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Group Project ICS2205 Web Intelligence

Task 1: Graph Analysis

Packages Install

```
In [1]: #Removing the old installation
! pip uninstall -y networkx-neo4j

#Installing new package
! pip install git+https://github.com/ybaktir/networkx-neo4j

Found existing installation: networkx-neo4j 0.0.3
Uninstalling networkx-neo4j-0.0.3:
  Successfully uninstalled networkx-neo4j-0.0.3
Collecting git+https://github.com/ybaktir/networkx-neo4j
  Cloning https://github.com/ybaktir/networkx-neo4j to c:\users\user\appdata\local\temp\pip-req-build-6cxdzq5i
  Resolved https://github.com/ybaktir/networkx-neo4j to commit 97dc9563bf992ea9714cbdb99cb9e6a41c7cce65
Requirement already satisfied: neo4j-driver in c:\users\user\anaconda3\lib\site-packages (from networkx-neo4j==0.0.3) (5.2.0)
Requirement already satisfied: pytz in c:\users\user\anaconda3\lib\site-packages (from neo4j-driver->networkx-neo4j==0.0.3) (2021.3)
Building wheels for collected packages: networkx-neo4j
  Building wheel for networkx-neo4j (setup.py): started
  Building wheel for networkx-neo4j (setup.py): finished with status 'done'
  Created wheel for networkx-neo4j: filename=networkx_neo4j-0.0.3-py3-none-any.whl size=13787 sha256=ba5406a376b5bbc20b3b203f41cd897102fe62181300feb8795bd593ea14582d
  Stored in directory: C:\Users\User\AppData\Local\Temp\pip-ephem-wheel-cache-2yxxu1m1\wheels\2d\b5\b3\16aa7b50037368b08214f6295804dfee8e1db866ccb4bc0350
Successfully built networkx-neo4j
Installing collected packages: networkx-neo4j
Successfully installed networkx-neo4j-0.0.3

Running command git clone -q https://github.com/ybaktir/networkx-neo4j 'C:\Users\User\AppData\Local\Temp\pip-req-build-6cxdzq5i'
```

Packages

```
In [2]: import json
import os
from datetime import timedelta
import networkx as nx
import matplotlib.pyplot as plt
from neo4j import GraphDatabase, basic_auth
import string
import numpy as np
```

1. Creating the passing network from the StatsBomb dataset for specific matches that are part of a particular competition of your choice (Total marks: 30)

1.1. Parse the competition files to get the list of competitions (e.g. Champions League etc) and then for a particular competition get the relevant matches for a specific season. (5 marks)

The following Function will be used extensively, throughout this notebook:

Function is used to load and parse a JSON file

```
In [3]: #Function which Loads the json file, given a file name
def GetJSONFiles(fileName):
    #Try exception used as error handling if file is not found
    try:
        #Opening the JSON file
        file=open(fileName, encoding="utf8")
    except FileNotFoundError:
```

```

#Respective error shown
print("File Not Found Error")
#Closing file
file.close()
else:
    #Parsing through file and saving contents in variable
    data = json.load(file)

    #Closing file
    file.close()

    #Returning file data
    return data

```

In [4]: #Loading competition json files, through the use of the GetJsonFiles Function
competitions=GetJSONFiles("open-data-master/data/competitions.json")

Displaying list of competitions, as a menu to the user, and proper validation of user input for Competition_id

In [5]: #uniqueCompetitionid array being used to hold the unique competition ids, as to not show duplicate competitions
uniquecompetitionid=[]
#Looping through the competitions dictionary, and displaying the competition id and competition name
print("Competition Id: \t Competition Name:")
for competition in competitions:
 #Checking if current competition id is not in uniquecompetitionid, if not it will proceed to print information a
 #and add the current competition to the uniqueCompetitionid array
 if competition["competition_id"] not in uniquecompetitionid:
 print(competition["competition_id"], "\t\t\t", competition["competition_name"])
 uniquecompetitionid.append(competition["competition_id"])

#User input for competition_id
competition_id=-1
#Looping until a valid competition id is entered, a valid competition id pertains to any value in the
#uniquecompetitionid array
while competition_id not in uniquecompetitionid:
 competition_id=int(input("Input Competition Id\n"))

Competition Id:	Competition Name:
16	Champions League
37	FA Women's Super League
43	FIFA World Cup
1238	Indian Super league
11	La Liga
49	NWSL
2	Premier League
55	UEFA Euro
53	UEFA Women's Euro
72	Women's World Cup

Input Competition Id
16

Displaying list of seasons, as a menu to the user, and proper validation of user input for Season_id

In [6]: #uniqueseasonid array being used to only hold the unique season ids
uniqueseasonid=[]
#Looping through the competitions dictionary, and displaying the season id and season date
print("Season Id: \t Season Date:")
for competition in competitions:
 #Checking if the competition id inputted previously by the user matches the current competition id and checking
 #current season id is not in uniqueseasonid, if not it will proceed to print the information about the season,
 #and add the season to the uniqueseasonid array
 if competition["competition_id"]==competition_id and competition["season_id"] not in uniqueseasonid:
 print(competition["season_id"], "\t\t\t", competition["season_name"])
 uniqueseasonid.append(competition["season_id"])

#User input for season_id
season_id=-1
#Looping until a valid season id is entered, a valid season id pertains to any value in the
#uniqueseasonid array
while season_id not in uniqueseasonid:
 season_id=int(input("Input Season Id\n"))

Season Id:	Season Date:
4	2018/2019
1	2017/2018
2	2016/2017
27	2015/2016
26	2014/2015
25	2013/2014
24	2012/2013
23	2011/2012
22	2010/2011
21	2009/2010
41	2008/2009
39	2006/2007
37	2004/2005
44	2003/2004
76	1999/2000

Input Season Id
4

Retrieving relevant matches from the given competition_id and season_id

Displaying list of matches, as a menu to the user, and proper validation of user input for Match_id

```
In [7]: #Retrieving relevant matches given a competition_id and season_id, by constructing the path of the required matches
fileName="open-data-master/data/matches/"+str(competition_id)+"-"+str(season_id)+".json"
matches=GetJSONFiles(fileName)
```

```
In [8]: #uniquematchid array being used to only hold the unique match ids
uniquematchid=[]
#Looping through the matches list, and displaying the match id and match date
print("Match Id: \t\t\t Match Date:")
for match in matches:
    #Checking if the current match id is not in uniquematchid, if not it will proceed to print information about the
    #and add the current match to the uniquematchid array
    if match["match_id"] not in uniquematchid:
        print(match["match_id"],"\t\t\t",match["match_date"])
        uniquematchid.append(match["match_id"])

#User input for match_id
match_id=-1
#Looping until a valid match id is entered, a valid match id pertains to any value in the
#uniquematchid array
while match_id not in uniquematchid:
    match_id=int(input("Input Match Id\n"))
```

Match Id:	Match Date:
22912	2019-06-01

Input Match Id
22912

Retrieving all the information for the given match_id, and storing it in a variable

```
In [9]: #Required match variable to hold the contents of the required match
requiredmatch=[]
#Looping through all the matches in the matches array
for match in matches:
    #Initialising requiredmatch variable, if current match id matches user inputted match id, and breaking from the L
    if match["match_id"]== match_id:
        requiredmatch=match
        break
```

1.2. From the match id you will need to load the events details for that match, including the lineup for each team and then generate the passing networks. (20 marks)

To do this you need to:

1.2 a) Extract the lineup for each team;

```
In [10]: #Dictionary to hold all the players in the lineups
playerdetails={}
#Retrieving relevant Lineup given a match_id, by constructing the path of the required lineup file
teaml lineup=GetJSONFiles("open-data-master/data/lineups/"+str(match_id)+".json")

#Displaying Match and match date
print("Match: ",requiredmatch["match_date"])
#Looping through all the teams in the team lineup
for team in teamlineup:
    #Displaying the current team name
    print("Team: ",team["team_name"],"\n")
```

```
#Looping through all the players in the team, and printing the player name, as well as storing said player in th
for player in team["lineup"]:
    print(player["player_name"])
    playerdetails[player["player_id"]]=player
print("\n")
```

Match: 2019-06-01

Team: Tottenham Hotspur

Christian Dannemann Eriksen
 Jan Vertonghen
 Harry Winks
 Heung-Min Son
 Moussa Sissoko
 Bamidele Alli
 Hugo Lloris
 Kieran Trippier
 Fernando Llorente Torres
 Danny Rose
 Lucas Rodrigues Moura da Silva
 Harry Kane
 Eric Dier
 Toby Alderweireld

Team: Liverpool

Fábio Henrique Tavares
 James Philip Milner
 Joe Gomez
 Joël Andre Job Matip
 Mohamed Salah
 Jordan Brian Henderson
 Roberto Firmino Barbosa de Oliveira
 Georginio Wijnaldum
 Sadio Mané
 Andrew Robertson
 Trent Alexander-Arnold
 Virgil van Dijk
 Divock Okoth Origi
 Alisson Ramsés Becker

1.2 b) Then filter the data to extract the passes;

```
In [11]: #Retrieving relevant events given a match_id, by constructing the path of the required events file
eventsfile=GetJSONFiles("open-data-master/data/events/"+str(match_id)+".json")
#Dictionary to hold the events which are passed
eventpasses={}

#Looping through all the events in the eventsfile
for event in eventsfile:
    #Checking if the event is a pass, and that the event has a recipient, if so it will enter the if statement
    if event["type"]["name"]=="Pass" :
        if "recipient" in event["pass"].keys():
            #Printing the player A passed to player B, and storing in dictionary if it isn't in dictionary, else
            #it will increment the element in the eventpasses dictionary, to record the frequency of player A passing
            print(event["player"]["name"], " passed to: " +event["pass"]["recipient"]["name"])
            if (str(event["player"]["name"])+","+str(event["pass"]["recipient"]["name"])) not in eventpasses.keys():
                eventpasses[str(event["player"]["name"])+","+str(event["pass"]["recipient"]["name"])] =1
            else:
                eventpasses[str(event["player"]["name"])+","+str(event["pass"]["recipient"]["name"])] +=1
```

Jordan Brian Henderson passed to: Joël Andre Job Matip
Joël Andre Job Matip passed to: Sadio Mané
Kieran Trippier passed to: Harry Kane
Fábio Henrique Tavares passed to: Roberto Firmino Barbosa de Oliveira
Moussa Sissoko passed to: Harry Winks
Jordan Brian Henderson passed to: Sadio Mané
Toby Alderweireld passed to: Harry Kane
Virgil van Dijk passed to: Georginio Wijnaldum
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Jan Vertonghen passed to: Danny Rose
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Toby Alderweireld passed to: Fernando Llorente Torres
Joël Andre Job Matip passed to: Trent Alexander-Arnold
Jan Vertonghen passed to: Hugo Lloris

1.2 c) Get the number of times that some player A passes the ball to some player B;

```
In [12]: #Looping through all the contents of the eventpasses dictionary, and printing player names, and pass frequency  
for passes in eventpasses.keys():  
    playerids=passes.split(",")  
    print(playerids[0], " passed to: " +playerids[1]+" "+str(eventpasses[passes])+" time/s")
```

Jordan Brian Henderson passed to: Joël Andre Job Matip 2 time/s
Joël Andre Job Matip passed to: Sadio Mané 3 time/s
Kieran Trippier passed to: Harry Kane 10 time/s
Fábio Henrique Tavares passed to: Roberto Firmino Barbosa de Oliveira 4 time/s
Moussa Sissoko passed to: Harry Winks 6 time/s
Jordan Brian Henderson passed to: Sadio Mané 5 time/s
Toby Alderweireld passed to: Harry Kane 4 time/s
Virgil van Dijk passed to: Georginio Wijnaldum 3 time/s
Georginio Wijnaldum passed to: Jordan Brian Henderson 2 time/s
Sadio Mané passed to: Jordan Brian Henderson 2 time/s
Harry Kane passed to: Bamidele Alli 3 time/s
Christian Dannemann Eriksen passed to: Harry Kane 7 time/s
Andrew Robertson passed to: Roberto Firmino Barbosa de Oliveira 9 time/s
Toby Alderweireld passed to: Bamidele Alli 4 time/s
Fábio Henrique Tavares passed to: Mohamed Salah 2 time/s
Jan Vertonghen passed to: Bamidele Alli 3 time/s
Fábio Henrique Tavares passed to: Sadio Mané 3 time/s
Kieran Trippier passed to: Harry Winks 7 time/s
Harry Winks passed to: Bamidele Alli 10 time/s
Bamidele Alli passed to: Christian Dannemann Eriksen 8 time/s
Andrew Robertson passed to: Sadio Mané 16 time/s
Sadio Mané passed to: Andrew Robertson 7 time/s
Andrew Robertson passed to: Mohamed Salah 7 time/s
Joël Andre Job Matip passed to: Roberto Firmino Barbosa de Oliveira 1 time/s
Trent Alexander-Arnold passed to: Mohamed Salah 13 time/s
Danny Rose passed to: Heung-Min Son 6 time/s
Kieran Trippier passed to: Toby Alderweireld 7 time/s
Toby Alderweireld passed to: Hugo Lloris 14 time/s
Hugo Lloris passed to: Toby Alderweireld 14 time/s
Toby Alderweireld passed to: Jan Vertonghen 21 time/s
Jan Vertonghen passed to: Hugo Lloris 16 time/s
Toby Alderweireld passed to: Kieran Trippier 11 time/s
Kieran Trippier passed to: Christian Dannemann Eriksen 15 time/s
Christian Dannemann Eriksen passed to: Harry Winks 5 time/s
Harry Winks passed to: Toby Alderweireld 6 time/s
Toby Alderweireld passed to: Danny Rose 5 time/s
Heung-Min Son passed to: Jan Vertonghen 3 time/s
Jan Vertonghen passed to: Toby Alderweireld 25 time/s
Bamidele Alli passed to: Heung-Min Son 13 time/s
Kieran Trippier passed to: Jan Vertonghen 4 time/s
Moussa Sissoko passed to: Hugo Lloris 5 time/s
Hugo Lloris passed to: Jan Vertonghen 16 time/s
Kieran Trippier passed to: Bamidele Alli 4 time/s
Sadio Mané passed to: Mohamed Salah 6 time/s
Mohamed Salah passed to: Sadio Mané 4 time/s
Heung-Min Son passed to: Toby Alderweireld 1 time/s
Danny Rose passed to: Hugo Lloris 2 time/s
Hugo Lloris passed to: Harry Kane 6 time/s
Jan Vertonghen passed to: Moussa Sissoko 4 time/s
Moussa Sissoko passed to: Christian Dannemann Eriksen 4 time/s
Trent Alexander-Arnold passed to: Alisson Ramsés Becker 1 time/s
Heung-Min Son passed to: Moussa Sissoko 2 time/s
Harry Winks passed to: Kieran Trippier 8 time/s
Trent Alexander-Arnold passed to: Jordan Brian Henderson 9 time/s
Jan Vertonghen passed to: Danny Rose 9 time/s
Heung-Min Son passed to: Bamidele Alli 7 time/s
Bamidele Alli passed to: Danny Rose 3 time/s
Danny Rose passed to: Jan Vertonghen 9 time/s
Jan Vertonghen passed to: Harry Winks 6 time/s
Harry Winks passed to: Heung-Min Son 1 time/s
Christian Dannemann Eriksen passed to: Heung-Min Son 8 time/s
Alisson Ramsés Becker passed to: Virgil van Dijk 7 time/s
Virgil van Dijk passed to: Alisson Ramsés Becker 6 time/s
Alisson Ramsés Becker passed to: Fábio Henrique Tavares 3 time/s
Fábio Henrique Tavares passed to: Alisson Ramsés Becker 1 time/s
Virgil van Dijk passed to: Sadio Mané 1 time/s
Trent Alexander-Arnold passed to: Virgil van Dijk 3 time/s
Andrew Robertson passed to: Alisson Ramsés Becker 3 time/s
Alisson Ramsés Becker passed to: Joël Andre Job Matip 3 time/s
Joël Andre Job Matip passed to: Mohamed Salah 2 time/s
Danny Rose passed to: Harry Kane 4 time/s
Toby Alderweireld passed to: Harry Winks 4 time/s
Harry Winks passed to: Jan Vertonghen 3 time/s
Virgil van Dijk passed to: Mohamed Salah 3 time/s
Jan Vertonghen passed to: Kieran Trippier 2 time/s
Christian Dannemann Eriksen passed to: Moussa Sissoko 2 time/s
Danny Rose passed to: Harry Winks 7 time/s
Virgil van Dijk passed to: Andrew Robertson 6 time/s
Harry Winks passed to: Danny Rose 6 time/s
Harry Winks passed to: Hugo Lloris 1 time/s
Harry Winks passed to: Moussa Sissoko 7 time/s
Moussa Sissoko passed to: Bamidele Alli 3 time/s
Andrew Robertson passed to: Fábio Henrique Tavares 5 time/s
Andrew Robertson passed to: Georginio Wijnaldum 4 time/s
Moussa Sissoko passed to: Jan Vertonghen 4 time/s

Jan Vertonghen passed to: Heung-Min Son 2 time/s
Fábio Henrique Tavares passed to: Joël Andre Job Matip 1 time/s
Joël Andre Job Matip passed to: Virgil van Dijk 5 time/s
Andrew Robertson passed to: Virgil van Dijk 3 time/s
Virgil van Dijk passed to: Joël Andre Job Matip 5 time/s
Fábio Henrique Tavares passed to: Jordan Brian Henderson 3 time/s
Jordan Brian Henderson passed to: Trent Alexander-Arnold 3 time/s
Hugo Lloris passed to: Heung-Min Son 2 time/s
Jordan Brian Henderson passed to: Mohamed Salah 3 time/s
Harry Winks passed to: Harry Kane 2 time/s
Joël Andre Job Matip passed to: Fábio Henrique Tavares 3 time/s
Christian Dannemann Eriksen passed to: Bamidele Alli 7 time/s
Jordan Brian Henderson passed to: Andrew Robertson 2 time/s
Harry Kane passed to: Christian Dannemann Eriksen 2 time/s
Fábio Henrique Tavares passed to: Trent Alexander-Arnold 2 time/s
Trent Alexander-Arnold passed to: Roberto Firmino Barbosa de Oliveira 3 time/s
Bamidele Alli passed to: Moussa Sissoko 2 time/s
Bamidele Alli passed to: Harry Winks 4 time/s
Alisson Ramsés Becker passed to: Andrew Robertson 7 time/s
Georginio Wijnaldum passed to: Sadio Mané 1 time/s
Sadio Mané passed to: Georginio Wijnaldum 4 time/s
Georginio Wijnaldum passed to: Andrew Robertson 2 time/s
Virgil van Dijk passed to: Jordan Brian Henderson 2 time/s
Mohamed Salah passed to: Roberto Firmino Barbosa de Oliveira 3 time/s
Roberto Firmino Barbosa de Oliveira passed to: Mohamed Salah 3 time/s
Roberto Firmino Barbosa de Oliveira passed to: Sadio Mané 2 time/s
Jordan Brian Henderson passed to: Roberto Firmino Barbosa de Oliveira 3 time/s
Heung-Min Son passed to: Christian Dannemann Eriksen 6 time/s
Georginio Wijnaldum passed to: Fábio Henrique Tavares 1 time/s
Fábio Henrique Tavares passed to: Andrew Robertson 3 time/s
Sadio Mané passed to: Roberto Firmino Barbosa de Oliveira 2 time/s
Hugo Lloris passed to: Kieran Trippier 7 time/s
Christian Dannemann Eriksen passed to: Toby Alderweireld 2 time/s
Toby Alderweireld passed to: Moussa Sissoko 3 time/s
Hugo Lloris passed to: Christian Dannemann Eriksen 2 time/s
Kieran Trippier passed to: Moussa Sissoko 6 time/s
Trent Alexander-Arnold passed to: Sadio Mané 6 time/s
Hugo Lloris passed to: Harry Winks 2 time/s
Moussa Sissoko passed to: Kieran Trippier 2 time/s
Moussa Sissoko passed to: Toby Alderweireld 5 time/s
Toby Alderweireld passed to: Heung-Min Son 3 time/s
Joël Andre Job Matip passed to: Trent Alexander-Arnold 3 time/s
Mohamed Salah passed to: Trent Alexander-Arnold 2 time/s
Hugo Lloris passed to: Moussa Sissoko 3 time/s
Bamidele Alli passed to: Harry Kane 2 time/s
Kieran Trippier passed to: Hugo Lloris 4 time/s
Jordan Brian Henderson passed to: Fábio Henrique Tavares 2 time/s
Trent Alexander-Arnold passed to: Georginio Wijnaldum 1 time/s
Georginio Wijnaldum passed to: Trent Alexander-Arnold 2 time/s
Moussa Sissoko passed to: Heung-Min Son 2 time/s
Christian Dannemann Eriksen passed to: Danny Rose 2 time/s
Harry Kane passed to: Harry Winks 1 time/s
Harry Winks passed to: Christian Dannemann Eriksen 3 time/s
Bamidele Alli passed to: Kieran Trippier 1 time/s
Moussa Sissoko passed to: Danny Rose 2 time/s
Danny Rose passed to: Bamidele Alli 8 time/s
Danny Rose passed to: Moussa Sissoko 2 time/s
Joël Andre Job Matip passed to: Andrew Robertson 2 time/s
Mohamed Salah passed to: Jordan Brian Henderson 2 time/s
Georginio Wijnaldum passed to: Mohamed Salah 2 time/s
Roberto Firmino Barbosa de Oliveira passed to: Andrew Robertson 2 time/s
Roberto Firmino Barbosa de Oliveira passed to: Jordan Brian Henderson 2 time/s
Trent Alexander-Arnold passed to: Joël Andre Job Matip 1 time/s
Virgil van Dijk passed to: Trent Alexander-Arnold 1 time/s
Heung-Min Son passed to: Harry Kane 3 time/s
Hugo Lloris passed to: Danny Rose 4 time/s
Andrew Robertson passed to: Jordan Brian Henderson 1 time/s
Jordan Brian Henderson passed to: Virgil van Dijk 1 time/s
Joël Andre Job Matip passed to: Alisson Ramsés Becker 2 time/s
Christian Dannemann Eriksen passed to: Kieran Trippier 7 time/s
Mohamed Salah passed to: Georginio Wijnaldum 1 time/s
Alisson Ramsés Becker passed to: Sadio Mané 2 time/s
Georginio Wijnaldum passed to: Roberto Firmino Barbosa de Oliveira 2 time/s
Kieran Trippier passed to: Heung-Min Son 7 time/s
Heung-Min Son passed to: Kieran Trippier 1 time/s
Harry Kane passed to: Heung-Min Son 4 time/s
Roberto Firmino Barbosa de Oliveira passed to: Georginio Wijnaldum 1 time/s
Roberto Firmino Barbosa de Oliveira passed to: Fábio Henrique Tavares 1 time/s
Danny Rose passed to: Christian Dannemann Eriksen 2 time/s
Alisson Ramsés Becker passed to: Trent Alexander-Arnold 2 time/s
Andrew Robertson passed to: Trent Alexander-Arnold 1 time/s
Joël Andre Job Matip passed to: Georginio Wijnaldum 1 time/s
Christian Dannemann Eriksen passed to: Jan Vertonghen 2 time/s
Jan Vertonghen passed to: Harry Kane 2 time/s
Jordan Brian Henderson passed to: Divock Okoth Origi 4 time/s

Andrew Robertson passed to: Divock Okoth Origi 3 time/s
 Fábio Henrique Tavares passed to: Virgil van Dijk 1 time/s
 Virgil van Dijk passed to: James Philip Milner 1 time/s
 James Philip Milner passed to: Andrew Robertson 1 time/s
 Andrew Robertson passed to: James Philip Milner 1 time/s
 James Philip Milner passed to: Virgil van Dijk 1 time/s
 Joël Andre Job Matip passed to: Divock Okoth Origi 2 time/s
 Divock Okoth Origi passed to: Jordan Brian Henderson 1 time/s
 Alisson Ramsés Becker passed to: Divock Okoth Origi 2 time/s
 Christian Dannemann Eriksen passed to: Lucas Rodrigues Moura da Silva 1 time/s
 Fábio Henrique Tavares passed to: James Philip Milner 1 time/s
 James Philip Milner passed to: Divock Okoth Origi 1 time/s
 Divock Okoth Origi passed to: Sadio Mané 2 time/s
 Sadio Mané passed to: Trent Alexander-Arnold 1 time/s
 Trent Alexander-Arnold passed to: James Philip Milner 1 time/s
 Trent Alexander-Arnold passed to: Divock Okoth Origi 3 time/s
 Danny Rose passed to: Lucas Rodrigues Moura da Silva 4 time/s
 Lucas Rodrigues Moura da Silva passed to: Kieran Trippier 2 time/s
 Mohamed Salah passed to: James Philip Milner 2 time/s
 Jan Vertonghen passed to: Christian Dannemann Eriksen 2 time/s
 Harry Kane passed to: Danny Rose 1 time/s
 Virgil van Dijk passed to: Fábio Henrique Tavares 1 time/s
 Kieran Trippier passed to: Danny Rose 2 time/s
 Alisson Ramsés Becker passed to: Mohamed Salah 3 time/s
 Mohamed Salah passed to: Divock Okoth Origi 2 time/s
 Sadio Mané passed to: Divock Okoth Origi 1 time/s
 Lucas Rodrigues Moura da Silva passed to: Moussa Sissoko 1 time/s
 Toby Alderweireld passed to: Christian Dannemann Eriksen 1 time/s
 Sadio Mané passed to: James Philip Milner 1 time/s
 Bamidele Alli passed to: Lucas Rodrigues Moura da Silva 1 time/s
 Lucas Rodrigues Moura da Silva passed to: Bamidele Alli 1 time/s
 Kieran Trippier passed to: Eric Dier 5 time/s
 Eric Dier passed to: Jan Vertonghen 2 time/s
 Eric Dier passed to: Bamidele Alli 2 time/s
 Alisson Ramsés Becker passed to: James Philip Milner 2 time/s
 James Philip Milner passed to: Trent Alexander-Arnold 1 time/s
 Danny Rose passed to: Toby Alderweireld 1 time/s
 Toby Alderweireld passed to: Eric Dier 1 time/s
 Bamidele Alli passed to: Eric Dier 1 time/s
 Eric Dier passed to: Christian Dannemann Eriksen 3 time/s
 Jan Vertonghen passed to: Eric Dier 2 time/s
 Harry Kane passed to: Kieran Trippier 1 time/s
 Toby Alderweireld passed to: Lucas Rodrigues Moura da Silva 1 time/s
 Lucas Rodrigues Moura da Silva passed to: Heung-Min Son 1 time/s
 Virgil van Dijk passed to: Divock Okoth Origi 1 time/s
 Divock Okoth Origi passed to: Mohamed Salah 6 time/s
 James Philip Milner passed to: Mohamed Salah 1 time/s
 Jan Vertonghen passed to: Fernando Llorente Torres 2 time/s
 Eric Dier passed to: Toby Alderweireld 1 time/s
 Kieran Trippier passed to: Fernando Llorente Torres 2 time/s
 Kieran Trippier passed to: Lucas Rodrigues Moura da Silva 1 time/s
 Christian Dannemann Eriksen passed to: Fernando Llorente Torres 1 time/s
 Danny Rose passed to: Fernando Llorente Torres 2 time/s
 Hugo Lloris passed to: Fernando Llorente Torres 1 time/s
 Fernando Llorente Torres passed to: Christian Dannemann Eriksen 1 time/s
 Danny Rose passed to: Eric Dier 2 time/s
 Eric Dier passed to: Fernando Llorente Torres 1 time/s
 Joe Gomez passed to: Mohamed Salah 1 time/s
 Fábio Henrique Tavares passed to: Divock Okoth Origi 2 time/s
 Fernando Llorente Torres passed to: Lucas Rodrigues Moura da Silva 2 time/s
 Fernando Llorente Torres passed to: Harry Kane 1 time/s
 Eric Dier passed to: Harry Kane 1 time/s
 Toby Alderweireld passed to: Fernando Llorente Torres 1 time/s

1.2 d) Retrieve the top 11 players for each team based on the playing minutes (since players might be substituted during the game);

For this method, it is assumed, that the total match time is 90 minutes

Calculating time each player has played

```

In [13]: #List which holds the player time, for every team
teamplayerTime=[]
#List from previous method which holds teamlineup
teamlineup
#List to hold the team names
teamNames=[]

#Looping through all the teams in the teamlineup
for team in teamlineup:
    #Appending team name to teamNames array
    teamNames.append(team["team_name"])
    #Dictionary, which hold, the playerTime for each player
    playerTime={}
  
```

```

#Looping through all the players in the team
for player in team["lineup"]:
    #Looping through all the positions, a player has
    for positions in player["positions"]:
        #Calculating the time a player has played in the game, via string split, to parse the time in integer, a
        #utilising timedelta to calculate the total time a player has played
        #If statement to check that starting time and ending time are not null
        if positions["from"]!=None and positions["to"]!=None:
            sTime=positions["from"].split(":")
            eTime=positions["to"].split(":")
            startTime = timedelta(minutes=int(sTime[0]), seconds=int(sTime[1]))
            endTime = timedelta(minutes=int(eTime[0]), seconds=int(eTime[1]))
            #If statment to check if player is already in playerTime dict,
            #if yes the player time is appended otherwise a new entry is added
            if(player["player_name"] not in playerTime.keys()):
                playerTime[player["player_name"]] = timedelta(minutes=0, seconds=0);
            playerTime[player["player_name"]]+=endTime-startTime

        #If statement to check that starting time is null, but not ending time
        elif positions["to"]==None and positions["from"]!=None:
            sTime=positions["from"].split(":")
            eTime="90:00".split(":")
            startTime = timedelta(minutes=int(sTime[0]), seconds=int(sTime[1]))
            endTime = timedelta(minutes=int(eTime[0]), seconds=int(eTime[1]))
            #If statment to check if player is already in playerTime dict,
            #if yes the player time is appended otherwise a new entry is added
            if(player["player_name"] not in playerTime.keys()):
                playerTime[player["player_name"]] = timedelta(minutes=0, seconds=0);
            playerTime[player["player_name"]]+=endTime-startTime

        #If statement to check that starting time and ending time are null
        elif positions["to"]==None and positions["from"]==None:
            startTime = timedelta(minutes=0, seconds=0)
            endTime = timedelta(minutes=0, seconds=0)
            #If statment to check if player is already in playerTime dict,
            #if yes the player time is appended otherwise a new entry is added
            if(player["player_name"] not in playerTime.keys()):
                playerTime[player["player_name"]] = timedelta(minutes=0, seconds=0);
            playerTime[player["player_name"]]+=endTime-startTime

    #Appending to list
    teamplayerTime.append(playerTime)

```

Sorting the player times, to obtain the top 11 players

```

In [14]: #List which will hold the sorted team time
sortedTeamTime=[]
#List which will hold the top 11 player names for both team
sortedPlayerNames=[]
#Looping through all the teams, and sorting the list by time, appending result to sortedTeamTime list
for team in teamplayerTime:
    sortedTeamTime.append({Key: Value for Key, Value in sorted(team.items(), key=lambda item: item[1], reverse=True)})

#Counter will be used as an index for team names
count=0
#Looping through all the teams in the sortedTeamTime list
for team in sortedTeamTime:
    #Printing team name
    print("Team: ",teamNames[count]," top 11 players:\n")
    #player count which will be used to only show, the top 11 players
    playercount=0
    #List which will hold the top 11 player names for one team
    playerNameTeam=[]
    #Looping through all the players
    for player in team.keys():
        #If playercount>10 , then break from loop
        if playercount>10:
            break
        #Print statement
        print(player+" has played for: "+str(team[player])+" hours")
        #Appending player to playerNameTeam
        playerNameTeam.append(player)
        #Incrementing player count
        playercount+=1
    #Appending to sortedPlayerNames list
    sortedPlayerNames.append(playerNameTeam)
    print("\n")
    #Incrementing counter
    count+=1

```

Team: Tottenham Hotspur top 11 players:

Christian Dannemann Eriksen has played for: 1:30:00 hours
 Jan Vertonghen has played for: 1:30:00 hours
 Heung-Min Son has played for: 1:30:00 hours
 Hugo Lloris has played for: 1:30:00 hours
 Kieran Trippier has played for: 1:30:00 hours
 Danny Rose has played for: 1:30:00 hours
 Harry Kane has played for: 1:30:00 hours
 Toby Alderweireld has played for: 1:30:00 hours
 Bamidele Alli has played for: 1:21:17 hours
 Moussa Sissoko has played for: 1:13:31 hours
 Harry Winks has played for: 1:05:12 hours

Team: Liverpool top 11 players:

Fábio Henrique Tavares has played for: 1:30:00 hours
 Joël Andre Job Matip has played for: 1:30:00 hours
 Mohamed Salah has played for: 1:30:00 hours
 Jordan Brian Henderson has played for: 1:30:00 hours
 Andrew Robertson has played for: 1:30:00 hours
 Trent Alexander-Arnold has played for: 1:30:00 hours
 Virgil van Dijk has played for: 1:30:00 hours
 Alisson Ramsés Becker has played for: 1:30:00 hours
 Sadio Mané has played for: 1:28:58 hours
 Georginio Wijnaldum has played for: 1:01:50 hours
 Roberto Firmino Barbosa de Oliveira has played for: 0:57:51 hours

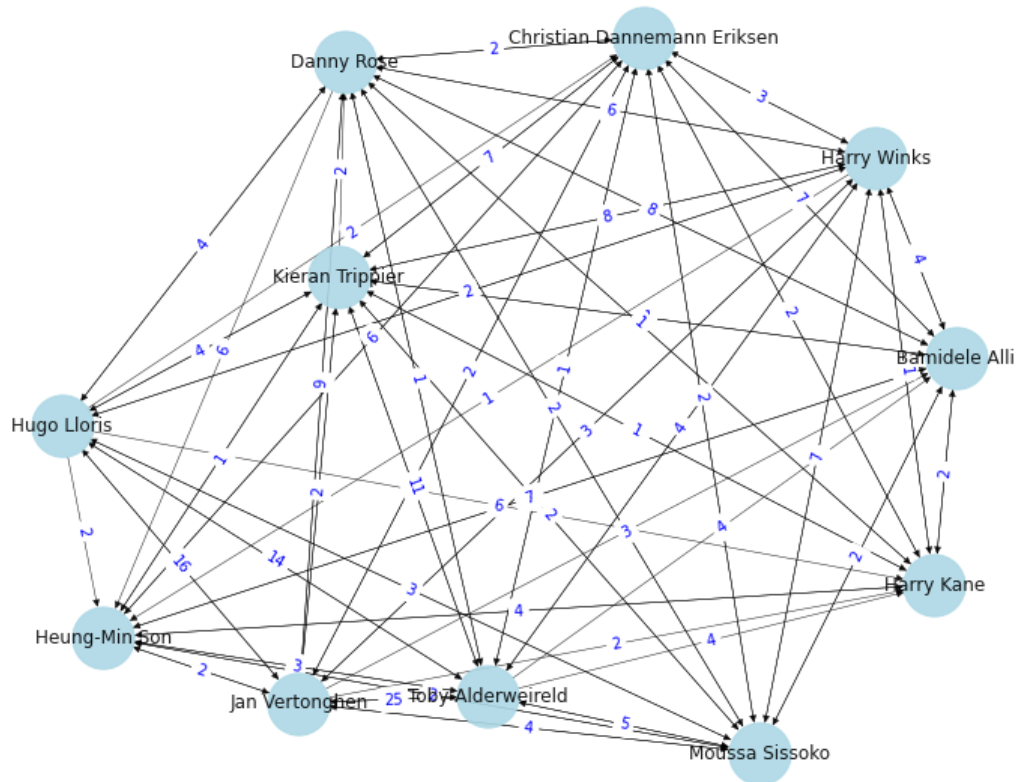
1.2 e) Generate and plot the passing network using networkX4.

Generating passing network graph of the first team

```
In [15]: #Printing teamName
print(teamNames[0])
#Creating Graph
graph1 = nx.DiGraph(name=("Passing Network"+str(teamNames[0])))
#Declaring vairable which will hold the edgelabels
edge_labels1={}
#Looping through all the passes in the eventpasses dictionary
for passes in eventpasses.keys():
    playerids=passes.split(",")
    #Creating edges between player on the graph, and saving number of passes in edgelabels1
    if playerids[0] in sortedPlayerNames[0] and playerids[1] in sortedPlayerNames[0]:
        graph1.add_edge(playerids[0], playerids[1],weight=eventpasses[passes])
        edge_labels1[(str(playerids[0]),str(playerids[1]))]=str(eventpasses[passes])

#Setting plot size
plt.figure(figsize=(10,8))
#Setting graph configurations:
pos1=nx.spring_layout(graph1, k=7, iterations=77)
options = {"node_color":"lightblue","node_size":1700,"edge_color":"black","width": .50,"alpha": .9}
#Drawing graph
nx.draw(graph1,pos = pos1, with_labels = True, **options)
#Drawing edge labels
output=nx.draw_networkx_edge_labels(graph1,pos = pos1,edge_labels=edge_labels1,font_color="blue")
```

Tottenham Hotspur

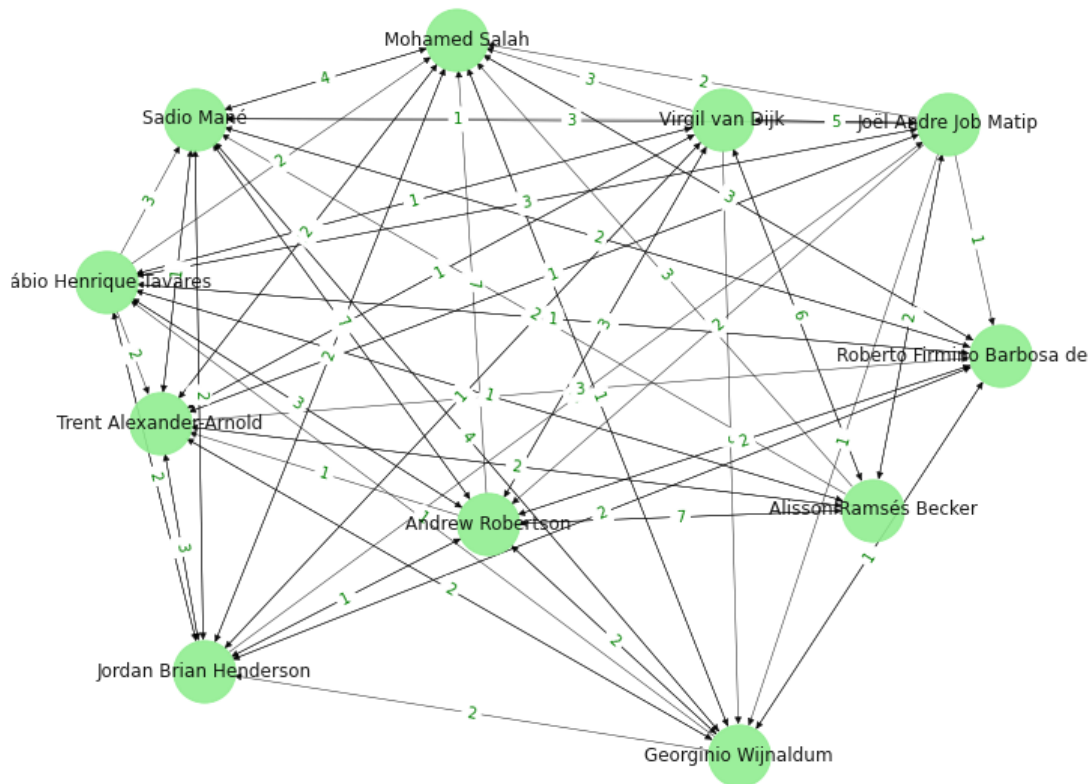


Generating passing network graph of the second team

```
In [16]: #Printing teamName
print(teamNames[1])
#Creating Graph
graph2 = nx.DiGraph(name=("Passing Network"+str(teamNames[1])))
#Declaring vairable which will hold the edgelabels
edge_labels2={}
#Looping through all the passes in the eventpasses dictionary
for passes in eventpasses.keys():
    playerids=passes.split(",")
    #Creating edges between player on the graph, and saving number of passes in edgelabels2
    if playerids[0] in sortedPlayerNames[1] and playerids[1] in sortedPlayerNames[1]:
        graph2.add_edge(playerids[0], playerids[1],weight=eventpasses[passes])
        edge_labels2[(str(playerids[0]),str(playerids[1]))]=str(eventpasses[passes])

#Setting plot size
plt.figure(figsize=(10,8))
#Setting graph configurations:
pos1=nx.spring_layout(graph2, k=7, iterations=77)
options = {"node_color":"lightgreen","node_size":1700,"edge_color":"black","width": .50,"alpha": .9}
#Drawing graph
nx.draw(graph2,pos = pos1, with_labels = True, **options)
#Drawing edge labels
output=nx.draw_networkx_edge_labels(graph2,pos = pos1,edge_labels=edge_labels2,font_color="green")

Liverpool
```



1.3. Finally store the passing network for that match in Neo4j Desktop5. It is recommended that you use libraries such as nxneo4j6 or py2neo7 to interface with Neo4j.(5 marks)

Importing Library nxneo4j, so as to store passing network in neo4j

```
In [17]: import nxneo4j
```

Establishing Connection with neo4j

```
In [18]: #The settings below need to be changed accordingly depending on the user s
user='neo4j'
url='bolt://localhost:7687'
password='test'
driver = GraphDatabase.driver(url,auth=basic_auth(user,password))
```

Creating graph, and graph configuration

```
In [20]: #Graph Configuration
config = {
    'node_label': 'Player',
    'relationship_type': 'PASSEDT0',
    'identifier_property': 'name'
}

#Creating directed graph, and deleting any previous data
Graph = nxneo4j.DiGraph(driver,config=config)
Graph.delete_all()
```

Appending passing network of team 1 to graph

```
In [21]: #Printing team Name
print(teamNames[0])
#Looping through all the passes in the eventspasses dictionary
for passes in eventspasses.keys():
    playerids=passes.split(",")
    #Checking whether player A is in team 1 and player B is in the correct team, if so adding nodes to graph, and ed
    if playerids[0] in sortedPlayerNames[0] and playerids[1] in sortedPlayerNames[0]:
        Graph.add_node(playerids[0],team=teamNames[0],teamId = 1)
        Graph.add_node(playerids[1],team=teamNames[0],teamId = 1)
        Graph.add_edge(playerids[0],playerids[1],weight=eventspasses[passes], team=teamNames[0])
```

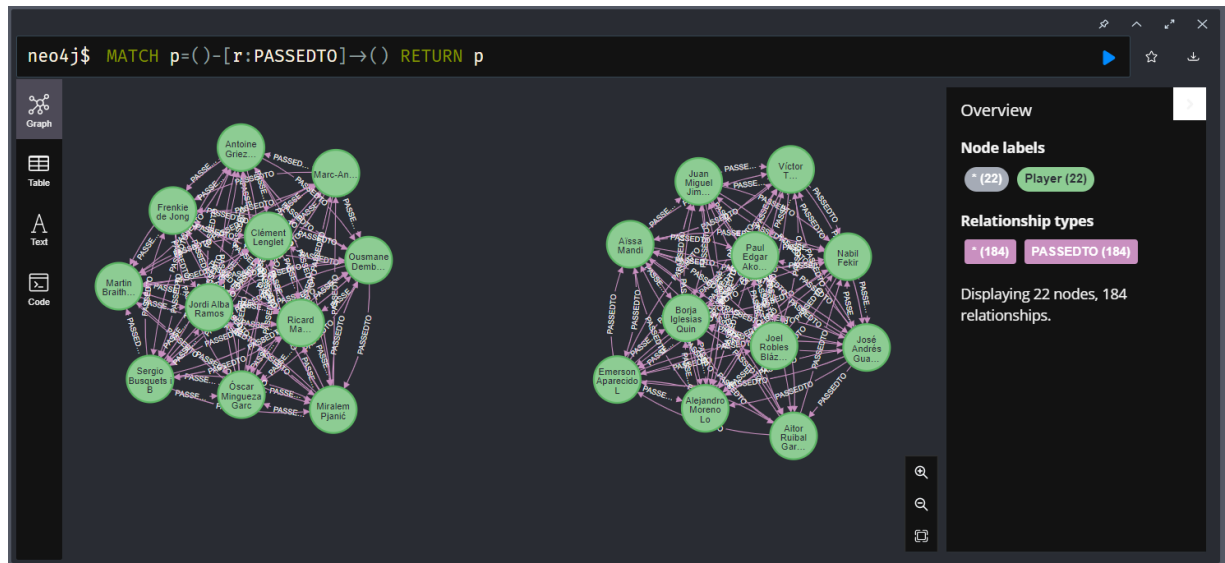
Tottenham Hotspur

Appending passing network of team 2 to graph

```
In [22]: #Printing team Name
print(teamNames[1])
#Looping through all the passes in the eventspasses dictionary
for passes in eventspasses.keys():
    playerids=passes.split(",")
    #Checking whether player A is in team 1 and player B is in the correct team, if so adding nodes to graph, and ed
    if playerids[0] in sortedPlayerNames[1] and playerids[1] in sortedPlayerNames[1]:
        Graph.add_node(playerids[0],team=teamNames[1], teamId = 2)
        Graph.add_node(playerids[1],team=teamNames[1], teamId = 2)
        Graph.add_edge(playerids[0],playerids[1],weight=eventspasses[passes], team=teamNames[1])
```

Liverpool

Given a competition id of 11, season id of 90, and match id of 3773631 we tested to make sure that the graphs were working with neo4j. This can be seen in the image below.



2. Analyse the underlying structure of the passing network by computing the following statistics for the passing network for each team using networkX (Total marks: 20):

Provide information about any challenges that you might have encountered when computing these statistics, and explain how you solved them.

Challenges Encountered

1. We had to distinguish between the individual teams and as such we resolved said issue by adding the corresponding team labels.
2. In section 2.2 we were initially plotting the graphs according to the player, rather than the degree and this was resolved by assigning the xvalues to be the varying degrees instead of player names and working out the distribution accordingly.

2.1 Total number of passes (4 marks)

Printing total number of passes for team 1

```
In [23]: #Variable which will hold totalPasses
totalPasses1=0
#Looping through all the edges
for edge in edge_labels1.values():
    #Appending edge weight to totalpasses
    totalPasses1+=int(edge)
#Print Statement
print("The total number of passes for "+str(teamNames[0])+" is: ",totalPasses1)
```

The total number of passes for Tottenham Hotspur is: 494

Printing total number of passes for team 2

```
In [24]: #Variable which will hold totalPasses
totalPasses2=0
#Looping through all the edges
```



```

for edge in edge_labels2.values():
    #Appending edge weight to totalpasses
    totalPasses2+=int(edge)
#Print Statement
print("The total number of passes for "+str(teamNames[1])+" is: ",totalPasses2)

```

The total number of passes for Liverpool is: 261

2.2 Degree distribution (plot the distribution) (6 marks)

Function will be used to calculate and plot the Degree Distribution of an entered, given the dictionary of degrees, and graph

```

In [25]: def PlotDegreeDistribution(degree,Graph,title):
    #Calculating max and min degree
    maxdegree=max([player[1] for player in degree])
    mindegree=min([player[1] for player in degree])

    #Finding out vertex degree
    values=range(mindegree,maxdegree+1)
    yvalues=[]
    for v in values:
        count=0
        for index in degree:
            if v==index[1]:
                count+=1
        yvalues.append(count)
    #Normalising
    yvalues = [float(value)/sum(yvalues) for value in yvalues]

    #Plotting bars and xlabels
    plt.bar(values, yvalues,0.4,color="lightblue")
    plt.xticks(values, values)

    #Printing values on bars
    for i in range(len(values)):
        plt.text(values[i]-0.2,yvalues[i],round(yvalues[i],3))

    #Plotting labels and showing graph
    plt.xlabel("Degree")
    plt.ylabel("No of Vertices")
    plt.title("Vertex Degree "+title)
    plt.show()

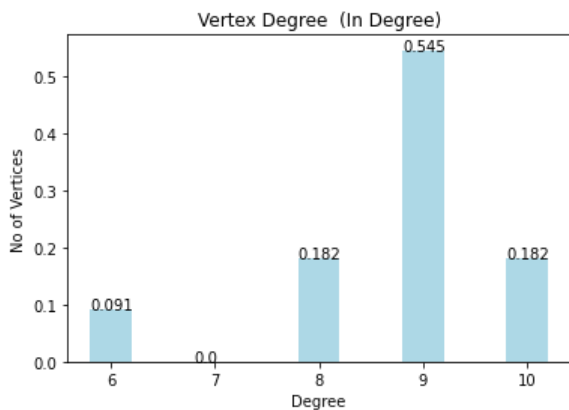
```

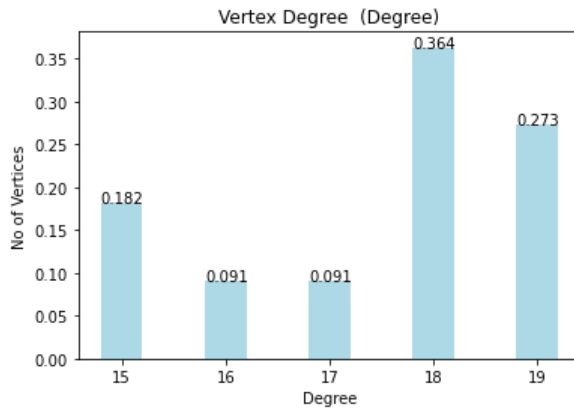
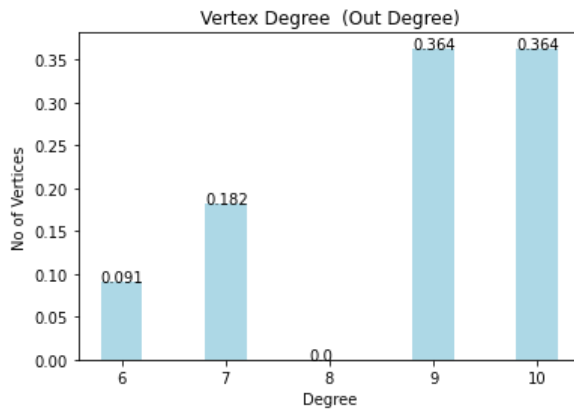
Plotting the Degree distribution of team 1

```

In [26]: Graph=graph1
    #Dictionaries which will hold the indegree, outdegree and degree of graph1
    playerindegree=Graph.in_degree(list(Graph.nodes))
    playeroutdegree=Graph.out_degree(list(Graph.nodes))
    playerdegree=Graph.degree(list(Graph.nodes))
    #Displaying respective plots
    PlotDegreeDistribution(playerindegree,Graph," (In Degree)")
    PlotDegreeDistribution(playeroutdegree,Graph," (Out Degree)")
    PlotDegreeDistribution(playerdegree,Graph," (Degree)")

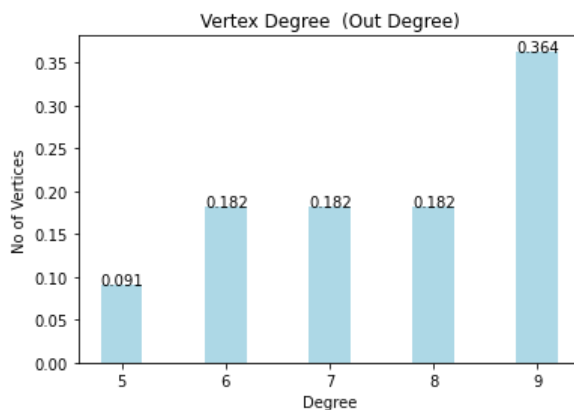
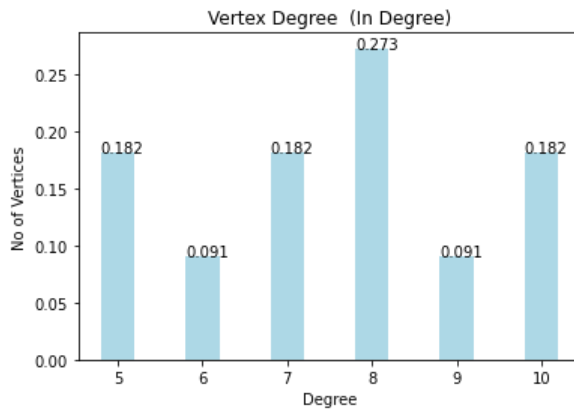
```

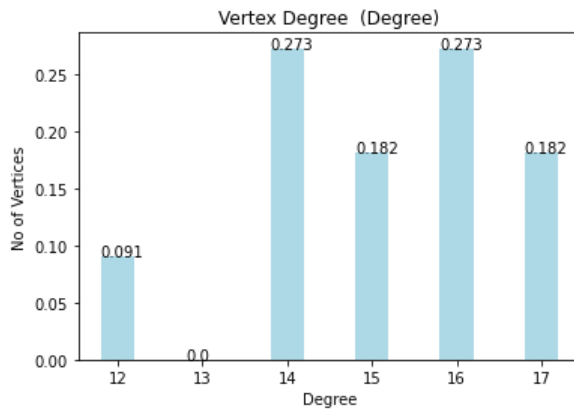




Plotting the Degree distribution of team 2

```
In [27]: Graph=graph2
#Dictionaries which will hold the indegree, outdegree and degree of graph1
playerindegree=Graph.in_degree(list(Graph.nodes))
playeroutdegree=Graph.out_degree(list(Graph.nodes))
playerdegree=Graph.degree(list(Graph.nodes))
#Displaying respective plots
PlotDegreeDistribution(playerindegree,Graph," (In Degree)")
PlotDegreeDistribution(playeroutdegree,Graph," (Out Degree)")
PlotDegreeDistribution(playerdegree,Graph," (Degree)")
```





2.3 Average path length (5 marks)

Function which Calculated the shortest path for every node in a given graph

```
In [28]: def CalculateShortestPath(Graph):
#Dictionary which holds the sum of the shortest path lengths starting from a specific node and reaching all other
sumShortestPath={}

#Calculating the sum of the shortest paths for each node
for node1 in Graph.nodes:
    total=0
    for node2 in Graph.nodes:
        #Checking that the nodes are unique
        if node1!=node2:
            #Adding the distance to the total value
            total+=nx.shortest_path_length(Graph, node1, node2, weight='weight')
        #Storing the new total value
        sumShortestPath[node1]=total

    factor=1.0/(len(Graph.nodes)-1)
    #Normalising the values in the dictionary
    sumShortestPath = {k: v*factor for k, v in sumShortestPath.items() }
    return sumShortestPath
```

Calculating Average path length for team 1

```
In [29]: pathlength1=CalculateShortestPath(graph1)
averagepathlength1 = 0

#Looping through the pathlength values and adding them together
for value in pathlength1.values():
    averagepathlength1+=value

#Calculating the average path length
averagepathlength1=averagepathlength1/len(pathlength1)
print("The average path length is: ",averagepathlength1)
```

The average path length is: 3.145454545454545

Calculating Average path length for team 2

```
In [30]: pathlength2=CalculateShortestPath(graph2)
averagepathlength2 = 0

#Looping through the pathlength values and adding them together
for value in pathlength2.values():
    averagepathlength2+=value

#Calculating the average path length
averagepathlength2=averagepathlength2/len(pathlength2)
print("The average path length is: ",averagepathlength2)
```

The average path length is: 2.2545454545454544

2.4 Global clustering coefficient (5 marks)

Calculating Global clustering coefficient for team 1

```
In [31]: #Calculating global cluster coefficient
globalclusteringcoefficient1=nx.clustering(graph1)
#Calculating average global cluster coefficient
averageglobalclusteringcoefficient1 = sum(globalclusteringcoefficient1.values())/len(graph1.nodes)
#Printing the result
print("The global clustering coefficient of team 1 is: ",averageglobalclusteringcoefficient1)
```

The global clustering coefficient of team 1 is: 0.873683969135262

Calculating Global clustering coefficient for team 2

```
In [32]: #Calculating global cluster coefficient
globalclusteringcoefficient2=nx.clustering(graph2)
#Calculating average global cluster coefficient
averageglobalclusteringcoefficient2 = sum(globalclusteringcoefficient2.values())/len(graph2.nodes)
#Printing the result
print("The global clustering coefficient is: ",averageglobalclusteringcoefficient2)
```

The global clustering coefficient is: 0.7570240790204259

3. Query Neo4j directly using Cypher to answer the following questions regarding each team (Total marks: 40):

Include the Cypher queries in the jupyter notebook as markdown. Furthermore, you need to also explain any parameters used and any encountered issues and how these were solved.

Challenges Encountered

No issues were encountered during this section

The following images consider the following parameters: a competition id of 11, season id of 90, and match id of 3773631.

3.1 Who is the most active player in terms of passes? (10 marks)

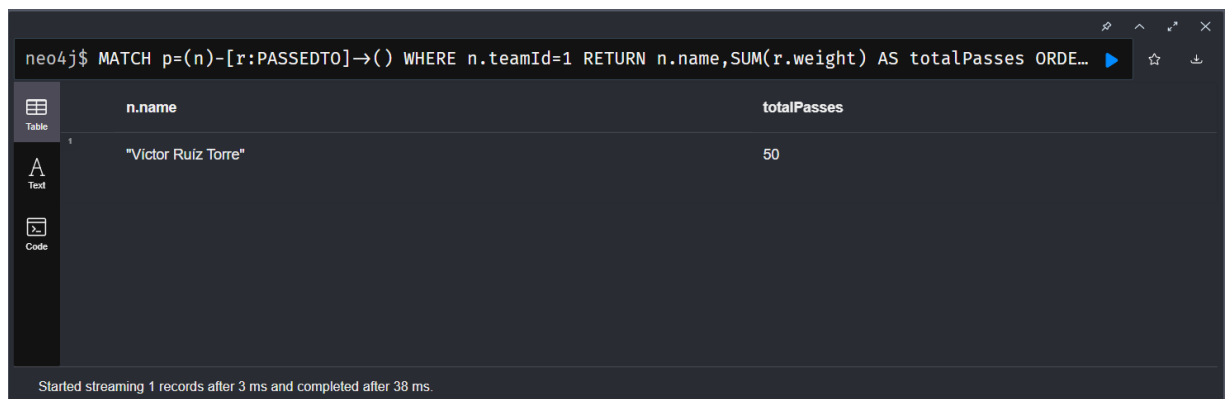
Retrieving the most active player from team one

This is achieved by summing the weight of each player in team one, ordering the resultant data in descending order and displaying only one player, that being the player with the highest total passes.

Cypher Query

```
MATCH p=(n)-[r:PASSEDT0]->() WHERE n.teamId=1 RETURN n.name,SUM(r.weight) AS totalPasses ORDER BY totalPasses DESC LIMIT 1
```

Results:



The screenshot shows a Neo4j Cypher query interface. The query entered is: `MATCH p=(n)-[r:PASSEDT0]->() WHERE n.teamId=1 RETURN n.name,SUM(r.weight) AS totalPasses ORDER BY totalPasses DESC LIMIT 1`. The results are displayed in a table with two columns: `n.name` and `totalPasses`. The first result is `"Victor Ruiz Torre"` with `50` total passes. The interface also shows a status bar at the bottom indicating "Started streaming 1 records after 3 ms and completed after 38 ms."

n.name	totalPasses
"Victor Ruiz Torre"	50

Retrieving the most active player from team two

This is achieved by summing the weight of each player in team two, ordering the resultant data in descending order and displaying only one player, that being the player with the highest total passes.

Cypher Query

```
MATCH p=(n)-[r:PASSEDT0]->() WHERE n.teamId=2 RETURN n.name,SUM(r.weight) AS totalPasses ORDER BY totalPasses DESC LIMIT 1
```

Results:

```
neo4j$ MATCH p=(n)-[r:PASSEDT0]->() WHERE n.teamId=2 RETURN n.name,SUM(r.weight) AS totalPasses ORDE...
```

	n.name	totalPasses
1	"Frenkie de Jong"	81

Started streaming 1 records after 3 ms and completed after 9 ms.

3.2 Which players have an intermediary role (list the top 3 per team)? (10 marks)

Retrieving the top three players which have an intermediary role in team one.

This is achived by summing the total number of passes given and recieved for each player and then ordering the returned list of players in descending order and displaying the top three.

Cypher Query

```
CALL {
MATCH (n:Player)-[r:PASSEDT0]->(m:Player)
WHERE n.teamId=1
WITH n, sum(r.weight) AS playerWeight
ORDER BY playerWeight DESC
RETURN collect(n.name) AS MostActivePlayer, playerWeight AS NumberOfPasses
UNION ALL
MATCH (n:Player)-[r:PASSEDT0]->(m:Player)
WHERE n.teamId=1
WITH m, sum(r.weight) AS playerWeight
ORDER BY playerWeight DESC
RETURN collect(m.name) AS MostActivePlayer, playerWeight AS NumberOfPasses
}
RETURN MostActivePlayer, sum(NumberOfPasses) AS totalPasses
ORDER BY totalPasses DESC
LIMIT 3
```

Results:

```
neo4j$ CALL { MATCH (n:Player)-[r:PASSEDT0]->(m:Player) WHERE n.teamId=1 WITH n, sum(r.weight) AS pl...
```

	MostActivePlayer	totalPasses
1	["Victor Ruiz Torre"]	93
2	["Aïssa Mandi"]	84
3	["José Andrés Guardado Hernández"]	70

Started streaming 3 records after 571 ms and completed after 599 ms.

Retrieving the top three players which have an intermediary role in team two.

This is achived by summing the total number of passes given and recieved for each player and then ordering the returned list of players in descending order and displaying the top three.

Cypher Query

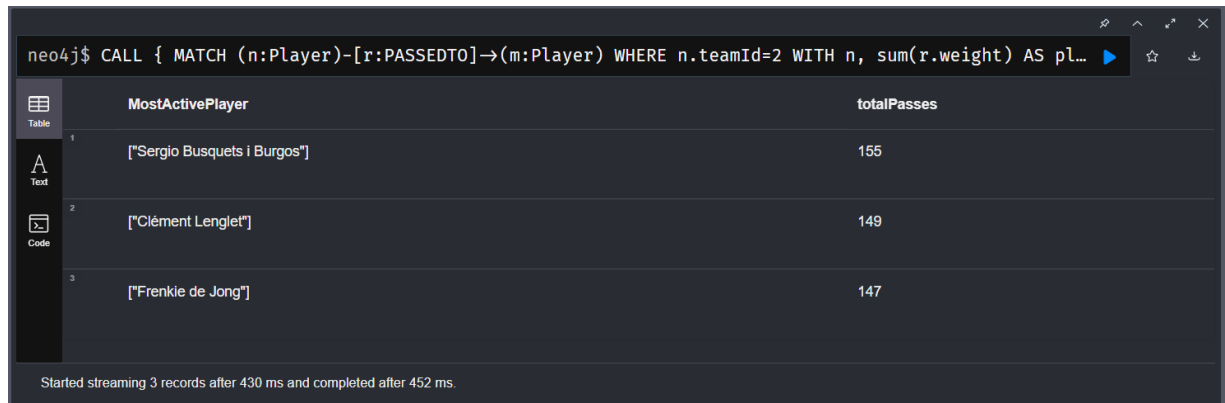
```
CALL {
MATCH (n:Player)-[r:PASSEDT0]->(m:Player)
WHERE n.teamId=2
WITH n, sum(r.weight) AS playerWeight
```

```

ORDER BY playerWeight DESC
RETURN collect(n.name) AS MostActivePlayer, playerWeight AS NumberOfPasses
UNION ALL
MATCH (n:Player)-[r:PASSEDTO]->(m:Player)
WHERE n.teamId=2
WITH m, sum(r.weight) AS playerWeight
ORDER BY playerWeight DESC
RETURN collect(m.name) AS MostActivePlayer, playerWeight AS NumberOfPasses
}
RETURN MostActivePlayer, sum(NumberOfPasses) AS totalPasses
ORDER BY totalPasses DESC
LIMIT 3

```

Results:



	MostActivePlayer	totalPasses
1	["Sergio Busquets i Burgos"]	155
2	["Clément Lenglet"]	149
3	["Frenkie de Jong"]	147

Started streaming 3 records after 430 ms and completed after 452 ms.

3.3 How central is a player? (10 marks)

Retrieving the list of players in conjunction with their level of centrality for team one.

This is achieved by summing the total number of relations that a player has with other players on the field. The more players that pass to or receive a pass from the player in question form a relation and the number of different relations determines a player's centrality.

Cypher Query

```

CALL {
MATCH (n:Player)-[r:PASSEDTO]->(m:Player)
WHERE n.teamId=1
WITH n, count(r) AS playerWeight
ORDER BY playerWeight DESC
RETURN n.name AS MostCentralPlayer, playerWeight AS totalInteractions
UNION ALL
MATCH (n:Player)-[r:PASSEDTO]->(m:Player)
WHERE n.teamId=1
WITH m, count(r) AS playerWeight
ORDER BY playerWeight DESC
RETURN m.name AS MostCentralPlayer, playerWeight AS totalInteractions
}
RETURN MostCentralPlayer, sum(totalInteractions) AS totalInteractions
ORDER BY totalInteractions DESC

```

Results:

neo4j\$ CALL { MATCH (n:Player)-[r:PASSEDTO]→(m:Player) WHERE n.teamId=1 WITH n, count(r) AS playerW... ▶ ☆ ↴

	MostCentralPlayer	totalInteractions
1	"Aïssa Mandi"	18
2	"Paul Edgar Akouokou"	18
3	"Nabil Fekir"	18
4	"Victor Ruiz Torre"	17
5	"José Andrés Guardado Hernández"	17
6	"Borja Iglesias Quintas"	17
7		

Started streaming 11 records after 2 ms and completed after 11 ms.

Retrieving the list of players in conjunction with their level of centrality for team two.

This is achieved by summing the total number of relations that a player has with other players on the field. The more players that pass to or receive a pass from the player in question form a relation and the number of different relations determines a player's centrality.

Cypher Query

```
CALL {
MATCH (n:Player)-[r:PASSEDTO]->(m:Player)
WHERE n.teamId=2
WITH n, count(r) AS playerWeight
ORDER BY playerWeight DESC
RETURN n.name AS MostCentralPlayer, playerWeight AS totalInteractions
UNION ALL
MATCH (n:Player)-[r:PASSEDTO]->(m:Player)
WHERE n.teamId=3
WITH m, count(r) AS playerWeight
ORDER BY playerWeight DESC
RETURN m.name AS MostCentralPlayer, playerWeight AS totalInteractions
}
RETURN MostCentralPlayer, sum(totalInteractions) AS totalInteractions
ORDER BY totalInteractions DESC
```

Results:

neo4j\$ CALL { MATCH (n:Player)-[r:PASSEDTO]→(m:Player) WHERE n.teamId=2 WITH n, count(r) AS playerW...

	MostCentralPlayer	totalInteractions
1	"Clément Lenglet"	20
2	"Ricard Puig Martí"	19
3	"Frenkie de Jong"	19
4	"Antoine Griezmann"	19
5	"Miralem Pjanić"	18
6	"Ousmane Dembélé"	18
7		

Started streaming 11 records after 253 ms and completed after 263 ms.

3.4 Who is the player that received the highest number of passes? (10 marks)

Retrieving the player that recieved the highest number of passes from team one.

This is achived by summing the weight of each player in team one, ordering the resultant data in descending order and displaying only one player, that being the player with the highest total recieved passes

Cypher Query.

MATCH p=()-[r:PASSEDTO]->(n) WHERE n.teamId=1 RETURN n.name,SUM(r.weight) AS totalPasses ORDER BY totalPasses DESC LIMIT 1

Results:

neo4j\$ MATCH p=()-[r:PASSEDTO]→(n) WHERE n.teamId=1 RETURN n.name,SUM(r.weight) AS totalPasses ORDE...

	n.name	totalPasses
1	"Borja Iglesias Quintas"	45

Started streaming 1 records after 5 ms and completed after 10 ms.

Retrieving the player that recieved the highest number of passes from team two.

This is achived by summing the weight of each player in team one, ordering the resultant data in descending order and displaying only one player, that being the player with the highest total recieved passes

Cypher Query.

MATCH p=()-[r:PASSEDTO]->(n) WHERE n.teamId=2 RETURN n.name,SUM(r.weight) AS totalPasses ORDER BY totalPasses DESC LIMIT 1

Results:

neo4j\$ MATCH p=()-[r:PASSEDT0]→(n) WHERE n.teamId=2 RETURN n.name,SUM(r.weight) AS totalPasses ORDE... ▶ ☆ ↴

Table

Text

Code

	n.name	totalPasses
1	"Sergio Busquets i Burgos"	78

Started streaming 1 records after 2 ms and completed after 7 ms.