1 ER Diagrams

We want to store sports teams and their players in our database. Draw an ER diagram corresponding to data given below:

- Every Team in our database will have a unique team_name and a stadium where they play their games.
- Each Coach has a name.
- Each Player will have a player_id, name and their average score.
- Our database will contain who Plays_For which team and also the “position” that the player plays in. We also need to store who Captains a team, and who Coaches a team.
- Every Team needs players, and needs exactly one captain.
- Each Player can be on at most one team, but may currently be a free agent and not on any team.
- Each team needs coaches and may have many.
- A Coach is uniquely identified by which team they coach.
2 Functional Dependencies

1. When there’s a lot of symbols floating around, it’s best to keep track of the "type" of the various symbols and expressions. Consider a set of functional dependencies \( F = \{ X \rightarrow Y, Y \rightarrow Z \} \). For each of the following symbols or expressions, indicate whether it is (a) an attribute, (b) a set of attributes, (c) a set of sets of attributes, (d) a functional dependency, (e) a set of functional dependencies, or (f) none of the above.

   (a) \( X \) (b) a set of attributes
   (b) \( XY \) (b) a set of attributes
   (c) \( X \rightarrow Y \) (d) a functional dependency
   (d) \( F \) (e) a set of functional dependencies
   (e) \( F+ \) (e) a set of functional dependencies
   (f) \( X+ \) (b) a set of attributes
   (g) Armstrong’s reflexivity axiom (f) an axiom

2. Consider a relation \( R(x, y, z) \) and the list of functional dependencies \( X \rightarrow Y, XY \rightarrow YZ, \) and \( Y \rightarrow X \) where \( X = \{ x \}, Y = \{ y \}, \) and \( Z = \{ z \}. \) For each of the following relations, indicate which functional dependencies it might satisfy.

   1. None
   2. \( XY \rightarrow YZ \)
   3. \( X \rightarrow Y, XY \rightarrow YZ \)
   4. \( X \rightarrow Y, XY \rightarrow YZ, Y \rightarrow X \)

3. Consider the set \( F = \{ A \rightarrow B, AB \rightarrow AC, BC \rightarrow BD, DA \rightarrow C \} \) of functional dependencies. Compute the following attribute closures.

   (a) \( A+ \) \( ABCD \)
   (b) \( B+, C+, D+ \) \( B, C, D; \) \( B, C, \) and \( D \) do not appear alone on the left of any functional dependency, so nothing is in their attribute closures besides themselves.
   (c) \( AB+, AC+, AD+ \) \( ABCD; \) \( A+ = ABCD, \) so \( AX = ABCD \) for any \( X. \)
(d) BC+ BCD
(e) BD+ BD
(f) CD+ CD
(g) BCD+ BCD

4. Consider again the set F of functional dependencies from Question 3. Indicate whether the following sets of attributes are candidate keys, superkeys (but not candidate keys), or neither.

(a) A candidate key
(b) B, C, D neither
(c) AB, AC, AD superkey
(d) BC neither
(e) BD neither
(f) CD neither
(g) BCD neither

3 Normal Forms

1. Decompose R = ABCDEFG into BCNF, given the functional dependency set: F = AB → CD, C → EF, G → A, G → F, CE → F.

   AB→CD => decompose ABCDEFG into ABCD, ABEFG
   G→A => decompose ABEFG into AG, BEFG
   G→F => decompose BEFG into FG, BEG
   Final relations: ABCD, AG, FG, BEG.

2. Does the above decomposition preserve dependencies? Why/why not?

   No, C → EF and CE → F are not represented in the closure of the union of each subrelation’s dependencies.