Computer Science 143, Homework 4

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Part 1

Problem 1

Yes, this is a lossless decomposition. Since $A \to BC$ and $B \to D$, we have that $A \to BCD$. Then since $CD \to E$, we have that $A \to BCDE$. So $A \to ADE$, and A is a superkey for R_2. Since $R_1 \cap R_2 = \{A\}$, we have $R_1 \cap R_2 \to R_2$.

Problem 2

$$\{A \to B, C \to B, C \to A\}$$

Problem 3

a) Yes. We have that $E \to A$ and $A \to BC$, so $E \to ABC$. Then we have $B \to D$, so $E \to ABCD$. Along with the trivial functional dependency $E \to E$, we get $E \to ABCDE$ or $E \to R$. Thus E is a key for R.

b) Yes. We have the trivial functional dependency $BC \to BC$ and $B \to D$, so $BC \to BCD$. Then we have $CD \to E$, so $BC \to BCDE$. Finally we have $E \to A$, so $BC \to ABCDE$, or $BC \to R$. Thus BC is a key for R.

Problem 4

This is not in BCNF. Consider the functional dependency $B \to D$. The dependency $B \to F$ cannot be derived from the closure of the set of funtional dependencies, so B is not a key for R. Thus there exists some nontrivial functional dependency in R where the left hand side is not a key for R. If it was in BCNF, this could not happen. To normalize it into BCNF, decompose it into the relations $R_1(A, F)$, $R_2(A, B, C)$, $R_3(C, E)$, and $R_4(B, D)$.

Problem 5

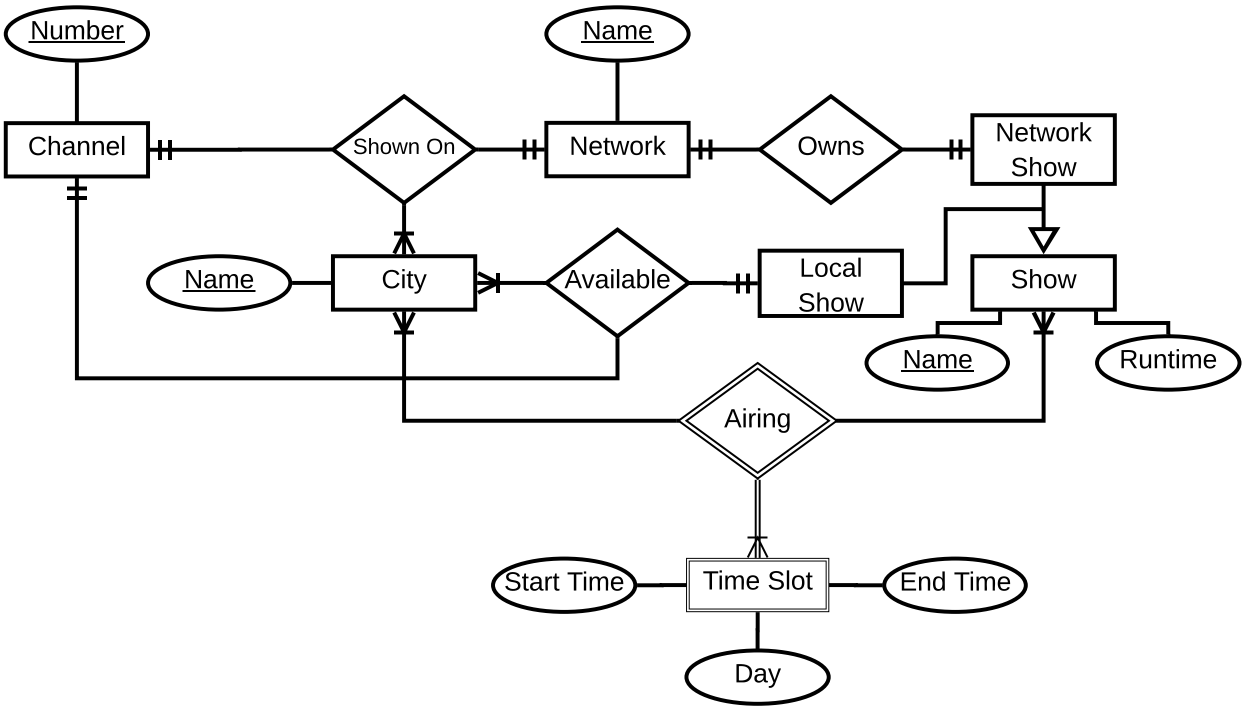
$$\{(a, b_1, c_1, d_2), (a, b_1, c_1, d_3), (a, b_2, c_2, d_1),\\ (a, b_2, c_2, d_3), (a, b_3, c_3, d_1), (a, b_3, c_3, d_2)\}$$

Problem 6

No it is not in 4NF. We have a nontrivial multivalue dependency $A \twoheadrightarrow B$ where A is not a key, which violates the conditions of 4NF. To normalize it into 4NF, decompose it into the relations $R_1(A, D, F)$, $R_2(A, B)$, $R_3(A, C)$, and $R_4(A, E)$.

Part 2

Problem 1



Some assumptions I made were that a given show could only be shown on one channel in a given city, and a network could only be associated with one channel in a given city. Multiple cities can have a given network on a given channel, and multiple cities can have a given show on a given channel. I used subclasses to represent the distiction between a network show and a local show. With these relationships, one can determine the channel that a show will be shown on. Separate from this, there is a weak entity set called "Time Slot" which allows us to determine when shows are shown in a given city. A show may be shown multiple times for a given city, a city may have multiple shows showing in a given time slot, and a show may have multiple cities that it's showing in for a given timeslot. Thus all the arrows in this relationship set are many to many.

Problem 2

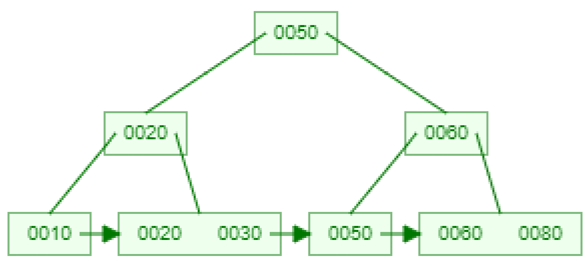
This can be converted into the three relations shown below.

assembly(<u>number</u>, name, cost)
parts(<u>number</u>, name)
composed_of(<u>assembly_number</u>, parts_number, quantity)

In these tables, assembly_number is a foreign key that references the key of assembly, and parts_number is a foreign key that references the key of parts.

Part 3

Problem 1



Problem 2