

COMP421: Database Systems  
Project: Database Design and Data Modelling

Part 3: Application  
Due: Mar 15th, 12:00 pm

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## Relational Schema

Teams(country, status, goal\_differential, web\_URL, gname)

web\_URL foreign key referencing NationalAssociation

web\_URL NOT NULL

gname foreign key referencing Groups

gname NOT NULL

Grouped(country, gname, points)

country foreign key referencing Teams

gname foreign key referencing Groups

Groups(gname)

National Associations(web\_URL, aname, country)

country foreign key referencing Teams

country NOT NULL

Players(pid, pname, number, position, DOB, country)

country foreign key referencing Teams

country NOT NULL

Coaches(cid, cname, DOB, role, country)

country foreign key referencing Teams

country NOT NULL

Referees(rid, rname, country, experience)

Stadiums(sname, capacity, location)

Matches(mid, match\_length, score, start\_time, round, date, sname)

sname foreign key referencing Stadiums

sname NOT NULL

Scheduled(country, mid)

country foreign key referencing Teams

mid foreign key referencing Matches

Refereed(rid, mid, role)

rid foreign key referencing Referees

mid foreign key referencing Matches

Played(pid, mid, y\_cards, r\_card, specific\_position, time\_in, time\_out)

pid foreign key referencing Players

mid foreign key referencing Matches

Goals(gid, pid, mid, penalty, occurrence\_order, scorer\_name, time)

pid foreign key referencing Players

pid NOT NULL

mid foreign key referencing Matches

mid NOT NULL

Seats(seatNumber, sname, sectionNumber)

sname foreign key referencing Stadiums

sname NOT NULL

Clients(email, name, password)

Tickets(date, seatNumber, sname, mid, price, purchase\_status)

seatNumber foreign key referencing Seat

sname foreign key referencing Stadiums

mid foreign key referencing Matches

Buys(email, date, seatNumber, sname, mid)

email foreign key referencing Client

date foreign key referencing Tickets

seatNumber foreign key referencing Seat

sname foreign key referencing Stadiums

mid foreign key referencing Matches

\*\*\* Differences between the relational schema defined above and the relations created in the DB2 database \*\*\*:

- 1) 'Scheduled' relation expressing a participation constraint between 'Teams' and 'Matches' was not implemented as its own relation table in the database, and was instead implemented as 2 attributes in the 'Matches' entities. They must be NOT NULL to ensure a Match doesn't exist without having 2 teams that will play in it (participation constraint).

\*\*\*This is how the database was set up in all previous deliverables, however for P3 we are asked to have matches without defined participating countries, since the instructions specify that “all matches have been scheduled”. Thus, a placeholder team with a country name ‘unknown’ is used for such matches.\*\*\*

- 2) Score attribute in ‘Matches’ was implemented as separate t1\_score and t2\_score, as we now have team1 and team2 attributes as defined above. The previously defined score attribute in the Part1 relational schema would have needed to be a string because of our design, which would not be useful in any types of queries. On the other hand, the new separate score attributes serve the same purpose and can be queried appropriately, i.e. the score attribute didn’t store useful data compared to the separate team1 score and team2 score attributes. However, most queries can still use the ‘Goals’ relation to calculate scores of all matches, since the ‘Goals’ relation links all goals to their scorer and respective match.
- 3) The National Association relation is represented within the Teams relation as name and URL attributes, possible by the one-to-one constraint between them (i.e. no relation table created for National Associations).

## Important constraints for proper database operation

- This implementation controls the purchasing of tickets using the ‘purchased\_status’ attribute of tickets. i.e. Tickets that have been sold will not appear when users query for available tickets.
- Matches have team 1 and team 2 score attribute values, which should correspond to the amount of goals created in the database along with the correct goal information (i.e. goal scored from player in the correct team, with the correct ordering of goals, etc.). These relations are not yet enforced to reflect the actual match data in ‘Matches’, however, relevant data was added to the database as default values.
- The total number of tickets available for a given match must be upper-bounded by the stadium capacity it takes place in.
- Match scheduling constraints are not enforced yet i.e. more than one match cannot occur at the same time in the same stadium and a team cannot play more than one match at the same time.

```
//We assume the string literal "unknown" is the placeholder for Matches  
that have undecided participating countries
```

- Moreover, since the database has been designed such that it cannot have null values for its team attributes, we have a placeholder team with country ‘unknown’ in the Teams relations that will be used while matches have undecided participants.

## Application Interaction

a)

i)

Run a query in the database that shows match information about ALL matches, including the participating countries if already known.

```
db2 => SELECT team1, team2, date, start_time, round, t1_score, t2_score FROM Matches WHERE NOT team1 = 'unknown' AND NOT team2 = 'unknown';
```

TEAM1	TEAM2	DATE	START_TIME	ROUND	T1_SCORE	T2_SCORE
Canada	France	10/01/2022	15:00:00	group-round	2	1
Argentina	Germany	10/01/2022	18:00:00	group-round	3	1
Canada	Argentina	10/02/2022	09:00:00	group-round	1	0
France	Germany	10/02/2022	12:00:00	group-round	1	2
France	Argentina	10/03/2022	08:00:00	group-round	0	0
Germany	Canada	10/03/2022	16:00:00	group-round	0	3
Saudi Arabia	Cuba	03/10/2023	15:00:00	group-round	2	2
USA	Mexico	03/10/2023	18:00:00	group-round	1	2
Saudi Arabia	USA	03/15/2023	09:00:00	group-round	-	-
Cuba	Mexico	03/15/2023	12:00:00	group-round	-	-
Mexico	Saudi Arabia	03/16/2023	08:00:00	group-round	-	-
Cuba	USA	03/16/2023	16:00:00	group-round	-	-

12 record(s) selected.

```
db2 =>
```

ii)

Start the application, choose the first item of the main menu and enter a country for which there are at least 2 matches in the result of the previous query.

```
cs421g105@winter2023-comp421:~/p3$ java Soccer
```

```
Soccer Main Menu
1. List information of matches of a country
2. Insert initial player information for a match
3. View and modify a client ticket portfolio
4. Exit Application
Please Enter Your Option:1

Enter a country for which the matches will be shown:
Canada
Canada      France      01-Oct-2022   group-round   2   1   1
Canada      Argentina   02-Oct-2022   group-round   1   0   0
Germany     Canada      03-Oct-2022   group-round   0   3   0
Canada      unknown     01-Sep-2023   quarterfinals N/A N/A 0

Enter [A/a] to find matches of another country, [P/p] to go to the previous menu:
```

iii)

Go back to the previous menu.

```
cs421g105@winter2023-comp421:~/p3$ java Soccer

Soccer Main Menu
    1. List information of matches of a country
    2. Insert initial player information for a match
    3. View and modify a client ticket portfolio
    4. Exit Application
Please Enter Your Option:1

Enter a country for which the matches will be shown:
Canada
Canada      France      01-Oct-2022    group-round    2    1    1
Canada      Argentina  02-Oct-2022    group-round    1    0    0
Germany     Canada     03-Oct-2022    group-round    0    3    0
Canada      unknown    01-Sep-2023    quarterfinals  N/A  N/A  0

Enter [A/a] to find matches of another country, [P/p] to go to the previous menu:
p

Soccer Main Menu
    1. List information of matches of a country
    2. Insert initial player information for a match
    3. View and modify a client ticket portfolio
    4. Exit Application
Please Enter Your Option:
```

b)

i)

Run a query in the database that shows information about ALL matches that take place within 3 days of the date the query is posed including any matches that might not yet the countries determined.

```
db2 => SELECT mid, team1, team2, date, start_time, round FROM Matches WHERE date >= '2023-03-14' AND date <= '2023-03-17';

MID      TEAM1      TEAM2      DATE      START_TIME  ROUND
-----
    9 Saudi Arabia      USA      03/15/2023 09:00:00  group-round
   10 Cuba      Mexico      03/15/2023 12:00:00  group-round
   11 Mexico      Saudi Arabia  03/16/2023 08:00:00  group-round
   12 Cuba      USA      03/16/2023 16:00:00  group-round

  4 record(s) selected.

db2 =>
```

ii)

Then run a query in the database that shows for one of the matches M in the previous query and one of the countries C of this match all the players of this country that play in the match. The result should be empty.

```
OpenSSH SSH client
db2 => SELECT p2.pname, p2.number, p.specific_position, p.time_in, p.time_out, p.y_cards, p.r_card FROM Played p, Players p2 WHERE p.pid = p2.pid AND p.mid = 12 AND p2.country = 'USA';
PNAME                                NUMBER    SPECIFIC_POSITION    TIME_IN    TIME_OUT    Y_CARDS    R_CARD
-----
0 record(s) selected.
db2 =>
```

iii)

Run another query that shows all the players of the team of country C. For better visibility, it should have around 5 players.

```
db2 => SELECT pname, number, position, DOB, country FROM Players WHERE country = 'USA' AND pid NOT IN (SELECT pid FROM Played WHERE mid = 12);
PNAME                                NUMBER    POSITION              DOB              COUNTRY
-----
Spider Man                          98 Forward          12/08/1993 USA
Iron Man                             12 Midfield         11/18/2001 USA
Captain America                     38 Midfield         07/23/1998 USA
Hawkeye Ismid                       52 Goalie           10/18/2000 USA
Black Panther                       99 Defender         02/04/1994 USA
5 record(s) selected.
db2 =>
```

iv)

In the application, choose the second item of the main menu.

```
cs421g105@winter2023-comp421:~/p3$ java Soccer

Soccer Main Menu
1. List information of matches of a country
2. Insert initial player information for a match
3. View and modify a client ticket portfolio
4. Exit Application
Please Enter Your Option:2
9 Saudi Arabia USA 2023-03-15 group-round
10 Cuba Mexico 2023-03-15 group-round
11 Mexico Saudi Arabia 2023-03-16 group-round
12 Cuba USA 2023-03-16 group-round
Enter a match identifier from the list above or press [P] to return to the previous menu:
```

v)

Enter the same match id M and country C that you used for the second of the above database queries.  
(Result in vi.)

```
cs421g105@winter2023-comp421:~/p3$ java Soccer

Soccer Main Menu
    1. List information of matches of a country
    2. Insert initial player information for a match
    3. View and modify a client ticket portfolio
    4. Exit Application
Please Enter Your Option:2
    9 Saudi Arabia USA 2023-03-15 group-round
   10 Cuba Mexico 2023-03-15 group-round
   11 Mexico Saudi Arabia 2023-03-16 group-round
   12 Cuba USA 2023-03-16 group-round
Enter a match identifier from the list above or press [P] to return to the previous menu:
12
Enter a country from the selected match or press [P] to return to the previous menu:
USA
```

vi)

Show the result as indicated in the task.

```
Enter a match identifier from the list above or press [P] to return to the previous menu:
12
Enter a country from the selected match or press [P] to return to the previous menu:
USA
The following players from USA are already entered for match 12:

Possible players from USA not yet selected:

1. Spider Man 98 Forward
2. Iron Man 12 Midfield
3. Captain America 38 Midfield
4. Hawkeye Ismid 52 Goalie
5. Black Panther 99 Defender

Enter the number of the player you want to insert or [P] to go to the previous menu.
```



vii)

In your application program select one of the available players and show the result.

```
Enter the number of the player you want to insert or [P] to go to the previous menu.
3
Enter the specific position the player is playing in the match.
Right Midfield
The following players from USA are already entered for match 12:

Captain America 38 Right Midfield from time 00:00:00 to time null yellow: 0 red: 0

Possible players from USA not yet selected:

1. Spider Man 98 Forward
2. Iron Man 12 Midfield
3. Hawkeye Ismid 52 Goalie
4. Black Panther 99 Defender

Enter the number of the player you want to insert or [P] to go to the previous menu.
```

viii)

In your program set the maximum number of players of a team for a match to two or three (just for testing) and show an example execution where you reach this limit. Your program should not allow further inserts. We set our limit to two players of a team for a match for this question. Actual limit will be 11 at the time of submission.

Adding the second player:

```
Enter the number of the player you want to insert or [P] to go to the previous menu.
2
Enter the specific position the player is playing in the match.
Left Midfield
The following players from USA are already entered for match 12:

Iron Man 12 Left Midfield from time 00:00:00 to time null yellow: 0 red: 0
Captain America 38 Right Midfield from time 00:00:00 to time null yellow: 0 red: 0

Possible players from USA not yet selected:

1. Spider Man 98 Forward
2. Hawkeye Ismid 52 Goalie
3. Black Panther 99 Defender
```

Adding the third player is not allowed (our max in this case is 2) so we print a message "Maximum players for USA in match 12 has been reached. Your player has not been inserted." and go back to the previous menu:



```

Enter the number of the player you want to insert or [P] to go to the previous menu.
1
Enter the specific position the player is playing in the match.
Forward
Maximum number of players for USA in match 12 has been reached. Your player has not been inserted.
  9 Saudi Arabia USA 2023-03-15 group-round
 10 Cuba Mexico 2023-03-15 group-round
 11 Mexico Saudi Arabia 2023-03-16 group-round
 12 Cuba USA 2023-03-16 group-round
Enter a match identifier from the list above or press [P] to return to the previous menu:

```

ix)

Go back to the main menu and from there exit the application.

```

Enter a match identifier from the list above or press [P] to return to the previous menu:
p
Soccer Main Menu
  1. List information of matches of a country
  2. Insert initial player information for a match
  3. View and modify a client ticket portfolio
  4. Exit Application
Please Enter Your Option:4
Exit Application
cs421g105@winter2023-comp421:~/p3$

```

x)

Run a query in the database that shows for M and country C the players that play in M .

```

db2 => SELECT p2.pname, p2.number, p.specific_position, p.time_in, p.time_out, p.y_cards, p.r_card FROM Played p, Players p2 WHERE p.pid = p2.pid AND p.mid = 12 AND p2.country = 'USA';

```

PNAME	NUMBER	SPECIFIC_POSITION	TIME_IN	TIME_OUT	Y_CARDS	R_CARD
Iron Man	12	Left Midfield	00:00:00	-	0	0
Captain America	38	Right Midfield	00:00:00	-	0	0

```

  2 record(s) selected.
db2 =>

```

### c) EXECUTION FLOW for Functionality 3

Functionality 3 implements a ticket manager that allows the input of an existing client email to view and modify that client's ticket portfolio. The program assumes input email is valid and exists in the database within the "Client" relation. The creation of new clients is not supported.

Once a client email is given to the application, the user can either view the tickets owned by the given client or choose to purchase new tickets for upcoming matches. If they choose to view their tickets, then a pretty print of the client tickets is shown. If they want to add new tickets, then a list of all upcoming matches is shown. The user is then asked to select one of the matches and the application shows a list of available tickets for that match. If no tickets are available, the list will be empty. If tickets are available, the user can input the seat number they want to purchase and that ticket will be reserved for them. Obviously, no purchase interface has been implemented. The application simply assumes the client has paid and reserves the ticket/seat for the client by adding it in the 'Buys' relation with an associated client email. The application will show an updated list of available tickets for the match and prompt the user once more. At every stage of the functionality, the user can return to the previous menu if needed.

-----  
Screenshot showing all the tickets owned for user email 'd.w@gmail.com'

```
db2 => SELECT m.team1, m.team2, m.round, m.start_time, temp.date, temp.seatnumber, temp.sname, temp.price FROM Matches m, (SELECT t.mid, t.date, t.seatnumber, t.sname, t.price FROM Tickets t, Buys b WHERE t.mid = b.mid AND t.seatnumber = b.seatnumber AND b.email = 'd.w@gmail.com' ORDER BY t.date)temp WHERE m.mid = temp.mid;
```

TEAM1	SEATNUMBER	SNAME	TEAM2	PRICE	ROUND	START_TIME	DATE
Argentina	10	BC Place	Germany	+1.00000000000000E+002	group-round	18:00:00	10/01/2022
Canada	10	BC Place	Argentina	+1.00000000000000E+002	group-round	09:00:00	10/02/2022
France	10	BC Place	Germany	+1.00000000000000E+002	group-round	12:00:00	10/02/2022
Saudi Arabia	10	King Fahd International Stadium	Cuba	+1.00000000000000E+002	group-round	15:00:00	03/10/2023
Saudi Arabia	30	King Fahd International Stadium	Cuba	+2.00000000000000E+002	group-round	15:00:00	03/10/2023
USA	20	King Fahd International Stadium	Mexico	+2.00000000000000E+002	group-round	18:00:00	03/10/2023
Cuba	20	King Fahd International Stadium	Mexico	+1.00000000000000E+002	group-round	12:00:00	03/15/2023
Mexico	20	King Fahd International Stadium	Saudi Arabia	+2.00000000000000E+002	group-round	08:00:00	03/16/2023

8 record(s) selected.

```
db2 =>
```

---

Screenshot showing all the upcoming matches after the current date (i.e. taken at March 14th, 2023)

```
db2 => SELECT mid, team1, team2, date, start_time, round, sname FROM Matches WHERE date >= '2023-03-14' ORDER BY date;
```

MID	TEAM1 SNAME	TEAM2	DATE	START_TIME	ROUND
und	9 Saudi Arabia King Fahd International Stadium	USA	03/15/2023	09:00:00	group-ro
und	10 Cuba King Fahd International Stadium	Mexico	03/15/2023	12:00:00	group-ro
und	11 Mexico King Fahd International Stadium	Saudi Arabia	03/16/2023	08:00:00	group-ro
und	12 Cuba King Fahd International Stadium	USA	03/16/2023	16:00:00	group-ro
inals	13 Canada Allianz Arena	unknown	09/01/2023	15:00:00	quarterf
inals	14 unknown Estadio José María Minella	Argentina	09/02/2023	15:00:00	quarterf
ls	15 unknown Stade De France	unknown	09/06/2023	15:00:00	semifina

7 record(s) selected.

```
db2 =>
```

---

Screenshot showing the available tickets for Match: Cuba @ Mexico on 03/15/2023 in King Fahd Stadium

=> mid = 10

```
db2 => SELECT seatNumber, price FROM Tickets WHERE mid = 10 AND purchase_status = 0 ORDER BY date;
```

SEATNUMBER	PRICE
10	+1.0000000000000000E+002
40	+2.0000000000000000E+002
50	+2.0000000000000000E+002

3 record(s) selected.

```
db2 =>
```

### Application Flow, Starting at the main menu

#### Soccer Main Menu

1. List information of matches of a country
2. Insert initial player information for a match
3. View and modify a client ticket portfolio
4. Exit Application

Please Enter Your Option:

---

Screenshot of Ticket Manager Menu (Option 3)

```
4. Exit Application
Please Enter Your Option:3
Enter email:
d.w@gmail.com

Ticket Portfolio Manager: 'd.w@gmail.com'
1. View owned tickets
2. Buy new tickets
3. Return to previous Menu
Please Enter Your Option:
```

Screenshot of Ticket Manager Function after selecting **Option 1** in Ticket Menu

```
Please Enter Your Option:1

-----All tickets owned by user 'd.w@gmail.com'-----
Argentina @ Germany    group-round    18:00:00    01-Oct-2022    10    100.0$    BC Place
Canada @ Argentina     group-round    09:00:00    02-Oct-2022    10    100.0$    BC Place
France @ Germany       group-round    12:00:00    02-Oct-2022    10    100.0$    BC Place
Saudi Arabia @ Cuba    group-round    15:00:00    10-Mar-2023    10    100.0$    King Fahd International Stadium
Saudi Arabia @ Cuba    group-round    15:00:00    10-Mar-2023    30    200.0$    King Fahd International Stadium
USA @ Mexico           group-round    18:00:00    10-Mar-2023    20    200.0$    King Fahd International Stadium
Cuba @ Mexico          group-round    12:00:00    15-Mar-2023    20    100.0$    King Fahd International Stadium
Mexico @ Saudi Arabia  group-round    08:00:00    16-Mar-2023    20    200.0$    King Fahd International Stadium

Ticket Portfolio Manager: 'd.w@gmail.com'
1. View owned tickets
2. Buy new tickets
3. Return to previous Menu
Please Enter Your Option:
```

Screenshot of Ticket Manager Function after selecting **Option 2** in Ticket Menu

```
Please Enter Your Option:2

-----All upcoming matches-----
1. Saudi Arabia @ USA    15-Mar-2023    09:00:00    group-round
2. Cuba @ Mexico         15-Mar-2023    12:00:00    group-round
3. Mexico @ Saudi Arabia 16-Mar-2023    08:00:00    group-round
4. Cuba @ USA            16-Mar-2023    16:00:00    group-round
5. Canada @ unknown      01-Sep-2023    15:00:00    quarterfinals
6. unknown @ Argentina   02-Sep-2023    15:00:00    quarterfinals
7. unknown @ unknown     06-Sep-2023    15:00:00    semifinals
Select one of the upcoming matches by entering the line number or press [P/p] to return to the previous Menu:
```

The screenshot above shows the application asking for the user to select one of the matches for which available tickets will be shown.

Screenshot of Ticket Manager Function after selecting **Ticket Line 2 (Cuba @ Mexico 15-Mar-2023)** in the previous 'upcoming matches menu'.

```
Select one of the upcoming matches by entering the line number or press [P/p] to return to the previous Menu:
2
-----All available tickets for the selected match-----
| Teams: Cuba @ Mexico | Date: 15-Mar-2023 | Start Time: 12:00:00 | Match Round: group-round | Stadium: King Fahd International Stadium |
|10   |100.0$ |
|40   |200.0$ |
|50   |200.0$ |
Enter the seat number of the ticket to purchase or press [P/p] to return to the previous Menu:
```

The screenshot above shows there are 3 tickets available for the selected match: Seat numbers 10, 40 and 50. The application prompts the user to buy one of the shown seats or to return to the previous menu.

Screenshot of Ticket Manager Function after selecting to buy the ticket for **Seat number 40 (for the match Cuba @ Mexico 15-Mar-2023)**. An insert was sent to the database to reserve the chosen ticket for the client (email = 'd.w@gmail.com') and an update was sent to make the reserved ticket unavailable for other purchases (i.e. purchase\_status = 1).

```
Enter the seat number of the ticket to purchase or press [P/p] to return to the previous Menu:
40
Purchasing...
-----All available tickets for the selected match-----
| Teams: Cuba @ Mexico | Date: 15-Mar-2023 | Start Time: 12:00:00 | Match Round: group-round | Stadium: King Fahd International Stadium |
|10   |100.0$ |
|50   |200.0$ |
Enter the seat number of the ticket to purchase or press [P/p] to return to the previous Menu:
```

As shown above, the ticket with seat number 40 for the chosen match is no longer available and should now be shown in the owned tickets for the current client (email = 'd.w@gmail.com').

Screenshot of Ticket Manager Function after entering P (or p) to return to previous menus. The previous menu shows the upcoming matches once more.

```
Enter the seat number of the ticket to purchase or press [P/p] to return to the previous Menu:
P
-----All upcoming matches-----
1. Saudi Arabia @ USA      15-Mar-2023   09:00:00   group-round
2. Cuba @ Mexico          15-Mar-2023   12:00:00   group-round
3. Mexico @ Saudi Arabia   16-Mar-2023   08:00:00   group-round
4. Cuba @ USA              16-Mar-2023   16:00:00   group-round
5. Canada @ unknown        01-Sep-2023   15:00:00   quarterfinals
6. unknown @ Argentina     02-Sep-2023   15:00:00   quarterfinals
7. unknown @ unknown       06-Sep-2023   15:00:00   semifinals
Select one of the upcoming matches by entering the line number or press [P/p] to return to the previous Menu:
```

Screenshot of Ticket Manager Function after entering p (or P) to return to previous menus. The previous menu shows the ticket manager menu.

```
Select one of the upcoming matches by entering the line number or press [P/p] to return to the previous Menu:
p

Ticket Portfolio Manager: 'd.w@gmail.com'
  1. View owned tickets
  2. Buy new tickets
  3. Return to previous Menu
Please Enter Your Option:
```

Screenshot of Ticket Manager Function after selecting **Option 1** in the Ticket Manager Menu. The screenshot should now show the new ticket(s) that has been “purchased” (i.e. in this case reserved) for the current client ‘email = d.w@gmail.com’.

```
3. Return to previous Menu
Please Enter Your Option:1

-----All tickets owned by user 'd.w@gmail.com'-----
Argentina @ Germany      group-round    18:00:00    01-Oct-2022    10    100.0$    BC Place
Canada @ Argentina       group-round    09:00:00    02-Oct-2022    10    100.0$    BC Place
France @ Germany         group-round    12:00:00    02-Oct-2022    10    100.0$    BC Place
Saudi Arabia @ Cuba       group-round    15:00:00    10-Mar-2023    10    100.0$    King Fahd International Stadium
Saudi Arabia @ Cuba       group-round    15:00:00    10-Mar-2023    30    200.0$    King Fahd International Stadium
USA @ Mexico              group-round    18:00:00    10-Mar-2023    20    200.0$    King Fahd International Stadium
Cuba @ Mexico             group-round    12:00:00    15-Mar-2023    20    100.0$    King Fahd International Stadium
Cuba @ Mexico             group-round    12:00:00    15-Mar-2023    40    200.0$    King Fahd International Stadium
Mexico @ Saudi Arabia     group-round    08:00:00    16-Mar-2023    20    200.0$    King Fahd International Stadium

Ticket Portfolio Manager: 'd.w@gmail.com'
  1. View owned tickets
  2. Buy new tickets
  3. Return to previous Menu
Please Enter Your Option:
```

As expected, the application now shows the new ticket reserved for **Seat number 40** for the match **Cuba @ Mexico** on **15-Mar-2023**. This user now owns two tickets for this match, as shown above.

Screenshot of Ticket Manager Function after selecting **Option 3** in the Ticket Manager Menu to return to the application main menu.

```
3. Return to previous Menu
Please Enter Your Option:3

Soccer Main Menu
  1. List information of matches of a country
  2. Insert initial player information for a match
  3. View and modify a client ticket portfolio
  4. Exit Application
Please Enter Your Option:
```



## Validation of proper application behavior using the db2 command line to query our database

Screenshot showing all the tickets owned for user email '[d.w@gmail.com](mailto:d.w@gmail.com)' after running the above application execution flow

```
db2 => SELECT m.team1, m.team2, m.round, m.start_time, temp.date, temp.seatnumber, temp.sname, temp.price FROM Matches m, (SELECT t.mid, t.date, t.seatnumber, t.sname, t.price FROM Tickets t, Buys b WHERE t.mid = b.mid AND t.seatnumber = b.seatnumber AND b.email = 'd.w@gmail.com' ORDER BY t.date)temp WHERE m.mid = temp.mid;
```

TEAM1 SEATNUMBER	SNAME	TEAM2	PRICE	ROUND	START_TIME	DATE
Argentina	10 BC Place	Germany	+1.00000000000000E+002	group-round	18:00:00	10/01/2022
Canada	10 BC Place	Argentina	+1.00000000000000E+002	group-round	09:00:00	10/02/2022
France	10 BC Place	Germany	+1.00000000000000E+002	group-round	12:00:00	10/02/2022
Saudi Arabia	10 King Fahd International Stadium	Cuba	+1.00000000000000E+002	group-round	15:00:00	03/10/2023
Saudi Arabia	30 King Fahd International Stadium	Cuba	+2.00000000000000E+002	group-round	15:00:00	03/10/2023
USA	20 King Fahd International Stadium	Mexico	+2.00000000000000E+002	group-round	18:00:00	03/10/2023
Cuba	20 King Fahd International Stadium	Mexico	+1.00000000000000E+002	group-round	12:00:00	03/15/2023
Cuba	40 King Fahd International Stadium	Mexico	+2.00000000000000E+002	group-round	12:00:00	03/15/2023
Mexico	20 King Fahd International Stadium	Saudi Arabia	+2.00000000000000E+002	group-round	08:00:00	03/16/2023

9 record(s) selected.

db2 =>

As expected, the new ticket reserved for **Seat number 40 for the match Cuba @ Mexico on 15-Mar-2023** is shown. The queried client now owns two tickets for this match, as shown above, and also owns 9 tickets (i.e. 9 records) instead of 8 tickets (i.e. 8 records).

Screenshot showing the available tickets for Match: **Cuba @ Mexico on 03/15/2023** in King Fahd Stadium (match mid=10) after running the above application execution flow

```
db2 => SELECT seatNumber, price FROM Tickets WHERE mid = 10 AND purchase_status = 0 ORDER BY date;
```

SEATNUMBER	PRICE
10	+1.00000000000000E+002
50	+2.00000000000000E+002

2 record(s) selected.

db2 =>

As expected, the ticket that was reserved for **Seat number 40 for the match Cuba @ Mexico on 15-Mar-2023** is no longer available and isn't shown in this query result. Two tickets are now available (i.e. 2 records) as opposed to 3 tickets (i.e. 3 records) that were available before the application execution flow.

## Indexing

An index over the relation 'Matches' and the attribute date would be very useful, as most of the applications complex queries and execution flow uses match dates as conditional checks to filter the outputs needed. For example, whenever a client desires to purchase tickets or a user wants to modify the players participating in a match, the application uses the date attribute of the matches to only show some or all matches that will occur after the current date of the query requested. This way, the application prevents some data corruption and input errors. Moreover, queries will usually either target upcoming matches (for scheduling purposes) OR target completed matches (for statistical purposes). Other application functionality examples that could use the match date attribute to increase performance and reduce operation costs would be the following: Scheduling matches, scheduling referee assignments, showing team performance statistics (past matches), etc.

```
db2 => CREATE INDEX MatchDate ON Matches(date);
DB20000I  The SQL command completed successfully.
db2 =>
```

## Data Analytics

```
SELECT p.country, count(*) AS numgoals
FROM Goals g, Players p, Matches m
WHERE m.round = 'group-round' AND g.pid = p.pid AND g.mid = m.mid AND
(p.country = m.team1 OR p.country = m.team2)
GROUP BY p.country
ORDER BY numgoals desc
LIMIT 5;
```

Goals Scored During Group Round by Country

