CSCI - 4380 Database Systems

Homework 2

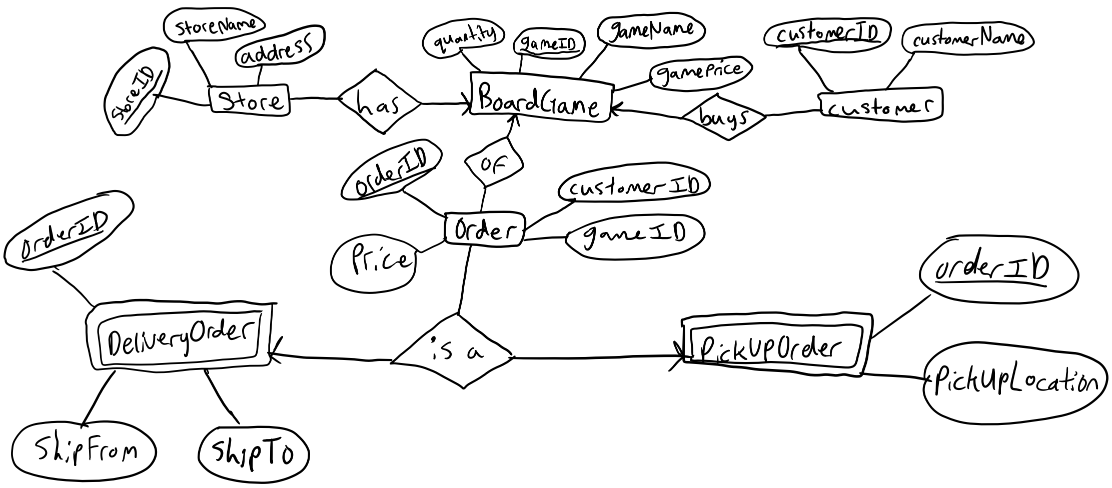
Data Model Design

This homework will focus on concepts related to the creation of a data model.

It is due on Thursday February 7 at 15:59PM and should be submitted electronically on the class Submitty site.

1. You have been hired to help develop a database for the sales system for a new store that will sell board games. The system should support the following:
   - Inventory management (both what games are in stock for a given store location and what games are available for order)
   - Customer management (for sales and marketing purposes)
   - Order management (orders that have been placed by customers, both for delivery and for pick-up in a location)

   (a) (12 points) Draw an Entity-Relationship diagram for your system.



   (b) (8 points) Convert your Entity-Relationship diagram into a relational model

BoardGame(gameID, gameName, gamePrice, quantity) Customer(customerID, customerName) Store(storeID, storeName, address) Order(orderID, customerID, gameID, price) PickUpOrder(orderID, pickUpLocation) DeliveryOrder(orderID, shipFrom, shipTo)

2. Given the relation *StudentEnrollment*(*id*, *name*, *major*, *mailboxNumber*, *courseNumber*, *semester*, *professor*), abbreviated $E(i,n,m,b,c,s,p)$ and the functional dependencies $i \rightarrow nm$, $ics \rightarrow nmp$, $cs \rightarrow p$, and $mb \rightarrow i$

(a) (2 points) What are the keys of the relation?

$E(i,n,m,b,c,s,p)$ with F = { $i \rightarrow nm$, $ics \rightarrow nmp$, $cs \rightarrow p$, and $mb \rightarrow i$ }

BCNF: For all functional dependencies, the LHS must be a super key regardless if the RHS is prime or not.
3NF: For all functional dependencies, if the RHS is non-prime, then the LHS must be a super key. If the RHS is prime, then the LHS can either be a super key or not.

LHS	M	RHS
i,c,s,b	m	n,p

Now check the closure of every subset of the LHS to determine the super keys.
i+ = inm NO
ic+ = icnm NO
ics+ = icsnmp NO
icsb+ = icsnmpb YES

Now we check the M column as well
mcsb+ = cspinmb YES

These are the super keys of the relation. Since they are minimal, they are also the candidate keys.
Keys = {icsb, mcsb}

(b) (1 point) This relation is not in BCNF. Why not?

This relation is not in BCNF. This is because we have a violation in $i \rightarrow nm$. The LHS is not a super key; it does not connect to every attribute in the relation.

(c) (9 points) Decompose the relation into sub-relations that are in BCNF using the algorithm presented in class. Use the 1st violating FD above as the starting point for your 1st decomposition. Make sure you've listed any FDs that hold for your sub-relations.

The first violation in $i \rightarrow nm$. We will use this for our decomposition into 2 sub relations.
{ $i \rightarrow nm$, $ics \rightarrow nmp$, $cs \rightarrow p$, and $mb \rightarrow i$ }

R1 = {inm} i-> nm #Cannot be broken up further
R2 = {ibcsp} cs->p
R21 = {csp} #Cannot be broken up further
R22 = {csib} #Cannot be broken up further

These are the sub-relations that are BCNF: {inm, csp, csib}

(d) (2 points) Which of the original FDs isn't preserved by your decomposition? How do you know?

The FD not preserved by our decomposition is mb-> i because it does not appear in our answer for part (c). ics -> npm is also not preserved but not from our decomposition and thus not part of our answer.

(e) (6 points) Decompose the original relation into sub-relations in 3NF, using the synthesis algorithm described in class.

We know our candidate keys which are {icsb, mcsb}

We now merge our functional dependencies whose LHS are the same and whose RHS contain non key attributes. We then get the following functional dependencies:

i -> n

cs -> p

Now we check each of them to see if that functional dependency violates 3NF.
in with FD i -> n violates

csp with FD cs -> p violates

Now we have the following from removing the RHS of the FDs
Imbcs with FD i -> m and bm -> i.

Our sub relations are {in, csp, imbcs}