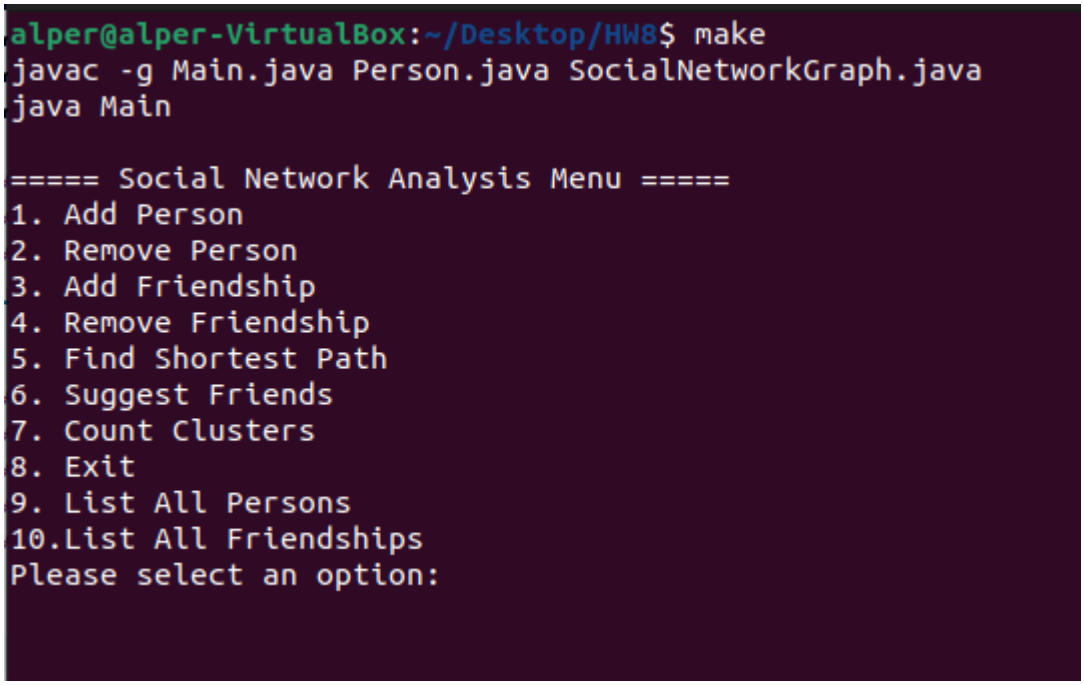
Alper Tavşanoğlu-210104004142-HW-8-Report

The purpose of this program is comprehensive implementation of a social network analysis system using graph data structures and algorithms. The objective is to simulate a social network and perform extensive analyses on the network, such as suggesting friends and counting clusters. Operations:



SocialNetworkGraph class provides functionalities for adding and removing people, establishing friendships, searching for the shortest path between two individuals, suggesting potential friends, and counting distinct clusters within the network. This implementation facilitates the study and analysis of social dynamics using graph theory principles.

Map<String, Person> to store individuals using a unique identifier.

Map<Person, List<Person>> to maintain friendships, representing an undirected graph.

Adding and Removing People

addPerson(String name, int age, List<String> hobbies): Adds a new person to the network. The method generates a unique key combining the person's name and their entry timestamp to ensure uniqueness.

removePerson(String name, LocalDateTime timestamp): Removes a person from the network using their name and exact timestamp, also cleaning up any associated friendships.

Adding and Removing Friendship

addFriendship(String name1, LocalDateTime timestamp1, String name2, LocalDateTime timestamp2): Establishes a friendship between two specified individuals if they exist in the network.

removeFriendship(String name1, LocalDateTime timestamp1, String name2, LocalDateTime timestamp2): Removes an existing friendship, if it exists.

And Other Important Methods

findShortestPath(String startName, LocalDateTime startTimestamp, String endName, LocalDateTime endTimestamp): Implements a Breadth-First Search (BFS) to find the shortest path between two individuals, useful for understanding connection depths.

suggestFriends(String name, LocalDateTime timestamp, int maxSuggestions): Suggests potential friends based on mutual friends and common hobbies, scored and sorted by relevance.

countClusters(): Uses BFS to determine and count distinct clusters or connected components within the network, providing insights into the overall network structure.

Helper Methods

createUniqueFriendshipKey(String name1, String name2): Generates a consistent and unique key for each friendship to manage and identify relationships uniquely regardless of the order of names.

ScoreDetail Class: Nested within SocialNetworkGraph, this helper class facilitates the scoring of potential friendships based on shared interests and mutual connections.

The SocialNetworkGraph class effectively models a social network using a graph-based approach, supporting a variety of operations crucial for social network analysis. Through careful implementation and data structures, this class provides a tool for simulating and analyzing interpersonal relationships and network dynamics.

Compile and Examples

First Option

For running the code we can use makefile directly. With **make** command program runs automaticly.

Second Option

Or without using makefile we can compile with these commads first **javac Main.java** and then **java Main** .

Makefile also have **make clean** command which removes everything except **java codes, PDF** and **makefile**. (for javadoc **make cleandoc**)

Makefile also have **make doc** command which generate javadoc.

Main.java | Makefile

```
JC = javac
JFLAGS = -g
TARGET = Main
SOURCES = Main.java Person.java SocialNetworkGraph.java
JD = javadoc
JDFLAGS = -protected -splitindex -use -author -version -d ./javadoc

default: $(TARGET)

$(TARGET): $(SOURCES)
	$(JC) $(JFLAGS) $^
	java $(TARGET)

doc:
	$(JD) $(JDFLAGS) *.java

cleandoc:
	rm -r ./javadoc

cleanfile:
	rm *.txt

clean:
	rm -f *.class

.PHONY: clean default

```

Examples on next page

Manuel Terminal Examples

Add Person

```
alper@alper-VirtualBox:~/Desktop/HW8$ make
javac -g Main.java Person.java SocialNetworkGraph.java
java Main

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 1
Enter name: Alper Tavsanoglu
Enter age: 24
Enter hobbies (comma-separated): coding,swimming,football
Person added: Alper Tavsanoglu (Timestamp: 2024-05-29 13:52:01)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option:
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 1
Enter name: Kenan Kara
Enter age: 35
Enter hobbies (comma-separated): football,fishing
Person added: Kenan Kara (Timestamp: 2024-05-29 13:54:35)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option:
```

I added more person… (i added extra functionalty to see all persons because for adding friendshpi or other things program want input for timestamp.So with printing all persons easy to enter these information**)**

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Alper Tavsanoglu (Age: 24, Hobbies: [coding, swimming, football]) (Timestamp: 2024-05-29 13:52:01)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)
```

Add Friendship

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Alper Tavsanoglu (Age: 24, Hobbies: [coding, swimming, football]) (Timestamp: 2024-05-29 13:52:01)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 3
Enter first person's name: Alper Tavsanoglu
Enter first person's timestamp: 2024-05-29 13:52:01
Enter second person's name: Burcu Beyaz
Enter second person's timestamp: 2024-05-29 13:57:14
Friendship added between Alper Tavsanoglu and Burcu Beyaz
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Alper Tavsanoglu (Age: 24, Hobbies: [coding, swimming, football]) (Timestamp: 2024-05-29 13:52:01)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 3
Enter first person's name: Kenan Kara
Enter first person's timestamp: 2024-05-29 13:54:35
Enter second person's name: Ahmet Tek
Enter second person's timestamp: 2024-05-29 13:56:06
Friendship added between Kenan Kara and Ahmet Tek
```

I added more friendship… (i added extra functionalty to see all friendships**)**

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 10
Listing all friendships in the network

Kenan Kara is friends with Ahmet Tek
Kenan Kara is friends with Alper Tavsanoglu
Burcu Beyaz is friends with Alper Tavsanoglu

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option:
```

Find Shortest Path

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 5
Enter first person's name: Burcu Beyaz
Enter first person's timestamp: 2024-05-29 13:57:14
Enter second person's name: Kenan Kara
Enter second person's timestamp: 2024-05-29 13:54:35

Shortest path: Burcu Beyaz -> Alper Tavsanoglu -> Kenan Kara

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 5
Enter first person's name: Ahmet Tek
Enter first person's timestamp: 2024-05-29 13:56:06
Enter second person's name: Burcu Beyaz
Enter second person's timestamp: 2024-05-29 13:57:14

Shortest path: Ahmet Tek -> Kenan Kara -> Alper Tavsanoglu -> Burcu Beyaz

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option:
```

Suggest Friends

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Alper Tavsanoglu (Age: 24, Hobbies: [coding, swimming, football]) (Timestamp: 2024-05-29 13:52:01)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 6
Enter person's name: Burcu Beyaz
Enter person's timestamp: 2024-05-29 13:57:14
Enter maximum number of friends to suggest: 2
Suggested friends for Burcu Beyaz:
Kenan Kara (Score: 1.0, 1 mutual friends, 0 common hobbies)
Ahmet Tek (Score: 0.5, 0 mutual friends, 1 common hobbies)
```

For Suggest Score 0

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 6
Enter person's name: Buse Esra
Enter person's timestamp: 2024-05-29 13:57:33
Enter maximum number of friends to suggest: 2
No suggesting friend found.
```

Count Clusters (Even if a person has no friends, they get marked as visited and are included as a cluster of size one.)

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 7

Counting clusters in the social network...
Number of clusters found: 2

Cluster 1:
Kenan Kara
Ahmet Tek
Alper Tavsanoglu
Burcu Beyaz

Cluster 2:
Buse Esra

===== Social Network Analysis Menu =====
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 10
Listing all friendships in the network

Kenan Kara is friends with Ahmet Tek
Kenan Kara is friends with Alper Tavsanoglu
Burcu Beyaz is friends with Alper Tavsanoglu
```

Remove Person (when removed person automaticly removed from friendship. Also it important for clusters.)

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Alper Tavsanoglu (Age: 24, Hobbies: [coding, swimming, football]) (Timestamp: 2024-05-29 13:52:01)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 2
Enter name: Alper Tavsanoglu
Enter timestamp: 2024-05-29 13:52:01
Person removed: Alper Tavsanoglu (Timestamp: 2024-05-29 13:52:01)
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 10
Listing all friendships in the network

Kenan Kara is friends with Ahmet Tek
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 7

Counting clusters in the social network...
Number of clusters found: 3

Cluster 1:
Kenan Kara
Ahmet Tek

Cluster 2:
Buse Esra

Cluster 3:
Burcu Beyaz
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)
```

Remove Friendship

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 4
Enter first person's name: Kenan Kara
Enter first person's timestamp: 2024-05-29 13:54:35
Enter second person's name: Ahmet Tek
Enter second person's timestamp: 2024-05-29 13:56:06
Friendship removed between Kenan Kara and Ahmet Tek
```

So we have no more Friendship now

```
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Kenan Kara (Age: 35, Hobbies: [football, fishing]) (Timestamp: 2024-05-29 13:54:35)
Buse Esra (Age: 30, Hobbies: [cooking]) (Timestamp: 2024-05-29 13:57:33)
Ahmet Tek (Age: 20, Hobbies: [hiking, reading]) (Timestamp: 2024-05-29 13:56:06)
Burcu Beyaz (Age: 25, Hobbies: [singing, painting, reading]) (Timestamp: 2024-05-29 13:57:14)

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 7

Counting clusters in the social network...
Number of clusters found: 4

Cluster 1:
Kenan Kara

Cluster 2:
Buse Esra

Cluster 3:
Ahmet Tek

Cluster 4:
Burcu Beyaz
```

Auto Define Examples

In Main class i added demonstration data. We can also use automaticly added person informations.

```
/**
 * Initializes demonstration data in the social network.
 */
        private static void initializeDemoData() {
                LocalDateTime now = LocalDateTime.now();                                        // Predefined timestamps for consistency in demonstration
                // Adding some people for demonstration
                //      network.addPerson("Ali",24, Arrays.asList("cod"));
                //      network.addPerson("Alper Tavsan",24, Arrays.asList("coding", "hiking"));
                network.addPerson("John Doe", 25, Arrays.asList("reading", "hiking", "cooking"));
                network.addPerson("Jane Smith", 22, Arrays.asList("swimming", "cooking"));
                network.addPerson("Alice Johnson", 27, Arrays.asList("hiking", "painting"));
                network.addPerson("Bob Brown", 30, Arrays.asList("reading", "swimming"));
                network.addPerson("Emily Davis", 28, Arrays.asList("running", "swimming"));
                network.addPerson("Frank Wilson", 26, Arrays.asList("reading", "hiking"));
                // Add some friendships
                network.addFriendship("John Doe", now, "Jane Smith", now);
                network.addFriendship("John Doe", now, "Alice Johnson", now);
                network.addFriendship("Jane Smith", now, "Bob Brown", now);
                network.addFriendship("Emily Davis", now, "Frank Wilson", now);
                //      network.addFriendship("Alper Tavsan", now, "Bob Brown", now);
                //find shortest path
                //      network.findShortestPath("John Doe", now, "Alper Tavsan", now);
                network.findShortestPath("John Doe", now, "Bob Brown", now);
                network.countClusters();
        }
```

In Line 19 i comment it. We can use it with removing comment.

```
17          public static void main(String[] args) {
18
19                  //initializeDemoData();
20                  while (true) {
21                          displayMenu();
22                          String choice = scanner.nextLine().trim();
23                          switch (choice) {
24                                  case "1":
25                                          addPerson();
26                                  break;
27                                  case "2":
```

Example next page

```
alper@alper-VirtualBox:~/Desktop/HW8$ make
javac -g Main.java Person.java SocialNetworkGraph.java
java Main
Person added: John Doe (Timestamp: 2024-05-29 14:37:10)
Person added: Jane Smith (Timestamp: 2024-05-29 14:37:11)
Person added: Alice Johnson (Timestamp: 2024-05-29 14:37:11)
Person added: Bob Brown (Timestamp: 2024-05-29 14:37:11)
Person added: Emily Davis (Timestamp: 2024-05-29 14:37:11)
Person added: Frank Wilson (Timestamp: 2024-05-29 14:37:11)
Friendship added between John Doe and Jane Smith
Friendship added between John Doe and Alice Johnson
Friendship added between Jane Smith and Bob Brown
Friendship added between Emily Davis and Frank Wilson

Shortest path: John Doe -> Jane Smith -> Bob Brown

Counting clusters in the social network...
Number of clusters found: 2

Cluster 1:
Emily Davis
Frank Wilson

Cluster 2:
Bob Brown
Jane Smith
John Doe
Alice Johnson

===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 10
Listing all friendships in the network

Jane Smith is friends with John Doe
Jane Smith is friends with Bob Brown
Alice Johnson is friends with John Doe
Frank Wilson is friends with Emily Davis
```

```
===== Social Network Analysis Menu =====
1. Add Person
2. Remove Person
3. Add Friendship
4. Remove Friendship
5. Find Shortest Path
6. Suggest Friends
7. Count Clusters
8. Exit
9. List All Persons
10.List All Friendships
Please select an option: 9
Listing all persons in the network:
Emily Davis (Age: 28, Hobbies: [running, swimming]) (Timestamp: 2024-05-29 14:37:11)
Bob Brown (Age: 30, Hobbies: [reading, swimming]) (Timestamp: 2024-05-29 14:37:11)
Alice Johnson (Age: 27, Hobbies: [hiking, painting]) (Timestamp: 2024-05-29 14:37:11)
John Doe (Age: 25, Hobbies: [reading, hiking, cooking]) (Timestamp: 2024-05-29 14:37:10)
Frank Wilson (Age: 26, Hobbies: [reading, hiking]) (Timestamp: 2024-05-29 14:37:11)
Jane Smith (Age: 22, Hobbies: [swimming, cooking]) (Timestamp: 2024-05-29 14:37:11)
```