

# Public Transport Network Analysis

July 14, 2020

## 1 Introduction

## 2 Data

The data are obtained from the paper named "A collection of public transport network data sets for 25 cities", where the authors incorporated 25 cities' public transport data from various sources which are openly available. They publish the data in different format including network edge lists, temporal network event lists, SQLite databases, GeoJSON files, and the GTFS data format. Different modes of public transport network datasets are available there e.g., rail, bus, subway, tram, ferry, walk etc.

## 3 Rail Network

Among 25 cities, 12 cities' rail network data are available.

Table 1: Network descriptions

City	# of nodes	# of edges
Adelaide	175	230
Berlin	204	507
Brisbane	297	382
Canberra	3	4
Dublin	102	185
Helsinki	75	119
Lisbon	65	136
Luxembourg	43	107
Melbourne	225	569
Paris	433	1094
Rome	116	199
Sydney	524	975

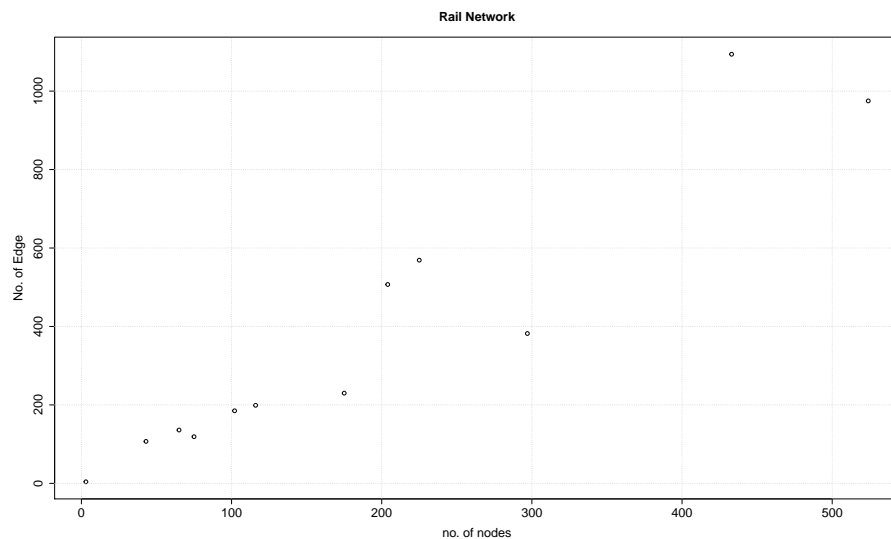


Figure 1: Node vs Edge

## 4 Figure 1

Figure 1 clearly shows that nodes and edges have a positive linear relationship.

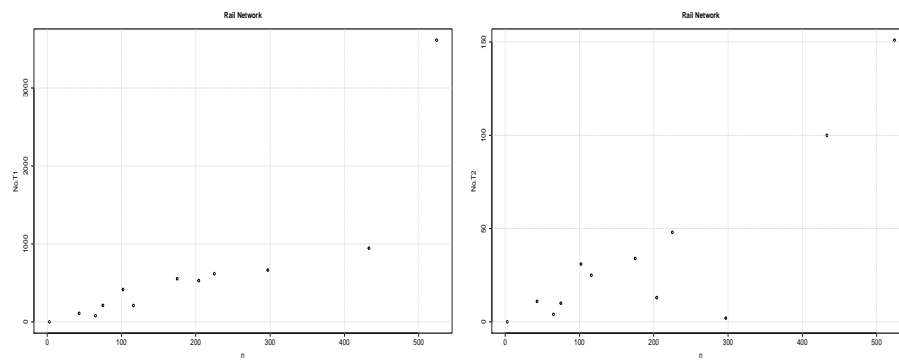


Figure 2: (a) Node vs Motif T1, (b) Node vs Motif T2

## 5 Figure 2

Figure 2 indicates motif T1 and T2 increase with nodes.

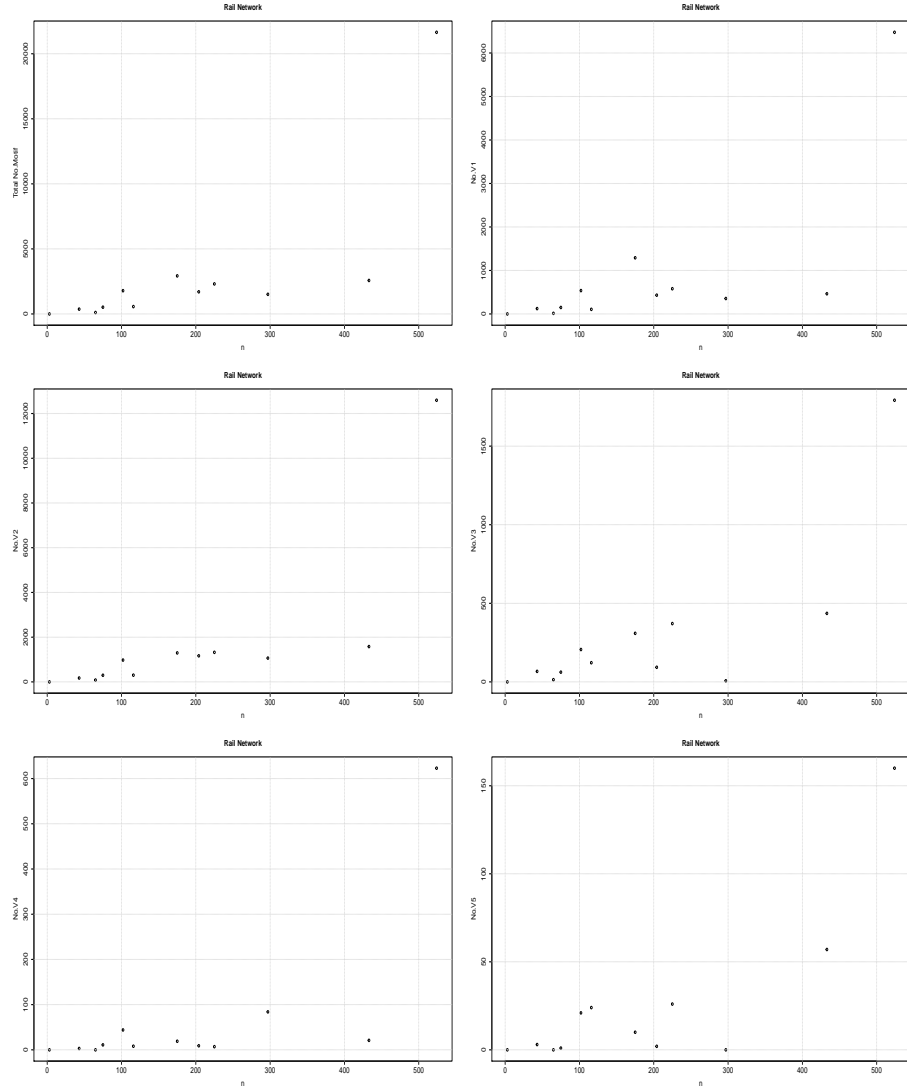


Figure 3: (a) Node vs Motif Total, (b) Node vs Motif V1, (c) Node vs Motif V2, (d) Node vs Motif V3, (e) Node vs Motif V4 and (f) Node vs Motif V5

## 6 Figure 3

In figure 3, it seems all 4 nodes motifs have a positive linear relationship with nodes except motif V4. Here, it looks like that motif V4 and nodes didn't follow any pattern.

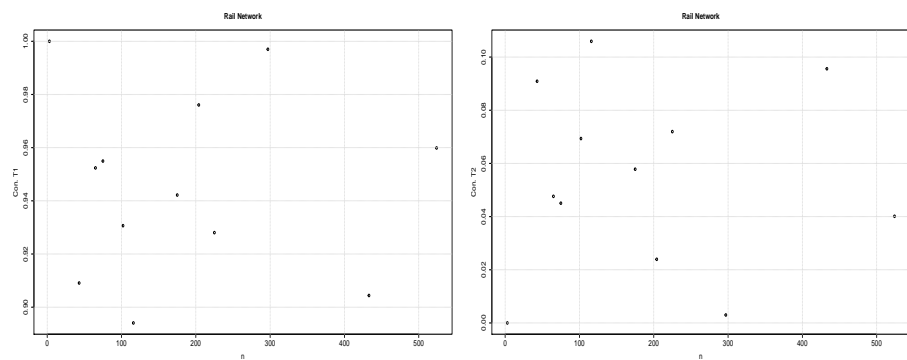


Figure 4: (a) Node vs Concentration T1, (b) Node vs Concentration T2

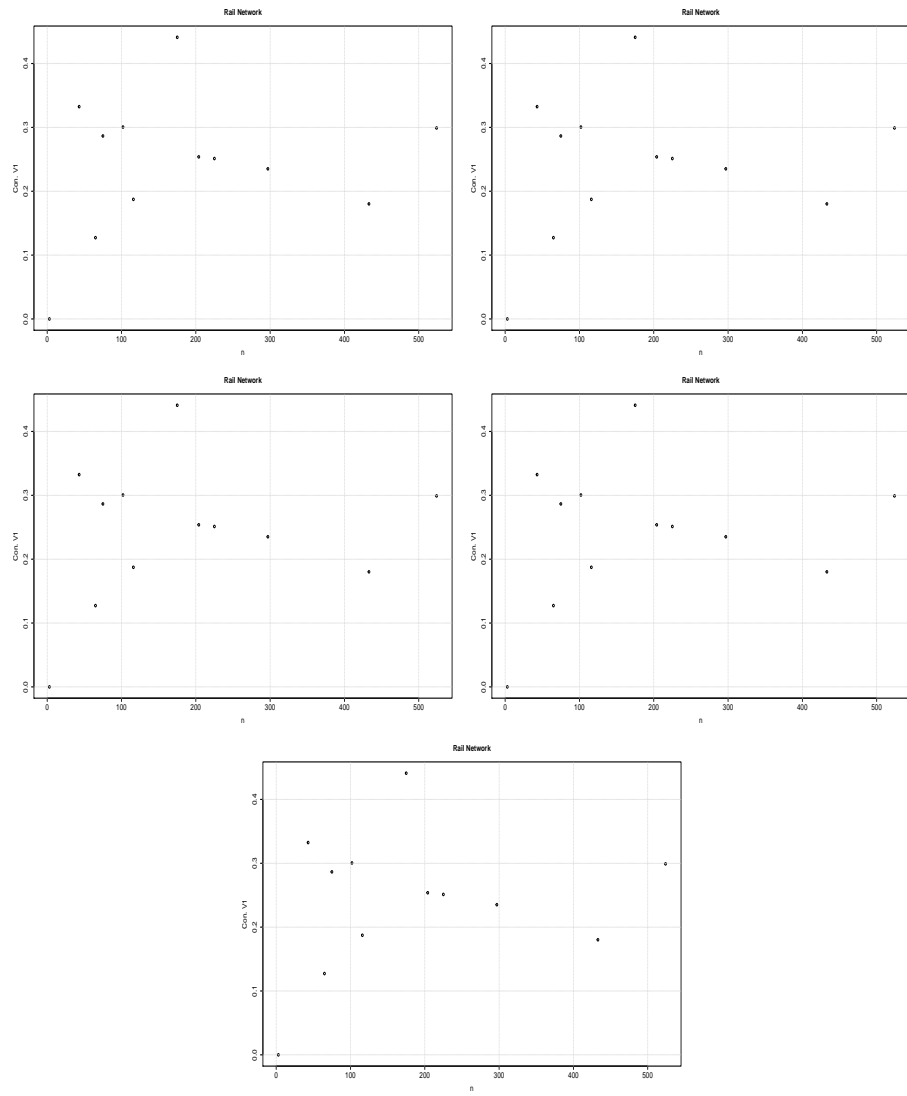


Figure 5: (a) Node vs Concentration V1, (b) Node vs Concentration V2, (c) Node vs Concentration V3, (d) Node vs Concentration V4, and (e) Node vs Concentration V5

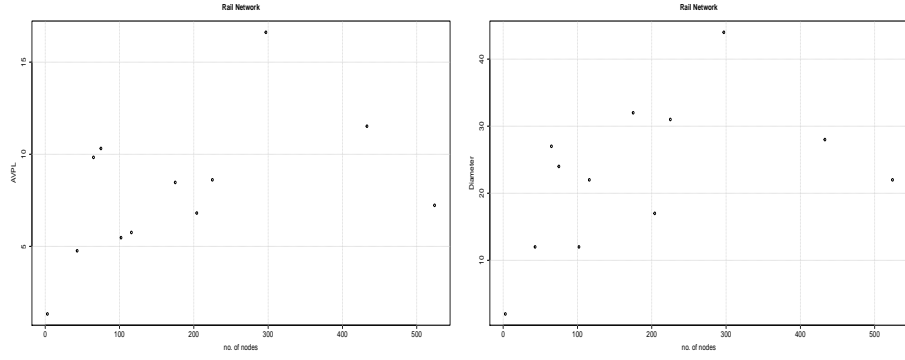


Figure 6: (a) Node vs AVPL, (b) Node vs Diameter

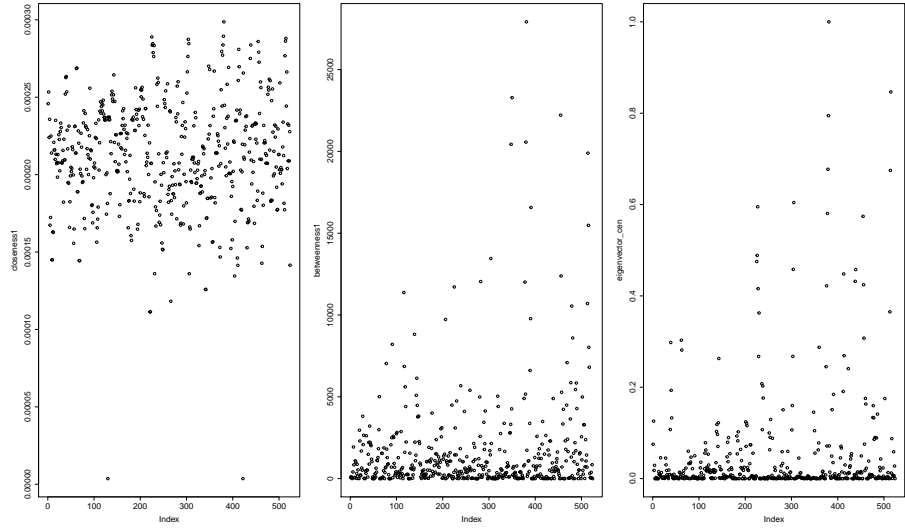


Figure 7: Node Centrality (a) closeness, (b) betweenness and (c) eigenvector centrality



Figure 8: Adelaide Rail Network Map

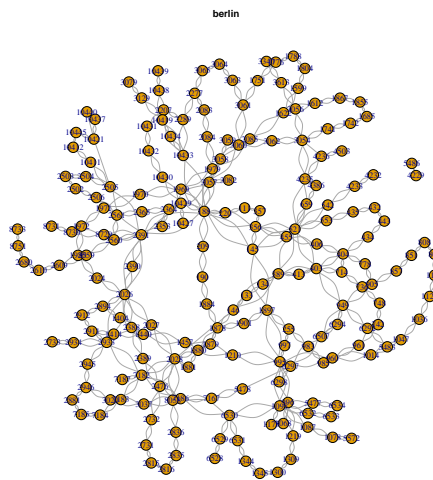


Figure 9: Berlin Rail Network Map



Figure 10: Brisbane Rail Network Map

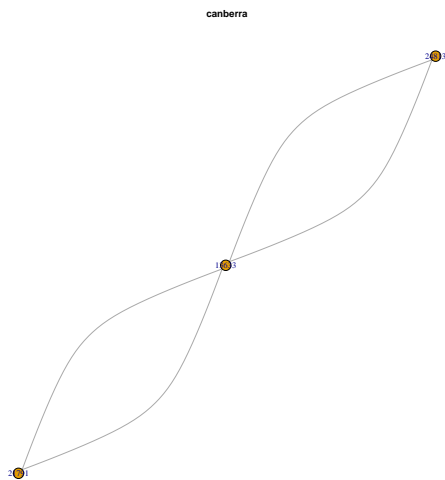


Figure 11: Canberra Rail Network Map





Figure 12: Dublin Rail Network Map



Figure 13: Helsinki Rail Network Map

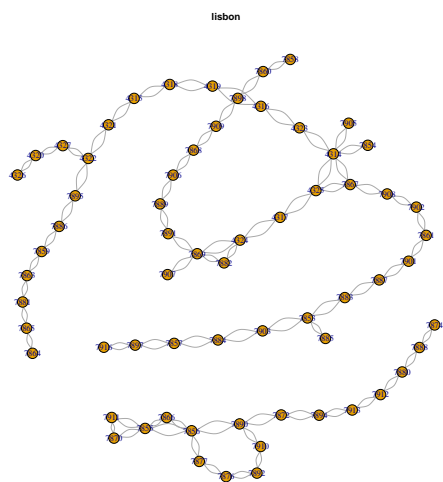


Figure 14: Lisbon Rail Network Map

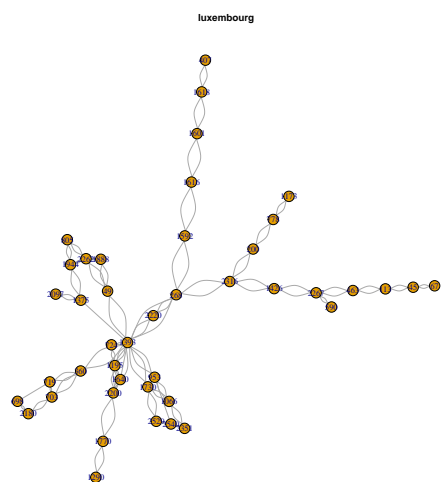


Figure 15: Luxembourg Rail Network Map

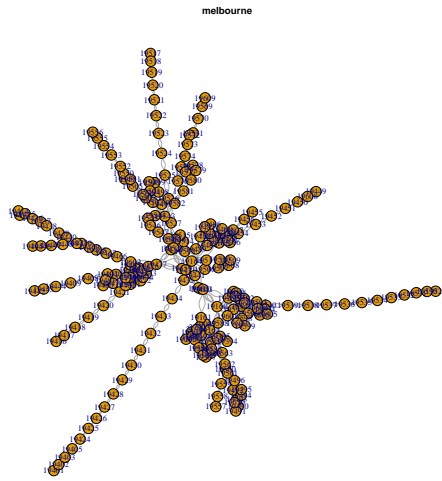


Figure 16: Melbourne Rail Network Map

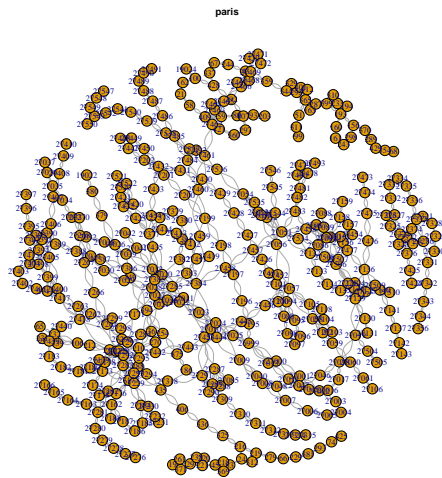


Figure 17: Paris Rail Network Map

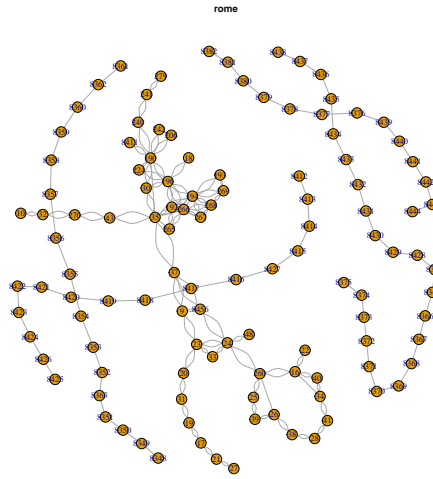


Figure 18: Rome Rail Network Map

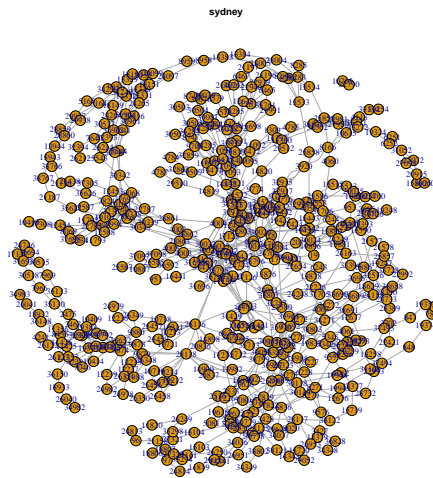


Figure 19: Sydney Rail Network Map

## 7 Subway Network

9 cities' subway network data are available there among 25 cities.

Table 2: Network descriptions

City	# of nodes	# of edges
Athens	61	124
Berlin	175	366
Helsinki	19	32
Lisbon	50	104
Paris	383	727
Prague	122	119
Rennes	29	28
Rome	148	142
Toulouse	40	72

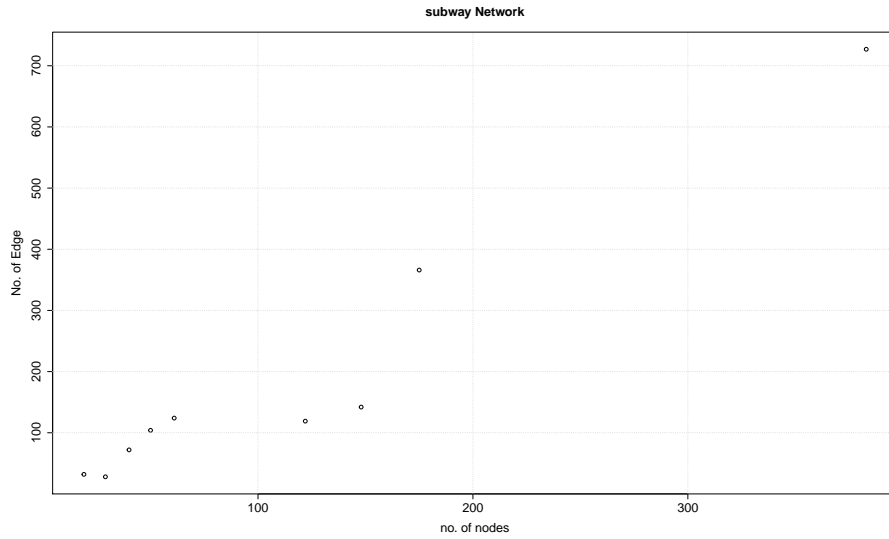


Figure 20: Node vs Edge

## 8 Figure 20

Figure 20 gives the impression that no. of edges increases while no. of nodes increase, i.e. which cities have more network nodes they reasonably have higher edges.

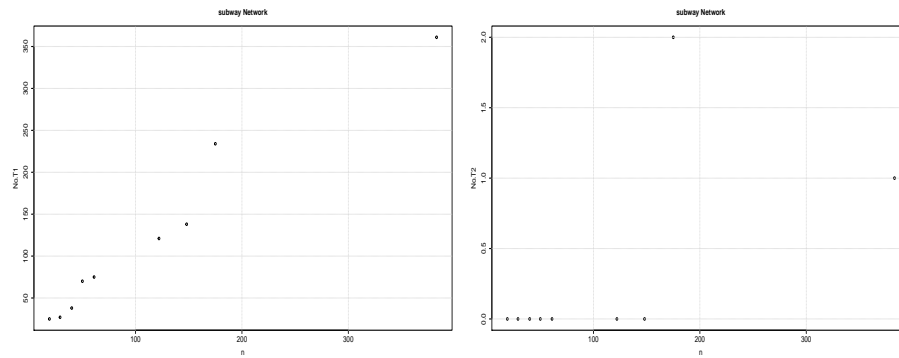


Figure 21: (a) Node vs Motif T1, (b) Node vs Motif T2

## 9 Figure 21

In figure 21, it seems most of the cities don't have motif T2, while motif T1 is positively related with nodes.

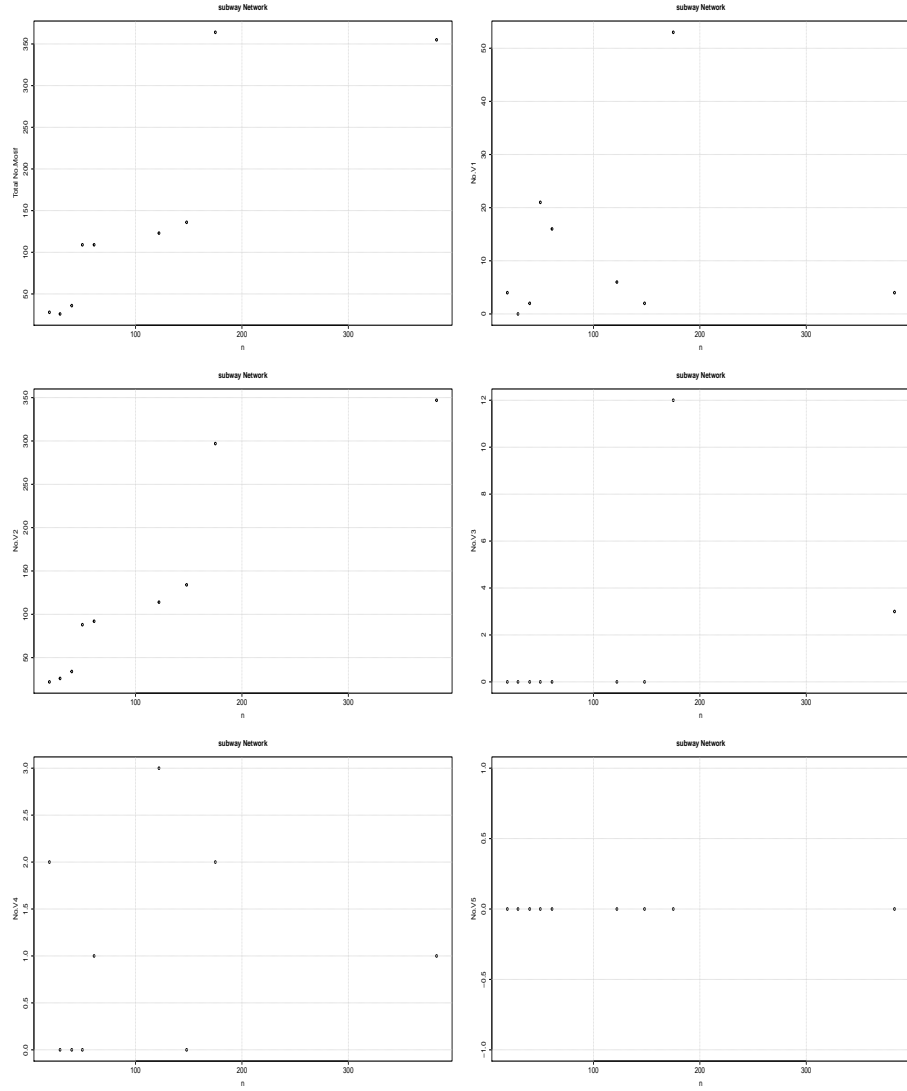


Figure 22: (a) Node vs Motif Total, (b) Node vs Motif V1, (c) Node vs Motif V2, (d) Node vs Motif V3, (e) Node vs Motif V4 and (f) Node vs Motif V5

## 10 Figure 22

In figure 22, it seems among all 4 nodes motif V2 is positively related with nodes, while motif it's hard to find the pattern of motif V1 and V4 with nodes. Motif V3 and V5 didn't present in most of the cities network.

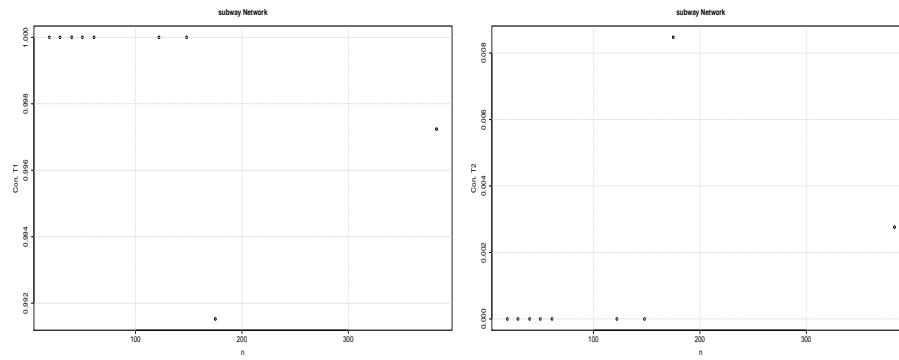


Figure 23: (a) Node vs Concentration T1, (b) Node vs Concentration T2



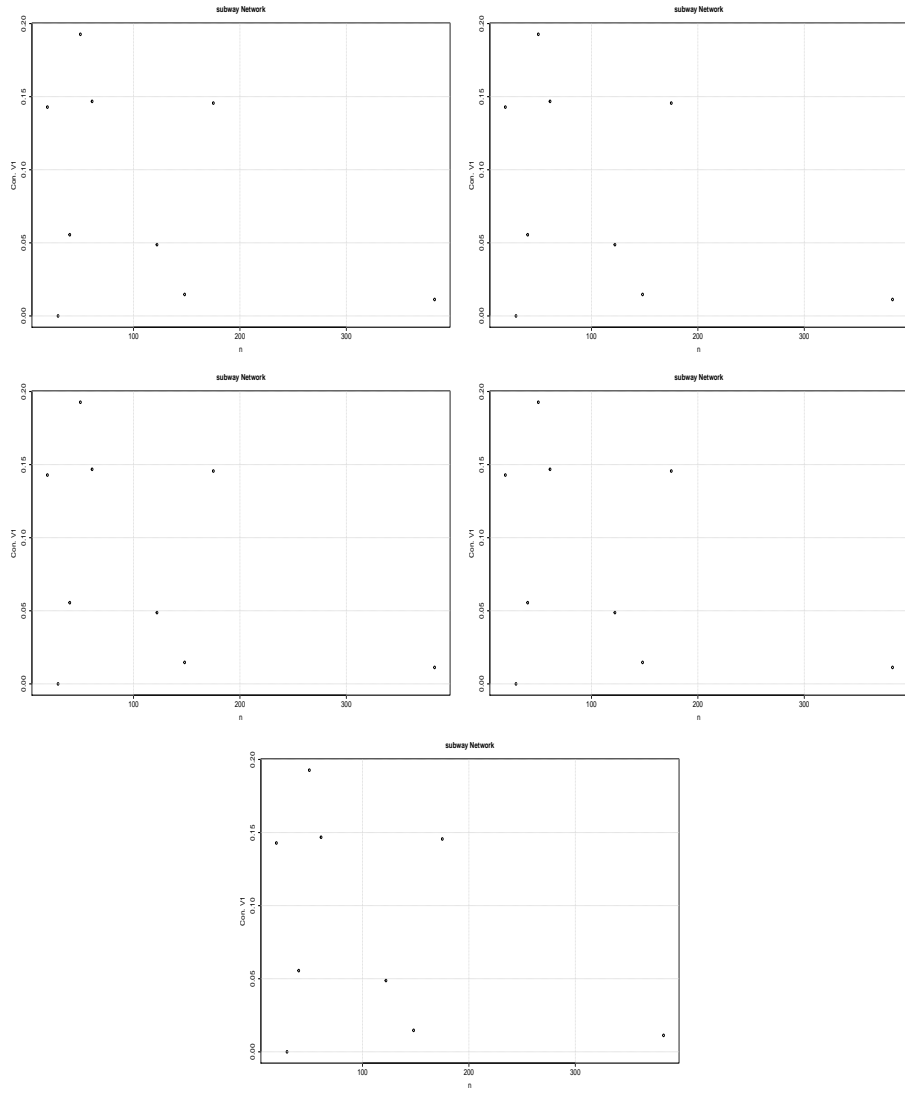


Figure 24: (a) Node vs Concentration V1, (b) Node vs Concentration V2, (c) Node vs Concentration V3, (d) Node vs Concentration V4, and (e) Node vs Concentration V5

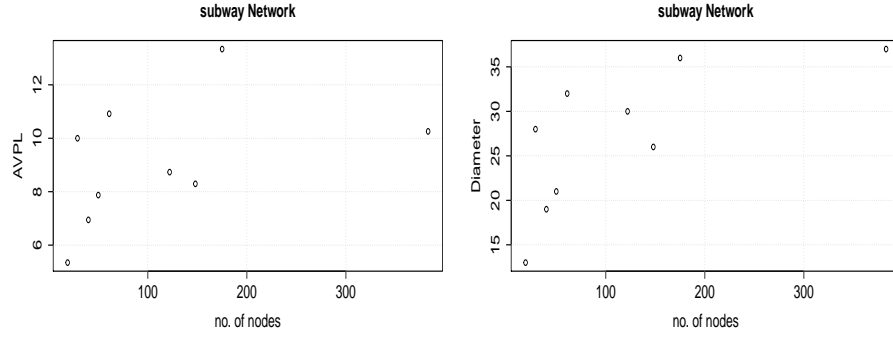


Figure 25: (a) Node vs AVPL, (b) Node vs Diameter

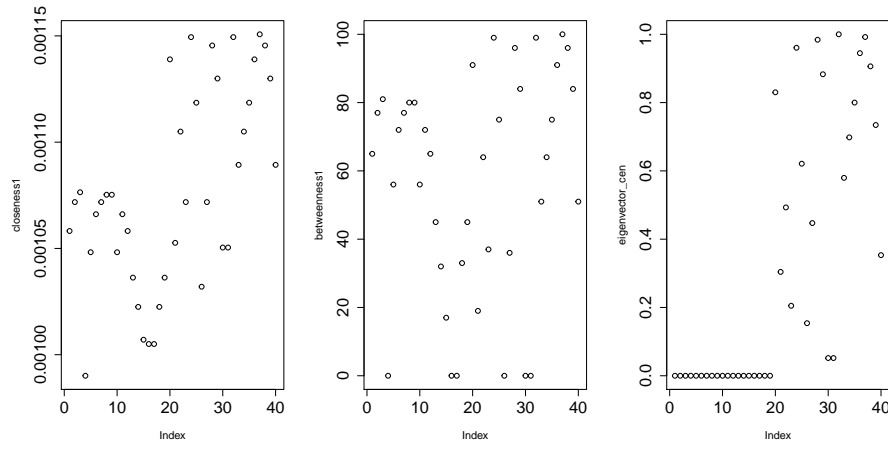


Figure 26: Node Centrality (a) closeness, (b) betweenness and (c) eigenvector centrality

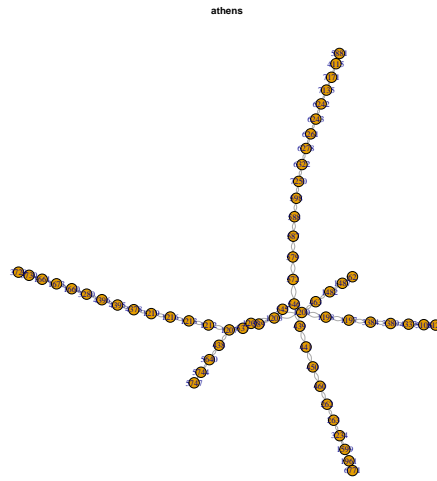


Figure 27: Athens subway Network Map

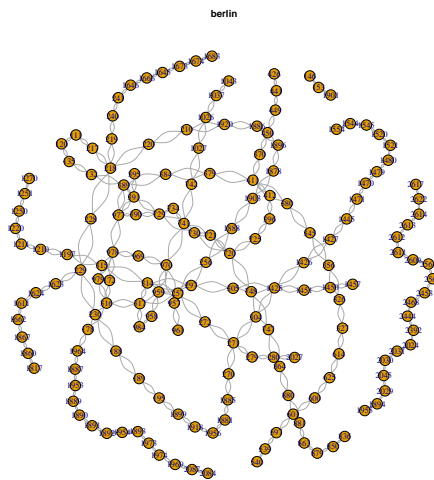


Figure 28: Berlin subway Network Map

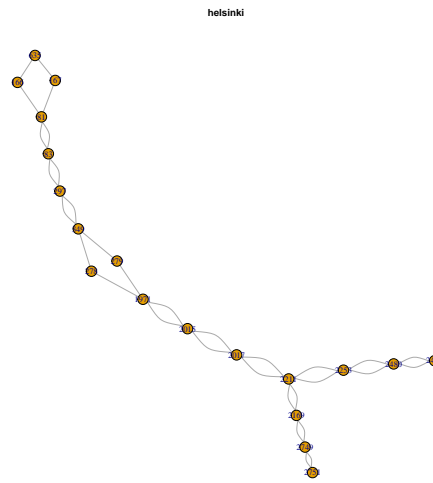


Figure 29: Helsinki subway Network Map



Figure 30: Lisbon subway Network Map



Figure 31: Paris subway Network Map

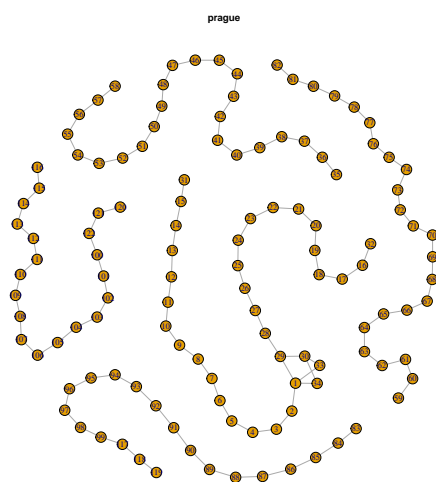


Figure 32: Prague subway Network Map

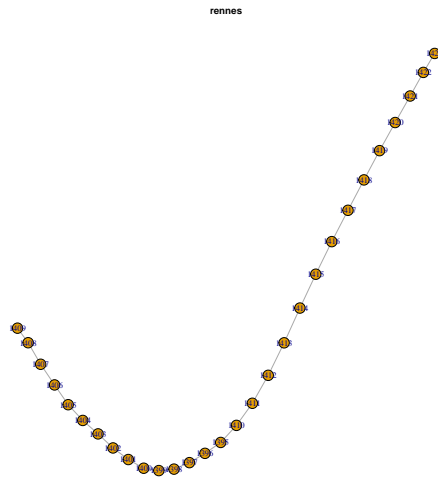


Figure 33: Rennes subway Network Map

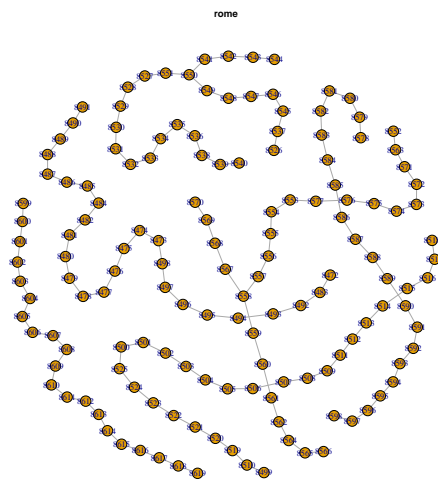


Figure 34: Rome subway Network Map



Figure 35: Toulouse subway Network Map

## 11 Bus Network

27 cities' bus network data are found and used in this study.

Table 3: Network descriptions

City	# of nodes	# of edges
Adelaide	7318	8973
Antofagasta	650	971
Athens	6658	7870
Belfast	1917	2181
Berlin	4322	10208
Bordeaux	3212	3805
Brisbane	9317	11294
Canberra	2761	3214
Detroit	5683	5948
Dublin	4361	5276
Grenoble	1383	1514
Helsinki	6642	8611
Kuopio	549	704
Lisbon	6949	8730
Luxembourg	1352	3127
Melbourne	17579	19430
Nantes	2208	2587
Palermo	2176	2561
Paris	10880	12604
Prague	4476	5911
Rennes	1378	1643
Rome	7500	9669
Sydney	23414	27556
Toulouse	3237	3668
Turku	1850	2341
Venice	1733	2398
Winnipeg	5079	5846



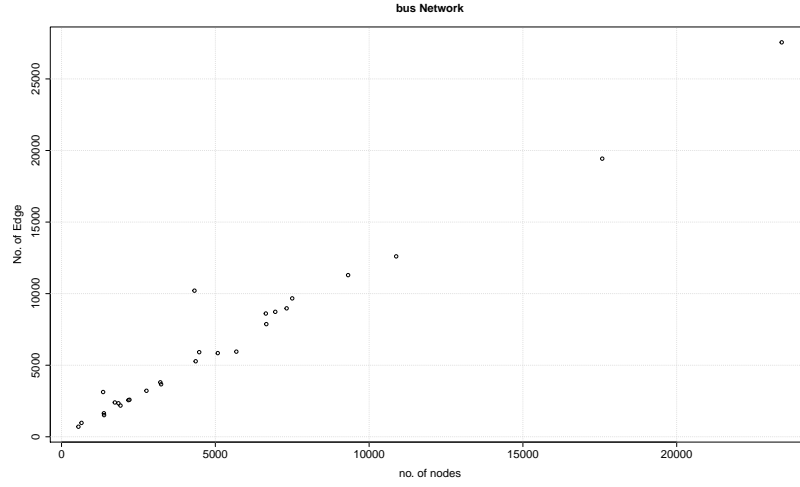


Figure 36: Node vs Edge

## 12 Figure 36

Figure 36 clearly shows cities network edge has a positive linear relationship with nodes.

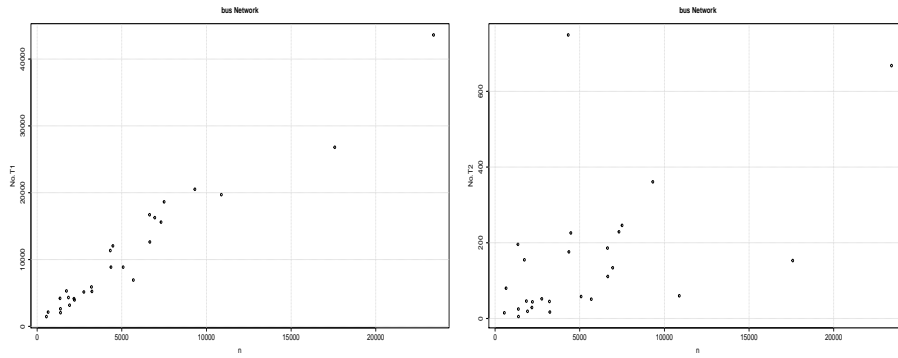


Figure 37: (a) Node vs Motif T1, (b) Node vs Motif T2

## 13 Figure 37

Figure 37 indicates motif T1 and T2 have a positive linear relationship with nodes.

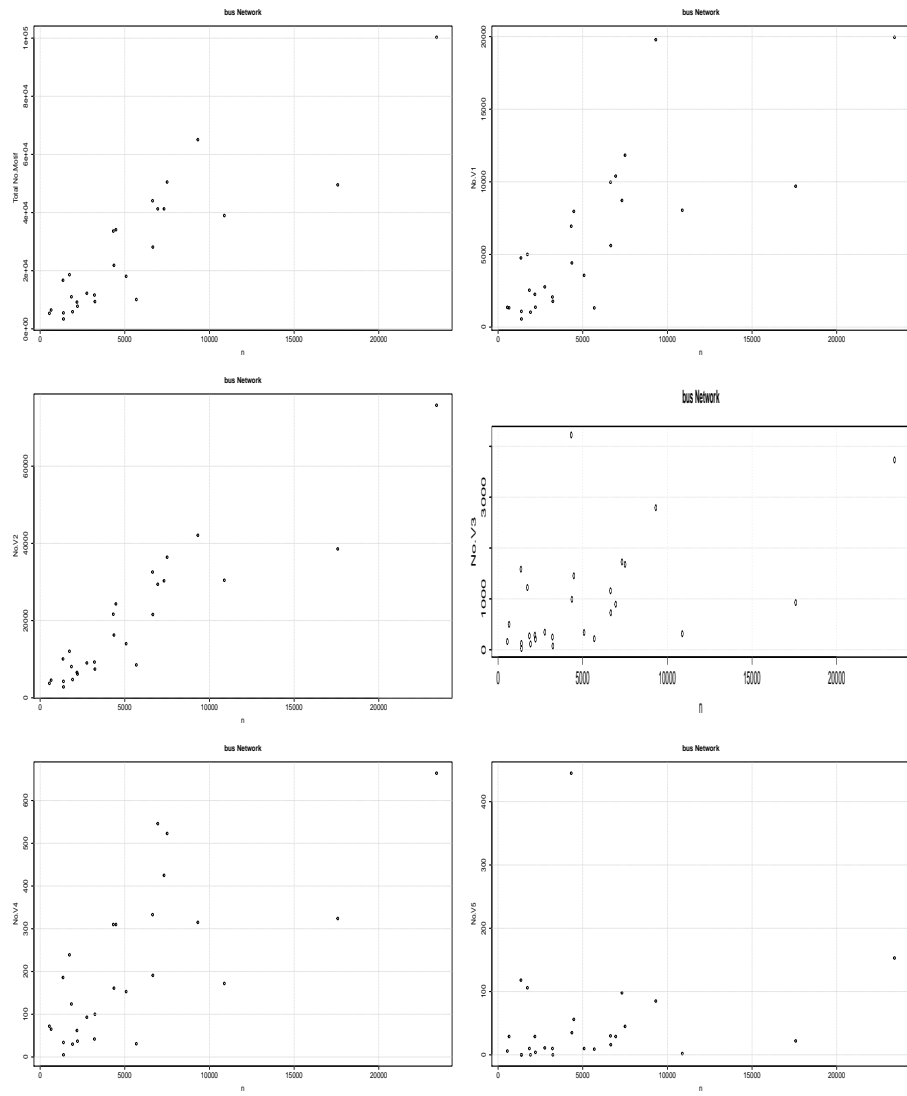


Figure 38: (a) Node vs Motif Total, (b) Node vs Motif V1, (c) Node vs Motif V2, (d) Node vs Motif V3, (e) Node vs Motif V4 and (f) Node vs Motif V5

## 14 Figure 38

In figure 38, it seems all 4 node motifs are positively related with nodes.

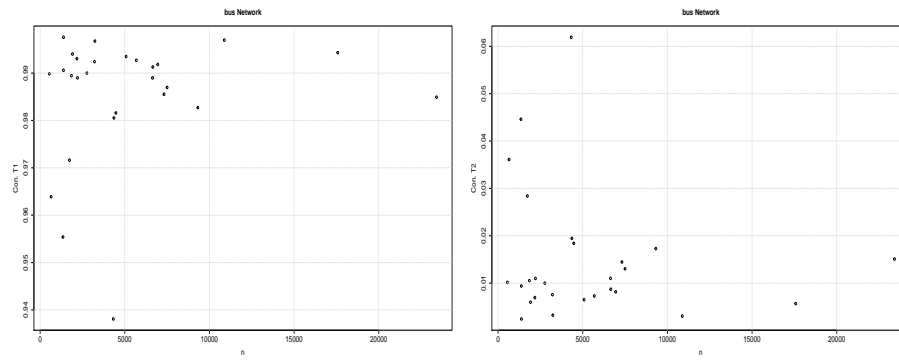


Figure 39: (a) Node vs Concentration T1, (b) Node vs Concentration T2

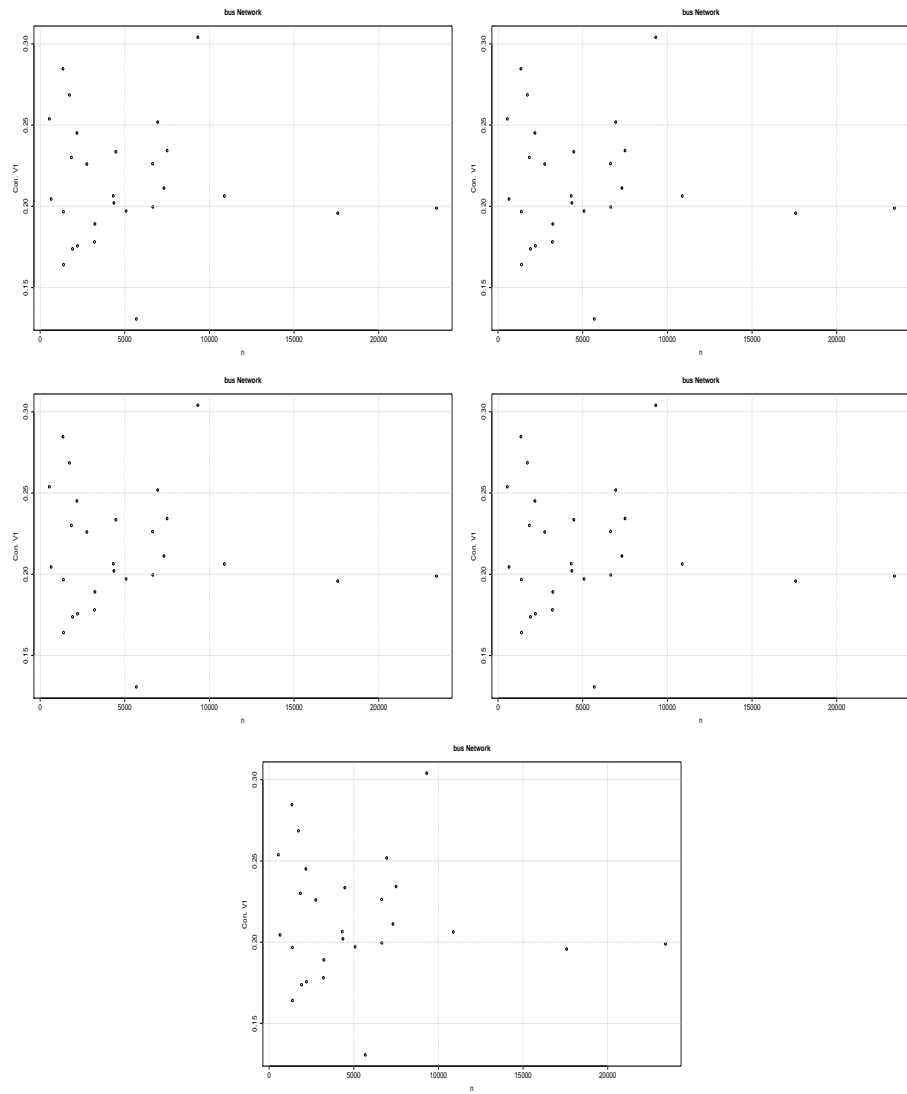


Figure 40: (a) Node vs Concentration V1, (b) Node vs Concentration V2, (c) Node vs Concentration V3, (d) Node vs Concentration V4, and (e) Node vs Concentration V5

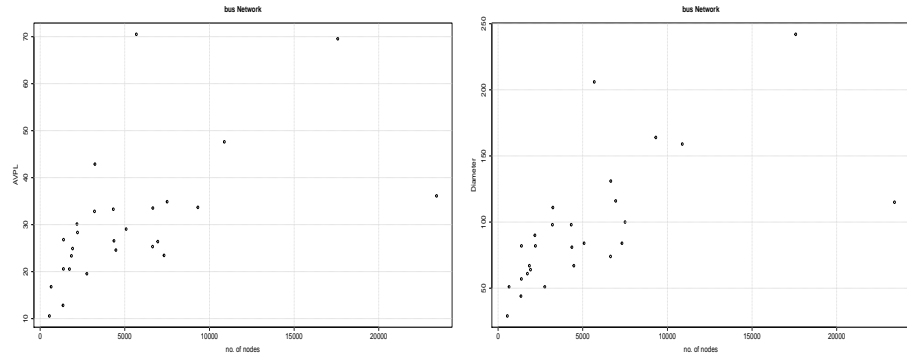


Figure 41: (a) Node vs AVPL, (b) Node vs Diameter

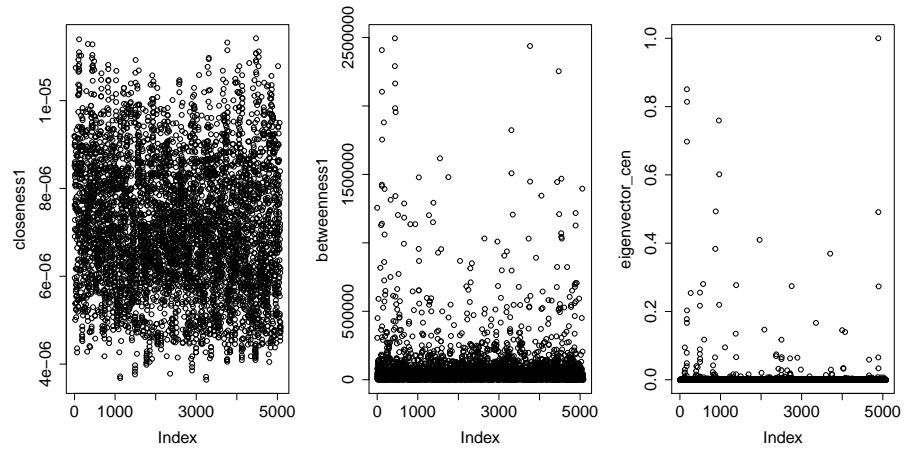


Figure 42: Node Centrality (a) closeness, (b) betweenness and (c) eigenvector centrality

## 15 Tram Network

Among 25 cities, 16 cities' tram network data are available.

Table 4: Network descriptions

City	# of nodes	# of edges
Adelaide	56	54
Athens	49	96
Berlin	479	990
Bordeaux	218	222
Dublin	108	106
Grenoble	164	168
Helsinki	270	306
Melbourne	1694	1738
Nantes	147	192
Paris	356	356
Prague	598	716
Rome	185	196
Sydney	44	44
Toulouse	52	53
Venice	70	72

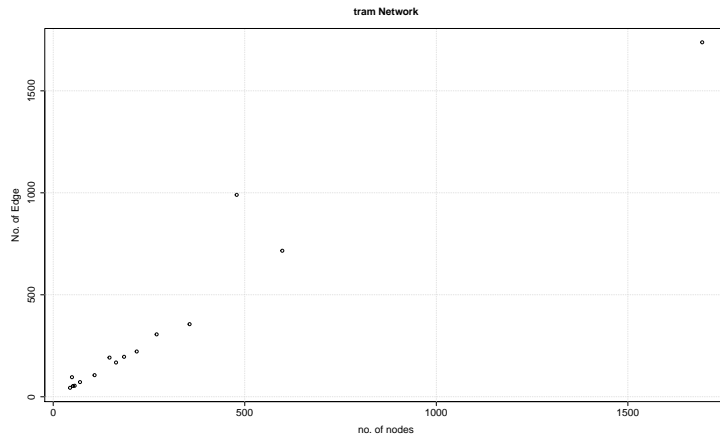


Figure 43: Node vs Edge

## 16 Figure 43

Figure 43 shows that nodes and edges have a positive linear relationship.

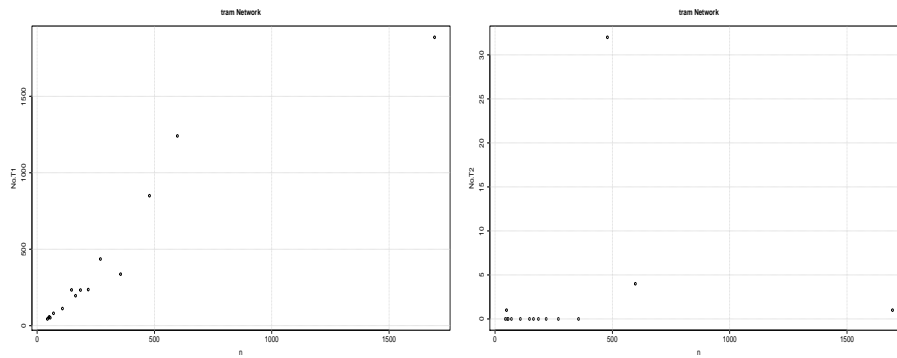


Figure 44: (a) Node vs Motif T1, (b) Node vs Motif T2

## 17 Figure 44

Figure 44 shows 3 nodes motif T1 has a positive linear relationship with nodes, while motif T2 is not present in most of the cities.

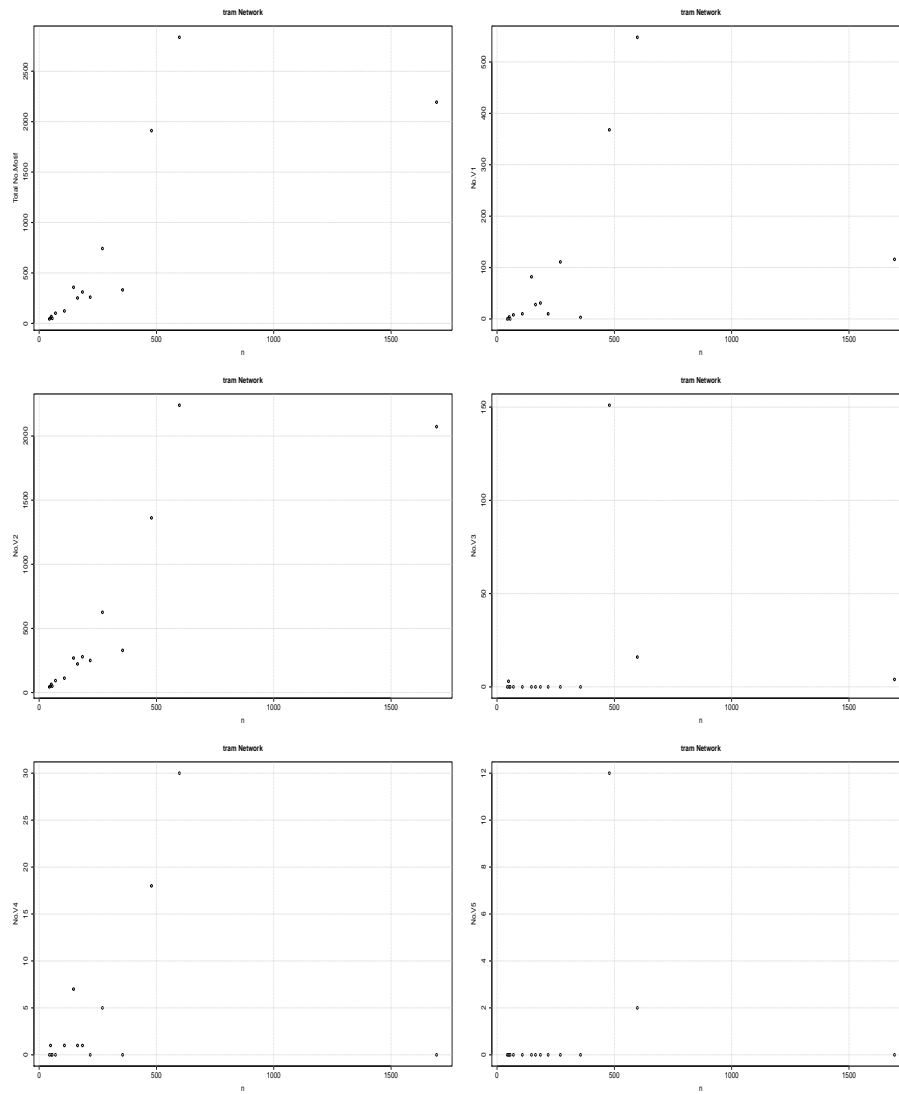


Figure 45: (a) Node vs Motif Total, (b) Node vs Motif V1, (c) Node vs Motif V2, (d) Node vs Motif V3, (e) Node vs Motif V4 and (f) Node vs Motif V5

## 18 Figure 45

In figure 45, it seems most of cities doesn't have 4 nodes motif V3 and V5. Motif V1, V2 has a positive relationship with nodes.



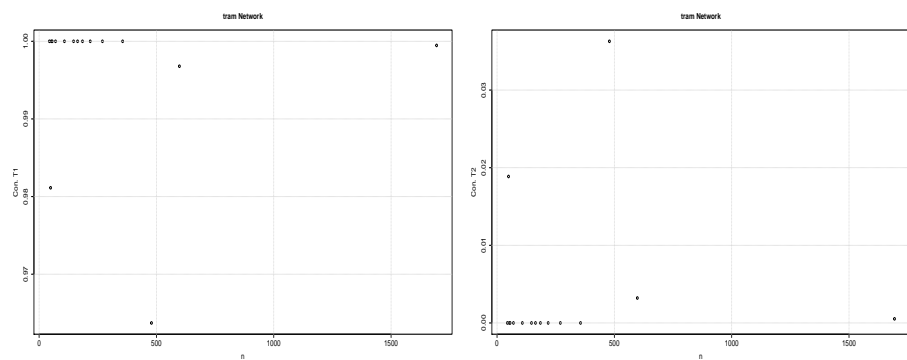


Figure 46: (a) Node vs Concentration T1, (b) Node vs Concentration T2

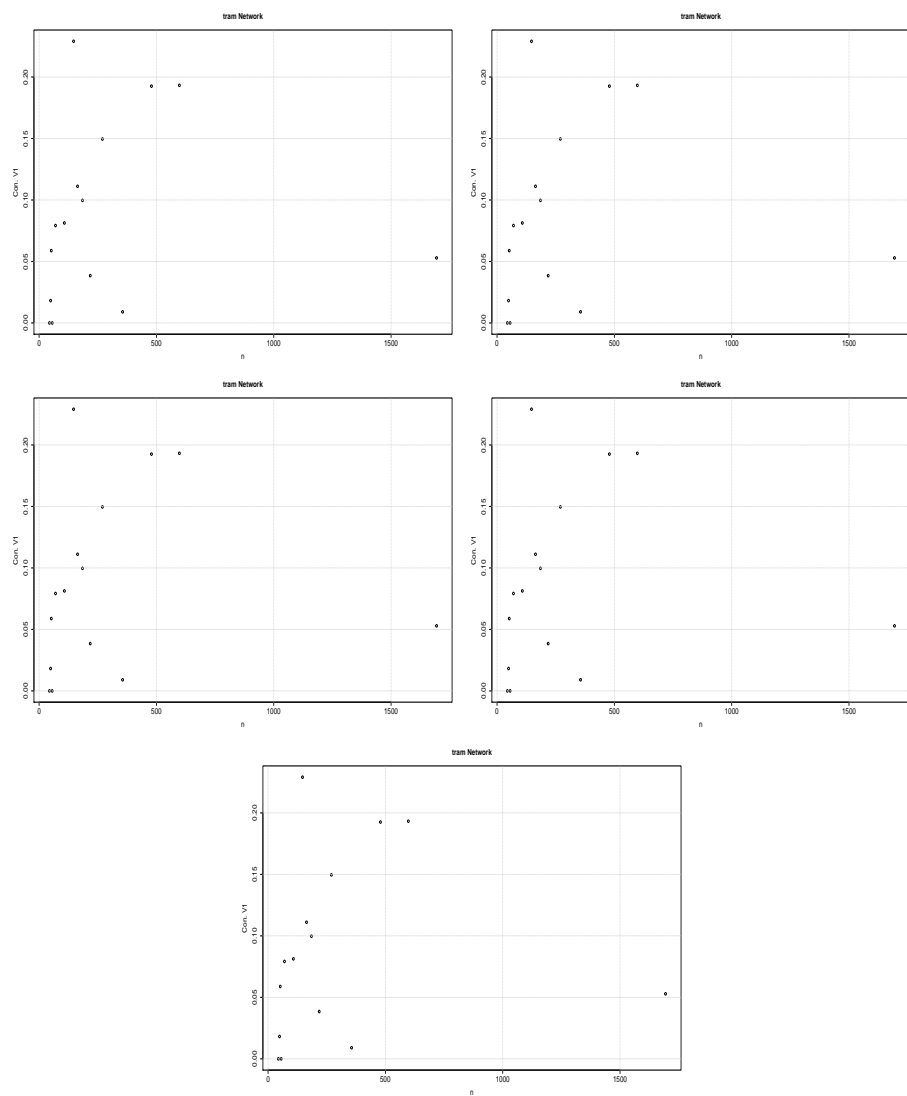


Figure 47: (a) Node vs Concentration V1, (b) Node vs Concentration V2, (c) Node vs Concentration V3, (d) Node vs Concentration V4, and (e) Node vs Concentration V5

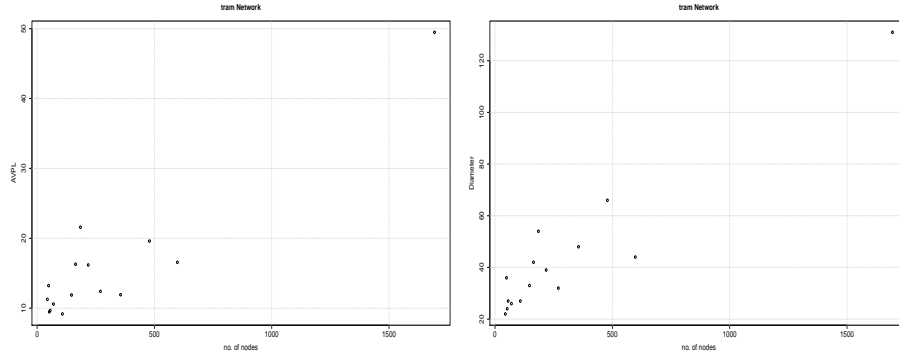


Figure 48: (a) Node vs AVPL, (b) Node vs Diameter

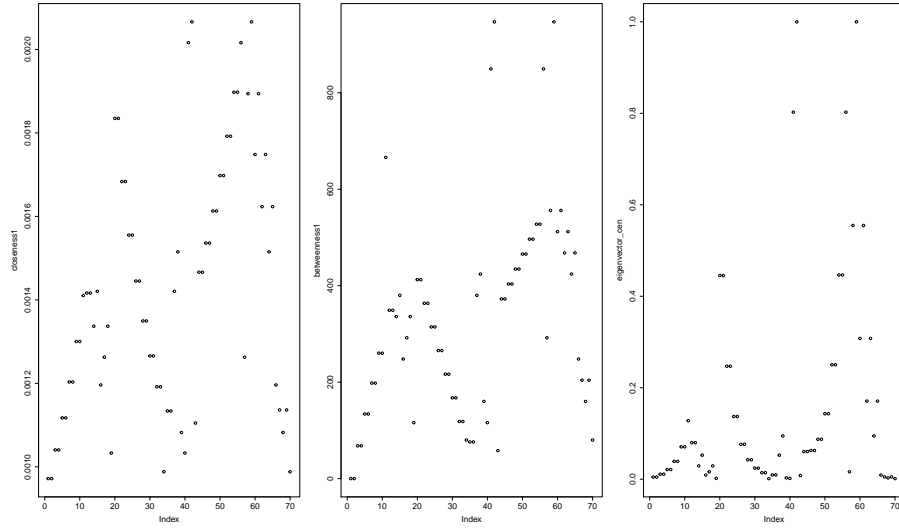


Figure 49: Node Centrality (a) closeness, (b) betweenness and (c) eigenvector centrality

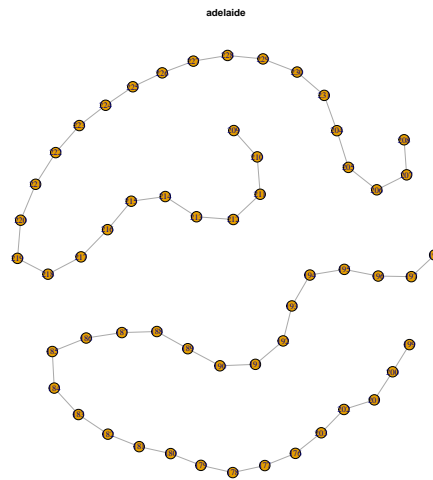


Figure 50: Adelaide tram Network Map



Figure 51: Athens tram Network Map



Figure 52: Berlin tram Network Map

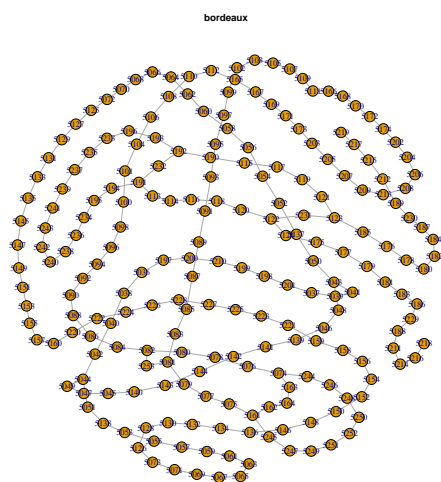


Figure 53: Bordeaux tram Network Map

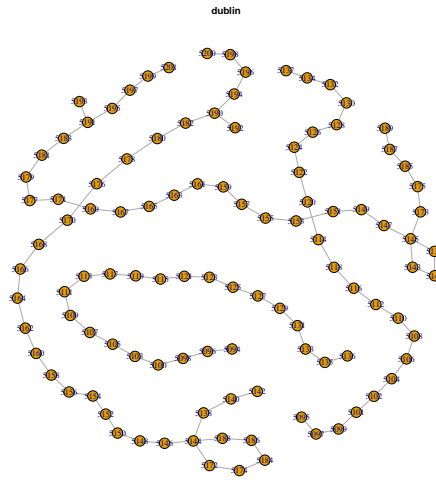


Figure 54: Dublin tram Network Map



Figure 55: Grenoble tram Network Map



Figure 56: Helsinki tram Network Map

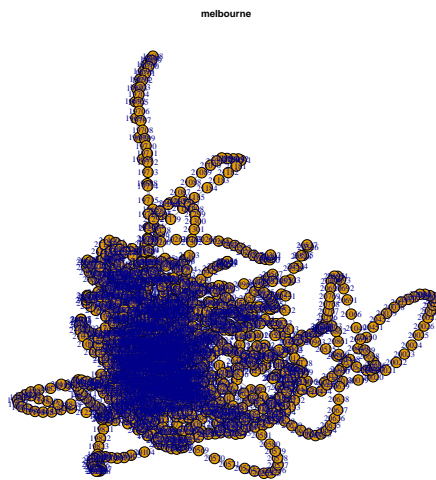


Figure 57: Melbourne tram Network Map

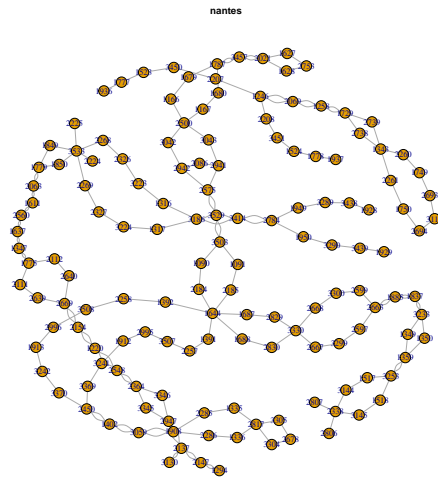


Figure 58: Nantes tram Network Map



Figure 59: Paris tram Network Map



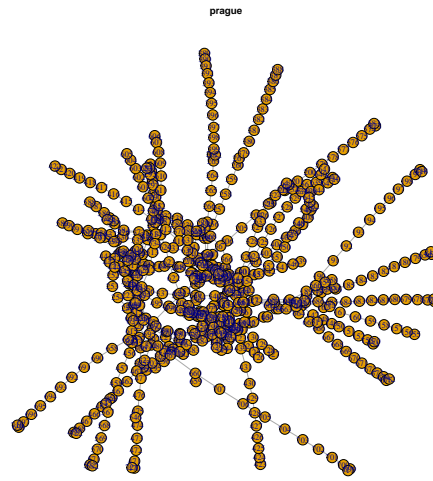


Figure 60: Prague tram Network Map



Figure 61: Rome tram Network Map

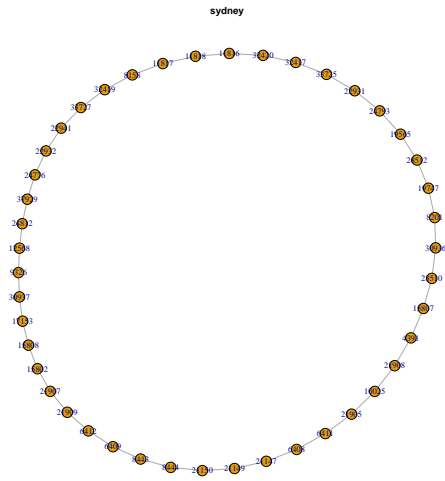


Figure 62: Sydney tram Network Map

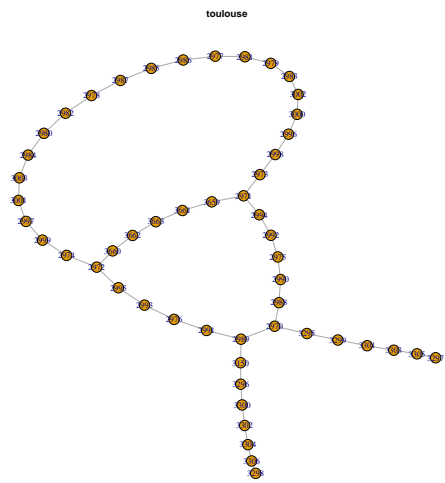


Figure 63: Toulouse tram Network Map

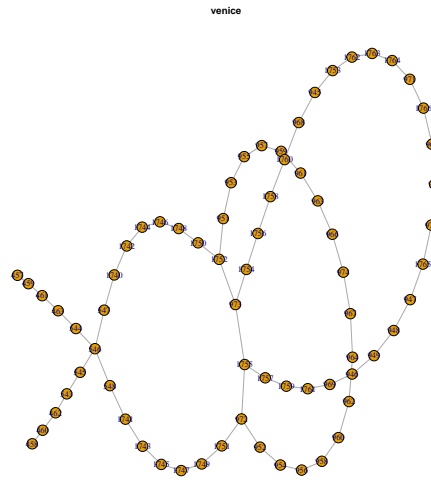


Figure 64: Venice tram Network Map