College of Engineering and Applied Sciences

CS 4310 Design and Analysis of Algorithms

Assignment 5: Programming – Dijkstra's Shortest Path

Algorithm

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Question 1

Ideas and Experimental Procedures:

For this programming assignment that includes finding the shortest path between two places on the US road network using Dijkstra's shortest path algorithm on the graph, Eclipse IDE was utilized to write the code, compile it, and run it to display the proper results.

Basically, the main idea was to read all the data present on each file, create an undirected weighted graph using the road file in which two connecting roads will behave as edges from source to destination. Then, on that graph utilize the Dijkstra's algorithm that utilizes the priority queue to find the shortest path and to determine the shortest path distance between two places. To explain with further details, both the files place.txt and road.txt were read and separate array lists were created for both to store all the data related to all the places and all the roads. Then, using the road list that had source place ID and destination place ID, each road was supposed to be each edge for the graph and hash map was utilized to create the graph data structure (undirected weighted graph) for all the roads. Then, the graph was put into the Dijkstra's algorithm that included priority queue to determine the shortest path which returns the separate map that includes all the possible paths that it went through and finally returns the shortest path and shortest path distance. Finally, at the end back tracking was utilized from destination to source to print only the shortest paths from source to destination.

This code was written, compiled, and run using Eclipse IDE for Java Developers. To run the program in Eclipse IDE, the source of the java project to be run needs to be selected. Right click on it and select 'Run As'. Finally, choose 'Java Application'. My computer had JRE System library (JavaSE-14) to run the program in Eclipse. After running the program, it simply asks for "Source Name" and "Destination Name" and then prints the respective output result.

Example Output

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Enter the Source Name
CADEATH VALLEY JCT
Enter the Destination Name
MINEW HAVEN
Searching from 7705(CADEATH VALLEY JCT) to 38352(MINEW HAVEN)
        1: 7705(CADEATH VALLEY JCT) -> 7647(null), S127, 7.21 mi.
        2: 7647(null) -> 47068(NVLATHROP WELLS), S373, 16.5 mi.
        3: 47068(NVLATHROP WELLS) -> 47069(null), U95, 8.94 mi.
        4: 47069(null) -> 47074(null), U95, 7.62 mi.
        5: 47074(null) -> 47070(NVMERCURY S), U95, 9.45 mi.
        6: 47070(NVMERCURY S) -> 47071(null), U95, 4.15 mi.
        7: 47071(null) -> 47073(null), U95, 8.21 mi.
        8: 47073(null) -> 47072(NVINDIAN SPRINGS), U95, 4.49 mi.
        9: 47072(NVINDIAN SPRINGS) -> 47077(null), U95, 25.22 mi.
        10: 47077(null) -> 47078(null), U95   ANCHO DR, 4.0 mi.
        11: 47078(null) -> 47079(null), , 12.53 mi.
        12: 47079(null) -> 47081(null), , 0.94 mi.
        13: 47081(null) -> 47085(null),       AMB BLVD, 1.39 mi.
        14: 47085(null) -> 47083(null), I15, 1.29 mi.
        15: 47083(null) -> 47080(NV I15 MP058), I15, 3.21 mi.
        16: 47080(NV I15 MP058) -> 47075(NV I15 MP064), I15, 9.56 mi.
        17: 47075(NV I15 MP064) -> 47067(null), I15, 26.63 mi.
        18: 47067(null) -> 2001(null), I15, 32.98 mi.
        19: 2001(null) -> 1998(AZLITTLEFIELD), I15, 8.65 mi.
        20: 1998(AZLITTLEFIELD) -> 1980(null), I15, 20.68 mi.
        21: 1980(null) -> 80933(null), I15, 1.91 mi.
        22: 80933(null) -> 80929(null), I15, 4.49 mi.
        23: 80929(null) -> 80927(UTST GEORGE E), I15, 2.35 mi.
        24: 80927(UTST GEORGE E) -> 80923(null), I15, 2.13 mi.
        25: 80923(null) -> 80918(null), I15, 5.16 mi.
        26: 80918(null) -> 80908(null), I15, 11.54 mi.
        27: 80908(null) -> 80904(null), I15, 14.82 mi.
        28: 80904(null) -> 80892(UT I15 MP057), I15, 14.71 mi.
        29: 80892(UT I15 MP057) -> 80890(null), I15, 0.11 mi.
        30: 80890(null) -> 80884(UTCEDAR CITY W), I15, 1.98 mi.
        31: 80884(UTCEDAR CITY W) -> 80876(null), I15, 2.67 mi.
        32: 80876(null) -> 80875(null), I15, 0.33 mi.
        33: 80875(null) -> 80874(null), I15, 0.12 mi.
        34: 80874(null) -> 80873(null), I15, 0.34 mi.
        35: 80873(null) -> 80866(null), I15, 8.02 mi.
        36: 80866(null) -> 80864(null), I15, 4.95 mi.
        37: 80864(null) -> 80862(UTPAROWAN N), I15, 2.6 mi.
        38: 80862(UTPAROWAN N) -> 80858(null), I15, 4.48 mi.
        39: 80858(null) -> 80853(null), I15, 12.31 mi.
        40: 80853(null) -> 80851(null), I15, 6.72 mi.
        41: 80851(null) -> 80841(UTBEAVER S), I15, 7.53 mi.
        42: 80841(UTBEAVER S) -> 80835(UTBEAVER N), I15, 3.33 mi.
        43: 80835(UTBEAVER N) -> 80828(null), I15, 8.17 mi.
        44: 80828(null) -> 80819(null), I15, 11.83 mi.
        45: 80819(null) -> 80816(null), I15, 0.3 mi.
        46: 80816(null) -> 80815(null), I70, 1.23 mi.
        47: 80815(null) -> 80812(null), I70, 5.62 mi.
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48: 80812(null) -> 80814(null), I70, 13.42 mi.
49: 80814(null) -> 80805(null), I70, 14.93 mi.
50: 80805(null) -> 80803(UTRICHFIELD W), I70, 1.14 mi.
51: 80803(UTRICHFIELD W) -> 80797(null), I70, 1.44 mi.
52: 80797(null) -> 80794(null), I70, 0.75 mi.
53: 80794(null) -> 80790(null), I70, 9.23 mi.
54: 80790(null) -> 80787(UTSALINA S), I70, 7.32 mi.
55: 80787(UTSALINA S) -> 80804(null), I70, 32.24 mi.
56: 80804(null) -> 80802(UT I70 MP089), I70, 1.87 mi.
57: 80802(UT I70 MP089) -> 80795(null), I70, 3.2 mi.
58: 80795(null) -> 80788(UT I70 MP147), I70, 54.68 mi.
59: 80788(UT I70 MP147) -> 80778(UT I70 MP156), I70, 8.7 mi.
60: 80778(UT I70 MP156) -> 80776(UTGREEN RIVER S), I70, 4.27 mi.
61: 80776(UTGREEN RIVER S) -> 80785(null), I70, 19.72 mi.
62: 80785(null) -> 80786(null), I70, 22.45 mi.
63: 80786(null) -> 80773(UT I70 MP212), I70, 9.67 mi.
64: 80773(UT I70 MP212) -> 12676(null), I70, 17.37 mi.
65: 12676(null) -> 12671(COMACK SW), I70, 11.01 mi.
66: 12671(COMACK SW) -> 12683(COLOMA S), I70, 3.96 mi.
67: 12683(COLOMA S) -> 12685(null), I70, 4.42 mi.
68: 12685(null) -> 12684(null), , 0.15 mi.
69: 12684(null) -> 12697(null), U6, 5.63 mi.
70: 12697(null) -> 12699(COGRAND JUNCTION N), U6, 0.27 mi.
71: 12699(COGRAND JUNCTION N) -> 12700(null), I70, 5.75 mi.
72: 12700(null) -> 12703(COCLIFTON N), I70, 5.25 mi.
73: 12703(COCLIFTON N) -> 12701(null), I70, 1.51 mi.
74: 12701(null) -> 12692(CO I70 MP044), I70, 5.68 mi.
75: 12692(CO I70 MP044) -> 12680(null), I70, 4.99 mi.
76: 12680(null) -> 12679(CO I70 MP049), I70, 0.06 mi.
77: 12679(CO I70 MP049) -> 12668(null), I70, 7.53 mi.
78: 12668(null) -> 12635(COPARACHUTE), I70, 9.94 mi.
79: 12635(COPARACHUTE) -> 12613(CO I70 MP087), I70, 19.53 mi.
80: 12613(CO I70 MP087) -> 12611(CORIFLE S), I70, 5.35 mi.
81: 12611(CORIFLE S) -> 12606(CONEW CASTLE SE), I70, 6.98 mi.
82: 12606(CONEW CASTLE SE) -> 12593(null), I70, 16.33 mi.
83: 12593(null) -> 12604(null), I70, 2.58 mi.
84: 12604(null) -> 12605(COGLENWOOD SPRINGS), I70, 0.16 mi.
85: 12605(COGLENWOOD SPRINGS) -> 12594(null), I70, 1.38 mi.
86: 12594(null) -> 12595(null), I70, 0.72 mi.
87: 12595(null) -> 12549(null), I70, 12.09 mi.
88: 12549(null) -> 12531(CO I70 MP133), I70, 3.13 mi.
89: 12531(CO I70 MP133) -> 12523(COGYPSUM W), I70, 6.16 mi.
90: 12523(COGYPSUM W) -> 12492(COEAGLE N), I70, 6.95 mi.
91: 12492(COEAGLE N) -> 12404(null), I70, 7.5 mi.
92: 12404(null) -> 12439(COWOLCOTT S), I70, 2.38 mi.
93: 12439(COWOLCOTT S) -> 12567(COMINTURN NW), I70, 14.71 mi.
94: 12567(COMINTURN NW) -> 12609(null), I70, 19.05 mi.
95: 12609(null) -> 12614(COBRECKENRIDGE), I70, 5.2 mi.
96: 12614(COBRECKENRIDGE) -> 12574(COFRISCO), I70, 7.35 mi.
97: 12574(COFRISCO) -> 12545(CODILLON), I70, 3.12 mi.
98: 12545(CODILLON) -> 12461(null), I70, 8.67 mi.
99: 12461(null) -> 12453(CO I70 MP216), I70, 2.04 mi.
100: 12453(CO I70 MP216) -> 12289(null), I70, 15.56 mi.
101: 12289(null) -> 12285(COEMPIRE E), I70, 0.36 mi.
102: 12285(COEMPIRE E) -> 12331(COIDAHO SPRINGS), I70, 7.38 mi.
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103: 12331(COIDAHO SPRINGS) -> 12325(CO I70 MP244), I70, 4.63 mi.
104: 12325(CO I70 MP244) -> 12323(null), U6, 2.82 mi.
105: 12323(null) -> 12326(null), U6, 0.15 mi.
106: 12326(null) -> 12327(null), U6, 0.08 mi.
107: 12327(null) -> 12293(COGOLDEN NW), U6, 11.1 mi.
108: 12293(COGOLDEN NW) -> 12267(COWHEAT RIDGE W), S58, 5.43 mi.
109: 12267(COWHEAT RIDGE W) -> 12264(COWHEAT RIDGE NW), I70, 0.39 mi.
110: 12264(COWHEAT RIDGE NW) -> 12256(null), I70, 1.56 mi.
111: 12256(null) -> 12254(COWHEAT RIDGE E), I70, 1.53 mi.
112: 12254(COWHEAT RIDGE E) -> 12253(null), I70, 0.38 mi.
113: 12253(null) -> 12251(null), I76, 0.54 mi.
114: 12251(null) -> 12250(null), I76, 0.01 mi.
115: 12250(null) -> 12249(null), I76, 0.03 mi.
116: 12249(null) -> 12247(null), I76, 0.09 mi.
117: 12247(null) -> 12241(null), I76, 0.66 mi.
118: 12241(null) -> 12238(COWESTMINSTER S), I76, 1.5 mi.
119: 12238(COWESTMINSTER S) -> 12227(null), I76, 1.1 mi.
120: 12227(null) -> 12223(CO I25 MP216), I76, 1.45 mi.
121: 12223(CO I25 MP216) -> 12222(null), I76, 0.35 mi.
122: 12222(null) -> 12220(COCOMMERCE CITY WN), I76, 0.78 mi.
123: 12220(COCOMMERCE CITY WN) -> 12208(COTHORNTON SE), I76, 2.8 mi.
124: 12208(COTHORNTON SE) -> 12199(null), I76, 0.95 mi.
125: 12199(null) -> 12186(null), I76, 1.27 mi.
126: 12186(null) -> 12176(null), I76, 0.84 mi.
127: 12176(null) -> 12165(null), I76, 1.09 mi.
128: 12165(null) -> 12162(CO I76 MP016), I76, 2.8 mi.
129: 12162(CO I76 MP016) -> 12160(null), I76, 0.51 mi.
130: 12160(null) -> 12137(null), I76, 0.15 mi.
131: 12137(null) -> 12135(null), I76, 0.12 mi.
132: 12135(null) -> 12122(null), I76, 1.64 mi.
133: 12122(null) -> 12091(CO I76 MP025), I76, 4.81 mi.
134: 12091(CO I76 MP025) -> 12089(null), I76, 0.11 mi.
135: 12089(null) -> 12087(null), I76, 0.68 mi.
136: 12087(null) -> 12080(null), I76, 0.58 mi.
137: 12080(null) -> 12040(COHUDSON), I76, 6.36 mi.
138: 12040(COHUDSON) -> 11981(null), I76, 29.27 mi.
139: 11981(null) -> 11979(null), I76, 5.2 mi.
140: 11979(null) -> 11977(null), I76, 0.45 mi.
141: 11977(null) -> 11972(COFORT MORGAN W), I76, 8.98 mi.
142: 11972(COFORT MORGAN W) -> 11961(COFORT MORGAN N), I76, 4.51 mi.
143: 11961(COFORT MORGAN N) -> 11962(null), I76, 1.35 mi.
144: 11962(null) -> 11960(null), I76, 4.17 mi.
145: 11960(null) -> 11959(COBRUSH N), I76, 3.99 mi.
146: 11959(COBRUSH N) -> 11966(COBRUSH ENE), , 1.05 mi.
147: 11966(COBRUSH ENE) -> 11957(CO I76 MP092), U34  B, 0.96 mi.
148: 11957(CO I76 MP092) -> 11952(null), I76, 7.36 mi.
149: 11952(null) -> 11879(null), I76, 10.63 mi.
150: 11879(null) -> 11853(COATWOOD S), I76, 5.52 mi.
151: 11853(COATWOOD S) -> 11814(null), I76, 8.91 mi.
152: 11814(null) -> 11810(COSTERLING E), I76, 0.73 mi.
153: 11810(COSTERLING E) -> 11799(null), I76, 0.76 mi.
154: 11799(null) -> 11770(null), I76, 31.83 mi.
155: 11770(null) -> 11768(null), I76, 7.46 mi.
156: 11768(null) -> 11764(COJULESBURG S), I76, 15.22 mi.
157: 11764(COJULESBURG S) -> 11749(null), I76, 3.86 mi.
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158: 11749(null) -> 46306(NE I80 MP102), I76, 2.51 mi.
159: 46306(NE I80 MP102) -> 46289(null), I80, 4.73 mi.
160: 46289(null) -> 46287(null), I80, 0.83 mi.
161: 46287(null) -> 46251(null), I80, 17.94 mi.
162: 46251(null) -> 46250(NEOGALLALA S), I80, 0.36 mi.
163: 46250(NEOGALLALA S) -> 46252(null), I80, 0.22 mi.
164: 46252(null) -> 46248(null), I80, 23.1 mi.
165: 46248(null) -> 46230(NESUTHERLAND S), I80, 7.79 mi.
166: 46230(NESUTHERLAND S) -> 46260(null), I80, 18.75 mi.
167: 46260(null) -> 46263(NENORTH PLATTE S), I80, 0.27 mi.
168: 46263(NENORTH PLATTE S) -> 46264(null), I80, 0.52 mi.
169: 46264(null) -> 46288(NE I80 MP190), I80, 12.67 mi.
170: 46288(NE I80 MP190) -> 46335(null), I80, 17.68 mi.
171: 46335(null) -> 46354(NEGOTHENBURG S), I80, 3.59 mi.
172: 46354(NEGOTHENBURG S) -> 46343(NEGOTHENBURG), S47, 0.92 mi.
173: 46343(NEGOTHENBURG) -> 46390(NECOZAD), U30, 10.52 mi.
174: 46390(NECOZAD) -> 46462(null), U30, 12.41 mi.
175: 46462(null) -> 46464(NELEXINGTON C-W), U30, 1.04 mi.
176: 46464(NELEXINGTON C-W) -> 46465(NELEXINGTON C-E), U30, 0.39 mi.
177: 46465(NELEXINGTON C-E) -> 46466(null), U30, 0.86 mi.
178: 46466(null) -> 46478(null), U30, 12.08 mi.
179: 46478(null) -> 46481(null), U30, 3.9 mi.
180: 46481(null) -> 46483(NEELM CREEK), U30, 2.24 mi.
181: 46483(NEELM CREEK) -> 46489(null), U30, 7.07 mi.
182: 46489(null) -> 46499(null), U30, 6.22 mi.
183: 46499(null) -> 46494(NEKEARNEY), U30   ATSON BLVD, 2.5 mi.
184: 46494(NEKEARNEY) -> 46488(null), U30   5TH ST, 2.03 mi.
185: 46488(null) -> 46480(null), U30, 5.2 mi.
186: 46480(null) -> 46457(null), U30, 12.67 mi.
187: 46457(null) -> 46421(NEWOOD RIVER), U30, 6.38 mi.
188: 46421(NEWOOD RIVER) -> 46404(NEWOOD RIVER E), U30, 1.09 mi.
189: 46404(NEWOOD RIVER E) -> 46368(null), U30, 9.54 mi.
190: 46368(null) -> 46356(NEGRAND ISLAND W), U30, 2.96 mi.
191: 46356(NEGRAND ISLAND W) -> 46352(NEGRAND ISLAND C), U30, 1.46 mi.
192: 46352(NEGRAND ISLAND C) -> 46350(null), U30, 0.47 mi.
193: 46350(null) -> 46348(null), U30, 0.11 mi.
194: 46348(null) -> 46346(null), U30, 0.26 mi.
195: 46346(null) -> 46344(null), U30, 0.45 mi.
196: 46344(null) -> 46341(null), U30, 0.27 mi.
197: 46341(null) -> 46337(null), U30, 1.66 mi.
198: 46337(null) -> 46332(null), U30, 1.24 mi.
199: 46332(null) -> 46249(NECENTRAL CITY), U30, 18.67 mi.
200: 46249(NECENTRAL CITY) -> 46164(null), U30, 8.64 mi.
201: 46164(null) -> 46187(null), S92, 3.37 mi.
202: 46187(null) -> 46188(null), S92, 8.52 mi.
203: 46188(null) -> 46189(NEOSCEOLA W), S92, 2.98 mi.
204: 46189(NEOSCEOLA W) -> 46162(null), U81, 12.36 mi.
205: 46162(null) -> 46151(null), S92, 12.88 mi.
206: 46151(null) -> 46150(null), S15, 1.5 mi.
207: 46150(null) -> 46155(null), S92, 9.95 mi.
208: 46155(null) -> 46156(null), S92, 3.94 mi.
209: 46156(null) -> 46154(null), S79, 1.01 mi.
210: 46154(null) -> 46152(NEWAHOO), S92, 9.85 mi.
211: 46152(NEWAHOO) -> 46118(null), U77, 7.7 mi.
212: 46118(null) -> 46122(null), S92, 7.1 mi.
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213: 46122(null) -> 46124(null), S92, 3.81 mi.
214: 46124(null) -> 46121(null), U275, 3.04 mi.
215: 46121(null) -> 46119(null), U275, 2.95 mi.
216: 46119(null) -> 46123(null), U275, 1.12 mi.
217: 46123(null) -> 46120(null), S38   CENTER RD, 0.87 mi.
218: 46120(null) -> 46116(NEOMAHA WSW), S38   CENTER RD, 2.68 mi.
219: 46116(NEOMAHA WSW) -> 46115(null), S38   CENTER RD, 1.79 mi.
220: 46115(null) -> 46117(null), S38   CENTER RD, 0.48 mi.
221: 46117(null) -> 46114(null), S38   CENTER RD, 1.03 mi.
222: 46114(null) -> 46108(null), S38   ENTER ST, 1.73 mi.
223: 46108(null) -> 46100(null),      ADDLE CREEK RD, 0.91 mi.
224: 46100(null) -> 46099(null),      EAVENWORTH AV, 0.46 mi.
225: 46099(null) -> 46098(null),      EAVENWORTH AV, 0.9 mi.
226: 46098(null) -> 46094(null), , 0.24 mi.
227: 46094(null) -> 46092(null), , 1.02 mi.
228: 46092(null) -> 46087(null),      4TH ST, 0.23 mi.
229: 46087(null) -> 46088(null), U6   OUGLAS ST, 0.07 mi.
230: 46088(null) -> 46086(null), U6   OUGLAS ST, 0.17 mi.
231: 46086(null) -> 46085(null), U6   OUGLAS ST, 0.15 mi.
232: 46085(null) -> 46074(NEOMAHA CBD-NE), U6   OUGLAS ST, 0.24 mi.
233: 46074(NEOMAHA CBD-NE) -> 28003(null), I480, 0.04 mi.
234: 28003(null) -> 27999(null), I480, 0.73 mi.
235: 27999(null) -> 28000(null), U6   BROADWAY, 2.08 mi.
236: 28000(null) -> 28001(null), U6   BROADWAY, 0.72 mi.
237: 28001(null) -> 28002(null), U6   ANESVILLE BLVD, 0.1 mi.
238: 28002(null) -> 27995(IACOUNCIL BLUFFS), U6   ANESVILLE BLVD, 0.98 mi.
239: 27995(IACOUNCIL BLUFFS) -> 27986(null), U6   ANESVILLE BLVD, 3.0 mi.
240: 27986(null) -> 27975(null), I80, 1.22 mi.
241: 27975(null) -> 27852(null), I80, 17.73 mi.
242: 27852(null) -> 27848(IAAVOCA N), I80, 12.85 mi.
243: 27848(IAAVOCA N) -> 27847(null), I80, 9.35 mi.
244: 27847(null) -> 27851(IAELK HORN S), I80, 4.93 mi.
245: 27851(IAELK HORN S) -> 27849(null), I80, 5.88 mi.
246: 27849(null) -> 27850(IA I80 MP070), I80, 9.62 mi.
247: 27850(IA I80 MP070) -> 27853(null), I80, 3.01 mi.
248: 27853(null) -> 27860(IAADAIR SW), I80, 2.01 mi.
249: 27860(IAADAIR SW) -> 27856(null), I80, 10.83 mi.
250: 27856(null) -> 27859(null), I80, 10.87 mi.
251: 27859(null) -> 27844(null), I80, 1.96 mi.
252: 27844(null) -> 27813(IAI80 MP100), I80, 0.96 mi.
253: 27813(IAI80 MP100) -> 27804(null), I80, 6.23 mi.
254: 27804(null) -> 27780(null), I80, 3.67 mi.
255: 27780(null) -> 27754(null), I80, 9.79 mi.
256: 27754(null) -> 27740(null), I80, 2.42 mi.
257: 27740(null) -> 27739(null), I80, 0.68 mi.
258: 27739(null) -> 27738(null), I235, 2.11 mi.
259: 27738(null) -> 27737(IADES MOINES W), I235, 1.69 mi.
260: 27737(IADES MOINES W) -> 27735(null), I235, 3.14 mi.
261: 27735(null) -> 27734(null), I235, 0.06 mi.
262: 27734(null) -> 27733(IADES MOINES), I235, 2.27 mi.
263: 27733(IADES MOINES) -> 27729(null), I235, 0.14 mi.
264: 27729(null) -> 27716(null), I235, 0.67 mi.
265: 27716(null) -> 27699(null), I235, 2.03 mi.
266: 27699(null) -> 27684(null), U6   REDERICK HUBBELL AV, 3.32 mi.
267: 27684(null) -> 27676(null), U6   REDERICK HUBBELL AV, 0.33 mi.
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268: 27676(null) -> 27668(null), U6, 0.78 mi.
269: 27668(null) -> 27663(null), U6, 0.61 mi.
270: 27663(null) -> 27658(IABONDURANT), I80, 1.66 mi.
271: 27658(IABONDURANT) -> 27649(null), I80, 6.07 mi.
272: 27649(null) -> 27628(IACOLFAX N), I80, 5.34 mi.
273: 27628(IACOLFAX N) -> 27631(null), I80, 3.65 mi.
274: 27631(null) -> 27648(null), I80, 4.97 mi.
275: 27648(null) -> 27645(null), I80, 0.43 mi.
276: 27645(null) -> 27646(null), I80, 3.26 mi.
277: 27646(null) -> 27647(IA I80 MP173), I80, 5.7 mi.
278: 27647(IA I80 MP173) -> 27619(null), I80, 7.2 mi.
279: 27619(null) -> 27616(IA I80 MP182), I80, 2.03 mi.
280: 27616(IA I80 MP182) -> 27615(IAMALCOM S), I80, 8.99 mi.
281: 27615(IAMALCOM S) -> 27618(IAGUERNSEY N), I80, 9.98 mi.
282: 27618(IAGUERNSEY N) -> 27617(null), I80, 2.97 mi.
283: 27617(null) -> 27642(IAWILLIAMSBURG N), I80, 15.01 mi.
284: 27642(IAWILLIAMSBURG N) -> 27641(IAI80 MP225), I80, 5.02 mi.
285: 27641(IAI80 MP225) -> 27639(null), I80, 3.97 mi.
286: 27639(null) -> 27623(null), I80, 10.11 mi.
287: 27623(null) -> 27624(null), I80, 0.93 mi.
288: 27624(null) -> 27625(IA I80 MP240), I80, 0.61 mi.
289: 27625(IA I80 MP240) -> 27640(null), I80, 5.71 mi.
290: 27640(null) -> 27644(null), I80, 0.95 mi.
291: 27644(null) -> 27660(null), I80, 6.19 mi.
292: 27660(null) -> 27683(IA I80 MP267), I80, 13.17 mi.
293: 27683(IA I80 MP267) -> 27687(IA I80 MP271), I80, 4.12 mi.
294: 27687(IA I80 MP271) -> 27689(null), I80, 7.01 mi.
295: 27689(null) -> 27711(null), I80, 11.8 mi.
296: 27711(null) -> 27714(null), I80, 1.58 mi.
297: 27714(null) -> 27722(null), I80, 1.42 mi.
298: 27722(null) -> 27731(IATOLEDO), I80, 2.57 mi.
299: 27731(IATOLEDO) -> 27732(IA I80 MP298  BETT), I80, 2.32 mi.
300: 27732(IA I80 MP298  BETT) -> 27749(IALE CLAIRE SW), I80, 8.53 mi.
301: 27749(IALE CLAIRE SW) -> 22790(null), I80, 0.35 mi.
302: 22790(null) -> 22797(ILRAPIDS CITY W), I80, 0.28 mi.
303: 22797(ILRAPIDS CITY W) -> 22836(null), I80, 3.2 mi.
304: 22836(null) -> 22811(ILJOSLIN W), I88, 5.64 mi.
305: 22811(ILJOSLIN W) -> 22812(null), S92, 2.91 mi.
306: 22812(null) -> 22813(ILJOSLIN E), S92, 1.4 mi.
307: 22813(ILJOSLIN E) -> 22819(ILHOOPPOLE NW), S92, 11.37 mi.
308: 22819(ILHOOPPOLE NW) -> 22803(ILYORKTOWN W), S78, 0.92 mi.
309: 22803(ILYORKTOWN W) -> 22801(null), S92, 3.99 mi.
310: 22801(null) -> 22802(null), S92, 5.73 mi.
311: 22802(null) -> 22808(ILNORMANDY W), S92, 3.42 mi.
312: 22808(ILNORMANDY W) -> 22821(ILOHIO S), S92, 11.72 mi.
313: 22821(ILOHIO S) -> 22832(ILLA MOILLE N), S92, 9.98 mi.
314: 22832(ILLA MOILLE N) -> 22828(null), U34, 5.84 mi.
315: 22828(null) -> 22826(null), U34, 1.53 mi.
316: 22826(null) -> 22827(ILMENDOTA C-W), U34, 0.49 mi.
317: 22827(ILMENDOTA C-W) -> 22835(null), U52, 0.8 mi.
318: 22835(null) -> 22842(null), U52, 0.69 mi.
319: 22842(null) -> 22855(null), U52, 0.67 mi.
320: 22855(null) -> 22920(ILTROY GROVE W), U52, 3.31 mi.
321: 22920(ILTROY GROVE W) -> 22916(ILTROY GROVE E), U52, 4.07 mi.
322: 22916(ILTROY GROVE E) -> 22914(ILPRAIRIE CENTER F), U52, 10.86 mi.
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323: 22914(ILPRAIRIE CENTER F) -> 22897(ILHARDING SE), U52, 2.04 mi.
324: 22897(ILHARDING SE) -> 22893(ILNORWAY NE), U52, 8.68 mi.
325: 22893(ILNORWAY NE) -> 22891(null), U52, 2.59 mi.
326: 22891(null) -> 22868(ILCENTRAL N), U52, 9.34 mi.
327: 22868(ILCENTRAL N) -> 22861(null), U52, 9.27 mi.
328: 22861(null) -> 22852(null), U52, 1.93 mi.
329: 22852(null) -> 22851(ILSHOREWOOD), U52, 1.13 mi.
330: 22851(ILSHOREWOOD) -> 22850(ILSHOREWOOD E), U52, 0.51 mi.
331: 22850(ILSHOREWOOD E) -> 22848(ILJOLIET C-W), U52, 3.3 mi.
332: 22848(ILJOLIET C-W) -> 22844(ILJOLIET C-W), U52, 1.77 mi.
333: 22844(ILJOLIET C-W) -> 22846(null), U52, 0.32 mi.
334: 22846(null) -> 22845(null), S172, 0.24 mi.
335: 22845(null) -> 22839(ILJOLIET C-NE), S172, 0.57 mi.
336: 22839(ILJOLIET C-NE) -> 22853(ILNEW LENOX), U30   INCOLN HWY, 4.3 mi.
337: 22853(ILNEW LENOX) -> 22833(null), I80, 2.26 mi.
338: 22833(null) -> 22820(IL I80 MP145  ARBU), I80, 5.68 mi.
339: 22820(IL I80 MP145  ARBU) -> 22825(ILTINLEY PARK S), I80, 3.14 mi.
340: 22825(ILTINLEY PARK S) -> 22805(IL I80 MP151), I80, 2.8 mi.
341: 22805(IL I80 MP151) -> 22800(null), I80, 0.61 mi.
342: 22800(null) -> 22789(ILHOMEWOOD N), I80, 3.06 mi.
343: 22789(ILHOMEWOOD N) -> 22792(null), I80   RI-STATE TOLLWY, 0.71 mi.
344: 22792(null) -> 22793(null), I80   RI-STATE TOLLWY, 0.25 mi.
345: 22793(null) -> 22791(ILTHORNTON), I80   RI-STATE TOLLWY, 1.25 mi.
346: 22791(ILTHORNTON) -> 22794(ILS HOLLAND SE), I80   RI-STATE TOLLWY, 2.81
mi.
347: 22794(ILS HOLLAND SE) -> 22795(ILLANSING NW), I80   INGERY EXWY, 1.2 mi.
348: 22795(ILLANSING NW) -> 22796(null), I80   INGERY EXWY, 1.75 mi.
349: 22796(null) -> 25024(INHAMMOND SW), I80   RI-STATE HWY, 0.87 mi.
350: 25024(INHAMMOND SW) -> 25023(INHAMMOND S), I80   RI-STATE HWY, 1.51 mi.
351: 25023(INHAMMOND S) -> 25028(null), I80   RI-STATE HWY, 2.46 mi.
352: 25028(null) -> 25030(null), I80   RI-STATE HWY, 3.93 mi.
353: 25030(null) -> 25032(INGARY SE), I80   RI-STATE HWY, 1.01 mi.
354: 25032(INGARY SE) -> 25029(INGARY SE-IC), I80   RI-STATE HWY, 1.87 mi.
355: 25029(INGARY SE-IC) -> 25019(null), I80   RI-STATE HWY, 3.27 mi.
356: 25019(null) -> 25014(null), I80   RI-STATE HWY, 0.95 mi.
357: 25014(null) -> 25011(null), I94   RI-STATE HWY, 0.15 mi.
358: 25011(null) -> 25009(null), I94   RI-STATE HWY, 0.26 mi.
359: 25009(null) -> 24998(null), I94   RI-STATE HWY, 2.39 mi.
360: 24998(null) -> 24991(INPORTAGE C), I94   RI-STATE HWY, 2.58 mi.
361: 24991(INPORTAGE C) -> 24990(null), I94   RI-STATE HWY, 0.93 mi.
362: 24990(null) -> 24972(INCHESTERTON N), I94   RI-STATE HWY, 3.57 mi.
363: 24972(INCHESTERTON N) -> 24956(null), I94   RI-STATE HWY, 2.05 mi.
364: 24956(null) -> 24928(null), I94, 4.52 mi.
365: 24928(null) -> 24929(null), I94, 1.79 mi.
366: 24929(null) -> 24930(INMICHIGAN CITY S-), I94, 0.18 mi.
367: 24930(INMICHIGAN CITY S-) -> 24931(null), I94, 0.64 mi.
368: 24931(null) -> 24877(null), I94, 4.02 mi.
369: 24877(null) -> 24862(INMICHIGAN CITY E-), I94, 0.65 mi.
370: 24862(INMICHIGAN CITY E-) -> 24865(null), U20, 0.3 mi.
371: 24865(null) -> 24878(null), U20, 3.55 mi.
372: 24878(null) -> 24904(null), U20, 7.78 mi.
373: 24904(null) -> 24907(null), S2, 3.2 mi.
374: 24907(null) -> 24909(null), S2, 7.49 mi.
375: 24909(null) -> 24910(INSOUTH BEND W), S2   ESTERN AV, 2.02 mi.
376: 24910(INSOUTH BEND W) -> 24906(null), S2   ESTERN AV, 4.08 mi.
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377: 24906(null) -> 24905(null), S2    ESTERN AV, 0.49 mi.
378: 24905(null) -> 24901(null), U33   AIN ST, 0.38 mi.
379: 24901(null) -> 24897(null), U33   AIN ST, 0.08 mi.
380: 24897(null) -> 24895(null),       ASALLE ST, 0.1 mi.
381: 24895(null) -> 24894(null),       ASALLE ST, 0.76 mi.
382: 24894(null) -> 24873(null), S23   DDY ST, 0.52 mi.
383: 24873(null) -> 24863(null), S23   OUTH BEND AV, 0.7 mi.
384: 24863(null) -> 24842(null), S23   OUTH BEND AV, 2.2 mi.
385: 24842(null) -> 24841(null), I80   AST-WEST TOLLRD, 0.8 mi.
386: 24841(null) -> 24828(null), I80   AST-WEST TOLLRD, 2.09 mi.
387: 24828(null) -> 24821(null), I80   AST-WEST TOLLRD, 4.39 mi.
388: 24821(null) -> 24822(null), I80   AST-WEST TOLLRD, 0.64 mi.
389: 24822(null) -> 24823(INELKHART N), I80    AST-WEST TOLLRD, 3.94 mi.
390: 24823(INELKHART N) -> 24827(null), I80    AST-WEST TOLLRD, 4.06 mi.
391: 24827(null) -> 24825(null), I80   AST-WEST TOLLRD, 0.31 mi.
392: 24825(null) -> 24820(null), I80   AST-WEST TOLLRD, 4.59 mi.
393: 24820(null) -> 24809(null), S15, 2.19 mi.
394: 24809(null) -> 39595(null), S103, 3.09 mi.
395: 39595(null) -> 39602(null), U12, 4.83 mi.
396: 39602(null) -> 39604(null), U12, 10.83 mi.
397: 39604(null) -> 39599(null), U12, 1.26 mi.
398: 39599(null) -> 39596(MISTURGIS), U12, 0.51 mi.
399: 39596(MISTURGIS) -> 39589(null), U12, 1.63 mi.
400: 39589(null) -> 39571(null), U12, 5.55 mi.
401: 39571(null) -> 39508(null), U12, 14.86 mi.
402: 39508(null) -> 39505(MICOLDWATER W), U12, 0.75 mi.
403: 39505(MICOLDWATER W) -> 39506(MICOLDWATER), U12, 2.22 mi.
404: 39506(MICOLDWATER) -> 39509(null), O69 B, 1.44 mi.
405: 39509(null) -> 39507(null), U12, 1.2 mi.
406: 39507(null) -> 39498(null), U12, 6.55 mi.
407: 39498(null) -> 39493(MIALLEN), U12, 3.54 mi.
408: 39493(MIALLEN) -> 39480(MIJONESVILLE), U12, 4.93 mi.
409: 39480(MIJONESVILLE) -> 39451(null), U12, 17.27 mi.
410: 39451(null) -> 39452(MISOMERSET E), U12, 0.25 mi.
411: 39452(MISOMERSET E) -> 39445(MICAMBRIDGE JUNCTI), U12, 7.29 mi.
412: 39445(MICAMBRIDGE JUNCTI) -> 39431(null), U12, 7.36 mi.
413: 39431(null) -> 39430(null), U12, 0.13 mi.
414: 39430(null) -> 39435(MICLINTON W), U12, 3.51 mi.
415: 39435(MICLINTON W) -> 39423(null), U12, 2.96 mi.
416: 39423(null) -> 39381(null), U12, 10.23 mi.
417: 39381(null) -> 39346(MISALINE NE), U12   ICHIGAN AV, 6.52 mi.
418: 39346(MISALINE NE) -> 39338(null), U12   ICHIGAN AV, 1.12 mi.
419: 39338(null) -> 39326(MIYPSILANTI SW), U12   ICHIGAN AV, 1.01 mi.
420: 39326(MIYPSILANTI SW) -> 39316(null),       ICHIGAN AV, 0.79 mi.
421: 39316(null) -> 39299(null),       ICHIGAN AV, 1.31 mi.
422: 39299(null) -> 39300(MIYPSILANTI CBD), U12  BICHIGAN AV, 0.22 mi.
423: 39300(MIYPSILANTI CBD) -> 39252(null), U12  BICHIGAN AV, 3.72 mi.
424: 39252(null) -> 39245(MIWILLOW RUN SE), U12  BICHIGAN AV, 0.66 mi.
425: 39245(MIWILLOW RUN SE) -> 39235(null), U12   ICHIGAN RD, 0.54 mi.
426: 39235(null) -> 39204(null), U12   ICHIGAN RD, 1.88 mi.
427: 39204(null) -> 39199(null), U12   ICHIGAN RD, 0.09 mi.
428: 39199(null) -> 39171(MIWAYNE W), U12   ICHIGAN RD, 2.31 mi.
429: 39171(MIWAYNE W) -> 39169(null), U12   ICHIGAN AV, 2.98 mi.
430: 39169(null) -> 39155(null), U12   ICHIGAN AV, 1.82 mi.
431: 39155(null) -> 39142(null), U12   ICHIGAN AV, 1.04 mi.
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432: 39142(null) -> 39102(MIDEARBORN W), U12   ICHIGAN AV, 3.01 mi.
433: 39102(MIDEARBORN W) -> 39097(null), U12   ICHIGAN AV, 0.45 mi.
434: 39097(null) -> 39090(null), U12   ICHIGAN AV, 2.03 mi.
435: 39090(null) -> 39086(MIDEARBORN C-W), U12   ICHIGAN AV, 0.53 mi.
436: 39086(MIDEARBORN C-W) -> 39071(null), U12   ICHIGAN AV, 1.09 mi.
437: 39071(null) -> 39037(null), U12   ICHIGAN AV, 1.9 mi.
438: 39037(null) -> 39023(MIDEARBORN E), I94   DSEL FORD FRWY, 0.37 mi.
439: 39023(MIDEARBORN E) -> 38974(null), I94   DSEL FORD FRWY, 1.62 mi.
440: 38974(null) -> 38959(null), I94   DSEL FORD FRWY, 0.46 mi.
441: 38959(null) -> 38948(null), I94   DSEL FORD FRWY, 0.27 mi.
442: 38948(null) -> 38928(MI I96 MP190), I94   DSEL FORD FRWY, 0.86 mi.
443: 38928(MI I96 MP190) -> 38926(null), I94   DSEL FORD FRWY, 0.2 mi.
444: 38926(null) -> 38922(null), I94   DSEL FORD FRWY, 0.1 mi.
445: 38922(null) -> 38920(null), I94   DSEL FORD FRWY, 0.48 mi.
446: 38920(null) -> 38914(MIDETROIT C-NW), I94   DSEL FORD FRWY, 0.53 mi.
447: 38914(MIDETROIT C-NW) -> 38907(null), I94   DSEL FORD FRWY, 0.53 mi.
448: 38907(null) -> 38896(MIDETROIT C-N), I94   DSEL FORD FRWY, 0.66 mi.
449: 38896(MIDETROIT C-N) -> 38883(null), I94   DSEL FORD FRWY, 0.59 mi.
450: 38883(null) -> 38870(null), I94   DSEL FORD FRWY, 0.85 mi.
451: 38870(null) -> 38852(MIDETROIT E), I94   DSEL FORD FRWY, 0.9 mi.
452: 38852(MIDETROIT E) -> 38846(MIDETROIT C-ENE), I94   DSEL FORD FRWY, 0.82
mi.
453: 38846(MIDETROIT C-ENE) -> 38835(null), S3   RATIOT AV, 1.0 mi.
454: 38835(null) -> 38829(null), S3   RATIOT AV, 0.25 mi.
455: 38829(null) -> 38777(null), S3   RATIOT AV, 1.45 mi.
456: 38777(null) -> 38755(null), S3   RATIOT AV, 0.68 mi.
457: 38755(null) -> 38715(MIEAST DETROIT), S3   RATIOT AV, 1.16 mi.
458: 38715(MIEAST DETROIT) -> 38661(MIROSEVILLE), S3   RATIOT AV, 3.45 mi.
459: 38661(MIROSEVILLE) -> 38641(null), S3   RATIOT AV, 0.76 mi.
460: 38641(null) -> 38621(null), S3   RATIOT AV, 1.77 mi.
461: 38621(null) -> 38600(null), S3   RATIOT AV, 0.97 mi.
462: 38600(null) -> 38554(null), S3   RATIOT AV, 2.25 mi.
463: 38554(null) -> 38549(null), S3   RATIOT AV, 0.46 mi.
464: 38549(null) -> 38522(null),       RATIOT AV, 1.56 mi.
465: 38522(null) -> 38517(null),       RATIOT AV, 0.32 mi.
466: 38517(null) -> 38482(MIMT CLEMENS NE), S3   RATIOT AV, 2.14 mi.
467: 38482(MIMT CLEMENS NE) -> 38462(null), S3   RATIOT AV, 0.69 mi.
468: 38462(null) -> 38395(null), S3   RATIOT AV, 2.73 mi.
469: 38395(null) -> 38368(null),       RATIOT RD, 1.24 mi.
470: 38368(null) -> 38352(MINEW HAVEN),       RATIOT AV, 2.71 mi.
It takes 2118.45 miles from 7705(CADEATH VALLEY JCT) to 38352(MINEW HAVEN).
```

Analysis

        The graph was represented using the Hash Map with Integer value place ID as key and array list of path nodes (each node contain place ID and distance from another place) as value. The edges were added from the road list parsed from road.txt file that sets the source and destination place along with distance between them.

        Priority Queue for the algorithm was utilized using in built priority queue of Java with path nodes as parameter (each node contain place ID and distance from another place). The priority for the queue is the shortest distance between two places using comparison. When the node for the paths gets added to the queue, the total distance from source to that node vertex (place) is added and relaxed.

Packages utilized:

        java.util.ArrayList

        java.util.HashMap

        java.util.PriorityQueue

        java.util.Comparator

        java.util.Scanner

        java.io.File

        java.io.FileNotFoundException

        java.util.Collection

        java.util.Iterator

        java.util.LinkedHashMap

        java.util.Map

        java.util.Set

Using all the packages and implementing graphs and priority queue helped to easily store the data for shortest path in the hash map. Since, hash map does not duplicate keys, it was easy to save the record for each place ID and simply connect its edges to remaining place ID using road list for the graph. It was easier to implement and understand how the graph was forming and how priority queue will easily help my algorithm to create another hash map that contains only shortest possible path.

Time Complexity

For the Dijkstra's algorithm implemented for determining shortest possible path, the asymptotic time complexity is $O(V + E * \log V)$ with the use of priority queue.

For the whole program to run, another hash map was needed to print all the roads present in the shortest path from source to destination. So, total time complexity of run time of the whole program should be $O(n^2)$.

For the example output given above, total experimental time was estimated to be approximately around 10 seconds.

Conclusion

From this homework assignment, I learnt more about formation of graph data structure utilizing different methods such using array list, hash map and even linked list. But at the end, I chose hash map for the proper implementation of graph. This also gave me more flexibility to implement priority queue in the Dijkstra's algorithm for finding the shortest path. This assignment was a perfect example to tackle the real-world problems and it helped to enrich my problem-solving knowledge even more. It was little difficult because the distance was floating point value which created a lot of imbalance during the conversion and data structure implementation. But I was able to learn more about the utilization of those data structures for generic primitives and different values that are not primitives as well. Finally, my experience with this assignment will help me perform even better in my future projects in programming, design and analysis of algorithms.