization
- *account* specialization is a total specialization

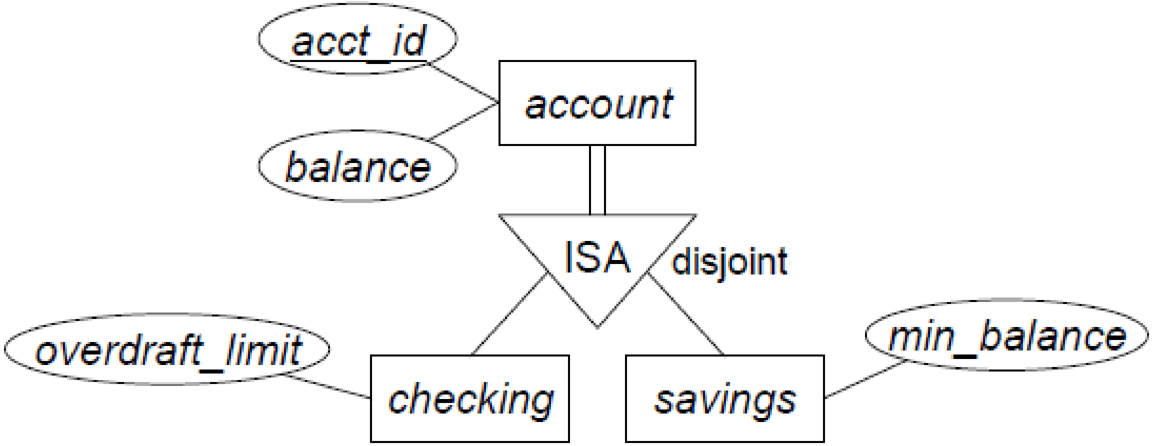
Completeness Constraints (2)

- Default constraint is partial specialization
- Specify total specialization constraint with a double line on superclass side
- Updated bank account diagram:



Account Types?

- Our bank schema so far:



- How to tell whether an account is a checking account or a savings account?
  – No attribute indicates type of account

Membership Constraints

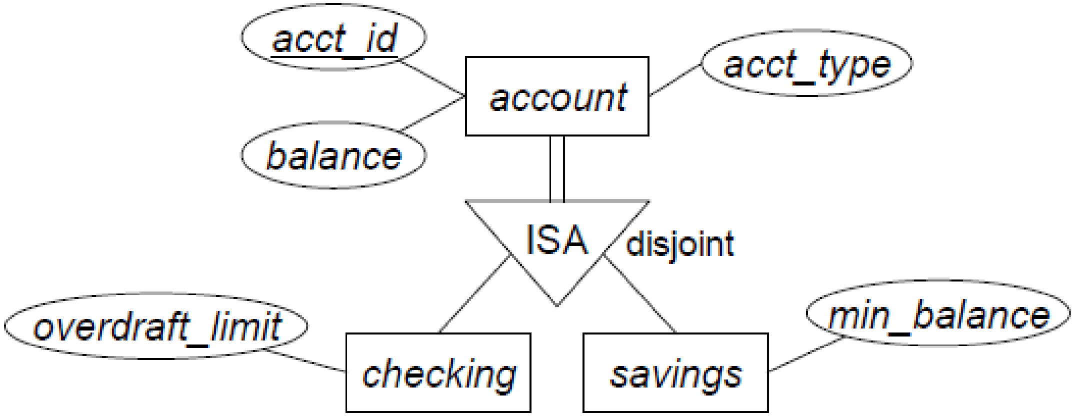
- Membership constraints specify which entities are members of lower-level entity-sets
  - e.g. which accounts are checking or savings accounts
- Condition-defined lower-level entity-sets
  - Membership is specified by a predicate
  - If an entity satisfies a lower-level entity-set's predicate then it is a member of that lower-level entity-set
  - If *all* lower-level entity-sets refer to the same attribute, this is called attribute-defined specialization
    - e.g. *account* could have an *account_type* attribute

Membership Constraints (2)

- Entities may simply be assigned to lower-level entity-sets by a database user
  - No explicit predicate governs membership
  - Called user-defined membership
- Generally used when an entity's membership could change in the future
- Bank account example:
  - Accounts *could* use user-defined membership, but wouldn't make so much sense
  - Makes it harder to write queries involving only one kind of account
  - Best choice is probably attribute-defined membership

Bank Accounts

- Final bank account diagram:

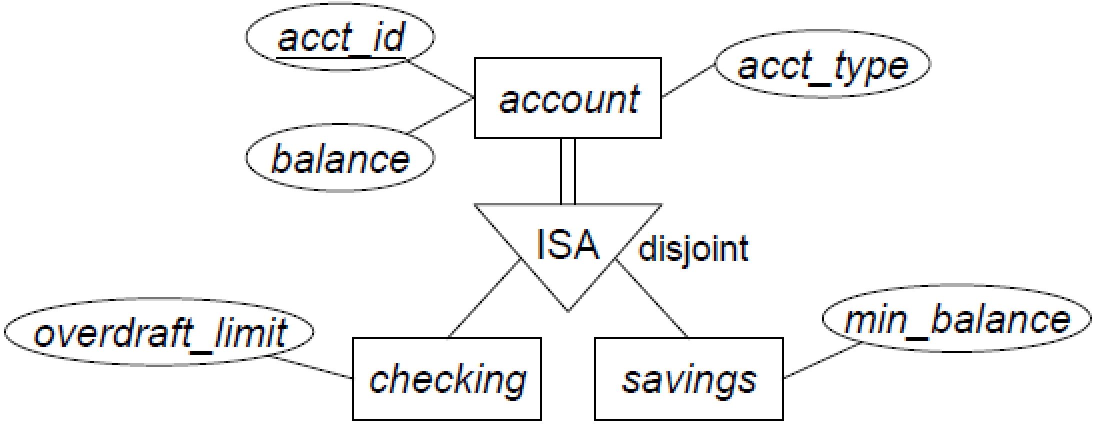


- Would also create relationship-sets against various entity-sets in hierarchy
  - associate *customer* with *account*
  - associate *check_txns* weak entity-set with *checking*

Mapping to Relational Model

- Mapping generalization/specialization to relational model is straightforward
- Create relation schema for higher-level entity-set
  - Including primary keys, etc.
- Create schemas for lower-level entity-sets
  - Subclass schemas include superclass' primary key attributes!
  - Primary key is same as superclass' primary key
    - If subclass contains its own primary key, treat as a separate candidate key
  - Foreign key reference from subclass schemas to superclass schema, on primary-key attributes

Mapping Bank Account Schema



- Schemas:

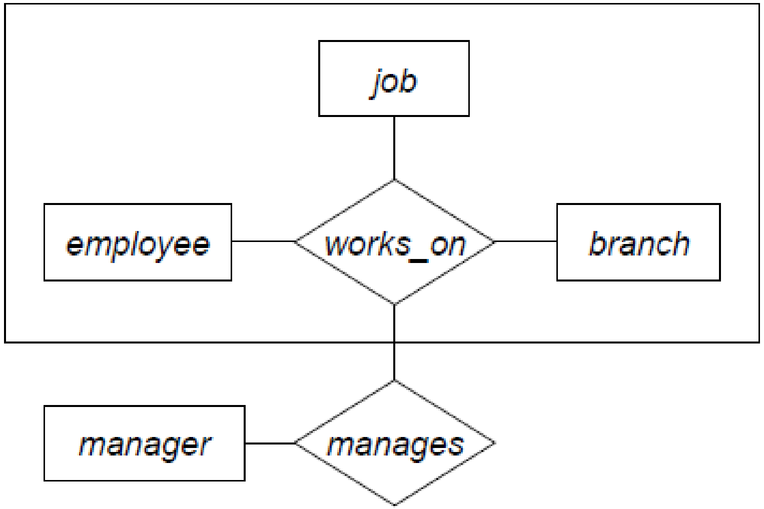
  account(acct_id, acct_type, balance)
  checking(acct_id, overdraft_limit)
  savings(acct_id, min_balance)

  – Could use `CHECK` constraints SQL tables for membership constraints, other constraints

Aggregation

Aggregation

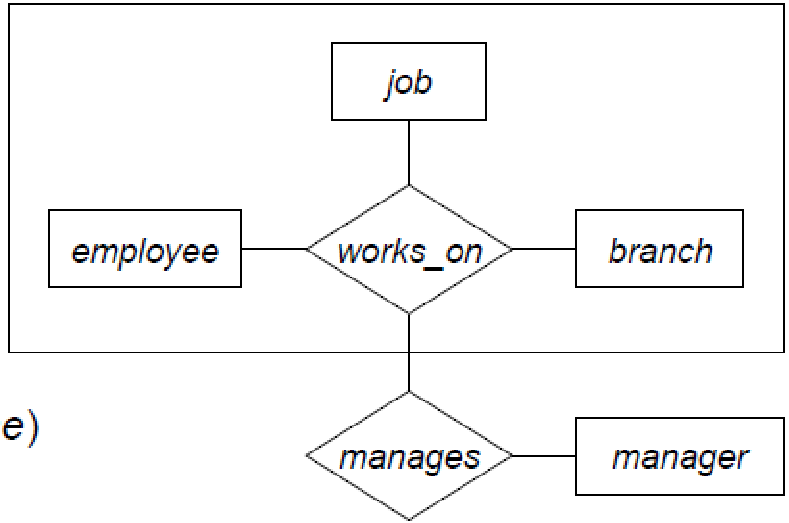
- Another option is to treat *works_on* relationship as an aggregate
  - Build a relationship against the aggregate
  - *manages* implicitly includes set of entities participating in a *works_on* relationship instance
  - Jobs can also have no manager



Mapping to Relational Model

- Mapping for aggregation is straightforward
- For entity-sets and relationship-set being used as an aggregate, mapping is unchanged
- Relationship-set against the aggregate:
  - Includes primary keys of participating entity-sets
  - Includes all primary key attributes of aggregated relationship-set
  - Also includes any descriptive attributes
  - Primary key of relationship-set includes all the above primary key attributes
  - Foreign key against aggregated relationship-set, as well as participating entity-sets

Manager Example



- Job schemas:

  employee(emp_id, emp_name)
  job(title, level)
  branch(branch_name, branch_city, assets)
  works_on(emp_id, branch_name, title)

- Manager schemas:

  manager(mgr_id, mgr_name)
  manages(mgr_id, emp_id, branch_name, title)

References

1. Ramez Elmasri, Shamkant B. Navathe, —Fundamentals of Database Systems, Sixth Edition , Pearson, 2011. **(Chapter 8)**
2. http://users.cms.caltech.edu/~donnie/dbcourse/intro0607/lectures/Lecture18.pdf

Thank You