

# Functional Dependency Diagrams, Normalised Relations, and Constraints

## Tutorial

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# Football League Database

A football league is composed of four divisions (1,2,3,4) each containing many different teams, where each team has a unique name (e.g. Manchester united, Sheffield Wednesday etc.), and the number of points each team has amassed so far in the league competition. Information is also stored concerning each team's captain, and home ground address. The names of all professional footballers (not unique) in the league and the teams for which they play is stored in the database. Also, maintained in the database for each player is a record of their ability in the following positions (goalkeeper, defender, midfielder, striker) in a football team. A player can have the ability to play in more than one position. For example, a footballer named Alan Shearer, position = 'Defender', expertise = 2, however for position = 'Striker', expertise = 11, values > 0).

- (a) Draw a Functional Dependence diagram for the relations in the above database stating any assumptions made in your solution.
- (b) Derive a set of fully normalised relations (i.e. table names and attributes) from the dependence diagram, indicating clearly the primary key (candidate identifier(s)) and foreign keys of each relation.
- (c) Write down any constraints on column values you may deem important.

## (A) Functional Dependency Diagram Methodology

1. Underline all of the nouns in the description
2. Create a spreadsheet of example data where each column is named by one of the nouns identified in (1)
3. Check if there are any problems with identifying any of the nouns, hint: nouns with non unique values and add an identifier column for it, e.g. *clientID* if the problematic noun was *client*.
4. Check if any *other columns* should correspond with that new identifying column and change the example data where appropriate.
5. Go through each column and ask the question: “Does any other column(s) determine my value? The answer can be
  - a. “no”,
  - b. “yes, the ... column determines my value” or
  - c. “yes , the columns ... and ... determine my value”
6. Write the name of the determining column(s) within a single box with an arrow pointing to the name of the other column (boxed on its own)

## (B) Normalised Relations Methodology

1. Using the functional dependency diagram from (A), identify all of the boxed attribute names that determine something else in the diagram, e.g. clientID determines clientname
2. Work through each to create a relation or table with the primary key being the boxed attribute, B, e.g. the existence of clientID should indicate the need for a client table with clientID as the primary key.
3. Add all determined from B as attributes in that table.
4. Do the same for all other boxed attributes identified in (1) above, underlining the primary keys.
5. Add a note to each table to say which attributes are foreign keys of others.

## (C) Constraints Methodology

1. Read through the question again but paying special attention to the sentences that add a constraint to the data in some way, e.g. if a client belongs to one of 5 user groups, a sensible constraint to add is that the values of Usergroup attribute must be the values, 1-5.
2. Make a list of all constraints that should be applied.

(A) Functional Dependency Diagram  
Answer Walkthrough

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| Teamname  | Captain             | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|---------------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

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| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | Jane Smith          | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
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| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | Felicity Drumond    | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | Felicity Drumond    | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | Margaret Harrington | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | Margaret Harrington | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
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| Liverpool | Felicity Drumond    | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | Felicity Drumond    | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | Felicity Drumond    | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | Felicity Drumond    | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | Felicity Drumond    | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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| Westham   | Margaret Harrington | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
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| Westham   | Margaret Harrington | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | Margaret Harrington | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | Margaret Harrington | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
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|-----------|---------------------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | Jane Smith          | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | Jane Smith          | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | Jane Smith          | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
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| Liverpool | Felicity Drumond    | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
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| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
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| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
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5. Go through each column and ask the question: “Do any other column(s) determine my value? The answer can be
  - a. “no”, → do nothing
  - b. “yes, the ... column determines my value” or → 6 below
  - c. “yes , the columns ... and ... determine my value” → 6 below
6. Write the name of the determining column(s) within a single box with an arrow pointing to the name of the other column (boxed on its own)

## What determines my value?

| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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## What determines my value?

- Teamname and CaptainID have a 1-to-1 relationship & this can make it more tricky to figure out which one is the determinant
- Hint 1: which question is likely to be asked more frequently: (a) Who is the captain of Man U? or (b) What team is Captain Jane Smith the captain of? If (a) then Teamname is the determinant, (b) then CaptainID is the determinant
- Hint 2: Is either value more likely to change from time to time? This makes it *less likely* to be the determinant.

| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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What determines my value?



| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

What determines my value?



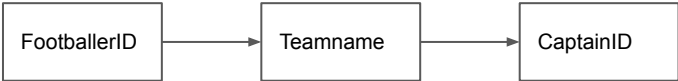
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
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| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
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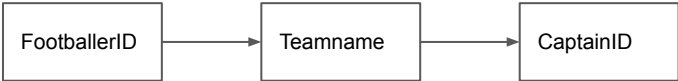
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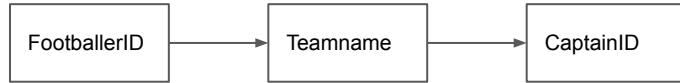


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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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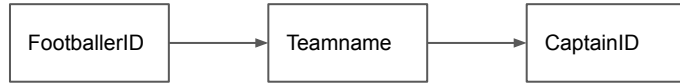
## What determines my value?



No other attribute determines FootballerID → ???

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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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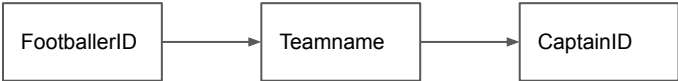
## What determines my value?



No other attribute determines FootballerID → no change to dependency diagram

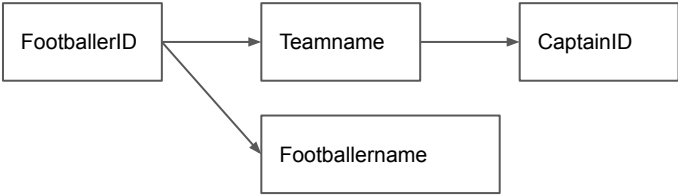
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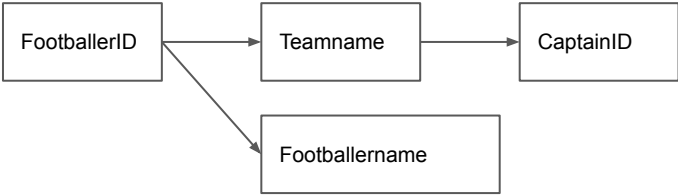
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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
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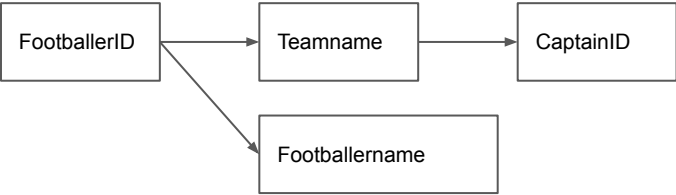
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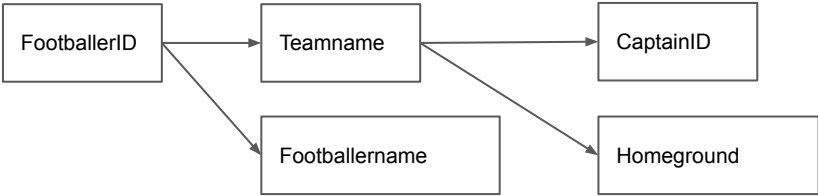
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| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
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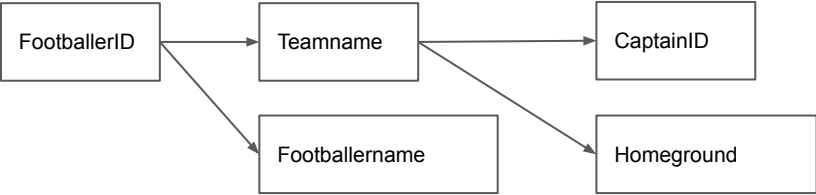
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| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

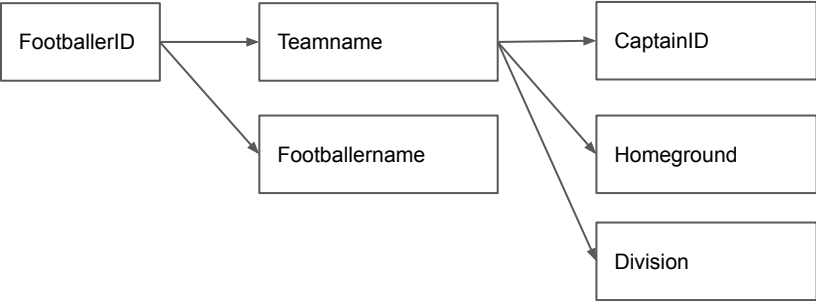


What determines my value?



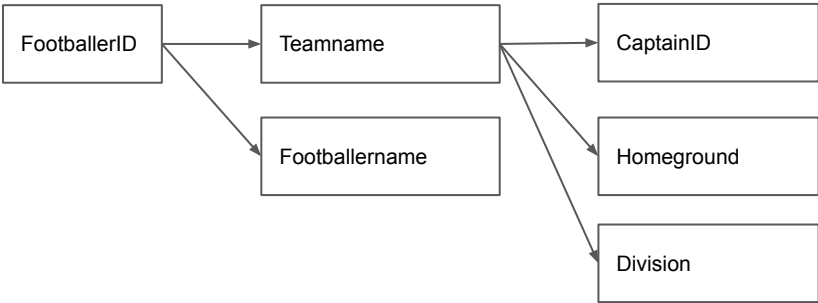
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

# What determines my value?



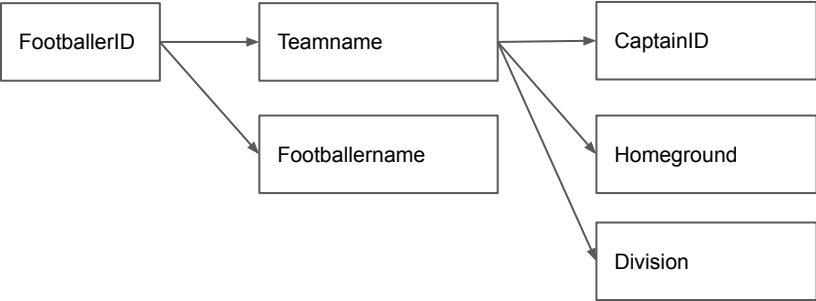
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 25          | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |

What determines my value?



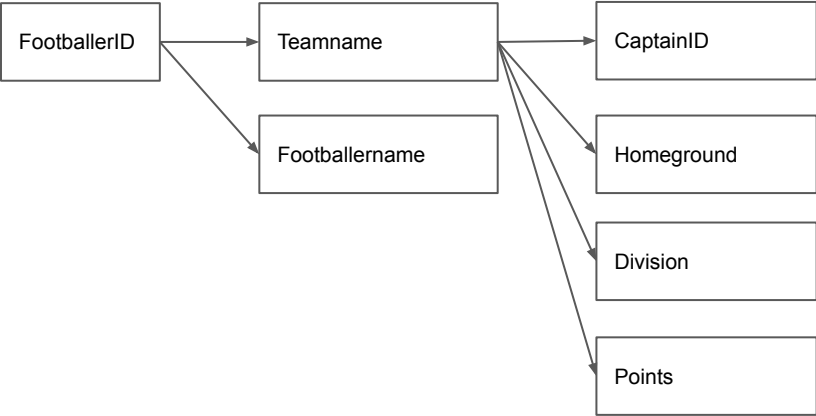
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

What determines my value?



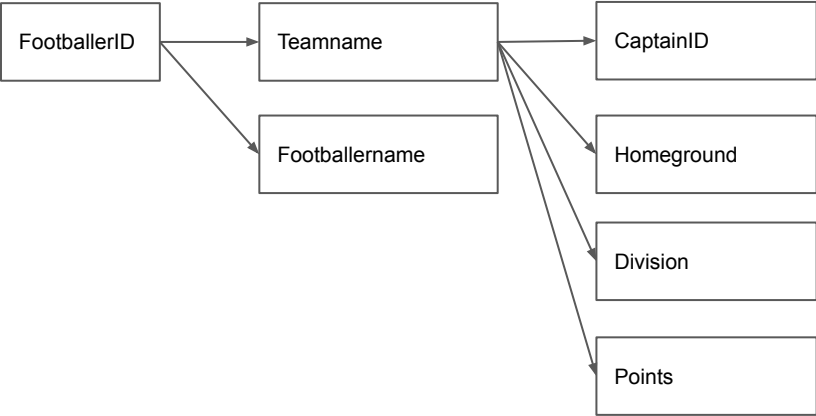
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |

What determines my value?



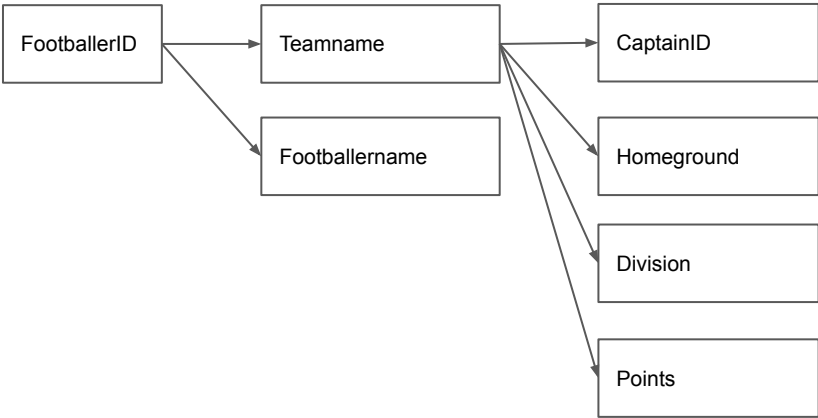
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |

What determines my value?



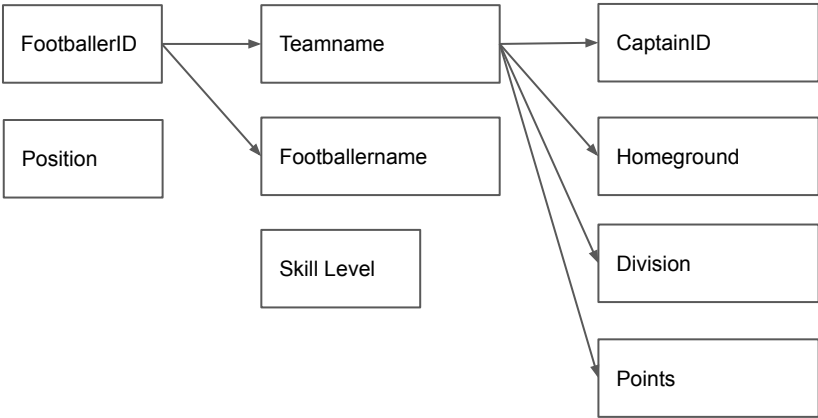
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 4           | striker    |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |

What determines my value?



| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |

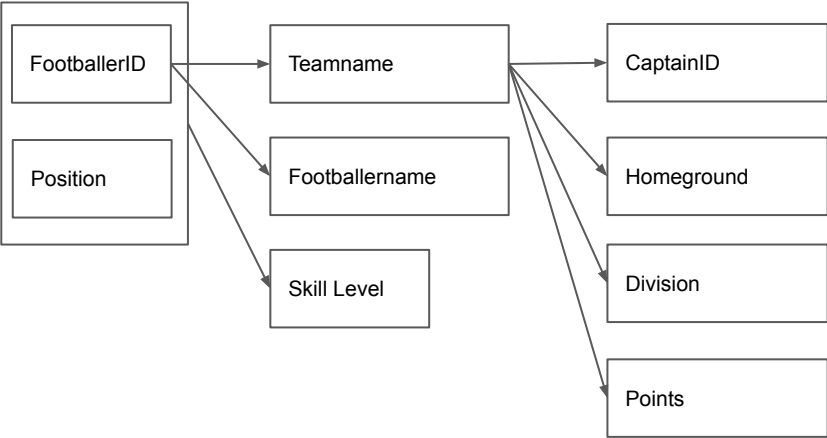
What determines my value?



| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 12          | goalkeeper |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
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| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |

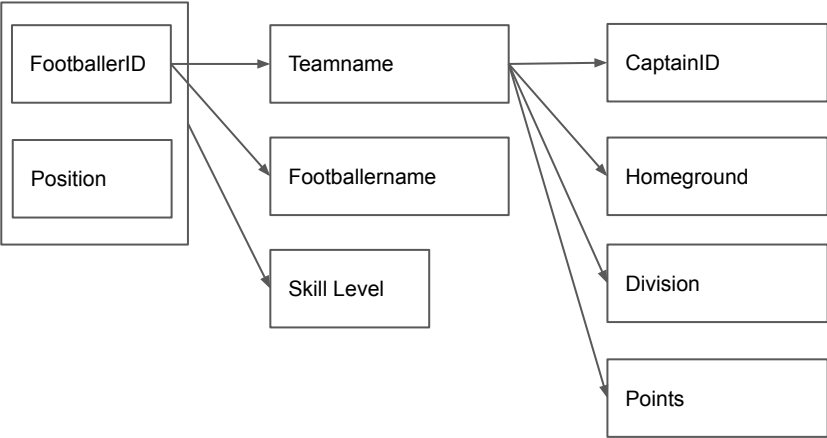


What determines my value?



| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
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| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | midfielder |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |

What determines my value?



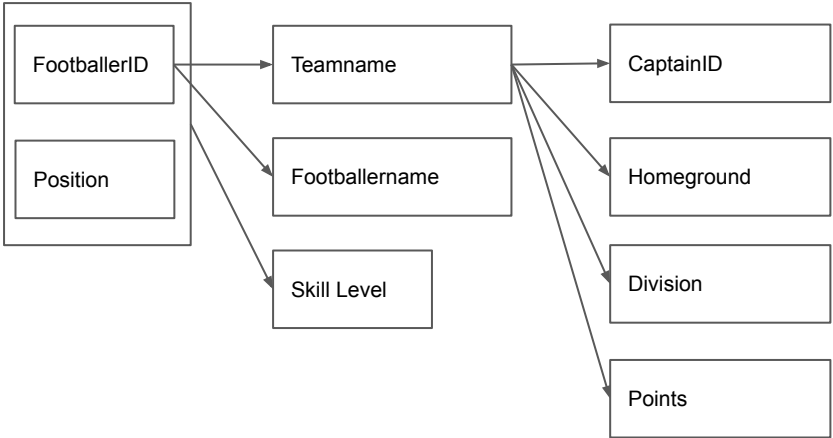
| Teamname  | CaptainID | FootballerID | Footballername      | Homeground   | Division (1-4) | Points | Skill level | Position   |
|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 15          | goalkeeper |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |

What determines my value?

No other attribute determines the position value, all 4 are recorded for every footballer

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|-----------|-----------|--------------|---------------------|--------------|----------------|--------|-------------|------------|
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 10          | goalkeeper |
| Man U     | 1         | 1            | Jane Smith          | Old Trafford | 1              | 22     | 12          | defender   |
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| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 14          | defender   |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 22          | midfielder |
| Liverpool | 3         | 2            | Michelle Jones      | Anfield      | 1              | 25     | 1           | striker    |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 1           | goalkeeper |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 23          | defender   |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 10          | midfielder |
| Liverpool | 3         | 3            | Felicity Drumond    | Anfield      | 1              | 25     | 11          | striker    |
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| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 23          | defender   |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 13          | midfielder |
| Westham   | 4         | 4            | Margaret Harrington | Olympic Park | 2              | 30     | 2           | striker    |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 5           | goalkeeper |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 13          | defender   |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 7           | midfielder |
| Westham   | 4         | 5            | Jane Smith          | Olympic Park | 2              | 30     | 14          | striker    |

Final Determinancy Diagram

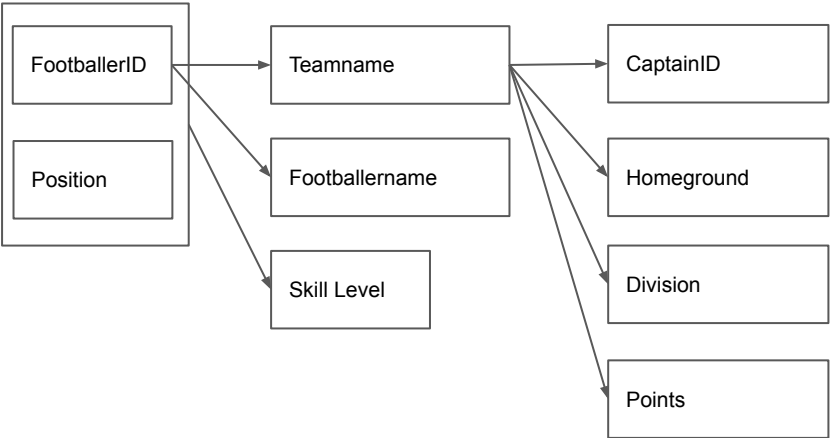


## (b) Normalised Relations Answer Walkthrough

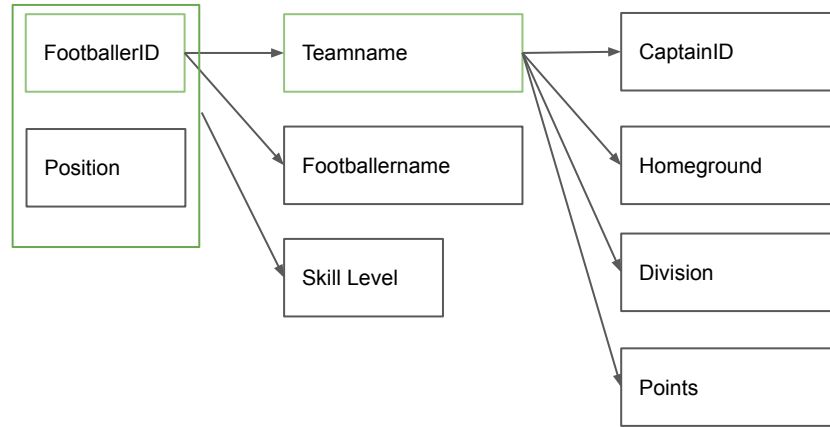
## (B) Normalised Relations Methodology

1. Using the functional dependency diagram from (A), identify all of the boxed attribute names that determine something else in the diagram, e.g. clientID determines clientname
2. Work through each to create a relation or table with the primary key being the boxed attribute, B, e.g. the existence of clientID should indicate the need for a client table with clientID as the primary key.
3. Add all determined from B as attributes in that table.
4. Do the same for all other boxed attributes identified in (1) above, underlining the primary keys.
5. Add a note to each table to say which attributes are foreign keys of others.

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



## Normalised Relations (or Tables) with Primary and Foreign Keys Identified



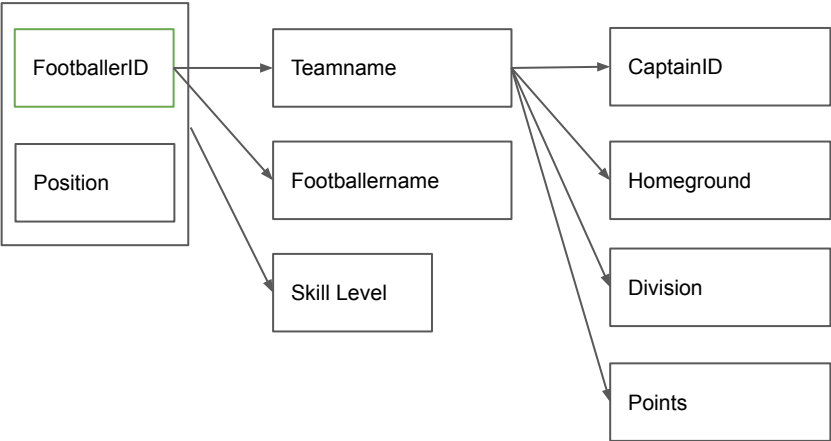
1. Identify all with an arrow coming out of them
2. Each will be the start of a distinct table
3. Work through each one individually



## (B) Normalised Relations Methodology

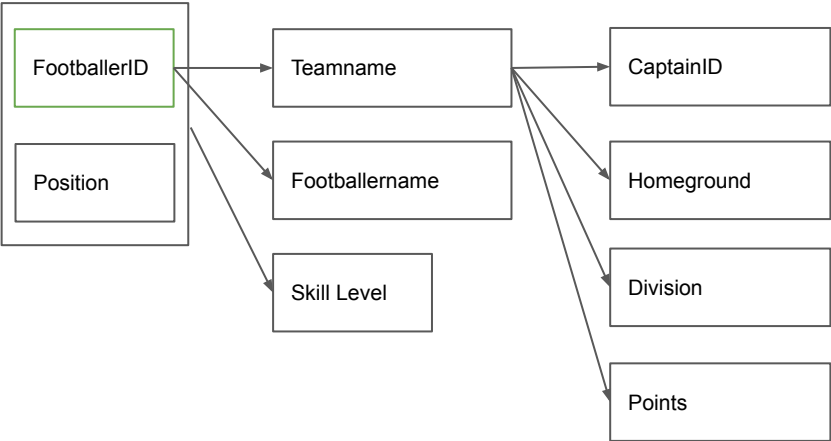
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Normalised Relations (or Tables) with Primary and Foreign Keys Identified



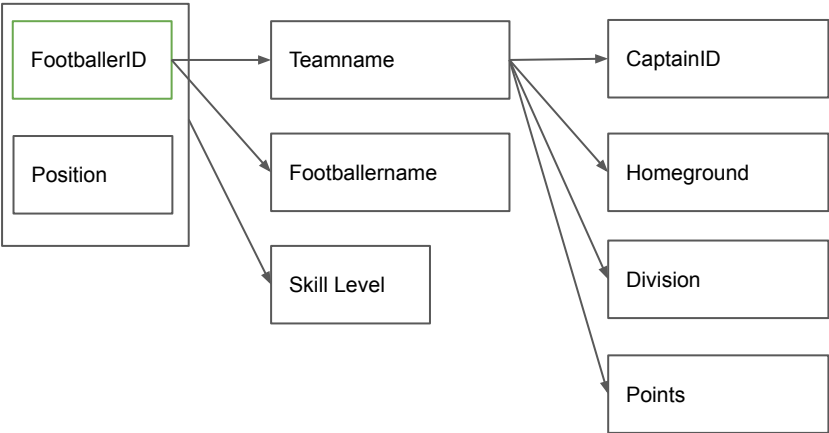
Footballer (???, ...)

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



Footballer (FootballerID, ...?)

Normalised Relations (or Tables) with Primary and Foreign Keys Identified

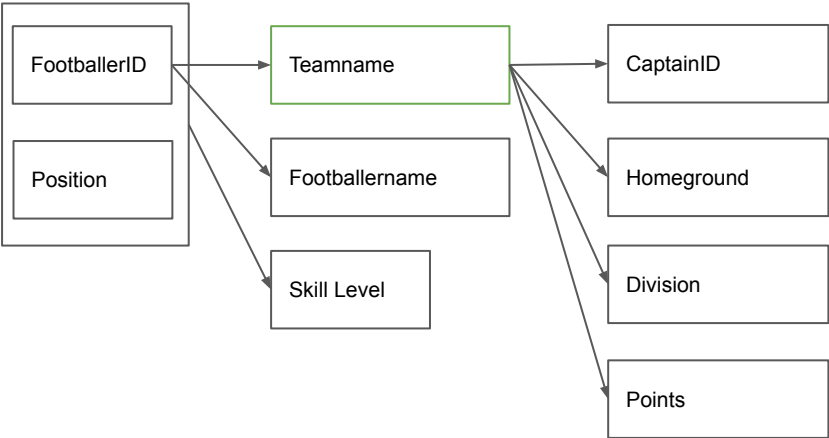


Footballer ( FootballerID, Teamname, Footballername)

## (B) Normalised Relations Methodology

1. Using the functional dependency diagram from (A), identify all of the boxed attribute names that determine something else in the diagram, e.g. clientID determines clientname
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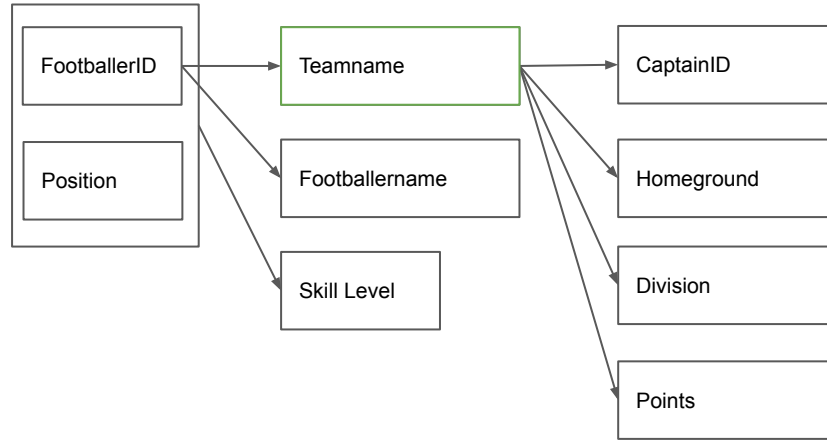
Normalised Relations (or Tables) with Primary and Foreign Keys Identified



Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, ...)

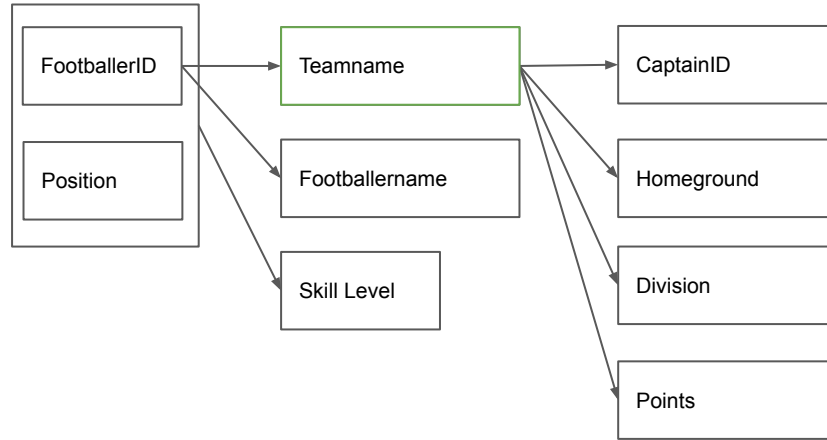
## Normalised Relations (or Tables) with Primary and Foreign Keys Identified



Footballer ( FootballerID, Teamname, Footballername)

Team (Teamname, ...?)

## Normalised Relations (or Tables) with Primary and Foreign Keys Identified

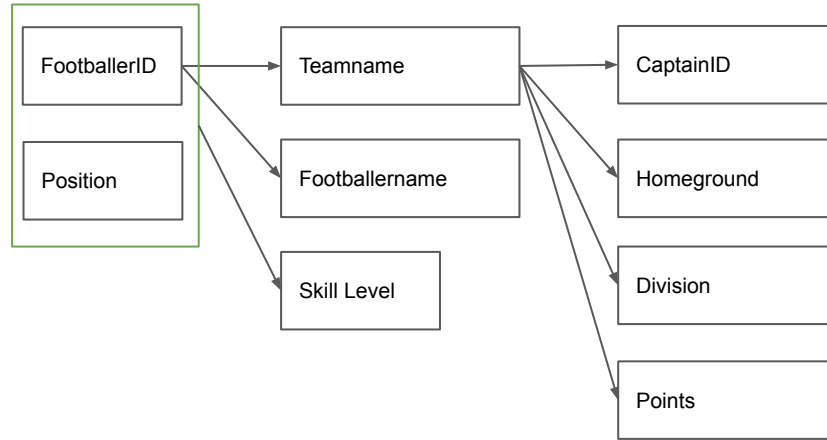


Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, CaptainID, Homeground, Division, Points)



## Normalised Relations (or Tables) with Primary and Foreign Keys Identified

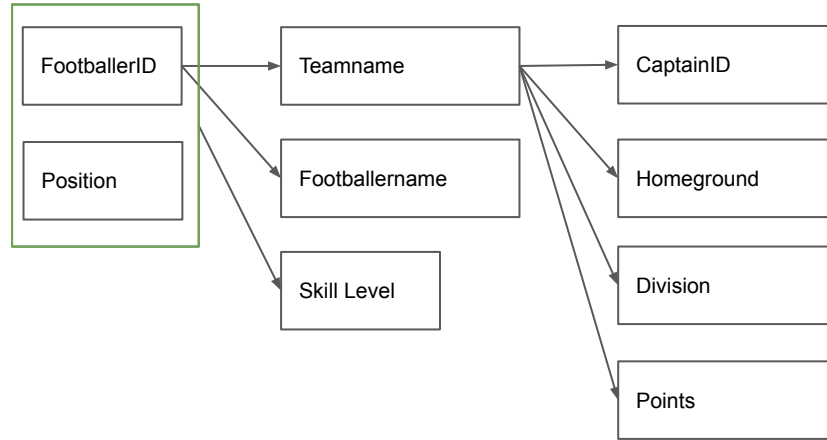


Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, CaptainID, Homeground, Division, Points)

FB\_position( ... )

## Normalised Relations (or Tables) with Primary and Foreign Keys Identified

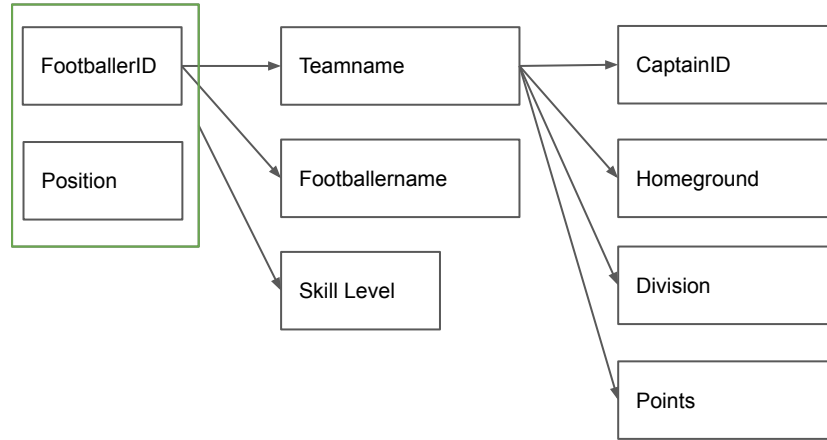


Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, CaptainID, Homeground, Division, Points)

FB\_position ( FootballerID, Position, ...?)

## Normalised Relations (or Tables) with Primary and Foreign Keys Identified

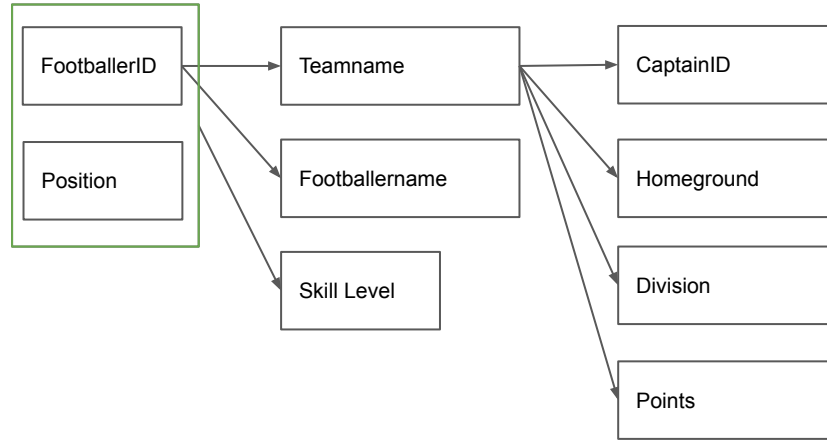


Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, CaptainID, Homeground, Division, Points)

FB\_position ( FootballerID, Position, Skill Level)

## Normalised Relations (or Tables) with Primary and Foreign Keys Identified



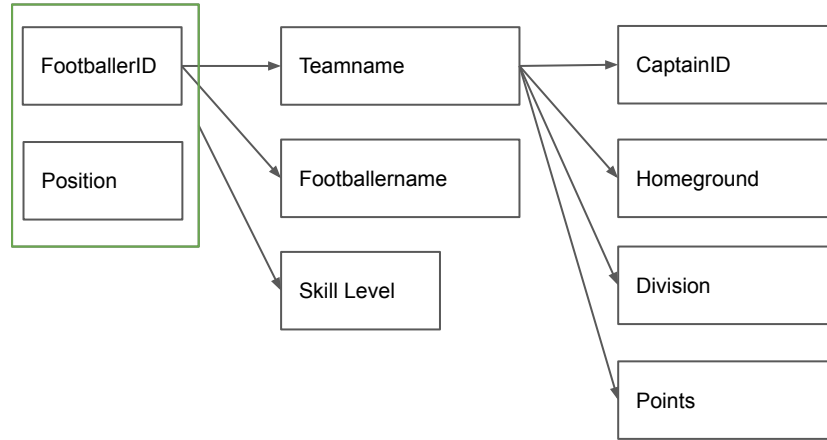
Footballer ( FootballerID, Teamname, Footballername)

Team ( Teamname, CaptainID, Homeground, Division, Points)

FB\_position ( FootballerID, Position, Skill Level)

Think about naming FB\_position better now  
we know what is in that relation!

## Normalised Relations (or Tables) with Primary and Foreign Keys Identified



Footballer ( FootballerID, Teamname, Footballername)

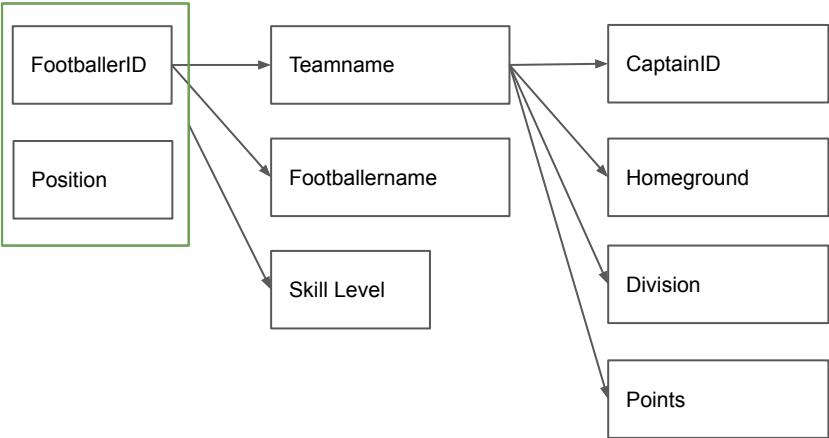
Team ( Teamname, CaptainID, Homeground, Division, Points)

FootballSkills( FootballerID, Position, Skill Level)

## (B) Normalised Relations Methodology

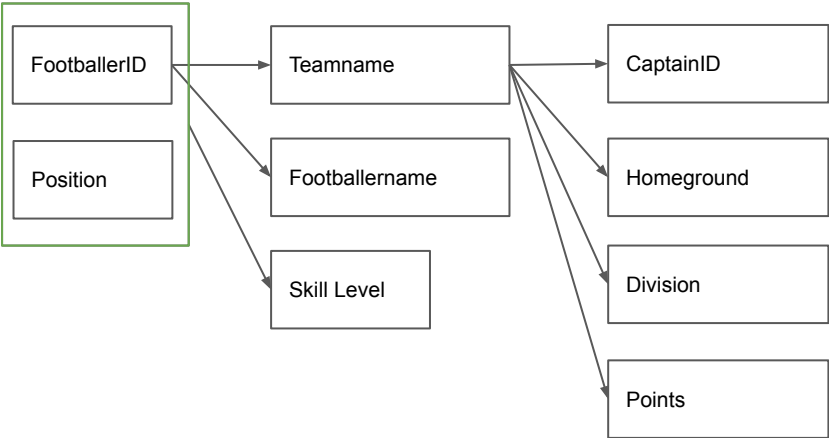
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5. Add a note to each table to say which attributes are foreign keys of others.

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



|   | Foreign Keys? |
|---|---------------|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | ?             |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     |               |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) |               |

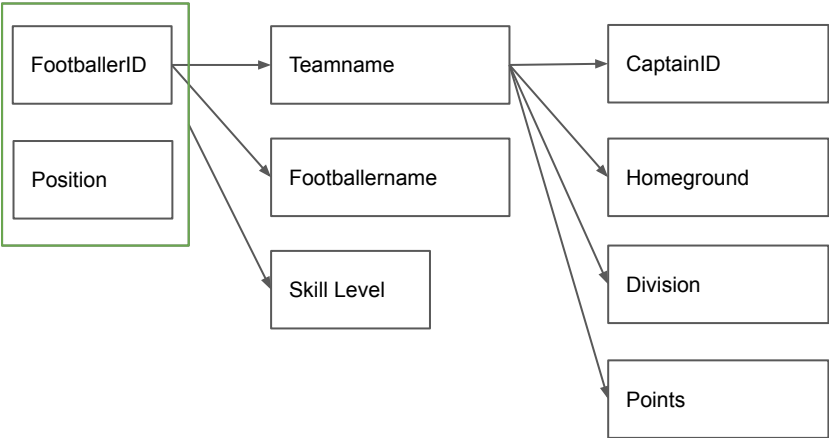
Normalised Relations (or Tables) with Primary and Foreign Keys Identified



|   | Foreign Keys?                    |
|---|----------------------------------|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | Teamnname is FK of Team.Teamname |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     |                                  |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) |                                  |

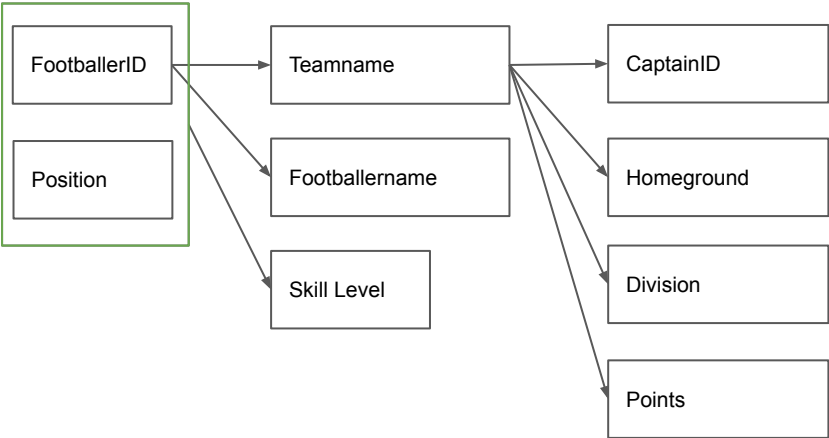


Normalised Relations (or Tables) with Primary and Foreign Keys Identified



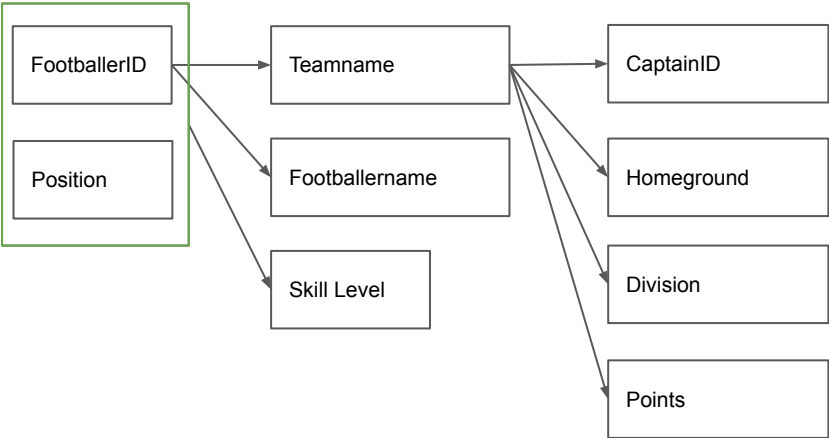
|   | Foreign Keys?                    |
|---|----------------------------------|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | Teamnname is FK of Team.Teamname |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     | ?                                |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) |                                  |

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



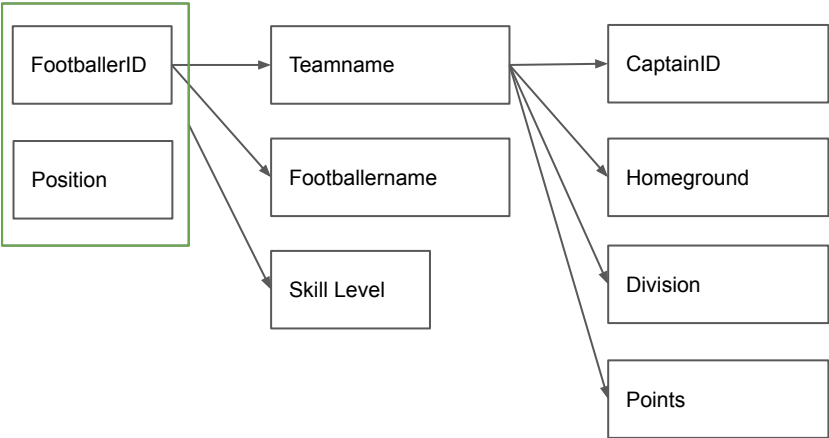
|   | Foreign Keys?                                |
|---|--|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | Teamnname is FK of Team.Teamname             |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     | CaptainID is a FK of Footballer.FootballerID |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) |  |

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



|   | Foreign Keys?                                |
|---|--|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | Teamnname is FK of Team.Teamname             |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     | CaptainID is a FK of Footballer.FootballerID |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) | ?  |

Normalised Relations (or Tables) with Primary and Foreign Keys Identified



|   | Foreign Keys?                                 |
|---|---|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          | Teamnname is FK of Team.Teamname              |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     | CaptainID is a FK of Footballer.FootballerID  |
| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) | FootballerID is FK of Footballer.FootballerID |

## (C) Constraints

### Answer Walkthrough

## (C) Constraints Methodology

1. Read through the question again but paying special attention to the sentences that add a constraint to the data in some way, e.g. if a client belongs to one of 5 user groups, a sensible constraint to add is that the values of Usergroup attribute must be the values, 1-5.
2. Make a list of all constraints that should be applied.

# Reread: Football League Database

A football league is composed of four divisions (1,2,3,4) each containing many different teams, where each team has a unique name (e.g. Manchester united, Sheffield Wednesday etc.), and the number of points each team has amassed so far in the league competition. Information is also stored concerning each team's captain, and home ground address. The names of all professional footballers (not unique) in the league and the teams for which they play is stored in the database. Also, maintained in the database for each player is a record of their ability in the following positions (goalkeeper, defender, midfielder, striker) in a football team. A player can have the ability to play in more than one position. For example, a footballer named Alan Shearer, position = 'Defender', expertise = 2, however for position = 'Striker', expertise = 11, values > 0).

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|   | Constraints? |
|---|--------------|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          |              |
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| FootballSkills ( <u>FootballerID</u> , <u>Position</u> , Skill Level) |              |



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|   | Constraints?                          |
|---|---------------------------------------|
| Footballer ( <u>FootballerID</u> , Teamname, Footballername)          |                                       |
| Team ( <u>Teamname</u> , CaptainID, Homeground, Division, Points)     | Division must be integer in range 1-4 |
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|   |                                       |
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|   |  |
|---|--|
|   | Constraints?   |
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|   |  |
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|   |  |
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# Functional Dependency Diagrams, Normalised Relations, and Constraints

## Tutorial

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