

# FIFA World Cup (1930-2014)

Sri Aditya Panda (UIN: 223003437)  
Arjun Jayaraj Moothedath (UIN: 722008073)  
Dakshina Ilangovan (UIN: 622009678)  
Rajashree Rao Polsani (UIN: 223001584)

## 4 FUNCTIONAL DEPENDENCIES AND MULTI-VALUE DEPENDENCIES

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This section lists functional dependencies and multi-valued dependencies for each relation in the database schema. Furthermore we have checked if there are any BCNF and 4NF violations and in case of violations, decomposed the relation so that the end relations confirm to all normal forms

The following schemas have been derived based on the proposed ER diagram.

1. TEAM(Country\_Code, Country\_Name, Association, Points, Ranking)
2. WORLD\_CUP (Year, Host\_Country, Winner, Runner\_Up)
3. PLAYER(Country\_Code, Player\_Name, Player\_Role, DOB, Jersey\_Number, Club)
4. MATCH(Stadium, Stadium\_Address, Match\_Number, Winner, Decision, Team\_1, Team\_2, Team\_1\_Score, Team\_2\_Score, Date.Day, Date.Month, Date.Year)
5. GOAL(Match\_Number, Date.Year, Time)
6. TEAM\_PARTICIPATES\_IN\_WORLD\_CUP(Group, Country\_Code, Year)
7. WORLD\_CUP\_PLAYED\_BY\_PLAYER(Year, Player\_Name, Country\_Code)
8. MATCH\_PLAYED\_BY(Match\_Number, Date.Year, Player\_Name, Country\_Code)
9. PLAYER\_SCORES\_GOALS(Player\_Name, Country\_Code, Match\_Number, Date.Year, Time)

### FUNCTIONAL DEPENDENCIES

1. WORLD\_CUP (Year, Host\_Country, Winner, Runner\_Up)

#### Initial FDs

Year → Winner  
Year → Runner\_Up  
Year → Host\_Country

#### Closures

$\{Year\}^+ = \{Year, Winner, Runner\_Up, Host\_Country\}$

Closures for supersets of years is same as that of 'Year'. Rest of the closures contain same elements as the original set on which closure is being calculated.

#### New FDs

The FDs listed above are minimal FDs. Rest of the non-trivial FDs will have 'Year' as one of the attribute on the left hand side of dependency

**Keys:** Year

### BCNF violations

Since the left hand side of all FDs is superset of 'Year'. There are no violations.

2. TEAM(Country\_Code, Country\_Name, Association, Points, Ranking)

### Initial FDs

Country\_Code  $\rightarrow$  Ranking

Country\_Code  $\rightarrow$  Points

Country\_Code  $\rightarrow$  Association

Country\_Code  $\rightarrow$  Country\_Name

### Closures

$\{\text{Country\_Code}\}^+ = \{\text{Country\_Code}, \text{Ranking}, \text{Points}, \text{Association}, \text{Country\_Name}\}$

Closures for supersets of 'Country\_Code' is same as that of 'Country\_Code'. Rest of the closures contain same elements as the original set on which closure is being calculated.

### New FDs

The FDs listed above are minimal FDs. Rest of the non-trivial FDs will have 'Country\_Code' as one of the attribute on the left hand side of dependency.

**Keys:** Country\_Code

### BCNF violations

Since the left hand side of all FDs is superset of 'Country\_Code'. There are no violations.

3. PLAYER(Country\_Code, Player\_Name, Player\_Role, DOB, Jersey\_Number, Club)

### Initial FDs

Country\_Code, Player\_Name  $\rightarrow$  Player\_Role

Country\_Code, Player\_Name  $\rightarrow$  DOB

Country\_Code, Player\_Name  $\rightarrow$  Jersey\_Number

Country\_Code, Player\_Name  $\rightarrow$  Club

### Closures

$\{\text{Country\_Code}, \text{Player\_Name}\}^+ = \{\text{Player\_Role}, \text{DOB}, \text{Jersey\_Number}, \text{Club}, \text{Country\_Code}, \text{Player\_Name}\}$

Closures for supersets of {Country\_Code, Player\_Name} is same as that of {Country\_Code, Player\_Name}. Rest of the closures contain same elements as the original set on which closure is being calculated.

### New FDs

The FDs listed above are minimal FDs. Rest of the non-trivial FDs will have {Country\_Code, Player\_Name} as one of the attribute on the left hand side of dependency

**Keys:** {Country\_Code, Player\_Name}

### BCNF violations

Since the left hand side of all FDs is superset of {Country\_Code, Player\_Name}. There are no violations.

4. MATCH(Stadium, Stadium\_Address, Match\_Number, Winner, Decision, Team\_1, Team\_2, Team\_1\_Score, Team\_2\_Score, Date.Day, Date.Month, Date.Year)

### Initial FDs

Match\_Number, Date.Year  $\rightarrow$  Stadium  
Match\_Number, Date.Year  $\rightarrow$  Stadium\_Address  
Match\_Number, Date.Year  $\rightarrow$  Winner  
Match\_Number, Date.Year  $\rightarrow$  Decision  
Match\_Number, Date.Year  $\rightarrow$  Team\_1  
Match\_Number, Date.Year  $\rightarrow$  Team\_2  
Match\_Number, Date.Year  $\rightarrow$  Team\_1\_Score  
Match\_Number, Date.Year  $\rightarrow$  Team\_2\_Score  
Match\_Number, Date.Year  $\rightarrow$  Date.Day  
Match\_Number, Date.Year  $\rightarrow$  Date.Month  
Stadium  $\rightarrow$  Stadium\_Address

### Closures

{Match\_Number, Date.Year}<sup>+</sup> = {Stadium, Stadium\_Address, Winner, Decision, Team\_1, Team\_2, Team\_1\_Score, Team\_2\_Score, Date.Day, Date.Month, Match\_Number, Date.Year}

{Stadium}<sup>+</sup> = {Stadium, Stadium\_Address}

Closures for supersets of Stadium contain those of stadium and the set itself. Closures for supersets of {Match\_Number, Date.Year} is same as that of {Match\_Number, Date.Year}. Rest of the closures contain same elements as the original set on which closure is being calculated.

### New FDs

The FDs listed above are minimal FDs. Rest of the non-trivial FDs will have {Match\_Number, Date.Year} or Stadium as one of the attribute on the left hand side of dependency

**Keys:** Match\_Number, Date.Year

### BCNF Violations

Stadium  $\rightarrow$  Stadium\_Address

This FD violates BCNF. Thus After decomposing we have two relations

STADIUM (Stadium, Stadium\_Address)

Keys: Stadium

FD: Stadium  $\rightarrow$  Stadium\_Address

MATCH (Match\_Number, Date.Year, Stadium, Winner, Decision, Team\_1, Team\_2, Team\_1\_Score, Team\_2\_Score, Date.Day, Date.Month)

Keys: Match\_Number, Date.Year

FDs:

Match\_Number, Year  $\rightarrow$  Stadium

Match\_Number, Year  $\rightarrow$  Winner

Match\_Number, Year  $\rightarrow$  Decision

Match\_Number, Year  $\rightarrow$  Team\_1

Match\_Number, Year  $\rightarrow$  Team\_2

Match\_Number, Year  $\rightarrow$  Team\_1\_Score

Match\_Number, Year  $\rightarrow$  Team\_2\_Score

Match\_Number, Year  $\rightarrow$  Date.Day

Match\_Number, Year  $\rightarrow$  Date.Month

5. GOAL\_AND\_PLAYER\_SCORES\_GOALS(Match\_Number, Date.Year, Time, Player\_Name, Country\_Code)

GOAL AND PLAYER have a many-one relationship as PLAYER\_SCORES\_GOALS. The relations GOAL and PLAYER\_SCORES\_GOALS can be effectively combined as Time in GOAL is associated with exactly one player, hence no redundancy is introduced. We thus eliminate the relation PLAYER\_SCORES\_GOALS by combining it with relation GOAL to form GOAL\_AND\_PLAYER\_SCORES\_GOALS

No functional dependencies.

**Keys:** {Match\_Number, Year, Time, Player\_Name, Country\_Code}

6. TEAM\_PARTICIPATES\_IN\_WORLD\_CUP(Group, Country\_Code, Year)

**Initial FDs:**

Country\_Code, Year  $\rightarrow$  Group

**Closures**

$\{\text{Country\_Code}, \text{Year}\}^+ = \{\text{Country\_Code}, \text{Year}, \text{Group}\}$

Closures for supersets of {Country\_Code, Year} is same as that of {Country\_Code, Year}. Rest of the closures contain same elements as the original set on which closure is being calculated.

**New FDs**

The FDs listed above are minimal FDs. Rest of the non-trivial FDs will have {Country\_Code, Year} as one of the attribute on the left hand side of dependency

**Keys:** {Country\_Code, Year}

**BCNF violations**

Since the left hand side of all FDs is superset of {Country\_Code, Year}. There are no violations.

7. WORLD\_CUP\_PLAYED\_BY\_PLAYER(Year, Player\_Name, Country\_Code)

No functional dependencies.

**Keys:** {Country\_Code, Year, Player\_Name}

8. MATCH\_PLAYED\_BY(Match\_Number, Date.Year, Player\_Name, Country\_Code)

No functional dependencies.

**Keys:** {Country\_Code, Player\_Name, Match\_Number, Date.Year}

### MULTI VALUED DEPENDENCIES

We did not find any MVDs in our database application since there is no redundant data in each of the relations after considering BCNF violations. If we consider any relation the probability of finding  $A_1...A_n, B_1...B_n, t, u$  as defined in slide 6 of Lecture 6 is very low. When we consider each relation it is difficult to find two mutually exclusive subsets of attributes of the relation which hold the same set of values for many tuples. For example, if we consider two mutually exclusive attribute sets of PLAYER {Player\_Role, DOB} and {Jersey\_Number, Club}. Finding tuples which have the same Player\_Role and DOB or Jersey\_Number and Club is difficult. Thus the MVD: Player\_Name, Country\_Code  $\twoheadrightarrow$  Player\_Role, DOB is not a valid MVD.

### EXTRA NOTES:

1. We have combined the relations GOAL and PLAYER\_SCORES\_GOALS into GOAL\_AND\_PLAYER\_SCORES\_GOALS relation since it is a many to one relation and every goal can be scored by exactly one player.
2. We would not prefer to combine any other relations as that would lead to BCNF and 4NF violations.
3. As all the normal form violations have been resolved, we have decided not to change any aspects of the database schema.

The final relations are

1. TEAM(Country\_Code, Country\_Name, Association, Points, Ranking)
2. WORLD\_CUP (Year, Host\_Country, Winner, Runner\_Up)
3. PLAYER(Country\_Code, Player\_Name, Player\_Role, DOB, Jersey\_Number, Club)
4. MATCH(Stadium, Match\_Number, Winner, Decision, Team\_1, Team\_2, Team\_1\_Score, Team\_2\_Score, Date.Day, Date.Month, Date.Year)
5. STADIUM(Stadium, Stadium\_Address)
6. GOAL\_AND\_PLAYER\_SCORES\_GOALS(Match\_Number, Date.Year, Time, Player\_Name, Country\_Code)
7. TEAM\_PARTICIPATES\_IN\_WORLD\_CUP(Group, Country\_Code, Year)
8. WORLD\_CUP\_PLAYED\_BY\_PLAYER(Year, Player\_Name, Country\_Code)
9. MATCH\_PLAYED\_BY(Match\_Number, Date.Year, Player\_Name, Country\_Code)