The Advantage is at the Ladies: Brain Size Bias-Compensated Graph-Theoretical Parameters are Also Better in Women's Connectomes

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Abstract

In our previous study we have shown that the female connectomes have significantly better, deep graph-theoretical parameters, related to superior "connectivity", than the connectome of the males. Since the average female brain is smaller than the average male brain, one cannot rule out that the significant advantages are due to the size- and not to the sex-differences in the data. To filter out the possible brain-volume related artifacts, we have chosen 36 small male and 36 large female brains such that all the brains in the female set are larger than all the brains in the male set. For the sets, we have computed the corresponding braingraphs and computed numerous graph-theoretical parameters. We have found that (i) the small male brains lack the better connectivity advantages shown in our previous study for female brains in general; (ii) in numerous parameters, the connectomes computed from the large-brain females, still have the significant, deep connectivity advantages, demonstrated in our previous study.

1. Introduction

While the neuronal-scale mapping of the connections of the whole human brain with more than 80 billion neurons is not possible today, a diffusion MRI-based workflow is available for mapping these connections with much less resolution [1, 2, 3, 4]. The result of that workflow is the connectome, or the braingraph of the subject: the several hundred nodes of this graph correspond to distinct areas of the gray matter of the brain, and two nodes are connected by an edge if the workflow finds fibers of axons connecting the areas, corresponding to these two nodes.

These connectomes describe tens of thousands of connections between distinct cerebral areas in a much more detailed manner than was possible before

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the era of diffusion MRI imaging. Additionally, the braingraphs make possible the quantitative analysis of the connections of the human brain.

One natural question is finding the connections that are present in a majority of healthy subjects. In [5] we described the Budapest Reference Connectome Server `http://connectome.pitgroup.org` that generates and visualizes the consensus braingraph of healthy individuals according to selectable parameters.

Another related question is the mapping of the individual variability of the connectomes in distinct areas of the gray matter. Using data from 392 healthy individuals, we have mapped the surprisingly different variability of the connections in distinct lobes and smaller cortical areas in [6].

An interesting area is characterizing the significant differences in the brain-connections of distinct groups of subjects. Hundreds of publications appear describing differences of the connectomes of healthy and diseased individuals (e.g., [7, 8, 9, 10, 11]).

Much fewer articles deal with sex differences of the structural properties of the connectomes. The authors of [12] and [13] have applied statistics for the numbers of edges connecting larger, fixed anatomical areas of the cortex in men and women, and have found significant differences between the sexes in these numbers. The work [13] analyzed the 95-vertex graphs of 949 subjects aged from 8 through 22 years on a publicly unavailable dataset. One of the main results of [13] is showing that males have more intra-hemispheric edges while females have more inter-hemispheric edges.

Instead of simple edge-counting, we have applied much deeper – even some NP-hard – graph-theoretical algorithms for discovering sex differences between the connectomes in [14]. The graph dataset examined in [14] contained the data of 96 subjects of ages between 22 and 35 years, from the Human Connectome Project [3]. From the data of each subjects five graphs were computed with different resolutions and each graph with five different edge weights. The graph dataset is publicly available (without any registration) at `http://braingraph.org/download-pit-group-connectomes/` for independent verification and further analysis.

We have found in [14] that the female brain has such graph-theoretical properties that are associated with "better connectivity" in computer interconnection networks [15] and elsewhere. Namely, women's braingraphs have

(i) more edges;

(ii) larger minimum bisection width (balanced minimum cut) within each hemisphere, even when normalized with the edge number;

(iii) larger eigengap;

(iv) more spanning forests;

(v) larger minimum vertex cover

than the braingraphs of men.

Property (i), the larger edge number, is a straightforward characteristic of a "better connected" graph. In computer interconnections networks, the quantity (ii) is a standard measure of the "quality" of the network [15]: the higher the width is the better the network. We note that the advantage remains valid even if we normalize the bisection width with the larger edge-number of the female connectomes! Quantity (iii) is related to the expander property of the graphs [16]: the larger the eigengap, the better expander is the graph. Good expander graphs have good intrinsic "connectivity" properties, such as a fast convergence to the stationary distribution of a random walk on an expander graph [16].

A minimum vertex cover is the smallest subset S of the nodes of the graph such that each edge contains at least one vertex from S (i.e., each edge is "covered" by an element of S). The result in [14] says that the edges in the braingraph of females need more vertices to cover than in the case of males.

It is known for a long time that on the average, the female brain weights less and is smaller than the brain of males [17, 18]. Clearly, this statistical difference may have implications for the diffusion MR imaging workflow, and, consequently, to the construction of the braingraphs from the imaging data.

For example, larger brains have longer axonal fibers, and those longer fibers are more difficult to follow in the tractography phase of the data processing workflow: if we assume that there is a fixed error probability at every step of the tractography algorithm, then longer fibers will produce more errors, and, consequently, are much harder to follow and discover than short ones [19, 20].

Therefore, it might happen that the statistically significant differences in the graph properties of the connectomes of different sexes are due to simple size differences. Clearly, any brain-size dependent "artificial" correction of the diffusion MRI data or the tractography results would meet well-founded criticism, and is not a realistic choice for data analysis.

The article [21] states that the sex differences in the ratio of the intrahemispheric/interhemispheric connections in the connectome are due to the differences in the brain size. In order to show this, they have selected 69 small brain subjects (55 females and 14 males) and 69 large brain subjects (14 females and 55 males), and after acquiring and analyzing their — publicly unavailable — data, they have found that the ratio of the intrahemispheric/interhemispheric streamlines (the authors of [21] called it "connectivity ratio") is significantly larger in the small brain group than in the large brain group (0.218 vs. 0.201, p=0.005 from Table 1 of [21]).

We do not think that the results of [21] are really decisive on the question since the large brain group contained mostly males and the small brain group mostly females.

In our present work, we have computed braingraphs from the data of more than 400 subjects of the Human Connectome Project's [3] anonymized 500 Subjects Release, and from this large set we were able to choose two rather unusual sets of subjects: 36 large-brain females and 36 small-brain males such that every single female brain is of larger volume than every single male brain in the set. Therefore, the sex-related differences in the connectomes in this set will be free

ID	Sex	FS_Mask_Vol	ID	Sex	FS_Mask_Vol	ID	Sex	FS_Mask_Vol	ID	Sex	FS_Mask_Vol
756055	M	1398429	445543	M	1601802	896778	F	1642544	627549	F	1695382
729254	M	1507375	136833	M	1601858	792564	F	1644609	178142	F	1698595
138534	M	1516755	134324	M	1602993	268850	F	1646627	133019	F	1701129
217126	M	1523090	107422	M	1603895	901139	F	1647983	784565	F	1707127
211417	M	1531553	142626	M	1608980	187547	F	1648110	155231	F	1709262
212116	M	1538421	101107	M	1615636	162733	F	1648240	167743	F	1713227
137936	M	1549600	695768	M	1618175	957974	F	1649595	290136	F	1719074
148941	M	1551979	849971	M	1619144	199150	F	1650276	161630	F	1730584
122620	M	1556604	573451	M	1626578	351938	F	1650682	106521	F	1738241
163331	M	1557239	101309	M	1631429	872764	F	1652110	113619	F	1738878
171633	M	1561084	994273	M	1631997	702133	F	1653573	148335	F	1751817
594156	M	1567367	837560	M	1632384	307127	F	1665346	715647	F	1758402
163129	M	1577975	133928	M	1632517	120111	F	1667579	562446	F	1761754
108525	M	1579224	395958	M	1632986	638049	F	1683759	779370	F	1776129
992774	M	1584956	203418	M	1633225	709551	F	1686019	113215	F	1792647
599671	M	1587970	158136	M	1633937	135932	F	1686291	872158	F	1794916
540436	M	1594532	126628	M	1635888	436239	F	1687330	298051	F	1813101
958976	M	1598758	168341	M	1636025	173435	F	1689523	170934	F	1831788

Table 1: The list of subject-IDs, their sex and their brain volumes in the present study. The subjects are listed in the increasing order according to their brain volumes. The IDs refer to the Human Connectome Project's [3] anonymized 500 Subjects Release. The corresponding braingraphs can be downloaded from the site `http://braingraph.org/download-pit-group-connectomes/`. The first six columns contain the data for 36 small-brain males, the last six columns the data of the 36 large-brain females. The columns with header FS_Mask_Vol contains the FreeSurfer-computed Brain Mask Volumes in mm^3 [22].

from the size bias.

2. Results and Discussion

Here we consider the diffusion MRI data of small-brain males and large-brain females in order to compensate for the possible brain-size bias in the data acquisition and the data processing steps.

We have chosen a set of 36 female and 36 male brains from the Human Connectome Project's [3] anonymized 500 Subjects Release, such that each female brain in the set is larger than every male brain in the set (see Table 1). Next, as in [14], for every subject we have computed braingraphs of five different resolutions: 83, 129, 234, 463 and 1015 vertices, and for all graphs we have constructed five different edge weights:

- `Unweighted`: Every edge has the same, unit weight.
- `FiberN`: The number of fiber tracts that define the edge.
- `FAMean`: The average of the fractional anisotropies [23] of the fiber tracts, belonging to the edge.

- `FiberLengthMean`: The average length of the fiber tracts belonging to the edge.
- `FiberNDivLength`: The count of the fiber tracts of the edge, divided by their average length.

The most relevant weight function in our present study is the fractional anisotropy `FAMean`. This quantity, for each voxel, gives a measure of anisotropy with a real number between 0 and 1: 0, if the diffusion-ellipsoid in the voxel is a perfect sphere, and its value is getting closer to 1, if the ellipsoid has one large and two small axes, and it is 1 if the ellipsoid reduces to a line segment. More exactly, One can assign a fractional anisotropy to fiber tracts by averaging the value for each voxels on the tract. The `FAMean` weight is the average of the fractional anisotropies, taken for all fiber tracts defining the graph-edge in question.

<table>
<tr><th>Nodes</th><th>Property</th><th>Group (F | M) means</th><th>p (1st)</th><th>p (2nd)</th><th>p (corrected)</th></tr>
<tr><td>83</td><td>All_AdjLMaxDivD_FAMean</td><td>1.353 | 1.399</td><td>0.00195</td><td>0.00003</td><td>0.00155</td></tr>
<tr><td>234</td><td>All_MinVertexCover_FAMean</td><td>52.243 | 49.132</td><td>0.00298</td><td>0.00008</td><td>0.00379</td></tr>
<tr><td>129</td><td>All_MinVertexCover_FAMean</td><td>29.504 | 28.027</td><td>0.00867</td><td>0.00073</td><td>0.03505</td></tr>
<tr><td>129</td><td>All_MinSpanningForest_FAMean</td><td>30.710 | 27.945</td><td>0.005129</td><td>0.00096</td><td>0.04507</td></tr>
<tr><td>234</td><td>Left_MinVertexCover_FAMean</td><td>26.154 | 24.571</td><td>0.00062</td><td>0.00113</td><td>0.05192</td></tr>
<tr><td>83</td><td>All_MaxMatching_FAMean</td><td>18.693 | 17.688</td><td>0.00408</td><td>0.00120</td><td>0.05407</td></tr>
<tr><td>83</td><td>Right_LogSpanningForestN_FAMean</td><td>51.672 | 47.347</td><td>0.00422</td><td>0.00197</td><td>0.08681</td></tr>
<tr><td>83</td><td>All_MaxFracMatching_FAMean</td><td>18.744 | 17.795</td><td>0.00283</td><td>0.00199</td><td>0.08575</td></tr>
<tr><td>83</td><td>All_MinVertexCover_FAMean</td><td>18.744 | 17.795</td><td>0.00283</td><td>0.00199</td><td>0.08376</td></tr>
<tr><td>83</td><td>All_LogSpanningForestN_FAMean</td><td>110.058 | 101.687</td><td>0.00287</td><td>0.00365</td><td>0.14977</td></tr>
<tr><td>83</td><td>All_MinSpanningForest_FAMean</td><td>20.162 | 18.323</td><td>0.00538</td><td>0.00428</td><td>0.17106</td></tr>
<tr><td>83</td><td>Right_Sum_FAMean</td><td>103.256 | 94.541</td><td>0.00240</td><td>0.00567</td><td>0.22122</td></tr>
<tr><td>129</td><td>Left_MinVertexCover_FAMean</td><td>14.647 | 13.925</td><td>0.00217</td><td>0.00585</td><td>0.22215</td></tr>
<tr><td>234</td><td>All_LogSpanningForestN_FAMean</td><td>334.237 | 308.236</td><td>0.00428</td><td>0.00593</td><td>0.21951</td></tr>
<tr><td>83</td><td>Left_LogSpanningForestN_FAMean</td><td>53.522 | 48.713</td><td>0.00990</td><td>0.00746</td><td>0.26874</td></tr>
<tr><td>129</td><td>All_LogSpanningForestN_FAMean</td><td>192.234 | 179.953</td><td>0.00714</td><td>0.00833</td><td>0.29154</td></tr>
<tr><td>234</td><td>All_Sum_FAMean</td><td>683.263 | 630.432</td><td>0.00295</td><td>0.01170</td><td>0.39796</td></tr>
<tr><td>129</td><td>Left_LogSpanningForestN_FAMean</td><td>95.757 | 89.284</td><td>0.00401</td><td>0.01603</td><td>0.52905</td></tr>
<tr><td>234</td><td>Left_LogSpanningForestN_FAMean</td><td>165.628 | 152.443</td><td>0.00043</td><td>0.01635</td><td>0.52333</td></tr>
<tr><td>83</td><td>All_Sum_FAMean</td><td>217.684 | 201.464</td><td>0.00510</td><td>0.01788</td><td>0.55437</td></tr>
<tr><td>83</td><td>Left_MaxFracMatching_FAMean</td><td>9.242 | 8.803</td><td>0.00192</td><td>0.02533</td><td>0.76004</td></tr>
<tr><td>83</td><td>Left_MinVertexCover_FAMean</td><td>9.242 | 8.803</td><td>0.00192</td><td>0.02533</td><td>0.73470</td></tr>
<tr><td>83</td><td>Left_MaxMatching_FAMean</td><td>9.187 | 8.742</td><td>0.00408</td><td>0.02558</td><td>0.71621</td></tr>
<tr><td>129</td><td>All_Sum_FAMean</td><td>386.878 | 360.531</td><td>0.00566</td><td>0.02624</td><td>0.70860</td></tr>
<tr><td>234</td><td>Left_Sum_FAMean</td><td>338.278 | 313.589</td><td>0.00264</td><td>0.03474</td><td>0.90314</td></tr>
<tr><td>234</td><td>All_MinVertexCover_FiberLengthMean</td><td>5345.241 | 4942.425</td><td>0.00624</td><td>0.03583</td><td>0.89570</td></tr>
<tr><td>129</td><td>All_MinSpanningForest_FiberLengthMean</td><td>1671.711 | 1639.914</td><td>0.00419</td><td>0.03734</td><td>0.89622</td></tr>
<tr><td>129</td><td>Left_Sum_FAMean</td><td>193.159 | 179.854</td><td>0.00640</td><td>0.04110</td><td>0.94530</td></tr>
<tr><td>83</td><td>Right_Sum_FiberLengthMean</td><td>7597.945 | 6933.002</td><td>0.00616</td><td>0.05527</td><td>1.21602</td></tr>
<tr><td>83</td><td>Left_MinSpanningForest_FAMean</td><td>9.767 | 9.066</td><td>0.00644</td><td>0.05603</td><td>1.17663</td></tr>
<tr><td>234</td><td>All_MaxMatching_FiberLengthMean</td><td>5329.953 | 4998.430</td><td>0.00501</td><td>0.05622</td><td>1.12431</td></tr>
<tr><td>234</td><td>Left_AdjLMaxDivD_FAMean</td><td>1.552 | 1.597</td><td>0.00188</td><td>0.06919</td><td>1.31463</td></tr>
<tr><td>83</td><td>All_Sum_FiberLengthMean</td><td>16777.596 | 15541.031</td><td>0.00895</td><td>0.07094</td><td>1.27698</td></tr>
<tr><td>234</td><td>All_MaxFracMatching_FiberLengthMean</td><td>5341.519 | 5025.310</td><td>0.00595</td><td>0.07252</td><td>1.23279</td></tr>
</table>

Table 2: Statistical analysis of the differences in graph-theoretical parameters of connectomes computed from 36 small-brain male and 36 large-brain female cerebral MRIs. The first column gives the number of vertices. The second column gives the graph-parameters computed: Each parameter-name is separated by two "_" symbols into three segments: The first segment describes the hemisphere or the whole connectome using descriptors Left, Right or All. The second segment gives the graph-parameter computed (defined in the "Methods" section, e.g.,`MaxMatching`), and the third segment specifies the weight function applied, the choices are **`Unweighted, FiberN, FAMean, FiberLengthMean, FiberNDivLength`**. The third and the fourth columns contain the average values for the female and the male groups, respectively. The fifth column describes the p-values of the first round, the sixth column in the second round, and the seventh column the Holm-Bonferroni corrections for the p-values. With p=0.05 *all* the first four rows describe significantly different graph theoretical properties between sexes. One-by-one, each row with italic values in column 6 describe differences between sexes, with significance p=0.05. For the details we refer to the section "Statistical analysis".

The lack of both significant and non-significant advantages of males with small brains

Suppose that the statistically significant differences of the graph-theoretical parameters, describing better connectivity of the female braingraphs in [14], are due solely to the brain volume differences and not to the sex differences of the subjects. Then in our subject-sets of small-brain men and large-brain women the same, significant differences in the graph-theoretical parameters should have been observed showing the advantage of the small-brain males.

Surprisingly, this is not true, with one single exception:

As one can observe in the first row of Table 2, `All_AdjLMaxDivD_FAMean` (the largest eigenvalue of the generalized adjacency matrix, divided by the average (generalized) degree, computed with the `FAMean` weight function) is significantly larger for men than for women in the 83-vertex resolution. All the other parameters that were significant statistically (denoted by an italic font in the sixth column) are still larger for the female group, showing better connections in that group.

This means that the lower cerebral volume will not imply better connectivity, therefore the results of [14] are due to sex differences and not size differences or other artifacts.

FAMean-weighted significant connectivity advantages of females

We need to remark that almost all graph-parameters, implying better connectivity for the connectomes of women in Table 2, were weighted by `FAMean`. We think that fiber tracts with high `FAMean` values were tracked very reliably and were able to produce statistically significant results.

More exactly, we have found (in Table 2) the following parameters significantly differing in both tests:

`MinVertexCover` for the whole brain, and also just for the left hemisphere in several resolutions: this quantity gives the minimum number of vertices that is needed to cover all edges in the graph. We note that the meaning of this NP-hard quantity and also its computing needs much deeper tools than the numerous edge-counting statistics published elsewhere.

`Sum` describes the number of edges in the graph; we have significant differences within the left and the right hemispheres, as well as in the whole connectome. The number of spanning forests also give significant advantages for the female connectomes. Similarly, the maximum matching and the maximum fractional matching is also significantly larger in female connectomes for several resolutions.

In the ANOVA round 1, when only the data from group 0 were analyzed, we have found lots of significant-looking results showing the better connectivity of the female brains even in our large-brain set with other weight functions as well. For example, in the Appendix, in the 463 node resolution, the minimum number of the vertices that are needed to cover all the edges in the whole braingraph is larger in female connectomes than in male ones even with the `FiberN` weight function, with $p = 0.017$. Or, in the same 463-node resolution, the minimum balanced bisection width, normalized with the number of edges in the right hemisphere is larger for women than in men with $p = 0.05$ in the unweighted graph. We say that these are "significant-looking" results since our strict analysis in the holdout set did not find all of these to be significant (see the "Statistical Analysis" section for details).

In summary, with the `FAMean` weight function several (but not all) differences we have found between the graph parameters of male and female connectomes remained valid for the small-brain men - large-brain women datasets. Additionally, with numerous other weight functions the advantage of the female connectomes in connectivity related parameters is shown in the Appendix.

3. Methods

The data source is the Human Connectome Project's [3] anonymized 500 Subjects Release. The workflow that produces the braingraphs or connectomes are detailed in [14] and in [5]: the Connectome Mapper Toolkit [4] (`http://cmtk.org`) was used for segmentation, partitioning, tractography and for the graph construction. For partitioning, FreeSurfer was applied with the Desikan-Killiany anatomical atlas that produced 83, 129, 234, 463 and 1015 regions of interests. Tractography was performed with randomized seeding by the Connectome Mapper Toolkit [4], applying the deterministic streamline method with the MRtrix processing tool [24]. We have computed the graphs from more than 400 diffusion MR images.

Choosing two sets of the same cardinality: large female brains and small male brains

The selection of large female and small male brains were done using the following mathematical scheme:

There is such a brain size B that an equal number of men have smaller brains than B as the women who have larger brains than B. This is true because each person has a different brain size, and when we increase B from the minimum possible brain size to the maximum possible brain size, at each step we either encounter a man (in this case the number of men with smaller brains than B increases by 1), or we encounter a woman (in this case the number of women with larger brains than B decreases by 1). Since at the beginning the number of small-brain men was 0 and the number of large-brain women was N_W (the number of women in the study), and at the end the number of small-brain men will be N_M (the number of men in the study) and the number of large-brain women will be 0, this means that at some point the two numbers will be equal because, at each step, both change by 1 in the proper direction. This is a well-defined interval between two consecutive brain sizes. We looked for this division point B, and then considered only the men with smaller brains and the women with larger brains.

This way we were able to select 36 female and 36 male brains, such that all the female brains have larger volumes than all the male brains in the set.

Graph parameters and their descriptions

The *generalized adjacency matrix* is an $n \times n$ matrix, where n denotes the number of vertices of the graph. Its rows and columns correspond to the nodes of the graph, and the element in the intersection of row i and column j, a_{ij} is zero if the i^{th} and the j^{th} vertices are not connected by an edge, and a_{ij} is the weight of the edge, connecting the i^{th} and the j^{th} vertices otherwise.

The degree of a node is the number of the edges, incident to the vertex. The generalized degree of a vertex is the sum of the weights of the edges, incident to the vertex.

The following graph-parameters were computed for the graphs of different resolutions and weights:

- Number of edges (`Sum`). The sum of the weights of the edges. If the graph is unweighted, then it is equal to the number of edges in the graph.

- Normalized largest eigenvalue (`AdjLMaxDivD`): The largest eigenvalue of the generalized adjacency matrix, divided by the average (generalized) degree.

- Eigengap of the transition matrix (`PGEigengap`): The transition matrix P_G can be constructed after dividing the rows of the generalized adjacency matrix by the generalized degree of the vertex, corresponding to the row. Since the (generalized) degree of any vertex is equal to the sum of its row in the generalized adjacency matrix, the sum of any row of P_G is 1. If the weights are non-negative, then the rows of P_G define a probability distribution, which corresponds to the transition probabilities in a random walk. The eigengap of matrix P_G is the difference between its largest and the second largest eigenvalues. The eigengap is closely related to the expander property of the graph: the larger the gap, the better expander is the graph [16].

- Hoffman's bound (`HoffmanBound`) is defined by

$$1 + \frac{\lambda_{max}}{|\lambda_{min}|},$$

where λ_{max} and λ_{min} denote the largest and smallest eigenvalues of the adjacency matrix. It bounds the chromatic number of the graph from below.

- Logarithm of the number of spanning forests (`LogAbsSpanningForestN`): The famous matrix-tree theorem of Kirchoff [25, 26] computes the number of the spanning trees in a connected graph from the spectrum of its Laplacian matrix. Heuristically, more "connected" graphs have more spanning trees, since the addition of a new edge to the graph may give rise to the number of the spanning trees. For non-connected graphs, the number of spanning forests equals the product of the numbers of the spanning trees of the components of the graph. The quantity `LogAbsSpanningForestN` is defined as the logarithm of the number of spanning forests in the unweighted case; and in the weighted case it equals to the sum of the logarithms of the weights of the spanning trees in the forests. Note that this value can be negative if all the weights are small.

- Minimum bisection width, or the balanced minimum cut, divided by the number of edges (`MinCutBalDivSum`): Suppose we want to partition the graph into two sets whose size may differ by at most 1, in a way that the the number (or the sum of the weights) of the edges, crossing the cut, is minimal. For the whole braingraph, one would expect that this minimum cut corresponds to the edges in the *corpus callosum* between the two hemispheres of the brain. Indeed, our results show exactly this. Therefore, this quantity is more interesting when computed only for the left- or the right hemisphere, and not for the whole brain.

- Minimum cost spanning tree (`MinSpanningForest`), computed with the algorithm of Kruskal.

- Minimum vertex cover (`MinVertexCoverBinary`): is the size of the minimum set of vertices selected in a way that each edge is incident to at least one of the selected vertices. We have computed this NP-hard graph-parameter only for unweighted graphs by an integer-program solver named SCIP (`http://scip.zib.de`), [27, 28], which provided exact solutions.

- Minimum weighted vertex cover (`MinVertexCover`): We assign a fractional weight to each vertex such that, for each edge, the sum of the weights of its two endpoints is greater or equal to 1, then we minimize the sum of all weights for all vertices. This is a relaxation of the vertex-cover problem above [29], and can be computed by a linear programming approach.

- Maximum matching (`MaxMatching`): A matching is a set of edges that do not share any vertices; or, equivalently: each vertex covered by the matching edges are covered by exactly one edge from the matching. A maximum matching is the matching in a graph containing the largest number of edges. A maximum matching in a weighted graph is the matching with the maximum sum of weights taken on its edges.

- Maximum fractional matching (`MaxFracMatching`): is the linear-programming relaxation of the maximum matching problem. In the unweighted case, we are searching for non-negative values $x(e)$ for each edge e in the graph, such that for each vertex v in the graph, the sum of $x(e)$-s for the edges that are incident to v is at most 1. The maximum of the sums of $\sum_e x(e)$ is the maximum fractional matching for a graph. For the weighted version with weight function w, instead of $\sum_e x(e)$, $\sum_e x(e)w(e)$ needs to be maximized.

- (`OutBasalGanglia, OutBrainstem, OutFrontal, OutInsula, OutLimbic, OutOccipital, OutParietal, OutTemporal, OutThalamus`) These quantities give the sum of the weights of the edges, crossing the border of the cerebral lobes noted.

All the parameters described above were computed for the graphs made of the left and the right hemispheres and also for the whole connectome, and for all the resolutions and with all the 5 weight functions (with the following exceptions: `MinVertexCoverBinary` and `MaxMatching` was computed only for the unweighted case, and the `MinSpanningTree` was not computed for the unweighted case). The results for each individual graph are made available as a large Excel file at the site `http://uratim.com/big_table_sbmbbw.zip`.

A note on the syntax of the results

Each parameter-name is separated by two "_" symbols into three segments (e.g., `All_HoffmanBound_FAMean`): The first segment describes the hemisphere or the whole connectome using descriptors Left, Right or All. The second segment gives the graph-parameter computed (defined in the "Methods" section, e.g.,`HoffmanBound`), and the third segment specifies the weight function applied, the choices are `Unweighted, FiberN, FAMean, FiberLengthMean, FiberNDivLength`. The weight functions are defined in the "Results and discussion" section.

Statistical analysis

The statistical analysis of the sex differences in the graph-theoretical parameters were done similarly as in [14]:

The subjects were divided into two sets: set 0 and set 1, denoted in the first column of the large, detailed result file at `http://uratim.com/big_table_sbmbbw.zip`. The selection was done by the parity of the digits of the ID of the subjects: if the sum of the digits of the ID number of the subject was even, the ID was assigned to group 0, and if it was odd, then to group 1. Group 0 was used for hypothesis-making while group 1 was the holdout set to verify hypotheses.

We applied the statistical null hypothesis [30] that the graph parameters do not differ between the male and the female groups. A small p value shows that the null-hypothesis is most probably false, i.e., the graph parameters significantly differ between the sexes.

We have used ANOVA (Analysis of variance) [31] to assign p-values for all parameters in each hemisphere and each resolution and each weight-assignment for data, originated from group 0.

We selected those parameters after the first ANOVA application where the p-values were less than 1%. These selected parameters were analyzed with a second ANOVA application for the holdout group 1. Next, the resulting p-values were adjusted with the Holm-Bonferroni correction method [32] with a significance level of 5%. The detailed results with the male and female average values of the parameters with the p-values of the first ANOVA are given in the Appendix, grouped by the resolution of the graph. The results of the second ANOVA and the Holm-Bonferroni corrections are given on Table 2.

In Table 2 those Holm-Bonferroni corrected p-values were highlighted in bold that all differs significantly between the male and the female groups, with a level of significance of 5%.

4. Conclusions

We have shown by analyzing the connectomes of 36 small-brain men and 36 large-brain women that the advantage of the female connectomes in numerous graph-connectivity related, deep graph theoretical parameters, are due to the sex differences, and not for the size differences.

Data availability:

The raw and the pre-processed MRI data are available at the Human Connectome Project's website: `http://www.humanconnectome.org/documentation/S500` [3]. Unlike numerous braingraph-related articles, our graphs that we assembled in the present work can be downloaded from the site `http://braingraph.org/download-pit-group-connectomes/`. The results for each individual graph are made available as a large Excel file at the site `http://uratim.com/big_table_sbmbbw.zip`.

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References

[1] P. Hagmann, P. E. Grant, D. A. Fair, Mr connectomics: a conceptual framework for studying the developing brain., Front Syst Neurosci 6 (2012) 43. doi:10.3389/fnsys.2012.00043.
URL http://dx.doi.org/10.3389/fnsys.2012.00043

[2] R. C. Craddock, M. P. Milham, S. M. LaConte, Predicting intrinsic brain activity., Neuroimage 82 (2013) 127–136. doi:10.1016/j.neuroimage.2013.05.072.
URL http://dx.doi.org/10.1016/j.neuroimage.2013.05.072

[3] J. A. McNab, B. L. Edlow, T. Witzel, S. Y. Huang, H. Bhat, K. Heberlein, T. Feiweier, K. Liu, B. Keil, J. Cohen-Adad, M. D. Tisdall, R. D. Folkerth, H. C. Kinney, L. L. Wald, The Human Connectome Project and beyond: initial applications of 300 mT/m gradients., Neuroimage 80 (2013) 234–245. doi:10.1016/j.neuroimage.2013.05.074.
URL http://dx.doi.org/10.1016/j.neuroimage.2013.05.074

[4] A. Daducci, S. Gerhard, A. Griffa, A. Lemkaddem, L. Cammoun, X. Gigandet, R. Meuli, P. Hagmann, J.-P. Thiran, The connectome mapper: an open-source processing pipeline to map connectomes with MRI., PLoS One 7 (12) (2012) e48121. doi:10.1371/journal.pone.0048121.
URL http://dx.doi.org/10.1371/journal.pone.0048121

[5] B. Szalkai, C. Kerepesi, B. Varga, V. Grolmusz, The Budapest Reference Connectome Server v2. 0, Neuroscience Letters 595 (2015) 60–62.

[6] C. Kerepesi, B. Szalkai, B. Varga, V. Grolmusz, Comparative connectomics: Mapping the inter-individual variability of connections within the regions of the human brain, arXiv preprint arXiv:1507.00327.

[7] F. Agosta, S. Galantucci, P. Valsasina, E. Canu, A. Meani, A. Marcone, G. Magnani, A. Falini, G. Comi, M. Filippi, Disrupted brain connectome in semantic variant of primary progressive aphasia., Neurobiol Agingdoi:10.1016/j.neurobiolaging.2014.05.017.
URL http://dx.doi.org/10.1016/j.neurobiolaging.2014.05.017

[8] A. F. Alexander-Bloch, P. T. Reiss, J. Rapoport, H. McAdams, J. N. Giedd, E. T. Bullmore, N. Gogtay, Abnormal cortical growth in schizophrenia targets normative modules of synchronized development., Biol Psychiatrydoi:10.1016/j.biopsych.2014.02.010.
URL http://dx.doi.org/10.1016/j.biopsych.2014.02.010

[9] J. T. Baker, A. J. Holmes, G. A. Masters, B. T. T. Yeo, F. Krienen, R. L. Buckner, D. Öngür, Disruption of cortical association networks in schizophrenia and psychotic bipolar disorder., JAMA Psychiatry 71 (2) (2014) 109–118. doi:10.1001/jamapsychiatry.2013.3469.
URL http://dx.doi.org/10.1001/jamapsychiatry.2013.3469

[10] P. Besson, V. Dinkelacker, R. Valabregue, L. Thivard, X. Leclerc, M. Baulac, D. Sammler, O. Colliot, S. Lehéricy, S. Samson, S. Dupont, Structural connectivity differences in left and right temporal lobe epilepsy., Neuroimage 100C (2014) 135–144. doi:10.1016/j.neuroimage.2014.04.071.
URL http://dx.doi.org/10.1016/j.neuroimage.2014.04.071

[11] L. Bonilha, T. Nesland, C. Rorden, P. Fillmore, R. P. Ratnayake, J. Fridriksson, Mapping remote subcortical ramifications of injury after ischemic strokes., Behav Neurol 2014 (2014) 215380. doi:10.1155/2014/215380.
URL http://dx.doi.org/10.1155/2014/215380

[12] N. Jahanshad, I. Aganj, C. Lenglet, A. Joshi, Y. Jin, M. Barysheva, K. L. McMahon, G. De Zubicaray, N. G. Martin, M. J. Wright, et al., Sex differences in the human connectome: 4-tesla high angular resolution diffusion imaging (hardi) tractography in 234 young adult twins, in: Biomedical Imaging: From Nano to Macro, 2011 IEEE International Symposium on, IEEE, 2011, pp. 939–943.

[13] M. Ingalhalikar, A. Smith, D. Parker, T. D. Satterthwaite, M. A. Elliott, K. Ruparel, H. Hakonarson, R. E. Gur, R. C. Gur, R. Verma, Sex differences in the structural connectome of the human brain., Proc Natl Acad Sci U S A 111 (2) (2014) 823–828. doi:10.1073/pnas.1316909110.
URL http://dx.doi.org/10.1073/pnas.1316909110

[14] B. Szalkai, B. Varga, V. Grolmusz, Graph theoretical analysis reveals: Women's brains are better connected than men's, PLOS One 10 (7) (2015) e0130045. doi:doi:10.1371/journal.pone.0130045.
URL http://dx.plos.org/10.1371/journal.pone.0130045

[15] R. E. Tarjan, Data structures and network algorithms, Vol. 44 of CBMS-NSF Regional Conference Series in Applied Mathematics, Society for Industrial Applied Mathematics, 1983.

[16] S. Hoory, N. Linial, A. Wigderson, Expander graphs and their applications, Bulletin of the American Mathematical Society 43 (4) (2006) 439–561.

[17] A. S. Dekaban, Changes in brain weights during the span of human life: relation of brain weights to body heights and body weights., Ann Neurol 4 (4) (1978) 345–356. doi:10.1002/ana.410040410.
URL http://dx.doi.org/10.1002/ana.410040410

[18] J. S. Allen, H. Damasio, T. J. Grabowski, Normal neuroanatomical variation in the human brain: an mri-volumetric study., Am J Phys Anthropol 118 (4) (2002) 341–358. doi:10.1002/ajpa.10092.
URL http://dx.doi.org/10.1002/ajpa.10092

[19] G. Girard, K. Whittingstall, R. Deriche, M. Descoteaux, Towards quantitative connectivity analysis: reducing tractography biases., Neuroimage 98 (2014) 266–278. doi:10.1016/j.neuroimage.2014.04.074.
URL http://dx.doi.org/10.1016/j.neuroimage.2014.04.074

[20] S. Jbabdi, H. Johansen-Berg, Tractography: where do we go from here?, Brain Connect 1 (3) (2011) 169–183. doi:10.1089/brain.2011.0033.
URL http://dx.doi.org/10.1089/brain.2011.0033

[21] J. Hänggi, L. Fövenyi, F. Liem, M. Meyer, L. Jäncke, The hypothesis of neuronal interconnectivity as a function of brain size-a general organization principle of the human connectome., Front Hum Neurosci 8 (2014) 915. doi:10.3389/fnhum.2014.00915.
URL http://dx.doi.org/10.3389/fnhum.2014.00915

[22] M. Reuter, N. J. Schmansky, H. D. Rosas, B. Fischl, Within-subject template estimation for unbiased longitudinal image analysis., Neuroimage 61 (4) (2012) 1402–1418. doi:10.1016/j.neuroimage.2012.02.084.
URL http://dx.doi.org/10.1016/j.neuroimage.2012.02.084

[23] P. J. Basser, C. Pierpaoli, Microstructural and physiological features of tissues elucidated by quantitative-diffusion-tensor mri., J Magn Reson 213 (2) (1996) 560–570. doi:10.1016/j.jmr.2011.09.022.
URL http://dx.doi.org/10.1016/j.jmr.2011.09.022

[24] J. Tournier, F. Calamante, A. Connelly, et al., Mrtrix: diffusion tractography in crossing fiber regions, International Journal of Imaging Systems and Technology 22 (1) (2012) 53–66.

[25] G. Kirchhoff, Über die Auflösung der Gleichungen, auf welche man bei der Untersuchung der linearen Vertheilung galvanischer Ströme geführt wird, Ann. Phys. Chem. 72 (12) (1847) 497–508.

[26] F. R. Chung, Spectral graph theory, Vol. 92, American Mathematical Soc., 1997.

[27] T. Achterberg, T. Berthold, T. Koch, K. Wolter, Constraint integer programming: A new approach to integrate CP and MIP, in: Integration of AI and OR techniques in constraint programming for combinatorial optimization problems, Springer, 2008, pp. 6–20.

[28] T. Achterberg, SCIP: solving constraint integer programs, Mathematical Programming Computation 1 (1) (2009) 1–41.

[29] D. S. Hochbaum, Approximation algorithms for the set covering and vertex cover problems, SIAM Journal on Computing 11 (3) (1982) 555–556.

[30] P. G. Hoel, Introduction to mathematical statistics., 5th Edition, John Wiley & Sons, Inc., New York, 1984.

[31] T. H. Wonnacott, R. J. Wonnacott, Introductory statistics, Vol. 19690, Wiley New York, 1972.

[32] S. Holm, A simple sequentially rejective multiple test procedure, Scandinavian Journal of Statistics (1979) 65–70.

5. Appendix

In this Appendix we give the graph-theoretic parameters computed for the 83, 129, 234, 463 and 1015-vertex graphs. The table contains their arithmetic means in the male and female groups, and the corresponding p-values for group 0 (see the "Statistical analysis" subsection). The graph-parameters and the syntax of the data are defined in the "Methods" section. Significant differences ($p < 0.01$) are denoted with an asterisk in the last column.

5.1. 83 nodes, round 1

Property	Female	Male	p-value	
All_AdjLMaxDivD_FAMean	1.35697	1.39840	0.00195	*
All_AdjLMaxDivD_FiberLengthMean	1.47297	1.42258	0.07853	
All_AdjLMaxDivD_FiberN	2.06602	2.13826	0.22061	
All_AdjLMaxDivD_FiberNDivLength	1.85001	1.87343	0.56770	
All_AdjLMaxDivD_Unweighted	1.26011	1.26981	0.36427	
All_HoffmanBound_FAMean	4.21756	4.11377	0.10446	
All_HoffmanBound_FiberLengthMean	3.18204	3.21898	0.60378	
All_HoffmanBound_FiberN	2.61190	2.58253	0.58132	
All_HoffmanBound_FiberNDivLength	2.43437	2.49011	0.41972	
All_HoffmanBound_Unweighted	4.48639	4.39983	0.21541	
All_LeftRatio_FAMean	0.96460	0.95909	0.72266	
All_LeftRatio_FiberLengthMean	1.01590	1.01323	0.89446	
All_LeftRatio_FiberN	0.99308	0.99250	0.96520	
All_LeftRatio_FiberNDivLength	0.98904	0.98939	0.97426	
All_LeftRatio_Unweighted	0.99523	0.99065	0.63900	
All_LogSpanningForestN_FAMean	107.94151	97.08760	0.00287	*
All_LogSpanningForestN_FiberLengthMean	455.16733	445.91974	0.02158	
All_LogSpanningForestN_FiberN	395.24633	390.93348	0.03833	
All_LogSpanningForestN_FiberNDivLength	146.08409	145.33936	0.72755	
All_LogSpanningForestN_Unweighted	190.04825	186.55742	0.04411	
All_MaxFracMatching_FAMean	18.60828	17.28793	0.00283	*
All_MaxFracMatching_FiberLengthMean	2036.50193	1821.53984	0.01830	
All_MaxFracMatching_FiberN	2347.16667	2391.85714	0.49338	
All_MaxFracMatching_FiberNDivLength	108.48762	109.71109	0.73742	
All_MaxFracMatching_Unweighted	40.90000	40.85714	0.78684	
All_MaxMatching_FAMean	18.54438	17.26157	0.00408	*
All_MaxMatching_FiberLengthMean	2041.39713	1823.19540	0.02283	
All_MaxMatching_FiberN	2332.46667	2394.14286	0.32065	
All_MaxMatching_FiberNDivLength	107.64318	109.83960	0.53256	
All_MaxMatching_Unweighted	40.60000	40.57143	0.88134	

All_MinCutBalDivSum_FAMean	0.03843	0.04534	0.09680	
All_MinCutBalDivSum_FiberLengthMean	0.02920	0.03626	0.15883	
All_MinCutBalDivSum_FiberN	0.02789	0.02766	0.94947	
All_MinCutBalDivSum_FiberNDivLength	0.03111	0.03071	0.90781	
All_MinCutBalDivSum_Unweighted	0.03567	0.04166	0.10640	
All_MinSpanningForest_FAMean	19.76563	17.81751	0.00538	*
All_MinSpanningForest_FiberLengthMean	1102.02369	1084.66325	0.19564	
All_MinSpanningForest_FiberN	99.00000	104.00000	0.07431	
All_MinSpanningForest_FiberNDivLength	3.47983	3.92020	0.01709	
All_MinVertexCoverBinary_Unweighted	59.33333	58.85714	0.41628	
All_MinVertexCover_FAMean	18.60828	17.28793	0.00283	*
All_MinVertexCover_FiberLengthMean	2036.50193	1821.53984	0.01830	
All_MinVertexCover_FiberN	2347.16667	2391.85714	0.49338	
All_MinVertexCover_FiberNDivLength	108.48762	109.71109	0.73742	
All_MinVertexCover_Unweighted	40.90000	40.85714	0.78684	
All_PGEigengap_FAMean	0.05014	0.05685	0.18480	
All_PGEigengap_FiberLengthMean	0.03839	0.04616	0.19918	
All_PGEigengap_FiberN	0.02904	0.02801	0.67953	
All_PGEigengap_FiberNDivLength	0.03133	0.03050	0.73932	
All_PGEigengap_Unweighted	0.04661	0.05229	0.18378	
All_Sum_FAMean	213.26306	189.73499	0.00510	*
All_Sum_FiberLengthMean	16550.10867	14481.75686	0.00895	*
All_Sum_FiberN	10821.80000	10557.92857	0.15757	
All_Sum_FiberNDivLength	460.41013	467.08372	0.56140	
All_Sum_Unweighted	552.93333	530.78571	0.02924	
Left_AdjLMaxDivD_FAMean	1.33695	1.37581	0.01968	
Left_AdjLMaxDivD_FiberLengthMean	1.42381	1.39134	0.22194	
Left_AdjLMaxDivD_FiberN	1.99137	2.04882	0.35745	
Left_AdjLMaxDivD_FiberNDivLength	1.76567	1.79038	0.55969	
Left_AdjLMaxDivD_Unweighted	1.24266	1.24448	0.85912	
Left_HoffmanBound_FAMean	4.57409	4.41467	0.12060	
Left_HoffmanBound_FiberLengthMean	3.21652	3.27301	0.53075	
Left_HoffmanBound_FiberN	2.73899	2.63259	0.12089	
Left_HoffmanBound_FiberNDivLength	2.62682	2.66592	0.65419	
Left_HoffmanBound_Unweighted	4.68245	4.52121	0.04470	
Left_LogSpanningForestN_FAMean	52.24226	46.42507	0.00990	*
Left_LogSpanningForestN_FiberLengthMean	227.92206	223.08226	0.06568	
Left_LogSpanningForestN_FiberN	198.01945	195.98984	0.14698	
Left_LogSpanningForestN_FiberNDivLength	72.92756	73.02259	0.94641	
Left_LogSpanningForestN_Unweighted	94.40670	92.55840	0.12817	
Left_MaxFracMatching_FAMean	9.21339	8.44291	0.00192	*
Left_MaxFracMatching_FiberLengthMean	1063.15137	957.78591	0.04989	
Left_MaxFracMatching_FiberN	1143.30000	1167.75000	0.55643	
Left_MaxFracMatching_FiberNDivLength	54.05855	54.06370	0.99810	
Left_MaxFracMatching_Unweighted	20.73333	20.64286	0.44362	
Left_MaxMatching_FAMean	9.14568	8.41959	0.00408	*
Left_MaxMatching_FiberLengthMean	1069.71962	956.71517	0.04596	
Left_MaxMatching_FiberN	1132.06667	1173.28571	0.30854	
Left_MaxMatching_FiberNDivLength	53.32822	53.95062	0.76065	
Left_MaxMatching_Unweighted	20.46667	20.50000	0.86371	

Left_MinCutBalDivSum_FAMean	0.23163	0.21678	0.26822	
Left_MinCutBalDivSum_FiberLengthMean	0.21504	0.20569	0.54701	
Left_MinCutBalDivSum_FiberN	0.12105	0.11721	0.61607	
Left_MinCutBalDivSum_FiberNDivLength	0.12600	0.11970	0.34886	
Left_MinCutBalDivSum_Unweighted	0.23212	0.21513	0.15751	
Left_MinSpanningForest_FAMean	9.73295	8.62564	0.00644	*
Left_MinSpanningForest_FiberLengthMean	554.92086	550.46353	0.59531	
Left_MinSpanningForest_FiberN	51.20000	55.42857	0.14696	
Left_MinSpanningForest_FiberNDivLength	1.77670	2.12087	0.13439	
Left_MinVertexCoverBinary_Unweighted	30.13333	29.57143	0.20838	
Left_MinVertexCover_FAMean	9.21339	8.44291	0.00192	*
Left_MinVertexCover_FiberLengthMean	1063.15137	957.78591	0.04989	
Left_MinVertexCover_FiberN	1143.30000	1167.75000	0.55643	
Left_MinVertexCover_FiberNDivLength	54.05855	54.06370	0.99810	
Left_MinVertexCover_Unweighted	20.73333	20.64286	0.44362	
Left_PGEigengap_FAMean	0.30932	0.28263	0.18222	
Left_PGEigengap_FiberLengthMean	0.30530	0.27410	0.21739	
Left_PGEigengap_FiberN	0.15447	0.14019	0.17287	
Left_PGEigengap_FiberNDivLength	0.13316	0.12753	0.39949	
Left_PGEigengap_Unweighted	0.28522	0.25775	0.12577	
Left_Sum_FAMean	103.09873	91.35247	0.01578	
Left_Sum_FiberLengthMean	8389.35457	7367.36299	0.02104	
Left_Sum_FiberN	5377.13333	5240.85714	0.24514	
Left_Sum_FiberNDivLength	227.73780	231.42849	0.57511	
Left_Sum_Unweighted	274.93333	263.64286	0.07612	
Right_AdjLMaxDivD_FAMean	1.32925	1.35005	0.11677	
Right_AdjLMaxDivD_FiberLengthMean	1.42649	1.39061	0.21015	
Right_AdjLMaxDivD_FiberN	2.02880	2.12861	0.13979	
Right_AdjLMaxDivD_FiberNDivLength	1.77135	1.81936	0.16523	
Right_AdjLMaxDivD_Unweighted	1.24392	1.24183	0.83764	
Right_HoffmanBound_FAMean	4.33520	4.23355	0.24893	
Right_HoffmanBound_FiberLengthMean	3.36481	3.39929	0.72637	
Right_HoffmanBound_FiberN	2.64897	2.59370	0.43090	
Right_HoffmanBound_FiberNDivLength	2.51960	2.58206	0.48071	
Right_HoffmanBound_Unweighted	4.53947	4.48295	0.42576	
Right_LogSpanningForestN_FAMean	50.74546	45.62445	0.00422	*
Right_LogSpanningForestN_FiberLengthMean	218.55743	213.89157	0.03654	
Right_LogSpanningForestN_FiberN	189.81521	187.54735	0.07859	
Right_LogSpanningForestN_FiberNDivLength	68.78101	67.89394	0.44590	
Right_LogSpanningForestN_Unweighted	89.90052	87.96104	0.03973	
Right_MaxFracMatching_FAMean	9.16146	8.66941	0.03172	
Right_MaxFracMatching_FiberLengthMean	957.31955	845.29704	0.02148	
Right_MaxFracMatching_FiberN	1121.66667	1175.42857	0.17210	
Right_MaxFracMatching_FiberNDivLength	52.40863	54.91359	0.24701	
Right_MaxFracMatching_Unweighted	20.16667	20.21429	0.68799	
Right_MaxMatching_FAMean	9.11447	8.66452	0.05138	
Right_MaxMatching_FiberLengthMean	953.80876	844.31972	0.02578	
Right_MaxMatching_FiberN	1120.06667	1173.28571	0.18539	
Right_MaxMatching_FiberNDivLength	52.12333	55.05770	0.17603	
Right_MaxMatching_Unweighted	19.80000	20.00000	0.08221	

Right_MinCutBalDivSum_FAMean	0.23842	0.21535	0.01075	
Right_MinCutBalDivSum_FiberLengthMean	0.22416	0.20040	0.02688	
Right_MinCutBalDivSum_FiberN	0.13019	0.11780	0.02021	
Right_MinCutBalDivSum_FiberNDivLength	0.12662	0.12085	0.30422	
Right_MinCutBalDivSum_Unweighted	0.23090	0.20775	0.00292	*
Right_MinSpanningForest_FAMean	10.16814	9.35471	0.04285	
Right_MinSpanningForest_FiberLengthMean	543.52392	531.64092	0.20128	
Right_MinSpanningForest_FiberN	50.46667	52.07143	0.45408	
Right_MinSpanningForest_FiberNDivLength	1.82428	2.03587	0.12688	
Right_MinVertexCoverBinary_Unweighted	28.86667	28.78571	0.85585	
Right_MinVertexCover_FAMean	9.16146	8.66941	0.03172	
Right_MinVertexCover_FiberLengthMean	957.31955	845.29704	0.02148	
Right_MinVertexCover_FiberN	1121.66667	1175.42857	0.17210	
Right_MinVertexCover_FiberNDivLength	52.40863	54.91359	0.24701	
Right_MinVertexCover_Unweighted	20.16667	20.21429	0.68799	
Right_PGEigengap_FAMean	0.30913	0.26010	0.00059	*
Right_PGEigengap_FiberLengthMean	0.31935	0.24662	0.00031	*
Right_PGEigengap_FiberN	0.16550	0.13996	0.00766	*
Right_PGEigengap_FiberNDivLength	0.14237	0.12923	0.04494	
Right_PGEigengap_Unweighted	0.28041	0.23217	0.00007	*
Right_Sum_FAMean	101.47390	89.64221	0.00240	*
Right_Sum_FiberLengthMean	7658.04606	6588.59066	0.00616	*
Right_Sum_FiberN	5138.73333	5017.57143	0.29217	
Right_Sum_FiberNDivLength	218.26533	220.84907	0.65453	
Right_Sum_Unweighted	257.13333	244.42857	0.01112	

5.2. 129 nodes, round 1

Property	Female	Male	p-value	
All_AdjLMaxDivD_FAMean	1.41264	1.43719	0.17554	
All_AdjLMaxDivD_FiberLengthMean	1.51388	1.48806	0.38135	
All_AdjLMaxDivD_FiberN	2.16657	2.28753	0.15888	
All_AdjLMaxDivD_FiberNDivLength	2.03504	2.11052	0.32365	
All_AdjLMaxDivD_Unweighted	1.29906	1.29108	0.47042	
All_HoffmanBound_FAMean	4.34264	4.26186	0.14326	
All_HoffmanBound_FiberLengthMean	3.23922	3.23931	0.99908	
All_HoffmanBound_FiberN	2.50923	2.48179	0.69252	
All_HoffmanBound_FiberNDivLength	2.40134	2.40527	0.95531	
All_HoffmanBound_Unweighted	4.57882	4.48873	0.13289	
All_LeftRatio_FAMean	0.99644	0.98958	0.69917	
All_LeftRatio_FiberLengthMean	1.03985	1.02933	0.57321	
All_LeftRatio_FiberN	0.98707	0.98873	0.89300	
All_LeftRatio_FiberNDivLength	0.98306	0.98686	0.72266	
All_LeftRatio_Unweighted	1.01804	1.01148	0.52537	
All_LogSpanningForestN_FAMean	189.65029	175.14710	0.00714	*
All_LogSpanningForestN_FiberLengthMean	736.38352	723.03913	0.03944	
All_LogSpanningForestN_FiberN	596.77500	590.36663	0.02532	
All_LogSpanningForestN_FiberNDivLength	208.78477	208.06750	0.79579	
All_LogSpanningForestN_Unweighted	319.35263	315.28948	0.14715	

All_MaxFracMatching_FAMean	47.79299	47.73239	0.99309	
All_MaxFracMatching_FiberLengthMean	3255.53791	2885.46483	0.01031	
All_MaxFracMatching_FiberN	2450.83333	2354.17857	0.10402	
All_MaxFracMatching_FiberNDivLength	131.20093	128.48485	0.60374	
All_MaxFracMatching_Unweighted	63.90000	63.82143	0.62381	
All_MaxMatching_FAMean	47.61671	47.42748	0.97825	
All_MaxMatching_FiberLengthMean	3250.31191	2881.03276	0.01010	
All_MaxMatching_FiberN	2442.06667	2349.00000	0.11996	
All_MaxMatching_FiberNDivLength	130.78627	128.19811	0.61957	
All_MaxMatching_Unweighted	63.60000	63.50000	0.60403	
All_MinCutBalDivSum_FAMean	0.04107	0.05867	0.03314	
All_MinCutBalDivSum_FiberLengthMean	0.01648	0.02001	0.23049	
All_MinCutBalDivSum_FiberN	0.02515	0.02466	0.87507	
All_MinCutBalDivSum_FiberNDivLength	0.04344	0.05116	0.26759	
All_MinCutBalDivSum_Unweighted	0.02012	0.02359	0.09504	
All_MinSpanningForest_FAMean	29.80087	27.32132	0.00560	*
All_MinSpanningForest_FiberLengthMean	1660.12748	1619.59859	0.00419	*
All_MinSpanningForest_FiberN	140.73333	139.35714	0.42330	
All_MinSpanningForest_FiberNDivLength	4.46488	4.57888	0.56445	
All_MinVertexCoverBinary_Unweighted	95.60000	95.50000	0.86573	
All_MinVertexCover_FAMean	29.28164	27.54695	0.00867	*
All_MinVertexCover_FiberLengthMean	3254.28136	2885.14192	0.01053	
All_MinVertexCover_FiberN	2450.83333	2354.17857	0.10402	
All_MinVertexCover_FiberNDivLength	122.18259	120.33442	0.64280	
All_MinVertexCover_Unweighted	63.90000	63.82143	0.62381	
All_PGEigengap_FAMean	0.02962	0.03269	0.30221	
All_PGEigengap_FiberLengthMean	0.02299	0.02684	0.28803	
All_PGEigengap_FiberN	0.02534	0.02418	0.58917	
All_PGEigengap_FiberNDivLength	0.02574	0.02491	0.67919	
All_PGEigengap_Unweighted	0.02738	0.03019	0.25874	
All_Sum_FAMean	383.21280	343.50552	0.00566	*
All_Sum_FiberLengthMean	29954.75727	26359.29258	0.01648	
All_Sum_FiberN	12055.20000	11753.07143	0.08683	
All_Sum_FiberNDivLength	539.10743	543.51648	0.72060	
All_Sum_Unweighted	996.80000	960.07143	0.05695	
Left_AdjLMaxDivD_FAMean	1.38282	1.41735	0.01972	
Left_AdjLMaxDivD_FiberLengthMean	1.44089	1.42883	0.57130	
Left_AdjLMaxDivD_FiberN	1.88927	2.02446	0.08956	
Left_AdjLMaxDivD_FiberNDivLength	1.77179	1.86037	0.15990	
Left_AdjLMaxDivD_Unweighted	1.26569	1.26226	0.67723	
Left_HoffmanBound_FAMean	4.55896	4.42698	0.04890	
Left_HoffmanBound_FiberLengthMean	3.28256	3.25849	0.74494	
Left_HoffmanBound_FiberN	2.77133	2.69944	0.31545	
Left_HoffmanBound_FiberNDivLength	2.65783	2.64829	0.90792	
Left_HoffmanBound_Unweighted	4.74063	4.59434	0.01729	
Left_LogSpanningForestN_FAMean	94.16378	85.56169	0.00401	*
Left_LogSpanningForestN_FiberLengthMean	370.60101	362.50884	0.02008	
Left_LogSpanningForestN_FiberN	299.54862	296.04072	0.04778	
Left_LogSpanningForestN_FiberNDivLength	104.45062	104.20143	0.88960	
Left_LogSpanningForestN_Unweighted	160.53642	157.70585	0.06838	

Left_MaxFracMatching_FAMean	23.96060	23.75461	0.95447	
Left_MaxFracMatching_FiberLengthMean	1684.63258	1492.07886	0.01201	
Left_MaxFracMatching_FiberN	1158.83333	1143.71429	0.70301	
Left_MaxFracMatching_FiberNDivLength	62.85453	63.36024	0.86300	
Left_MaxFracMatching_Unweighted	32.23333	32.14286	0.44362	
Left_MaxMatching_FAMean	23.78976	23.59561	0.95648	
Left_MaxMatching_FiberLengthMean	1681.84910	1490.02843	0.01201	
Left_MaxMatching_FiberN	1155.06667	1140.78571	0.71945	
Left_MaxMatching_FiberNDivLength	62.56412	63.10921	0.85180	
Left_MaxMatching_Unweighted	32.00000	31.85714	0.13873	
Left_MinCutBalDivSum_FAMean	0.39142	0.42795	0.51193	
Left_MinCutBalDivSum_FiberLengthMean	0.18373	0.17722	0.63821	
Left_MinCutBalDivSum_FiberN	0.11504	0.10370	0.17204	
Left_MinCutBalDivSum_FiberNDivLength	0.29372	0.28518	0.87111	
Left_MinCutBalDivSum_Unweighted	0.18528	0.17527	0.31089	
Left_MinSpanningForest_FAMean	14.31647	13.21554	0.02337	
Left_MinSpanningForest_FiberLengthMean	832.18125	816.19078	0.08567	
Left_MinSpanningForest_FiberN	69.93333	71.50000	0.53489	
Left_MinSpanningForest_FiberNDivLength	2.19041	2.40779	0.30460	
Left_MinVertexCoverBinary_Unweighted	48.60000	48.07143	0.26704	
Left_MinVertexCover_FAMean	14.58465	13.49574	0.00217	*
Left_MinVertexCover_FiberLengthMean	1683.88816	1491.95077	0.01217	
Left_MinVertexCover_FiberN	1158.83333	1143.71429	0.70301	
Left_MinVertexCover_FiberNDivLength	58.18846	59.30983	0.63976	
Left_MinVertexCover_Unweighted	32.23333	32.14286	0.44362	
Left_PGEigengap_FAMean	0.20897	0.19062	0.26005	
Left_PGEigengap_FiberLengthMean	0.21073	0.19264	0.37328	
Left_PGEigengap_FiberN	0.11048	0.09812	0.17273	
Left_PGEigengap_FiberNDivLength	0.08678	0.08249	0.37534	
Left_PGEigengap_Unweighted	0.18680	0.16841	0.20490	
Left_Sum_FAMean	190.73838	169.91048	0.00640	*
Left_Sum_FiberLengthMean	15551.42767	13553.58981	0.01063	
Left_Sum_FiberN	5953.20000	5808.28571	0.23195	
Left_Sum_FiberNDivLength	265.28431	268.10642	0.70300	
Left_Sum_Unweighted	507.13333	485.50000	0.03150	
Right_AdjLMaxDivD_FAMean	1.36927	1.36644	0.86545	
Right_AdjLMaxDivD_FiberLengthMean	1.46663	1.42300	0.22845	
Right_AdjLMaxDivD_FiberN	2.11492	2.26216	0.13799	
Right_AdjLMaxDivD_FiberNDivLength	1.81282	1.88803	0.20555	
Right_AdjLMaxDivD_Unweighted	1.26402	1.24367	0.05722	
Right_HoffmanBound_FAMean	4.31976	4.24036	0.35747	
Right_HoffmanBound_FiberLengthMean	3.31782	3.39672	0.40216	
Right_HoffmanBound_FiberN	2.63936	2.53312	0.14213	
Right_HoffmanBound_FiberNDivLength	2.60907	2.64209	0.57976	
Right_HoffmanBound_Unweighted	4.54479	4.47165	0.33936	
Right_LogSpanningForestN_FAMean	90.78121	84.79885	0.05405	
Right_LogSpanningForestN_FiberLengthMean	357.29779	351.79798	0.14316	
Right_LogSpanningForestN_FiberN	289.78041	286.90175	0.12791	
Right_LogSpanningForestN_FiberNDivLength	99.92977	99.41627	0.73502	
Right_LogSpanningForestN_Unweighted	153.35116	151.79460	0.36897	

Right_MaxFracMatching_FAMean	23.64340	23.92987	0.93393	
Right_MaxFracMatching_FiberLengthMean	1550.30409	1379.09472	0.02294	
Right_MaxFracMatching_FiberN	1211.23333	1160.21429	0.17444	
Right_MaxFracMatching_FiberNDivLength	66.22967	64.18666	0.48841	
Right_MaxFracMatching_Unweighted	31.66667	31.67857	0.92581	
Right_MaxMatching_FAMean	23.56597	23.74101	0.95917	
Right_MaxMatching_FiberLengthMean	1547.55246	1376.37203	0.02307	
Right_MaxMatching_FiberN	1206.66667	1157.00000	0.18644	
Right_MaxMatching_FiberNDivLength	66.04844	63.96700	0.47644	
Right_MaxMatching_Unweighted	31.53333	31.35714	0.35824	
Right_MinCutBalDivSum_FAMean	0.37749	0.40030	0.65833	
Right_MinCutBalDivSum_FiberLengthMean	0.18310	0.16294	0.08674	
Right_MinCutBalDivSum_FiberN	0.10626	0.09805	0.06373	
Right_MinCutBalDivSum_FiberNDivLength	0.27529	0.26502	0.82417	
Right_MinCutBalDivSum_Unweighted	0.18178	0.16539	0.05282	
Right_MinSpanningForest_FAMean	15.54990	14.25185	0.02184	
Right_MinSpanningForest_FiberLengthMean	822.88285	798.47914	0.01294	
Right_MinSpanningForest_FiberN	71.06667	69.64286	0.33198	
Right_MinSpanningForest_FiberNDivLength	2.33231	2.35222	0.88466	
Right_MinVertexCoverBinary_Unweighted	47.00000	47.07143	0.87068	
Right_MinVertexCover_FAMean	14.49525	13.89677	0.09572	
Right_MinVertexCover_FiberLengthMean	1550.06787	1378.66029	0.02307	
Right_MinVertexCover_FiberN	1211.23333	1160.21429	0.17444	
Right_MinVertexCover_FiberNDivLength	61.99819	60.10934	0.42599	
Right_MinVertexCover_Unweighted	31.66667	31.67857	0.92581	
Right_PGEigengap_FAMean	0.21510	0.18486	0.01701	
Right_PGEigengap_FiberLengthMean	0.21993	0.17854	0.01790	
Right_PGEigengap_FiberN	0.11815	0.09973	0.00710	*
Right_PGEigengap_FiberNDivLength	0.09679	0.08770	0.03556	
Right_PGEigengap_Unweighted	0.19093	0.16211	0.01242	
Right_Sum_FAMean	183.61218	164.74653	0.01787	
Right_Sum_FiberLengthMean	13876.53350	12267.36700	0.03808	
Right_Sum_FiberN	5795.86667	5648.07143	0.17406	
Right_Sum_FiberNDivLength	259.38730	260.72185	0.82866	
Right_Sum_Unweighted	468.46667	451.42857	0.13292	

5.3. 234 nodes, round 1

Property	Female	Male	p-value
All_AdjLMaxDivD_FAMean	1.59803	1.64024	0.08803
All_AdjLMaxDivD_FiberLengthMean	1.73972	1.72166	0.69642
All_AdjLMaxDivD_FiberN	2.98297	3.17562	0.18871
All_AdjLMaxDivD_FiberNDivLength	2.90553	3.05789	0.32675
All_AdjLMaxDivD_Unweighted	1.43488	1.44187	0.69379
All_HoffmanBound_FAMean	4.05843	4.02343	0.43528
All_HoffmanBound_FiberLengthMean	3.10090	3.12089	0.78071
All_HoffmanBound_FiberN	2.37479	2.35909	0.81574
All_HoffmanBound_FiberNDivLength	2.32613	2.31582	0.89211
All_HoffmanBound_Unweighted	4.24417	4.19579	0.33435

All_LeftRatio_FAMean	0.99382	0.98754	0.70349	
All_LeftRatio_FiberLengthMean	1.03212	1.01751	0.39210	
All_LeftRatio_FiberN	0.99604	0.99866	0.82533	
All_LeftRatio_FiberNDivLength	0.99635	1.00000	0.73087	
All_LeftRatio_Unweighted	1.01658	1.00968	0.49891	
All_LogSpanningForestN_FAMean	323.14013	299.07957	0.00428	*
All_LogSpanningForestN_FiberLengthMean	1313.09259	1289.79813	0.03407	
All_LogSpanningForestN_FiberN	954.63726	942.88185	0.04603	
All_LogSpanningForestN_FiberNDivLength	260.95250	258.64163	0.65016	
All_LogSpanningForestN_Unweighted	569.99349	562.00182	0.11783	
All_MaxFracMatching_FAMean	77.47689	86.69052	0.47644	
All_MaxFracMatching_FiberLengthMean	5264.48143	4669.21300	0.00595	*
All_MaxFracMatching_FiberN	2423.03333	2346.85714	0.02910	
All_MaxFracMatching_FiberNDivLength	146.84213	152.18921	0.50458	
All_MaxFracMatching_Unweighted	116.30000	116.10714	0.31677	
All_MaxMatching_FAMean	77.32548	86.50399	0.47709	
All_MaxMatching_FiberLengthMean	5267.90205	4664.13177	0.00501	*
All_MaxMatching_FiberN	2415.06667	2343.78571	0.03922	
All_MaxMatching_FiberNDivLength	146.14385	151.83590	0.47885	
All_MaxMatching_Unweighted	116.06667	115.85714	0.37721	
All_MinCutBalDivSum_FAMean	0.01514	0.02013	0.31079	
All_MinCutBalDivSum_FiberLengthMean	0.00958	0.01180	0.19575	
All_MinCutBalDivSum_FiberN	0.02351	0.02307	0.88283	
All_MinCutBalDivSum_FiberNDivLength	0.02792	0.03320	0.38016	
All_MinCutBalDivSum_Unweighted	0.01155	0.01338	0.14262	
All_MinSpanningForest_FAMean	50.15919	47.66875	0.03437	
All_MinSpanningForest_FiberLengthMean	2816.89991	2786.31135	0.05718	
All_MinSpanningForest_FiberN	246.66667	244.21429	0.32290	
All_MinSpanningForest_FiberNDivLength	8.09907	8.42327	0.35978	
All_MinVertexCoverBinary_Unweighted	166.46667	164.50000	0.14702	
All_MinVertexCover_FAMean	51.34924	48.31155	0.00298	*
All_MinVertexCover_FiberLengthMean	5263.01339	4680.07605	0.00624	*
All_MinVertexCover_FiberN	2429.30000	2347.64286	0.02321	
All_MinVertexCover_FiberNDivLength	129.96605	128.35597	0.58930	
All_MinVertexCover_Unweighted	116.26667	116.10714	0.40734	
All_PGEigengap_FAMean	0.01741	0.01917	0.32097	
All_PGEigengap_FiberLengthMean	0.01363	0.01606	0.25767	
All_PGEigengap_FiberN	0.02278	0.02175	0.59722	
All_PGEigengap_FiberNDivLength	0.02185	0.02112	0.67831	
All_PGEigengap_Unweighted	0.01558	0.01717	0.28447	
All_Sum_FAMean	663.03525	600.56092	0.00295	*
All_Sum_FiberLengthMean	50301.63361	44901.15736	0.01494	
All_Sum_FiberN	13010.73333	12717.64286	0.07686	
All_Sum_FiberNDivLength	612.72529	617.69320	0.69765	
All_Sum_Unweighted	1779.53333	1720.35714	0.05751	
Left_AdjLMaxDivD_FAMean	1.58188	1.64049	0.00188	*
Left_AdjLMaxDivD_FiberLengthMean	1.66505	1.67734	0.65526	
Left_AdjLMaxDivD_FiberN	2.53544	2.73240	0.07849	
Left_AdjLMaxDivD_FiberNDivLength	2.41172	2.58587	0.10342	
Left_AdjLMaxDivD_Unweighted	1.41220	1.42766	0.19979	

Left_HoffmanBound_FAMean	4.18213	4.15436	0.69068	
Left_HoffmanBound_FiberLengthMean	3.16103	3.13165	0.69090	
Left_HoffmanBound_FiberN	2.61131	2.59028	0.69022	
Left_HoffmanBound_FiberNDivLength	2.55253	2.52149	0.68292	
Left_HoffmanBound_Unweighted	4.36085	4.27881	0.19873	
Left_LogSpanningForestN_FAMean	160.55086	145.36374	0.00043	*
Left_LogSpanningForestN_FiberLengthMean	666.51767	651.53600	0.00282	*
Left_LogSpanningForestN_FiberN	483.77617	475.96167	0.01381	
Left_LogSpanningForestN_FiberNDivLength	131.44914	129.06273	0.45998	
Left_LogSpanningForestN_Unweighted	288.07253	282.09224	0.01055	
Left_MaxFracMatching_FAMean	39.10063	43.81774	0.48113	
Left_MaxFracMatching_FiberLengthMean	2723.34243	2404.61807	0.00298	*
Left_MaxFracMatching_FiberN	1190.10000	1185.96429	0.87482	
Left_MaxFracMatching_FiberNDivLength	74.54560	77.43346	0.48187	
Left_MaxFracMatching_Unweighted	59.13333	59.07143	0.67471	
Left_MaxMatching_FAMean	38.96026	43.61191	0.48363	
Left_MaxMatching_FiberLengthMean	2733.15685	2401.62800	0.00186	*
Left_MaxMatching_FiberN	1183.86667	1183.50000	0.98840	
Left_MaxMatching_FiberNDivLength	73.98551	77.20181	0.43128	
Left_MaxMatching_Unweighted	58.93333	58.78571	0.26516	
Left_MinCutBalDivSum_FAMean	0.17682	0.18449	0.88746	
Left_MinCutBalDivSum_FiberLengthMean	0.13085	0.12088	0.40639	
Left_MinCutBalDivSum_FiberN	0.09471	0.08283	0.10418	
Left_MinCutBalDivSum_FiberNDivLength	0.17229	0.17870	0.92359	
Left_MinCutBalDivSum_Unweighted	0.13170	0.12493	0.40732	
Left_MinSpanningForest_FAMean	24.84043	23.74120	0.12963	
Left_MinSpanningForest_FiberLengthMean	1429.01473	1418.56487	0.23304	
Left_MinSpanningForest_FiberN	128.13333	128.28571	0.95846	
Left_MinSpanningForest_FiberNDivLength	4.16924	4.54566	0.17006	
Left_MinVertexCoverBinary_Unweighted	84.26667	82.64286	0.03625	
Left_MinVertexCover_FAMean	25.73738	23.87149	0.00062	*
Left_MinVertexCover_FiberLengthMean	2723.68339	2414.02175	0.00300	*
Left_MinVertexCover_FiberN	1191.86667	1183.46429	0.75554	
Left_MinVertexCover_FiberNDivLength	65.88611	66.10788	0.90947	
Left_MinVertexCover_Unweighted	59.13333	59.03571	0.52377	
Left_PGEigengap_FAMean	0.13049	0.12036	0.34190	
Left_PGEigengap_FiberLengthMean	0.13090	0.12097	0.44738	
Left_PGEigengap_FiberN	0.08739	0.07658	0.11542	
Left_PGEigengap_FiberNDivLength	0.06688	0.06230	0.21569	
Left_PGEigengap_Unweighted	0.11641	0.10433	0.20469	
Left_Sum_FAMean	329.24155	296.86391	0.00264	*
Left_Sum_FiberLengthMean	25886.20314	22888.19605	0.00802	*
Left_Sum_FiberN	6488.00000	6345.21429	0.21051	
Left_Sum_FiberNDivLength	305.60029	308.85699	0.67183	
Left_Sum_Unweighted	902.66667	869.14286	0.02715	
Right_AdjLMaxDivD_FAMean	1.53535	1.54017	0.86686	
Right_AdjLMaxDivD_FiberLengthMean	1.66926	1.62871	0.45133	
Right_AdjLMaxDivD_FiberN	2.65172	2.83822	0.20338	
Right_AdjLMaxDivD_FiberNDivLength	2.33381	2.42285	0.35255	
Right_AdjLMaxDivD_Unweighted	1.39665	1.37491	0.26268	

Right_HoffmanBound_FAMean	4.09368	4.05022	0.42998	
Right_HoffmanBound_FiberLengthMean	3.16159	3.26745	0.17945	
Right_HoffmanBound_FiberN	2.54589	2.48387	0.22658	
Right_HoffmanBound_FiberNDivLength	2.54987	2.56558	0.76972	
Right_HoffmanBound_Unweighted	4.27328	4.24321	0.55020	
Right_LogSpanningForestN_FAMean	158.11129	149.15728	0.09220	
Right_LogSpanningForestN_FiberLengthMean	638.28386	629.75250	0.21522	
Right_LogSpanningForestN_FiberN	463.35779	459.45680	0.33133	
Right_LogSpanningForestN_FiberNDivLength	125.05479	125.10653	0.98601	
Right_LogSpanningForestN_Unweighted	276.64016	274.35545	0.50947	
Right_MaxFracMatching_FAMean	38.29213	42.79551	0.47324	
Right_MaxFracMatching_FiberLengthMean	2525.80952	2252.33000	0.02297	
Right_MaxFracMatching_FiberN	1143.36667	1114.50000	0.29332	
Right_MaxFracMatching_FiberNDivLength	69.99586	73.89356	0.37323	
Right_MaxFracMatching_Unweighted	57.16667	57.03571	0.37184	
Right_MaxMatching_FAMean	38.08601	42.66424	0.46269	
Right_MaxMatching_FiberLengthMean	2518.15458	2250.19058	0.02492	
Right_MaxMatching_FiberN	1143.93333	1112.92857	0.25811	
Right_MaxMatching_FiberNDivLength	69.89470	73.68388	0.38458	
Right_MaxMatching_Unweighted	56.73333	56.78571	0.75261	
Right_MinCutBalDivSum_FAMean	0.16974	0.17039	0.98933	
Right_MinCutBalDivSum_FiberLengthMean	0.13208	0.11282	0.05874	
Right_MinCutBalDivSum_FiberN	0.09241	0.08311	0.05924	
Right_MinCutBalDivSum_FiberNDivLength	0.16032	0.18258	0.71333	
Right_MinCutBalDivSum_Unweighted	0.12577	0.11149	0.05167	
Right_MinSpanningForest_FAMean	25.39625	24.04691	0.07033	
Right_MinSpanningForest_FiberLengthMean	1380.70294	1360.83076	0.09218	
Right_MinSpanningForest_FiberN	118.93333	117.35714	0.22005	
Right_MinSpanningForest_FiberNDivLength	3.97662	4.03133	0.77653	
Right_MinVertexCoverBinary_Unweighted	81.73333	81.35714	0.64589	
Right_MinVertexCover_FAMean	25.47790	24.31020	0.04371	
Right_MinVertexCover_FiberLengthMean	2524.64124	2253.53347	0.02391	
Right_MinVertexCover_FiberN	1147.73333	1115.07143	0.24439	
Right_MinVertexCover_FiberNDivLength	62.01048	61.37838	0.76647	
Right_MinVertexCover_Unweighted	57.13333	57.07143	0.67471	
Right_PGEigengap_FAMean	0.13264	0.10599	0.00210	*
Right_PGEigengap_FiberLengthMean	0.14008	0.10493	0.00216	*
Right_PGEigengap_FiberN	0.09018	0.07181	0.00216	*
Right_PGEigengap_FiberNDivLength	0.07040	0.06006	0.00239	*
Right_PGEigengap_Unweighted	0.11555	0.09106	0.00138	*
Right_Sum_FAMean	325.09144	294.90648	0.01679	
Right_Sum_FiberLengthMean	23910.27439	21483.83489	0.04481	
Right_Sum_FiberN	6217.00000	6073.57143	0.22048	
Right_Sum_FiberNDivLength	292.73367	294.05788	0.84987	
Right_Sum_Unweighted	855.93333	828.42857	0.17741	

5.4. 463 nodes, round 1

Property	Female	Male	p-value

All_AdjLMaxDivD_FAMean	2.15215	2.18281	0.42513	
All_AdjLMaxDivD_FiberLengthMean	2.36923	2.34378	0.69634	
All_AdjLMaxDivD_FiberN	5.04437	5.35726	0.28501	
All_AdjLMaxDivD_FiberNDivLength	4.86199	5.11531	0.39426	
All_AdjLMaxDivD_Unweighted	1.88052	1.87368	0.82914	
All_HoffmanBound_FAMean	3.65420	3.58216	0.11960	
All_HoffmanBound_FiberLengthMean	2.96234	2.96941	0.90399	
All_HoffmanBound_FiberN	2.28012	2.25731	0.67430	
All_HoffmanBound_FiberNDivLength	2.25237	2.24638	0.91985	
All_HoffmanBound_Unweighted	3.74999	3.70604	0.31877	
All_LeftRatio_FAMean	0.98244	0.97722	0.77315	
All_LeftRatio_FiberLengthMean	1.01576	1.00512	0.55466	
All_LeftRatio_FiberN	0.99557	0.99767	0.86144	
All_LeftRatio_FiberNDivLength	0.99550	0.99827	0.79576	
All_LeftRatio_Unweighted	1.00742	0.99995	0.52098	
All_LogSpanningForestN_FAMean	432.44074	391.29116	0.01203	
All_LogSpanningForestN_FiberLengthMean	2312.59245	2271.99890	0.12674	
All_LogSpanningForestN_FiberN	1455.41884	1430.04191	0.08913	
All_LogSpanningForestN_FiberNDivLength	151.41709	146.09748	0.60236	
All_LogSpanningForestN_Unweighted	934.57522	921.32293	0.33372	
All_MaxFracMatching_FAMean	97.96938	83.39334	0.12442	
All_MaxFracMatching_FiberLengthMean	8045.71403	7329.01371	0.02703	
All_MaxFracMatching_FiberN	2447.73333	2363.89286	0.01650	
All_MaxFracMatching_FiberNDivLength	139.63506	129.89153	0.27253	
All_MaxFracMatching_Unweighted	222.73333	221.32143	0.26994	
All_MaxMatching_FAMean	97.83775	83.26860	0.12360	
All_MaxMatching_FiberLengthMean	8061.55115	7311.80626	0.02059	
All_MaxMatching_FiberN	2440.86667	2360.00000	0.02188	
All_MaxMatching_FiberNDivLength	139.27123	129.37795	0.26989	
All_MaxMatching_Unweighted	222.53333	220.78571	0.16702	
All_MinCutBalDivSum_FAMean	0.00992	0.01046	0.65496	
All_MinCutBalDivSum_FiberLengthMean	0.00736	0.00859	0.34951	
All_MinCutBalDivSum_FiberN	0.02266	0.02230	0.90244	
All_MinCutBalDivSum_FiberNDivLength	0.02344	0.02198	0.61537	
All_MinCutBalDivSum_Unweighted	0.00793	0.00915	0.15562	
All_MinSpanningForest_FAMean	96.29849	91.93390	0.03440	
All_MinSpanningForest_FiberLengthMean	5383.39943	5298.45575	0.02238	
All_MinSpanningForest_FiberN	487.20000	477.71429	0.02138	
All_MinSpanningForest_FiberNDivLength	19.13123	19.47594	0.52402	
All_MinVertexCoverBinary_Unweighted	278.33333	272.57143	0.09750	
All_MinVertexCover_FAMean	88.73179	83.39334	0.00209	*
All_MinVertexCover_FiberLengthMean	8045.57652	7329.01371	0.02708	
All_MinVertexCover_FiberN	2447.73333	2363.89286	0.01650	
All_MinVertexCover_FiberNDivLength	131.52437	129.89153	0.52678	
All_MinVertexCover_Unweighted	222.73333	221.32143	0.26994	
All_PGEigengap_FAMean	0.01011	0.01058	0.82567	
All_PGEigengap_FiberLengthMean	0.00780	0.00905	0.51801	
All_PGEigengap_FiberN	0.01776	0.01454	0.32360	
All_PGEigengap_FiberNDivLength	0.01641	0.01372	0.37037	
All_PGEigengap_Unweighted	0.00888	0.00941	0.77175	

All_Sum_FAMean	996.96869	912.06881	0.00419	*
All_Sum_FiberLengthMean	72569.22842	65893.58253	0.02827	
All_Sum_FiberN	13388.06667	13083.92857	0.07726	
All_Sum_FiberNDivLength	648.40984	652.62526	0.75437	
All_Sum_Unweighted	2741.13333	2671.07143	0.19764	
Left_AdjLMaxDivD_FAMean	2.13170	2.18356	0.10520	
Left_AdjLMaxDivD_FiberLengthMean	2.28854	2.29653	0.87385	
Left_AdjLMaxDivD_FiberN	4.01054	4.39629	0.03562	
Left_AdjLMaxDivD_FiberNDivLength	3.75976	4.06768	0.08089	
Left_AdjLMaxDivD_Unweighted	1.84695	1.85515	0.74289	
Left_HoffmanBound_FAMean	3.78621	3.74262	0.52408	
Left_HoffmanBound_FiberLengthMean	3.02537	2.97013	0.43552	
Left_HoffmanBound_FiberN	2.51327	2.46954	0.31630	
Left_HoffmanBound_FiberNDivLength	2.49376	2.45224	0.50396	
Left_HoffmanBound_Unweighted	3.86677	3.84281	0.72661	
Left_LogSpanningForestN_FAMean	209.08024	184.73327	0.00676	*
Left_LogSpanningForestN_FiberLengthMean	1159.44215	1136.94931	0.06615	
Left_LogSpanningForestN_FiberN	727.97774	713.31628	0.05629	
Left_LogSpanningForestN_FiberNDivLength	73.75521	68.47575	0.40858	
Left_LogSpanningForestN_Unweighted	467.56327	458.41443	0.17067	
Left_MaxFracMatching_FAMean	48.19763	40.73958	0.12892	
Left_MaxFracMatching_FiberLengthMean	4050.62536	3692.90472	0.02154	
Left_MaxFracMatching_FiberN	1174.73333	1168.14286	0.82446	
Left_MaxFracMatching_FiberNDivLength	69.30024	65.10409	0.39737	
Left_MaxFracMatching_Unweighted	111.93333	111.17857	0.27767	
Left_MaxMatching_FAMean	48.18911	40.61401	0.12054	
Left_MaxMatching_FiberLengthMean	4081.33975	3683.09827	0.01115	
Left_MaxMatching_FiberN	1171.86667	1169.35714	0.93445	
Left_MaxMatching_FiberNDivLength	69.00646	64.86202	0.40792	
Left_MaxMatching_Unweighted	111.60000	110.78571	0.24543	
Left_MinCutBalDivSum_FAMean	0.09376	0.07990	0.23745	
Left_MinCutBalDivSum_FiberLengthMean	0.08212	0.07713	0.54194	
Left_MinCutBalDivSum_FiberN	0.06769	0.06039	0.16060	
Left_MinCutBalDivSum_FiberNDivLength	0.08034	0.05881	0.24301	
Left_MinCutBalDivSum_Unweighted	0.08572	0.07863	0.26173	
Left_MinSpanningForest_FAMean	46.72246	44.99254	0.11107	
Left_MinSpanningForest_FiberLengthMean	2703.40298	2683.84440	0.40476	
Left_MinSpanningForest_FiberN	245.80000	244.35714	0.65690	
Left_MinSpanningForest_FiberNDivLength	9.60443	10.12770	0.10870	
Left_MinVertexCoverBinary_Unweighted	139.60000	136.28571	0.06242	
Left_MinVertexCover_FAMean	43.55457	40.73958	0.00274	*
Left_MinVertexCover_FiberLengthMean	4050.47768	3692.90472	0.02160	
Left_MinVertexCover_FiberN	1174.73333	1168.14286	0.82446	
Left_MinVertexCover_FiberNDivLength	65.21177	65.10409	0.95567	
Left_MinVertexCover_Unweighted	111.93333	111.17857	0.27767	
Left_PGEigengap_FAMean	0.07719	0.07518	0.82459	
Left_PGEigengap_FiberLengthMean	0.07879	0.07763	0.91292	
Left_PGEigengap_FiberN	0.06028	0.05746	0.65896	
Left_PGEigengap_FiberNDivLength	0.04513	0.04595	0.84639	
Left_PGEigengap_Unweighted	0.06588	0.06319	0.71316	

Left_Sum_FAMean	488.88692	446.37002	0.00653	*
Left_Sum_FiberLengthMean	36672.41589	33169.82857	0.01816	
Left_Sum_FiberN	6671.40000	6520.07143	0.20059	
Left_Sum_FiberNDivLength	322.99072	325.71679	0.73536	
Left_Sum_Unweighted	1377.06667	1338.42857	0.15161	
Right_AdjLMaxDivD_FAMean	2.04805	2.06086	0.77728	
Right_AdjLMaxDivD_FiberLengthMean	2.24439	2.20712	0.61096	
Right_AdjLMaxDivD_FiberN	4.21492	4.48300	0.23523	
Right_AdjLMaxDivD_FiberNDivLength	3.69704	3.82114	0.49290	
Right_AdjLMaxDivD_Unweighted	1.81231	1.78539	0.42677	
Right_HoffmanBound_FAMean	3.63851	3.57214	0.26281	
Right_HoffmanBound_FiberLengthMean	2.99319	2.98754	0.93061	
Right_HoffmanBound_FiberN	2.41840	2.32451	0.02875	
Right_HoffmanBound_FiberNDivLength	2.47438	2.42756	0.32797	
Right_HoffmanBound_Unweighted	3.75198	3.66399	0.14648	
Right_LogSpanningForestN_FAMean	218.30058	201.22233	0.10548	
Right_LogSpanningForestN_FiberLengthMean	1144.40045	1125.84150	0.25579	
Right_LogSpanningForestN_FiberN	719.43735	708.80001	0.25777	
Right_LogSpanningForestN_FiberNDivLength	72.66745	72.68775	0.99730	
Right_LogSpanningForestN_Unweighted	461.18676	456.60569	0.59800	
Right_MaxFracMatching_FAMean	49.63129	42.48039	0.11971	
Right_MaxFracMatching_FiberLengthMean	3981.63098	3624.50964	0.05864	
Right_MaxFracMatching_FiberN	1168.00000	1134.71429	0.16479	
Right_MaxFracMatching_FiberNDivLength	67.01619	63.26438	0.39830	
Right_MaxFracMatching_Unweighted	110.76667	110.10714	0.37162	
Right_MaxMatching_FAMean	49.46915	42.49032	0.12642	
Right_MaxMatching_FiberLengthMean	3967.99213	3616.44584	0.05694	
Right_MaxMatching_FiberN	1165.93333	1132.21429	0.16580	
Right_MaxMatching_FiberNDivLength	66.85747	63.07703	0.39386	
Right_MaxMatching_Unweighted	110.60000	109.71429	0.20386	
Right_MinCutBalDivSum_FAMean	0.10473	0.08130	0.03861	
Right_MinCutBalDivSum_FiberLengthMean	0.09399	0.07564	0.01969	
Right_MinCutBalDivSum_FiberN	0.07226	0.06309	0.03249	
Right_MinCutBalDivSum_FiberNDivLength	0.08560	0.06297	0.20320	
Right_MinCutBalDivSum_Unweighted	0.09014	0.07466	0.00456	*
Right_MinSpanningForest_FAMean	49.66592	47.12049	0.06306	
Right_MinSpanningForest_FiberLengthMean	2674.03630	2607.48380	0.01248	
Right_MinSpanningForest_FiberN	241.86667	235.71429	0.05077	
Right_MinSpanningForest_FiberNDivLength	9.58006	9.56983	0.97811	
Right_MinVertexCoverBinary_Unweighted	138.53333	136.07143	0.22210	
Right_MinVertexCover_FAMean	45.05370	42.48039	0.01411	
Right_MinVertexCover_FiberLengthMean	3981.62212	3624.50964	0.05865	
Right_MinVertexCover_FiberN	1168.00000	1134.71429	0.16479	
Right_MinVertexCover_FiberNDivLength	63.09396	63.26438	0.92752	
Right_MinVertexCover_Unweighted	110.76667	110.10714	0.37162	
Right_PGEigengap_FAMean	0.07888	0.05424	0.02615	
Right_PGEigengap_FiberLengthMean	0.08149	0.05411	0.02193	
Right_PGEigengap_FiberN	0.06247	0.04384	0.03567	
Right_PGEigengap_FiberNDivLength	0.04964	0.03607	0.05054	
Right_PGEigengap_Unweighted	0.06734	0.04548	0.02094	

Right_Sum_FAMean	498.59453	455.98757	0.02310
Right_Sum_FiberLengthMean	35352.85906	32155.12919	0.07057
Right_Sum_FiberN	6410.26667	6265.28571	0.23548
Right_Sum_FiberNDivLength	310.98355	312.13891	0.87672
Right_Sum_Unweighted	1341.33333	1307.64286	0.34831

5.5. 1015 nodes, round 1

Property	Female	Male	p-value
All_AdjLMaxDivD_FAMean	3.22321	3.30998	0.17241
All_AdjLMaxDivD_FiberLengthMean	3.66249	3.62589	0.72808
All_AdjLMaxDivD_FiberN	9.97079	10.49734	0.43959
All_AdjLMaxDivD_FiberNDivLength	9.57304	10.04031	0.47421
All_AdjLMaxDivD_Unweighted	2.78189	2.80864	0.62854
All_HoffmanBound_FAMean	3.15950	3.07640	0.01768
All_HoffmanBound_FiberLengthMean	2.72401	2.71081	0.74127
All_HoffmanBound_FiberN	2.19459	2.18310	0.77482
All_HoffmanBound_FiberNDivLength	2.19470	2.19370	0.98348
All_HoffmanBound_Unweighted	3.17194	3.14136	0.39570
All_LeftRatio_FAMean	0.99025	0.98498	0.73871
All_LeftRatio_FiberLengthMean	1.02275	1.01334	0.55556
All_LeftRatio_FiberN	0.99483	0.99842	0.76208
All_LeftRatio_FiberNDivLength	0.99506	0.99977	0.65608
All_LeftRatio_Unweighted	1.01401	1.00766	0.55464
All_LogSpanningForestN_FAMean	439.73425	375.35402	0.01834
All_LogSpanningForestN_FiberLengthMean	4042.68840	3930.97587	0.09979
All_LogSpanningForestN_FiberN	2126.38756	2075.02830	0.10526
All_LogSpanningForestN_FiberNDivLength	-361.54957	-347.10187	0.41626
All_LogSpanningForestN_Unweighted	1445.09048	1410.64529	0.23969
All_MaxFracMatching_FAMean	367.10422	392.82651	0.48563
All_MaxFracMatching_FiberLengthMean	12444.27073	11352.81900	0.02610
All_MaxFracMatching_FiberN	2520.13333	2450.71429	0.02833
All_MaxFracMatching_FiberNDivLength	378.36572	407.34233	0.46533
All_MaxFracMatching_Unweighted	421.16667	412.17857	0.11468
All_MaxMatching_FAMean	366.74831	392.78175	0.47927
All_MaxMatching_FiberLengthMean	12434.60538	11353.55886	0.02719
All_MaxMatching_FiberN	2518.53333	2447.42857	0.02355
All_MaxMatching_FiberNDivLength	346.48796	404.43920	0.23863
All_MaxMatching_Unweighted	420.73333	412.21429	0.13777
All_MinCutBalDivSum_FAMean	0.01048	0.01455	0.20028
All_MinCutBalDivSum_FiberLengthMean	0.00513	0.00628	0.17564
All_MinCutBalDivSum_FiberN	0.02219	0.02192	0.92698
All_MinCutBalDivSum_FiberNDivLength	0.03288	0.03669	0.66309
All_MinCutBalDivSum_Unweighted	0.00563	0.00672	0.06268
All_MinSpanningForest_FAMean	200.77063	190.16600	0.01194
All_MinSpanningForest_FiberLengthMean	10938.82203	10614.65056	0.02669
All_MinSpanningForest_FiberN	963.93333	939.50000	0.01860
All_MinSpanningForest_FiberNDivLength	43.76266	43.96543	0.83113
All_MinVertexCoverBinary_Unweighted	461.60000	448.21429	0.10356

All_MinVertexCover_FAMean	152.79728	142.97533	0.00510	*
All_MinVertexCover_FiberLengthMean	12421.62501	11383.69815	0.03415	
All_MinVertexCover_FiberN	2526.33333	2449.85714	0.01990	
All_MinVertexCover_FiberNDivLength	139.35018	137.84455	0.55857	
All_MinVertexCover_Unweighted	421.96667	413.28571	0.13796	
All_PGEigengap_FAMean	0.00000	0.00107	0.14466	
All_PGEigengap_FiberLengthMean	0.00000	0.00103	0.16113	
All_PGEigengap_FiberN	0.00000	0.00190	0.13951	
All_PGEigengap_FiberNDivLength	0.00000	0.00170	0.13919	
All_PGEigengap_Unweighted	0.00000	0.00105	0.14705	
All_Sum_FAMean	1422.68895	1303.27462	0.00498	*
All_Sum_FiberLengthMean	99977.79501	90954.69035	0.03028	
All_Sum_FiberN	13586.53333	13269.50000	0.07020	
All_Sum_FiberNDivLength	671.66870	674.36023	0.84649	
All_Sum_Unweighted	3960.20000	3831.78571	0.14992	
Left_AdjLMaxDivD_FAMean	3.15407	3.26128	0.06781	
Left_AdjLMaxDivD_FiberLengthMean	3.48214	3.50359	0.79761	
Left_AdjLMaxDivD_FiberN	7.25286	8.08325	0.02928	
Left_AdjLMaxDivD_FiberNDivLength	6.94687	7.51631	0.14162	
Left_AdjLMaxDivD_Unweighted	2.69638	2.74517	0.33713	
Left_HoffmanBound_FAMean	3.22364	3.18000	0.37811	
Left_HoffmanBound_FiberLengthMean	2.75210	2.71714	0.43501	
Left_HoffmanBound_FiberN	2.40776	2.36099	0.30309	
Left_HoffmanBound_FiberNDivLength	2.38876	2.37013	0.70703	
Left_HoffmanBound_Unweighted	3.23817	3.19290	0.33180	
Left_LogSpanningForestN_FAMean	210.85942	178.12745	0.02486	
Left_LogSpanningForestN_FiberLengthMean	2032.22116	1971.64825	0.07003	
Left_LogSpanningForestN_FiberN	1068.89981	1041.23415	0.09149	
Left_LogSpanningForestN_FiberNDivLength	-179.63339	-171.63161	0.51982	
Left_LogSpanningForestN_Unweighted	728.12558	708.39172	0.18427	
Left_MaxFracMatching_FAMean	183.97769	197.14160	0.47430	
Left_MaxFracMatching_FiberLengthMean	6296.31570	5736.50436	0.01837	
Left_MaxFracMatching_FiberN	1220.00000	1213.53571	0.81314	
Left_MaxFracMatching_FiberNDivLength	188.25111	203.66306	0.43945	
Left_MaxFracMatching_Unweighted	211.53333	206.89286	0.13059	
Left_MaxMatching_FAMean	183.69446	196.98025	0.46852	
Left_MaxMatching_FiberLengthMean	6290.30035	5734.95255	0.01894	
Left_MaxMatching_FiberN	1218.86667	1214.35714	0.86884	
Left_MaxMatching_FiberNDivLength	188.08013	203.30161	0.44482	
Left_MaxMatching_Unweighted	211.20000	206.64286	0.14188	
Left_MinCutBalDivSum_FAMean	0.09885	0.10926	0.69063	
Left_MinCutBalDivSum_FiberLengthMean	0.05144	0.04757	0.51458	
Left_MinCutBalDivSum_FiberN	0.04602	0.04116	0.20617	
Left_MinCutBalDivSum_FiberNDivLength	0.20876	0.20881	0.99933	
Left_MinCutBalDivSum_Unweighted	0.05227	0.04713	0.21386	
Left_MinSpanningForest_FAMean	97.33236	92.63020	0.06143	
Left_MinSpanningForest_FiberLengthMean	5481.16240	5324.53691	0.04038	
Left_MinSpanningForest_FiberN	483.26667	473.42857	0.14910	
Left_MinSpanningForest_FiberNDivLength	21.95206	22.26390	0.52551	
Left_MinVertexCoverBinary_Unweighted	232.33333	225.28571	0.10878	

Left_MinVertexCover_FAMean	75.44749	70.49228	0.00733	*
Left_MinVertexCover_FiberLengthMean	6259.65401	5759.90764	0.03606	
Left_MinVertexCover_FiberN	1218.16667	1210.60714	0.77425	
Left_MinVertexCover_FiberNDivLength	69.27402	69.53888	0.88850	
Left_MinVertexCover_Unweighted	211.73333	207.50000	0.17616	
Left_PGEigengap_FAMean	0.01178	0.01763	0.54919	
Left_PGEigengap_FiberLengthMean	0.01241	0.01922	0.52171	
Left_PGEigengap_FiberN	0.00979	0.01642	0.43541	
Left_PGEigengap_FiberNDivLength	0.00689	0.01269	0.34893	
Left_PGEigengap_Unweighted	0.00976	0.01522	0.50417	
Left_Sum_FAMean	703.63345	641.32910	0.00531	*
Left_Sum_FiberLengthMean	50902.69786	46025.48488	0.01756	
Left_Sum_FiberN	6766.13333	6615.71429	0.20853	
Left_Sum_FiberNDivLength	334.51749	336.88634	0.77548	
Left_Sum_Unweighted	2004.66667	1929.57143	0.10019	
Right_AdjLMaxDivD_FAMean	3.11058	3.17176	0.44453	
Right_AdjLMaxDivD_FiberLengthMean	3.48779	3.51830	0.79334	
Right_AdjLMaxDivD_FiberN	7.76024	8.14382	0.37225	
Right_AdjLMaxDivD_FiberNDivLength	6.83772	7.07156	0.52127	
Right_AdjLMaxDivD_Unweighted	2.70744	2.71957	0.83883	
Right_HoffmanBound_FAMean	3.14757	3.04963	0.02036	
Right_HoffmanBound_FiberLengthMean	2.77024	2.68725	0.05471	
Right_HoffmanBound_FiberN	2.32441	2.23330	0.01858	
Right_HoffmanBound_FiberNDivLength	2.38419	2.30535	0.07109	
Right_HoffmanBound_Unweighted	3.16199	3.09316	0.07931	
Right_LogSpanningForestN_FAMean	223.08908	190.45255	0.05945	
Right_LogSpanningForestN_FiberLengthMean	2000.50088	1948.56703	0.17197	
Right_LogSpanningForestN_FiberN	1048.39181	1024.37929	0.19504	
Right_LogSpanningForestN_FiberNDivLength	-187.57760	-181.71216	0.49112	
Right_LogSpanningForestN_Unweighted	710.28043	694.54365	0.34901	
Right_MaxFracMatching_FAMean	182.91341	195.61348	0.49409	
Right_MaxFracMatching_FiberLengthMean	6136.77547	5605.35278	0.05092	
Right_MaxFracMatching_FiberN	1194.00000	1169.53571	0.23073	
Right_MaxFracMatching_FiberNDivLength	186.50824	201.72223	0.44500	
Right_MaxFracMatching_Unweighted	209.40000	205.17857	0.18566	
Right_MaxMatching_FAMean	182.80549	195.43970	0.49551	
Right_MaxMatching_FiberLengthMean	6133.19214	5607.85845	0.05338	
Right_MaxMatching_FiberN	1193.33333	1168.92857	0.23115	
Right_MaxMatching_FiberNDivLength	186.33486	201.44535	0.44822	
Right_MaxMatching_Unweighted	209.20000	205.21429	0.21712	
Right_MinCutBalDivSum_FAMean	0.10194	0.10852	0.79465	
Right_MinCutBalDivSum_FiberLengthMean	0.05798	0.05045	0.10536	
Right_MinCutBalDivSum_FiberN	0.04848	0.04187	0.01462	
Right_MinCutBalDivSum_FiberNDivLength	0.22021	0.21702	0.95938	
Right_MinCutBalDivSum_Unweighted	0.05808	0.04940	0.01406	
Right_MinSpanningForest_FAMean	103.51247	97.80199	0.02535	
Right_MinSpanningForest_FiberLengthMean	5449.19539	5284.24222	0.05427	
Right_MinSpanningForest_FiberN	482.53333	470.00000	0.08846	
Right_MinSpanningForest_FiberNDivLength	21.91228	22.07628	0.81623	
Right_MinVertexCoverBinary_Unweighted	229.06667	222.71429	0.16269	

Right_MinVertexCover_FAMean	77.19144	72.32630	0.01652
Right_MinVertexCover_FiberLengthMean	6150.67656	5612.96934	0.04968
Right_MinVertexCover_FiberN	1200.03333	1171.71429	0.16130
Right_MinVertexCover_FiberNDivLength	66.59407	66.55426	0.97982
Right_MinVertexCover_Unweighted	209.93333	205.64286	0.18522
Right_PGEigengap_FAMean	0.01467	0.00967	0.56364
Right_PGEigengap_FiberLengthMean	0.01533	0.00998	0.55712
Right_PGEigengap_FiberN	0.01218	0.00779	0.54063
Right_PGEigengap_FiberNDivLength	0.00960	0.00631	0.56034
Right_PGEigengap_Unweighted	0.01225	0.00787	0.54125
Right_Sum_FAMean	709.28257	651.61088	0.02201
Right_Sum_FiberLengthMean	48529.39175	44331.93496	0.07380
Right_Sum_FiberN	6514.80000	6355.14286	0.19297
Right_Sum_FiberNDivLength	322.73850	322.68174	0.99406
Right_Sum_Unweighted	1932.06667	1875.71429	0.28274