

MonteCarlo.java

```
1 //*****
2 //
3 // File:    MonteCarlo.java
4 // Package: ---
5 // Unit:    Class MonteCarlo
6 //
7 //*****
8
9 import java.io.FileNotFoundException;
10 import java.io.IOException;
11 import java.io.PrintWriter;
12 import edu.rit.pj2.Task;
13
14 /**
15  * Class MonteCarlo takes in a seed value for a random number
16  * generator, the upper and lower boundaries for the number of vertices in
17  * each graph as well as a number to increment by, the upper and lower
18  * boundaries for the edge probability as well as a number to increment by,
19  * the number of random graphs to generate for each combination of V (vertices)
20  * and p (edge probability), and finally, a prefix for naming each plot
21  * generated by this program. After checking for valid input, this program
22  * loops through each combination of vertices and edge probabilities, running
23  * the specified number of simulations on each combination. Each random graph
24  * (or simulation) is generated by looking at every possible pair of vertices,
25  * generating a random floating point between 0 and 1, and marking these
26  * vertices with an edge connecting them if the random value is less than or
27  * equal to the specified edge probability (for that unique graph). In each
28  * simulation, the distance values of each graph are calculated with a breadth
29  * first search from vertex A to vertex B using the depth of the search as the
30  * distance from A to B.
31  *
32  * @author Jimi Ford
33  * @version 2-15-2015
34  */
35 public class MonteCarlo extends Task {
36
37     // Private constants
38     private static final String[] arguments = {
39         "<seed>",
40         "<min_v>",
41         "<max_v>",
42         "<v_grain>",
43         "<min_p>",
44         "<max_p>",
45         "<p_grain>",
46         "<num_simulations>",
47         "<optional_plotfile_prefix>"
48     };
49
50     private static final int
51         SEED = 0,
52         MIN_VERTICES = 1,
53         MAX_VERTICES = 2,
54         VERTEX_GRANULARITY = 3,
55         MIN_P = 4,
56         MAX_P = 5,
57         P_GRANULARITY = 6,
58         NUMBER_OF_SIMULATIONS = 7,
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59     PLOT_FILE_PREFIX = 8;
60
61     /**
62     * MonteCarlo's main method to be invoked by Prof. Alan Kaminsky's
63     * Parallel Java 2 library.
64     *
65     * @param args command line arguments
66     *
67     * <P>
68     * usage: java pj2 MonteCarlo <seed> <min_v> <max_v>
69     * <v_grain> <min_p> <max_p> <p_grain>
70     * <num_simulations> <optional plotfile prefix>
71     * <P>
72     */
73     public void main(String[] args) {
74         if(args.length != 8 && args.length != 9) {
75             usage();
76         }
77
78         long seed = 0;
79         int minVertices = 0, maxVertices = 0, vertexGranularity = 0,
80             numSimulations = 0;
81         double pGrain = 0, minP = 0, maxP = 0;
82
83         try {
84             seed = Long.parseLong(args[SEED]);
85         } catch (NumberFormatException e) {
86             displayError(
87                 String.format("Argument %1s must be numeric and between %2d "+
88                     "and %3d inclusive.\n", arguments[SEED],
89                     Long.MIN_VALUE, Long.MAX_VALUE));
90         }
91
92         try {
93             minVertices = Integer.parseInt(args[MIN_VERTICES]);
94             if(minVertices < 1) throw new NumberFormatException();
95         } catch (NumberFormatException e) {
96             displayError(
97                 String.format("Argument %1s must be numeric and between 1 "+
98                     "and %2d inclusive.\n", arguments[MIN_VERTICES],
99                     Integer.MAX_VALUE));
100         }
101
102         try {
103             maxVertices = Integer.parseInt(args[MAX_VERTICES]);
104             if(maxVertices < minVertices)
105                 displayError(String.format(
106                     "Argument %1s must be greater than or equal to %2s.\n",
107                     arguments[MAX_VERTICES], arguments[MIN_VERTICES]));
108         } catch (NumberFormatException e) {
109             displayError(String.format(
110                 "Argument %1s must be numeric and between 1 and %2d inclusive.\n",
111                 arguments[MAX_VERTICES], Integer.MAX_VALUE));
112         }
113
114         try {
115             vertexGranularity = Integer.parseInt(args[VERTEX_GRANULARITY]);
116             if(vertexGranularity < 1) throw new NumberFormatException();

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117     } catch (NumberFormatException e) {
118         displayError(String.format(
119             "Argument %1s must be numeric and between 1 and %2d inclusive.\n",
120             arguments[VERTEX_GRANULARITY], Integer.MAX_VALUE));
121     }
122
123     try {
124         minP = Double.parseDouble(args[MIN_P]);
125         if(minP < 0 || minP > 1) throw new NumberFormatException();
126     } catch (NumberFormatException e) {
127         displayError(String.format(
128             "Argument %1s must be numeric and between "+
129             "0 inclusive and 1 inclusive.\n",
130             arguments[MIN_P]));
131     }
132
133     try {
134         maxP = Double.parseDouble(args[MAX_P]);
135         if(maxP < minP)
136             displayError(String.format(
137                 "Argument %1s must be greater than or equal to %2s.\n",
138                 arguments[MAX_P], arguments[MIN_P]));
139         if(maxP > 1) throw new NumberFormatException();
140     } catch (NumberFormatException e) {
141         displayError(String.format(
142             "Argument %1s must be numeric and between "+
143             "0 inclusive and 1 inclusive.\n",
144             arguments[MAX_P]));
145     }
146
147     try {
148         pGrain = Double.parseDouble(args[P_GRANULARITY]);
149         if(pGrain <= 0 || pGrain > 1)
150             throw new NumberFormatException();
151     } catch (NumberFormatException e) {
152         displayError(String.format(
153             "Argument %1s must be numeric and between "+
154             "0 exclusive and 1 inclusive.\n",
155             arguments[P_GRANULARITY]));
156     }
157
158     try {
159         numSimulations = Integer.parseInt(args[NUMBER_OF_SIMULATIONS]);
160         if(numSimulations < 1) throw new NumberFormatException();
161     } catch (NumberFormatException e) {
162         displayError(String.format(
163             "Argument %1s must be numeric and between 1 and %2d inclusive.\n",
164             arguments[NUMBER_OF_SIMULATIONS], Integer.MAX_VALUE));
165     }
166
167     // store file prefix
168     final String plotFilePrefix = args.length == 9 ?
169         args[PLOT_FILE_PREFIX] : "plot";
170
171     String pMinStr = Double.toString(minP);
172     String pMaxStr = Double.toString(maxP);
173     String pGrainStr = Double.toString(pGrain);
174     final int sigFig =

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175         Math.max(Math.max(
176             pGrainStr.length() - pGrainStr.indexOf('.') - 1,
177             pMaxStr.length() - pMaxStr.indexOf('.') - 1),
178             pMinStr.length() - pMinStr.indexOf('.') - 1);
179     int exp = 1;
180     for(int i = 0; i < sigFig; i++) {
181         exp *= 10;
182     }
183     final int pMax = (int) (Math.round(maxP * exp));
184     final int pMin = (int) (Math.round(minP * exp));
185     final int pInc = (int) (Math.round(pGrain * exp));
186     pGrainStr = null;
187
188
189
190     SimulationResultCollection results = new SimulationResultCollection(
191         minVertices, maxVertices, vertexGranularity, pMin, pMax, pInc, exp);
192
193     // loop through number of vertices
194     for(int vCount = minVertices; vCount <= maxVertices;
195         vCount += vertexGranularity) {
196         // loop through edgeProbability
197         for(int p = pMin; p <= pMax; p += pInc) {
198             double prob = p / (double) exp;
199             // loop through each simulation
200             results.add(new Simulation(this, seed, vCount, prob,
201                 numSimulations).simulate());
202         }
203         try {
204             new PlotHandler(plotFilePrefix, results, vCount).write();
205         } catch (IOException e) {
206             System.err.println("Error writing file for v="+vCount);
207         }
208     }
209
210     StringBuilder builder = new StringBuilder();
211     for(int p = 0; p <= pMax; p += pInc) {
212         builder.append(", " + (p / ((double) exp)));
213     }
214     builder.append('\n');
215     for(int v = minVertices; v <= maxVertices; v += vertexGranularity) {
216         builder.append(v + ", ");
217         for(int p = pMin; p <= pMax; p += pInc) {
218             builder.append(results.get(v,p)+" ");
219         }
220         builder.append('\n');
221     }
222     PrintWriter tableWriter = null;
223     final String tableSuffix = "-table.csv";
224     try {
225         tableWriter = new PrintWriter(plotFilePrefix + tableSuffix);
226         tableWriter.print(builder.toString());
227     } catch (FileNotFoundException e) {
228         System.err.println("Error writing table data to file \""+
229             plotFilePrefix + tableSuffix + "\"");
230     } finally {
231         if(tableWriter != null) tableWriter.close();
232     }

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233     System.out.println("Finished simulations! run \"java PlotHandler\" "+
234     "followed by any number of .dwg files (that were previously generated) "+
235     "to visualize the results.");
236 } // main
237
238
239 /**
240  * Display the proper usage of this program and exit.
241  */
242 private static void usage() {
243     System.err.printf ("Usage: java pj2 MonteCarlo "+
244     "%1s %2s %3s %4s %5s %6s %7s %8s %9s\n",
245     arguments[SEED],
246     arguments[MIN_VERTICES],
247     arguments[MAX_VERTICES],
248     arguments[VERTEX_GRANULARITY],
249     arguments[MIN_P],
250     arguments[MAX_P],
251     arguments[P_GRANULARITY],
252     arguments[NUMBER_OF_SIMULATIONS],
253     arguments[PLOT_FILE_PREFIX]);
254     System.exit(1);
255 }
256
257 /**
258  * Print an error message to System.err and gracefully exit
259  * @param msg the error message to display
260  */
261 private static void displayError(String msg) {
262     System.err.println(msg);
263     usage();
264 }
265 }
266

```