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In [1]: import networkx as nx
import matplotlib.pyplot as plt
from itertools import combinations
# Function to calculate Jaccard similarity
def jaccard_similarity(set1, set2):
    intersection = len(set1.intersection(set2))
    union = len(set1.union(set2))
    return intersection / union if union > 0 else 0

# Define the Topics dictionary
topics = {
    'A2': ['resource', 'environmental', 'human', 'concept', 'allocation', 'security', 'closed', 'natural', 'recyclable'],
    'A4': ['adaptation', 'climate', 'disaster', 'change', 'assessment', 'risk', 'hazard', 'local', 'natural'],
    'A6': ['land', 'rice', 'model', 'change', 'production', 'paddy', 'map', 'scenario', 'future'],
    'A3': ['program', 'education', 'course', 'student', 'sustainability', 'curriculum', 'master', 'university', 'science'],
    'A8': ['reduction', 'emission', 'target', 'greenhouse', 'lowcarbon', 'company', 'country', 'global', 'society'],
    'A13': ['urban', 'city', 'environmental', 'transformation', 'ruralurban', 'sustainable', 'transition', 'economic', 'strate'],
    'A9': ['soil', 'carbon', 'organic', 'emission', 'management', 'sequestration', 'agriculture', 'ecosystem', 'greenhouse'],
    'A11': ['drought', 'region', 'intensity', 'index', 'impact', 'extreme', 'systemic', 'dynamic', 'west'],
    'A10': ['coastal', 'rise', 'sealevel', 'vulnerability', 'change', 'climate', 'century', 'coast', 'assessment'],
    'A14': ['innovation', 'transition', 'technology', 'design', 'society', 'industrial', 'system', 'pathway', 'sustainable'],
    'A7': ['water', 'lake', 'quality', 'pollution', 'forest', 'loss', 'fertilizer', 'nitrogen', 'sustainability'],
    'A5': ['desertification', 'livelihood', 'pressure', 'drylands', 'alternative', 'poverty', 'ecosystem', 'land', 'marginal'],
    'A1': ['sustainability', 'science', 'network', 'research', 'issue', 'society', 'cluster', 'paper', 'conference'],
    'A12': ['engineering', 'industrial', 'ecology', 'sustainable', 'education', 'competence', 'cultural', 'system', 'state'],
    'B1': ['sustainability', 'science', 'research', 'field', 'education', 'knowledge', 'collaboration', 'challenge', 'contribu'],
    'B3': ['adaptation', 'change', 'island', 'climate', 'community', 'risk', 'impact', 'beach', 'measure'],
    'B6': ['emission', 'cost', 'reduction', 'mitigation', 'power', 'curve', 'abatement', 'potential', 'country'],
    'B4': ['landscape', 'food', 'place', 'approach', 'relation', 'community', 'system', 'biodiversity', 'production'],
    'B9': ['vulnerability', 'hazard', 'assessment', 'risk', 'component', 'livelihood', 'exposure', 'method', 'change'],
    'B2': ['transdisciplinarity', 'process', 'project', 'type', 'knowledge', 'practice', 'mode', 'research', 'problem'],
    'B10': ['assessment', 'sustainability', 'system', 'impact', 'analysis', 'method', 'tool', 'discourse', 'decision'],
    'B15': ['energy', 'transition', 'degrowth', 'growth', 'cluster', 'intensity', 'consumption', 'electricity', 'initiative'],
    'B12': ['ecosystem', 'service', 'biodiversity', 'conservation', 'system', 'garden', 'area', 'activity', 'forest'],
    'B8': ['resilience', 'system', 'transformation', 'threshold', 'community', 'perturbation', 'management', 'concept', 'gover'],
    'B5': ['water', 'river', 'approach', 'resource', 'wastewater', 'flow', 'management', 'landuse', 'demand'],
    'B14': ['reuse', 'good', 'sale', 'model', 'market', 'book', 'wastewater', 'equipment', 'waste'],
    'B13': ['governance', 'dimension', 'sustainability', 'urbanization', 'integration', 'multiactor', 'risk', 'framework', 're'],
    'B7': ['rice', 'date', 'rate', 'yield', 'indicator', 'month', 'fertilization', 'district', 'planting'],

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'B11': ['city', 'region', 'consumption', 'farmer', 'production', 'adoption', 'government', 'policy', 'factor'],
'C2': ['research', 'transdisciplinary', 'project', 'knowledge', 'stakeholder', 'process', 'researcher', 'collaboration', '
'C4': ['climate', 'adaptation', 'change', 'risk', 'uncertainty', 'assessment', 'model', 'sensitivity', 'vulnerability'],
'C14': ['value', 'social', 'relational', 'valuation', 'intrinsic', 'individual', 'concept', 'economics', 'people'],
'C6': ['scenario', 'future', 'model', 'positive', 'population', 'alternative', 'land', 'ecosystem', 'change'],
'C15': ['sdgs', 'development', 'goal', 'sustainable', 'indicator', 'target', 'progress', 'national', 'implementation'],
'C1': ['sustainability', 'science', 'system', 'transition', 'digital', 'discipline', 'society', 'research', 'concept'],
'C7': ['water', 'governance', 'nexus', 'supply', 'management', 'resource', 'demand', 'system', 'decision'],
'C5': ['landscape', 'agroforestry', 'management', 'tree', 'conservation', 'system', 'mediterranean', 'land', 'policy'],
'C12': ['service', 'ecosystem', 'forest', 'capital', 'natural', 'assessment', 'biodiversity', 'payment', 'ecological'],
'C17': ['blue', 'growth', 'economy', 'fishery', 'degrowth', 'marine', 'coastal', 'smallscale', 'economic'],
'C20': ['place', 'meaning', 'sense', 'transformative', 'attachment', 'stewardship', 'transformation', 'narrative', 'transi
'C19': ['cultural', 'selection', 'multilevel', 'evolution', 'evolutionary', 'group', 'institution', 'grouplevel', 'resourc
'C18': ['indigenous', 'knowledge', 'science', 'local', 'community', 'western', 'river', 'traditional', 'protocol'],
'C8': ['food', 'household', 'security', 'consumption', 'production', 'crop', 'healthy', 'health', 'sustainable'],
'C9': ['delta', 'vulnerability', 'region', 'amazon', 'coastal', 'population', 'change', 'risk', 'flood'],
'C13': ['conflict', 'environmental', 'justice', 'movement', 'social', 'distribution', 'injustice', 'violence', 'metabolism
'C10': ['resilience', 'community', 'capital', 'social', 'natural', 'adaptive', 'disturbance', 'capacity', 'framework'],
'C11': ['urban', 'city', 'myth', 'public', 'citizen', 'data', 'governance', 'vision', 'experiment'],
'C3': ['education', 'future', 'program', 'competency', 'educational', 'student', 'curriculum', 'sustainable', 'practice'],
'C16': ['trap', 'human', 'socialecological', 'policy', 'system', 'response', 'dynamic', 'ecological', 'model'],
'D13': ['environmental', 'sustainability', 'impact', 'principle', 'sustainable', 'transition', 'social', 'consumption', 'p
'D9': ['food', 'diet', 'land', 'system', 'landuse', 'agricultural', 'pathway', 'biodiversity', 'emission'],
'D19': ['system', 'transformation', 'leverage', 'point', 'sustainability', 'inner', 'change', 'transformative', 'deep'],
'D2': ['knowledge', 'research', 'indigenous', 'coproduction', 'project', 'transdisciplinary', 'partnership', 'process', 'm
'D17': ['sdgs', 'goal', 'sustainable', 'target', 'tradeoff', 'synergy', 'indicator', 'interlinkages', 'data'],
'D5': ['forest', 'ecosystem', 'service', 'landscape', 'carbon', 'deforestation', 'plan', 'medium', 'enterprise'],
'D4': ['climate', 'change', 'adaptation', 'risk', 'resilience', 'response', 'impact', 'transformative', 'flood'],
'D14': ['governance', 'network', 'action', 'situation', 'power', 'actor', 'institutional', 'analysis', 'social'],
'D7': ['water', 'river', 'basin', 'irrigation', 'management', 'scarcity', 'economic', 'agricultural', 'resource'],
'D15': ['bioeconomy', 'discourse', 'transformation', 'growth', 'strategy', 'decolonial', 'economy', 'socioecological', 'al
'D6': ['scenario', 'future', 'land', 'basin', 'assessment', 'river', 'invasion', 'model', 'landuse'],
'D12': ['urban', 'city', 'expansion', 'community', 'land', 'different', 'smart', 'population', 'laboratory'],
'D10': ['community', 'capital', 'resilience', 'social', 'natural', 'disaster', 'local', 'human', 'resource'],
'D8': ['emission', 'carbon', 'energy', 'mitigation', 'cost', 'industry', 'reduction', 'sector', 'netzero'],
'D16': ['value', 'landscape', 'nature', 'relational', 'people', 'contribution', 'conservation', 'nonmaterial', 'life'],
'D11': ['nexus', 'peace', 'governance', 'resource', 'approach', 'scale', 'solution', 'challenge', 'indicator'],
'D3': ['competency', 'education', 'program', 'student', 'sustainability', 'university', 'learning', 'interdisciplinary', '
'D1': ['science', 'sustainability', 'research', 'researcher', 'problem', 'scientific', 'field', 'tension', 'method'],
'D18': ['crisis', 'covid19', 'pandemic', 'global', 'research', 'transformation', 'challenge', 'response', 'opportunity'],

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'D20': ['generation', 'future', 'narrative', 'intergenerational', 'imaginary', 'intervention', 'participatory', 'participa']
}
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In [2]: # Calculate Jaccard similarity between all topic pairs
topic_combinations = list(combinations(topics.keys(), 2))
similarity_scores = []
# Set a threshold to identify overlapping topics (adjust as needed)
threshold = 0.1

for topic1, topic2 in topic_combinations:
    # Check if the topics start with the same letter or are the same topic
    if topic1[0] != topic2[0] and topic1 != topic2:
        words1 = set(topics[topic1])
        words2 = set(topics[topic2])
        similarity = jaccard_similarity(words1, words2)
        if similarity > threshold:
            similarity_scores.append((topic1, topic2, similarity))

# Print similarity scores above the threshold
print("Similarity scores above the threshold:")
for topic1, topic2, similarity in similarity_scores:
    print(f"Jaccard similarity between {topic1} and {topic2}: {similarity:.4f}")
```

Similarity scores above the threshold:

Jaccard similarity between A2 and D10: 0.2000
Jaccard similarity between A4 and B3: 0.2857
Jaccard similarity between A4 and B9: 0.2857
Jaccard similarity between A4 and C4: 0.3846
Jaccard similarity between A4 and C12: 0.1250
Jaccard similarity between A4 and C9: 0.1250
Jaccard similarity between A4 and D4: 0.2857
Jaccard similarity between A4 and D10: 0.2000
Jaccard similarity between A6 and C4: 0.1250
Jaccard similarity between A6 and C6: 0.3846
Jaccard similarity between A6 and D6: 0.2857
Jaccard similarity between A3 and B1: 0.2000
Jaccard similarity between A3 and C1: 0.1250
Jaccard similarity between A3 and C3: 0.2857
Jaccard similarity between A3 and D3: 0.3846
Jaccard similarity between A3 and D1: 0.1250
Jaccard similarity between A8 and B6: 0.2000
Jaccard similarity between A8 and D8: 0.1250
Jaccard similarity between A13 and C20: 0.1250
Jaccard similarity between A13 and C11: 0.1250
Jaccard similarity between A13 and D13: 0.2000
Jaccard similarity between A13 and D15: 0.1250
Jaccard similarity between A13 and D12: 0.1250
Jaccard similarity between A9 and D5: 0.1250
Jaccard similarity between A9 and D8: 0.1250
Jaccard similarity between A10 and B3: 0.1250
Jaccard similarity between A10 and B9: 0.2000
Jaccard similarity between A10 and C4: 0.2857
Jaccard similarity between A10 and C9: 0.2000
Jaccard similarity between A10 and D4: 0.1250
Jaccard similarity between A14 and C1: 0.2000
Jaccard similarity between A14 and D13: 0.1250
Jaccard similarity between A14 and D9: 0.1250
Jaccard similarity between A5 and C6: 0.2000
Jaccard similarity between A1 and B1: 0.2000
Jaccard similarity between A1 and C1: 0.2857
Jaccard similarity between A1 and D1: 0.2000
Jaccard similarity between A12 and C3: 0.1250
Jaccard similarity between B1 and C2: 0.2000
Jaccard similarity between B1 and C1: 0.2000

Jaccard similarity between B1 and C18: 0.1250
Jaccard similarity between B1 and D2: 0.1250
Jaccard similarity between B1 and D3: 0.1250
Jaccard similarity between B1 and D1: 0.2857
Jaccard similarity between B1 and D18: 0.1250
Jaccard similarity between B3 and C4: 0.2857
Jaccard similarity between B3 and C9: 0.1250
Jaccard similarity between B3 and D4: 0.3846
Jaccard similarity between B6 and D8: 0.2857
Jaccard similarity between B4 and C5: 0.1250
Jaccard similarity between B4 and C8: 0.1250
Jaccard similarity between B4 and D9: 0.2000
Jaccard similarity between B9 and C4: 0.2857
Jaccard similarity between B9 and C9: 0.2000
Jaccard similarity between B9 and D4: 0.1250
Jaccard similarity between B2 and C2: 0.3846
Jaccard similarity between B2 and D2: 0.2857
Jaccard similarity between B2 and D1: 0.1250
Jaccard similarity between B10 and C1: 0.1250
Jaccard similarity between B10 and C7: 0.1250
Jaccard similarity between B10 and D13: 0.1250
Jaccard similarity between B10 and D19: 0.1250
Jaccard similarity between B10 and D1: 0.1250
Jaccard similarity between B15 and C17: 0.1250
Jaccard similarity between B15 and D13: 0.1250
Jaccard similarity between B12 and C5: 0.1250
Jaccard similarity between B12 and C12: 0.2857
Jaccard similarity between B12 and D9: 0.1250
Jaccard similarity between B12 and D5: 0.2000
Jaccard similarity between B8 and C1: 0.1250
Jaccard similarity between B8 and C7: 0.2000
Jaccard similarity between B8 and C5: 0.1250
Jaccard similarity between B8 and C10: 0.1250
Jaccard similarity between B8 and D19: 0.1250
Jaccard similarity between B8 and D10: 0.1250
Jaccard similarity between B5 and C7: 0.2857
Jaccard similarity between B5 and D7: 0.2857
Jaccard similarity between B5 and D6: 0.1250
Jaccard similarity between B5 and D11: 0.1250
Jaccard similarity between B11 and C8: 0.1250
Jaccard similarity between B11 and D13: 0.1250

Jaccard similarity between C2 and D2: 0.3846
 Jaccard similarity between C2 and D1: 0.2000
 Jaccard similarity between C4 and D4: 0.2857
 Jaccard similarity between C4 and D6: 0.1250
 Jaccard similarity between C14 and D16: 0.2000
 Jaccard similarity between C6 and D6: 0.2857
 Jaccard similarity between C6 and D12: 0.1250
 Jaccard similarity between C15 and D17: 0.3846
 Jaccard similarity between C1 and D13: 0.1250
 Jaccard similarity between C1 and D19: 0.1250
 Jaccard similarity between C1 and D1: 0.2000
 Jaccard similarity between C7 and D7: 0.2000
 Jaccard similarity between C7 and D11: 0.2000
 Jaccard similarity between C5 and D9: 0.1250
 Jaccard similarity between C5 and D16: 0.1250
 Jaccard similarity between C12 and D5: 0.2000
 Jaccard similarity between C12 and D10: 0.1250
 Jaccard similarity between C17 and D15: 0.1250
 Jaccard similarity between C20 and D19: 0.1250
 Jaccard similarity between C18 and D2: 0.1250
 Jaccard similarity between C18 and D10: 0.1250
 Jaccard similarity between C8 and D13: 0.1250
 Jaccard similarity between C9 and D4: 0.2000
 Jaccard similarity between C13 and D13: 0.1250
 Jaccard similarity between C10 and D10: 0.3846
 Jaccard similarity between C11 and D12: 0.1250
 Jaccard similarity between C3 and D3: 0.2857

```

In [3]: # Calculate Jaccard similarity between all topic pairs and obtain unique similarity scores
topic_combinations = list(combinations(topics.keys(), 2))
similarity_scores = []
threshold = 0.1

for topic1, topic2 in topic_combinations:
    if topic1[0] != topic2[0]: # Exclude pairs with the same first letter
        words1 = set(topics[topic1])
        words2 = set(topics[topic2])
        similarity = jaccard_similarity(words1, words2)
        if similarity > threshold:
            similarity_scores.append((topic1, topic2, similarity))
  
```

```

# Remove duplicate pairs
unique_similarity_scores = []
for score in similarity_scores:
    if (score[1], score[0], score[2]) not in unique_similarity_scores: # Check reverse pair as well
        unique_similarity_scores.append(score)

# Create a graph
G = nx.Graph()
for topic1, topic2, similarity in unique_similarity_scores:
    G.add_edge(topic1, topic2, weight=similarity)

# Draw the graph
pos = nx.spring_layout(G, seed=42)
edge_labels = {(u, v): f"{d['weight']:.2f}" for u, v, d in G.edges(data=True)}

node_colors = {'A': 'skyblue', 'B': 'magenta', 'C': 'lightgreen', 'D': 'lightcoral'}
colors = [node_colors[node[0]] for node in G.nodes()]

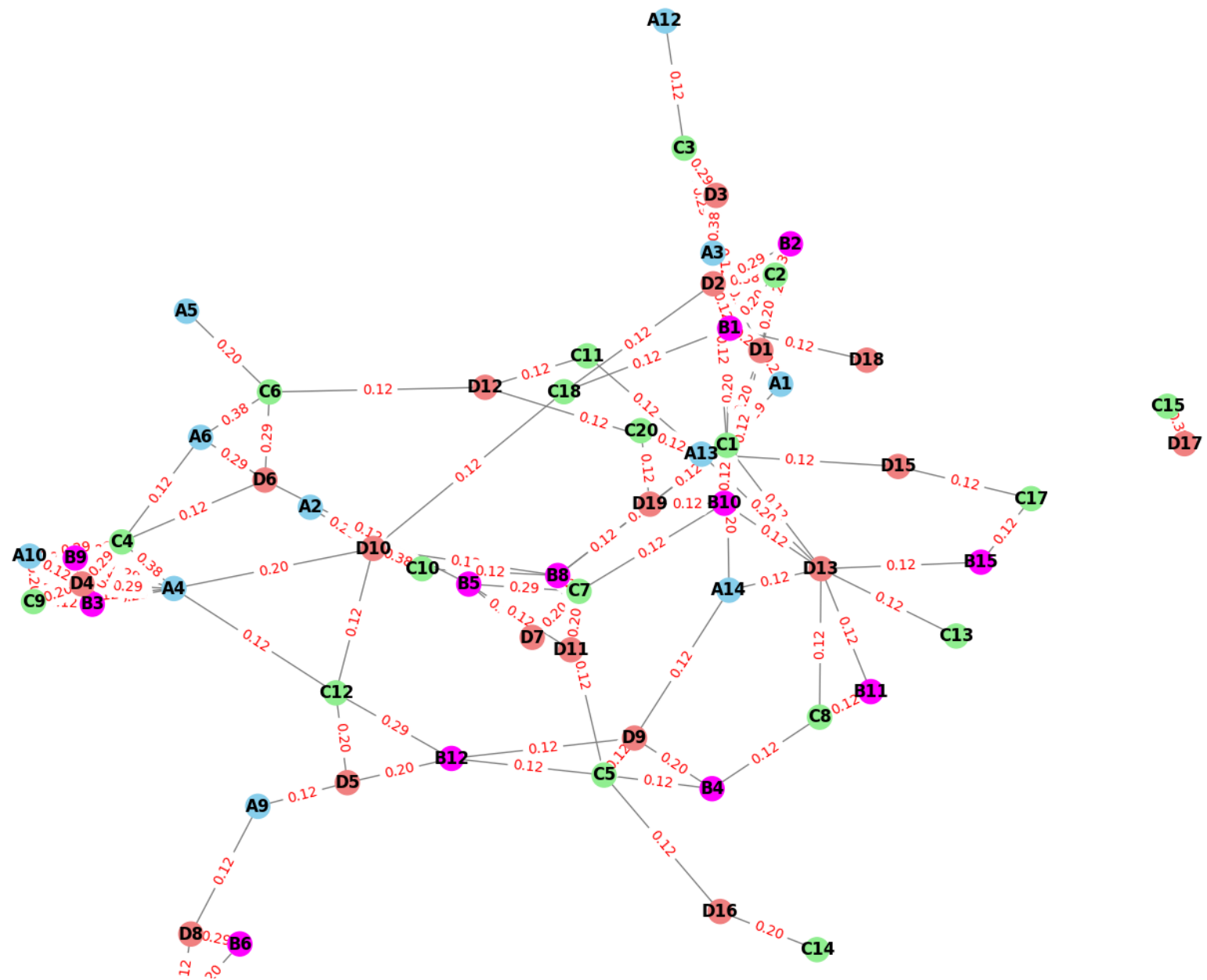
plt.figure(figsize=(14, 12))

nx.draw(G, pos, with_labels=True, font_weight='bold', node_color=colors, edge_color='gray')
nx.draw_networkx_edge_labels(G, pos, edge_labels=edge_labels, font_color='red')

plt.title("Topic Similarity Graph (Threshold = {})".format(threshold))
plt.show()

```

Topic Similarity Graph (Threshold = 0.1)





```
In [4]: # Calculate Jaccard similarity between all topic pairs
from itertools import combinations

topic_combinations = list(combinations(topics.keys(), 2))
similarity_scores = []
# Set a threshold to identify overlapping topics (adjust as needed)
threshold = 0.1

for topic1, topic2 in topic_combinations:
    # Check if the topics start with the same letter or are the same topic
    if topic1[0] != topic2[0] and topic1 != topic2:
        words1 = set(topics[topic1])
        words2 = set(topics[topic2])
        similarity = jaccard_similarity(words1, words2)
        if similarity > threshold:
            similarity_scores.append((topic1, topic2, similarity))

# Print similarity scores above the threshold
print("Similarity scores above the threshold:")
for topic1, topic2, similarity in similarity_scores:
    print(f"Jaccard similarity between {topic1} and {topic2}: {similarity:.4f}")

import networkx as nx
import matplotlib.pyplot as plt

# Create a graph
G = nx.Graph()
for topic1, topic2, similarity in similarity_scores:
    G.add_edge(topic1, topic2, weight=similarity)

# Draw the graph
pos = nx.spring_layout(G, seed=42) # Position nodes using the Fruchterman-Reingold force-directed algorithm
edge_labels = {(u, v): f"{d['weight']:.2f}" for u, v, d in G.edges(data=True)}
```

```
# Assign different node colors based on the first letter of topic codes
node_colors = {'A': 'skyblue', 'B': 'magenta', 'C': 'lightgreen', 'D': 'lightcoral'}
colors = [node_colors[node[0]] for node in G.nodes()]

# Increase the figure size
plt.figure(figsize=(10, 8))

nx.draw(G, pos, with_labels=True, font_weight='bold', node_color=colors, edge_color='gray')
# Uncomment the line below if you want to add edge labels
# nx.draw_networkx_edge_labels(G, pos, edge_labels=edge_labels, font_color='red')

plt.title("Topic Similarity Graph (Threshold = {}).format(threshold))
plt.show()
```

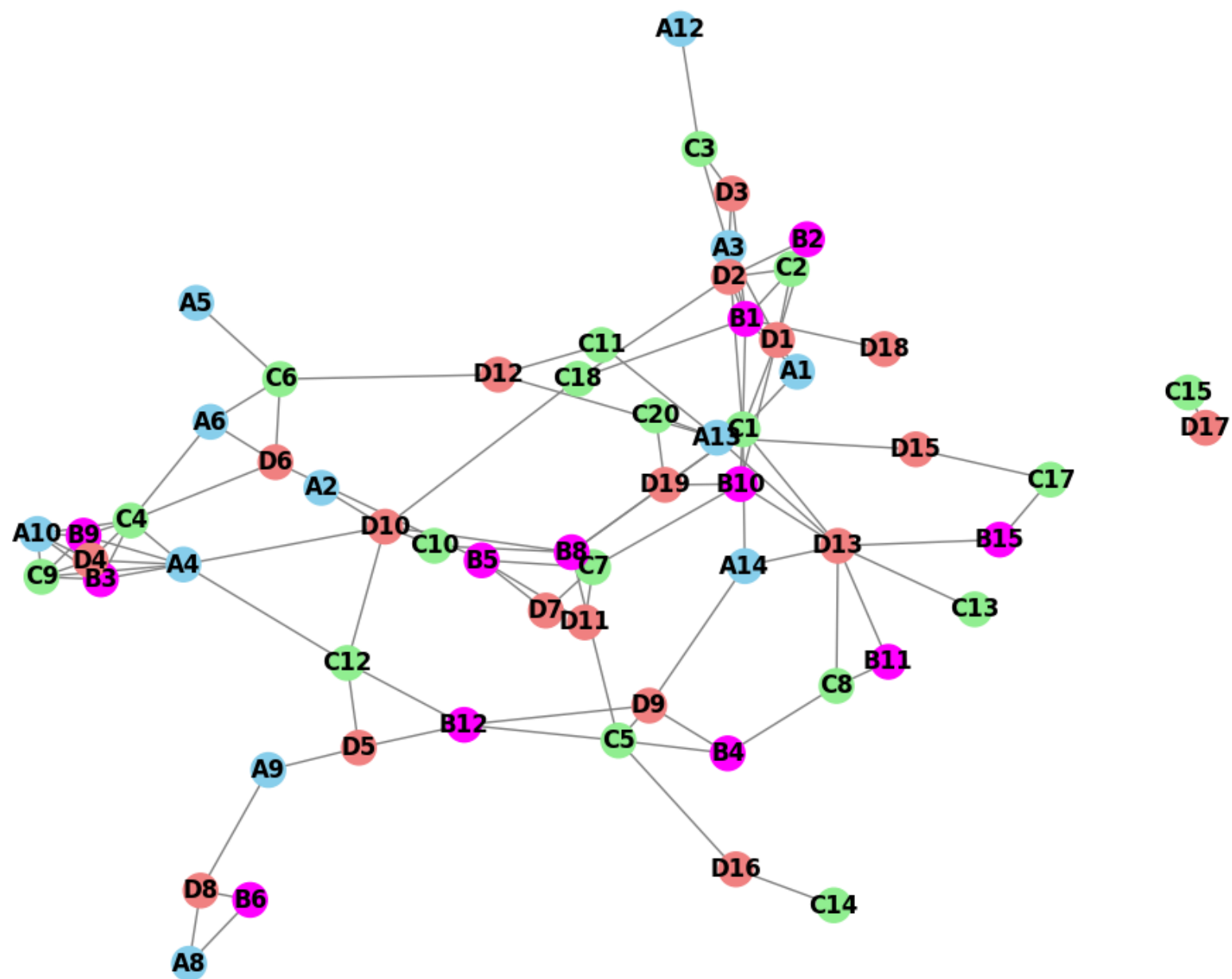
Similarity scores above the threshold:

Jaccard similarity between A2 and D10: 0.2000
Jaccard similarity between A4 and B3: 0.2857
Jaccard similarity between A4 and B9: 0.2857
Jaccard similarity between A4 and C4: 0.3846
Jaccard similarity between A4 and C12: 0.1250
Jaccard similarity between A4 and C9: 0.1250
Jaccard similarity between A4 and D4: 0.2857
Jaccard similarity between A4 and D10: 0.2000
Jaccard similarity between A6 and C4: 0.1250
Jaccard similarity between A6 and C6: 0.3846
Jaccard similarity between A6 and D6: 0.2857
Jaccard similarity between A3 and B1: 0.2000
Jaccard similarity between A3 and C1: 0.1250
Jaccard similarity between A3 and C3: 0.2857
Jaccard similarity between A3 and D3: 0.3846
Jaccard similarity between A3 and D1: 0.1250
Jaccard similarity between A8 and B6: 0.2000
Jaccard similarity between A8 and D8: 0.1250
Jaccard similarity between A13 and C20: 0.1250
Jaccard similarity between A13 and C11: 0.1250
Jaccard similarity between A13 and D13: 0.2000
Jaccard similarity between A13 and D15: 0.1250
Jaccard similarity between A13 and D12: 0.1250
Jaccard similarity between A9 and D5: 0.1250
Jaccard similarity between A9 and D8: 0.1250
Jaccard similarity between A10 and B3: 0.1250
Jaccard similarity between A10 and B9: 0.2000
Jaccard similarity between A10 and C4: 0.2857
Jaccard similarity between A10 and C9: 0.2000
Jaccard similarity between A10 and D4: 0.1250
Jaccard similarity between A14 and C1: 0.2000
Jaccard similarity between A14 and D13: 0.1250
Jaccard similarity between A14 and D9: 0.1250
Jaccard similarity between A5 and C6: 0.2000
Jaccard similarity between A1 and B1: 0.2000
Jaccard similarity between A1 and C1: 0.2857
Jaccard similarity between A1 and D1: 0.2000
Jaccard similarity between A12 and C3: 0.1250
Jaccard similarity between B1 and C2: 0.2000
Jaccard similarity between B1 and C1: 0.2000

Jaccard similarity between B1 and C18: 0.1250
Jaccard similarity between B1 and D2: 0.1250
Jaccard similarity between B1 and D3: 0.1250
Jaccard similarity between B1 and D1: 0.2857
Jaccard similarity between B1 and D18: 0.1250
Jaccard similarity between B3 and C4: 0.2857
Jaccard similarity between B3 and C9: 0.1250
Jaccard similarity between B3 and D4: 0.3846
Jaccard similarity between B6 and D8: 0.2857
Jaccard similarity between B4 and C5: 0.1250
Jaccard similarity between B4 and C8: 0.1250
Jaccard similarity between B4 and D9: 0.2000
Jaccard similarity between B9 and C4: 0.2857
Jaccard similarity between B9 and C9: 0.2000
Jaccard similarity between B9 and D4: 0.1250
Jaccard similarity between B2 and C2: 0.3846
Jaccard similarity between B2 and D2: 0.2857
Jaccard similarity between B2 and D1: 0.1250
Jaccard similarity between B10 and C1: 0.1250
Jaccard similarity between B10 and C7: 0.1250
Jaccard similarity between B10 and D13: 0.1250
Jaccard similarity between B10 and D19: 0.1250
Jaccard similarity between B10 and D1: 0.1250
Jaccard similarity between B15 and C17: 0.1250
Jaccard similarity between B15 and D13: 0.1250
Jaccard similarity between B12 and C5: 0.1250
Jaccard similarity between B12 and C12: 0.2857
Jaccard similarity between B12 and D9: 0.1250
Jaccard similarity between B12 and D5: 0.2000
Jaccard similarity between B8 and C1: 0.1250
Jaccard similarity between B8 and C7: 0.2000
Jaccard similarity between B8 and C5: 0.1250
Jaccard similarity between B8 and C10: 0.1250
Jaccard similarity between B8 and D19: 0.1250
Jaccard similarity between B8 and D10: 0.1250
Jaccard similarity between B5 and C7: 0.2857
Jaccard similarity between B5 and D7: 0.2857
Jaccard similarity between B5 and D6: 0.1250
Jaccard similarity between B5 and D11: 0.1250
Jaccard similarity between B11 and C8: 0.1250
Jaccard similarity between B11 and D13: 0.1250

Jaccard similarity between C2 and D2: 0.3846
Jaccard similarity between C2 and D1: 0.2000
Jaccard similarity between C4 and D4: 0.2857
Jaccard similarity between C4 and D6: 0.1250
Jaccard similarity between C14 and D16: 0.2000
Jaccard similarity between C6 and D6: 0.2857
Jaccard similarity between C6 and D12: 0.1250
Jaccard similarity between C15 and D17: 0.3846
Jaccard similarity between C1 and D13: 0.1250
Jaccard similarity between C1 and D19: 0.1250
Jaccard similarity between C1 and D1: 0.2000
Jaccard similarity between C7 and D7: 0.2000
Jaccard similarity between C7 and D11: 0.2000
Jaccard similarity between C5 and D9: 0.1250
Jaccard similarity between C5 and D16: 0.1250
Jaccard similarity between C12 and D5: 0.2000
Jaccard similarity between C12 and D10: 0.1250
Jaccard similarity between C17 and D15: 0.1250
Jaccard similarity between C20 and D19: 0.1250
Jaccard similarity between C18 and D2: 0.1250
Jaccard similarity between C18 and D10: 0.1250
Jaccard similarity between C8 and D13: 0.1250
Jaccard similarity between C9 and D4: 0.2000
Jaccard similarity between C13 and D13: 0.1250
Jaccard similarity between C10 and D10: 0.3846
Jaccard similarity between C11 and D12: 0.1250
Jaccard similarity between C3 and D3: 0.2857

Topic Similarity Graph (Threshold = 0.1)



```

In [7]: import plotly.graph_objects as go
import pandas as pd
# Sample data (replace this with your actual data)
data = [
    {'Source': 'A1 (Advancing sustainable science research) ', 'Target': 'B1 (Advancing sustainable science research) ', 'Value': 0.2000},
    {'Source': 'A1 (Advancing sustainable science research) ', 'Target': 'C1 (Advancing sustainable science research) ', 'Value': 0.2000},
    {'Source': 'A1 (Advancing sustainable science research) ', 'Target': 'D1 (Advancing sustainable science research)', 'Value': 0.2000},
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]

# Clean the 'Source' and 'Target' values by stripping spaces
for item in data:
    item['Source'] = item['Source'].strip()
    item['Target'] = item['Target'].strip()

```

```

# Define a default value for all links as a list
default_value = [0.1] * len(data)

# Define time periods and their positions
time_periods = {
    '2006-2010': ["A1 (Advancing sustainable science research)", "A2 (Coupled human and natural systems)", "A3 (Sustainability)", "A4 (Sustainable development)", "A5 (Sustainable consumption and production)"],
    '2011-2015': ["B1 (Advancing sustainable science research)", "B2 (Transdisciplinary knowledge development)", "B3 (Climate change)", "B4 (Sustainable consumption and production)", "B5 (Sustainable development)"],
    '2016-2020': ["C1 (Advancing sustainable science research)", "C2 (Transdisciplinary knowledge development)", "C3 (Sustainable consumption and production)", "C4 (Sustainable development)", "C5 (Sustainable consumption and production)"],
    '2021-2023': ["D1 (Advancing sustainable science research)", "D2 (Transdisciplinary knowledge development)", "D3 (Sustainable consumption and production)", "D4 (Sustainable development)", "D5 (Sustainable consumption and production)"]
}

# Create a DataFrame from the data
df = pd.DataFrame(data)

# Create nodes for all topics with custom font size and color
node_labels = []
node_dict = {}
node_colors = []

for topics in time_periods.values():
    node_labels.extend(topics)

for node_label in node_labels:
    node_dict[node_label] = len(node_dict)

    # Determine the node color based on the starting letter
    starting_letter = node_label[0]
    if starting_letter == 'A':
        node_colors.append('grey')
    elif starting_letter == 'B':
        node_colors.append('green')
    elif starting_letter == 'C':
        node_colors.append('purple')
    elif starting_letter == 'D':
        node_colors.append('red')

# Define x-locations based on the initial letter of the source
x_locations = {
    'A': 0, # Set 'A' to x-location 0
    'B': 1, # Set 'B' to x-location 1

```

```

    'C': 2, # Set 'C' to x-location 2
    'D': 3, # Set 'D' to x-location 3
}

# Modify the x-values for each node based on the initial letter of the source
x_values = [x_locations[node_label[0]] if node_label.strip() else -1 for node_label in node_labels]

# Create a color mapping dictionary based on the initial letter
color_mapping = {
    'A': 'Lavender',
    'B': 'Tan',
    'C': 'cyan',
    'D': 'cyan',
}

# Assign colors to the links based on the initial letter of the source node
link_colors = [color_mapping[node_label[0]] for node_label in df['Source']]

# Create a Sankey diagram with Plotly
fig = go.Figure(go.Sankey(
    node=dict(
        pad=25,
        thickness=30,
        line=dict(color="black", width=0.5),
        label=node_labels,
        x=x_values,
        color=node_colors,
    ),
    link=dict(
        source=[node_dict[item['Source']] for item in data],
        target=[node_dict[item['Target']] for item in data],
        value=default_value, # Use the updated default_value list
        color=link_colors # Use the corrected link_colors list
    )
))

# Set the node label size to 18, color to blue, and make it bold
fig.update_traces(
    textfont=dict(size=12, color="#00001C"),
)

```

```
# Customize the appearance of the Sankey diagram
fig.update_layout(
    title_text="Topic Evolution Sankey Diagram",
    xaxis=dict(
        title="Time Periods",
    ),
    height=1300, # Adjust the height as needed
)

# Show the Sankey diagram
fig.show()
```