2. ER Diagram: Figure 1 shows the ER diagram of the Company Employee Administrative Database (COMPANY).

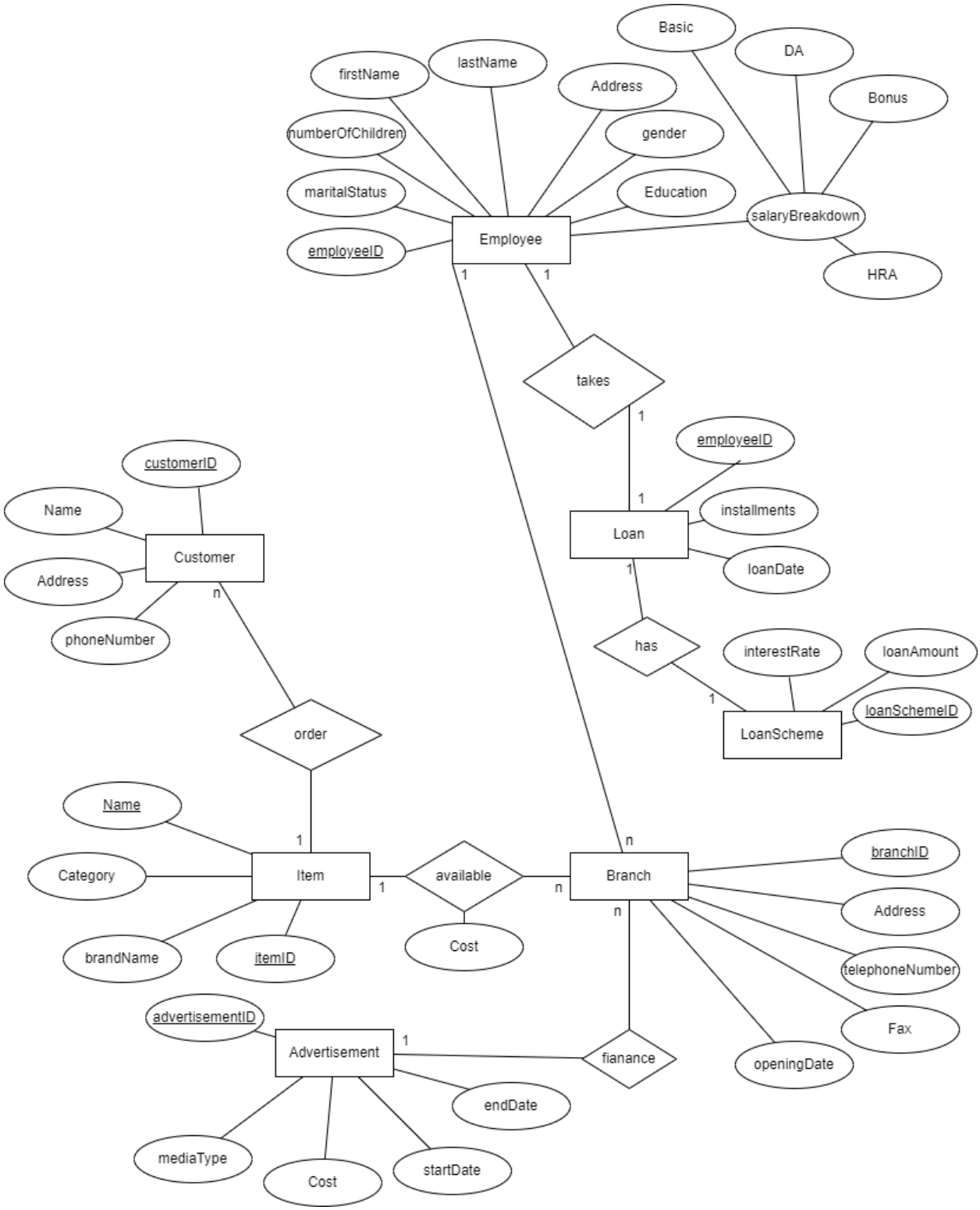

Figure 1. ER diagram of the Company Employee Administrative Database.

3. ER Diagram Uncaptured Constraints

The following is a list of constraints that are not captured by the ER diagram of COMPANY:

- Employee.employeeID will be a 10 digit numeric ID.
- Employee.maritialStatus is a set of 3 classifications: Single, Married, Widowed
- Employee.Education is a set of 5 classifications: None, Highschool, Bachelors, Masters, PhD
- salaryBreakdown.[Basic, DA, Bonus, HRA] are all dollar amounts given in USD
- LoanScheme.loanSchemeID is a 10 digit numeric ID
- Loan.loadDate is a date field
- Branch.branchID is a 10 digit numeric ID.
- Advertisement.mediaType is a set of 5 classifications: TV, Poster, Radio, Billboard, Sign Flipper Employee
- Advertisement.advertisementID is a 10 digit numeric ID
- Item.category is a set of classifications that are specified in a typical retail store
- Customer.customerID is a 10 digit numeric ID
- Item.itemID is a 10 digit numeric ID
- The database will store up to 20 different loan schemes
- An employee may only take one loan at a time
- The database will must be updated by at least one administrator and up to 5 administrators
- The database will store up to 20 branches

4. Processing Needs

Form Name	Description
Loan	
Update Loan Information	The admin can update the loan information whenever there is a written request to him/her by the employee, preferably by email.
Loan Scheme	
Removal of Loan	Whenever a loan is terminated, the admin will delete the record from the loan table.
Update Loan Information	The admin can update the loan information whenever there is a written request to him/her by the employee, preferably by email.

Employee	
Removal of Employee	An admin can remove an employee so long as they do not have any outstanding loans
Addition of Employee	An admin can add an employee with an employeeID and salary
Branch	
Add Advertisement	A branch manager can create a new advertisement and specify the ad type
Remove Advertisement	A branch manager can remove a advertisement
Update Branch Information	A branch manager can update the information of a branch
Advertisement	
Update Cost	A branch manager can update the cost of an advertisement in the case that the ad is renewed or the cost changes (ie. salary changes of sign flipper)
Update Media Type	A branch manager can update, expand, or contract the media types that apply to a given advertisement provided the proper materials exist to do so
Update Ad Dates	A branch manager can update the dates that an ad is set to run in case of renewal, this may accompany changes in media type and cost
Item	
Update Item Cost	A branch manager can update the cost of an item
Remove Item	A branch manager can remove an item being sold
Add Item	A branch manager can add a new item being sold
Customer	

Update Customer Information	Customers can update their own contact information such as name, address, and phone number at any time.

Branch Contact	Returns the main contact of the branch

5. Relational Table Details: This table summarizes all the queries

Table Name	Description	Attributes
Advertisement	Advertisement description	Advertisement Media Type: Returns the media type of the advertisement Advertisement startDate: Returns the start date of the advertisement used Advertisement endDate: Returns the end date of the advertisement used Advertisement Cost: Returns the cost of the advertisement Advertisement BranchID: Returns the branch ID of the advertisement Advertisement advertisementID: Returns the advertisement ID of the advertisement
Item	Item description	Item Category: Returns the category of the item Item Brand Name:Returns the brand name of the item Item BranchID:Returns the branch ID of the item Item Name: Returns the name of the item Item itemID:Returns the itemID of the item
Customer	Customer description	Customer Address: Returns the customer's address Customer phoneNumber: Returns the customer's number Customer customerID: Returns the customer's ID Customer Name: Returns the customer's name

Branch	Branch description	Branch Opening date: returns the branch's opening date Branch Address: returns the branch's address Branch telephone number: returns the branch's telephone number Branch fax: returns the branch's fax information Branch branchID: returns the branch's id
Employee	Employee description	employee firstName: returns first name employee lastName: returns last name employee address: returns address name employee gender: returns gender employee Education: returns education employee numberOfChildren: returns number of children employee marital status: returns marital status employee employeeID: returns employee id employee branchID: returns branchID where they work
Loan	loan description	loan installments: returns loan installment loan loanDate: returns date loan was made loan loanAmount: returns loan amount loan loanID: returns loan Id loan loanSchemeID: returns scheme ID of the loan
LoanScheme	loan scheme description	loanScheme interestRate: returns interest rate of the loan loanScheme loanAmount: returns amount loaned loanScheme loanSchemeID: returns scheme ID of the loan

6. Relational Schema with Referential Integrity (From Elmasri & Navathe, 2004)

The ER diagram of COMPANY is mapped to the relational schema shown in figure 2 with arrows indicating referential integrity.

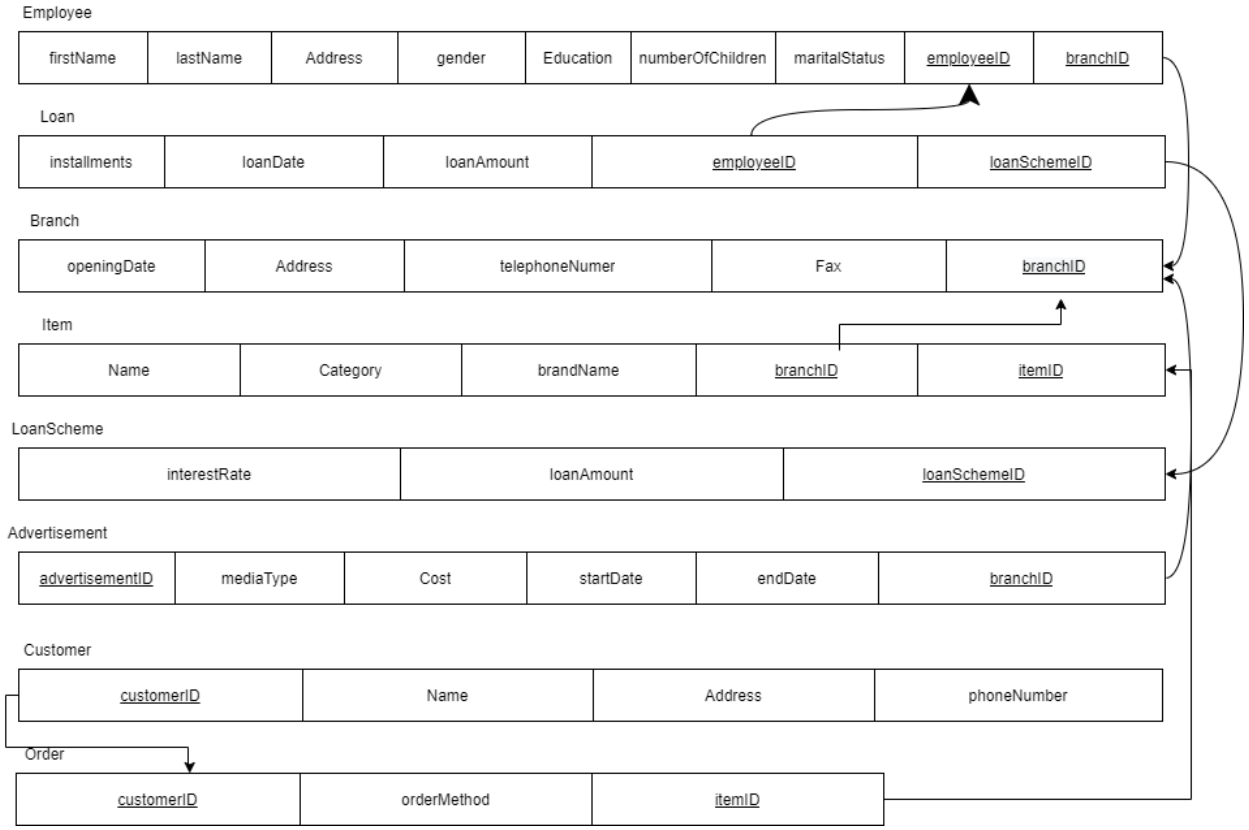

Figure 2 Relational schema of the ASU Marketplace Database with arrows indicating referential integrity.

7. Functional Dependencies

The following is a set of functional dependencies (FD's) of our database.

F = {FD1: employeeID → firstName, lastName, Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanSchemeID, branchID

FD2: loanSchemeID → loanAmount, intersestRate

FD3: advertisementID → mediaType, adCost, startDate, endDate, branchID

FD4: branchID → branchAddress, telephoneNumber, Fax, openingDate

FD5: itemID → brandName, Category, iName, branchID

FD6: customerID → cAddress, cName, cPhone }

Universal Schema:

Company (employeeID, firstName, lastName, employee.Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanAmount, intersestRate, branch.Address, branch.telephoneNumber, Fax, openingDate, mediaType, Cost, startDate, endDate, brandName, Category, item.Name, customer.Address, customer.Name, customer.phoneNumber)

The minimal universal key is (employeeID, loanSchemeID, branchID, advertisementID, itemID, customerID).

The following attribute closure of the minimal universal key shows that the minimal universal key can be used to derive all attributes in the universal schema:

Given	employeeID, loanSchemeID, branchID, advertisementID, itemID, customerID
FD1	firstName, lastName, Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanSchemeID, branchID
FD2	loanAmount, intersestRate
FD3	mediaType, Cost, startDate, endDate, branchID
FD4	Address, telephoneNumber, Fax, openingDate
FD5	brandName, Category, Name, branchID

FD6	Address, Name, phoneNumber

The universal key (employeeID, loanSchemeID, branchID, advertisementID, itemID, customerID) is minimal because no subset of it forms a key of the universal schema.

The minimal universal key is important to determine whether the schema has the lossless join property. If there exists a table in the relational schema that contains the minimal universal key, then the schema has the lossless join property. The lossless join property is not necessary if the application does not require a view of the universal schema. This example does not have the lossless join property because the minimal universal key is not contained in one of the tables.

8. Discussing of Resulting Relational Design

8.1 Normal Form of Relations With Justification

Each FD in F is an entity relationship where the entity and all of its attributes are uniquely identified by an ID for that specific entity. Designing our database this way has the effect of each entity already being in BCNF. This allows us to decompose each FD into its own table where the left hand side acts as a super key for that entity. These tables can then be joined to access the totality of the database's attributes.

BCNF:

R_1(employeeID, firstName, lastName, Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanSchemeID, branchID)

R_2(loanSchemeID, loanAmount, intersestRate)

R_3(advertisementID, mediaType, adCost, startDate, endDate, branchID)

R_4(branchID, branchAddress, telephoneNumber, Fax, openingDate)

R_5(itemID, brandName, Category, iName, branchID)

R_6(customerID, cAddress, cName, cPhone)

8.2 Verification of Lossless Join Property

F = {FD1: employeeID → firstName, lastName, Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanSchemeID, branchID

FD2: loanSchemeID → loanAmount, intersestRate

FD3: advertisementID → mediaType, adCost, startDate, endDate, branchID

FD4: branchID → branchAddress, telephoneNumber, Fax, openingDate

FD5: itemID → brandName, Category, iName, branchID

FD6: customerID → cAddress, cName, cPhone }

	empID	fName	lName	Address	gender	Education	nOfChild	maritalStatus	salary	installments	loanDate	loanSchemeID	branchID	loanAmount	interestRate	advertisementID	mediaType	adCost	startDate	endDate	branchAdd	telephone	fax	openingDate	itemID	brandName	category	iName	customerID	cAddress	cName	cPhone
R1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔						✔	✔	✔	✔								
R2												✔		✔	✔						✔	✔	✔	✔								
R3													✔			✔	✔	✔	✔	✔	✔	✔	✔	✔								
R4													✔								✔	✔	✔	✔								
R5													✔								✔	✔	✔	✔	✔	✔	✔	✔				
R6																													✔	✔	✔	✔

Since no row is completely filled in, this is a *lossy join*. In practicality, we would have a lossless join, however we have not accounted for all of the other possible functional dependencies. As a result, this decomposition is lossy. Joining the tables would result in access to all attributes.

8.3 Dependency Preservation

Functional Dependency	Validation	Covered By Relation
FD1: employeeID → firstName, lastName, Address, gender, Education, numberOfChildren, maritalStatus, salaryBreakdown, installments, loanDate, loanSchemeID, branchID	✔	1
FD2: loanSchemeID → loanAmount, intersestRate	✔	2
FD3: advertisementID → mediaType, adCost, startDate, endDate, branchID	✔	3
FD4: branchID → branchAddress, telephoneNumber, Fax, openingDate	✔	4
FD5: itemID → brandName, Category, iName, branchID	✔	5
FD6: customerID → cAddress, cName, cPhone	✔	6

Since each of the functional dependencies is covered by a relation, the decomposition *is dependency-preserving.*

9 Transaction Processing Needs

9.1 Forms

Form Name and Description	**Relations Accessed**	**Explicit Constraints Checked**
Employee Hire Form The HR office enters in new information for each newly hired employee. The employee is given a branch. Employees are added to the record.	Employee, Branch	none

Employee Branch Switch The HR office helps employees switch to a different main branch	Employee, Branch	An employee can only have one main branch at a time
Advertisement form An employee fills out the advertisement form so an ad can be used for a branch/item.	Item, branch	none
Loan form An employee fills out the loan form so they can take out a loan and select a loan scheme.	Loan, LoanScheme, Employee	An employee can only take out one loan at a time
Customer Complaint form Customers can fill out a complaint form about an item or employee if they feel the need to.	Customer, Employee, Item	none
Employee Termination If HR feels the need to, they can fire employees. They will need to fill out this form.	Employee	none
Employee update information If employee information changes, they can update the information by filling out this form and sending it to HR.	Employee	none

9.2 Reports

The following table summarizes the reports in the database.

Report Name	**Description**	**Relations Accessed**
Marketing Strategies	Lists the advertisements that each branch used for marketing with critical details including the duration of that specific ad, as well as associated costs and type of ad.	● Branch ● finance ● Advertisement
Past Orders	Lists the orders completed by customer for the specified branch including the information about the items in the transaction as an invoice. Customer details are also listed.	● Branch ● available ● item ● order ● Customer
Employee List	Lists employee information, including the information of employee's salary and loans taken (if any) as well as personal information like marital status and number of children for each employee. The list is sorted in alphabetical order by employee's last name.	● Employee ● takes ● Loan ● LoanScheme

9.3 Queries

This table summarizes all the queries within the Database.

Query Name	Description	Output	Relations Accessed
Married employees with kids	Retrieve information on each employee who is married and has kids.	● Employee first name ● Employee last name ● Employee marital status ● Number of children	● Employee
Employees that currently have made loans > $20,000	Retrieve information on employees that have made larger loans greater than or equal to $20,000	● Employee first name ● Employee last name	● Employee ● Loan
Employees that work at multiple branches	Retrieve information on each employee that works at multiple branches	● Employee first name ● Employee last name ● Each branch they work at (branchID)	● Employee ● Branch
Items that are only sold at one branch	Retrieve information on items that are only sold at one branch	● Item Id ● Item Name ● Branch Id	● Item ● Branch
Customers that have never had an order delivered	Retrieve information for each customer that have never had an order delivered	● Customer Name ● Customer Id	● Customer ● Order
Advertisements that cost more more than 10,000	Retrieve information on advertisements that cost above 10,000	● Advertisement media type ● Advertisement cost ● Advertisement start date ● Advertisement end date ● Advertisement branch id	● Advertisements
Employee with >=2 number of children	List names of all employees with two or more number of children	● Employee first name ● Employee last name ● Number of children	● Employee
Employee with no number of children	Retrieve the names of employees who have no children	● Employee first name ● Employee last name ● Number of children	● Employee
Loans made after 2020 with a small interest rate	Retrieve information of the loans made after 2020 with an interest rate less than 2%	● LoanScheme ID	● Loan ● LoanScheme