Department of Computer Science
City University of Hong Kong

CS3402 Database Systems

Assignment 1 (Due: 2024)

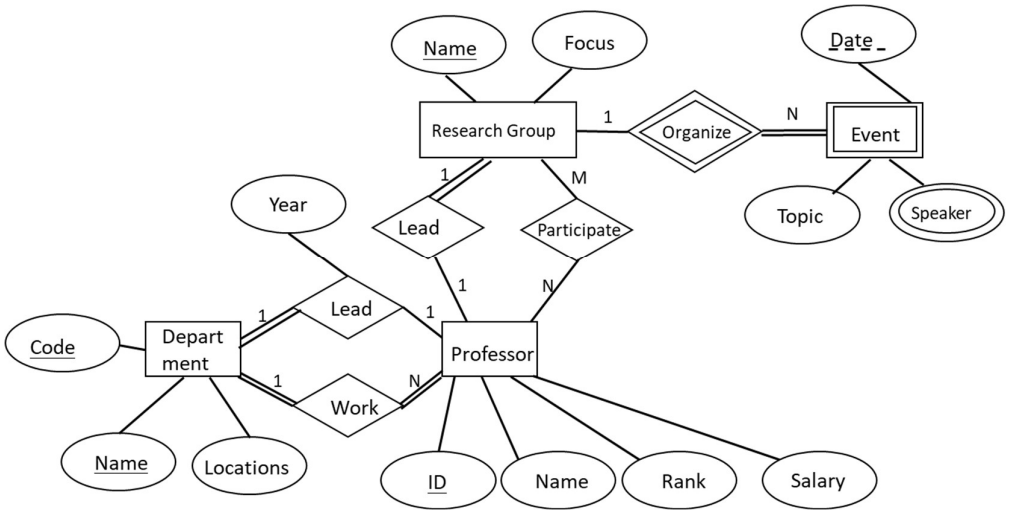
Question 1. (50 marks)

Design an ER diagram for a university's academic system:

- The university is composed of several departments, each with a unique code, a unique name, and a location.
- Each department is led by one head, who is also a professor, and we record from which year the head starts lead the department. A professor can lead at most one department.
- Each professor works for a specific department and has a unique employee ID, name, rank, and salary.
- A professor can lead a maximum of one research group but can participate in no or multiple groups.
- Each research group has a unique group name, a primary focus, a lead researcher who is also a professor, and can have no or multiple other professors participating in it.
- Each research group hosts a series of events. The details of each event, including the date, topic, and one or multiple invited speakers, are recorded. Events organized by different research groups can occur on the same day or with same topic, but each research group only hosts one event on a given day.

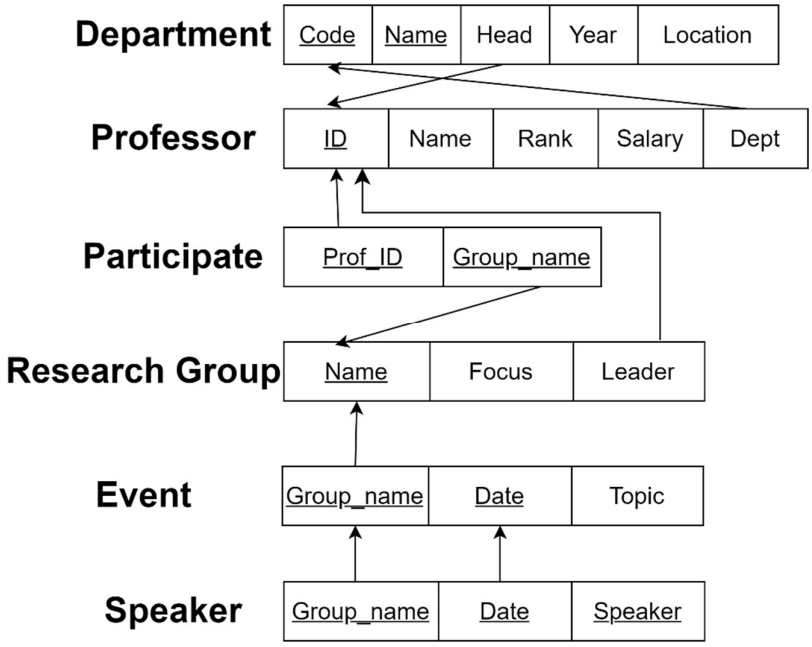
(a) Draw the ER diagram and state any assumptions you make. Ensure not to introduce extra entities, attributes, or relationships beyond the description provided. (30 marks)

Solution:



(b) For your ER diagram given above, convert it into relational schema using the mapping guidelines discussed in the lecture. For each relation (table) obtained, specify the name and its attributes, its primary key, as well as foreign key references. (20 marks)

Solution:



Question 2. (50 marks)

Consider the relation R = {A, B, C, D, E, F, G, H, I, J} and the set of functional dependencies F = { {A, B} -> {C}, {A} -> {D, E}, {B} -> {F}, {F} ->{G, H}, {D} -> {I, J} }.

(a) Proof {A}->{E,I} holds by using inference rules. (10 marks)

Solution:

1 A->{D,E} (Given)
2 A->E and A->D (1, Decomposition rule)
3 D->{I,J} (Given)
4 D->I, D->J (3, Decomposition rule))
5 A->D and D->I (Proved)
6 A->I (5, Transitive rule)
7 A->E and A->I (Proved)
8 A->{E,I} (7, Union rule)

(b) Whether {A,B,D} is a super key? Whether {A,B,D} is a candidate key? Why? (10 marks)

Solution:

{A,B,D} +={A,B,C,D,E,F,G,H,I,J}, so it is a super key.
as its subset {A,B}+={ A,B,C,D,E,F,G,H,I,J} so {A,B,D} is not a candidate key.

(c) Whether {A,F} is a super key? Whether {A,F} is a candidate key? Why? (10 marks)

Solution:

{A,F} +={A,D,E,F,G,H,I,J} so it is not a super key. It is not a candidate key.

(d) Decompose R into 2NF but not 3NF. (10 marks)

Solution:

This table only have one candidate key, that is AB.
To normalize into 2NF, we remove the attributes that are functionally dependent on part of the key (A or B) from R and place them in separate relations R1 and R2, along with the part of the key they depend on (A or B), which are copied into each of these relations but also remains in the original relation, which we call R3.
R1 = {A, D, E, I, J}, R2 = {B, F, G, H}, R3 = {A, B, C}

(e) Decompose R into 3NF based on the results of (d). (10 marks)

Solution:

Next, we look for transitive dependencies in R1, R2, R3. The relation R1 has the transitive dependency {A} -> {D} -> {I, J}, so we remove the transitively dependent attributes {I, J} from R1 into a relation R11 and copy the attribute D they are dependent on into R11. The remaining attributes are kept in a relation R12. Hence, R1 is decomposed into R11 and R12 as follows:
R11 = {D, I, J}, R12 = {A, D, E}
The relation R2 is similarly decomposed into R21 and R22 based on the transitive dependency {B} -> {F} -> {G, H}:
R21 = {F, G, H}, R22 = {B, F}
The final set of relations in 3NF are
{R11, R12, R21, R22, R3}