Department of Commerce (CA)

CORE PAPER-II-DATABASE SYSTEM CONCEPTS

SEMESTER:I   SUB CODE: 18MCC12C

M.COM(CA)

UNIT5: Network approach-architecture of DBTG system-DBTG data struture-the set construct-singular sets-sample schema-the external level of DBTG-DBTG data manipulation.

REFERENCE BOOK:

An introduction to database system-C.J. Dates

An introduction to database system-Bipin

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Basic Concepts

- Data are represented by collections of *records*.
  - similar to an entity in the E-R model
  - Records and their fields are represented as *record type*

```
type customer = record           type account = record
    customer-name: string;            account-number: integer;
    customer-street: string;          balance: integer;
    customer-city: string;

end                               end
```

- Relationships among data are represented by *links*
  - similar to a restricted (binary) form of an E-R relationship
  - restrictions on links depend on whether the relationship is many-many, many-to-one, or one-to-one.
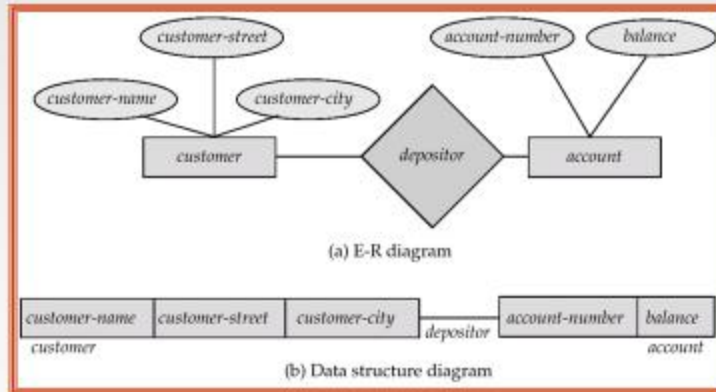
Data-Structure Diagrams

- Schema representing the design of a network database.

- A data-structure diagram consists of two basic components:
  - **Boxes**, which correspond to record types.
  - **Lines**, which correspond to links.

- Specifies the overall logical structure of the database.

Data-Structure Diagrams (Cont.)

■ For every E-R diagram, there is a corresponding data-structure diagram.

(a) E-R diagram

(b) Data structure diagram

Data-Structure Diagrams (Cont.)

■ Since a link cannot contain any data value, represent an E-R relationship with attributes with a new record type and links.


(a) E-R diagram

(b) Network diagram
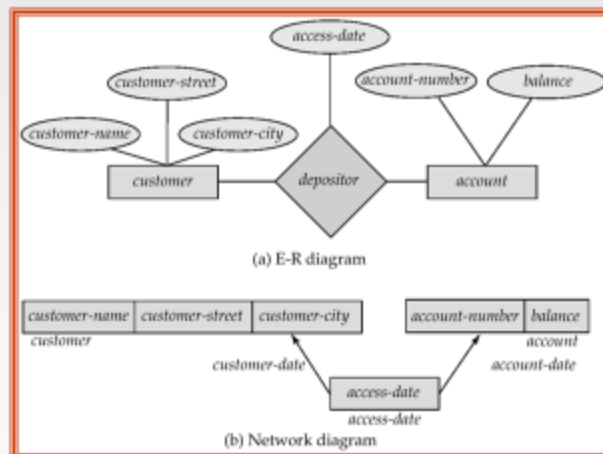
General Relationships

- To represent an E-R relationship of degree 3 or higher, connect the participating record types through a new record type that is linked directly to each of the original record types.

1. Replace entity sets *account, customer,* and *branch* with record types *account, customer,* and *branch,* respectively.
2. Create a new record type *Rlink* (referred to as a *dummy* record type).
3. Create the following many-to-one links:
   - *CustRlink* from *Rlink* record type to *customer* record type
   - *AcctRlnk* from *Rlink* record type to *account* record type
   - *BrncRlnk* from *Rlink* record type to *branch* record type

Network Representation of Ternary Relationship

(a) E-R diagram

(b) Data structure diagram
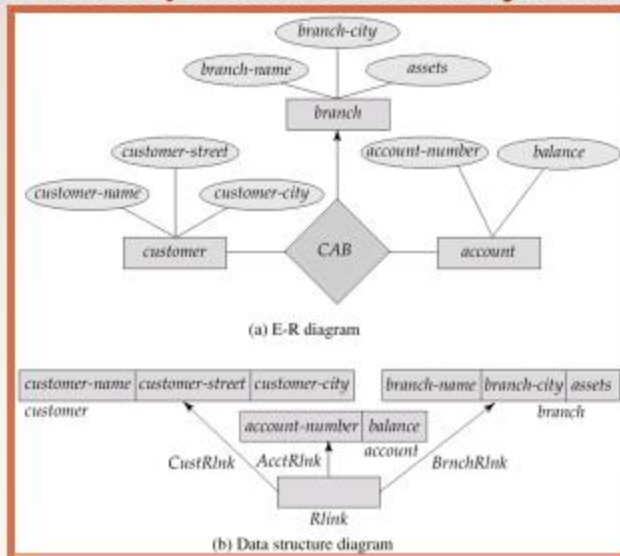
The DBTG CODASYL Model

- All links are treated as many-to-one relationships.
- To model many-to-many relationships, a record type is defined to represent the relationship and two links are used.

(a) E-R diagram

(b) Data structure diagram
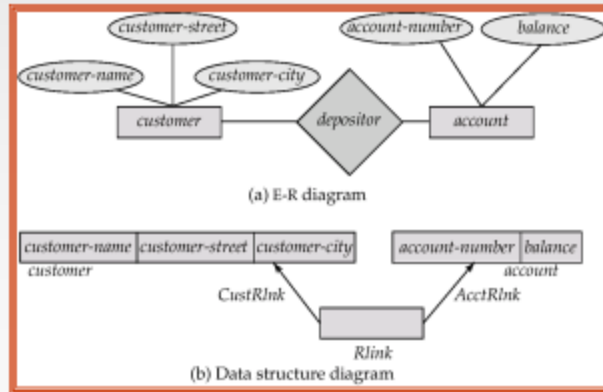
DBTG Sets

- The structure consisting of two record types that are linked together is referred to in the DBTG model as a *DBTG set*
- In each DBTG set, one record type is designated as the *owner*, and the other is designated as the *member*, of the set.
- Each DBTG set can have any number of *set occurrences* (actual instances of linked records).
- Since many-to-many links are disallowed, each set occurrence has precisely one owner, and has zero or more member records.
- No member record of a set can participate in more than one occurrence of the set at any point.
- A member record can participate simultaneously in several set occurrences of *different* DBTG sets.
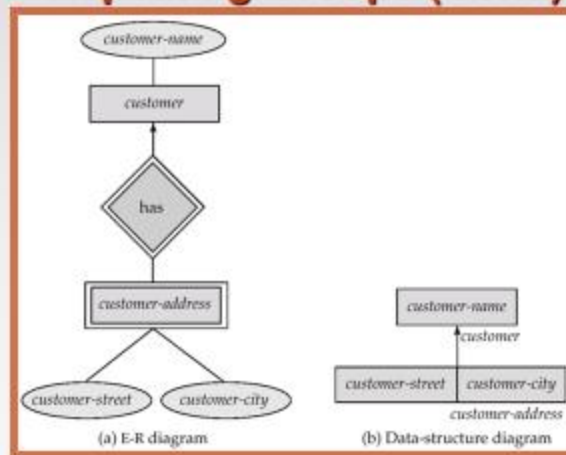
Repeating Groups

- Provide a mechanism for a field to have a set of values rather than a single value.
- Alternative representation of weak entities from the E-R model
- Example: Two sets.
  - *customer (customer-name)*
  - *customer-address (customer-street, customer-city)*
- The following diagrams represent these sets without the repeating-group construct.

Repeating Groups (Cont.)

(a) E-R diagram   (b) Data-structure diagram

- With the repeating-group construct, the data-structure diagram consists of the single record type *customer*.

DBTG Data-Retrieval Facility

- The DBTG data manipulation language consists of a number of commands that are embedded in a host language.

- *Run unit* — system application program consisting of a sequence of host language and DBTG command statements. Statements access and manipulate database items as well as locally declared variables.

- *Program work-area* (or *user work area*) — a buffer storage area the system maintains for each application program
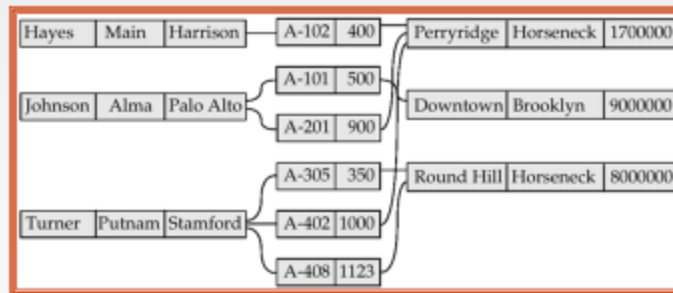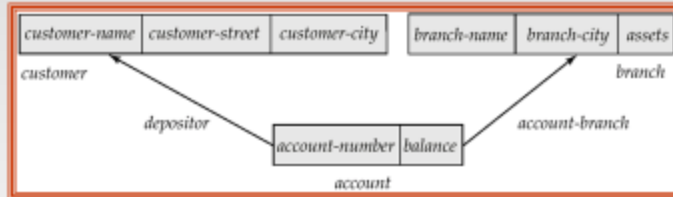
DBTG Variables

- Record Templates

- Currency pointers
  - Current of record type
  - Current of set type
  - Current of run unit

- Status flags
  - **DB-status** is most frequently used
  - Additional variables: **DB-set-name**, **DB-record-name**, and **DB-data-name**

Example Schema

customer-name	customer-street	customer-city		branch-name	branch-city	assets

customer

branch

depositor

account-branch

account-number	balance

account

Hayes	Main	Harrison		A-102	400		Perryridge	Horseneck	1700000
				A-101	500				
Johnson	Alma	Palo Alto		A-201	900		Downtown	Brooklyn	9000000
				A-305	350		Round Hill	Horseneck	8000000
Turner	Putnam	Stamford		A-402	1000				
				A-408	1123				

Example Program Work Area

- Templates for three record types: *customer*, *account*, and *branch*.
- Six currency pointers
  - Three pointers for record types: one each tot he most recently accessed *customer*, *account*, and *branch* record
  - Two pointers for set types: one to the most recently accessed record in an occurrence of the set *depositor*, one to the most recently accessed record in an occurrence of the set *account-branch*
  - One run-unit pointer.
- Status flags: four variables defined previously
- Following diagram shows an example program work area state.
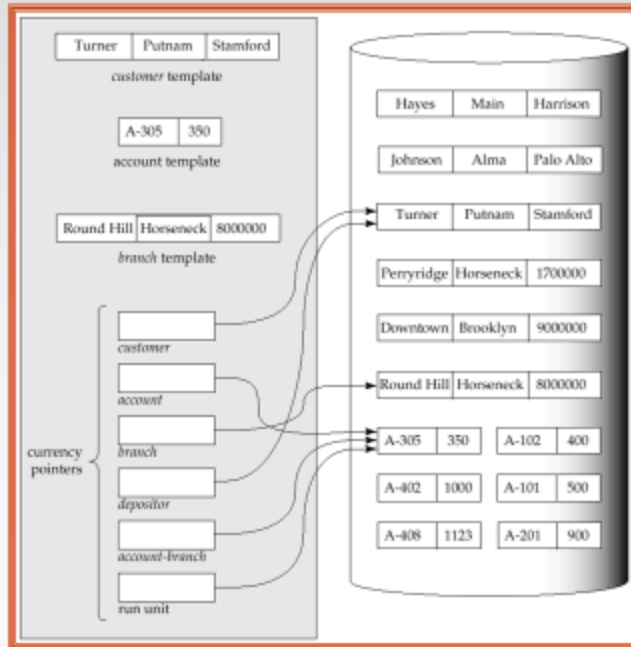
The Find and Get Commands

- **find** locates a record in the database and sets the appropriate currency pointers
- **get** copies of the record to which the current of run-unit points from the database to the appropriate program work area template
- Example: Executing a **find** command to locate the customer record belonging to Johnson causes the following changes to occur in the state of the program work area.
  - The current of the record type *customer* now points to the record of Johnson.
  - The current of set type *depositor* now points to the set owned by Johnson
  - The current of run unit now points to *customer* record Johnson.

Access of Individual Records

- **find any** \<record type\> **using** \<record-field\>
  Locates a record of type \<record type\> whose \<record-field\>
  value is the same as the value of \<record-field\> in the
  \<record type\> template in the program work area.

- Once such a record is found, the following currency pointers are set to
  point to that record:

  - The current of run-unit pointer

  - The record-type currency pointer for \<record type\>

  - For each set in which that record belongs, the appropriate set
    currency pointer

- **find duplicate** \<record type\> **using** \<record-field\>
  Locates (according to a system-dependent ordering) the next record
  that matches the \<record-field\>

Access of Records Within a Set

- Other **find** commands locate records in the DBTG set that is pointed
  to by the \<set-type\> currency pointer.

- **find first** \<record type\> **within** \<set-type\>
  Locates the first database record of type \<record type\>
  belonging to the current \<set-type\>.

- To locate the other members of a set,k we use

  find next \<record type\> **within** \<set-type\>

  which finds the next element in the set \<set-type\>.

- **find owner within** \<set-type\>
  Locates the owner of a particular DBTG set

Predicates

- For queries in which a field value must be matched with a specified range of values, rather than to only one, we need to:

    - **get** the appropriate records into memory
    - examine each one separately for a match
    - determine whether each is the; target of our **find** statement

A.41 ©Silberschatz, Korth and Sudarshan

Example DBTG Query

- Print the total number of accounts in the Perryridge branch with a balance greater than $10,000.

```
count := 0;
branch.branch-name := "Perryridge";
find any branch using  branch-name;
find first account within account-branch;
while DB-status = 0 do
    begin
      get account
      if account.balance > 10000 then count := count  + 1;
      find next account within  account-branch;
    end
print (count);
```

A.43 ©Silberschatz, Korth and Sudarshan

DBTG Update Facility

- DBTG mechanisms are available to update information in the database.
- To create a new record of type <record type>
  - insert the appropriate values in the corresponding <record type> template
  - add this new record to the database by executing

      store <record type>

- Can create and add new records only one at a time

DBTG Update Facility (Cont.)

- To modify an existing record of type <record type>
  - find that record in the database
  - get that record into memory
  - change the desired fields in the template of <record type>
  - reflect the changes to the record to which the currency point of <record type> points by executing

      modify <record type>

DBTG Update Facility (Cont.)

- To delete an existing record of type <record type>
  - make the currency pointer of that type point to the record in the database to be deleted
  - delete that record by executing

    erase <record type>

- Delete an entire set occurrence by finding the owner of the set and executing

    erase all <record type>

  - Deletes the owner of the set, as well as all the set's members.
  - If a member of the set is an owner of another set, the members of that second set also will be deleted.
  - **erase all** is recursive.

DBTG Set-Processing Facility

- Mechanisms are provided for inserting records into and removing records from a particular set occurrence
- Insert a new record into a set by executing the **connect** statement.

    connect <record type> **to** <set-type>

- Remove a record from a set by executing the **disconnect** statement.

    disconnect <record type> **from** <set-type>

Example disconnect Query

- Close account A-201, that is, delete the relationship between account A-201 and its customer, but archive the record of account A-201.

- The following program removes account A-201 from the set occurrence of type *depositor*.
  The account will still be accessible in the database for record-keeping purposes.

    > *account.account-number* := "A-201";
    > **find for update any** *account* **using** *account-number.*
    > **get** *account,*
    > **find** *owner* **within** *depositor,*
    > **disconnect** *account* **from** *depositor.*

DBTG Set-Processing Facility (Cont.)

- To move a record of type <record type> from one set occurrence to another set occurrence of type <set-type>
  - Find the appropriate record and the owner of the set occurrences to which that record is to be moved.
  - Move the record by executing

    reconnect <record type> **to** <set-type>

- Example: Move all accounts of Hayes that are currently at the Perryridge branch to the Downtown branch.

Example reconnect Query

```
customer.customer-name := "Hayes";
find any customer using customer-name;
find first account within depositor;
while DB-status = 0 do
    begin
        find owner within account-branch;
        get branch;
        if branch.branch-name = "Perryridge" then
            begin
                branch.branch-name := "Downtown";
                find any branch using branch-name;
                reconnect account to account-branch;
            end
        find next account within depositor,
    end
```

DBTG Set-Processing Facility (Cont.)

- A newly created member record of type <record type> of a set type <set-type> can be added to a set occurrence either explicitly (manually) or implicitly (automatically).

- Specify the insert mode at set-definition time via

    insertion is <insert mode>

  - **manual:**   **connect** <record type> **to** <set-type>

  - **automatic:**   **store** <record type>

Set Insertion Example

- Create account A535 for customer Hayes at the Downtown branch.
- Set insertion is **manual** for set type *depositor* and is **automatic** for set type *account-branch*.

> *branch.branch-name* := "Downtown";
> **find any** *branch* **using** *branch-name*;
> *account.account-number* := "A-535";
> *account.balance* := 0;
> **store** *account*;
> *customer.customer-name* := "Hayes";
> **find any** *customer* **using** *customer-name*;
> **connect** *account* **to** *depositor*;

DBTG Set-Processing Facility (Cont.)

- Restrictions on how and when a member record can be removed from a set occurrence are specified at set-definition time via

    retention is <retention-mode>

- <retention-mode> can take one of the three forms:

1. **fixed** — a member record cannot be removed. To reconnect a record to another set, we must erase that record, recreate it, and then insert it into the new set occurrence.

2. **mandatory** — a member record of a particular set occurrence can be reconnected to another set occurrence of only type <set-type>.

3. **optional** — no restrictions on how and when a member record can be removed from a set occurrence.

DBTG Set-Processing Facility (Cont.)

- The best way to delete a record that is the owner of set occurrence of type <set-type> depends on the specification of the set retention of <set-type>.

- **optional** — the record will be deleted and every member of the set that it owns will be disconnected. These records, however, will be in the database.

- **fixed** — the record and all its owned members will be deleted; a member record cannot be removed from the set occurrence without being deleted.

- **mandatory** — the record cannot be erased, because the mandatory status indicates that a member record must belong to a set occurrence. The record cannot be disconnected from that set.

Set Ordering

Set ordering is specified by a programmer when the set is defined:

order is <order-mode>

- **first.** A new record is inserted in the first position; the set is in reverse chronological ordering.

- **last.** A new record is inserted in the final position; the set is in chronological ordering.

- **next.** Suppose that the currency pointer or <set-type> points to record X.

  - If X is a member type, a new record is inserted in the next position following X.

  - If X is an owner type, a new record is inserted in the first position.

Set Ordering (Cont.)

- **prior.** If *X* is a member type, a new record is inserted in the position just prior to *X*. If *X* is an owner type, a new record is inserted in the last position.
- **system default.** A new record is inserted in an arbitrary position determined by the system.
- **sorted.** A new record is inserted in a position that ensures that the set will remain sorted. The sorting order is specified by a particular key value when a programmer defines the set.
- Example: Consider the set occurrence of type *depositor* with the owner-record customer Turner and member-record accounts A-305, A-402, and A-408 ordered as indicated in our example schema (page A.14).

Set Ordering Example

- Add a new account A-125. For each <order-mode> option, the new set ordering is as follows:
- **first**: {A-125,A-305,A-402,A-408}
- **last**: {A-305,A-402,A-408,A-125}
- **next**: Suppose that the currency pointer points to record "Turner"; then the new set order is {A-125,A-305,A-402,A-408}
- **prior**: Suppose that the currency pointer points to record A-402; then the new set order is {A-305,A-125,A-402,A-408}
- **system default**: Any arbitrary order is acceptable; thus, {A-305,A-402,A-125,A-408} is a valid set ordering
- **sorted**: The set must be ordered in ascending order with account number being the key; thus, the ordering must be {A-125,A-305,A-402,A-408}
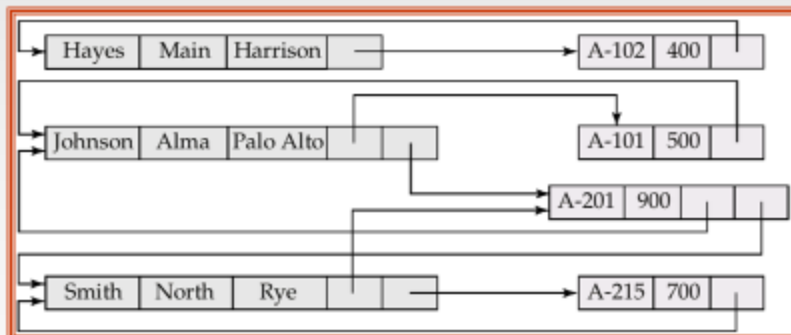
Mapping of Networks to Files

- We implement links by adding *pointer fields* to records that are associated via a link
- Each record must have one pointer field for each link with which it is associated.
- Example data-structure diagram and corresponding database.

Figure missing

Mapping of Networks to Files (Cont.)

- Diagram showing the sample instance with pointer fields to represent the links. Each link is replaced by two pointers.

Hayes	Main	Harrison			→	A-102	400	
Johnson	Alma	Palo Alto				A-101	500	
						A-201	900	
Smith	North	Rye			→	A-215	700	

Mapping of Networks to Files (Cont.)

- Since the *depositor* link is many to many, each record can be associated with an arbitrary number of records (e.g., the *account* record would have a pointer to the *customer* record for each customer who has that account).

- Direct implementation of many-to-many relationships requires the use of variable length records.

- The DBTG model restricts links to be either one to one or one to many; the number of pointers needed is reduced, and it is possible to retain fixed-length records.

Mapping of Networks to Files (Cont.)

- Because an *account* record can be associated with only one *customer* record, we need only one pointer in the *account* record to represent the *depositor* relationship.

- A *customer* record can be associated with many *account* records.

- Rather ant using multiple pointers in the *customer* record, we can use a *ring structure* to represent the entire occurrence of the DBTG set *depositor*.

- In a ring structure, the records of both the owner an member types for a set occurrence are organized into a circular list.

- There is one circular list for each set occurrence (that is, for each record of the owner type).
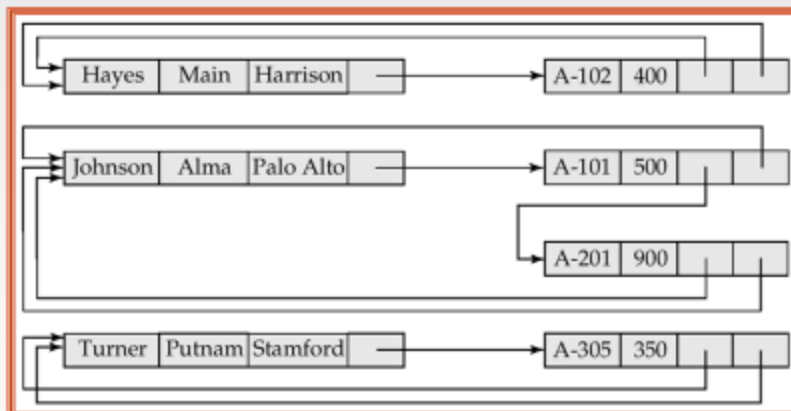
Example Ring Structure
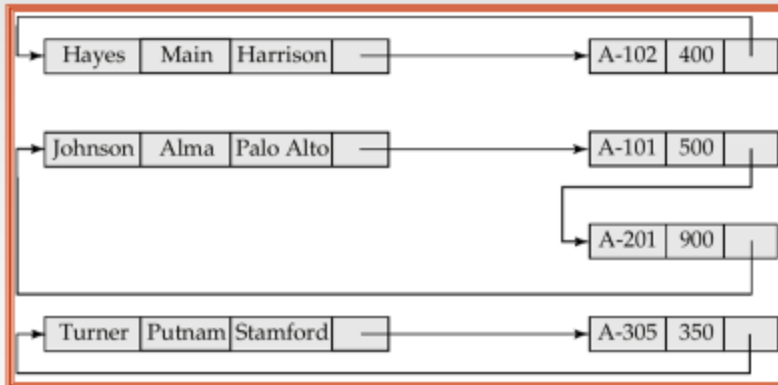
Modified Ring Structures

- Execute **find owner** via a ring structure in which every member-type record contains a second pointer which points to the owner record.

Physical Placement of Records

- To specify the storage strategy for DBTG set, add a **placement** clause to the definition of the member record type.
- The clause

     placement clustered via *depositor*

  will store members of each set occurrence close to one another physically on disk, if possible, in the same block.

- Store owner and member records close to one another physically on disk by adding the clause **near owner.**
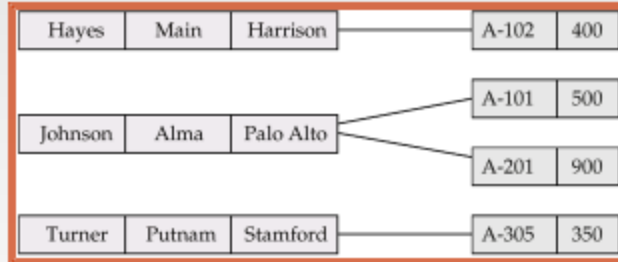
     placement clustered via *depositor* **near owner**

Physical Placement of Records (Cont.)

- Storing member records in the same block as the owner reduces the number of block accesses required to read an entire set occurrence.
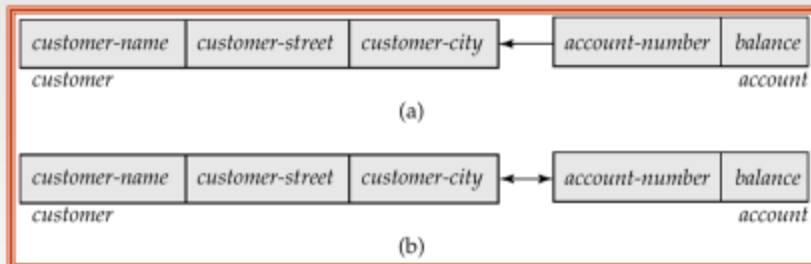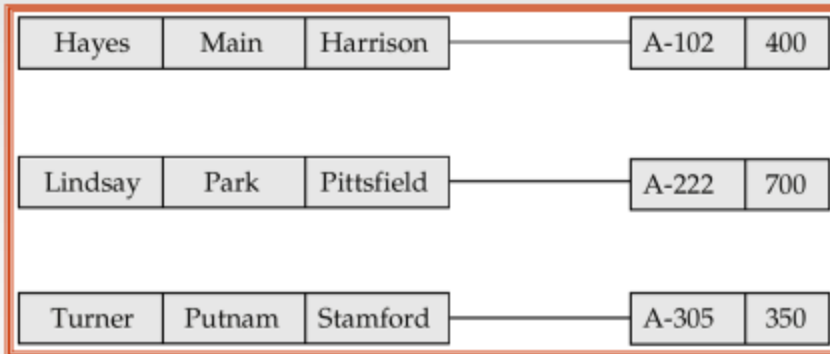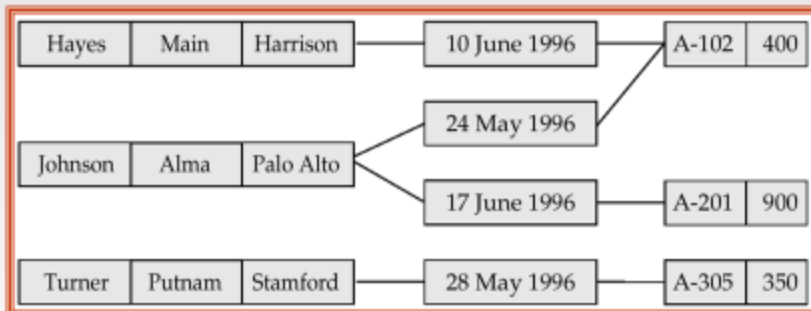
Sample Database

Hayes	Main	Harrison		A-102	400
				A-101	500
Johnson	Alma	Palo Alto		A-201	900
Turner	Putnam	Stamford		A-305	350

Two Data-Structure Diagrams

customer-name	customer-street	customer-city	◀—	account-number	balance
customer					account

(a)

customer-name	customer-street	customer-city	◀—▶	account-number	balance
customer					account

(b)

Sample Database Corresponding to Diagram of Figure A.3b

Hayes	Main	Harrison		A-102	400
Lindsay	Park	Pittsfield		A-222	700
Turner	Putnam	Stamford		A-305	350

Sample Database Corresponding to Diagram of Figure A.6b

Hayes	Main	Harrison	10 June 1996	A-102	400
Johnson	Alma	Palo Alto	24 May 1996		
			17 June 1996	A-201	900
Turner	Putnam	Stamford	28 May 1996	A-305	350

Sample Database Corresponding to Diagram of Figure A.8b

| A-102 | 400 | A-101 | 500 | A-201 | 900 | A-305 | 350 |

| Hayes | Main | Harrison | 1 | | Perryridge | Horseneck | 1700000 |

2

| Johnson | Alma | Palo Alto | | | Downtown | Brooklyn | 9000000 |

3

| Turner | Putnam | Stamford | | 4 | Round Hill | Horseneck | 8000000 |

Two Data-Structure Diagrams

| customer-name | customer-street | customer-city | ← | account-number | balance |
| customer | | | | | account |

(a)

| customer-name | customer-street | customer-city | | account-number | balance |
| customer | | | | | account |

access-date

access-date

(b)

Sample Database Corresponding to the Diagram of Figure A.11
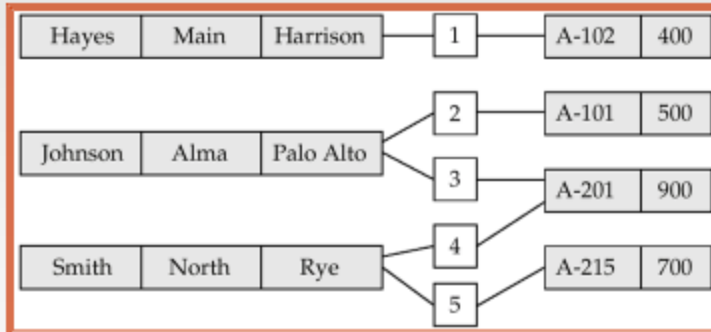
DBTG Set
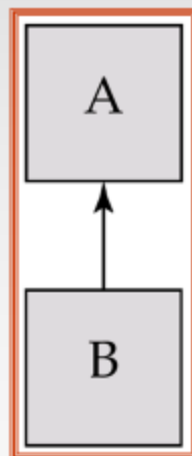
Three Set Occurrences
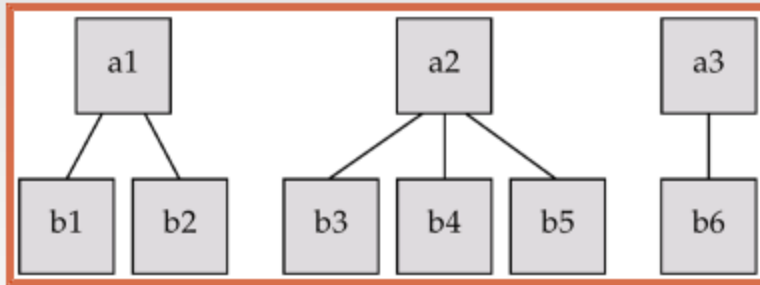
Data-Structure and E-R Diagram
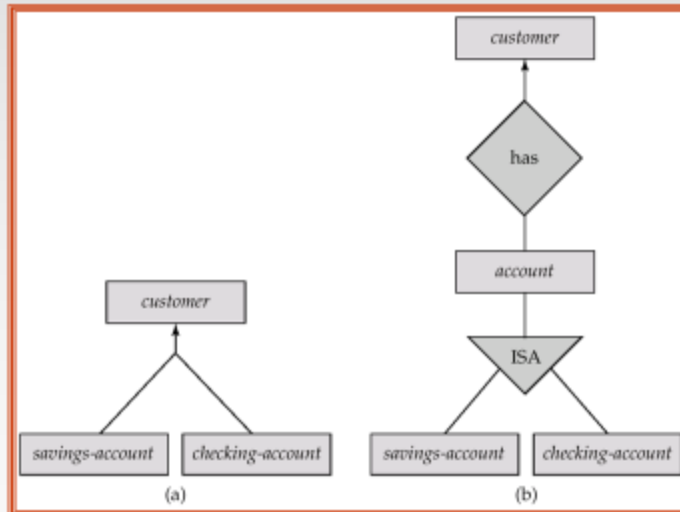
A *customer* Record
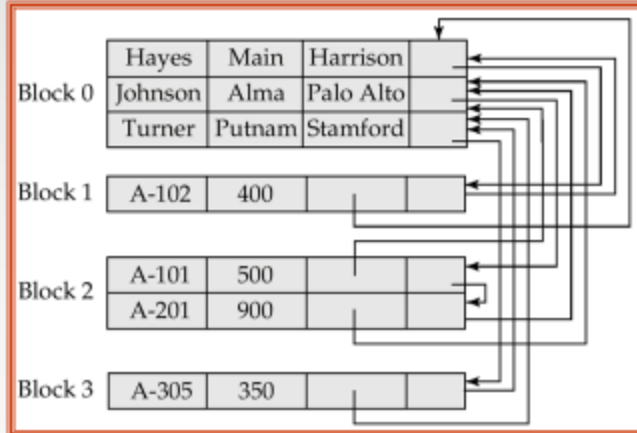
Turner	Putnam	Stamford
	Field	Horseneck

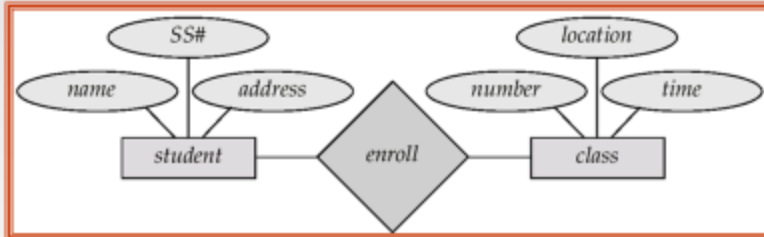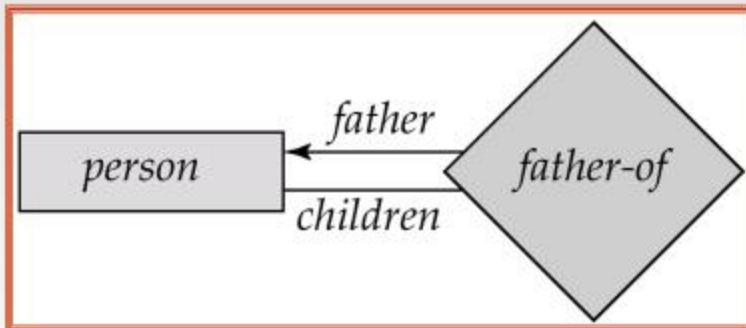# Clustered Record Placement for Instance for Figure A.1

Class Enrollment E-R Diagram

Parent—Child E-R Diagram

Car-Insurance E-R Diagram