

Human Facial Recognition Algorithm

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CSCE 350
December 4, 2015

1 Introduction

This project is meant to simulate the recognition human facial expressions. A facial expression can be recognized using vectors and comparing them to the template data, we find the top ten closest matches in the template data to determine which images are making certain facial expressions. So the top ten images from the AU01 are most likely surprised faces, the top ten from AU12 are happy faces, and AU17's top ten are more than likely sad faces.

The problem is making a solution that is time efficient. Since every element in a vector has to be compared to another vector to determine it's match, we have N^2 time. Of course there is also a large startup cost for opening and closing so many files.

2 Methodology

Improving time is a difficult task considering that there must be n^2 comparisons in order to get the right answer. In our solution, we start by loading the template file, after the template file has been loaded, we load the first query file, compare it to the template, and print the top ten matches. The comparisons are done in our Compare class, and the files are opened and closed in our Main class. We repeat this process until all of the files have been examined and their results printed.

We have a number of tricks to decrease the execution time. The first being applied at compile time. We use the `OFast` optimization flag in order to ensure that our program can run as fast as possible. Other than optimization, our speed up techniques include the *stable_sort*, and minimizing output. The stable sort is among the fastest sorting algorithms in C++. We

use it to sort the list of pairs as they come out of comparison functions. Once the pairs of 'rows' and 'similarity' are sorted, we take the last ten pairs in the vector to display the top ten.

Output is another crucial piece of our program. We did our best to have the least amount of output as possible. Output is expensive and slows the CPU down

3 Pseudo Code

```
// Compare function
void function Compare
  for n in template
    for k in template[n]
      x <- queryData[k]
      y <- template[n][k]
      xxSum += x*x
      yySum += y*y
      xySum += x*y
    // Calculate similarity
    sum <- xySum / (sqrt(xxSum) * sqrt(yySum))
    solution[n] <- sum
  // Sort by desc
  stable_sort(solution)

  // Print the top ten.
  print solution[1:10]
```

4 Experimental Results

../001_AU01_query.dat:	7: 119 -- 0.482342	3: 9 -- 0.463927
1: 8 -- 0.426736	8: 87 -- 0.477924	4: 7 -- 0.460817
2: 3 -- 0.423529	9: 33 -- 0.472904	5: 72 -- 0.452896
3: 38 -- 0.422017	10: 106 -- 0.465927	6: 114 -- 0.442112
4: 33 -- 0.42094	../001_AU17_query.dat:	7: 128 -- 0.436886
5: 19 -- 0.414205	1: 6 -- 0.462934	8: 49 -- 0.435003
6: 119 -- 0.412088	2: 131 -- 0.453913	9: 60 -- 0.433176
7: 116 -- 0.407938	3: 115 -- 0.441571	10: 41 -- 0.432754
8: 126 -- 0.407394	4: 71 -- 0.435934	../002_AU12_query.dat:
9: 41 -- 0.406872	5: 118 -- 0.435754	1: 3 -- 0.517137
10: 91 -- 0.405498	6: 36 -- 0.427402	2: 135 -- 0.511991
../001_AU12_query.dat:	7: 2 -- 0.423894	3: 128 -- 0.503594
1: 41 -- 0.517193	8: 56 -- 0.421689	4: 87 -- 0.479963
2: 3 -- 0.517137	9: 55 -- 0.421689	5: 70 -- 0.479864
3: 38 -- 0.51248	10: 86 -- 0.419778	6: 75 -- 0.47146
4: 91 -- 0.495798	../002_AU01_query.dat:	7: 8 -- 0.469299
5: 75 -- 0.488712	1: 5 -- 0.47524	8: 41 -- 0.466008
6: 135 -- 0.488521	2: 4 -- 0.47524	9: 38 -- 0.464723

10: 13 -- 0.461279	8: 124 -- 0.540504	6: 55 -- 0.417782
../002_AU17_query.dat:	9: 117 -- 0.533478	7: 44 -- 0.415042
1: 6 -- 0.459959	10: 61 -- 0.526581	8: 130 -- 0.414609
2: 9 -- 0.451929	../004_AU12_query.dat:	9: 27 -- 0.414135
3: 30 -- 0.4494	1: 105 -- 0.627848	10: 92 -- 0.411196
4: 7 -- 0.437144	2: 128 -- 0.584869	../006_AU01_query.dat:
5: 104 -- 0.435703	3: 126 -- 0.582415	1: 114 -- 0.549901
6: 103 -- 0.435703	4: 70 -- 0.556351	2: 17 -- 0.523267
7: 134 -- 0.435355	5: 111 -- 0.555623	3: 49 -- 0.519069
8: 128 -- 0.430776	6: 50 -- 0.552845	4: 10 -- 0.507243
9: 56 -- 0.430205	7: 59 -- 0.543982	5: 77 -- 0.506806
10: 55 -- 0.430205	8: 13 -- 0.541686	6: 69 -- 0.491489
../003_AU01_query.dat:	9: 43 -- 0.541075	7: 85 -- 0.481628
1: 7 -- 0.52345	10: 91 -- 0.529351	8: 53 -- 0.479729
2: 10 -- 0.519857	../004_AU17_query.dat:	9: 52 -- 0.479729
3: 85 -- 0.504173	1: 125 -- 0.578886	10: 18 -- 0.474132
4: 117 -- 0.501696	2: 104 -- 0.567499	../006_AU12_query.dat:
5: 114 -- 0.49945	3: 103 -- 0.567499	1: 128 -- 0.567225
6: 73 -- 0.489094	4: 39 -- 0.550003	2: 91 -- 0.564544
7: 93 -- 0.480159	5: 60 -- 0.541771	3: 87 -- 0.562226
8: 4 -- 0.47524	6: 105 -- 0.539325	4: 41 -- 0.552159
9: 51 -- 0.470271	7: 61 -- 0.53465	5: 50 -- 0.551123
10: 29 -- 0.468973	8: 86 -- 0.531641	6: 38 -- 0.550494
../003_AU12_query.dat:	9: 131 -- 0.530379	7: 135 -- 0.544712
1: 7 -- 0.52345	10: 115 -- 0.526261	8: 11 -- 0.541686
2: 10 -- 0.519857	../005_AU01_query.dat:	9: 79 -- 0.538918
3: 85 -- 0.504173	1: 88 -- 0.546914	10: 63 -- 0.525447
4: 117 -- 0.501696	2: 8 -- 0.519857	../006_AU17_query.dat:
5: 114 -- 0.49945	3: 7 -- 0.519857	1: 16 -- 0.796596
6: 73 -- 0.489094	4: 10 -- 0.509392	2: 17 -- 0.547982
7: 93 -- 0.480159	5: 114 -- 0.489214	3: 62 -- 0.508482
8: 4 -- 0.47524	6: 61 -- 0.48888	4: 63 -- 0.487228
9: 51 -- 0.470271	7: 85 -- 0.487806	5: 94 -- 0.481333
10: 29 -- 0.468973	8: 93 -- 0.486777	6: 37 -- 0.467462
../003_AU17_query.dat:	9: 42 -- 0.481571	7: 115 -- 0.464949
1: 131 -- 0.532777	10: 65 -- 0.478013	8: 131 -- 0.462744
2: 115 -- 0.516234	../005_AU12_query.dat:	9: 9 -- 0.460923
3: 56 -- 0.512027	1: 19 -- 0.54502	10: 127 -- 0.45889
4: 55 -- 0.512027	2: 116 -- 0.545012	../007_AU01_query.dat:
5: 130 -- 0.496604	3: 95 -- 0.533055	1: 77 -- 0.58077
6: 37 -- 0.496372	4: 119 -- 0.519957	2: 114 -- 0.555755
7: 9 -- 0.480108	5: 63 -- 0.515692	3: 26 -- 0.549863
8: 7 -- 0.473898	6: 57 -- 0.514221	4: 39 -- 0.546063
9: 2 -- 0.462934	7: 41 -- 0.513935	5: 69 -- 0.544099
10: 15 -- 0.460923	8: 54 -- 0.50381	6: 73 -- 0.540085
../004_AU01_query.dat:	9: 64 -- 0.50077	7: 120 -- 0.52069
1: 69 -- 0.585614	10: 79 -- 0.49852	8: 35 -- 0.508939
2: 85 -- 0.566872	../005_AU17_query.dat:	9: 132 -- 0.502946
3: 49 -- 0.556134	1: 94 -- 0.47566	10: 47 -- 0.500567
4: 93 -- 0.549484	2: 62 -- 0.458351	../007_AU12_query.dat:
5: 114 -- 0.547064	3: 57 -- 0.430176	1: 79 -- 0.572244
6: 51 -- 0.546065	4: 90 -- 0.421649	2: 18 -- 0.547982
7: 35 -- 0.544378	5: 56 -- 0.417782	3: 54 -- 0.537743

4: 63 -- 0.537463	2: 97 -- 0.417487	../010_AU17_query.dat:
5: 19 -- 0.5352	3: 10 -- 0.410465	1: 115 -- 0.525085
6: 46 -- 0.529934	4: 12 -- 0.396426	2: 131 -- 0.513062
7: 17 -- 0.523267	5: 39 -- 0.389026	3: 56 -- 0.499393
8: 116 -- 0.517829	6: 42 -- 0.378243	4: 55 -- 0.499393
9: 127 -- 0.487665	7: 36 -- 0.378052	5: 86 -- 0.491107
10: 95 -- 0.481147	8: 124 -- 0.376797	6: 48 -- 0.479846
../007_AU17_query.dat:	9: 107 -- 0.371591	7: 53 -- 0.476495
1: 18 -- 0.796596	10: 122 -- 0.367454	8: 52 -- 0.476495
2: 62 -- 0.531772	../009_AU12_query.dat:	9: 137 -- 0.471517
3: 127 -- 0.472313	1: 79 -- 0.553128	10: 136 -- 0.471517
4: 63 -- 0.470885	2: 24 -- 0.54688	../011_AU01_query.dat:
5: 37 -- 0.466514	3: 64 -- 0.52804	1: 93 -- 0.476551
6: 115 -- 0.464847	4: 43 -- 0.519295	2: 8 -- 0.468973
7: 17 -- 0.460581	5: 22 -- 0.513135	3: 7 -- 0.468973
8: 94 -- 0.460161	6: 41 -- 0.502726	4: 38 -- 0.462687
9: 130 -- 0.455067	7: 33 -- 0.485104	5: 53 -- 0.456103
10: 90 -- 0.450492	8: 83 -- 0.482471	6: 52 -- 0.456103
../008_AU01_query.dat:	9: 20 -- 0.476278	7: 10 -- 0.444159
1: 107 -- 0.491412	10: 87 -- 0.475633	8: 117 -- 0.436657
2: 69 -- 0.471386	../009_AU17_query.dat:	9: 85 -- 0.430654
3: 21 -- 0.448569	1: 25 -- 0.620705	10: 124 -- 0.429586
4: 35 -- 0.447887	2: 42 -- 0.435651	../011_AU12_query.dat:
5: 77 -- 0.444885	3: 27 -- 0.427931	1: 93 -- 0.476551
6: 117 -- 0.42832	4: 36 -- 0.4273	2: 8 -- 0.468973
7: 73 -- 0.424754	5: 131 -- 0.421381	3: 7 -- 0.468973
8: 82 -- 0.418556	6: 81 -- 0.418016	4: 38 -- 0.462687
9: 47 -- 0.418542	7: 115 -- 0.415875	5: 53 -- 0.456103
10: 17 -- 0.415244	8: 53 -- 0.414423	6: 52 -- 0.456103
../008_AU12_query.dat:	9: 52 -- 0.414423	7: 10 -- 0.444159
1: 63 -- 0.634026	10: 50 -- 0.408461	8: 117 -- 0.436657
2: 116 -- 0.588473	../010_AU01_query.dat:	9: 85 -- 0.430654
3: 41 -- 0.584808	1: 77 -- 0.569361	10: 124 -- 0.429586
4: 106 -- 0.555298	2: 39 -- 0.56834	../011_AU17_query.dat:
5: 79 -- 0.548145	3: 21 -- 0.549863	1: 137 -- 0.496554
6: 15 -- 0.54502	4: 85 -- 0.534623	2: 136 -- 0.496554
7: 87 -- 0.542637	5: 117 -- 0.519804	3: 125 -- 0.478886
8: 20 -- 0.5352	6: 125 -- 0.501971	4: 117 -- 0.472853
9: 54 -- 0.531836	7: 12 -- 0.493537	5: 71 -- 0.468924
10: 95 -- 0.530789	8: 35 -- 0.483476	6: 74 -- 0.46806
../008_AU17_query.dat:	9: 69 -- 0.481209	7: 12 -- 0.455947
1: 22 -- 0.54688	10: 124 -- 0.478338	8: 39 -- 0.453739
2: 78 -- 0.471824	../010_AU12_query.dat:	9: 5 -- 0.4494
3: 79 -- 0.465844	1: 27 -- 0.620705	10: 133 -- 0.448508
4: 108 -- 0.457323	2: 91 -- 0.472799	../012_AU01_query.dat:
5: 84 -- 0.452947	3: 41 -- 0.47201	1: 69 -- 0.497064
6: 50 -- 0.450805	4: 50 -- 0.471032	2: 125 -- 0.464364
7: 63 -- 0.450278	5: 87 -- 0.460677	3: 85 -- 0.4565
8: 18 -- 0.449513	6: 135 -- 0.456357	4: 124 -- 0.454612
9: 116 -- 0.447634	7: 123 -- 0.440848	5: 112 -- 0.445283
10: 109 -- 0.445465	8: 43 -- 0.440791	6: 122 -- 0.445066
../009_AU01_query.dat:	9: 59 -- 0.439666	7: 121 -- 0.445066
1: 49 -- 0.424286	10: 16 -- 0.427187	8: 53 -- 0.444641

9: 52 -- 0.444641	7: 12 -- 0.526149	5: 116 -- 0.579039
10: 12 -- 0.444312	8: 53 -- 0.516903	6: 91 -- 0.578456
../012_AU12_query.dat:	9: 52 -- 0.516903	7: 41 -- 0.563411
1: 79 -- 0.540424	10: 10 -- 0.511842	8: 50 -- 0.557508
2: 43 -- 0.51597	../014_AU01_query.dat:	9: 16 -- 0.552159
3: 135 -- 0.508341	1: 117 -- 0.585719	10: 57 -- 0.548422
4: 50 -- 0.49933	2: 69 -- 0.582894	../015_AU17_query.dat:
5: 83 -- 0.498853	3: 29 -- 0.56834	1: 98 -- 0.336549
6: 11 -- 0.490737	4: 124 -- 0.564557	2: 110 -- 0.33601
7: 38 -- 0.488026	5: 85 -- 0.563799	3: 112 -- 0.335508
8: 25 -- 0.485104	6: 93 -- 0.55448	4: 134 -- 0.329047
9: 41 -- 0.483984	7: 12 -- 0.550003	5: 48 -- 0.32154
10: 54 -- 0.474678	8: 125 -- 0.548446	6: 118 -- 0.320541
../012_AU17_query.dat:	9: 77 -- 0.546213	7: 133 -- 0.319302
1: 69 -- 0.497064	10: 49 -- 0.54613	8: 113 -- 0.319197
2: 125 -- 0.464364	../014_AU12_query.dat:	9: 128 -- 0.316761
3: 85 -- 0.4565	1: 135 -- 0.566093	10: 66 -- 0.315396
4: 124 -- 0.454612	2: 87 -- 0.564072	../016_AU01_query.dat:
5: 112 -- 0.445283	3: 41 -- 0.563411	1: 115 -- 0.517269
6: 122 -- 0.445066	4: 116 -- 0.556656	2: 63 -- 0.492699
7: 121 -- 0.445066	5: 50 -- 0.55532	3: 130 -- 0.485432
8: 53 -- 0.444641	6: 16 -- 0.550494	4: 131 -- 0.481979
9: 52 -- 0.444641	7: 106 -- 0.536927	5: 45 -- 0.476571
10: 12 -- 0.444312	8: 91 -- 0.529481	6: 57 -- 0.467547
../013_AU01_query.dat:	9: 79 -- 0.529237	7: 90 -- 0.465139
1: 85 -- 0.581734	10: 22 -- 0.524182	8: 22 -- 0.45962
2: 69 -- 0.576524	../014_AU17_query.dat:	9: 127 -- 0.458528
3: 49 -- 0.56933	1: 115 -- 0.570034	10: 61 -- 0.458116
4: 51 -- 0.547648	2: 130 -- 0.568128	../016_AU12_query.dat:
5: 10 -- 0.544378	3: 131 -- 0.546602	1: 95 -- 0.586065
6: 58 -- 0.52984	4: 116 -- 0.535135	2: 54 -- 0.580145
7: 114 -- 0.527924	5: 57 -- 0.514272	3: 50 -- 0.576833
8: 39 -- 0.521491	6: 127 -- 0.501163	4: 123 -- 0.561381
9: 117 -- 0.515601	7: 54 -- 0.498526	5: 59 -- 0.561275
10: 124 -- 0.5102	8: 90 -- 0.496629	6: 70 -- 0.548362
../013_AU12_query.dat:	9: 9 -- 0.496372	7: 135 -- 0.546883
1: 95 -- 0.554937	10: 63 -- 0.495476	8: 44 -- 0.545184
2: 116 -- 0.547272	../015_AU01_query.dat:	9: 11 -- 0.541075
3: 90 -- 0.526567	1: 65 -- 0.531867	10: 111 -- 0.540856
4: 63 -- 0.516572	2: 12 -- 0.525826	../016_AU17_query.dat:
5: 57 -- 0.515026	3: 10 -- 0.525258	1: 137 -- 0.506269
6: 54 -- 0.493189	4: 49 -- 0.506427	2: 136 -- 0.506269
7: 38 -- 0.49096	5: 72 -- 0.50199	3: 125 -- 0.474732
8: 111 -- 0.490495	6: 115 -- 0.489541	4: 126 -- 0.449095
9: 87 -- 0.49008	7: 13 -- 0.481571	5: 117 -- 0.443872
10: 15 -- 0.488599	8: 97 -- 0.481313	6: 64 -- 0.438673
../013_AU17_query.dat:	9: 61 -- 0.480751	7: 12 -- 0.437133
1: 50 -- 0.548467	10: 114 -- 0.478823	8: 53 -- 0.436563
2: 137 -- 0.546677	../015_AU12_query.dat:	9: 52 -- 0.436563
3: 136 -- 0.546677	1: 87 -- 0.619567	10: 39 -- 0.434192
4: 86 -- 0.546187	2: 106 -- 0.604417	../017_AU01_query.dat:
5: 125 -- 0.545266	3: 63 -- 0.585833	1: 42 -- 0.542911
6: 71 -- 0.526207	4: 22 -- 0.584808	2: 49 -- 0.522163

3: 85 -- 0.520194	1: 53 -- 0.565268	10: 86 -- 0.500935
4: 124 -- 0.508408	2: 52 -- 0.565268	../020_AU12_query.dat:
5: 120 -- 0.506127	3: 38 -- 0.547648	1: 63 -- 0.634881
6: 21 -- 0.500567	4: 10 -- 0.546065	2: 116 -- 0.61228
7: 69 -- 0.4991	5: 61 -- 0.535327	3: 57 -- 0.583341
8: 61 -- 0.487428	6: 85 -- 0.527838	4: 95 -- 0.568209
9: 38 -- 0.487423	7: 69 -- 0.52342	5: 130 -- 0.556875
10: 114 -- 0.482291	8: 93 -- 0.519535	6: 44 -- 0.548422
../017_AU12_query.dat:	9: 86 -- 0.513349	7: 106 -- 0.535054
1: 20 -- 0.529934	10: 71 -- 0.51188	8: 22 -- 0.518169
2: 116 -- 0.522711	../019_AU01_query.dat:	9: 115 -- 0.51729
3: 57 -- 0.508886	1: 54 -- 0.565268	10: 37 -- 0.515026
4: 95 -- 0.491803	2: 137 -- 0.547188	../020_AU17_query.dat:
5: 130 -- 0.485697	3: 136 -- 0.547188	1: 131 -- 0.54179
6: 127 -- 0.478957	4: 71 -- 0.544415	2: 12 -- 0.525209
7: 63 -- 0.478923	5: 85 -- 0.541877	3: 63 -- 0.515082
8: 37 -- 0.473745	6: 124 -- 0.527469	4: 9 -- 0.512027
9: 54 -- 0.472521	7: 69 -- 0.526044	5: 115 -- 0.507231
10: 115 -- 0.45364	8: 125 -- 0.519437	6: 134 -- 0.504123
../017_AU17_query.dat:	9: 10 -- 0.518097	7: 125 -- 0.503704
1: 133 -- 0.529631	10: 39 -- 0.516903	8: 137 -- 0.502311
2: 134 -- 0.521045	../019_AU12_query.dat:	9: 136 -- 0.502311
3: 118 -- 0.517999	1: 95 -- 0.663209	10: 86 -- 0.500935
4: 42 -- 0.510774	2: 57 -- 0.583341	../021_AU01_query.dat:
5: 113 -- 0.510396	3: 63 -- 0.582894	1: 85 -- 0.606074
6: 125 -- 0.501866	4: 46 -- 0.580145	2: 38 -- 0.52984
7: 112 -- 0.501786	5: 116 -- 0.575837	3: 10 -- 0.526223
8: 92 -- 0.5003	6: 20 -- 0.537743	4: 52 -- 0.515477
9: 91 -- 0.498004	7: 53 -- 0.535591	5: 69 -- 0.507203
10: 86 -- 0.497588	8: 22 -- 0.531836	6: 107 -- 0.506307
../018_AU01_query.dat:	9: 135 -- 0.529014	7: 82 -- 0.500253
1: 85 -- 0.577354	10: 44 -- 0.528188	8: 54 -- 0.498264
2: 38 -- 0.56933	../019_AU17_query.dat:	9: 114 -- 0.49393
3: 10 -- 0.556134	1: 54 -- 0.565268	10: 124 -- 0.492257
4: 114 -- 0.55489	2: 137 -- 0.547188	../021_AU12_query.dat:
5: 69 -- 0.554754	3: 136 -- 0.547188	1: 91 -- 0.591855
6: 42 -- 0.54613	4: 71 -- 0.544415	2: 46 -- 0.561275
7: 124 -- 0.529426	5: 85 -- 0.541877	3: 83 -- 0.555012
8: 61 -- 0.526253	6: 124 -- 0.527469	4: 11 -- 0.543982
9: 50 -- 0.522163	7: 69 -- 0.526044	5: 105 -- 0.538339
10: 17 -- 0.519069	8: 125 -- 0.519437	6: 44 -- 0.525912
../018_AU12_query.dat:	9: 10 -- 0.518097	7: 75 -- 0.521887
1: 46 -- 0.576833	10: 39 -- 0.516903	8: 64 -- 0.510514
2: 128 -- 0.567256	../020_AU01_query.dat:	9: 87 -- 0.502346
3: 126 -- 0.561974	1: 131 -- 0.54179	10: 16 -- 0.50105
4: 87 -- 0.560841	2: 12 -- 0.525209	../021_AU17_query.dat:
5: 44 -- 0.557508	3: 63 -- 0.515082	1: 12 -- 0.541771
6: 41 -- 0.55532	4: 9 -- 0.512027	2: 42 -- 0.533601
7: 11 -- 0.552845	5: 115 -- 0.507231	3: 71 -- 0.517096
8: 70 -- 0.552375	6: 134 -- 0.504123	4: 125 -- 0.515294
9: 16 -- 0.551123	7: 125 -- 0.503704	5: 104 -- 0.512785
10: 39 -- 0.548467	8: 137 -- 0.502311	6: 103 -- 0.512785
../018_AU17_query.dat:	9: 136 -- 0.502311	7: 89 -- 0.509792

8: 61 -- 0.505304	6: 25 -- 0.52804	4: 12 -- 0.488804
9: 131 -- 0.500515	7: 95 -- 0.526504	5: 105 -- 0.48541
10: 85 -- 0.499665	8: 44 -- 0.523034	6: 91 -- 0.471374
../022_AU01_query.dat:	9: 105 -- 0.522115	7: 10 -- 0.46957
1: 54 -- 0.535327	10: 135 -- 0.520067	8: 93 -- 0.467606
2: 12 -- 0.53465	../023_AU17_query.dat:	9: 52 -- 0.464324
3: 125 -- 0.533971	1: 67 -- 0.55424	10: 104 -- 0.463102
4: 85 -- 0.532786	2: 68 -- 0.468467	../025_AU12_query.dat:
5: 114 -- 0.529402	3: 134 -- 0.41274	1: 111 -- 0.620437
6: 10 -- 0.526581	4: 113 -- 0.410888	2: 135 -- 0.559058
7: 52 -- 0.526253	5: 51 -- 0.406677	3: 11 -- 0.556351
8: 42 -- 0.513159	6: 133 -- 0.393362	4: 53 -- 0.552375
9: 56 -- 0.511089	7: 44 -- 0.387798	5: 46 -- 0.548362
10: 55 -- 0.511089	8: 98 -- 0.381911	6: 125 -- 0.536137
../022_AU12_query.dat:	9: 61 -- 0.381842	7: 126 -- 0.532134
1: 116 -- 0.671814	10: 59 -- 0.381331	8: 128 -- 0.527904
2: 60 -- 0.634881	../024_AU01_query.dat:	9: 16 -- 0.524477
3: 22 -- 0.634026	1: 85 -- 0.608824	10: 87 -- 0.519764
4: 44 -- 0.585833	2: 117 -- 0.607168	../025_AU17_query.dat:
5: 57 -- 0.582894	3: 107 -- 0.588797	1: 125 -- 0.584594
6: 95 -- 0.577136	4: 10 -- 0.585614	2: 137 -- 0.577252
7: 130 -- 0.576861	5: 124 -- 0.583623	3: 136 -- 0.577252
8: 115 -- 0.555359	6: 42 -- 0.582894	4: 72 -- 0.565711
9: 90 -- 0.553944	7: 93 -- 0.582252	5: 134 -- 0.557071
10: 87 -- 0.551272	8: 38 -- 0.576524	6: 109 -- 0.550788
../022_AU17_query.dat:	9: 71 -- 0.565711	7: 111 -- 0.546544
1: 94 -- 0.547689	10: 52 -- 0.554754	8: 56 -- 0.544415
2: 19 -- 0.531772	../024_AU12_query.dat:	9: 55 -- 0.544415
3: 18 -- 0.508482	1: 66 -- 0.53064	10: 112 -- 0.543852
4: 115 -- 0.499635	2: 44 -- 0.502227	../026_AU01_query.dat:
5: 116 -- 0.491065	3: 68 -- 0.499201	1: 21 -- 0.540085
6: 60 -- 0.484805	4: 60 -- 0.493441	2: 117 -- 0.532692
7: 92 -- 0.47885	5: 22 -- 0.48635	3: 93 -- 0.525702
8: 130 -- 0.477662	6: 106 -- 0.48531	4: 114 -- 0.510137
9: 51 -- 0.46977	7: 57 -- 0.476308	5: 42 -- 0.504302
10: 40 -- 0.469494	8: 69 -- 0.468467	6: 72 -- 0.500118
../023_AU01_query.dat:	9: 87 -- 0.466272	7: 85 -- 0.490228
1: 45 -- 0.531867	10: 116 -- 0.463222	8: 8 -- 0.489094
2: 68 -- 0.499201	../024_AU17_query.dat:	9: 7 -- 0.489094
3: 64 -- 0.479349	1: 69 -- 0.55424	10: 29 -- 0.475012
4: 10 -- 0.478521	2: 59 -- 0.424343	../026_AU12_query.dat:
5: 13 -- 0.478013	3: 58 -- 0.424343	1: 83 -- 0.582673
6: 12 -- 0.456189	4: 68 -- 0.414473	2: 91 -- 0.571202
7: 88 -- 0.453877	5: 60 -- 0.412669	3: 67 -- 0.553169
8: 66 -- 0.452686	6: 130 -- 0.375662	4: 135 -- 0.542533
9: 85 -- 0.442997	7: 116 -- 0.372688	5: 119 -- 0.538823
10: 59 -- 0.441016	8: 57 -- 0.370082	6: 62 -- 0.521887
../023_AU12_query.dat:	9: 127 -- 0.36958	7: 11 -- 0.520221
1: 119 -- 0.585124	10: 131 -- 0.36671	8: 87 -- 0.515848
2: 91 -- 0.563661	../025_AU01_query.dat:	9: 105 -- 0.510669
3: 87 -- 0.558492	1: 45 -- 0.50199	10: 111 -- 0.497954
4: 75 -- 0.553169	2: 64 -- 0.496659	../026_AU17_query.dat:
5: 79 -- 0.532067	3: 42 -- 0.491082	1: 133 -- 0.552427

2: 42 -- 0.534356	../028_AU12_query.dat:	9: 74 -- 0.432818
3: 112 -- 0.523453	1: 20 -- 0.572244	10: 91 -- 0.425423
4: 113 -- 0.522452	2: 25 -- 0.553128	../030_AU01_query.dat:
5: 137 -- 0.504772	3: 22 -- 0.548145	1: 72 -- 0.608824
6: 136 -- 0.504772	4: 66 -- 0.547102	2: 61 -- 0.606074
7: 125 -- 0.502268	5: 36 -- 0.540424	3: 124 -- 0.597213
8: 104 -- 0.500658	6: 16 -- 0.538918	4: 93 -- 0.591164
9: 103 -- 0.500658	7: 53 -- 0.53382	5: 114 -- 0.585663
10: 117 -- 0.49261	8: 67 -- 0.532067	6: 38 -- 0.581734
../027_AU01_query.dat:	9: 41 -- 0.529237	7: 117 -- 0.577992
1: 21 -- 0.58077	10: 135 -- 0.527774	8: 52 -- 0.577354
2: 29 -- 0.569361	../028_AU17_query.dat:	9: 10 -- 0.566872
3: 42 -- 0.546213	1: 53 -- 0.543966	10: 42 -- 0.563799
4: 72 -- 0.544482	2: 125 -- 0.533565	../030_AU12_query.dat:
5: 114 -- 0.540187	3: 44 -- 0.529141	1: 44 -- 0.619567
6: 85 -- 0.519927	4: 12 -- 0.51766	2: 91 -- 0.614134
7: 38 -- 0.509957	5: 56 -- 0.515764	3: 106 -- 0.596457
8: 17 -- 0.506806	6: 55 -- 0.515764	4: 41 -- 0.564072
9: 132 -- 0.503661	7: 108 -- 0.514191	5: 16 -- 0.562226
10: 117 -- 0.49476	8: 89 -- 0.513979	6: 53 -- 0.560841
../027_AU12_query.dat:	9: 57 -- 0.504712	7: 67 -- 0.558492
1: 46 -- 0.480354	10: 115 -- 0.503952	8: 135 -- 0.557765
2: 25 -- 0.474569	../029_AU01_query.dat:	9: 119 -- 0.55308
3: 67 -- 0.455268	1: 61 -- 0.500253	10: 66 -- 0.551272
4: 36 -- 0.435932	2: 38 -- 0.481573	../030_AU17_query.dat:
5: 11 -- 0.428632	3: 124 -- 0.466297	1: 108 -- 0.578289
6: 79 -- 0.420381	4: 54 -- 0.465848	2: 125 -- 0.574981
7: 62 -- 0.419385	5: 85 -- 0.459661	3: 134 -- 0.54765
8: 119 -- 0.412913	6: 80 -- 0.446072	4: 39 -- 0.546187
9: 87 -- 0.410751	7: 114 -- 0.446054	5: 137 -- 0.536415
10: 44 -- 0.407916	8: 72 -- 0.440682	6: 136 -- 0.536415
../027_AU17_query.dat:	9: 56 -- 0.440267	7: 74 -- 0.536163
1: 22 -- 0.513614	10: 55 -- 0.440267	8: 118 -- 0.532421
2: 95 -- 0.4857	../029_AU12_query.dat:	9: 12 -- 0.531641
3: 79 -- 0.481051	1: 78 -- 0.582673	10: 115 -- 0.526581
4: 66 -- 0.480418	2: 91 -- 0.567781	../031_AU01_query.dat:
5: 116 -- 0.478594	3: 62 -- 0.555012	1: 13 -- 0.546914
6: 20 -- 0.478033	4: 105 -- 0.528225	2: 120 -- 0.526095
7: 115 -- 0.473315	5: 46 -- 0.514088	3: 42 -- 0.511376
8: 24 -- 0.471824	6: 135 -- 0.512653	4: 114 -- 0.509389
9: 30 -- 0.467786	7: 82 -- 0.506395	5: 124 -- 0.498194
10: 125 -- 0.467196	8: 16 -- 0.502346	6: 21 -- 0.49318
../028_AU01_query.dat:	9: 36 -- 0.498853	7: 72 -- 0.489258
1: 124 -- 0.498509	10: 111 -- 0.498056	8: 93 -- 0.487977
2: 85 -- 0.497218	../029_AU17_query.dat:	9: 10 -- 0.481588
3: 56 -- 0.493161	1: 86 -- 0.459726	10: 64 -- 0.48158
4: 55 -- 0.493161	2: 24 -- 0.452947	../031_AU12_query.dat:
5: 102 -- 0.487787	3: 81 -- 0.452925	1: 130 -- 0.579015
6: 61 -- 0.48035	4: 16 -- 0.448998	2: 116 -- 0.565478
7: 54 -- 0.480209	5: 53 -- 0.448335	3: 66 -- 0.553944
8: 114 -- 0.468302	6: 131 -- 0.444202	4: 37 -- 0.526567
9: 17 -- 0.468289	7: 40 -- 0.436954	5: 131 -- 0.524516
10: 72 -- 0.465035	8: 82 -- 0.436134	6: 115 -- 0.518273

7: 44 -- 0.508785	5: 94 -- 0.509898	3: 53 -- 0.506105
8: 60 -- 0.507243	6: 125 -- 0.49458	4: 133 -- 0.5013
9: 22 -- 0.506485	7: 11 -- 0.479541	5: 108 -- 0.499346
10: 57 -- 0.502219	8: 12 -- 0.477053	6: 51 -- 0.496342
../031_AU17_query.dat:	9: 112 -- 0.468655	7: 134 -- 0.495408
1: 125 -- 0.564511	10: 128 -- 0.466458	8: 52 -- 0.488306
2: 131 -- 0.535288	../033_AU12_query.dat:	9: 89 -- 0.479647
3: 89 -- 0.523157	1: 57 -- 0.663209	10: 39 -- 0.47151
4: 115 -- 0.521839	2: 116 -- 0.5891	../035_AU01_query.dat:
5: 84 -- 0.513979	3: 46 -- 0.586065	1: 74 -- 0.516093
6: 74 -- 0.510429	4: 66 -- 0.577136	2: 111 -- 0.5066
7: 63 -- 0.509792	5: 119 -- 0.576239	3: 138 -- 0.477733
8: 12 -- 0.508034	6: 111 -- 0.571202	4: 137 -- 0.473861
9: 10 -- 0.49636	7: 60 -- 0.568209	5: 136 -- 0.473861
10: 64 -- 0.491114	8: 37 -- 0.554937	6: 73 -- 0.471863
../032_AU01_query.dat:	9: 125 -- 0.548699	7: 128 -- 0.467363
1: 88 -- 0.591164	10: 15 -- 0.533055	8: 110 -- 0.466009
2: 72 -- 0.582252	../033_AU17_query.dat:	9: 126 -- 0.461905
3: 42 -- 0.55448	1: 65 -- 0.547689	10: 122 -- 0.458461
4: 10 -- 0.549484	2: 131 -- 0.504146	../035_AU12_query.dat:
5: 117 -- 0.547503	3: 125 -- 0.5011	1: 111 -- 0.478882
6: 76 -- 0.525702	4: 130 -- 0.498211	2: 123 -- 0.467095
7: 134 -- 0.523566	5: 59 -- 0.493196	3: 126 -- 0.457193
8: 114 -- 0.522187	6: 58 -- 0.493196	4: 138 -- 0.454723
9: 54 -- 0.519535	7: 89 -- 0.492974	5: 74 -- 0.454209
10: 52 -- 0.518723	8: 60 -- 0.491659	6: 11 -- 0.450762
../032_AU12_query.dat:	9: 115 -- 0.491298	7: 137 -- 0.446342
1: 90 -- 0.614134	10: 40 -- 0.487441	8: 136 -- 0.446342
2: 62 -- 0.591855	../034_AU01_query.dat:	9: 46 -- 0.445217
3: 44 -- 0.578456	1: 99 -- 0.693288	10: 16 -- 0.435428
4: 78 -- 0.571202	2: 94 -- 0.499575	../035_AU17_query.dat:
5: 86 -- 0.567781	3: 52 -- 0.495117	1: 110 -- 0.510256
6: 16 -- 0.564544	4: 125 -- 0.492962	2: 74 -- 0.509593
7: 67 -- 0.563661	5: 12 -- 0.490785	3: 72 -- 0.504281
8: 106 -- 0.557596	6: 53 -- 0.485454	4: 134 -- 0.500032
9: 125 -- 0.548596	7: 42 -- 0.481603	5: 111 -- 0.494459
10: 105 -- 0.543648	8: 45 -- 0.481313	6: 122 -- 0.492506
../032_AU17_query.dat:	9: 124 -- 0.474839	7: 121 -- 0.492506
1: 51 -- 0.5003	10: 44 -- 0.471983	8: 137 -- 0.492477
2: 65 -- 0.47885	../034_AU12_query.dat:	9: 136 -- 0.492477
3: 127 -- 0.470338	1: 99 -- 0.714235	10: 83 -- 0.487787
4: 115 -- 0.467339	2: 94 -- 0.533407	../036_AU01_query.dat:
5: 53 -- 0.457114	3: 53 -- 0.526412	1: 12 -- 0.567499
6: 44 -- 0.453725	4: 128 -- 0.494216	2: 74 -- 0.520643
7: 66 -- 0.453663	5: 41 -- 0.492288	3: 63 -- 0.512785
8: 108 -- 0.445726	6: 11 -- 0.490944	4: 96 -- 0.511999
9: 93 -- 0.445361	7: 135 -- 0.471847	5: 125 -- 0.508645
10: 75 -- 0.443491	8: 78 -- 0.467298	6: 10 -- 0.506061
../033_AU01_query.dat:	9: 105 -- 0.466443	7: 11 -- 0.500934
1: 99 -- 0.714235	10: 73 -- 0.461361	8: 77 -- 0.500658
2: 97 -- 0.693288	../034_AU17_query.dat:	9: 134 -- 0.499358
3: 98 -- 0.622835	1: 99 -- 0.622835	10: 42 -- 0.495422
4: 53 -- 0.540139	2: 125 -- 0.514859	../036_AU12_query.dat:

1: 11 -- 0.627848	10: 84 -- 0.514191	8: 136 -- 0.514869
2: 94 -- 0.543648	../038_AU01_query.dat:	9: 73 -- 0.511238
3: 12 -- 0.539325	1: 96 -- 0.513305	10: 11 -- 0.50992
4: 62 -- 0.538339	2: 105 -- 0.510256	../039_AU17_query.dat:
5: 53 -- 0.532859	3: 74 -- 0.497339	1: 134 -- 0.575808
6: 86 -- 0.528225	4: 88 -- 0.492974	2: 133 -- 0.567955
7: 67 -- 0.522115	5: 72 -- 0.49183	3: 122 -- 0.54212
8: 46 -- 0.520875	6: 110 -- 0.480005	4: 121 -- 0.54212
9: 111 -- 0.512131	7: 122 -- 0.47798	5: 74 -- 0.527392
10: 78 -- 0.510669	8: 121 -- 0.47798	6: 77 -- 0.522452
../036_AU17_query.dat:	9: 117 -- 0.477613	7: 51 -- 0.510396
1: 12 -- 0.567499	10: 103 -- 0.466009	8: 42 -- 0.503543
2: 74 -- 0.520643	../038_AU12_query.dat:	9: 118 -- 0.503
3: 63 -- 0.512785	1: 73 -- 0.620437	10: 125 -- 0.501152
4: 96 -- 0.511999	2: 98 -- 0.571202	../040_AU01_query.dat:
5: 125 -- 0.508645	3: 135 -- 0.570864	1: 72 -- 0.607168
6: 10 -- 0.506061	4: 11 -- 0.555623	2: 42 -- 0.585719
7: 11 -- 0.500934	5: 126 -- 0.548411	3: 88 -- 0.577992
8: 77 -- 0.500658	6: 74 -- 0.546544	4: 96 -- 0.547503
9: 134 -- 0.499358	7: 46 -- 0.540856	5: 124 -- 0.540072
10: 42 -- 0.495422	8: 128 -- 0.540288	6: 110 -- 0.534325
../037_AU01_query.dat:	9: 90 -- 0.539242	7: 10 -- 0.533478
1: 72 -- 0.588797	10: 123 -- 0.532492	8: 76 -- 0.532692
2: 42 -- 0.538747	../038_AU17_query.dat:	9: 120 -- 0.527526
3: 117 -- 0.534325	1: 111 -- 0.702241	10: 118 -- 0.524027
4: 124 -- 0.534193	2: 74 -- 0.550788	../040_AU12_query.dat:
5: 10 -- 0.521733	3: 127 -- 0.531018	1: 66 -- 0.671814
6: 88 -- 0.520368	4: 89 -- 0.522352	2: 130 -- 0.623496
7: 61 -- 0.506307	5: 98 -- 0.521516	3: 60 -- 0.61228
8: 38 -- 0.502886	6: 73 -- 0.514011	4: 98 -- 0.5891
9: 74 -- 0.501659	7: 53 -- 0.511729	5: 22 -- 0.588473
10: 23 -- 0.491412	8: 135 -- 0.50954	6: 44 -- 0.579039
../037_AU12_query.dat:	9: 137 -- 0.502663	7: 57 -- 0.575837
1: 44 -- 0.604417	10: 136 -- 0.502663	8: 93 -- 0.565478
2: 90 -- 0.596457	../039_AU01_query.dat:	9: 127 -- 0.56424
3: 94 -- 0.557596	1: 88 -- 0.585663	10: 41 -- 0.556656
4: 22 -- 0.555298	2: 21 -- 0.555755	../040_AU17_query.dat:
5: 116 -- 0.549718	3: 52 -- 0.55489	1: 131 -- 0.639145
6: 66 -- 0.542096	4: 17 -- 0.549901	2: 130 -- 0.591638
7: 41 -- 0.536927	5: 10 -- 0.547064	3: 40 -- 0.570034
8: 60 -- 0.535054	6: 80 -- 0.540187	4: 66 -- 0.555359
9: 111 -- 0.529288	7: 64 -- 0.529402	5: 44 -- 0.53165
10: 46 -- 0.497139	8: 38 -- 0.527924	6: 127 -- 0.530601
../037_AU17_query.dat:	9: 72 -- 0.526827	7: 89 -- 0.526581
1: 109 -- 0.702241	10: 96 -- 0.522187	8: 12 -- 0.526261
2: 89 -- 0.578289	../039_AU12_query.dat:	9: 30 -- 0.525085
3: 74 -- 0.528512	1: 133 -- 0.549456	10: 92 -- 0.521839
4: 12 -- 0.523213	2: 74 -- 0.543852	../041_AU01_query.dat:
5: 125 -- 0.520249	3: 134 -- 0.536227	1: 42 -- 0.541509
6: 53 -- 0.519632	4: 77 -- 0.523453	2: 120 -- 0.527526
7: 90 -- 0.516904	5: 122 -- 0.514969	3: 91 -- 0.526095
8: 137 -- 0.515852	6: 121 -- 0.514969	4: 21 -- 0.52069
9: 136 -- 0.515852	7: 137 -- 0.514869	5: 124 -- 0.517741

6: 50 -- 0.506127	4: 52 -- 0.497089	2: 11 -- 0.584869
7: 132 -- 0.499928	5: 105 -- 0.492506	3: 53 -- 0.567256
8: 72 -- 0.491833	6: 42 -- 0.478113	4: 16 -- 0.567225
9: 125 -- 0.488122	7: 113 -- 0.47798	5: 138 -- 0.545441
10: 117 -- 0.487651	8: 74 -- 0.474198	6: 114 -- 0.540288
../041_AU12_query.dat:	9: 96 -- 0.471078	7: 73 -- 0.527904
1: 67 -- 0.585124	10: 125 -- 0.467715	8: 44 -- 0.524106
2: 98 -- 0.576239	../043_AU01_query.dat:	9: 41 -- 0.511517
3: 90 -- 0.55308	1: 88 -- 0.597213	10: 6 -- 0.503594
4: 94 -- 0.539396	2: 72 -- 0.583623	../044_AU17_query.dat:
5: 78 -- 0.538823	3: 42 -- 0.564557	1: 119 -- 0.56424
6: 15 -- 0.519957	4: 10 -- 0.540504	2: 53 -- 0.534044
7: 119 -- 0.514822	5: 120 -- 0.540072	3: 112 -- 0.531018
8: 44 -- 0.511268	6: 110 -- 0.534193	4: 118 -- 0.530601
9: 114 -- 0.507055	7: 52 -- 0.529426	5: 130 -- 0.512138
10: 135 -- 0.505468	8: 56 -- 0.527469	6: 57 -- 0.504088
../041_AU17_query.dat:	9: 55 -- 0.527469	7: 66 -- 0.503337
1: 90 -- 0.543933	10: 117 -- 0.521236	8: 40 -- 0.501163
2: 125 -- 0.543608	../043_AU12_query.dat:	9: 111 -- 0.496021
3: 94 -- 0.537433	1: 128 -- 0.721561	10: 44 -- 0.493964
4: 89 -- 0.532421	2: 11 -- 0.582415	../045_AU01_query.dat:
5: 120 -- 0.524027	3: 53 -- 0.561974	1: 72 -- 0.542508
6: 51 -- 0.517999	4: 114 -- 0.548411	2: 88 -- 0.53761
7: 74 -- 0.510469	5: 73 -- 0.532134	3: 38 -- 0.505573
8: 137 -- 0.505043	6: 138 -- 0.507692	4: 42 -- 0.505421
9: 136 -- 0.505043	7: 41 -- 0.505482	5: 80 -- 0.503661
10: 116 -- 0.503	8: 16 -- 0.503313	6: 21 -- 0.502946
../042_AU01_query.dat:	9: 74 -- 0.500309	7: 123 -- 0.499928
1: 116 -- 0.54212	10: 44 -- 0.497711	8: 52 -- 0.496508
2: 115 -- 0.514969	../043_AU17_query.dat:	9: 120 -- 0.496223
3: 72 -- 0.50878	1: 74 -- 0.584594	10: 134 -- 0.495547
4: 52 -- 0.497089	2: 12 -- 0.578886	../045_AU12_query.dat:
5: 105 -- 0.492506	3: 89 -- 0.574981	1: 119 -- 0.623496
6: 42 -- 0.478113	4: 92 -- 0.564511	2: 118 -- 0.591638
7: 113 -- 0.47798	5: 137 -- 0.562782	3: 93 -- 0.579015
8: 74 -- 0.474198	6: 136 -- 0.562782	4: 66 -- 0.576861
9: 96 -- 0.471078	7: 98 -- 0.548699	5: 40 -- 0.568128
10: 125 -- 0.467715	8: 94 -- 0.548596	6: 60 -- 0.556875
../042_AU12_query.dat:	9: 42 -- 0.548446	7: 44 -- 0.532998
1: 46 -- 0.561381	10: 134 -- 0.547382	8: 22 -- 0.530612
2: 53 -- 0.546963	../044_AU01_query.dat:	9: 98 -- 0.526997
3: 114 -- 0.532492	1: 56 -- 0.505945	10: 90 -- 0.524861
4: 90 -- 0.513201	2: 55 -- 0.505945	../045_AU17_query.dat:
5: 135 -- 0.505237	3: 74 -- 0.493109	1: 118 -- 0.639145
6: 108 -- 0.503662	4: 111 -- 0.485078	2: 40 -- 0.546602
7: 44 -- 0.501253	5: 73 -- 0.483563	3: 119 -- 0.543562
8: 125 -- 0.496904	6: 137 -- 0.48241	4: 59 -- 0.54179
9: 11 -- 0.490189	7: 136 -- 0.48241	5: 58 -- 0.54179
10: 94 -- 0.488489	8: 112 -- 0.482314	6: 92 -- 0.535288
../042_AU17_query.dat:	9: 46 -- 0.463233	7: 9 -- 0.532777
1: 116 -- 0.54212	10: 57 -- 0.45895	8: 12 -- 0.530379
2: 115 -- 0.514969	../044_AU12_query.dat:	9: 93 -- 0.524516
3: 72 -- 0.50878	1: 129 -- 0.721561	10: 89 -- 0.520494

```

../046_AU01_query.dat:      8: 136 -- 0.523744      5: 39 -- 0.546677
  1: 116 -- 0.575808      9: 72 -- 0.50525      6: 137 -- 0.540196
  2: 74 -- 0.557071     10: 101 -- 0.5013      7: 89 -- 0.536415
  3: 89 -- 0.54765      ../047_AU01_query.dat:      8: 12 -- 0.524467
  4: 128 -- 0.547382      1: 74 -- 0.577252      9: 136 -- 0.523744
  5: 72 -- 0.54641      2: 128 -- 0.562782     10: 111 -- 0.515852
  6: 137 -- 0.540196      3: 56 -- 0.547188
  7: 136 -- 0.540196      4: 55 -- 0.547188
  8: 115 -- 0.536227      5: 39 -- 0.546677
  9: 96 -- 0.523566      6: 137 -- 0.540196
 10: 51 -- 0.521045      7: 89 -- 0.536415
../046_AU12_query.dat:      8: 12 -- 0.524467
  1: 114 -- 0.570864      9: 136 -- 0.523744
  2: 41 -- 0.566093     10: 111 -- 0.515852
  3: 73 -- 0.559058      ../047_AU12_query.dat:
  4: 90 -- 0.557765      1: 131 -- 0.545441
  5: 46 -- 0.546883      2: 114 -- 0.520178
  6: 16 -- 0.544712      3: 11 -- 0.512643
  7: 78 -- 0.542533      4: 129 -- 0.507692
  8: 53 -- 0.541067      5: 73 -- 0.502676
  9: 98 -- 0.532339      6: 103 -- 0.477733
 10: 57 -- 0.529014      7: 16 -- 0.467455
../046_AU17_query.dat:      8: 67 -- 0.463592
  1: 116 -- 0.567955      9: 115 -- 0.462002
  2: 77 -- 0.552427     10: 74 -- 0.460051
  3: 115 -- 0.549456      ../047_AU17_query.data
  4: 74 -- 0.537691      1: 74 -- 0.577252
  5: 51 -- 0.529631      2: 128 -- 0.562782
  6: 128 -- 0.524432      3: 56 -- 0.547188
  7: 137 -- 0.523744      4: 55 -- 0.547188

```

Time Statistics:

```

real  0m7.004s
user  0m6.822s
sys   0m0.164s

```

5 Conclusion

This program taught us the importance of optimization. In the past, programs in other classes have focused only on correctness. Often times optimization is overlooked, but this program forced us to think about ways to improve efficiency throughout the coding process. In order to improve efficiency we tried to minimize output as much as possible because I/O takes up a substantial amount of CPU time. We also used the `Ofast` optimization flag in our make file and a sorting algorithm in order to improve efficiency. This program was a good learning experience and will encourage us to not overlook optimization in future projects.