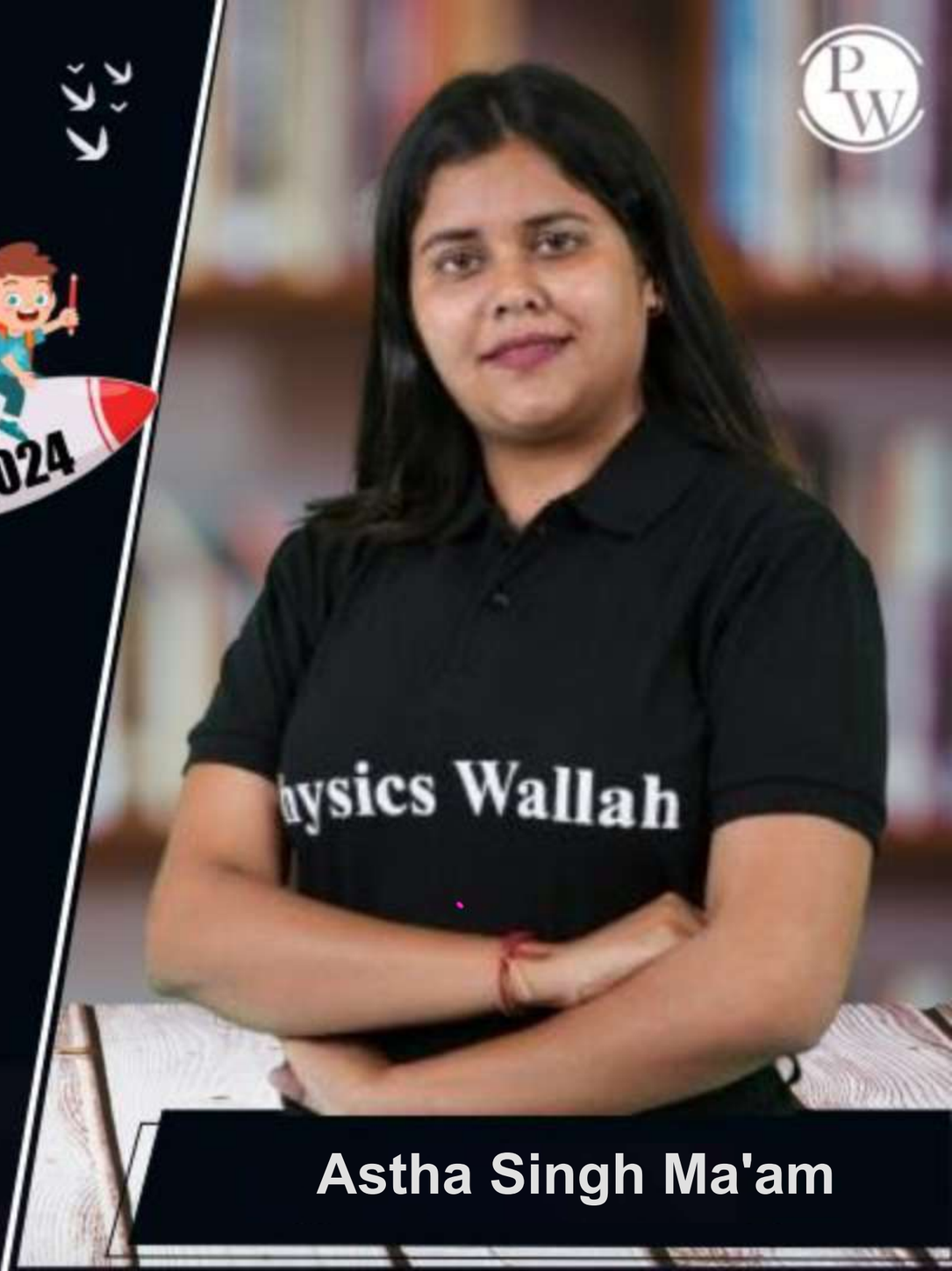
Data Science & Artificial Intelligence

Warehousing

Concept Hierarchies

ONE SHOT



Astha Singh Ma'am

Recap of Previous Lecture

Topic — One topic

Topic — Two topic

* Data Warehousing
* Schema
  - Star Schema
  - Snowflake

Topics to be Covered

- Topic: Tree Structure Diagrames
- Topic: General Structure
- Topic: Single Relationship
- Topic: Transforming many to many relationship
- Topic: Sample Database & Database Retrieval

Topic : Hierarchical Model

- Basic Concepts
- Tree-Structure Diagrams
- Data-Retrieval Facility
- Update Facility
- Virtual Records
- Mapping of Hierarchies to Files
- The IMS Database System

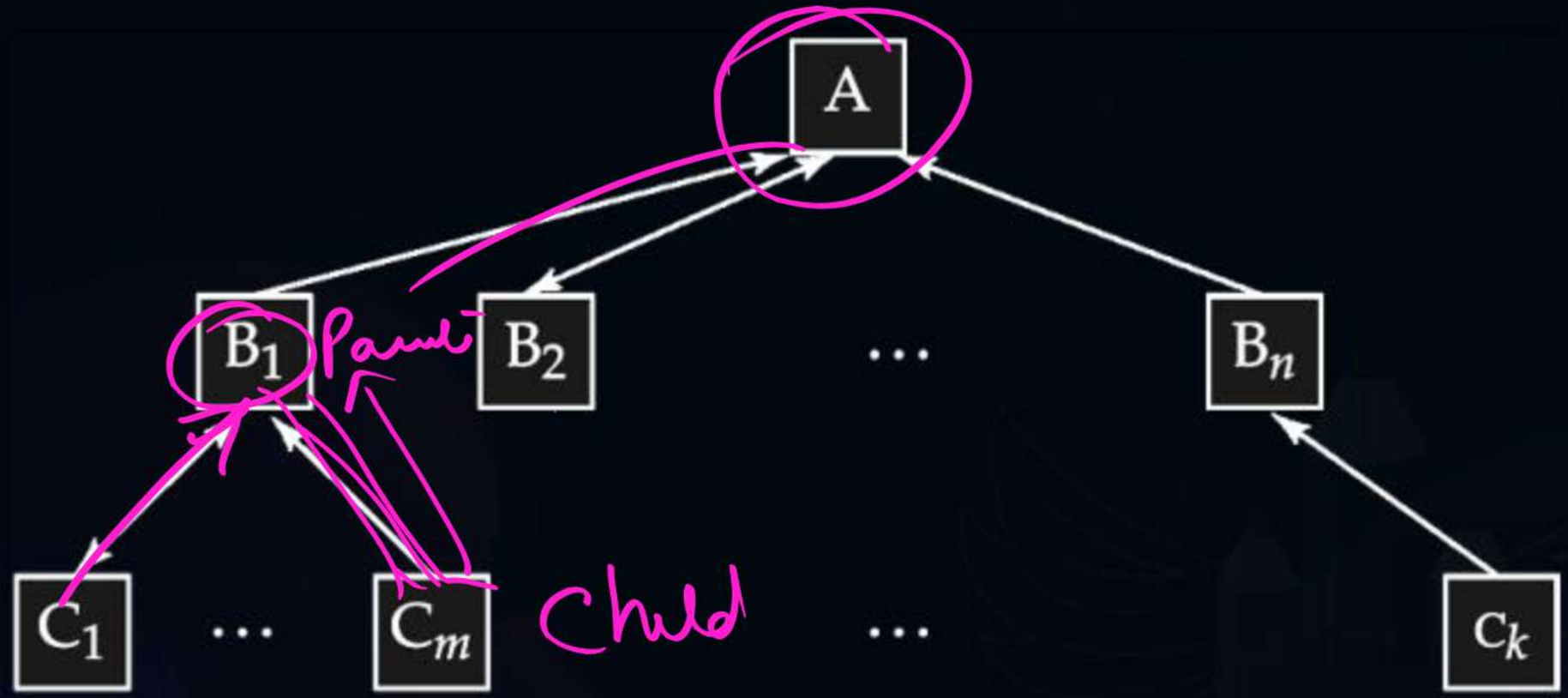
Topic : Basic Concepts

- A hierarchical database consists of a collection of records which are connected to one another through links.
- a record is a collection of fields, each of which contains only one data value.
- A link is an association between precisely two records.
- The hierarchical model differs from the network model in that the records are organized as collections of trees rather than as arbitrary graphs.

Topic : Tree-Structure Diagrams

- The schema for a hierarchical database consists of
  - boxes, which correspond to record types
  - lines, which correspond to links
- Record types are organized in the form of a rooted tree.
  - No cycles in the underlying graph.
  - Relationships formed in the graph must be such that only one-to-many or one-to-one relationships exist between a parent and a child.

Topic : General Structure

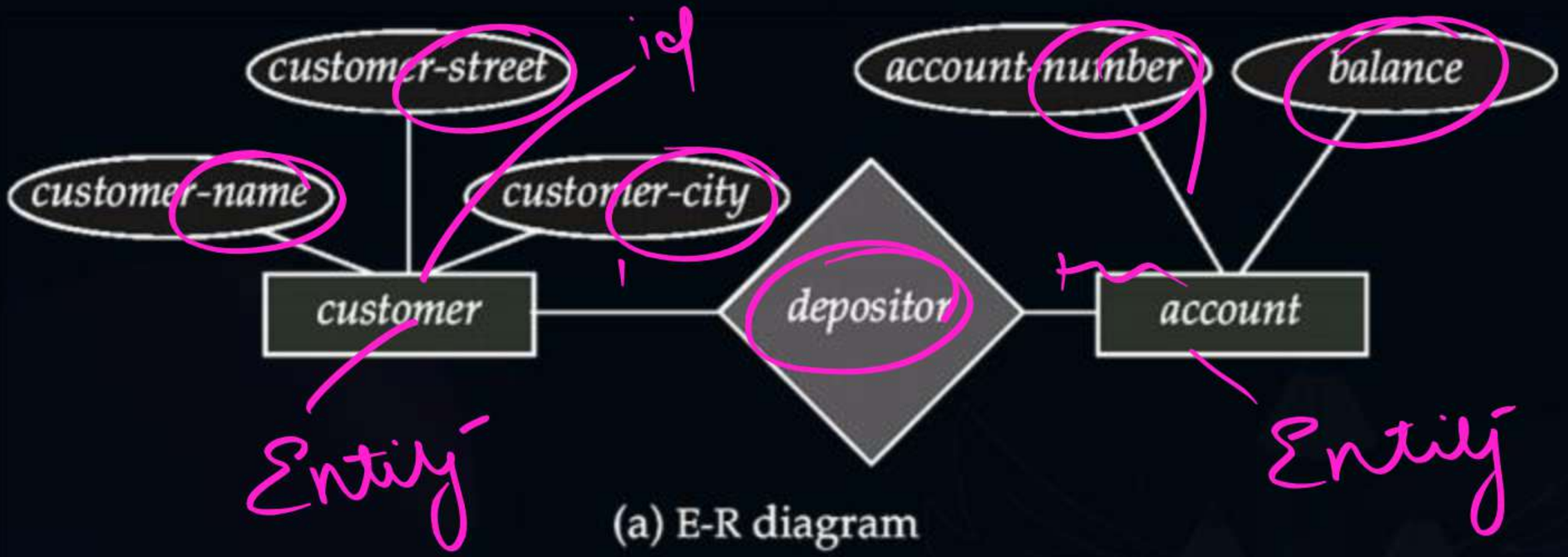


A parent may have an arrow pointing to a child, but a child must have an arrow pointing to its parent.

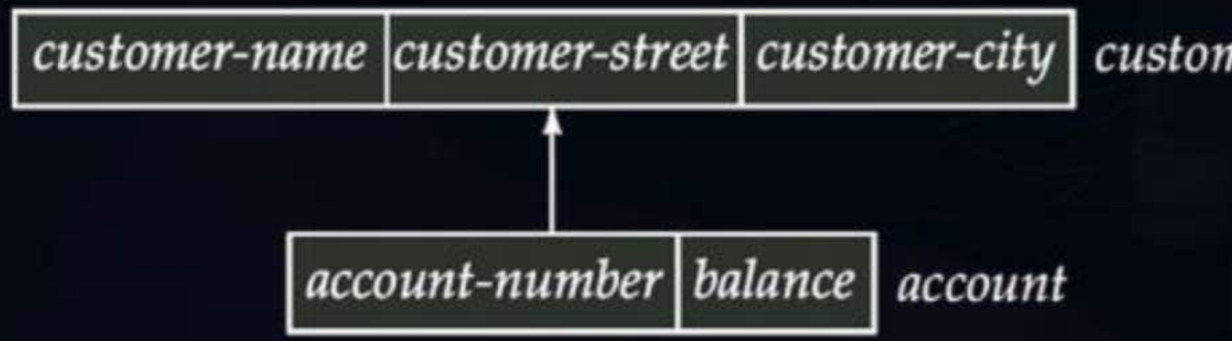
Topic : Tree-Structure Diagrams (Cont.)

- Database schema is represented as a collection of tree-structure diagrams.
  - single instance of a database tree
  - The root of this tree is a dummy node
  - The children of that node are actual instances of the appropriate record type
- When transforming E-R diagrams to corresponding tree-structure diagrams, we must ensure that the resulting diagrams are in the form of rooted trees.

Topic : Single Relationships



(a) E-R diagram



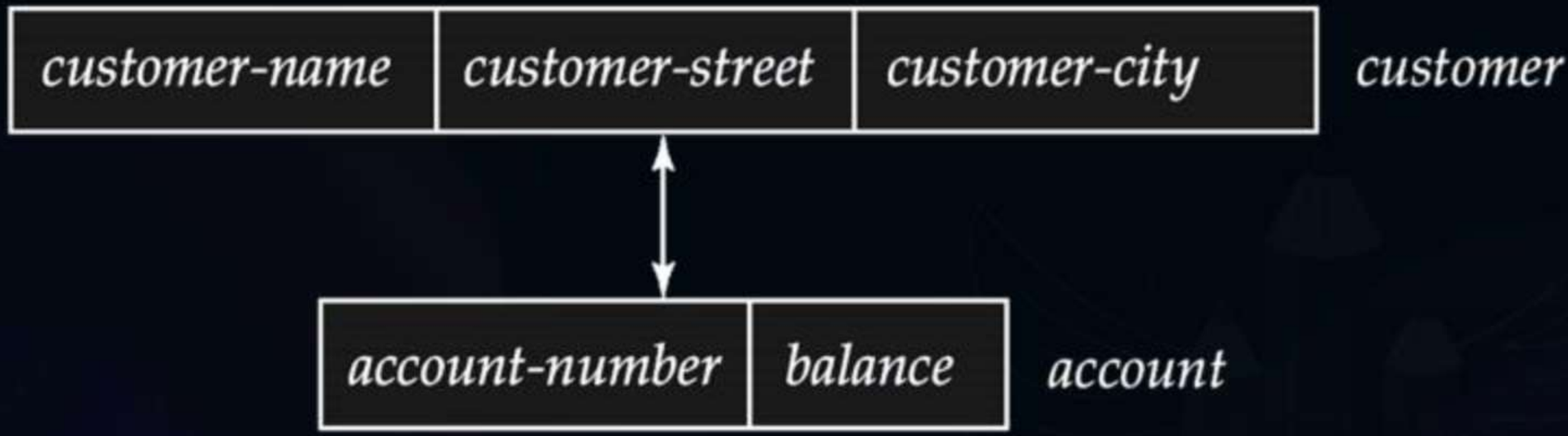
(b) Tree-structure diagram

Topic : Single relationships (Cont.)

- Example E-R diagram with two entity sets, customer and account, related through a binary, one-to-many relationship depositor.
- Corresponding tree-structure diagram has
  - the record type customer with three fields: customer-name, customer-street, and customer-city.
  - the record type account with two fields: account-number and balance
  - the link depositor, with an arrow pointing to customer

Topic : Single Relationships (Cont.)

- If the relationship depositor is one to one, then the link depositor has two arrows.



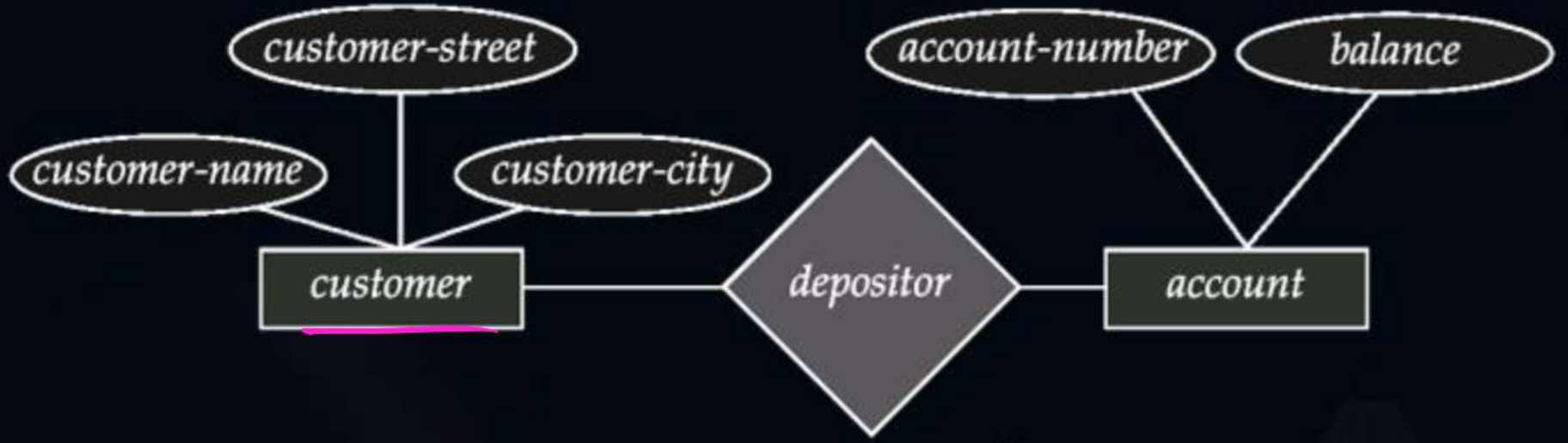
- Only one-to-many and one-to-one relationships can be directly represented in the hierarchical mode.

Topic : Transforming Many-To-Many Relationships

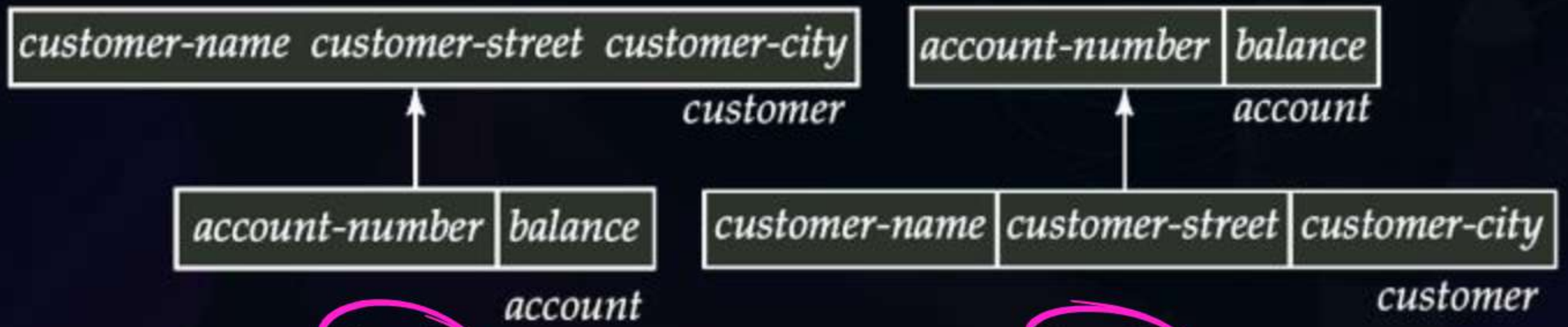
- Must consider the type of queries expected and the degree to which the database schema fits the given E-R diagram.

- In all versions of this transformation, the underlying database tree (or trees) will have replicated records.

Topic : Many-To Many Relationships (Cont.)



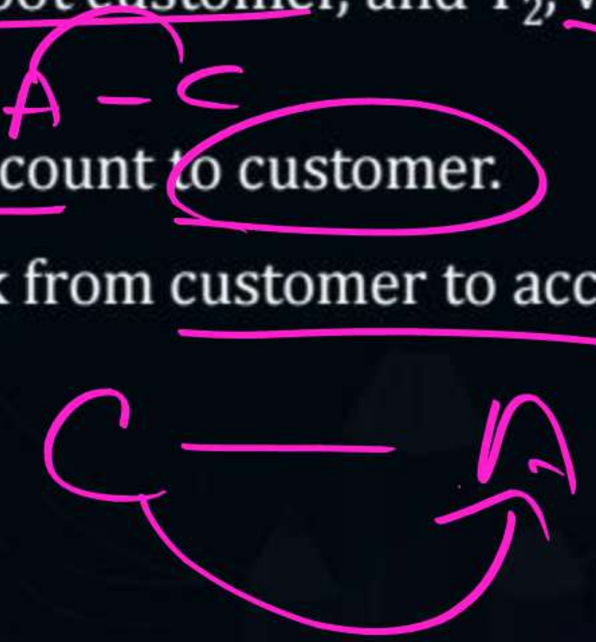
(a) E-R diagram



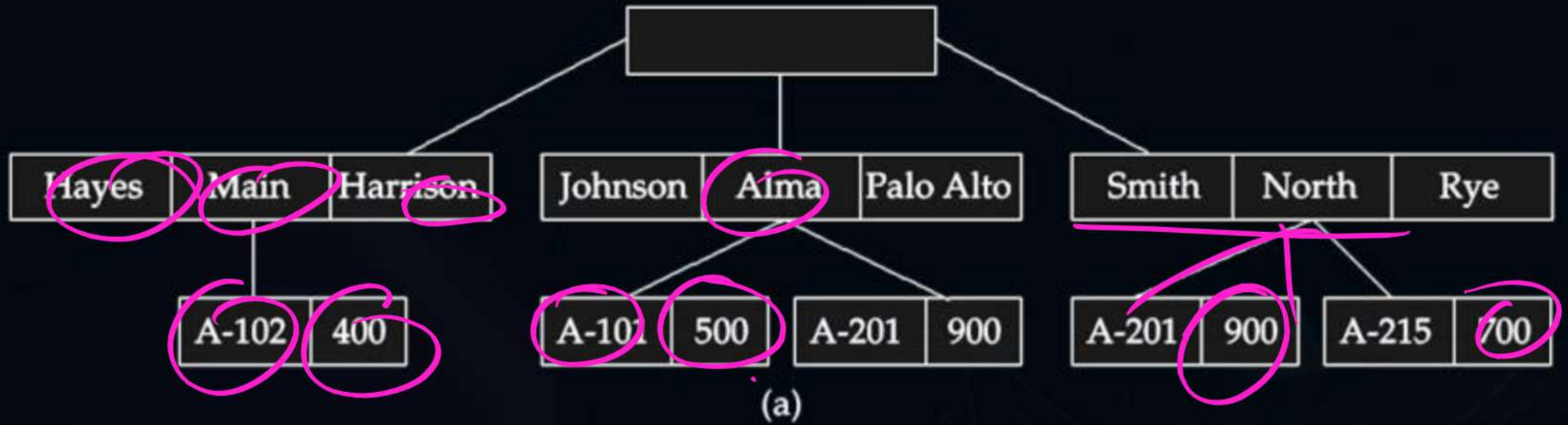
(b) Tree-structure diagrams

Topic : Many-To-Many Relationships (Cont.)

- Create two tree-structure diagrams, T_1, with the root customer, and T_2, with the root account.
- In T_1, create depositor, a many-to-one link from account to customer.
- In T_2, create account-customer, a many-to-one link from customer to account.

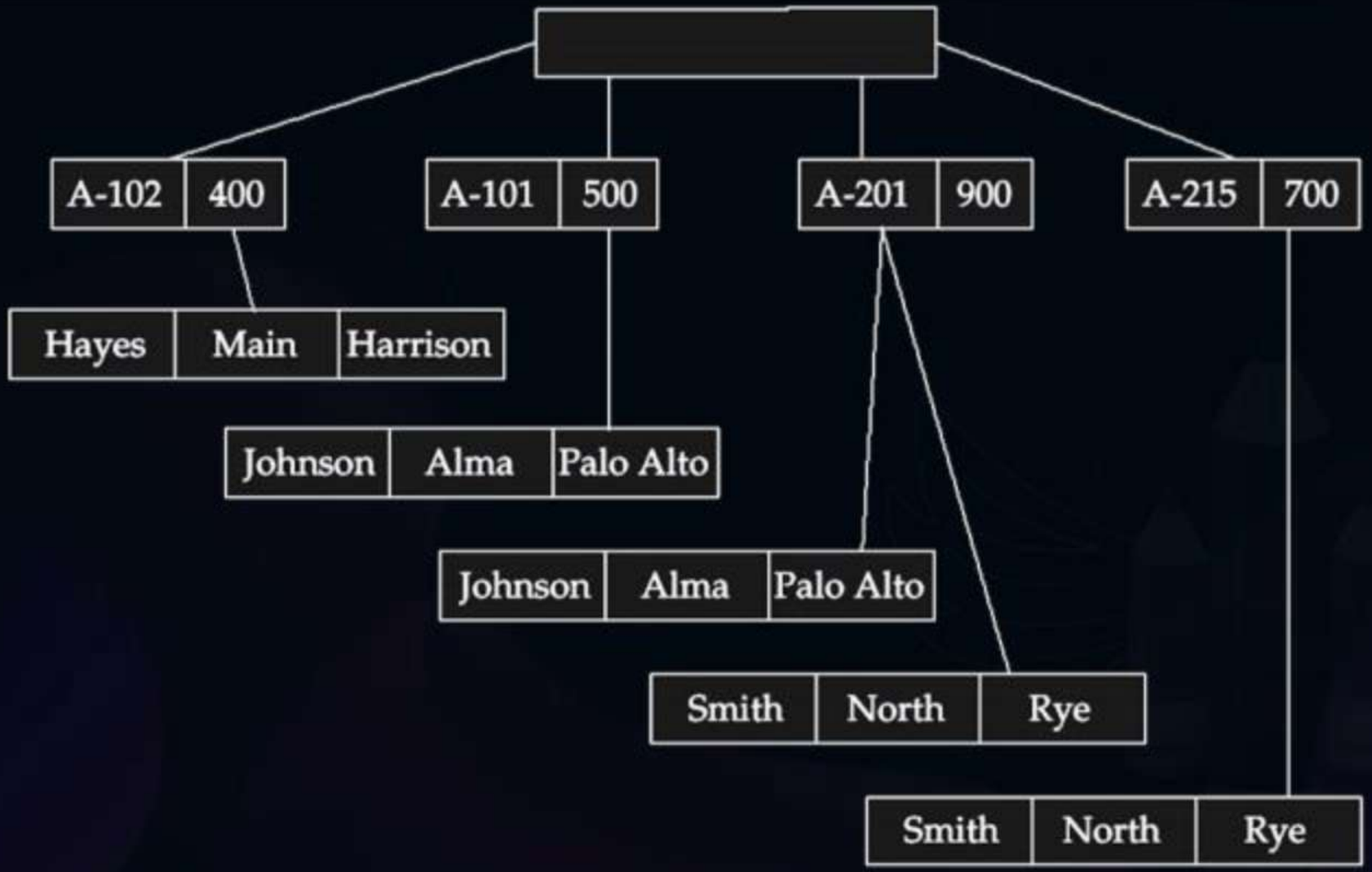


Topic : Sample Database



(a)

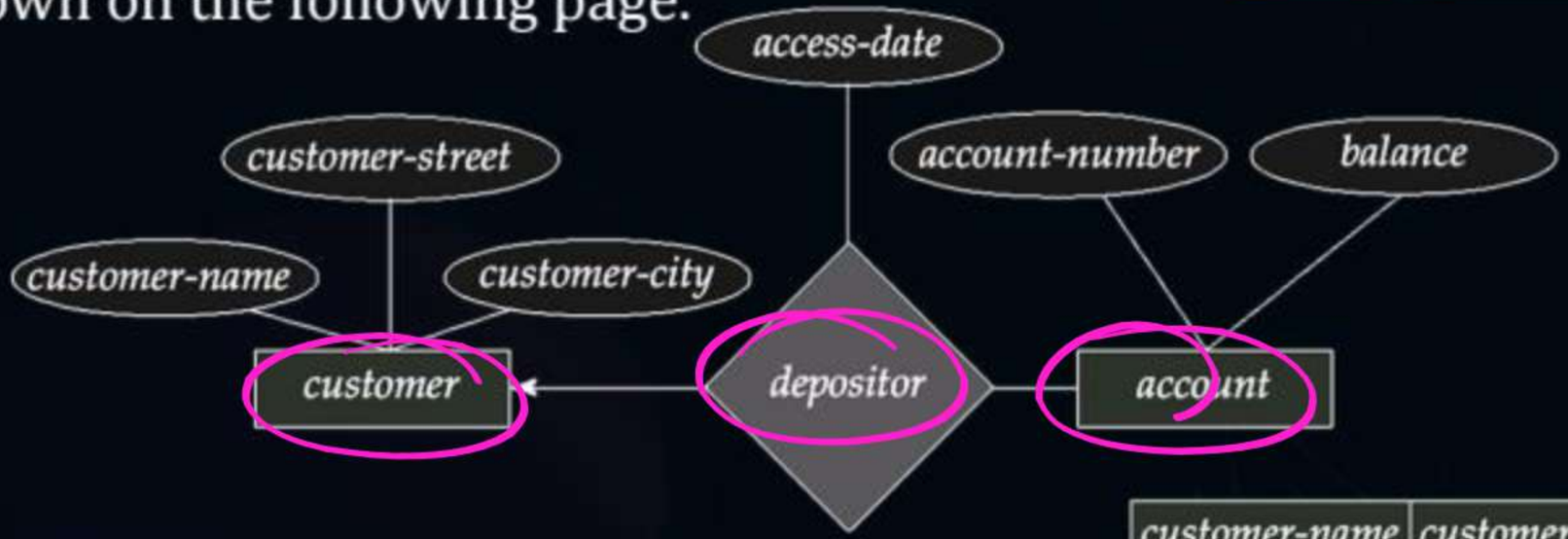
Topic : Sample Database



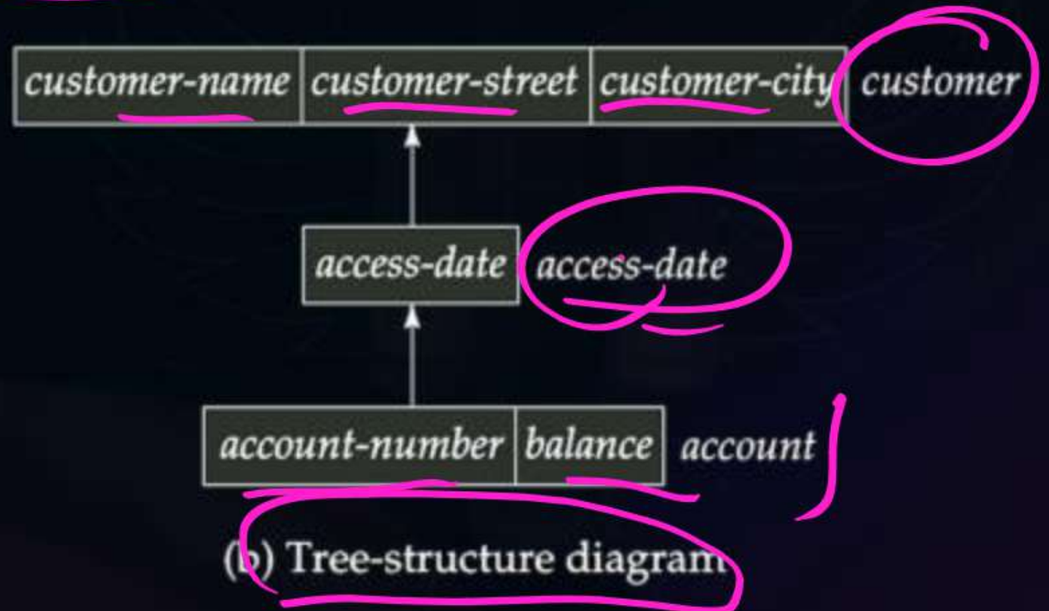
(b)

Topic : General Relationships

- Example ternary E-R diagram and corresponding tree-structure diagrams are shown on the following page.

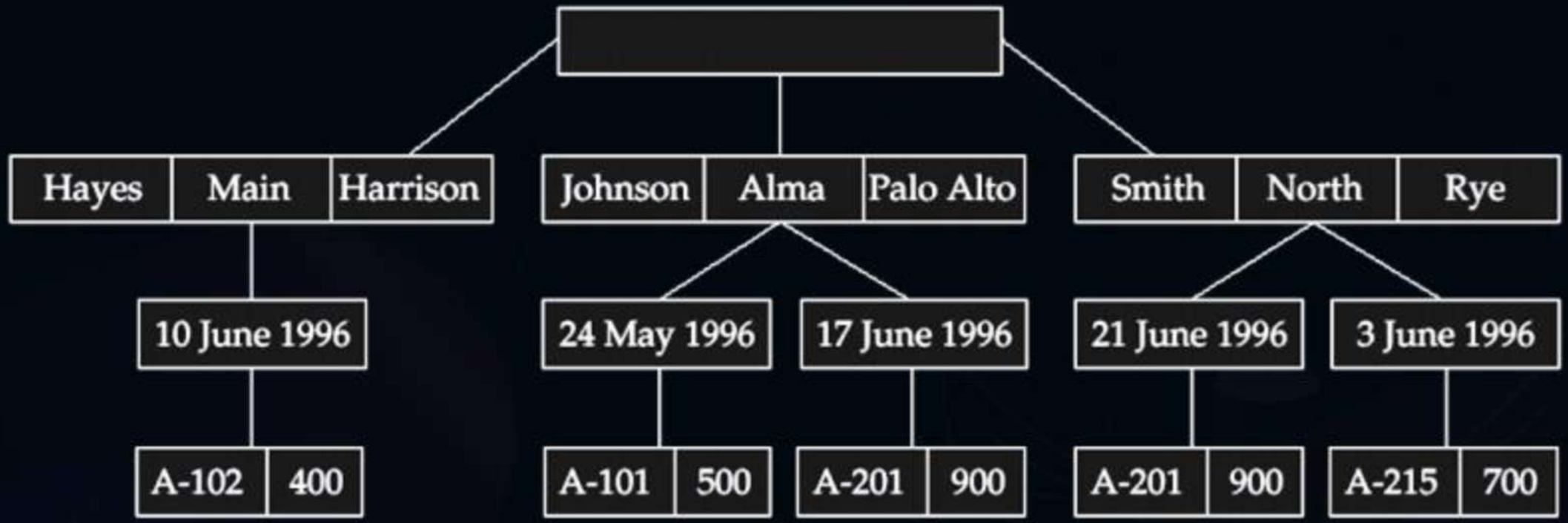


(a) E-R diagram



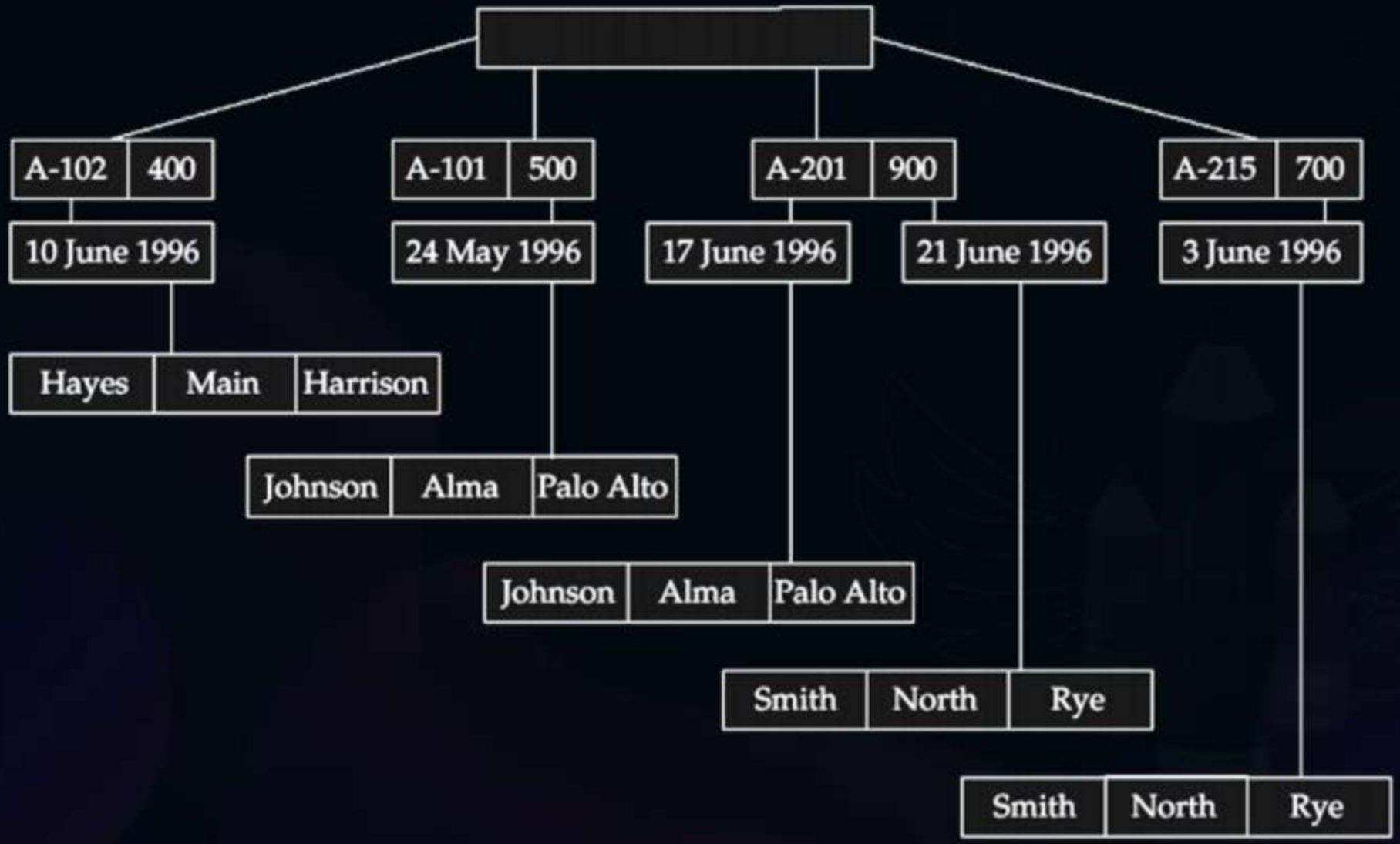
(b) Tree-structure diagram

Topic : Sample Ternary Databases. (a) T_1 (b) T_2



(a)

Topic : Sample Ternary Databases. (a) T_1 (b) T_2

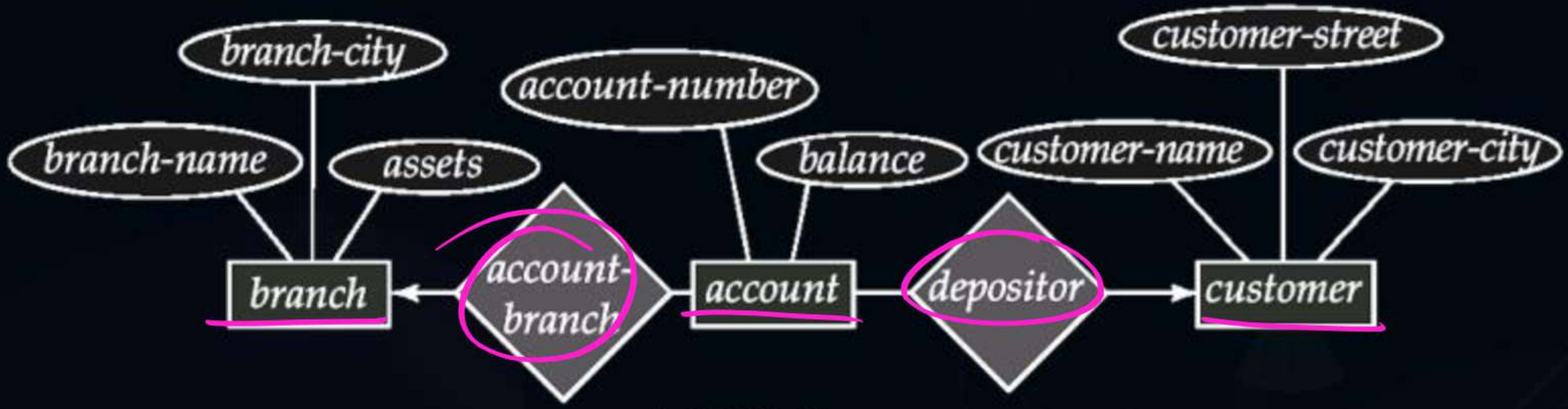


(b)

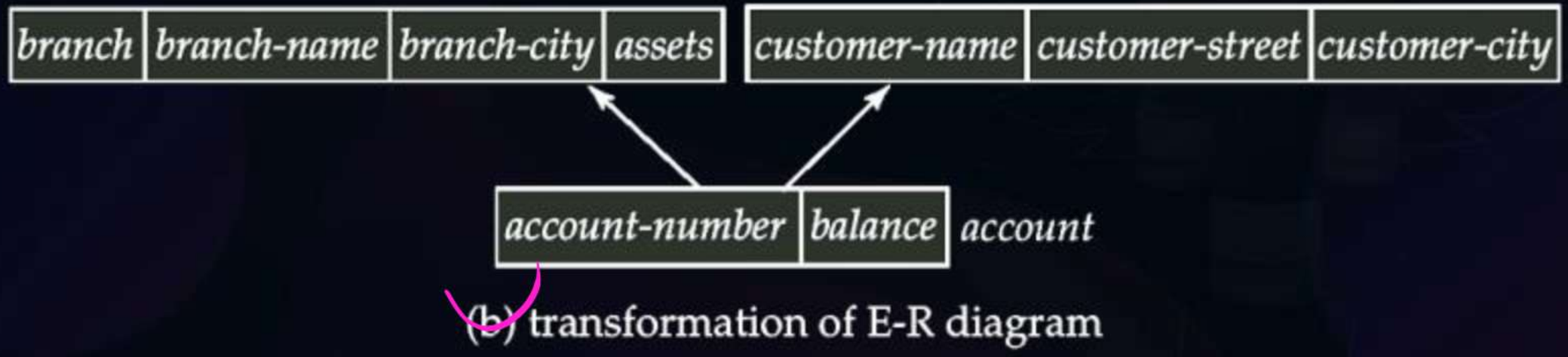
Topic : Several Relationships

- To correctly transform an E-R diagram with several relationships, split the unrooted tree structure diagrams into several diagrams, each of which is a rooted tree.
- Example E-R diagram and transformation leading to diagram that is not a rooted tree:

Topic : Several Relationships (Cont.)



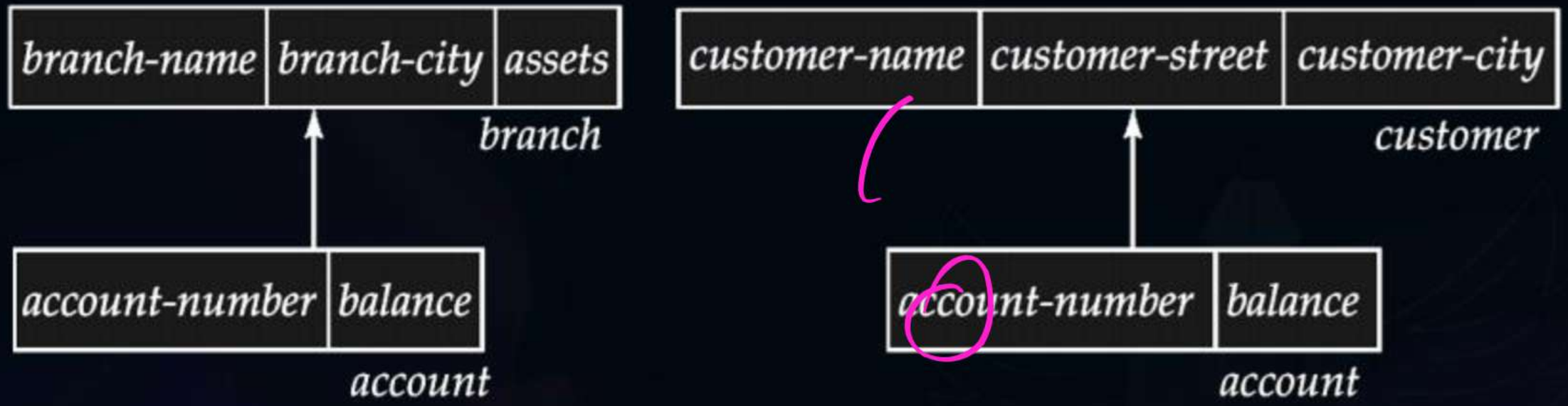
(a) E-R diagram



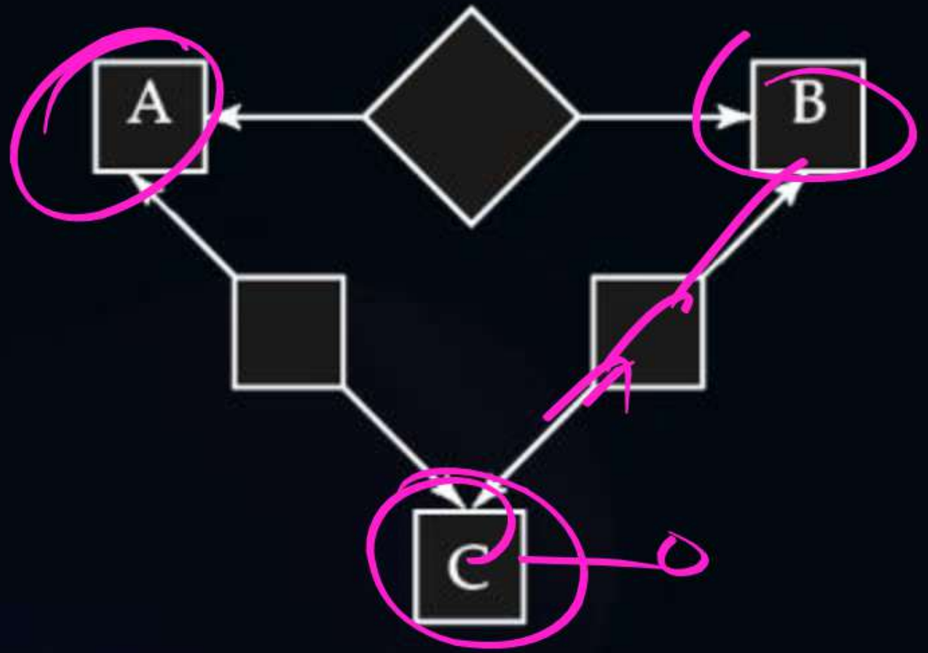
(b) transformation of E-R diagram

Topic : Several Relationships (Cont.)

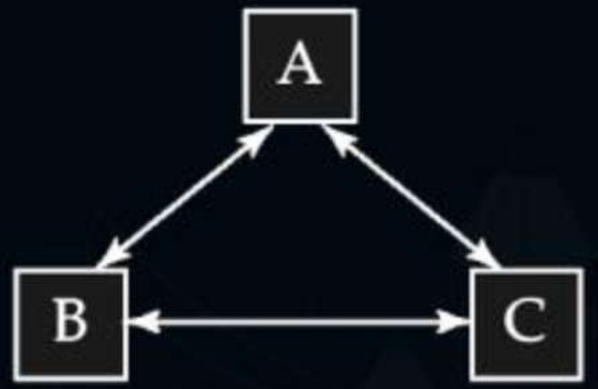
- Corresponding diagrams in the form of rooted trees.



Topic : Several Relationships (2nd Example)



(a)

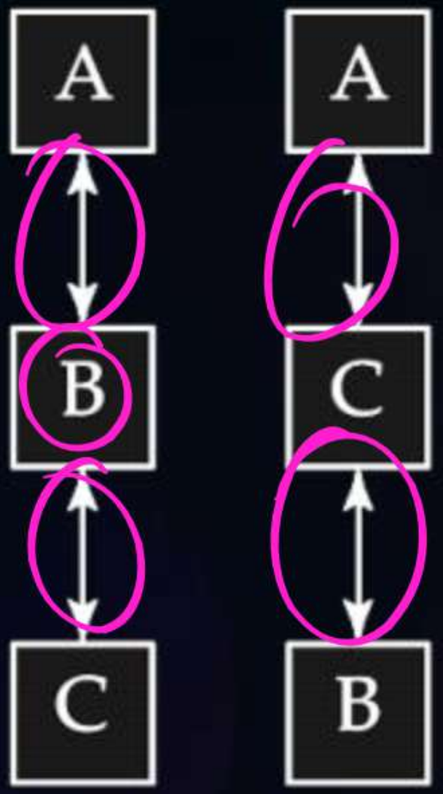


(b)

- Diagram (b) contains a cycle.
- Replicate all three record types, and create two separate diagrams.

Topic : Several Relationships (2nd Example)

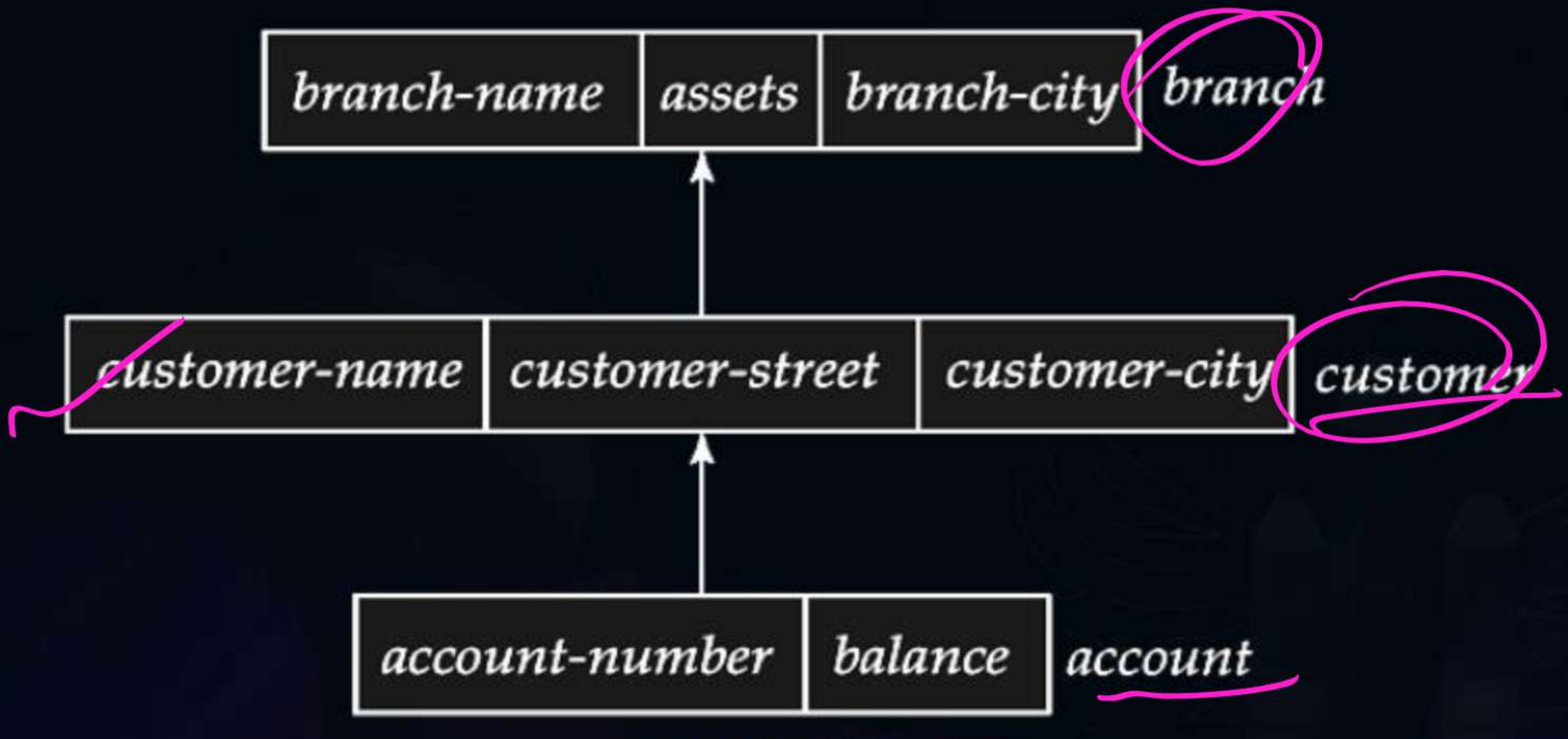
- Each diagram is now a rooted tree.



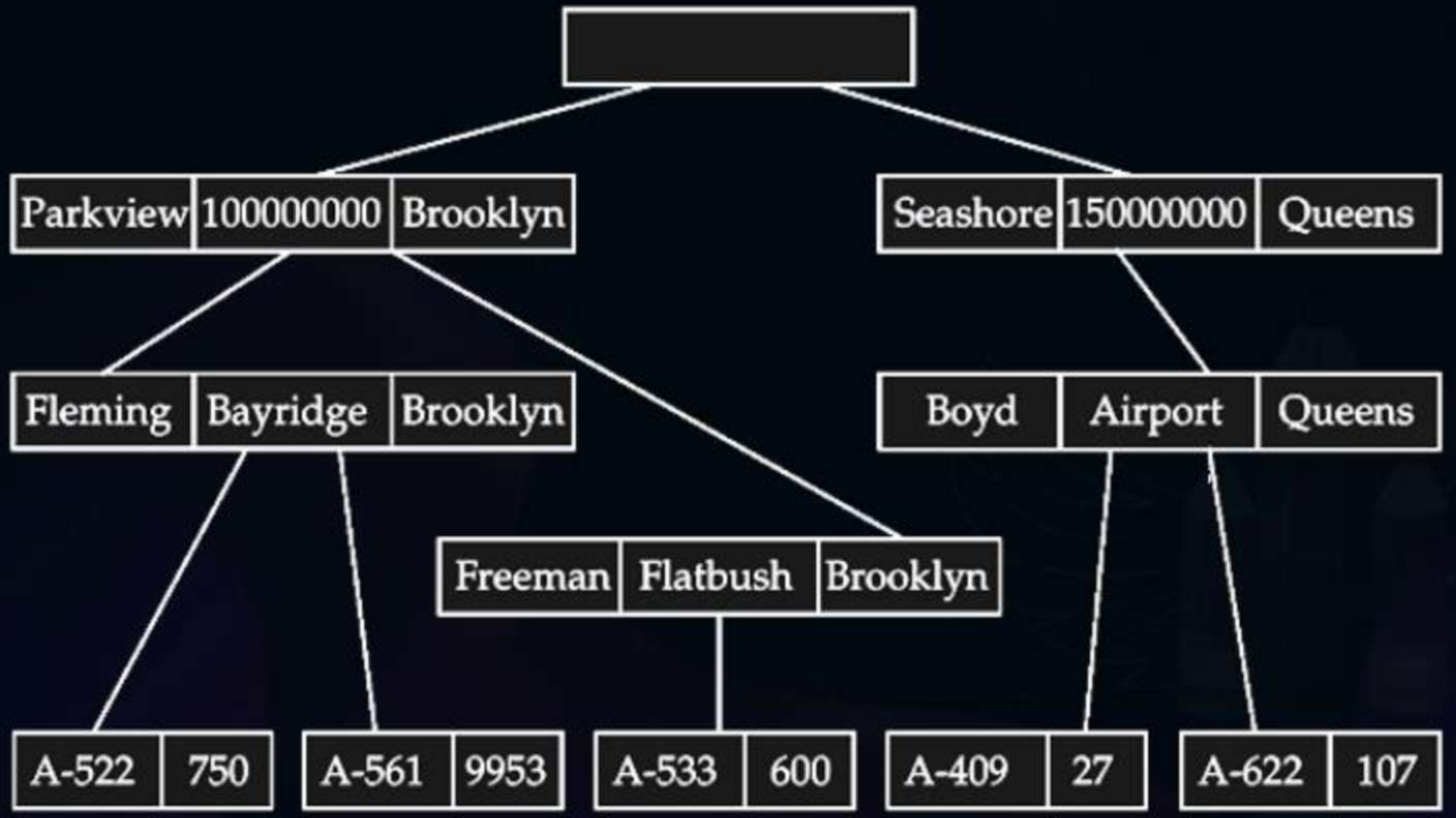
Topic : Data Retrieval Facility

- We present querying of hierarchical databases via a simplified version of DL/I, the data-manipulation language of IMS.
- Example schema: customer-account-branch
- A branch can have several customers, each of which can have several accounts.
- An account may belong to only one customer, and a customer can belong to only one branch.

Topic : Example Schema



Topic : Example Schema



Topic : Program Work Area

- A buffer storage area that contains these variables
  - Record templates
  - Currency pointers
  - Status flag
- A particular program work area is associated with precisely one application program.
- Example program work area:
  - Templates for three record types: customer, account, and branch.
  - Currency pointer to the most recently accessed record of branch, customer, or account type
  - One status variable.

Topic : The get Command

- Data items are retrieved through the get command
  - locates a record in the database and sets the currency pointer to point to it
  - copies that record from the database to the appropriate program work-area template
- The get command must specify which of the database trees is to be searched.
- State of the program work area after executing get command to locate the customer record belonging to Freeman
  - The currency pointer points now to the record of Freeman.
  - The information pertaining to Freeman is copied into the customer record work-area template.
  - DB-status is set to the value 0.

Topic : The get Command (Cont.)

- To scan all records in a consistent manner, we must impose an ordering on the records.
- Preorder search starts at the root, and then searches the subtrees of the root from left to right, recursively.
  - Starts at the root, visits the leftmost child, visits its leftmost child, and soon, until a leaf (childless) node is reached.
  - Move back to the parent of the leaf and visit the leftmost unvisited child.
  - Proceed in this manner until the entire three is visited.
- Preordered listing of the records in the example database three:
  Parkview, Fleming, A-522, A-561, Freeman, A533,
  Seashore, Boyd, A-409, A-622

Topic : Access Within A Database Tree

- Locates the first record (in preorder), of type <record type> that satisfies the <condition> of the where clause.
- The where clause is optional <condition> is a predicate that involves either an ancestor of <record type> or the <record type> itself.
- If where is omitted, locate the first record of type <record-type>
  - Set currency pointer to that record
  - Copy its contents into the appropriate work-area template.
- If no such record exists in the tree, then the search fails, and DB-status is set to an appropriate error message.

Topic : Example Queries

- Print the address of customer Fleming:

```
get first customer
where customer.customer-name = “Fleming”;
print (customer.customer-address);
```

- Print an account belonging to Fleming that has a balance greater than $10,000.

```
get first account
        where customer.customer-name = “Fleming”
                and account.balance > 10000;
        if DB-status = 0 then print (account.account-number);
```

Topic : Access Within a Database Tree (Cont.)

get next <record type>

where <condition>

- Locates the next record (in preorder) that satisfies <condition>
- If the where clause is omitted, then the next record of type <record type> is located.
- The currency pointer is used by the system to determine where to resume the search.
- As before, the currency pointer, the work-area template of type <record-type>, and DB-status are affected.

Topic : Example Query

- Print the account number of all the accounts that have a balance greater than $500

```
get first account
    where account. balance > 500;
while DB-status = 0 do
  begin
      print (account.account-number);
      get next account
          where account.balance > 500;
end
```

- When while loop returns DB-status ≠ 0, we exhausted all account records with account.balance > 500.

Topic : Access Within a Database Tree (Cont.)

get next within parent <record type>
where <condition>

- Searches only the specific subtree whose root is the most recent record that was located with either get first or get next.
- Locates the next record (in preorder) that satisfies <condition> in the subtree whose root is the parent of current of <record type>.
- If the where clause is omitted, then the next record of type <record type> within the designated subtree to resume search.
- Use currency pointer to determine where to resume search.
- DB-status is set to a nonzero value if no such record exists in the designated subtree (rather than if none exists in the entire tree).

Topic : Example Query

- Print the total balance of all accounts belonging to Boyd:

```
sum := 0;
get first customer
        where customer.customer-name = "Boyd";
get next within parent account;
while  DB-status = 0 do
begin
        sum = sum + account.balance;
        get next within parent account;
end
print (sum);
```

- We exit from the while loop and print out the value of sum only when the DB-status is set to a value not equal to 0. This value exists after the get next within parent operation fails.

Topic : Update Facility

- Various mechanisms are available for updating information in the database.
- Creation and deletion of records (via the insert and delete operations).
- Modification (via the replace operation) of the content of existing records.

Topic : Creation of New Records

- To insert <record type> into the database, first set the appropriate values in the corresponding <record type> work-area template. Then execute
- insert <record type>
  where <condition>
- If the where clause is included, the system searches the database three (in preorder) for a record that satisfies the <condition> in the where clause.
- Once such a record — say, X — is found, the newly created record is inserted in the tree as the leftmost child of X.
- If where is omitted, the record is inserted in the first position (in preorder) in the tree where <record type> can be inserted in accordance with the specified schema.

Topic : Example Queries

- Add a new customer, Jackson, to the Seashore branch:

```
customer.customer-name := “Jackson”;
customer.customer-street := “Old Road”;
customer.customer-city := “Queens”;
insert customer
    where branch.branch-name = “Seashore”;
```

- Create a new account numbered A-655 that belongs to customer “Jackson”;

```
account.account-number  := “A-655”;
account.balance := 100;
insert account
    where customer.customer-name = “Jackson”;
```

Topic : Modification of an Existing Record

- To modify an existing record of type <record type>, we must get that record into the work-area template for <record type>, and change the desired fields in that template.
- Reflect the changes in the database by executing
- replace
- replace dies not have <record type> as an argument; the record that is affected is the one to which the currency pointer points.
- DL/I requires that, prior to a record being modified, the get command must have the additional clause hold, so that the system is aware that a record is to be modified.

Topic : Example Query

- Change the street address of Boyd to Northview:

```
get hold first customer
        where customer.customer-name = “Boyd”;
customer.customer-street := “Northview”;
replace;
```

- If there were more than one record containing Boyd’s address, the program would have included a loop to search all Boyd records.

Topic : Deletion of a Record

- To delete a record of type <record type>, set the currency pointer to point to that record and execute delete.
- As a record modification, the get command must have the attribute hold attached to it. Example: Delete account A-561:
-
```
get hold first account
    where account.account-number = “A-561”;
delete;
```
- A delete operation deletes not only the record in question, but also the entire subtree rooted by that record. Thus, to delete customer Boyd and all his accounts, we write

```
get gold first customer
        where customer.customer-name = “Boyd”;
delete;
```

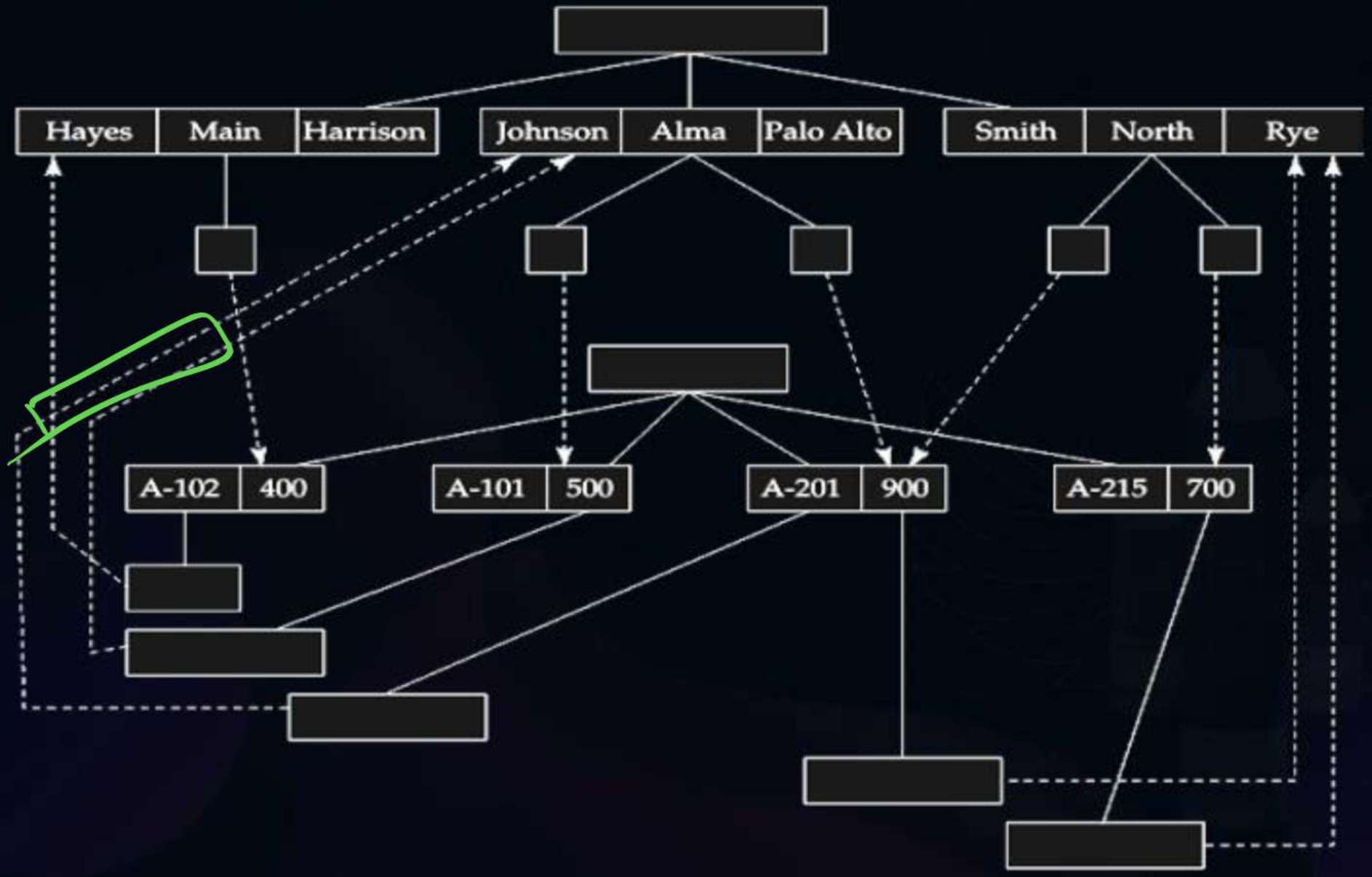
Topic : Virtual Records

- For many-to-many relationships, record replication is necessary to preserve the tree-structure organization of the database.
  - Data inconsistency may result when updating takes place
  - Waste of space is unavoidable
- Virtual record — contains no data value, only a logical pointer to a particular physical record.
- When a record is to be replicated in several database trees, a single copy of that record is kept in one of the trees and all other records are replaced with a virtual record.
- Let R be a record type that is replicated in $T_1, T_2, \ldots, T_n$. Create a new virtual record type virtual-R and replace R in each of the n – 1 trees with a record of type virtual-R.

Topic : Virtual Records (Cont.)

- Eliminate data replication in the diagram shown on page B.4: create virtual-customer and virtual-account.
- Replace account with virtual-account in the first tree, and replace customer with virtual-customer in the second tree.
- Add a dashed line from virtual-customer to customer, and from virtual-account to account, to specify the association between a virtual record and its corresponding physical record.

Topic : Sample Database



2 mins Summary

- **Topic** One
- **Topic** Two
- **Topic** Three
- **Topic** Four
- **Topic** Five

THANK - YOU