Overview of the data structure:

* ride\_id: Unique identifier for each ride
* rideable\_type: The type of bike used for the ride (classic bike, electric bike, etc.)
* started\_at: Start date and time of the ride
* ended\_at: End date and time of the ride
* start\_station\_name: Name of the starting station
* start\_station\_id: Unique identifier for the starting station
* end\_station\_name: Name of the ending station
* end\_station\_id: Unique identifier for the ending station
* start\_lat, start\_lng: Latitude and longitude of the start station
* end\_lat, end\_lng: Latitude and longitude of the end station
* member\_casual: Type of user (member or casual)

**A. Community Structure and Network Resilience**

**Objective**: This analysis aims to understand how the intrinsic community structures within the bike-sharing network—clusters of stations that exhibit more frequent interactions among themselves than with other parts of the network—affect its overall resilience.

**Approach**:

1. **Network Construction**: Create a graph where nodes represent the bike stations and edges represent trips between these stations. The weight of an edge could reflect the volume of trips, indicating the strength of the connection between stations.
2. **Community Detection**: Use community detection algorithms (such as modularity optimization, Girvan-Newman algorithm, or Louvain method) to identify clusters or communities within the network. These communities are characterized by higher intra-community connectivity compared to inter-community connections.
3. **Resilience Analysis**: Evaluate the network's resilience by simulating the removal of nodes (stations) or edges (trips) from the network. This can be done in two ways:
   * **Random Failures**: Randomly remove nodes or edges and assess the impact on network connectivity and the size of the largest connected component.
   * **Targeted Attacks**: Remove nodes or edges based on certain criteria (e.g., highest degree, betweenness centrality) and observe the effects on network resilience.
4. **Community Role**: Analyze how the removal of stations within a single community versus across different communities affects the overall network structure. Investigate whether certain communities serve as critical bridges or bottlenecks for network connectivity.

**Expected Insights**:

* Identify key communities within the bike-sharing network that are crucial for maintaining system-wide connectivity.
* Understand the role of community structures in absorbing disruptions and maintaining service continuity.
* Develop strategies for strengthening weak links between communities to enhance network resilience.