

Problem 0: BCNF Concepts

a. **(14AU Final Q10)**

A lossless decomposition is one in which all of the data in the original table is recovered exactly, if the decomposed tables are combined with natural joins.

Every BCNF decomposition is lossless.

TRUE or FALSE

b. **(17WI Final Q1)**

BCNF is a lossless decomposition and it does not preserve all functional dependencies.

TRUE or FALSE

c. **(14WI Final Q2)**

Consider Relation $R(ABCD)$, and functional dependencies (FDs): $BD \rightarrow AC$; $AB \rightarrow D$; $AC \rightarrow B$.

This relation is in Boyce-Codd Normal Form (BCNF).

TRUE or FALSE.

Identify a key (not a superkey)

BD or AB or AC

d. **(14 WI Final Q2)**

Consider Relation $R(ABCDE)$, and functional dependencies (FDs): $A \rightarrow C$; $B \rightarrow AE$; $E \rightarrow D$.

This relation is in Boyce-Codd Normal Form (BCNF).

TRUE or FALSE

Identify a key (not a superkey)

B

e. **(15AU Final Q2c)**

Consider the following relational schema and set of functional dependencies.

$R(A,B,C,D,E,F,G)$ with functional dependencies: $E \rightarrow C$; $G \rightarrow AD$; $B \rightarrow E$; $C \rightarrow BF$

Give one example of non-trivial functional dependency implied by the ones above:

Many solutions are possible. One example is $E \rightarrow BF$.

Compute E^+ , the closure of E.

$\{E\}^+ = \{B, C, E, F\}$

Problem 1: BCNF Decomposition

(17WI Final Q4)

Given $R(A, B, C, D, E)$, and functional dependencies: $A \rightarrow C$, $BD \rightarrow A$, $D \rightarrow E$

a) Decompose R into BCNF. In each step, explain which functional dependency you used to decompose and explain why further decomposition is needed. Your answer should consist of a list of table names and attributes. Make sure you indicate the keys for each relation.

One possible decomposition:

1. Use $A \rightarrow C$:

Decompose R into $R_1(A, C)$ and $T(A, B, D, E)$

T violates $BD \rightarrow A$ and $D \rightarrow E$, so we need to further decompose T

2. Use $D \rightarrow E$:

Decompose T into $R_2(B, D, A)$ and $R_3(D, E)$

Final relations: $R_1(\underline{A}, C)$, $R_2(\underline{B}, \underline{D}, A)$, and $R_3(\underline{D}, E)$

Problem 2: Entity Relationship Diagram

Consider the same database schema for a restaurant introduced in problem 2.

Ingredient(iid, name, allergen)

Dish(did, name, description, category)

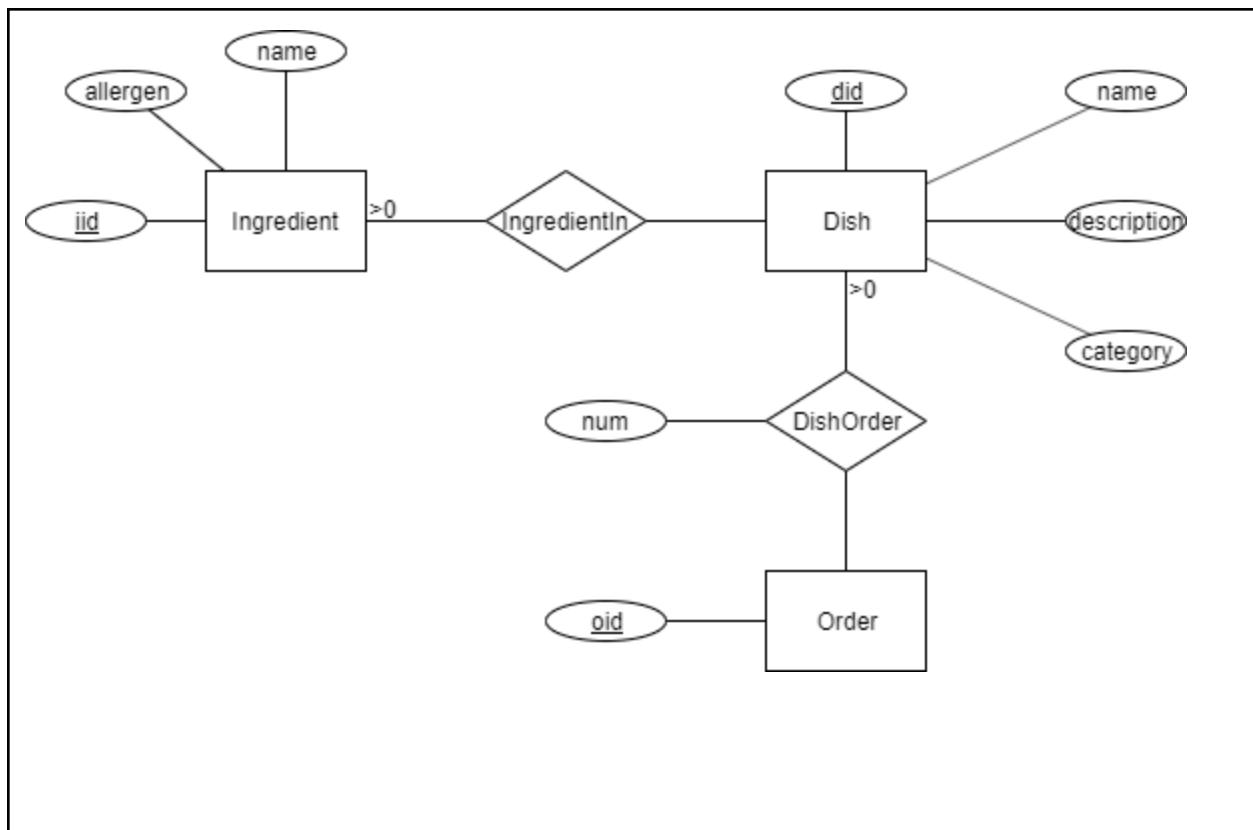
IngredientIn(iid, did)

Order(oid, customer)

DishOrder(oid, did, num)

Draw an E/R diagram to represent the database, with the Ingredient, Dish, and Order tables as the entities, and IngredientIn and DishOrder as the relationships. Make sure to enforce the following constraints:

1. Ingredient.**iid**, Dish.**did**, Order.**oid** are the primary keys of the corresponding tables
2. A Dish should have **at least one** Ingredient.
3. An Order should have **at least one** Dish.

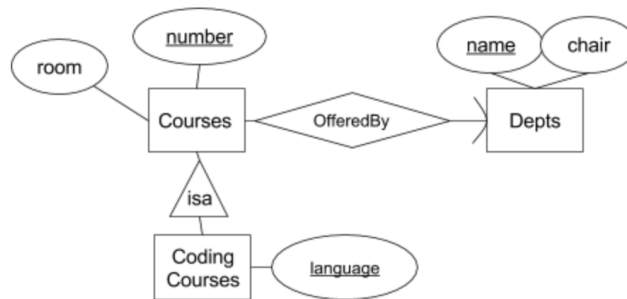


Problem 3: ER Diagram to BCNF Form

Convert the E/R diagram below to relations in BCNF form. Assume no values are NULL, and the arrow between OfferedBy and Depts is a round one. Include all keys and foreign keys. Use the following notation and explicitly state foreign key relationships. For instance:

$R(\underline{a}, b)$

$S(\underline{c}, d)$ -- c is a foreign key to R



Courses(number, room, name) -- name is foreign key to Depts

CodingCourses(language, number) -- number is foreign key to Courses

Depts(name, chair)

Language should not be a key of CodingCourses in the diagram.

This solution is copied from the 17WI Final, but it is actually invalid to have a key in a subclass, so the correct answer should be CodingCourses(language, number), where number is still a foreign key.