

Public Transport Network Analysis

July 24, 2020

1 Edge Vs Motif plot

1.1 Edge Vs Motif plot of Bus Network

Figure 55 indicates motif T1 and T2 have a positive linear relationship with edges.

In figure 56, it seems all 4 node motifs are positively related with edges.

1.2 Edge Vs Motif plot of Rail Network

Figure 81 indicates motif T1 and T2 increase with edges.

In figure 82, it's hard to find any pattern for 4 nodes motifs with edges except motif V2. Motif V2 is linearly positively related with edges.

1.3 Edge Vs Motif plot of Subway Network

In figure 101, it seems most of the cities don't have motif T2, while motif T1 is positively related with edges.

In figure 102, it seems among all 4 nodes motif, motif V2 is positively related with edges, while it's hard to find the pattern of motif V1 and V4 with edges. Motif V3 and V5 didn't present in most of the cities network.

1.4 Edge Vs Motif plot of Tram Network

Figure 133 shows 3 nodes motif T1 has a positive linear relationship with edges, while motif T2 is not present in most of the cities.

In figure 134, it seems most of cities doesn't have 4 nodes motif V3 and V5. Motif V1, V2 have positive relationship with edges.

2 Bus Network

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

Table 1: 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

Adelaide Bus Network

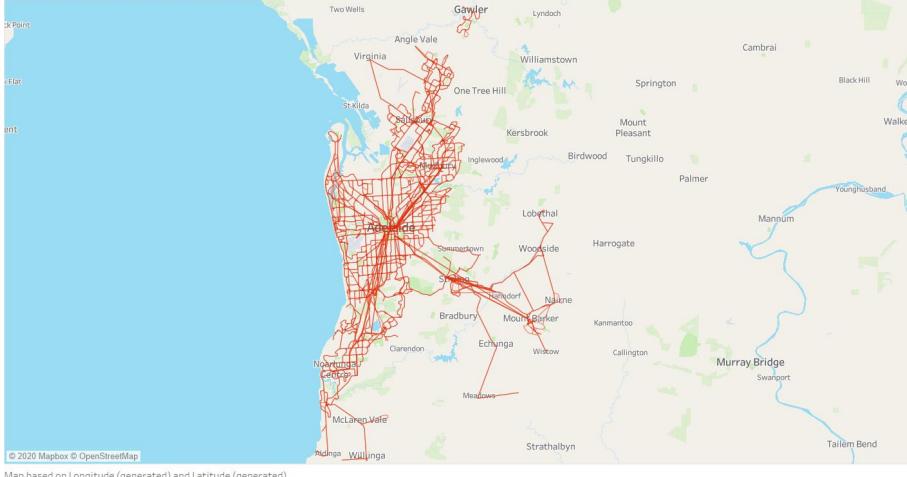


Figure 1: Adelaide Bus Network Map

No. of Nodes	7318
No. of Edges	8973

Motif	No.
T1	15602
T2	229
V1	8719
V2	30303
V3	1727
V4	425
V5	98

Figure 2: Adelaide Bus Network Motif

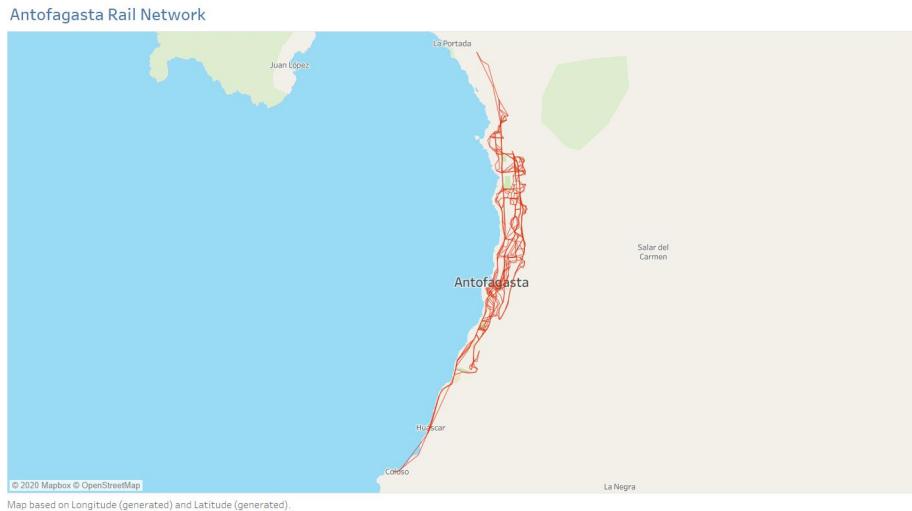


Figure 3: Antofagasta Bus Network Map

No. of Nodes	650
No. of Edges	971

Motif	No.
T1	2136
T2	80
V1	1327
V2	4569
V3	499
V4	65
V5	29

Figure 4: Antofagast Bus Network Motif

Athens Bus Network

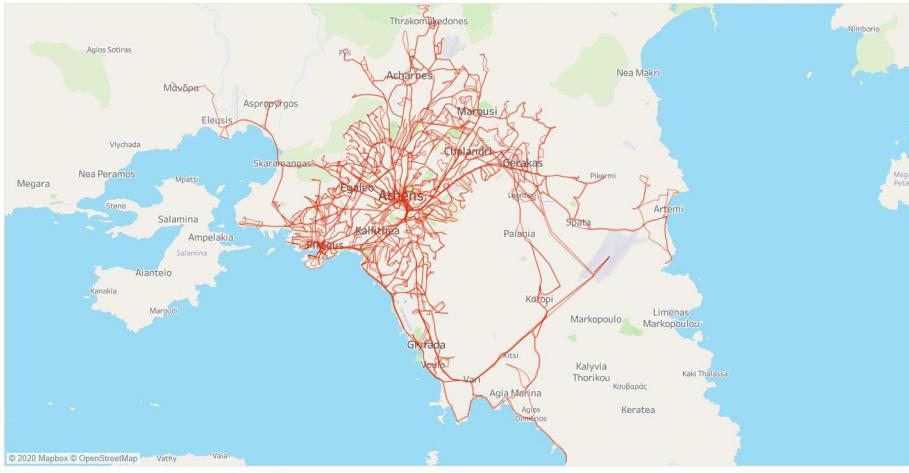


Figure 5: Athens Bus Network Map

No. of Nodes	6658
No. of Edges	7870

Motif	No.
T1	12632
T2	111
V1	5614
V2	21576
V3	727
V4	191
V5	16

Figure 6: Athens Bus Network Motif



Figure 7: Belfast Bus Network Map

No. of Nodes	1917
No. of Edges	2181
Motif	No.
T1	3167
T2	19
V1	1024
V2	4724
V3	113
V4	30
V5	0

Figure 8: Belfast Bus Network Motif

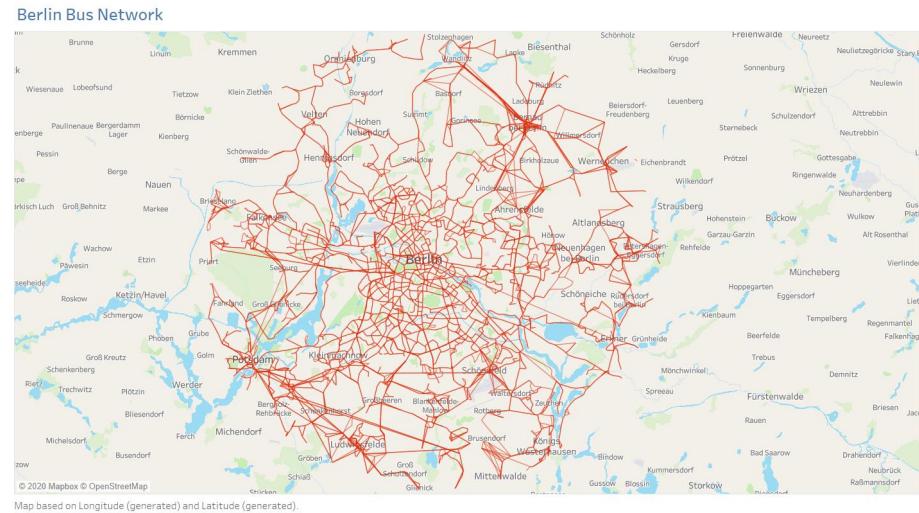


Figure 9: Berlin Bus Network Map

No. of Nodes	4322
No. of Edges	10208

Motif	No.
T1	11349
T2	749
V1	6944
V2	21653
V3	4224
V4	310
V5	445

Figure 10: Berlin Bus Network Motif

Bordeaux Bus Network



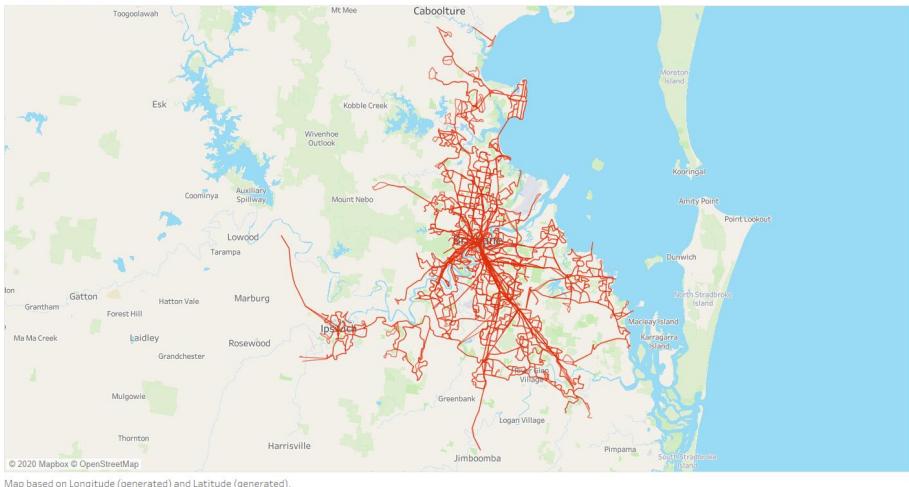
Figure 11: Bordeaux Bus Network Map

No. of Nodes	3212
No. of Edges	3805

Motif	No.
T1	5901
T2	45
V1	2071
V2	9254
V3	250
V4	42
V5	10

Figure 12: bordeaux Bus Network Motif

Brisbane Bus Network



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Map based on Longitude (generated) and Latitude (generated).

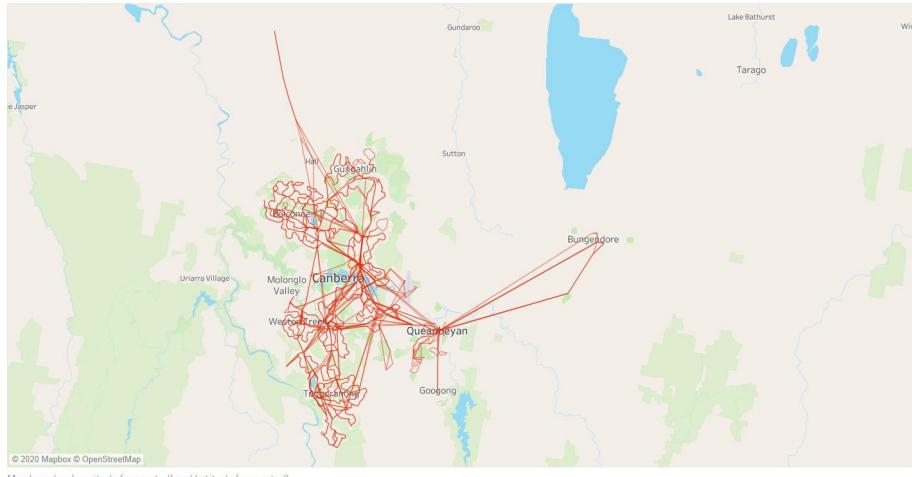
Figure 13: Brisbane Bus Network Map

No. of Nodes	9317
No. of Edges	11294

Motif	No.
T1	20518
T2	361
V1	19788
V2	42099
V3	2793
V4	315
V5	85

Figure 14: Brisbane Bus Network Motif

Canberra Bus Network



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Map based on Longitude (generated) and Latitude (generated).

Figure 15: Canberra Bus Network Map

No. of Nodes	2761
No. of Edges	3214

Motif	No.
T1	5149
T2	52
V1	2767
V2	9026
V3	345
V4	93
V5	11

Figure 16: Canberra Bus Network Motif

Detroit Bus Network

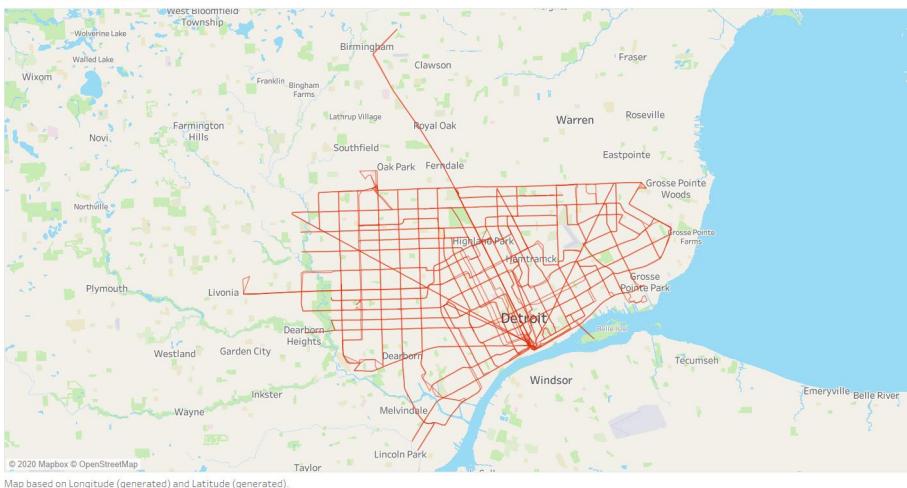


Figure 17: Detroit Bus Network Map

No. of Nodes	5683
No. of Edges	5948

Motif	No.
T1	6932
T2	51
V1	1319
V2	8517
V3	217
V4	31
V5	9

Figure 18: Detroit Bus Network Motif

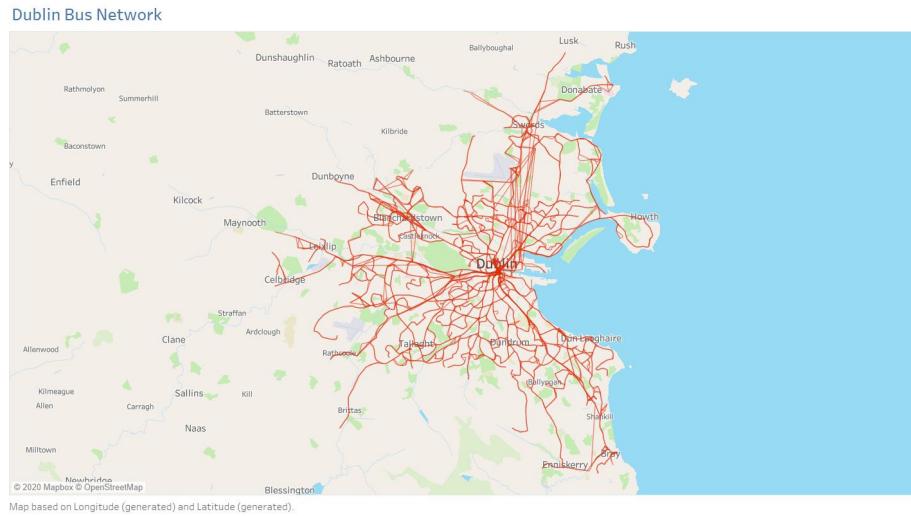


Figure 19: Dublin Bus Network Map

No. of Nodes	4361
No. of Edges	5276
Motif	No.
T1	8866
T2	176
V1	4417
V2	16251
V3	991
V4	161
V5	35

Figure 20: Dublin Bus Network Motif

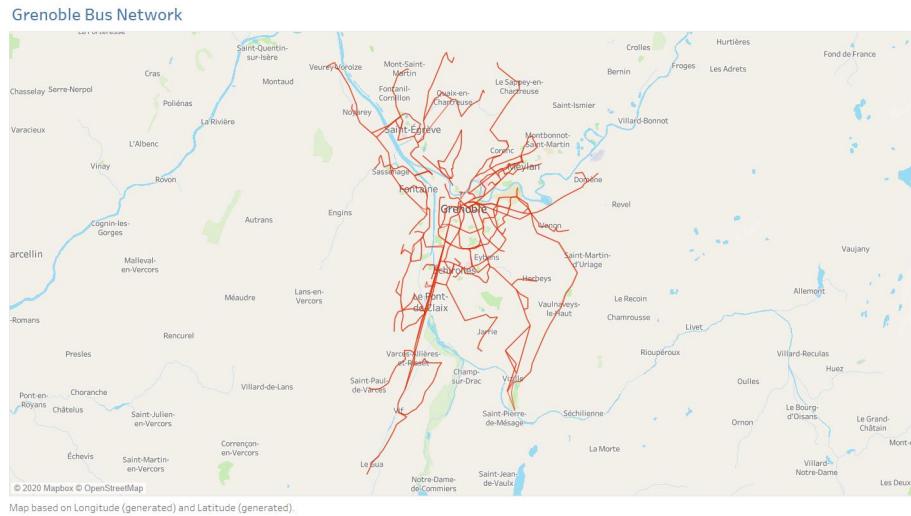


Figure 21: Grenoble Bus Network Map

No. of Nodes	1383
No. of Edges	1514

Motif	No.
T1	2047
T2	5
V1	559
V2	2819
V3	23
V4	5
V5	0

Figure 22: Grenoble Bus Network Motif

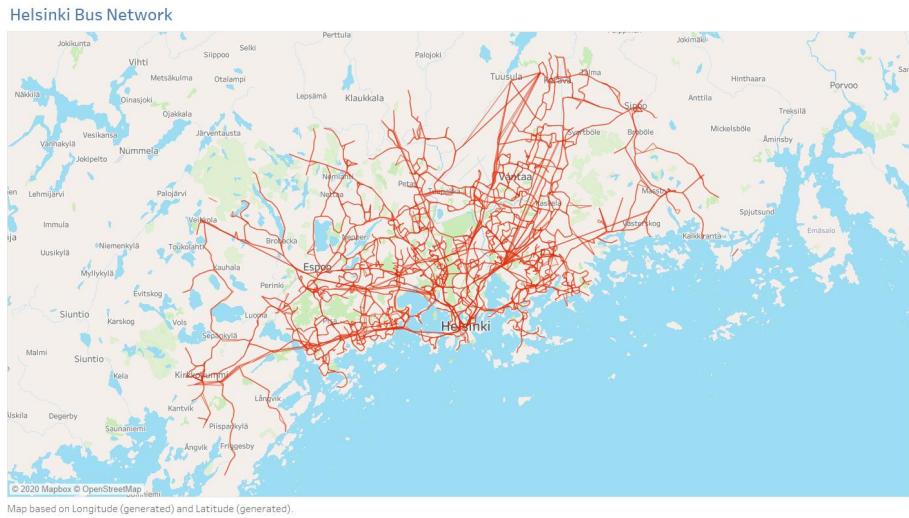


Figure 23: Helsinki Bus Network Map

No. of Nodes	6642
No. of Edges	8611
Motif	No.
T1	16705
T2	186
V1	9971
V2	32572
V3	1159
V4	333
V5	30

Figure 24: Helsinki Bus Network Motif

Kuopio Bus Network



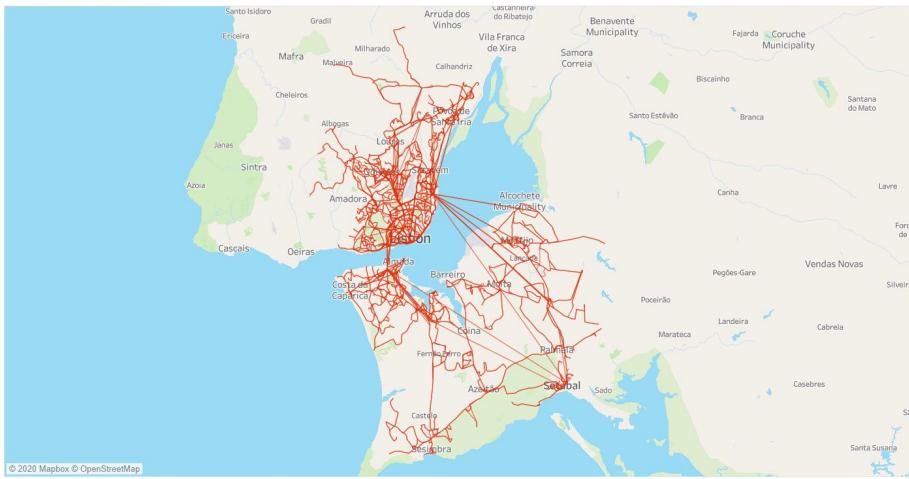
Figure 25: Kuopio Bus Network Map

No. of Nodes	549
No. of Edges	704

Motif	No.
T1	1463
T2	15
V1	1357
V2	3749
V3	161
V4	72
V5	6

Figure 26: Kuopio Bus Network Motif

Lisbon Bus Network



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Map based on Longitude (generated) and Latitude (generated).

Figure 27: Lisbon Bus Network Map

No. of Nodes	6949
No. of Edges	8730

Motif	No.
T1	16269
T2	134
V1	10394
V2	29408
V3	895
V4	546
V5	29

Figure 28: Lisbon Bus Network Motif

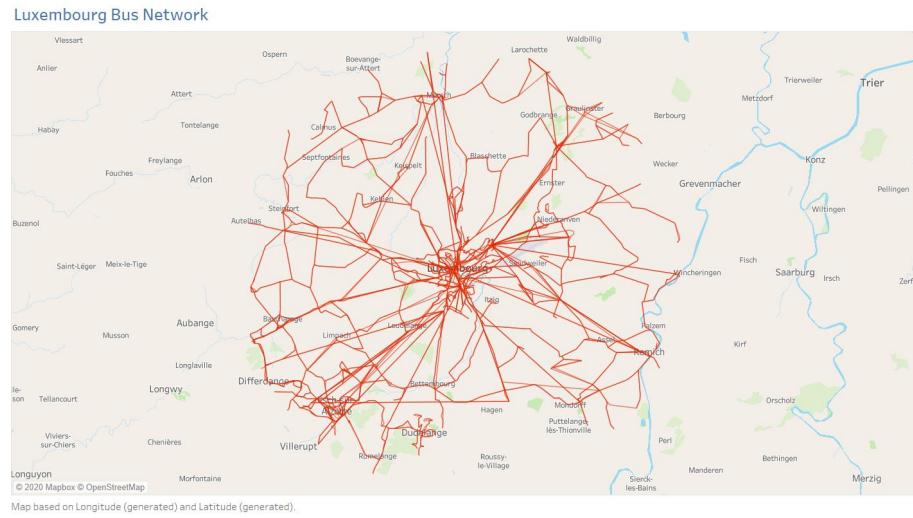


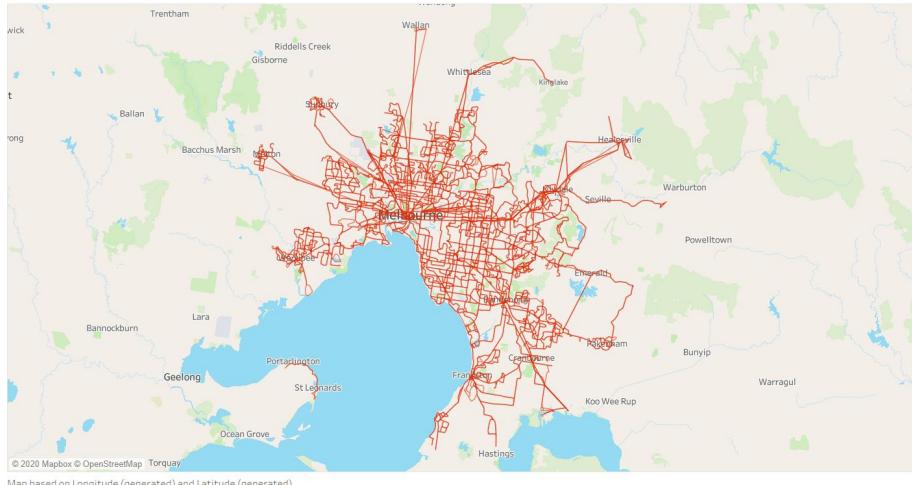
Figure 29: Luxembourg Bus Network Map

No. of Nodes	1352
No. of Edges	3127

Motif	No.
T1	4198
T2	196
V1	4760
V2	10066
V3	1584
V4	186
V5	118

Figure 30: Luxembourg Bus Network Motif

Melbourne Bus Network



Map based on Longitude (generated) and Latitude (generated).

Figure 31: Melbourne Bus Network Map

No. of Nodes	17579
No. of Edges	19430

Motif	No.
T1	26802
T2	153
V1	9698
V2	38560
V3	928
V4	324
V5	22

Figure 32: Melbourne Bus Network Motif



Figure 33: Nantes Bus Network Map

No. of Nodes	2208
No. of Edges	2587

Motif	No.
T1	3956
T2	44
V1	1367
V2	6162
V3	210
V4	37
V5	4

Figure 34: Nantes Bus Network Motif

Palermo Bus Network



Figure 35: Palermo Bus Network Map

No. of Nodes	2176
No. of Edges	2561

Motif	No.
T1	4146
T2	29
V1	2256
V2	6569
V3	287
V4	62
V5	29

Figure 36: Palermo Bus Network Motif

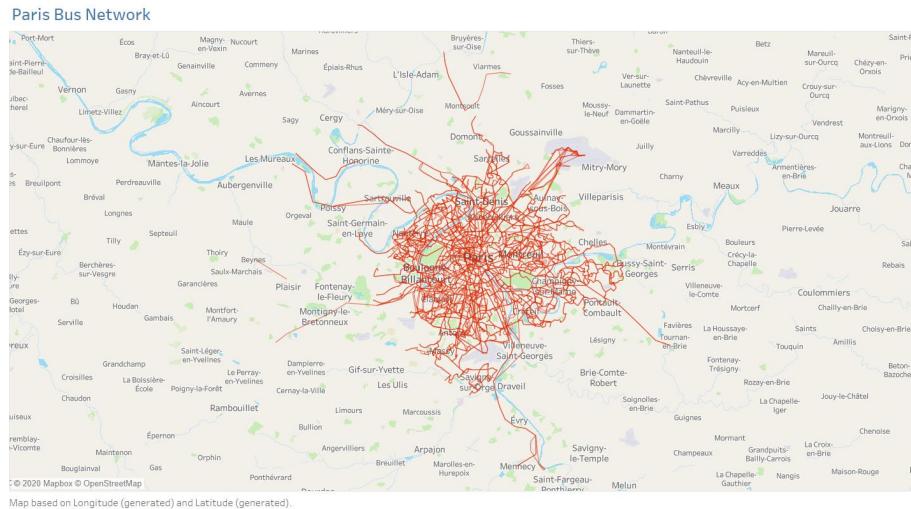


Figure 37: Paris Bus Network Map

No. of Nodes	10880
No. of Edges	12604
Motif	No.
T1	19712
T2	60
V1	8043
V2	30444
V3	315
V4	172
V5	2

Figure 38: Paris Bus Network Motif

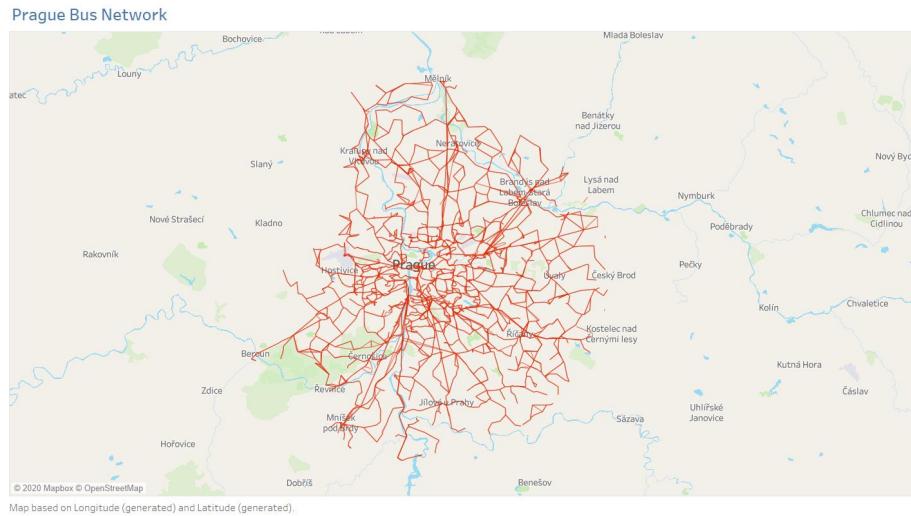


Figure 39: Prague Bus Network Map

No. of Nodes	4476
No. of Edges	5911
Motif	
T1	12048
T2	226
V1	7966
V2	24318
V3	1453
V4	310
V5	56

Figure 40: Prague Bus Network Motif

Rennes Bus Network

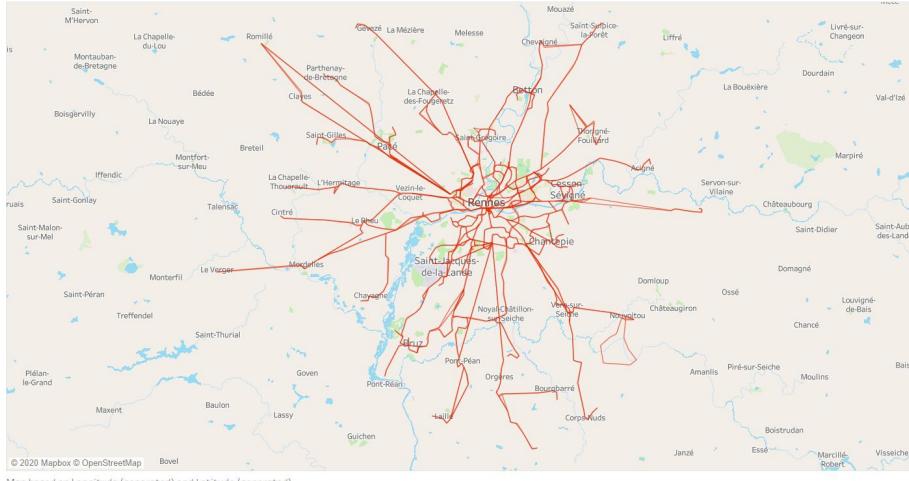


Figure 41: Rennes Bus Network Map

No. of Nodes	1378
No. of Edges	1643

Motif	No.
T1	2634
T2	25
V1	1081
V2	4257
V3	123
V4	34
V5	0

Figure 42: Rennes Bus Network Motif

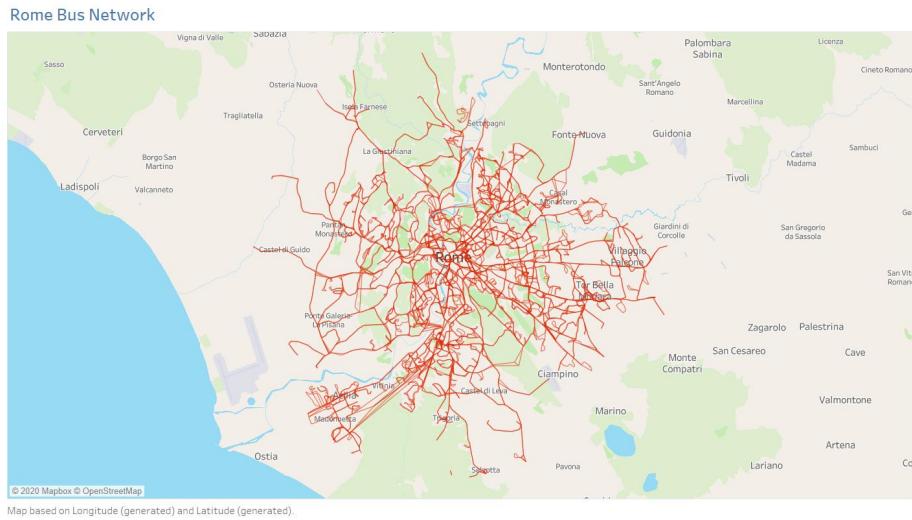


Figure 43: Rome Bus Network Map

No. of Nodes	7500
No. of Edges	9669
Motif	No.
T1	18635
T2	246
V1	11833
V2	36418
V3	1679
V4	523
V5	45

Figure 44: Rome Bus Network Motif

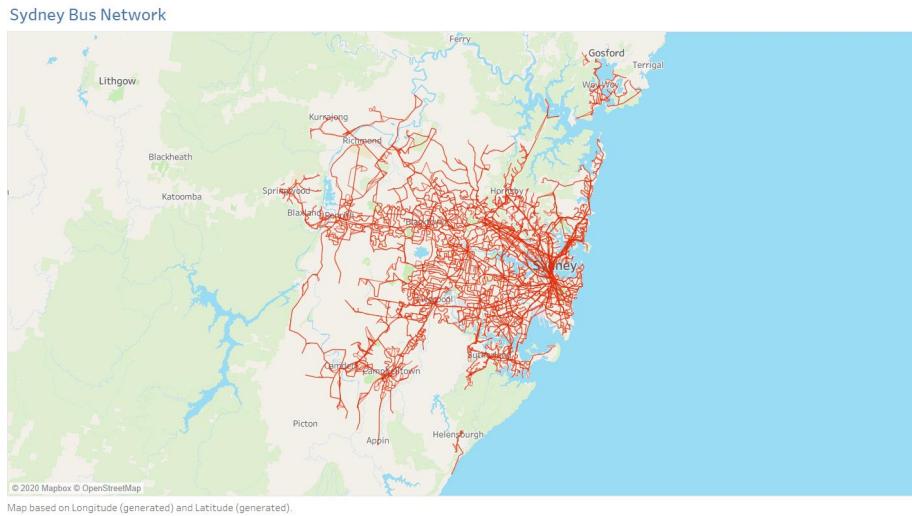


Figure 45: Sydney Bus Network Map

No. of Nodes	23414
No. of Edges	27556

Motif	No.
T1	43610
T2	668
V1	19952
V2	75781
V3	3733
V4	664
V5	153

Figure 46: Sydney Bus Network Motif

Toulouse Bus Network

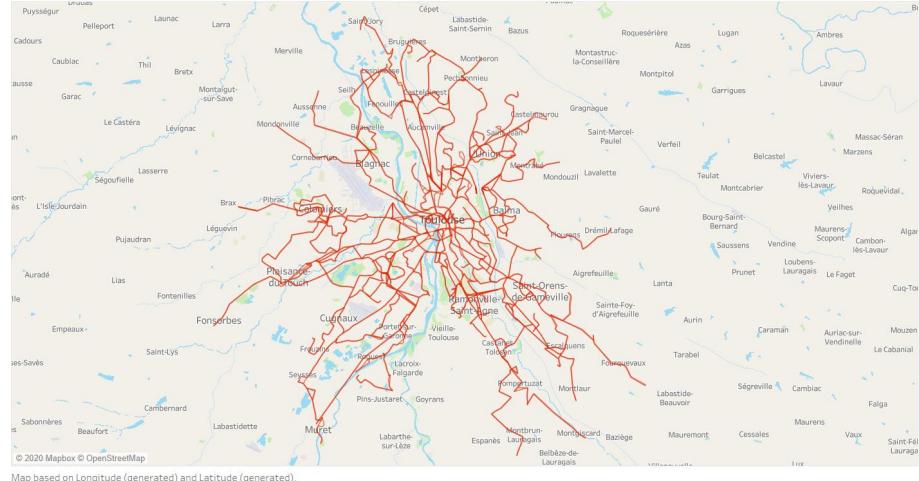


Figure 47: Toulouse Bus Network Map

No. of Nodes	3237
No. of Edges	3668

Motif	No.
T1	5233
T2	17
V1	1773
V2	7427
V3	73
V4	100
V5	0

Figure 48: Toulouse Bus Network Motif

Turku Bus Network



Figure 49: Turku Bus Network Map

No. of Nodes	1850
No. of Edges	2341

Motif	No.
T1	4318
T2	46
V1	2538
V2	8084
V3	273
V4	124
V5	10

Figure 50: Turku Bus Network Motif

Venice Bus Network

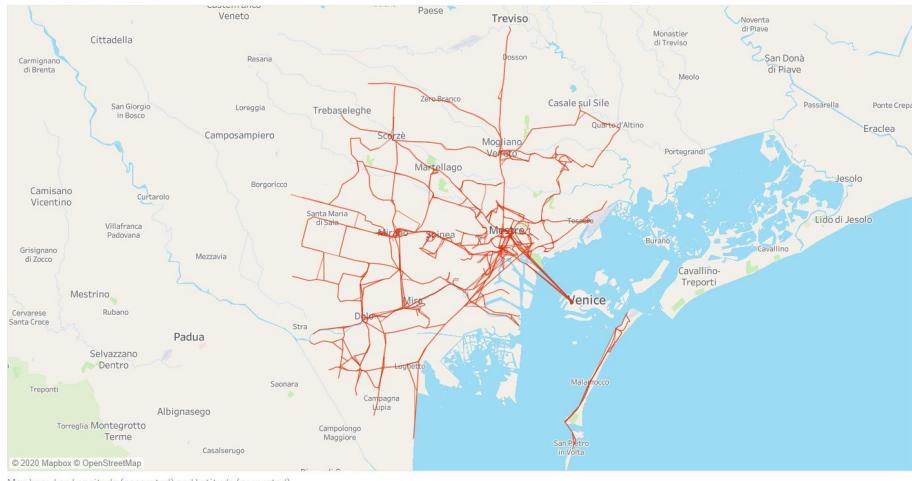


Figure 51: Venice Bus Network Map

No. of Nodes	1733
No. of Edges	2398

Motif	No.
T1	5304
T2	155
V1	5004
V2	12054
V3	1223
V4	239
V5	106

Figure 52: Venice Bus Network Motif

Winnipeg Bus Network

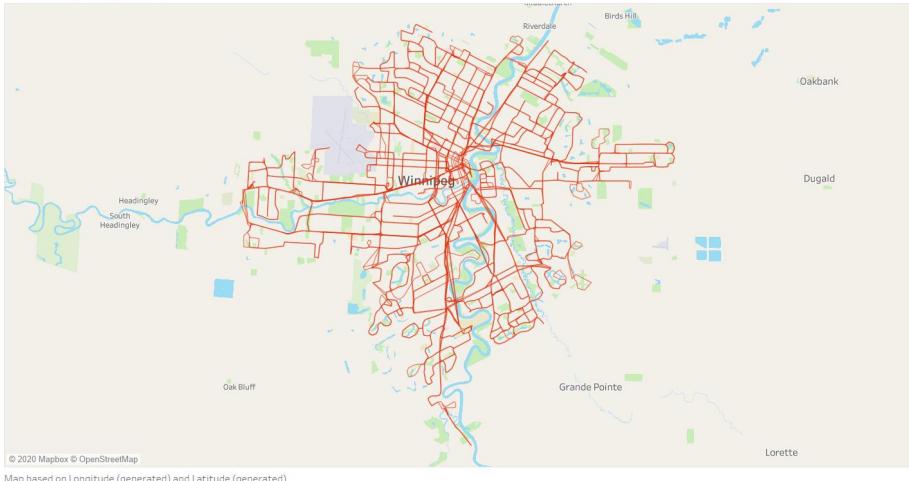


Figure 53: Winnipeg Bus Network Map

No. of Nodes	5079
No. of Edges	5846

Motif	No.
T1	8864
T2	58
V1	3563
V2	14011
V3	338
V4	153
V5	10

Figure 54: Winnipeg Bus Network Motif

3 Edge Vs Motif plot of Bus Network

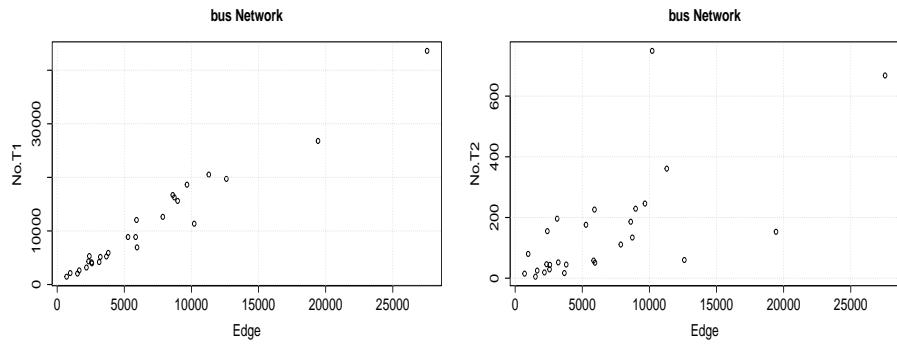


Figure 55: (a) Edge vs Motif T1, (b) Edge vs Motif T2

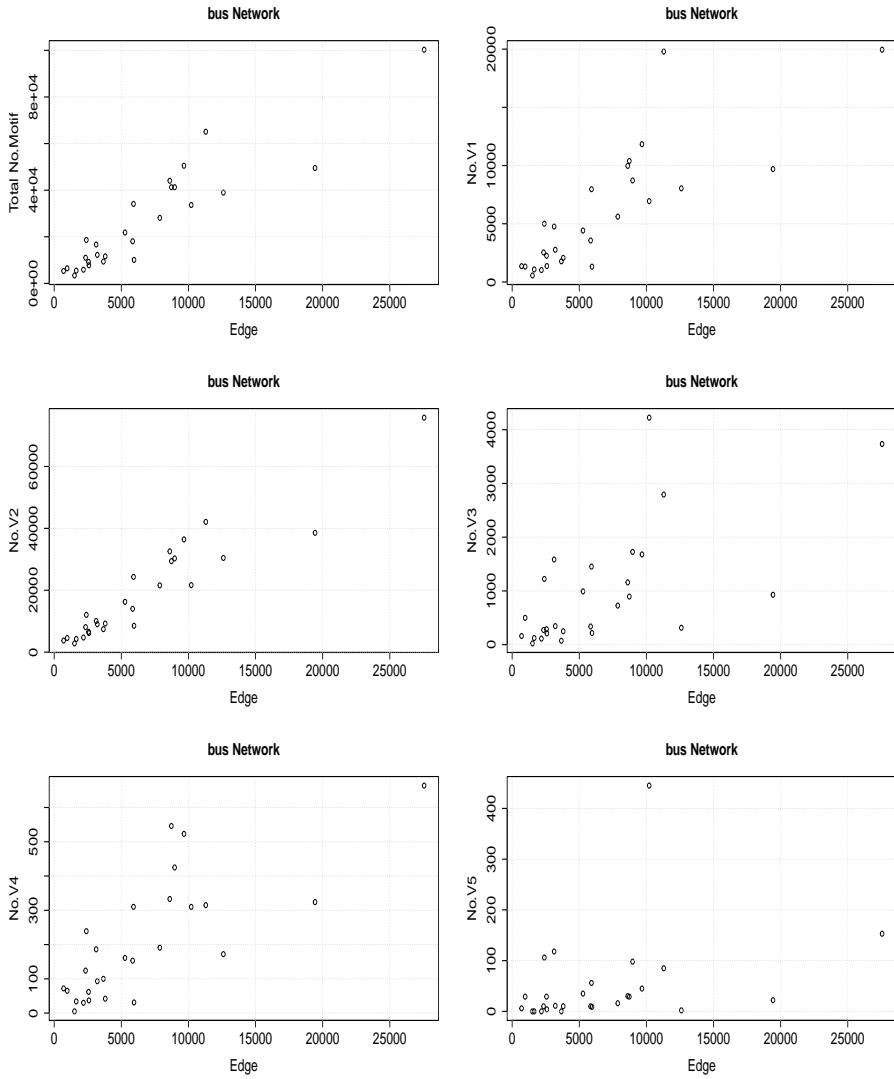


Figure 56: (a) Edge vs Motif Total, (b) Edge vs Motif V1, (c) Edge vs Motif V2, (d) Edge vs Motif V3, (e) Edge vs Motif V4 and (f) Edge vs Motif V5

4 Rail Network

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

Table 2: 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

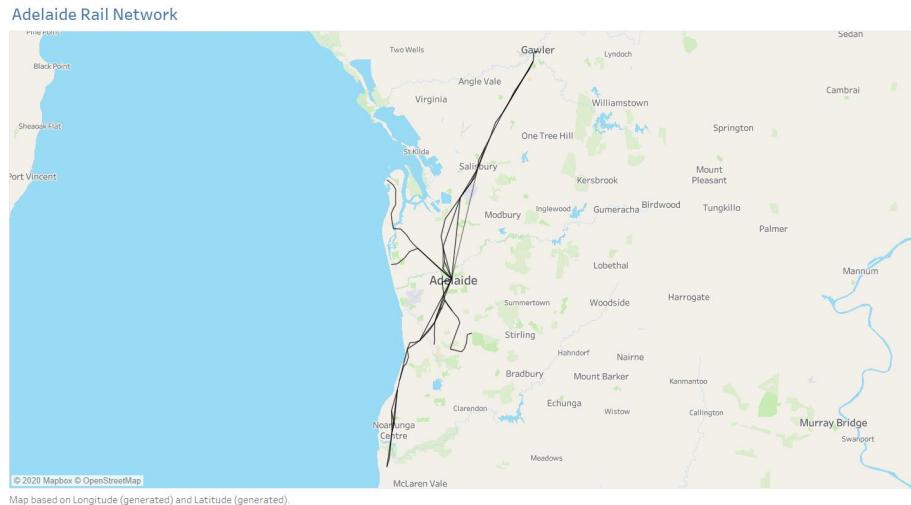


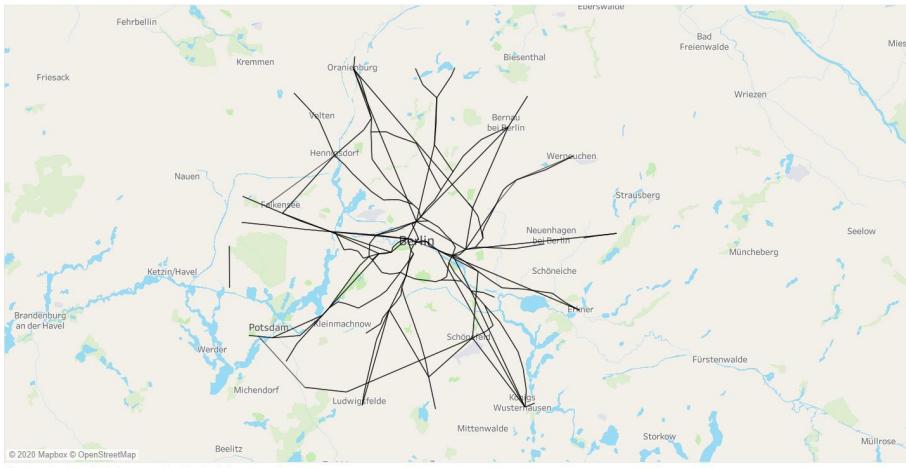
Figure 57: Adelaide Rail Network Map

No. of Nodes	175
No. of Edges	230

Motif	No.
T1	554
T2	34
V1	1291
V2	1296
V3	309
V4	19
V5	10

Figure 58: Adelaide Rail Network Motif

Berlin Rail Network



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Map based on Longitude (generated) and Latitude (generated).

Figure 59: Berlin Rail Network Map

No. of Nodes	204
No. of Edges	507

Motif	No.
T1	530
T2	13
V1	432
V2	1166
V3	93
V4	9
V5	2

Figure 60: Berlin Rail Network Motif

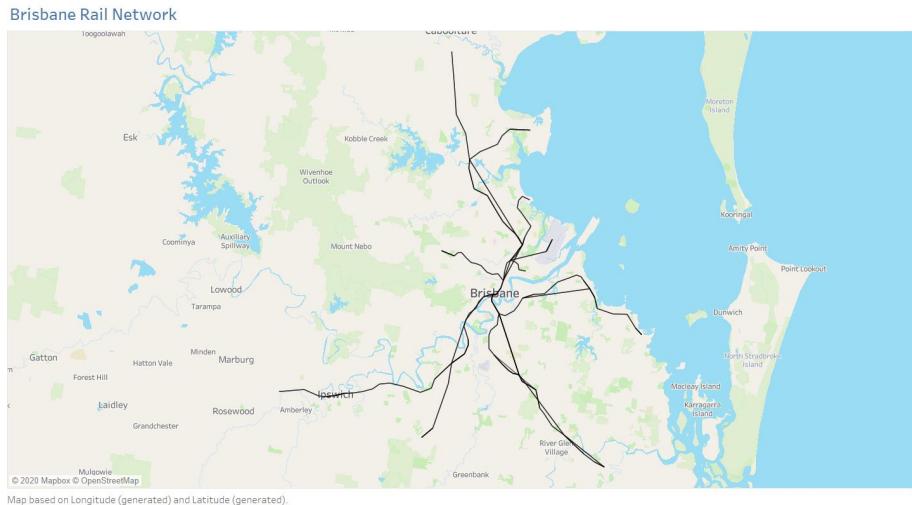


Figure 61: Brisbane Rail Network Map

No. of Nodes	297
No. of Edges	382

Motif	No.
T1	665
T2	2
V1	355
V2	1064
V3	7
V4	84
V5	0

Figure 62: Brisbane Rail Network Motif

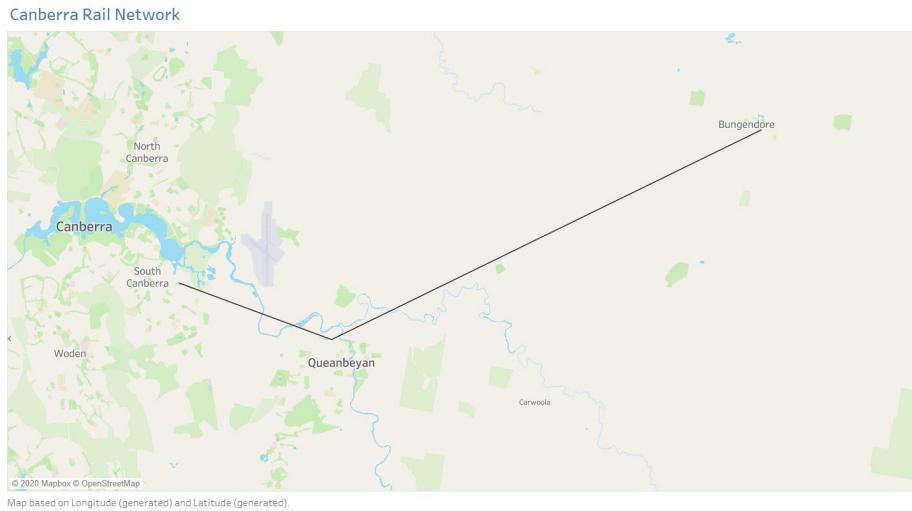


Figure 63: Canberra Rail Network Map

No. of Nodes	3
No. of Edges	4

Motif	No.
T1	1
T2	0
V1	0
V2	0
V3	0
V4	0
V5	0

Figure 64: Canberra Rail Network Motif

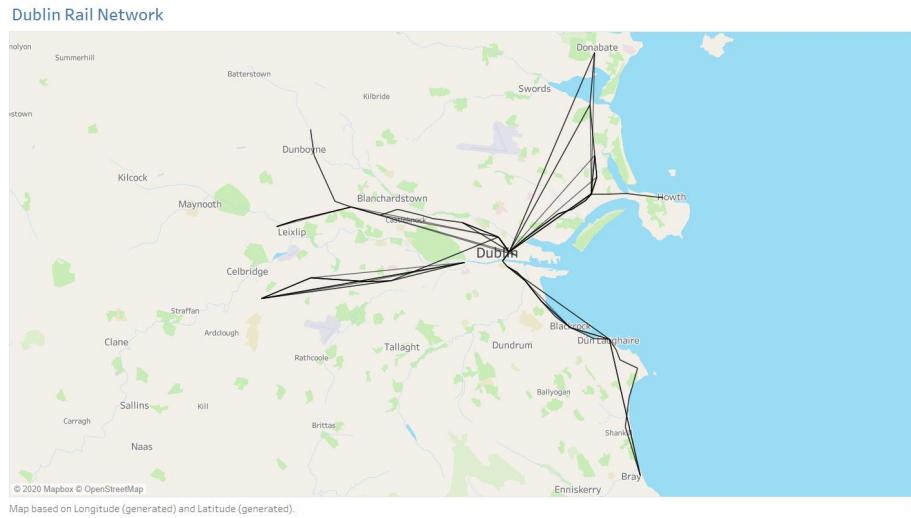


Figure 65: Dublin Rail Network Map

No. of Nodes	102
No. of Edges	185

Motif	No.
T1	416
T2	31
V1	537
V2	976
V3	206
V4	44
V5	21

Figure 66: Dublin Rail Network Motif

Helsinki Rail Network

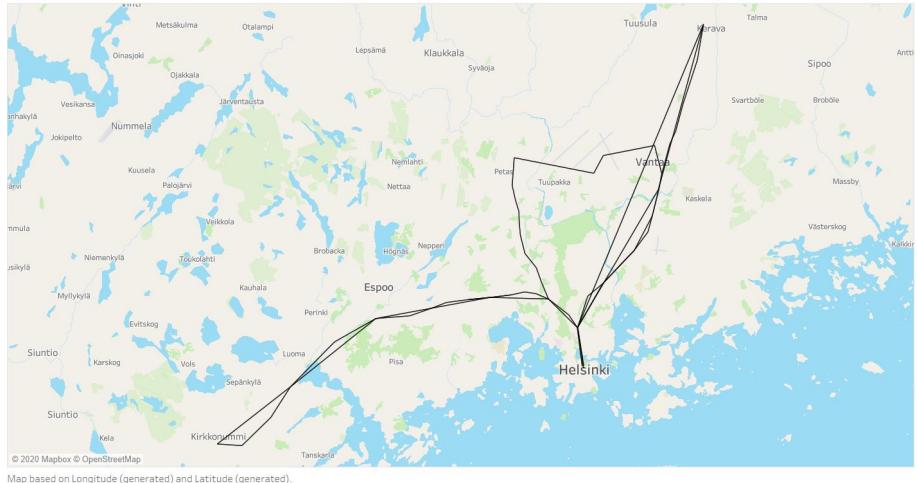


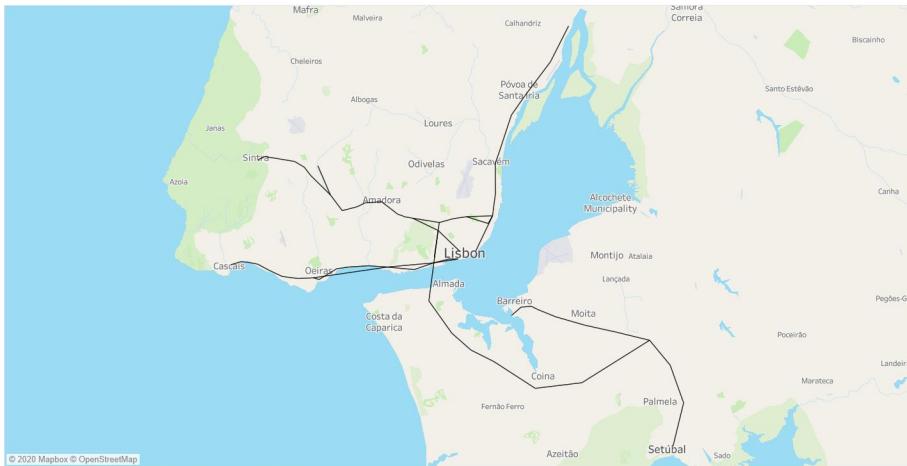
Figure 67: Helsinki Rail Network Map

No. of Nodes	75
No. of Edges	119

Motif	No.
T1	212
T2	10
V1	149
V2	297
V3	62
V4	11
V5	1

Figure 68: Helsinki Rail Network Motif

Lisbon Rail Network



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Map based on Longitude (generated) and Latitude (generated).

Figure 69: Lisbon Rail Network Map

No. of Nodes	65
No. of Edges	136

Motif	No.
T1	80
T2	4
V1	14
V2	82
V3	14
V4	0
V5	0

Figure 70: Lisbon Rail Network Motif

Luxembourg Rail Network

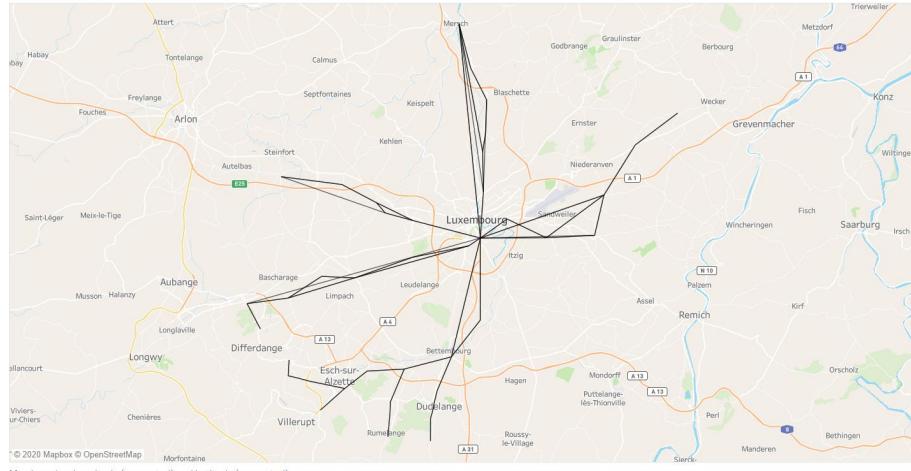


Figure 71: Luxembourg Rail Network Map

No. of Nodes	43
No. of Edges	107

Motif	No.
T1	110
T2	11
V1	123
V2	173
V3	67
V4	3
V5	3

Figure 72: Luxembourg Rail Network Motif

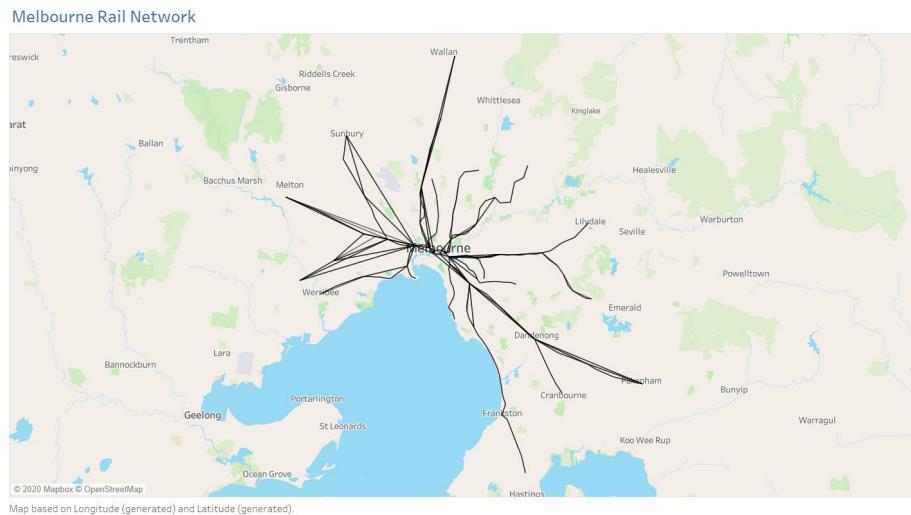


Figure 73: Melbourne Rail Network Map

No. of Nodes	225
No. of Edges	569

Motif	No.
T1	619
T2	48
V1	580
V2	1322
V3	371
V4	7
V5	26

Figure 74: Melbourne Rail Network Motif



Figure 75: Paris Rail Network Map

No. of Nodes	433
No. of Edges	1094
Motif	No.
T1	946
T2	100
V1	464
V2	1579
V3	436
V4	21
V5	57

Figure 76: Paris Rail Network Motif

Rome Rail Network

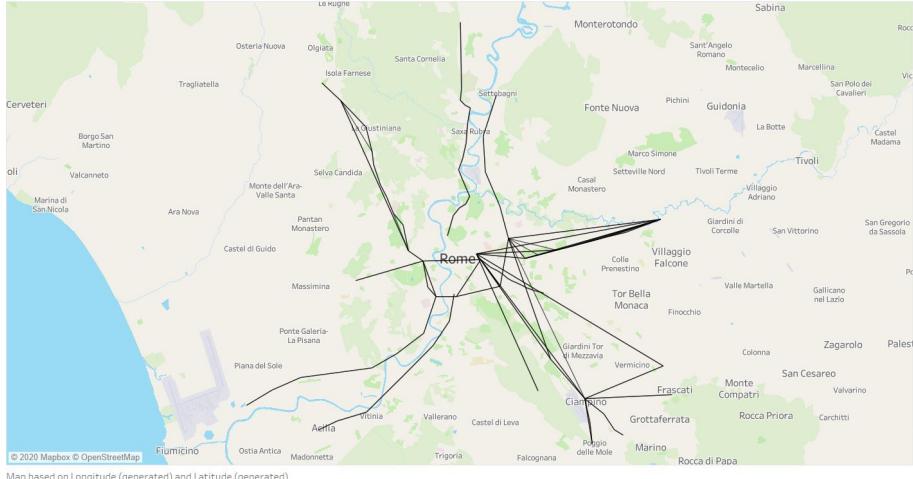


Figure 77: Rome Rail Network Map

No. of Nodes	116
No. of Edges	199

Motif	No.
T1	211
T2	25
V1	106
V2	301
V3	122
V4	8
V5	24

Figure 78: Rome Rail Network Motif

Sydney Rail Network



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Map based on Longitude (generated) and Latitude (generated).

Figure 79: Sydney Rail Network Map

No. of Nodes	524
No. of Edges	975

Motif	No.
T1	3613
T2	151
V1	6476
V2	12594
V3	1792
V4	623
V5	160

Figure 80: Sydney Rail Network Motif

5 Edge Vs Motif plot of Rail Network

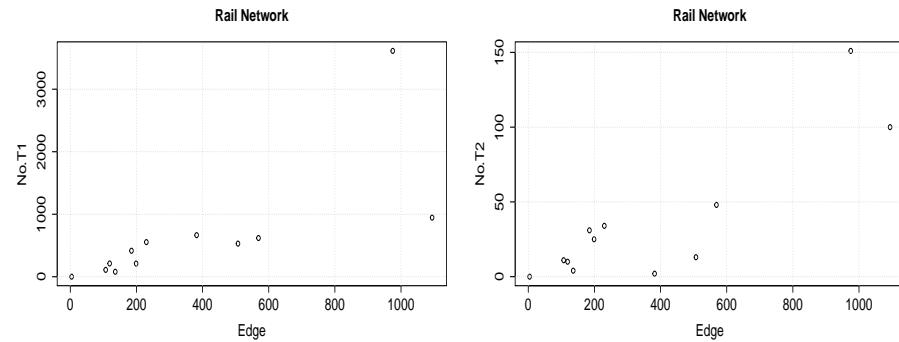


Figure 81: (a) Edge vs Motif T1, (b) Edge vs Motif T2

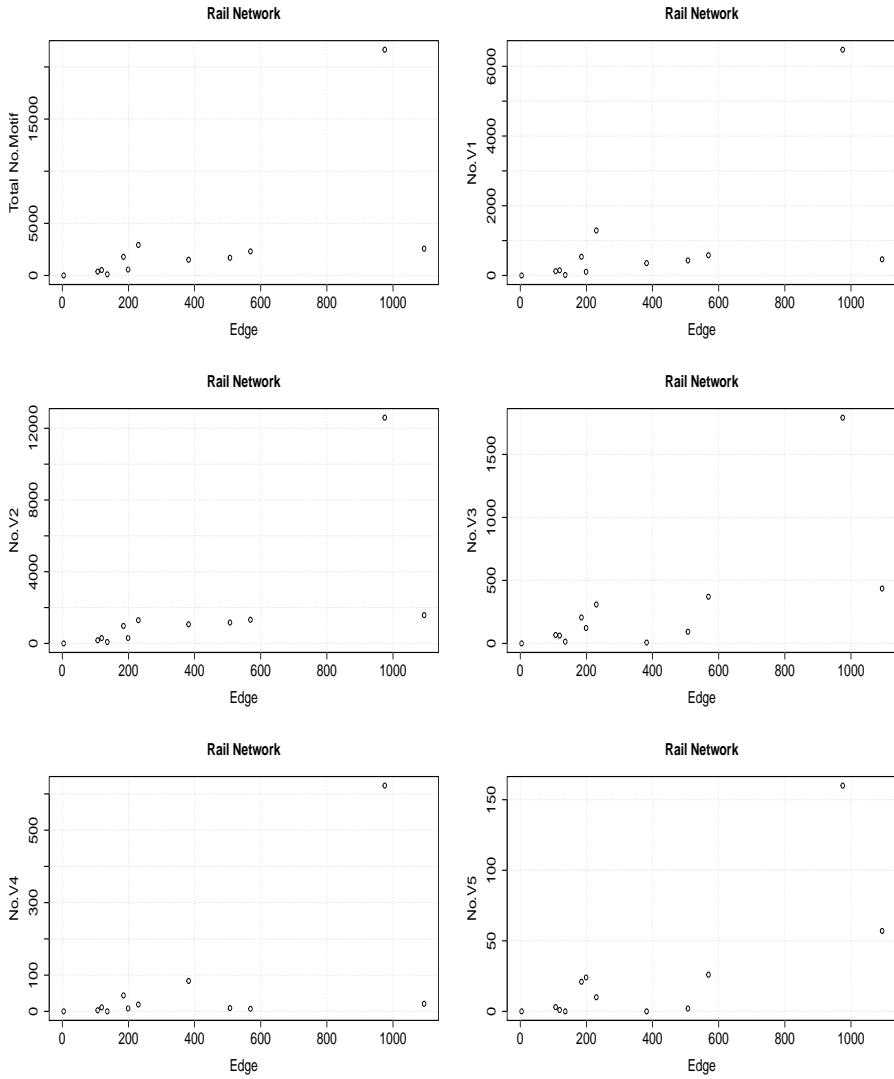


Figure 82: (a) Edge vs Motif Total, (b) Edge vs Motif V1, (c) Edge vs Motif V2, (d) Edge vs Motif V3, (e) Edge vs Motif V4 and (f) Edge vs Motif V5

6 Subway Network

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

Table 3: 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

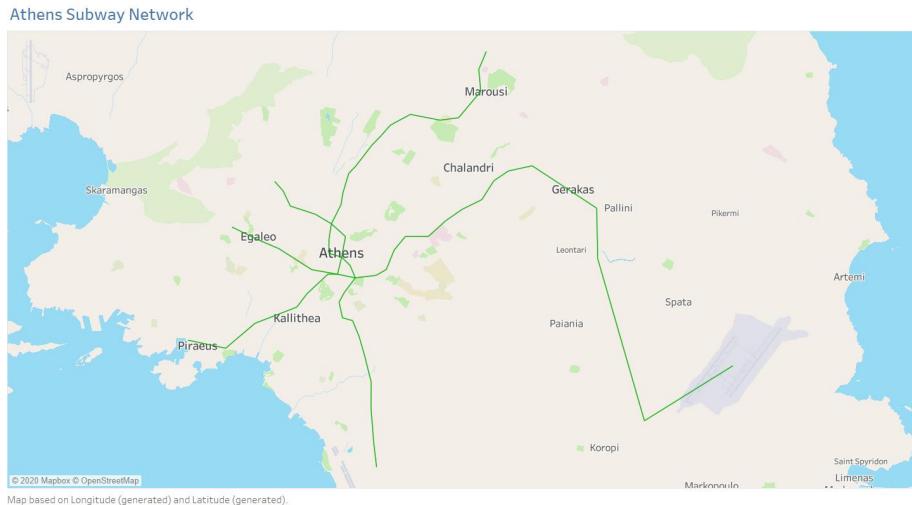


Figure 83: Athens Subway Network Map

No. of Nodes	61
No. of Edges	124
Motif	
T1	75
T2	0
V1	16
V2	92
V3	0
V4	1
V5	0

Figure 84: Athens Subway Network Motif

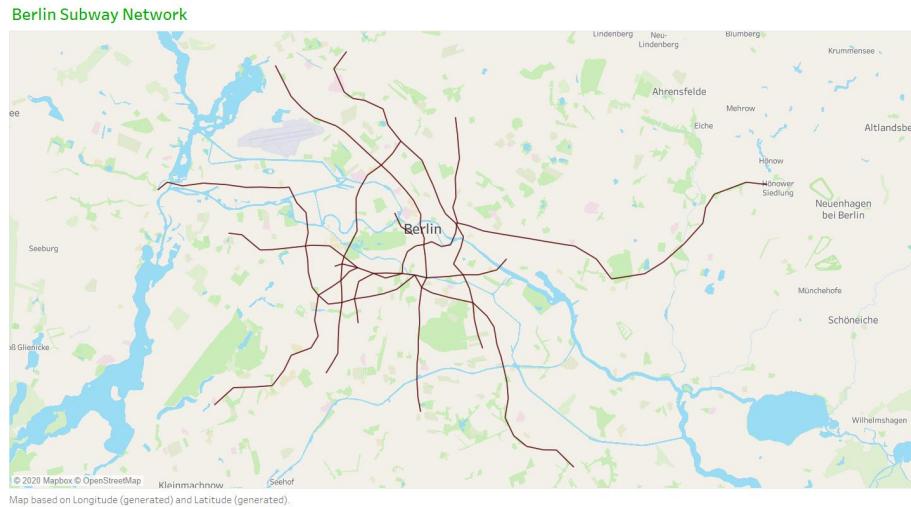


Figure 85: Berlin Subway Network Map

No. of Nodes	175
No. of Edges	366

Motif	No.
T1	234
T2	2
V1	53
V2	297
V3	12
V4	2
V5	0

Figure 86: Berlin Subway Network Motif

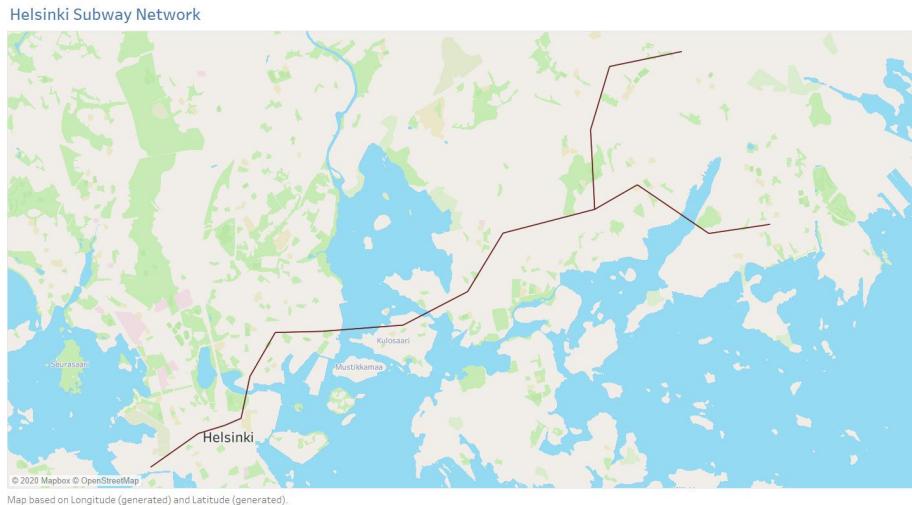


Figure 87: Helsinki Subway Network Map

No. of Nodes	19
No. of Edges	32

Motif	No.
T1	25
T2	0
V1	4
V2	22
V3	0
V4	2
V5	0

Figure 88: Helsinki Subway Network Motif

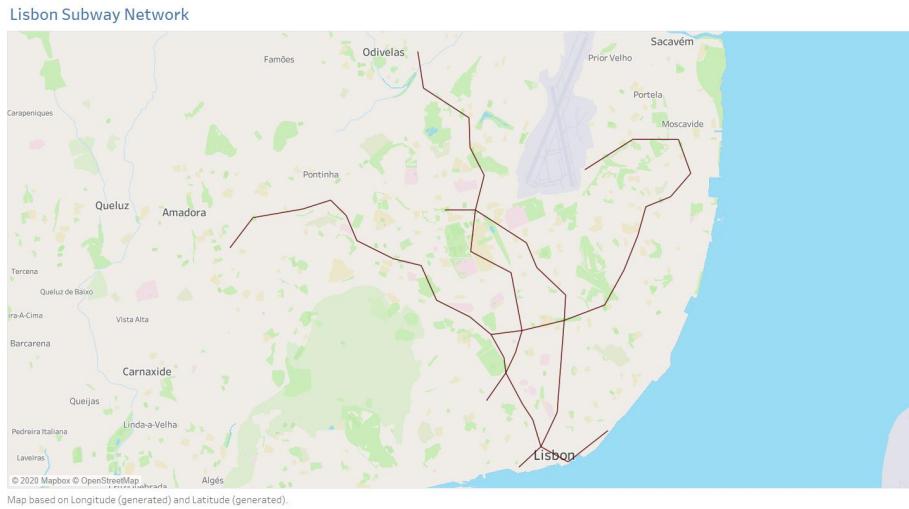


Figure 89: Lisbon Subway Network Map

No. of Nodes	50
No. of Edges	104

Motif	No.
T1	70
T2	0
V1	21
V2	88
V3	0
V4	0
V5	0

Figure 90: Lisbon Subway Network Motif

Paris Subway Network



Figure 91: Paris Subway Network Map

No. of Nodes	383
No. of Edges	727

Motif	No.
T1	361
T2	1
V1	4
V2	347
V3	3
V4	1
V5	0

Figure 92: Paris Subway Network Motif



Figure 93: Prague Subway Network Map

No. of Nodes	122
No. of Edges	119

Motif	No.
T1	121
T2	0
V1	6
V2	114
V3	0
V4	3
V5	0

Figure 94: Prague Subway Network Motif



Figure 95: Rennes Subway Network Map

No. of Nodes	29
No. of Edges	28

Motif	No.
T1	27
T2	0
V1	0
V2	26
V3	0
V4	0
V5	0

Figure 96: Rennes Subway Network Motif

Rome Subway Network

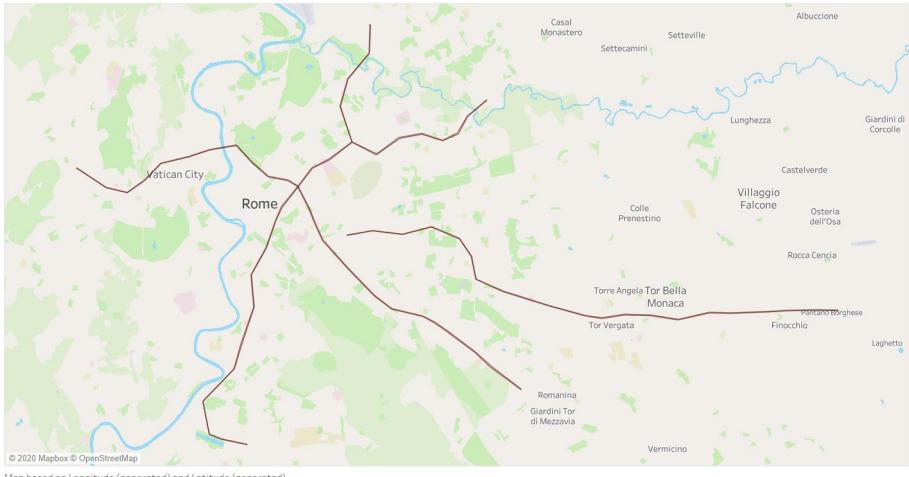


Figure 97: Rome Subway Network Map

No. of Nodes	148
No. of Edges	142

Motif	No.
T1	138
T2	0
V1	2
V2	134
V3	0
V4	0
V5	0

Figure 98: Rome Subway Network Motif

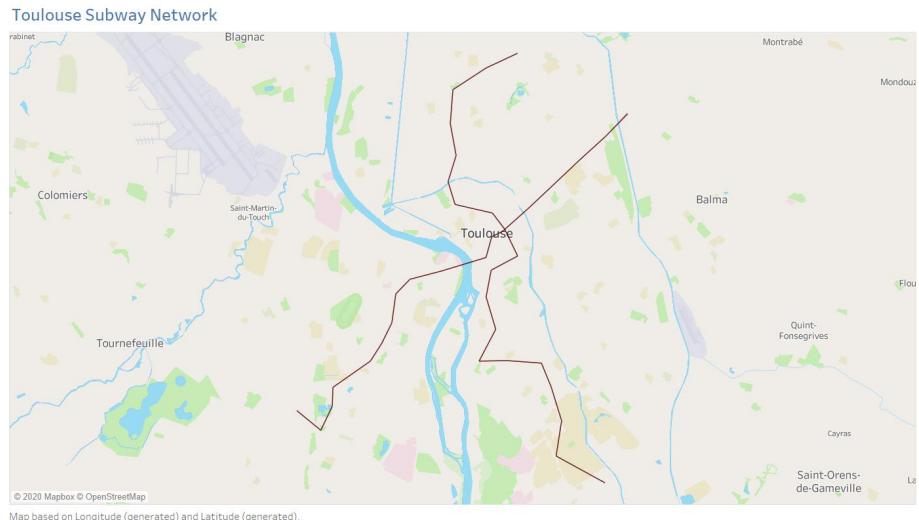


Figure 99: Toulouse Subway Network Map

No. of Nodes	40
No. of Edges	72
Motif	No.
T1	38
T2	0
V1	2
V2	34
V3	0
V4	0
V5	0

Figure 100: Toulouse Subway Network Motif

7 Edge Vs Motif plot of Subway Network

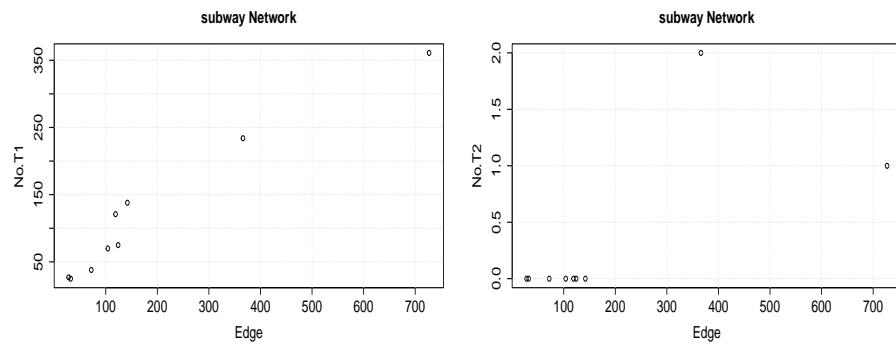


Figure 101: (a) Edge vs Motif T1, (b) Edge vs Motif T2

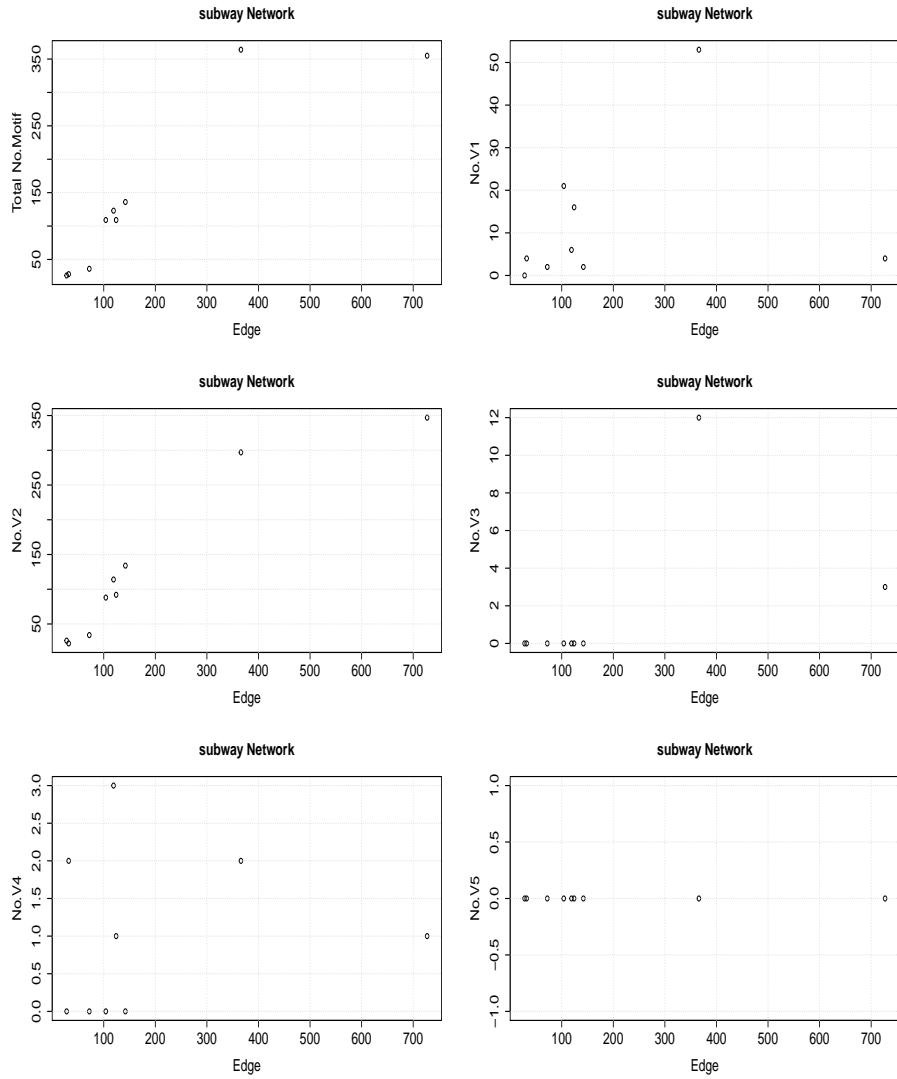


Figure 102: (a) Edge vs Motif Total, (b) Edge vs Motif V1, (c) Edge vs Motif V2, (d) Edge vs Motif V3, (e) Edge vs Motif V4 and (f) Edge vs Motif V5

8 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

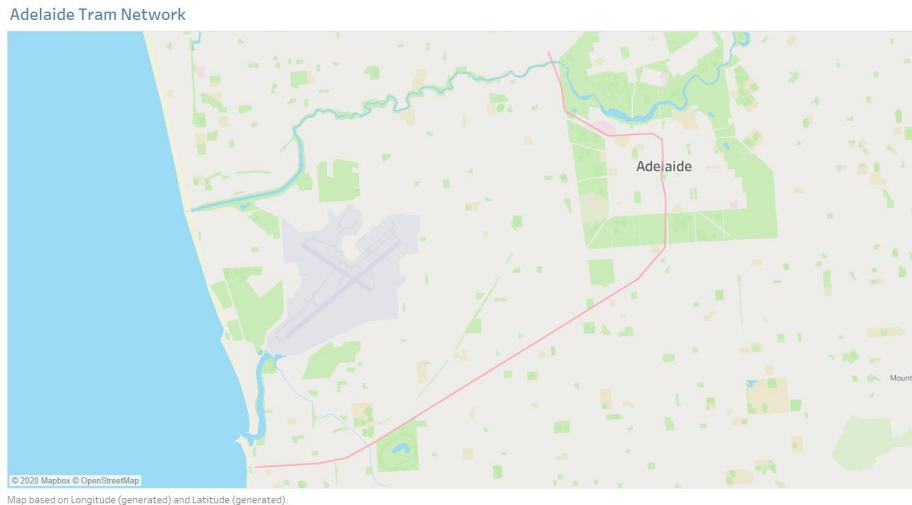


Figure 103: Adelaide Tram Network Map

No. of Nodes	56
No. of Edges	54

Motif	No.
T1	52
T2	0
V1	0
V2	50
V3	0
V4	0
V5	0

Figure 104: Adelaide Tram Network Motif

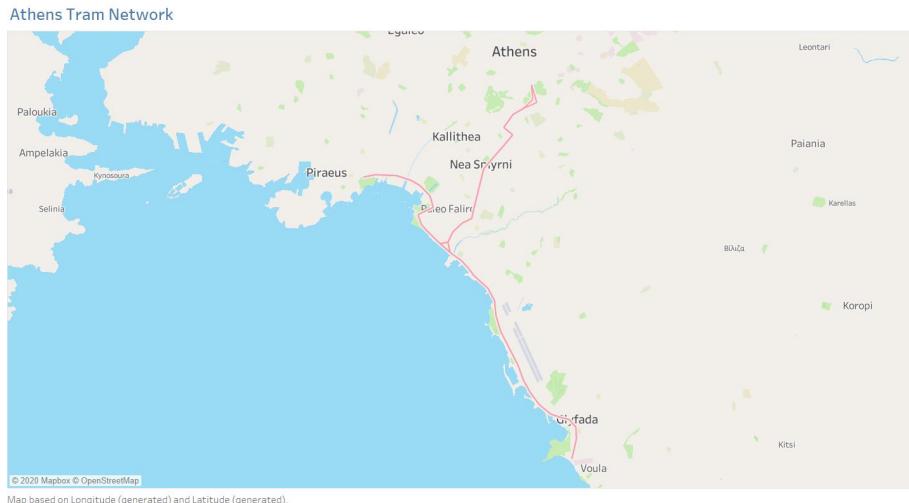


Figure 105: Athens Tram Network Map

No. of Nodes	49
No. of Edges	96

Motif	No.
T1	52
T2	1
V1	1
V2	50
V3	3
V4	1
V5	0

Figure 106: Athens Tram Network Motif

Berlin Tram Network

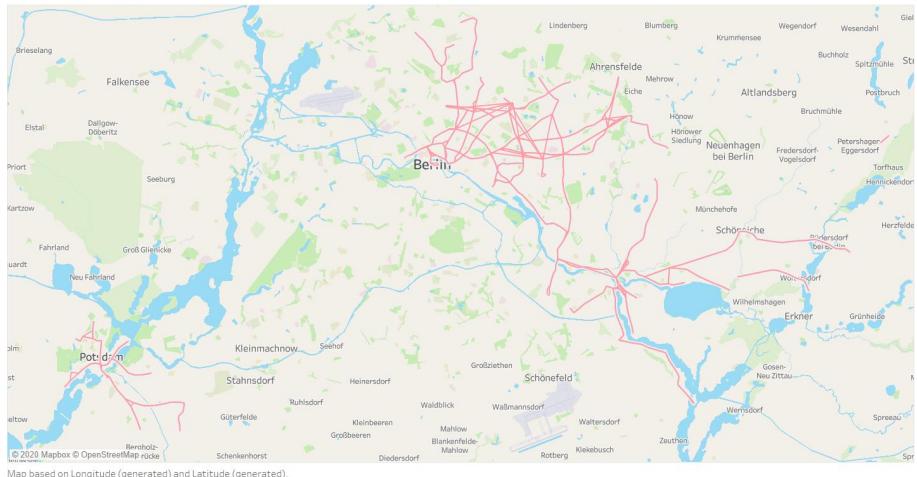


Figure 107: Berlin Tram Network Map

No. of Nodes	479
No. of Edges	990

Motif	No.
T1	850
T2	32
V1	368
V2	1362
V3	151
V4	18
V5	12

Figure 108: Berlin Tram Network Motif

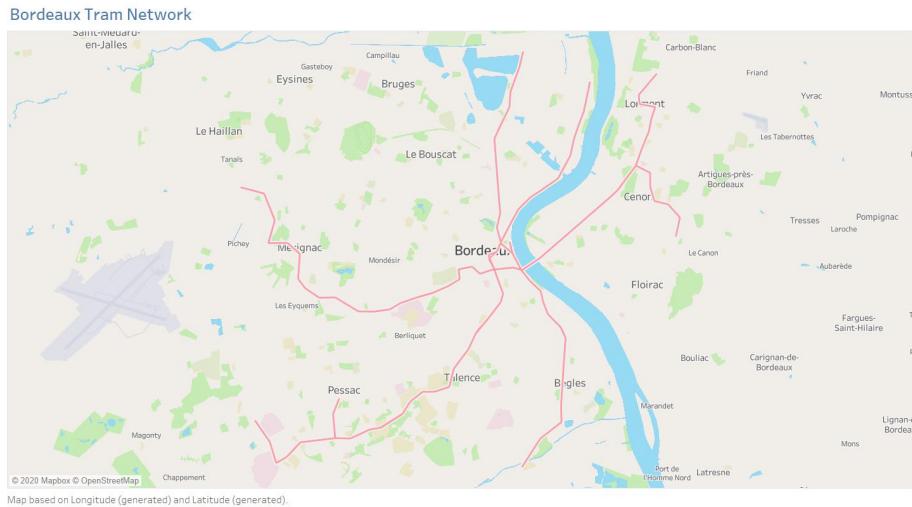


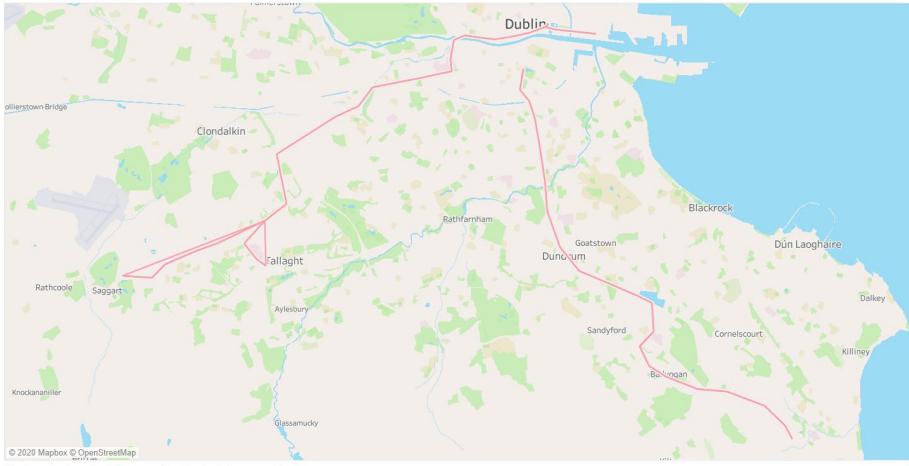
Figure 109: Bordeaux Tram Network Map

No. of Nodes	218
No. of Edges	222

Motif	No.
T1	236
T2	0
V1	10
V2	250
V3	0
V4	0
V5	0

Figure 110: Bordeaux Tram Network Motif

Dublin Tram Network



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Map based on Longitude (generated) and Latitude (generated).

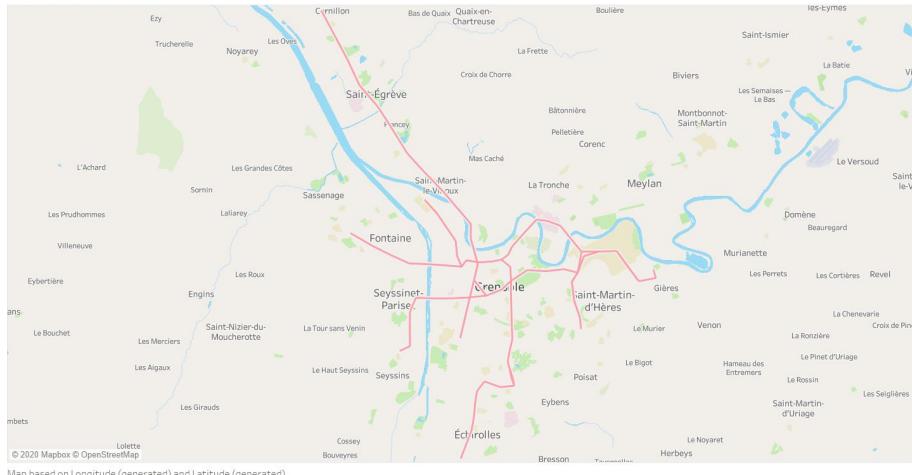
Figure 111: Dublin Tram Network Map

No. of Nodes	108
No. of Edges	106

Motif	No.
T1	112
T2	0
V1	10
V2	112
V3	0
V4	1
V5	0

Figure 112: Dublin Tram Network Motif

Grenoble Tram Network



Map based on Longitude (generated) and Latitude (generated).

Figure 113: Grenoble Tram Network Map

No. of Nodes	164
No. of Edges	168

Motif	No.
T1	196
T2	0
V1	28
V2	223
V3	0
V4	1
V5	0

Figure 114: Grenoble Tram Network Motif

Helsinki Tram Network



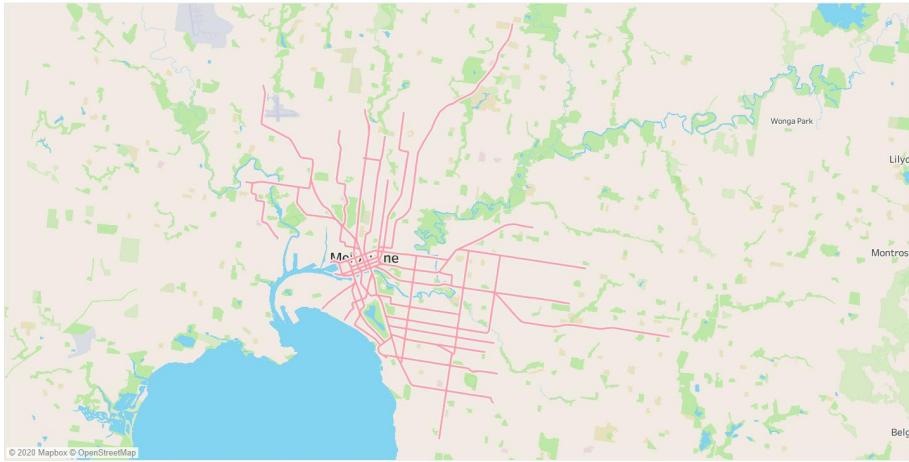
Figure 115: Helsinki Tram Network Map

No. of Nodes	270
No. of Edges	306

Motif	No.
T1	436
T2	0
V1	111
V2	626
V3	0
V4	5
V5	0

Figure 116: Helsinki Tram Network Motif

Melbourne Tram Network



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Map based on Longitude (generated) and Latitude (generated).

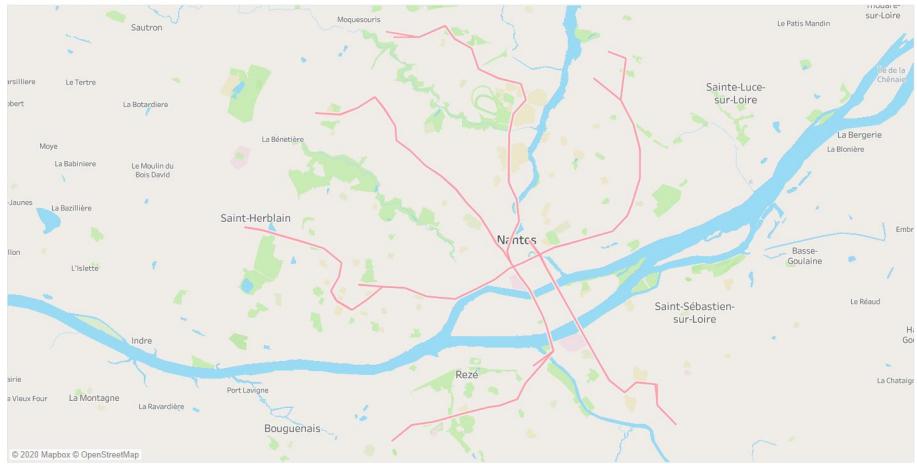
Figure 117: Melbourne Tram Network Map

No. of Nodes	1694
No. of Edges	1738

Motif	No.
T1	1886
T2	1
V1	116
V2	2073
V3	4
V4	0
V5	0

Figure 118: Melbourne Tram Network Motif

Nantes Tram Network



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Map based on Longitude (generated) and Latitude (generated).

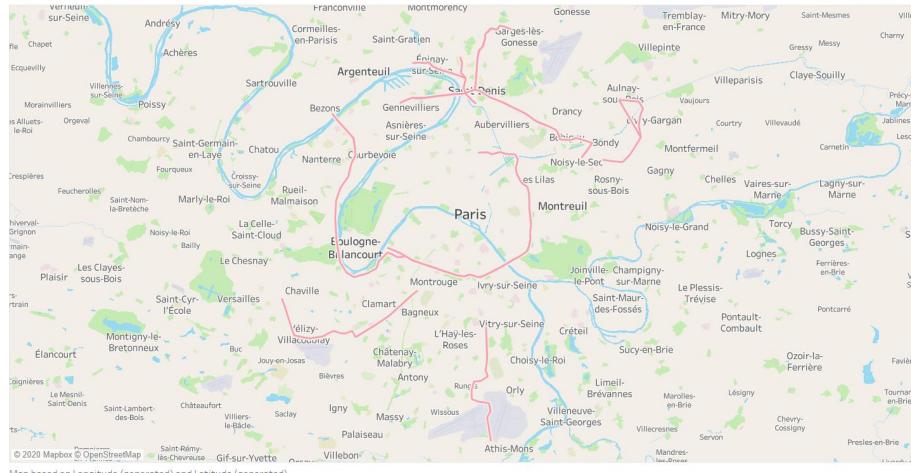
Figure 119: Nantes Tram Network Map

No. of Nodes	147
No. of Edges	192

Motif	No.
T1	234
T2	0
V1	82
V2	269
V3	0
V4	7
V5	0

Figure 120: Nantes Tram Network Motif

Paris Tram Network



Map based on Longitude (generated) and Latitude (generated).

Figure 121: Paris Tram Network Map

No. of Nodes	356
No. of Edges	356
Motif	No.
T1	337
T2	0
V1	3
V2	329
V3	0
V4	0
V5	0

Figure 122: Paris Tram Network Motif



Figure 123: Prague Tram Network Map

No. of Nodes	598
No. of Edges	716

Motif	No.
T1	1241
T2	4
V1	548
V2	2240
V3	16
V4	30
V5	2

Figure 124: Prague Tram Network Motif



Figure 125: Rome Tram Network Map

No. of Nodes	185
No. of Edges	196
Motif	
T1	233
T2	0
V1	31
V2	279
V3	0
V4	1
V5	0

Figure 126: Rome Tram Network Motif

Sydney Tram Network



Figure 127: Sydney Tram Network Map

No. of Nodes	44
No. of Edges	44

Motif	No.
T1	44
T2	0
V1	0
V2	44
V3	0
V4	0
V5	0

Figure 128: Sydney Tram Network Motif

Toulouse Tram Network

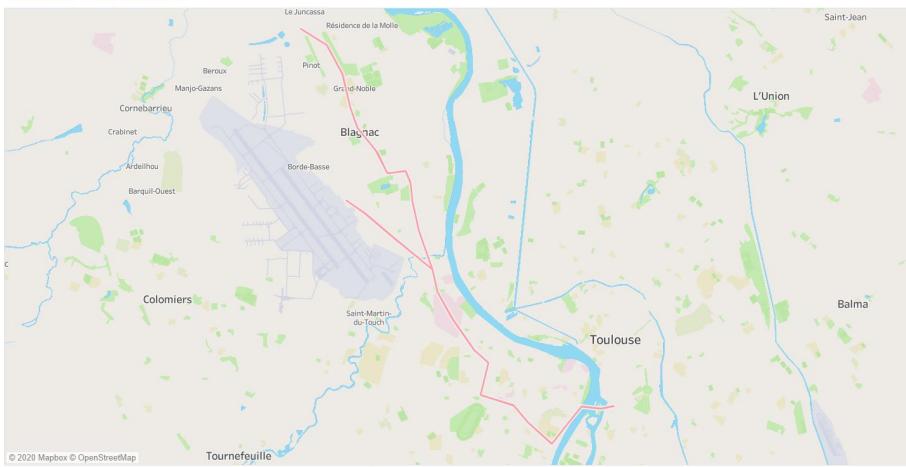


Figure 129: Toulouse Tram Network Map

No. of Nodes	52
No. of Edges	53

Motif	No.
T1	58
T2	0
V1	4
V2	64
V3	0
V4	0
V5	0

Figure 130: Toulouse Tram Network Motif

Venice Tram Network

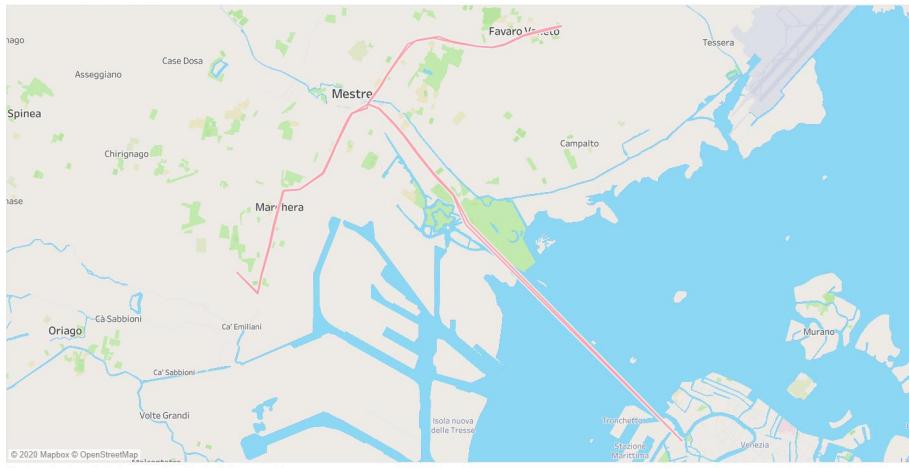


Figure 131: Venice Tram Network Map

No. of Nodes	70
No. of Edges	72

Motif	No.
T1	81
T2	0
V1	8
V2	93
V3	0
V4	0
V5	0

Figure 132: Venice Tram Network Motif

9 Edge Vs Motif plot of Tram Network

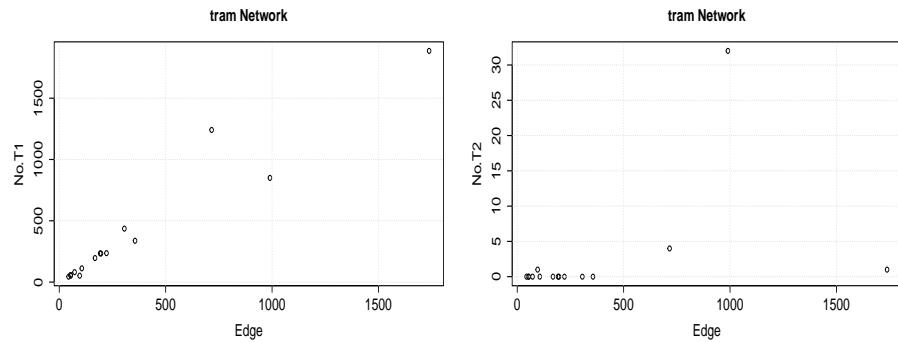


Figure 133: (a) Edge vs Motif T1, (b) Edge vs Motif T2

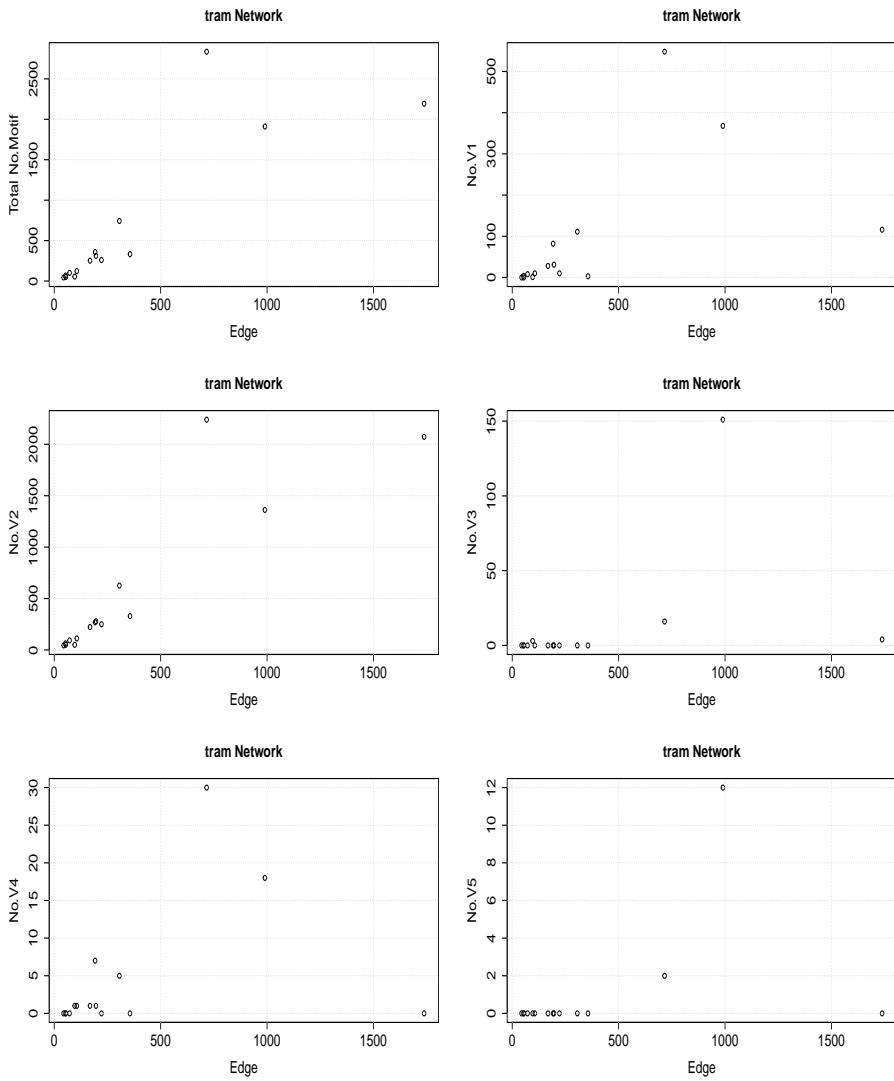


Figure 134: (a) Edge vs Motif Total, (b) Edge vs Motif V1, (c) Edge vs Motif V2, (d) Edge vs Motif V3, (e) Edge vs Motif V4 and (f) Edge vs Motif V5