5.7 My Visualization Project - Tree and Network Visualizations

Fire Impact Network   
A group of colored lines

Description automatically generated  
  
 **Description:**

This image represents a **network visualization of California State fires**, showing the **interconnectedness of various fire incidents**. The **color-coded clusters** indicate different **regions or types of fires**, while the **node sizes represent the intensity or spread of fires**. The **denser clusters** (e.g., the red region) likely correspond to **areas with frequent wildfires**, whereas the **sparser green sections** might indicate **less impacted zones**. The **edges (connections between nodes)** may represent **fire spread patterns, geographic proximity, or common causes**.

Fire Incident Clustering Based on Impact & Severity  
A colorful circles and dots

Description automatically generated  
  
 **Description:**

This visualization appears to be a **cluster-based representation of fire incidents**, where **node size represents severity** (e.g., acres burned, damage cost), and **color represents different categories** (e.g., residential fires, forest fires, industrial fires). Larger nodes indicate **major fire incidents**, while smaller nodes represent **minor but frequent incidents**. The **edges between nodes** may suggest **fire incidents that share common causes or characteristics**.

Part 1: Network Analysis Deep Dive

Stakeholder Network Needs:

* Important Relationship Patterns: Government agencies (CAL FIRE, USFS), emergency responders, researchers, and local communities focus on fire spread patterns, affected regions, and response coordination.
* Interaction with Network Data: Emergency responders need real-time fire spread and connectivity between regions, policymakers require historical trends and high-risk zones, and researchers analyze climate-related fire propagation factors.
* Insights from Networks: Networks help users visualize how wildfires spread, identify critical risk zones, and optimize emergency response pathways.

Data Assessment:

* Network Type: A geospatial-temporal graph network, representing fire spread and connectivity between different fire-prone areas.
* Nodes: Represent fire events or geographical locations; variables include fire intensity, burn area, date, and location.
* Edges: Represent fire spread or relationship between fire events; attributes include wind speed, topography influence, and proximity to other fires.
* Relationships Representation: Fire events are linked based on geospatial proximity, historical patterns, and meteorological conditions.
* Data Format: Fire data is in CSV, GeoJSON, and shapefiles, compatible with Gephi.
* Key Metrics:
  + Degree Centrality: Identifies key fire clusters.
  + Betweenness Centrality: Highlights critical zones for fire containment.
  + Clustering Coefficient: Reveals high-risk interconnected areas.
  + Modularity Analysis: Identifies fire-prone community structures.
* Data Integration: Connects with weather datasets, vegetation data, emergency response records, and satellite imagery.

Initial Design Exploration:

1. Fire Spread Network: Nodes as fire incidents, edges showing fire spread probability based on wind and topography.
2. Resource Allocation Network: Nodes as emergency response stations, edges as response routes, optimizing evacuation and firefighting resource placement.

* Design Rationale: One visualization focuses on fire behavior, the other on response efficiency.
* Sketches:
  + Fire Spread: Uses a force-directed layout with heatmap overlays.
  + Resource Allocation: A geographical network with weighted edges representing response times.

Part 2: AI-Assisted Design Process

AI Interactions Documentation:

* AI Model Used: ChatGPT-4, OpenAI (Feb 2025) for network modeling assistance.
* Prompts Used:
  1. "How to visualize California wildfire spread as a network in Gephi?"
  2. "What network metrics are useful for fire risk analysis?"
  3. "Suggest two different network visualizations for wildfire response planning."
* Prompt Strategy: Focused on fire dynamics, response planning, and geospatial analytics to tailor AI recommendations.

Implementation Plan:

* Tools Selected: Gephi for visualization, Python (NetworkX) for pre-processing, QGIS for geospatial data handling.
* Interactive Features:
  + Node filters to highlight active vs. historical fires.
  + Edge adjustments based on real-time weather data.
  + Clickable nodes for detailed fire event information.
* Data Preparation:
  + Cleaning: Removing redundant data points, handling missing values.
  + Standardization: Normalizing fire severity metrics.
* Handling Data Quality Issues: Cross-referencing satellite data with official CAL FIRE records.

Evaluation of AI Suggestions:

* Helpful Suggestions: Use of clustering coefficient for high-risk areas and weighted edges for fire spread probability.
* Limitations Encountered: AI lacked real-time GIS integration insights.
* Modifications Made: Combined AI suggestions with manual geospatial analysis.
* Best Practices Overlooked by AI: AI didn’t account for temporal fire evolution, which was corrected by implementing time-stamped edge weights.

This structured approach ensures an effective wildfire network visualization that aids policy decisions, emergency response, and future fire mitigation strategies.