Graph Analytics

Modeling Chat Data using a Graph Data Model

The graph model illustrates the dynamics of chat interaction between 'Catch the Pink Flamingo' users. A user of a team can create a chat-session, where other users on the same team are free to join and subsequently leave. Interaction is initiated when a user creates a post (also known as chat-item), to which other users can reply to with their own chat-item, or simply mention it as a quick reply. Such posts are linearly linked to one another as a response, and all of these posts are part of the same team chat-session. All relationships between entities of this graph model are universally marked with a timestamp, while the entities are identified by a unique ID value.

Creation of the Graph Database for Chats

Describe the steps you took for creating the graph database. As part of these steps

i) **Schema of the 6 CSV files** as follows:

CSV file	Field	Description
chat_create_team_chat	user.id	User ID value
	team.id	Team ID value
	teamchatsession.id	ID value assigned to the chat-session
	timestamp	Date/time of creation of chat-session and ownership assignment of chat-session to team.
chat_join_team_chat	user.id	User ID value
	teamchatsession.id	Team chat-session ID value
	timestamp	Date/time of user joining team chat-session
chat_leave_team_chat	user.id	User ID value
	teamchatsession.id	Team chat-session ID value

	timestamp	Date/time of user leaving team chat-session
chat_item_team_chat	user.id	User ID value
	teamchatsession.id	Team chat-session ID value
	chatitem.id	Post ID value
	timestamp	Date/time of post creation by user and linking of post to team chat-session.
chat_mention_team_chat	chatitem.id	Post ID value
	user.id	User ID value
	timestamp	Date/time of user mentioning a particular post as a quick reply.
chat_respond_team_chat	chatitem.id	Post -1 ID value
	chatitem.id	Post-2 ID value
	timestamp	Date/time of post-1 created as a response to post-2

ii) Explain the loading process and include a sample LOAD command

When loading a CSV file, each row is parsed for extracting ID values to create nodes, and timestamp values to create edges. Consider the following load command:

```
LOAD CSV FROM "file:/chat_create_team_chat.csv" AS row
MERGE (u:User {id: toInt(row[0])})
MERGE (t:Team {id: toInt(row[1])})
MERGE (c:TeamChatSession  {id: toInt(row[2])})
MERGE (u)-[:CreatesSession{timeStamp: row[3]}]->(c)
MERGE (c)-[:OwnedBy{timeStamp: row[3]}]->(t)
```

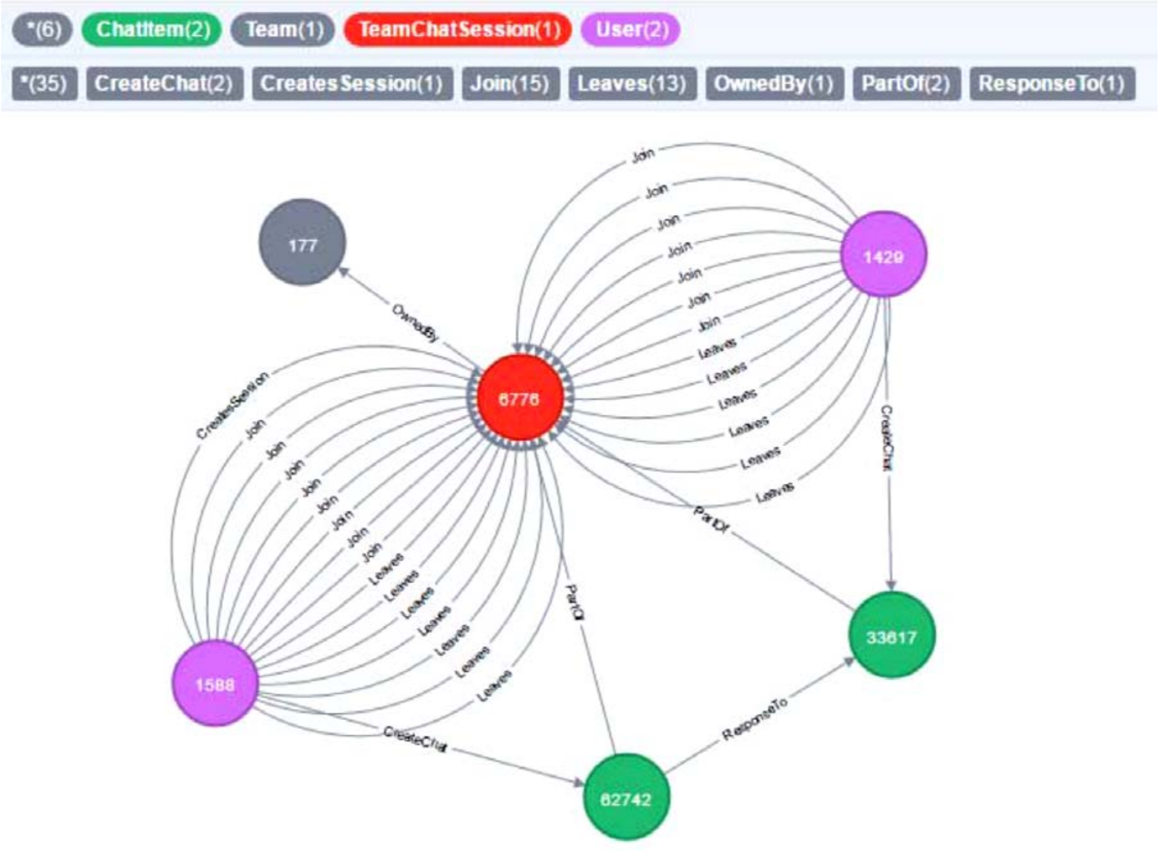
1st line loads the csv file from the specified location and parses each line as a 'row' variable. 2nd, 3rd and 4th lines create User, Team and TeamChatSession nodes, with respective ID values extracted from the 'row' tuple using index values in sequential notation. 4th and 5th lines create the CreatesSession and OwnedBy edges with respective timestamp values extracted in similar manner, to link up the nodes. The MERGE command used to create the node/edge if it does not exist in the graph, or merge the attributes into already existing nodes/edges.

iii) **Sample screenshot** of a part of the graph:

Query:

match
(u2:User)-[cc2:CreateChat]->ci2:ChatItem) <- [rt:ResponseTo]-(ci1:ChatItem)<-
[cc1:Create Chat]-(u1:User)-[cs:CreatesSession]->(tcs:TeamChatSession)-
[ob:OwnedBy]->(t:Team) return u2,cc2,ci2,rt,ci1,cc1,u1,cs,tcs,ob,t limit 1

Graph:



Finding the longest conversation chain and its participants

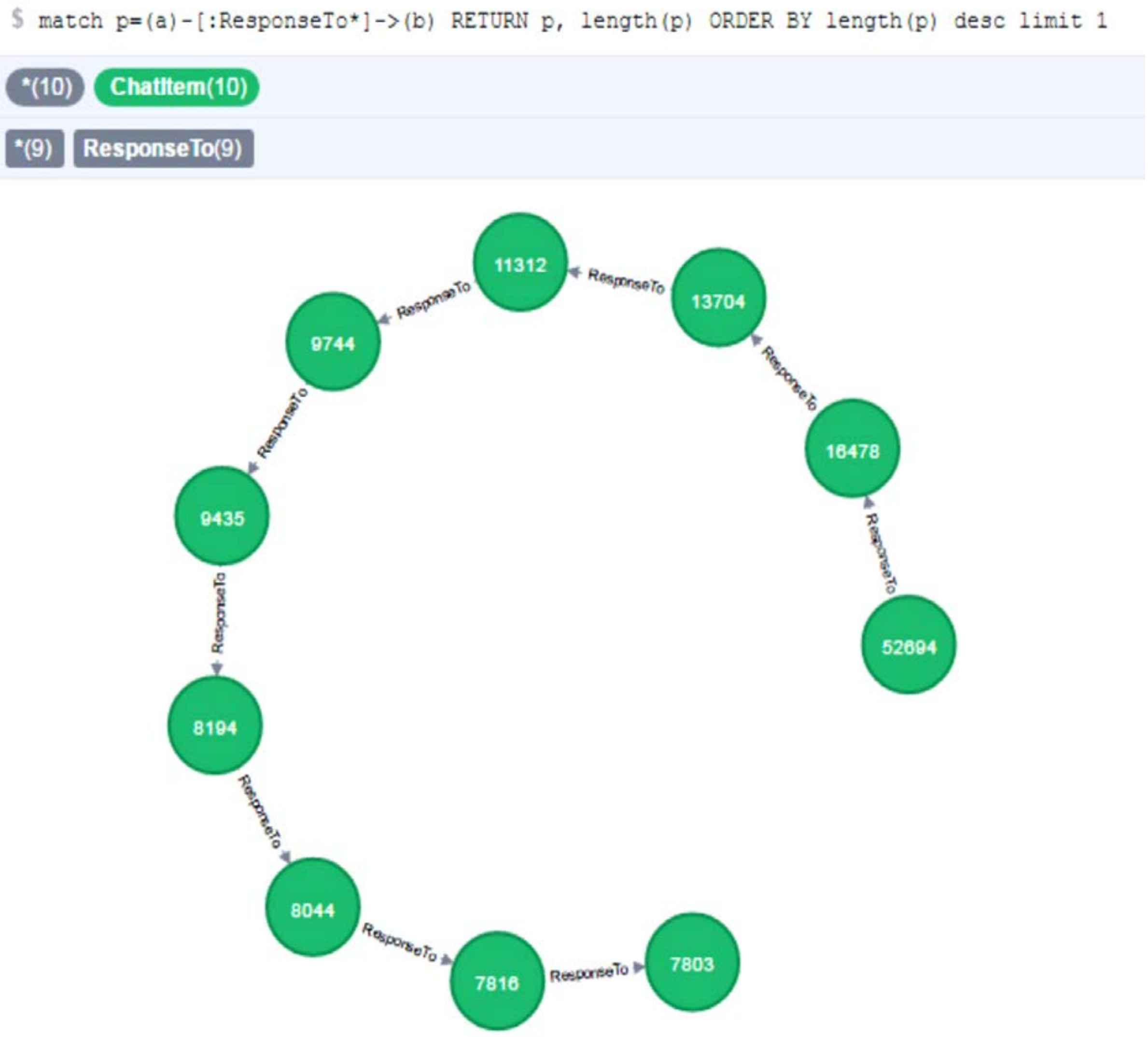
Longest conversation chain is traced via ChatItem nodes that are linked by ResponseTo edges. A logical chain would be to trace a set of nodes with edges going in the same direction, for the longest possible path.

Longest conversation chain has path length of 9, i.e. **<u>10</u> Chatitem nodes.**

Query:

```
match p=(a)-[:ResponseTo*]->(b)
RETURN p, length(p)
ORDER BY length(p) desc limit 1
```

Graph:

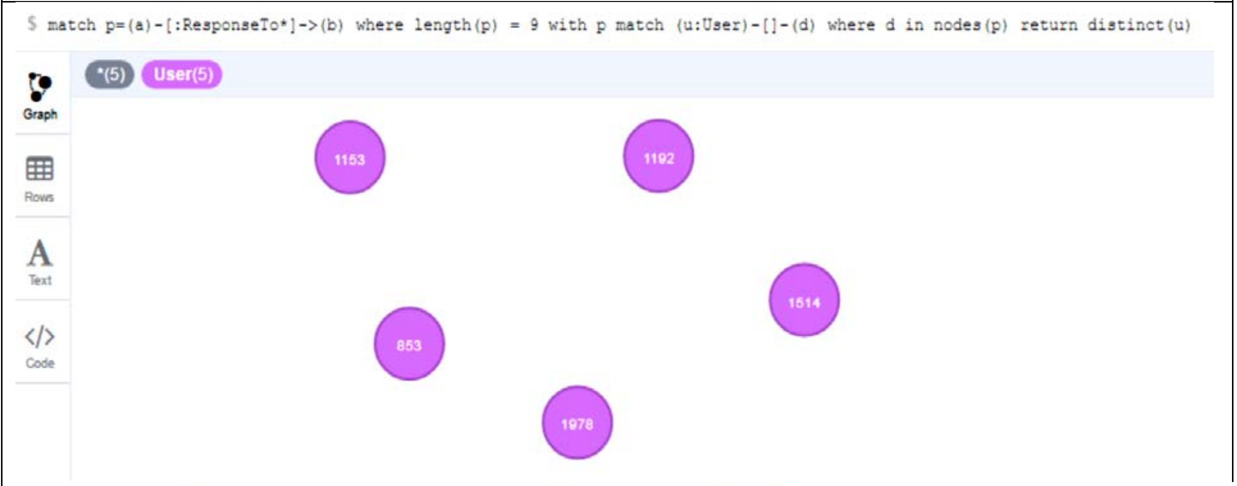


```
$ match p=(a)-[:ResponseTo*]->(b) RETURN p, length(p) ORDER BY length(p) desc limit 1
```

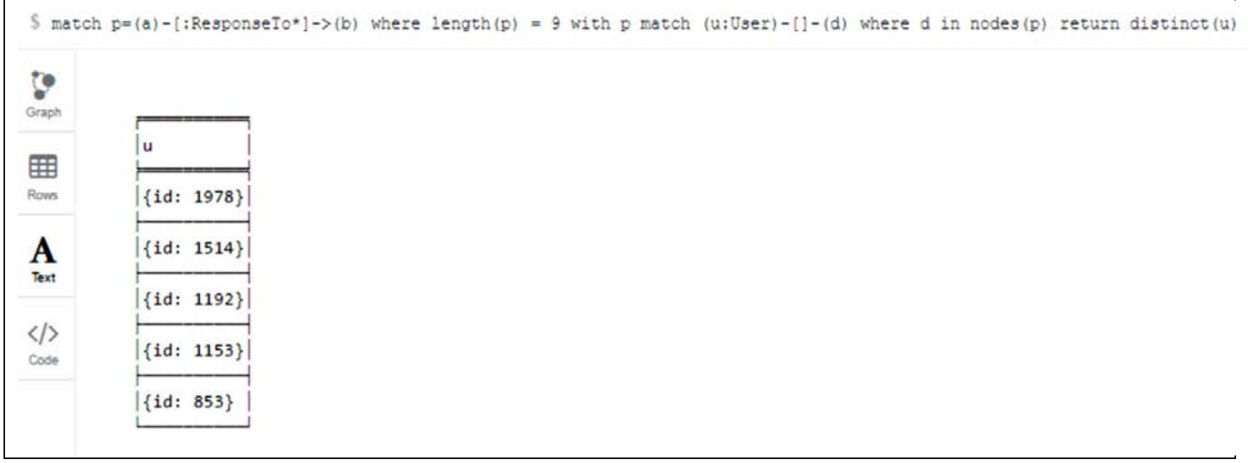
Now that the longest path has been determined to be 9, a subsequent query is used to find all the distinct users related to the 10 ChatItem nodes that are part this path. **5 unique users were extracted**.

Query:

```
match p=(a)-[:ResponseTo*]->(b)
where length(p) = 9
with p
match ( u:User)-[]-(d)
where d in nodes(p)
return distinct(u)
```



```
$ match p=(a)-[:ResponseTo*]->(b) where length(p) = 9 with p match (u:User)-[]-(d) where d in nodes(p) return distinct(u)
```



```
$ match p=(a)-[:ResponseTo*]->(b) where length(p) = 9 with p match (u:User)-[]-(d) where d in nodes(p) return distinct(u)
```

```
╒═══════════╕
│u          │
╞═══════════╡
│{id: 1978}│
├───────────┤
│{id: 1514}│
├───────────┤
│{id: 1192}│
├───────────┤
│{id: 1153}│
├───────────┤
│{id: 853} │
└───────────┘
```

Hence, the **number of chats** and **number of unique users** in the longest conversation chain are **10 and 5** respectively.

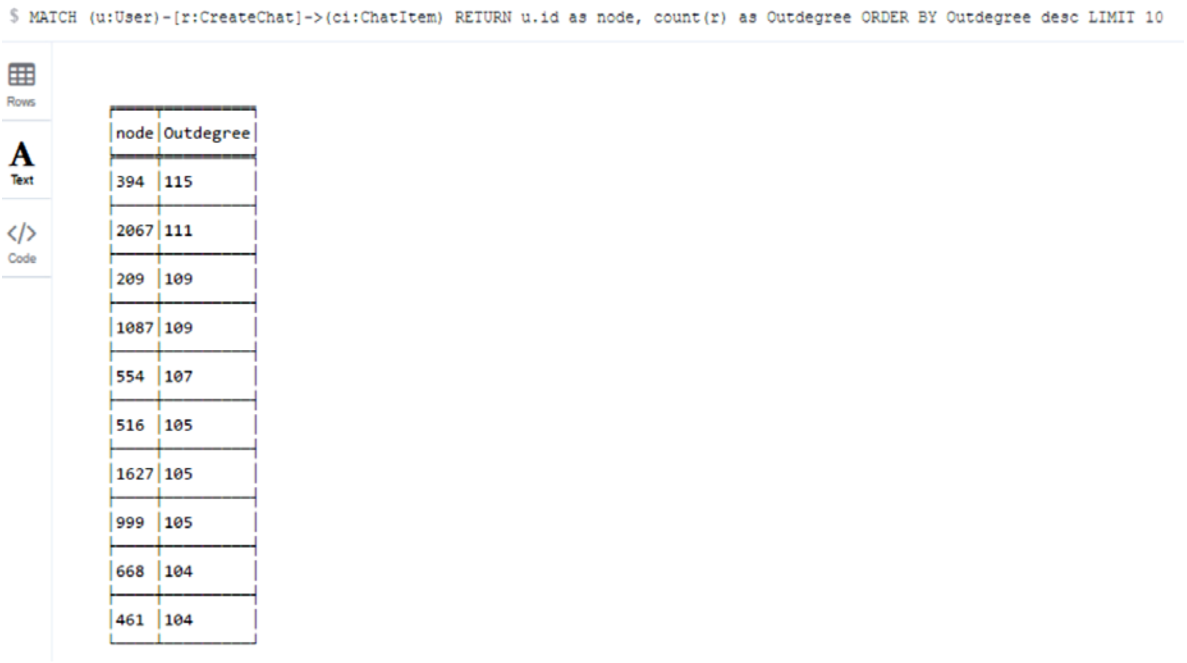
Analyzing the relationship between top 10 chattiest users and top 10 chattiest teams

We first match for directional CreateChat relationship from User node to ChatItem node, then count the relationship links between the 2 mentioned notes and subsequently return the sort list of user IDs, together with number of CreateChat edges (a.k.a out-degrees) that stem from them.

Query:

```
MATCH  (u:User)-[r:CreateChat]->( ci:ChatItem)
RETURN u.id as node, count(r) as Outdegree
ORDER BY Outdegree desc LIMIT 10
```

Graph:



```
$ MATCH (u:User)-[r:CreateChat]->(ci:ChatItem) RETURN u.id as node, count(r) as Outdegree ORDER BY Outdegree desc LIMIT 10
```

```
│node│Outdegree│
╞════╪═════════╡
│394 │115      │
├────┼─────────┤
│2067│111      │
├────┼─────────┤
│209 │109      │
├────┼─────────┤
│1087│109      │
├────┼─────────┤
│554 │107      │
├────┼─────────┤
│516 │105      │
├────┼─────────┤
│1627│105      │
├────┼─────────┤
│999 │105      │
├────┼─────────┤
│668 │104      │
├────┼─────────┤
│461 │104      │
└────┴─────────┘
```

Chattiest Users

Users	Number of Chats
394	115
2067	111
1087*	109
209*	109

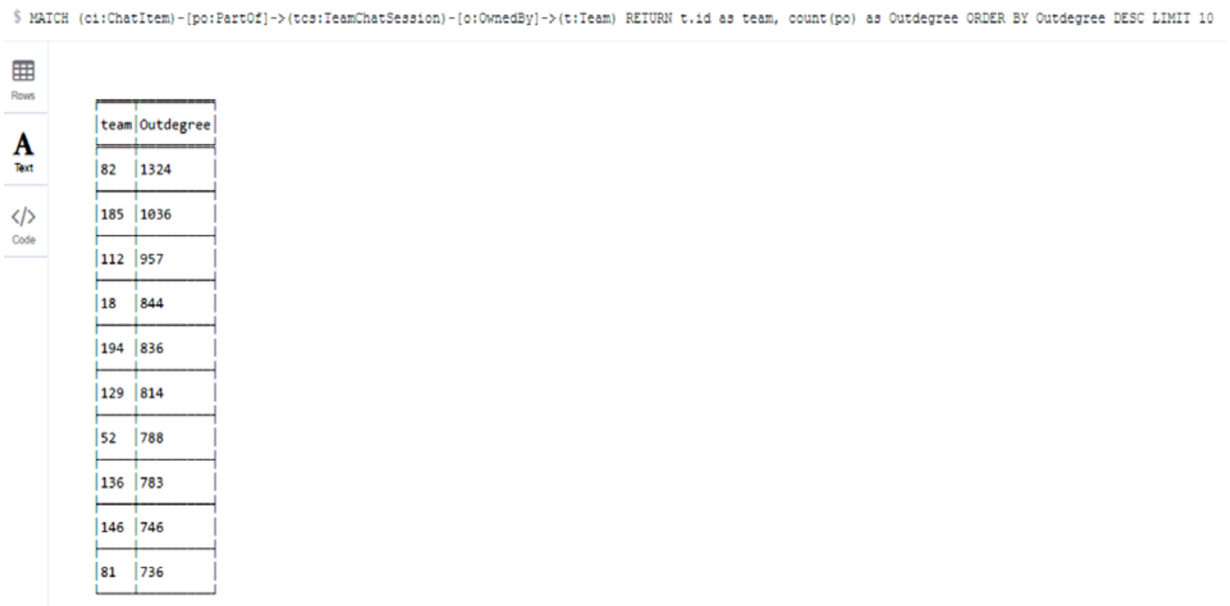
**A tie for 3rd placing between user 209 and 1087, both with 109 chatItems*

To find the chattiest teams, we match for all PartOf relationships linking Chatltem to TeamChatSession, where the latter is subsequently linked to a Team via Owned By relationship. Again we count the PartOf relationships for every TeamChatSession, isolate the top 10 with the highest numbers, then discover the Teams through the OwnedBy relationship.

Query:

```
MATCH (ci:Chatltem)-[po:PartOf]->(tcs:TeamChatSession)-[o:OwnedBy]->(t:Team)
RETURN t.id as team, count(po)  as Outdegree
ORDER  BY Outdegree DESC LIMIT 10
```

Graph:



```
$ MATCH (ci:ChatItem)-[po:PartOf]->(tcs:TeamChatSession)-[o:OwnedBy]->(t:Team) RETURN t.id as team, count(po) as Outdegree ORDER BY Outdegree DESC LIMIT 10
```

```
╒════╤═════════╕
│team│Outdegree│
╞════╪═════════╡
│82  │1324     │
├────┼─────────┤
│185 │1036     │
├────┼─────────┤
│112 │957      │
├────┼─────────┤
│18  │844      │
├────┼─────────┤
│194 │836      │
├────┼─────────┤
│129 │814      │
├────┼─────────┤
│52  │788      │
├────┼─────────┤
│136 │783      │
├────┼─────────┤
│146 │746      │
├────┼─────────┤
│81  │736      │
└────┴─────────┘
```

Chattiest Teams

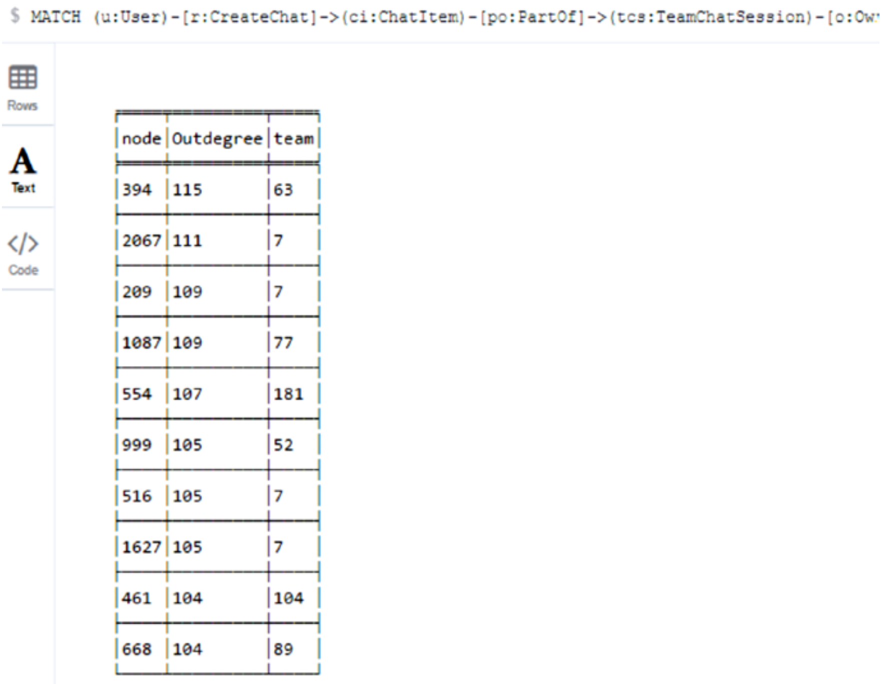
Teams	Number of Chats
82	1324
185	1036
112	957

We now modify our query for top 10 chattiest users to trace the users back to their respective team. This facilitates the investigation of whether the top 10 chattiest users reside within the top 10 chattiest teams.

Query:

```
MATCH
(u:User)-[r:CreateChat]->(ci:Chatltem)-[po:PartOf]->(tcs:TeamChatSession)-[o:OwnedBy]->(t:Team)
RETURN  u.id as node, count(r) as Outdegree, t.id as  team
ORDER  BY Outdegree desc LIMIT 10
```

Graph:



```
$ MATCH (u:User)-[r:CreateChat]->(ci:ChatItem)-[po:PartOf]->(tcs:TeamChatSession)-[o:Ow
```

```
╒════╤═════════╤════╕
│node│Outdegree│team│
╞════╪═════════╪════╡
│394 │115      │63  │
├────┼─────────┼────┤
│2067│111      │7   │
├────┼─────────┼────┤
│209 │109      │7   │
├────┼─────────┼────┤
│1087│109      │77  │
├────┼─────────┼────┤
│554 │107      │181 │
├────┼─────────┼────┤
│999 │105      │52  │
├────┼─────────┼────┤
│516 │105      │7   │
├────┼─────────┼────┤
│1627│105      │7   │
├────┼─────────┼────┤
│461 │104      │104 │
├────┼─────────┼────┤
│668 │104      │89  │
└────┴─────────┴────┘
```

As shown above, 9 out of 10 users hail from teams that are not part of the top 10 chattiest teams list. **The only exception is user ID:999 (6th chattiest user) belonging to Team ID:52 (7th exception is the chattiest team**.

Hence, it can also be concluded that the chattiest users do not usually hail from the chattiest teams.

How Active Are Groups of Users?

Activity is defined as user interacting with each other, i.e. 2 user nodes connected to each other via an edge for this definition to hold true. Given the present graph, we can connect 2 users in this manner based on either of the 2 following conditions:

1) User A is interacting with User B if A creates a ChatItem that B mentions, and both A and B are not referring to the same person. The following query creates the edge fulfilling this condition:

```
MATCH {u1:User)-[cc:CreateChat]->(ci:ChatItem)-[m:Mentioned]->(u2
:User) WHERE u1.id <> u2.id
MERGE (u1)-{:InteractsWith]->(u2)
```

2) User A is interacting with User B if A creates a ChatItem that is in response to a ChatItem that B has created on, and both A and B are not referring to the same person. The following query creates the edge fulfilling this condition:

```
MATCH
(u1:User)-[eel :CreateChat]->( cil:ChatItem)-[ rt:Response To]-
>(ci2:ChatItem)<-[ cc2:CreateChat]-( u2:User)
WHERE ul.id <> u2.id
MERGE {ul}-[:InteractsWith]->(u2}
```

Interactivity between 2 users is true if at any one ofthe above condition has been fulfilled at least once, hence the MERGE command is to ensure that at most 1*interactsWith* edge can be formulated between 2 separate User nodes.

Density of activity can be measured by the clustering coefficient of User nodes. For a User node *x* with outgoing edges connected to *k* other User nodes, these k nodes are known as *x's* neighbours, and the clustering coefficient of *x* is defined as the ratio of the total count of directed *InteractsWith* edges amongst neighbours themselves and the maximum possible number directed edges that could exists amongst themselves (which is (k * (k-1}} as the denominator).

Note:

A ratio value denotes that it can be between O and 1. A value of O means that either a node x has no neighbours, or only 1 neighbour, or have at least 2 neighbours but every neighbour is not connected to each other at all. A value of 1means that a node x has at least 2 neighbours and that every neighbour is bi-directionally connected to each other.

Based on the formula described above, the following query would calculate the Cluster Coefficient of a targeted node with id=123:

```
match (u1l:User { id:123 })-[iw1:InteractsWith]->(u2:User)
with collect(u2.id) as neighbours, count(u2} as k
match {u3:User)-[iw2:InteractsWith]->(u4:User)
where {u3.id in (neighbours)) and (u4.id in (neighbours)) and {u3.id <> u4.id}
with count(iw2} as numerator,  (k * (k - 1) * 1.0) as denominator
return numerator/denominator as clusterCoefficient
```

The above query is subsequently used to calculate the Cluster Coefficient for the top 3 chattiest users.

Most Active Users (based on Cluster Coefficients)

User ID	**Coefficient**
209	0.95
554	0.904
1078	0.82

Cluster Coefficient could potentially serve as a yardstick for identifying high-roller chatty users with strong cliques, and subsequently target them for sharing their in-game purchases as a form of advertisement within Team Chat-sessions.