

Data Import

```
In[ ]:= SetDirectory[  
    "C:/Users/serha/OneDrive/Masaüstü/MyRepo/master_thesis_MMT003/210718_product_diversity"  
    ];
```

```
In[ ]:= Get["../algorithm_packages/SingleNetworks-algorithm-package-2.wl"]  
(* ?SingleNetworks` * *)
```

```
In[ ]:= datafull = Import["../data/cgl_manipulated_27147_rev1.csv"];  
productionline = "CGL5-inc_sizes";  
stepsizewidth = 22;  
stepsize thickness = 0.1;
```

Data for First and Second Half of Complete Data

```
In[ ]:= Dimensions@datafull
```

```
Out[ ]:= {27147, 12}
```

```
In[ ]:= x = Floor[Length@datafull / 2];  
{a, b} = Range[x, Length@datafull, x];  
data1sthalf = Take[datafull, {1, a}];  
data2ndhalf = Take[datafull, {a + 1, b}];
```

```
In[ ]:= times = 10;  
picklist1sthalf = Table[  
    RandomSample[Range@Length@data1sthalf, Floor@((Length@data1sthalf) * 0.9)], times];  
reduceddata1sthalflist = Table[data1sthalf[[i, All]], {i, picklist1sthalf}];
```

```
picklist2ndhalf = Table[  
    RandomSample[Range@Length@data2ndhalf, Floor@((Length@data2ndhalf) * 0.9)], times];  
reduceddata2ndhalflist = Table[data2ndhalf[[i, All]], {i, picklist2ndhalf}];
```

```
picklistfull =  
    Table[RandomSample[Range@Length@datafull, Floor@((Length@datafull) * 0.9)], times];  
reduceddatafulllist = Table[datafull[[i, All]], {i, picklistfull}];
```

bar chart function

```

In[6]:= plotcolumn[modularity_, randommoddegree_,
  randommodcommunity_, zscoredegree_, zscorecommunities_, eZscores_] :=
Module[{labels, colors, modularityrange, errorBar, errorbars, charts},
  labels = {"Modularity", "Sng. Rnd. Mod.\n Degrees",
    "Sng. Rnd. Mod.\n Degrees & Modules", "Z-score cons. \n Degrees",
    "Z-score cons. \n Degrees & Modules"};
  colors = {{Purple, RGBColor[{0.266122, 0.486664, 0.802529}],
    RGBColor[{0.513417, 0.72992, 0.440682}]}, {RGBColor[
    {0.863512, 0.670771, 0.236564}], RGBColor[{0.857359, 0.131106, 0.132128}]}};
  modularityrange = {0, 0.52};
  errorBar[type_ : "Rectangle"][{x0_, x1_}, {y0_, y1_}, value_, meta_] := Block[
    {error, mags = QuantityMagnitude[value]}, error = Flatten[QuantityMagnitude[meta]];
    error = If[error === {}, 0, Last[error]];
    {ChartElementData[type][{{x0, x1}, {y0, y1}}, mags, meta],
    {Black, Line[{{{(x0 + x1) / 2, y1 - error}}, {(x0 + x1) / 2, y1 + error}},
      {{1 / 4 (3 x0 + x1), y1 + error}, {1 / 4 (x0 + 3 x1), y1 + error}},
      {{1 / 4 (3 x0 + x1), y1 - error}, {1 / 4 (x0 + 3 x1), y1 - error}}]}}];
  errorbars = {Mean@eZscores[[All, 1]] → StandardDeviation@eZscores[[All, 1]],
    Mean@eZscores[[All, 2]] → StandardDeviation@eZscores[[All, 2]]};
  charts = GraphicsColumn[{BarChart[{modularity, randommoddegree, randommodcommunity},
    ChartStyle → colors[[1]],
    ChartLabels → labels[[{1, 2, 3}]], Frame → True, FrameTicks →
      {{All, None}, {None, {{1, labels[[1]]}, {2, labels[[2]]}, {3, labels[[3]]}}}},
    PlotRange → {{0.5, 3.5}, modularityrange}], GraphicsRow[
    {Show[BarChart[{errorbars[[1]], 0 → 0}, ChartElementFunction → errorBar[],
      ChartStyle → colors[[2, 1]], Frame → True, PlotRange → {{0.5, 1.5}, {-10, 50}},
      FrameTicks → {{All, None}, {{1, labels[[4]]}, {2, labels[[5]]}, None}}},
      BarChart[{zscoredegree, 0}, ChartStyle → Transparent, Frame → True,
        PlotRange → {{0.5, 1.5}, {-10, 50}}, FrameTicks →
          {{All, None}, {{1, labels[[4]]}, {2, labels[[5]]}, None}}, AspectRatio → 2],
      Show[BarChart[{0 → 0, errorbars[[2]]}, ChartElementFunction → errorBar[],
        ChartStyle → colors[[2, 2]], Frame → True, PlotRange → {{1.5, 2.5}, {-10, 5}},
        FrameTicks → {{None, All}, {{1, labels[[4]]}, {2, labels[[5]]}, None}}},
        BarChart[{0, zscorecommunities}, ChartStyle → Transparent,
          Frame → True, PlotRange → {{1.5, 2.5}, {-10, 5}},
          FrameTicks → {{None, All}, {{1, labels[[4]]}, {2, labels[[5]]}, None}}},
          AspectRatio → 2]}}], Spacings → 1]]

```

Investigation of Constraints Impact in Real-life Production Events

Fixed Step Size Networks

Width Feature

```
In[ ]:= AbsoluteTiming[widthdataFixedstep1 = snetworkdatabinned[9, stepsizewidth, data1sthalf];
graphsandnodenumbers1 =
  snetworkgraph[widthdataFixedstep1[[1]], widthdataFixedstep1[[2]], 2, 7, 400, Green];
modularityvalues1 = N@GraphAssortativity[graphsandnodenumbers1[[1]],
  FindGraphCommunities[graphsandnodenumbers1[[1]], "Normalized" -> False];
singlerandomgraphsdegfxd1 = randomizinggraphdegfxd[graphsandnodenumbers1[[1]]];
singlerandomerdrenmodularityvalues1 = N@GraphAssortativity[singlerandomgraphsdegfxd1,
  FindGraphCommunities[singlerandomgraphsdegfxd1], "Normalized" -> False];
singlerandomgraphscomm1 = randomizinggraphmod[graphsandnodenumbers1[[1]]];
singlerandomcommmodularityvalues1 = N@GraphAssortativity[singlerandomgraphscomm1,
  FindGraphCommunities[singlerandomgraphscomm1], "Normalized" -> False];
Zscoresmodularity1 = zscorefunctionfortwonullmodels[graphsandnodenumbers1[[1]]];
bucketnode11 = graphsandnodenumbers1[[2]]]
```

```
Out[ ]:= {14.6022, 43}
```

```
In[ ]:= AbsoluteTiming[widthdataFixedstep2 = snetworkdatabinned[9, stepsizewidth, data2ndhalf];
graphsandnodenumbers12 =
  snetworkgraph[widthdataFixedstep2[[1]], widthdataFixedstep2[[2]], 2, 7, 400, Green];
modularityvalues12 = N@GraphAssortativity[graphsandnodenumbers12[[1]],
  FindGraphCommunities[graphsandnodenumbers12[[1]], "Normalized" -> False];
singlerandomgraphsdegfxd12 = randomizinggraphdegfxd[graphsandnodenumbers12[[1]]];
singlerandomerdrenmodularityvalues12 = N@GraphAssortativity[singlerandomgraphsdegfxd12,
  FindGraphCommunities[singlerandomgraphsdegfxd12], "Normalized" -> False];
singlerandomgraphscomm12 = randomizinggraphmod[graphsandnodenumbers12[[1]]];
singlerandomcommmodularityvalues12 = N@GraphAssortativity[singlerandomgraphscomm12,
  FindGraphCommunities[singlerandomgraphscomm12], "Normalized" -> False];
Zscoresmodularity12 = zscorefunctionfortwonullmodels[graphsandnodenumbers12[[1]]];
bucketnode12 = graphsandnodenumbers12[[2]]]
```

```
Out[ ]:= {22.5649, 44}
```

```
In[ ]:= AbsoluteTiming[widthdataFixedstep3 = snetworkdatabinned[9, stepsizewidth, datafull];
graphsandnodenumbers13 =
  snetworkgraph[widthdataFixedstep3[[1]], widthdataFixedstep3[[2]], 2, 7, 400, Green];
modularityvalues13 = N@GraphAssortativity[graphsandnodenumbers13[[1]],
  FindGraphCommunities[graphsandnodenumbers13[[1]], "Normalized" -> False];
singlerandomgraphsdegfxd13 = randomizinggraphdegfxd[graphsandnodenumbers13[[1]]];
singlerandomerdrenmodularityvalues13 = N@GraphAssortativity[singlerandomgraphsdegfxd13,
  FindGraphCommunities[singlerandomgraphsdegfxd13], "Normalized" -> False];
singlerandomgraphscomm13 = randomizinggraphmod[graphsandnodenumbers13[[1]]];
singlerandomcommmodularityvalues13 = N@GraphAssortativity[singlerandomgraphscomm13,
  FindGraphCommunities[singlerandomgraphscomm13], "Normalized" -> False];
Zscoresmodularity13 = zscorefunctionfortwonullmodels[graphsandnodenumbers13[[1]]];
bucketnode13 = graphsandnodenumbers13[[2]]]
```

```
Out[ ]:= {25.5203, 44}
```

Error Bars and Charts

```

In[ ]:= AbsoluteTiming[ewidthdataFixedstep1 =
  Table[snetworkdatabinned[9, stepsizewidth, i], {i, reduceddata1sthalflist}];
egraphsandnodenumbers1 = Table[snetworkgraph[ewidthdataFixedstep1[[i, 1]],
  ewidthdataFixedstep1[[i, 2]], 2, 7, 400, Green], {i, Length@reduceddata1sthalflist}];
emodularityvalues1 = Table[N@GraphAssortativity[egraphsandnodenumbers1[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers1[[i, 1]], "Normalized" → False],
  {i, Length@reduceddata1sthalflist}];
esinglerandomgraphsdegfxd1 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers1[[i, 1]], {i, Length@reduceddata1sthalflist}];
esinglerandomerdrenmodularityvalues1 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd1[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd1[[i]], "Normalized" → False],
    {i, Length@reduceddata1sthalflist}];
esinglerandomgraphscomm1 = Table[randomizinggraphmod[egraphsandnodenumbers1[[i, 1]],
  {i, Length@reduceddata1sthalflist}];
esinglerandomcommmodularityvalues1 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm1[[i]],
    FindGraphCommunities[esinglerandomgraphscomm1[[i]], "Normalized" → False],
    {i, Length@reduceddata1sthalflist}];
eZscoresmodularity1 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers1[[i, 1]], {i, Length@reduceddata1sthalflist}];
ebucketnode11 = Table[egraphsandnodenumbers1[[i, 2]],
  {i, Length@reduceddata1sthalflist}]]

Out[ ]:= {135.619, {42, 43, 43, 43, 43, 43, 41, 43, 41, 43}}

```

```

In[ ]:= AbsoluteTiming[ewidthdataFixedstep2 =
  Table[snetworkdatabinned[9, stepsizewidth, i], {i, reduceddata2ndhalflist}];
egraphsandnodenumbers12 = Table[snetworkgraph[ewidthdataFixedstep2[[i, 1]],
  ewidthdataFixedstep2[[i, 2]], 2, 7, 400, Green], {i, Length@reduceddata2ndhalflist}];
emodularityvalues12 = Table[N@GraphAssortativity[egraphsandnodenumbers12[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers12[[i, 1]]], "Normalized" → False],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphsdegfxd12 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers12[[i, 1]]], {i, Length@reduceddata2ndhalflist}];
esinglerandomerdrenmodularityvalues12 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd12[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd12[[i]]], "Normalized" → False],
    {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphscomm12 = Table[randomizinggraphmod[egraphsandnodenumbers12[[i, 1]]],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomcommmodularityvalues12 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm12[[i]],
    FindGraphCommunities[esinglerandomgraphscomm12[[i]]], "Normalized" → False],
    {i, Length@reduceddata2ndhalflist}];
eZscoresmodularity12 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers12[[i, 1]]], {i, Length@reduceddata2ndhalflist}];
ebucketnode12 = Table[egraphsandnodenumbers12[[i, 2]],
  {i, Length@reduceddata2ndhalflist}]]

Out[ ]:= {283.671, {44, 44, 44, 44, 44, 44, 44, 44, 44, 44}}

```

```

In[ ]:= AbsoluteTiming[ewidthdataFixedstep3 =
  Table[snetworkdatabinned[9, stepsizewidth, i], {i, reduceddatafulllist}];
  egraphsandnodenumbers13 = Table[snetworkgraph[ewidthdataFixedstep3[[i, 1]],
    ewidthdataFixedstep3[[i, 2]], 2, 7, 400, Green], {i, Length@reduceddatafulllist}];
  emodularityvalues13 = Table[N@GraphAssortativity[egraphsandnodenumbers13[[i, 1]],
    FindGraphCommunities[egraphsandnodenumbers13[[i, 1]]],
    "Normalized" → False], {i, Length@reduceddatafulllist}];
  esinglerandomgraphsdegfxd13 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers13[[i, 1]]], {i, Length@reduceddatafulllist}];
  esinglerandomerdrenmodularityvalues13 =
    Table[N@GraphAssortativity[esinglerandomgraphsdegfxd13[[i]],
      FindGraphCommunities[esinglerandomgraphsdegfxd13[[i]]],
      "Normalized" → False], {i, Length@reduceddatafulllist}];
  esinglerandomgraphscomm13 = Table[randomizinggraphmod[egraphsandnodenumbers13[[i, 1]]],
    {i, Length@reduceddatafulllist}];
  esinglerandomcommmodularityvalues13 =
    Table[N@GraphAssortativity[esinglerandomgraphscomm13[[i]],
      FindGraphCommunities[esinglerandomgraphscomm13[[i]]],
      "Normalized" → False], {i, Length@reduceddatafulllist}];
  eZscoresmodularity13 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers13[[i, 1]]], {i, Length@reduceddatafulllist}];
  ebucketnode13 = Table[egraphsandnodenumbers13[[i, 2]], {i, Length@reduceddatafulllist}]]

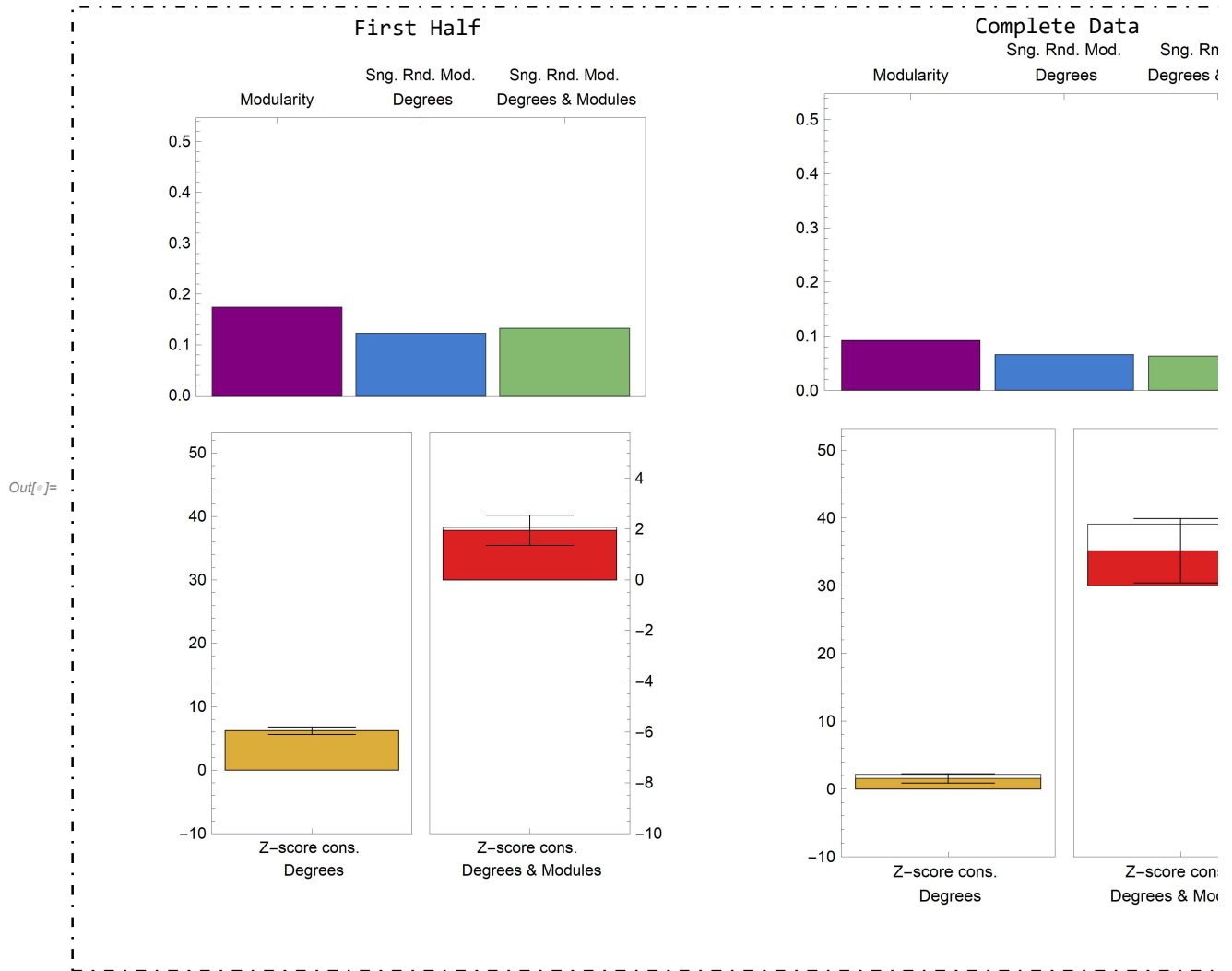
Out[ ]:= {289.067, {44, 44, 44, 44, 44, 44, 43, 44, 44, 44}}

In[ ]:= emodvalues1 = {emodularityvalues1, emodularityvalues12, emodularityvalues13};
  eZscores1 = {eZscoresmodularity1, eZscoresmodularity12, eZscoresmodularity13};
  Export["error_bar_values/" <> productionline <> "-modularity_values1.mx", emodvalues1];
  Export["error_bar_values/" <> productionline <> "-zscores1.mx", eZscores1];

In[ ]:= (*emodvalues1=Import["error_bar_values/CCM5-modularity_values1.mx"];
  eZscores1=Import["error_bar_values/CCM5-zscores1.mx"];*)

In[ ]:= set11 = plotcolumn[modularityvalues1,
  singlerandomerdrenmodularityvalues1, singlerandomcommmodularityvalues1,
  Zscoresmodularity1[[1]], Zscoresmodularity1[[2]], eZscores1[[1]]];
set12 = plotcolumn[modularityvalues12, singlerandomerdrenmodularityvalues12,
  singlerandomcommmodularityvalues12, Zscoresmodularity12[[1]],
  Zscoresmodularity12[[2]], eZscores1[[2]]];
set13 = plotcolumn[modularityvalues13, singlerandomerdrenmodularityvalues13,
  singlerandomcommmodularityvalues13, Zscoresmodularity13[[1]],
  Zscoresmodularity13[[2]], eZscores1[[3]]];
Legended[Framed[GraphicsRow[{set11, Magnify[set13, 1.03], set12}, ImageSize → 1093],
  FrameMargins → 5, FrameStyle → DotDashed], {Placed["First Half", {0.155, 0.99}],
  Placed["Complete Data", {0.505, 0.99}], Placed["Second Half", {0.86, 0.99}]}]}

```



Thickness Feature

```
In[ ]:= AbsoluteTiming[
  thicknessdataFixedstep1 = snetworkdatabinned[10, stepsizethickness, data1sthalf];
  graphsandnodenumbers2 = snetworkgraph[thicknessdataFixedstep1[[1]],
    thicknessdataFixedstep1[[2]], 2, 7, 400, Green];
  modularityvalues2 = N@GraphAssortativity[graphsandnodenumbers2[[1]],
    FindGraphCommunities[graphsandnodenumbers2[[1]], "Normalized" -> False];
  singlerandomgraphsdegfxd2 = randomizinggraphdegfxd[graphsandnodenumbers2[[1]]];
  singlerandomerdrenmodularityvalues2 = N@GraphAssortativity[singlerandomgraphsdegfxd2,
    FindGraphCommunities[singlerandomgraphsdegfxd2], "Normalized" -> False];
  singlerandomgraphscomm2 = randomizinggraphmod[graphsandnodenumbers2[[1]]];
  singlerandomcommmodularityvalues2 = N@GraphAssortativity[singlerandomgraphscomm2,
    FindGraphCommunities[singlerandomgraphscomm2], "Normalized" -> False];
  Zscoresmodularity2 = zscorefunctionfortwonullmodels[graphsandnodenumbers2[[1]]];
  bucketnode21 = graphsandnodenumbers2[[2]]]
```

Out[]= {11.2698, 28}

```
In[ ]:= AbsoluteTiming[
  thicknessdataFixedstep2 = snetworkdatabinned[10, stepsizethickness, data2ndhalf];
  graphsandnodenumbers22 = snetworkgraph[thicknessdataFixedstep2[[1]],
    thicknessdataFixedstep2[[2]], 2, 7, 400, Green];
  modularityvalues22 = N@GraphAssortativity[graphsandnodenumbers22[[1]],
    FindGraphCommunities[graphsandnodenumbers22[[1]], "Normalized" -> False];
  singlerandomgraphsdegfxd22 = randomizinggraphdegfxd[graphsandnodenumbers22[[1]]];
  singlerandomerdrenmodularityvalues22 = N@GraphAssortativity[singlerandomgraphsdegfxd22,
    FindGraphCommunities[singlerandomgraphsdegfxd22], "Normalized" -> False];
  singlerandomgraphscomm22 = randomizinggraphmod[graphsandnodenumbers22[[1]]];
  singlerandomcommmodularityvalues22 = N@GraphAssortativity[singlerandomgraphscomm22,
    FindGraphCommunities[singlerandomgraphscomm22], "Normalized" -> False];
  Zscoresmodularity22 = zscorefunctionfortwonullmodels[graphsandnodenumbers22[[1]]];
  bucketnode22 = graphsandnodenumbers22[[2]]]
```

```
Out[ ]:= {14.2695, 26}
```

```
In[ ]:= AbsoluteTiming[
  thicknessdataFixedstep3 = snetworkdatabinned[10, stepsizethickness, datafull];
  graphsandnodenumbers23 = snetworkgraph[thicknessdataFixedstep3[[1]],
    thicknessdataFixedstep3[[2]], 2, 7, 400, Green];
  modularityvalues23 = N@GraphAssortativity[graphsandnodenumbers23[[1]],
    FindGraphCommunities[graphsandnodenumbers23[[1]], "Normalized" -> False];
  singlerandomgraphsdegfxd23 = randomizinggraphdegfxd[graphsandnodenumbers23[[1]]];
  singlerandomerdrenmodularityvalues23 = N@GraphAssortativity[singlerandomgraphsdegfxd23,
    FindGraphCommunities[singlerandomgraphsdegfxd23], "Normalized" -> False];
  singlerandomgraphscomm23 = randomizinggraphmod[graphsandnodenumbers23[[1]]];
  singlerandomcommmodularityvalues23 = N@GraphAssortativity[singlerandomgraphscomm23,
    FindGraphCommunities[singlerandomgraphscomm23], "Normalized" -> False];
  Zscoresmodularity23 = zscorefunctionfortwonullmodels[graphsandnodenumbers23[[1]]];
  bucketnode23 = graphsandnodenumbers23[[2]]]
```

```
Out[ ]:= {18.2687, 28}
```

Error Bars and Charts


```

In[ ]:= AbsoluteTiming[ethicknessdataFixedstep1 =
  Table[snetworkdatabinned[10, stepsizethickness, i], {i, reduceddata1sthalflist}];
egraphsandnodenumbers2 = Table[snetworkgraph[ethicknessdataFixedstep1[[i, 1]],
  ethicknessdataFixedstep1[[i, 2]], 2, 7, 400, Green],
  {i, Length@reduceddata1sthalflist}];
emodularityvalues2 = Table[N@GraphAssortativity[egraphsandnodenumbers2[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers2[[i, 1]], "Normalized" -> False],
  {i, Length@reduceddata1sthalflist}];
esinglerandomgraphsdegfxd2 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers2[[i, 1]], {i, Length@reduceddata1sthalflist}];
esinglerandomerdrenmodularityvalues2 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd2[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd2[[i]], "Normalized" -> False],
    {i, Length@reduceddata1sthalflist}];
esinglerandomgraphscomm2 = Table[randomizinggraphmod[egraphsandnodenumbers2[[i, 1]],
  {i, Length@reduceddata1sthalflist}];
esinglerandomcommmodularityvalues2 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm2[[i]],
    FindGraphCommunities[esinglerandomgraphscomm2[[i]], "Normalized" -> False],
    {i, Length@reduceddata1sthalflist}];
eZscoresmodularity2 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers2[[i, 1]], {i, Length@reduceddata1sthalflist}];
ebucketnode21 = Table[egraphsandnodenumbers2[[i, 2]],
  {i, Length@reduceddata1sthalflist}]]

Out[ ]:= {152.888, {28, 28, 28, 28, 28, 28, 28, 28, 28, 28}}

```

```

In[ ]:= AbsoluteTiming[ethicknessdataFixedstep2 =
  Table[snetworkdataabinned[10, stepsizethickness, i], {i, reduceddata2ndhalflist}];
egraphsandnodenumbers22 = Table[snetworkgraph[ethicknessdataFixedstep2[[i, 1]],
  thicknessdataFixedstep2[[i, 2]], 2, 7, 400, Green],
  {i, Length@reduceddata2ndhalflist}];
emodularityvalues22 = Table[N@GraphAssortativity[egraphsandnodenumbers22[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers22[[i, 1]], "Normalized" -> False],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphsdegfxd22 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers22[[i, 1]], {i, Length@reduceddata2ndhalflist}];
esinglerandomerdrenmodularityvalues22 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd22[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd22[[i]], "Normalized" -> False],
    {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphscomm22 = Table[randomizinggraphmod[egraphsandnodenumbers22[[i, 1]],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomcommmodularityvalues22 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm22[[i]],
    FindGraphCommunities[esinglerandomgraphscomm22[[i]], "Normalized" -> False],
    {i, Length@reduceddata2ndhalflist}];
eZscoresmodularity22 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers22[[i, 1]], {i, Length@reduceddata2ndhalflist}];
ebucketnode22 = Table[egraphsandnodenumbers22[[i, 2]],
  {i, Length@reduceddata2ndhalflist}]]

Out[ ]:= {149.217, {26, 26, 26, 26, 26, 26, 25, 26, 25, 26}}

```

```

In[ ]:= AbsoluteTiming[ethicknessdataFixedstep3 =
  Table[snetworkdatabinned[10, stepsizethickness, i], {i, reduceddatafulllist}];
egraphsandnodenumbers23 =
  Table[snetworkgraph[ethicknessdataFixedstep3[[i, 1]], thicknessdataFixedstep3[[i, 2]],
    2, 7, 400, Green], {i, Length@reduceddatafulllist}];
emodularityvalues23 = Table[N@GraphAssortativity[egraphsandnodenumbers23[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers23[[i, 1]]],
  "Normalized" -> False], {i, Length@reduceddatafulllist}];
esinglerandomgraphsdegfxd23 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers23[[i, 1]]], {i, Length@reduceddatafulllist}];
esinglerandomerdrenmodularityvalues23 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd23[[i]],
  FindGraphCommunities[esinglerandomgraphsdegfxd23[[i]]],
  "Normalized" -> False], {i, Length@reduceddatafulllist}];
esinglerandomgraphscomm23 = Table[randomizinggraphmod[egraphsandnodenumbers23[[i, 1]]],
  {i, Length@reduceddatafulllist}];
esinglerandomcommmodularityvalues23 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm23[[i]],
  FindGraphCommunities[esinglerandomgraphscomm23[[i]]],
  "Normalized" -> False], {i, Length@reduceddatafulllist}];
eZscoresmodularity23 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers23[[i, 1]]], {i, Length@reduceddatafulllist}];
ebucketnode23 = Table[egraphsandnodenumbers23[[i, 2]], {i, Length@reduceddatafulllist}]]

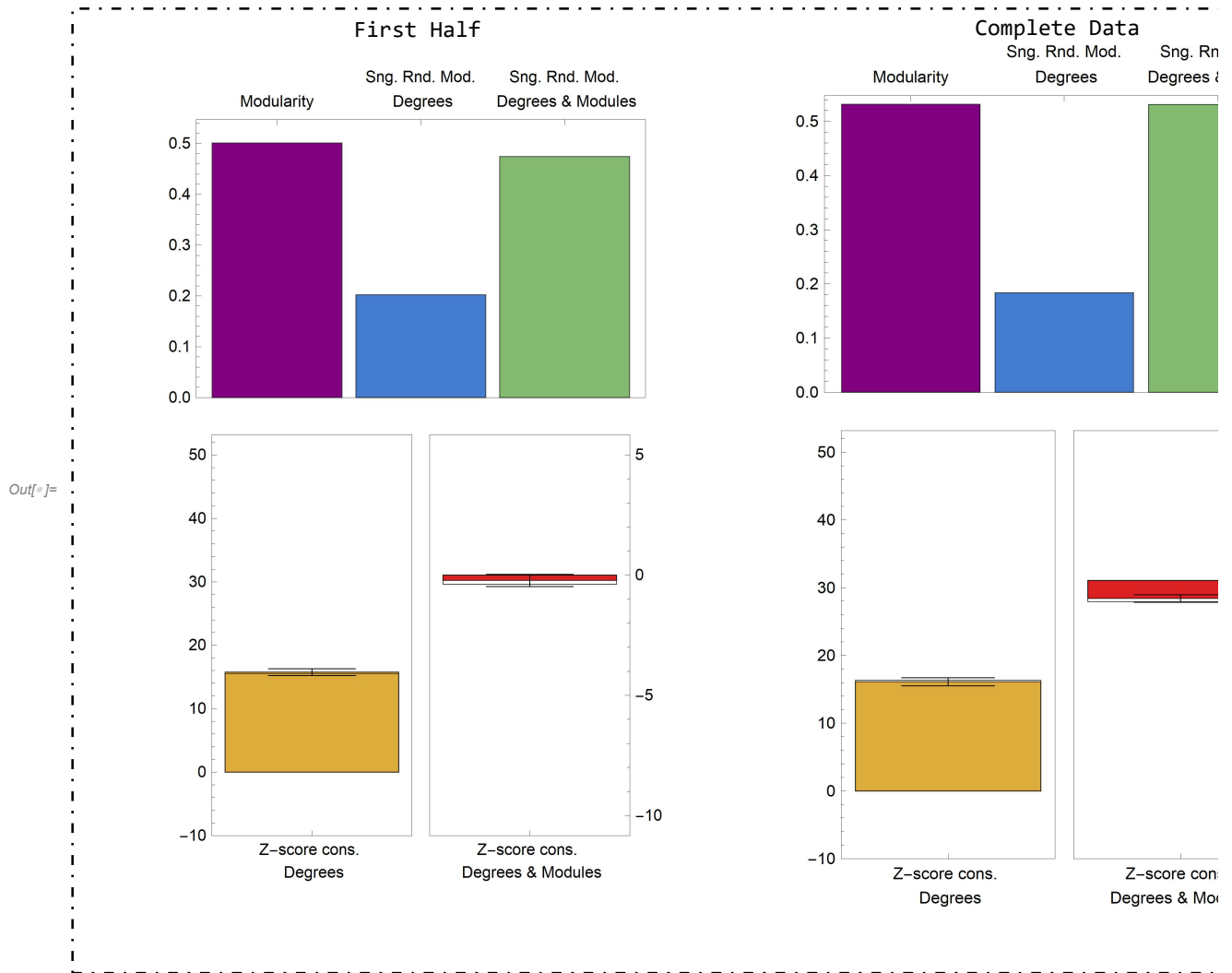
Out[ ]:= {137.541, {27, 28, 28, 28, 28, 28, 28, 28, 28, 28}}

In[ ]:= emodvalues2 = {emodularityvalues2, emodularityvalues22, emodularityvalues23};
eZscores2 = {eZscoresmodularity2, eZscoresmodularity22, eZscoresmodularity23};
Export["error_bar_values/" <> productionline <> "-modularity_values2.mx", emodvalues2];
Export["error_bar_values/" <> productionline <> "-zscores2.mx", eZscores2];

In[ ]:= (* emodvalues2=Import["error_bar_values/CCM5-modularity_values2.mx"];
eZscores2=Import["error_bar_values/CCM5-zscores2.mx"];*)

In[ ]:= set21 = plotcolumn[modularityvalues2,
  singlerandomerdrenmodularityvalues2, singlerandomcommmodularityvalues2,
  Zscoresmodularity2[[1]], Zscoresmodularity2[[2]], eZscores2[[1]]];
set22 = plotcolumn[modularityvalues22, singlerandomerdrenmodularityvalues22,
  singlerandomcommmodularityvalues22, Zscoresmodularity22[[1]],
  Zscoresmodularity22[[2]], eZscores2[[2]]];
set23 = plotcolumn[modularityvalues23, singlerandomerdrenmodularityvalues23,
  singlerandomcommmodularityvalues23, Zscoresmodularity23[[1]],
  Zscoresmodularity23[[2]], eZscores2[[3]]];
Legended[Framed[GraphicsRow[{set21, Magnify[set23, 1.03], set22}, ImageSize -> 1093],
  FrameMargins -> 5, FrameStyle -> DotDashed], {Placed["First Half", {0.155, 0.99}],
  Placed["Complete Data", {0.505, 0.99}], Placed["Second Half", {0.86, 0.99}]}]}

```



Fixed Bucket Size Networks

Width Feature

```
In[ ]:= AbsoluteTiming[
  widthdataFixedbucket1 = snetworkdatafxdbucket[9, bucketnode11, data1sthalf];
  graphsandnodenumbers3 = snetworkgraph[widthdataFixedbucket1[[1]],
    widthdataFixedbucket1[[2]], 2, 7, 400, Green];
  modularityvalues3 = N@GraphAssortativity[graphsandnodenumbers3[[1]],
    FindGraphCommunities[graphsandnodenumbers3[[1]], "Normalized" -> False];
  singlerandomgraphsdegfxd3 = randomizinggraphdegfxd[graphsandnodenumbers3[[1]]];
  singlerandomerdrenmodularityvalues3 = N@GraphAssortativity[singlerandomgraphsdegfxd3,
    FindGraphCommunities[singlerandomgraphsdegfxd3], "Normalized" -> False];
  singlerandomgraphscomm3 = randomizinggraphmod[graphsandnodenumbers3[[1]]];
  singlerandomcommmodularityvalues3 = N@GraphAssortativity[singlerandomgraphscomm3,
    FindGraphCommunities[singlerandomgraphscomm3], "Normalized" -> False];
  Zscoresmodularity3 = zscorefunctionfortwonullmodels[graphsandnodenumbers3[[1]]];]
```

```
Out[e]= {13.8327, Null}
```

```
In[e]:= bucketsize11 = widthdataFixedbucket1[ [4] ]
```

```
Out[e]= {316}
```

```
In[e]:= AbsoluteTiming[
```

```
widthdataFixedbucket2 = snetworkdatafxdbucket[9, bucketnode12, data2ndhalf];
graphsandnodenumbers32 = snetworkgraph[widthdataFixedbucket2[ [1] ],
widthdataFixedbucket2[ [2] ], 2, 7, 400, Green];
modularityvalues32 = N@GraphAssortativity[graphsandnodenumbers32[ [1] ],
FindGraphCommunities[graphsandnodenumbers32[ [1] ]], "Normalized" → False];
singlerandomgraphsdegfxd32 = randomizinggraphdegfxd[graphsandnodenumbers32[ [1] ]];
singlerandomerdrenmodularityvalues32 = N@GraphAssortativity[singlerandomgraphsdegfxd32,
FindGraphCommunities[singlerandomgraphsdegfxd32], "Normalized" → False];
singlerandomgraphscomm32 = randomizinggraphmod[graphsandnodenumbers32[ [1] ]];
singlerandomcommmodularityvalues32 = N@GraphAssortativity[singlerandomgraphscomm32,
FindGraphCommunities[singlerandomgraphscomm32], "Normalized" → False];
Zscoresmodularity32 = zscorefunctionfortwonullmodels[graphsandnodenumbers32[ [1] ]];]
```

```
Out[e]= {18.2675, Null}
```

```
In[e]:= bucketsize12 = widthdataFixedbucket2[ [4] ]
```

```
Out[e]= {309}
```

```
In[e]:= AbsoluteTiming[widthdataFixedbucket3 = snetworkdatafxdbucket[9, bucketnode13, datafull];
graphsandnodenumbers33 = snetworkgraph[
widthdataFixedbucket3[ [1] ], widthdataFixedbucket3[ [2] ], 2, 7, 400, Green];
modularityvalues33 = N@GraphAssortativity[graphsandnodenumbers33[ [1] ],
FindGraphCommunities[graphsandnodenumbers33[ [1] ]], "Normalized" → False];
singlerandomgraphsdegfxd33 = randomizinggraphdegfxd[graphsandnodenumbers33[ [1] ]];
singlerandomerdrenmodularityvalues33 = N@GraphAssortativity[singlerandomgraphsdegfxd33,
FindGraphCommunities[singlerandomgraphsdegfxd33], "Normalized" → False];
singlerandomgraphscomm33 = randomizinggraphmod[graphsandnodenumbers33[ [1] ]];
singlerandomcommmodularityvalues33 = N@GraphAssortativity[singlerandomgraphscomm33,
FindGraphCommunities[singlerandomgraphscomm33], "Normalized" → False];
Zscoresmodularity33 = zscorefunctionfortwonullmodels[graphsandnodenumbers33[ [1] ]];]
```

```
Out[e]= {20.0812, Null}
```

```
In[e]:= bucketsize13 = widthdataFixedbucket3[ [4] ]
```

```
Out[e]= {617}
```

Error Bars and Charts

```

In[ ]:= AbsoluteTiming[ewidthdataFixedbucket1 = Table[snetworkdatafxdbucket[9, i[[1]], i[[2]]],
  {i, MapThread[{#1, #2} &, {ebucketnode11, reduceddata1sthalflist}}]];
egraphsandsnodenumbers3 = Table[snetworkgraph[ewidthdataFixedbucket1[[i, 1]],
  ewidthdataFixedbucket1[[i, 2]], 2, 7, 400, Green],
  {i, Length@reduceddata1sthalflist}];
emodularityvalues3 = Table[N@GraphAssortativity[egraphsandsnodenumbers3[[i, 1]],
  FindGraphCommunities[egraphsandsnodenumbers3[[i, 1]], "Normalized" -> False],
  {i, Length@reduceddata1sthalflist}];
esinglerandomgraphsdegfxd3 = Table[randomizinggraphdegfxd[
  egraphsandsnodenumbers3[[i, 1]], {i, Length@reduceddata1sthalflist}];
esinglerandomerdrenmodularityvalues3 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd3[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd3[[i]], "Normalized" -> False],
    {i, Length@reduceddata1sthalflist}];
esinglerandomgraphscomm3 = Table[randomizinggraphmod[egraphsandsnodenumbers3[[i, 1]],
  {i, Length@reduceddata1sthalflist}];
esinglerandomcommmodularityvalues3 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm3[[i]],
    FindGraphCommunities[esinglerandomgraphscomm3[[i]], "Normalized" -> False],
    {i, Length@reduceddata1sthalflist}];
eZscoresmodularity3 = Table[zscorefunctionfortwonullmodels[
  egraphsandsnodenumbers3[[i, 1]], {i, Length@reduceddata1sthalflist}];]

```

```
Out[ ]:= {142.285, Null}
```

```

In[ ]:= AbsoluteTiming[ewidthdataFixedbucket2 = Table[snetworkdatafxdbucket[9, i[[1]], i[[2]]],
  {i, MapThread[{#1, #2} &, {ebucketnode12, reduceddata2ndhalflist}}]];
egraphsandsnodenumbers32 = Table[snetworkgraph[ewidthdataFixedbucket2[[i, 1]],
  ewidthdataFixedbucket2[[i, 2]], 2, 7, 400, Green],
  {i, Length@reduceddata2ndhalflist}];
emodularityvalues32 = Table[N@GraphAssortativity[egraphsandsnodenumbers32[[i, 1]],
  FindGraphCommunities[egraphsandsnodenumbers32[[i, 1]], "Normalized" -> False],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphsdegfxd32 = Table[randomizinggraphdegfxd[
  egraphsandsnodenumbers32[[i, 1]], {i, Length@reduceddata2ndhalflist}];
esinglerandomerdrenmodularityvalues32 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd32[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd32[[i]], "Normalized" -> False],
    {i, Length@reduceddata2ndhalflist}];
esinglerandomgraphscomm32 = Table[randomizinggraphmod[egraphsandsnodenumbers32[[i, 1]],
  {i, Length@reduceddata2ndhalflist}];
esinglerandomcommmodularityvalues32 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm32[[i]],
    FindGraphCommunities[esinglerandomgraphscomm32[[i]], "Normalized" -> False],
    {i, Length@reduceddata2ndhalflist}];
eZscoresmodularity32 = Table[zscorefunctionfortwonullmodels[
  egraphsandsnodenumbers32[[i, 1]], {i, Length@reduceddata2ndhalflist}];]

```

```
Out[ ]:= {267.815, Null}
```

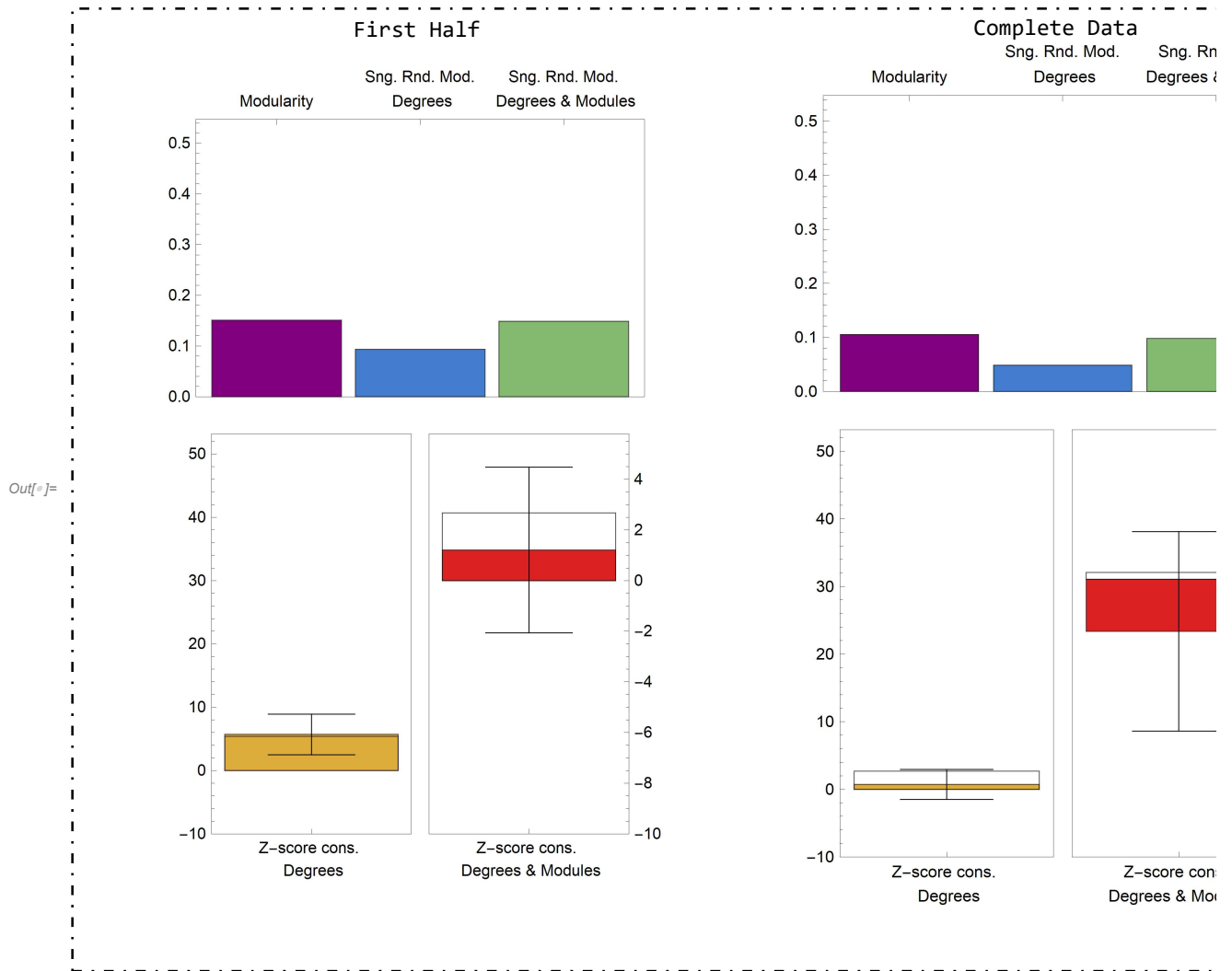
```
In[ ]:= AbsoluteTiming[ewidthdataFixedbucket3 = Table[snetworkdatafxdbucket[9, i[[1]], i[[2]]],
  {i, MapThread[{#1, #2} &, {ebucketnode13, reduceddatafulllist}}]];
egraphsandnodenumbers33 = Table[snetworkgraph[ewidthdataFixedbucket3[[i, 1]],
  ewidthdataFixedbucket3[[i, 2]], 2, 7, 400, Green], {i, Length@reduceddatafulllist}];
emodularityvalues33 = Table[N@GraphAssortativity[egraphsandnodenumbers33[[i, 1]],
  FindGraphCommunities[egraphsandnodenumbers33[[i, 1]],
    "Normalized" -> False], {i, Length@reduceddatafulllist}];
esinglerandomgraphsdegfxd33 = Table[randomizinggraphdegfxd[
  egraphsandnodenumbers33[[i, 1]], {i, Length@reduceddatafulllist}];
esinglerandomerdrenmodularityvalues33 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd33[[i]],
    FindGraphCommunities[esinglerandomgraphsdegfxd33[[i]],
      "Normalized" -> False], {i, Length@reduceddatafulllist}];
esinglerandomgraphscomm33 = Table[randomizinggraphmod[egraphsandnodenumbers33[[i, 1]],
  {i, Length@reduceddatafulllist}];
esinglerandomcommmodularityvalues33 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm33[[i]],
    FindGraphCommunities[esinglerandomgraphscomm33[[i]],
      "Normalized" -> False], {i, Length@reduceddatafulllist}];
eZscoresmodularity33 = Table[zscorefunctionfortwonullmodels[
  egraphsandnodenumbers33[[i, 1]], {i, Length@reduceddatafulllist}];]
```

```
Out[ ]:= {368.134, Null}
```

```
In[ ]:= emodvalues3 = {emodularityvalues3, emodularityvalues32, emodularityvalues33};
eZscores3 = {eZscoresmodularity3, eZscoresmodularity32, eZscoresmodularity33};
Export["error_bar_values/" <> productionline <> "-modularity_values3.mx", emodvalues3];
Export["error_bar_values/" <> productionline <> "-zscores3.mx", eZscores3];
```

```
In[ ]:= (* emodvalues3=Import["error_bar_values/CCM5-modularity_values3.mx"];
eZscores3=Import["error_bar_values/CCM5-zscores3.mx"]; *)
```

```
In[ ]:= set31 = plotcolumn[modularityvalues3,
  singlerandomerdrenmodularityvalues3, singlerandomcommmodularityvalues3,
  Zscoresmodularity3[[1]], Zscoresmodularity3[[2]], eZscores3[[1]]];
set32 = plotcolumn[modularityvalues32, singlerandomerdrenmodularityvalues32,
  singlerandomcommmodularityvalues32, Zscoresmodularity32[[1]],
  Zscoresmodularity32[[2]], eZscores3[[2]]];
set33 = plotcolumn[modularityvalues33, singlerandomerdrenmodularityvalues33,
  singlerandomcommmodularityvalues33, Zscoresmodularity33[[1]],
  Zscoresmodularity33[[2]], eZscores3[[3]]];
Legended[Framed[GraphicsRow[{set31, Magnify[set33, 1.03], set32}, ImageSize -> 1093],
  FrameMargins -> 5, FrameStyle -> DotDashed], {Placed["First Half", {0.155, 0.99}],
  Placed["Complete Data", {0.505, 0.99}], Placed["Second Half", {0.86, 0.99}]}
```



Thickness Feature

```

In[ ]:= AbsoluteTiming[
  thicknessdataFixedbucket1 = snetworkdatafxdbucket[10, bucketnode21, data1sthalf];
  graphsandnodenumbers4 = snetworkgraph[thicknessdataFixedbucket1[[1]],
    thicknessdataFixedbucket1[[2]], 2, 7, 400, Green];
  modularityvalues4 = N@GraphAssortativity[graphsandnodenumbers4[[1]],
    FindGraphCommunities[graphsandnodenumbers4[[1]], "Normalized" -> False];
  singlerandomgraphsdegfxd4 = randomizinggraphdegfxd[graphsandnodenumbers4[[1]]];
  singlerandomerdrenmodularityvalues4 = N@GraphAssortativity[singlerandomgraphsdegfxd4,
    FindGraphCommunities[singlerandomgraphsdegfxd4], "Normalized" -> False];
  singlerandomgraphscomm4 = randomizinggraphmod[graphsandnodenumbers4[[1]]];
  singlerandomcommmodularityvalues4 = N@GraphAssortativity[singlerandomgraphscomm4,
    FindGraphCommunities[singlerandomgraphscomm4], "Normalized" -> False];
  Zscoresmodularity4 = zscorefunctionfortwonullmodels[graphsandnodenumbers4[[1]]];

Out[ ]:= {29.9691, Null}

```



```
In[ ]:= bucketsize21 = thicknessdataFixedbucket1[[4]]
```

```
Out[ ]:= {485}
```

```
In[ ]:= AbsoluteTiming[
```

```
  thicknessdataFixedbucket2 = snetworkdatafxdbucket[10, bucketnode22, data2ndhalf];
  graphsandnodenumbers42 = snetworkgraph[thicknessdataFixedbucket2[[1]],
    thicknessdataFixedbucket2[[2]], 2, 7, 400, Green];
  modularityvalues42 = N@GraphAssortativity[graphsandnodenumbers42[[1]],
    FindGraphCommunities[graphsandnodenumbers42[[1]]], "Normalized" -> False];
  singlerandomgraphsdegfxd42 = randomizinggraphdegfxd[graphsandnodenumbers42[[1]]];
  singlerandomerdrenmodularityvalues42 = N@GraphAssortativity[singlerandomgraphsdegfxd42,
    FindGraphCommunities[singlerandomgraphsdegfxd42], "Normalized" -> False];
  singlerandomgraphscomm42 = randomizinggraphmod[graphsandnodenumbers42[[1]]];
  singlerandomcommmodularityvalues42 = N@GraphAssortativity[singlerandomgraphscomm42,
    FindGraphCommunities[singlerandomgraphscomm42], "Normalized" -> False];
  Zscoresmodularity42 = zscorefunctionfortwonullmodels[graphsandnodenumbers42[[1]]];]
```

```
Out[ ]:= {28.6945, Null}
```

```
In[ ]:= bucketsize22 = thicknessdataFixedbucket2[[4]]
```

```
Out[ ]:= {523}
```

```
In[ ]:= AbsoluteTiming[
```

```
  thicknessdataFixedbucket3 = snetworkdatafxdbucket[10, bucketnode23, datafull];
  graphsandnodenumbers43 = snetworkgraph[thicknessdataFixedbucket3[[1]],
    thicknessdataFixedbucket3[[2]], 2, 7, 400, Green];
  modularityvalues43 = N@GraphAssortativity[graphsandnodenumbers43[[1]],
    FindGraphCommunities[graphsandnodenumbers43[[1]]], "Normalized" -> False];
  singlerandomgraphsdegfxd43 = randomizinggraphdegfxd[graphsandnodenumbers43[[1]]];
  singlerandomerdrenmodularityvalues43 = N@GraphAssortativity[singlerandomgraphsdegfxd43,
    FindGraphCommunities[singlerandomgraphsdegfxd43], "Normalized" -> False];
  singlerandomgraphscomm43 = randomizinggraphmod[graphsandnodenumbers43[[1]]];
  singlerandomcommmodularityvalues43 = N@GraphAssortativity[singlerandomgraphscomm43,
    FindGraphCommunities[singlerandomgraphscomm43], "Normalized" -> False];
  Zscoresmodularity43 = zscorefunctionfortwonullmodels[graphsandnodenumbers43[[1]]];]
```

```
Out[ ]:= {33.0375, Null}
```

```
In[ ]:= bucketsize23 = thicknessdataFixedbucket3[[4]]
```

```
Out[ ]:= {970}
```

Error Bars and Charts

```

In[ ]:= AbsoluteTiming[
  ethicknessdataFixedbucket1 = Table[snetworkdatafxdbucket[10, i[[1]], i[[2]]],
    {i, MapThread[{#1, #2} &, {ebucketnode21, reduceddata1sthalflist}}];
  egraphsandnodenumbers4 = Table[snetworkgraph[ethicknessdataFixedbucket1[[i, 1]],
    ethicknessdataFixedbucket1[[i, 2]], 2, 7, 400, Green],
    {i, Length@reduceddata1sthalflist}];
  emodularityvalues4 = Table[N@GraphAssortativity[egraphsandnodenumbers4[[i, 1]],
    FindGraphCommunities[egraphsandnodenumbers4[[i, 1]], "Normalized" -> False],
    {i, Length@reduceddata1sthalflist}];
  esinglerandomgraphsdegfxd4 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers4[[i, 1]], {i, Length@reduceddata1sthalflist}];
  esinglerandomerdrenmodularityvalues4 =
    Table[N@GraphAssortativity[esinglerandomgraphsdegfxd4[[i]],
      FindGraphCommunities[esinglerandomgraphsdegfxd4[[i]], "Normalized" -> False],
      {i, Length@reduceddata1sthalflist}];
  esinglerandomgraphscomm4 = Table[randomizinggraphmod[egraphsandnodenumbers4[[i, 1]],
    {i, Length@reduceddata1sthalflist}];
  esinglerandomcommmodularityvalues4 =
    Table[N@GraphAssortativity[esinglerandomgraphscomm4[[i]],
      FindGraphCommunities[esinglerandomgraphscomm4[[i]], "Normalized" -> False],
      {i, Length@reduceddata1sthalflist}];
  eZscoresmodularity4 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers4[[i, 1]], {i, Length@reduceddata1sthalflist}];]

Out[ ]:= {204.245, Null}

```

```

In[ ]:= AbsoluteTiming[
  ethicknessdataFixedbucket2 = Table[snetworkdatafxdbucket[10, i[[1]], i[[2]]],
    {i, MapThread[{#1, #2} &, {ebucketnode22, reduceddata2ndhalflist}}];
  egraphsandnodenumbers42 = Table[snetworkgraph[ethicknessdataFixedbucket2[[i, 1]],
    ethicknessdataFixedbucket2[[i, 2]], 2, 7, 400, Green],
    {i, Length@reduceddata2ndhalflist}];
  emodularityvalues42 = Table[N@GraphAssortativity[egraphsandnodenumbers42[[i, 1]],
    FindGraphCommunities[egraphsandnodenumbers42[[i, 1]], "Normalized" -> False],
    {i, Length@reduceddata2ndhalflist}];
  esinglerandomgraphsdegfxd42 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers42[[i, 1]], {i, Length@reduceddata2ndhalflist}];
  esinglerandomerdrenmodularityvalues42 =
    Table[N@GraphAssortativity[esinglerandomgraphsdegfxd42[[i]],
      FindGraphCommunities[esinglerandomgraphsdegfxd42[[i]], "Normalized" -> False],
      {i, Length@reduceddata2ndhalflist}];
  esinglerandomgraphscomm42 = Table[randomizinggraphmod[egraphsandnodenumbers42[[i, 1]],
    {i, Length@reduceddata2ndhalflist}];
  esinglerandomcommmodularityvalues42 =
    Table[N@GraphAssortativity[esinglerandomgraphscomm42[[i]],
      FindGraphCommunities[esinglerandomgraphscomm42[[i]], "Normalized" -> False],
      {i, Length@reduceddata2ndhalflist}];
  eZscoresmodularity42 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers42[[i, 1]], {i, Length@reduceddata2ndhalflist}];]

Out[ ]:= {250.325, Null}

```

```

In[ ]:= AbsoluteTiming[
  ethicknessdataFixedbucket3 = Table[snetworkdatafxdbucket[10, i[[1]], i[[2]]],
    {i, MapThread[{#1, #2} &, {ebucketnode23, reduceddatafulllist}}];
  egraphsandnodenumbers43 = Table[snetworkgraph[ethicknessdataFixedbucket3[[i, 1]],
    ethicknessdataFixedbucket3[[i, 2]], 2, 7, 400, Green],
    {i, Length@reduceddatafulllist}];
  emodularityvalues43 = Table[N@GraphAssortativity[egraphsandnodenumbers43[[i, 1]],
    FindGraphCommunities[egraphsandnodenumbers43[[i, 1]]],
    "Normalized" → False], {i, Length@reduceddatafulllist}];
  esinglerandomgraphsdegfxd43 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers43[[i, 1]]], {i, Length@reduceddatafulllist}];
  esinglerandomerdrenmodularityvalues43 =
    Table[N@GraphAssortativity[esinglerandomgraphsdegfxd43[[i]],
      FindGraphCommunities[esinglerandomgraphsdegfxd43[[i]]],
      "Normalized" → False], {i, Length@reduceddatafulllist}];
  esinglerandomgraphscomm43 = Table[randomizinggraphmod[egraphsandnodenumbers43[[i, 1]]],
    {i, Length@reduceddatafulllist}];
  esinglerandomcommmodularityvalues43 =
    Table[N@GraphAssortativity[esinglerandomgraphscomm43[[i]],
      FindGraphCommunities[esinglerandomgraphscomm43[[i]]],
      "Normalized" → False], {i, Length@reduceddatafulllist}];
  eZscoresmodularity43 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers43[[i, 1]]], {i, Length@reduceddatafulllist}];

Out[ ]:= {301.612, Null}

In[ ]:= emodvalues4 = {emodularityvalues4, emodularityvalues42, emodularityvalues43};
eZscores4 = {eZscoresmodularity4, eZscoresmodularity42, eZscoresmodularity43};
Export["error_bar_values/" <> productionline <> "-modularity_values4.mx", emodvalues4];
Export["error_bar_values/" <> productionline <> "-zscores4.mx", eZscores4];

In[ ]:= (* emodvalues4=Import["error_bar_values/CCM5-modularity_values4.mx"];
eZscores4=Import["error_bar_values/CCM5-zscores4.mx"]; *)

In[ ]:= set41 = plotcolumn[modularityvalues4,
  singlerandomerdrenmodularityvalues4, singlerandomcommmodularityvalues4,
  Zscoresmodularity4[[1]], Zscoresmodularity4[[2]], eZscores4[[1]]];
set42 = plotcolumn[modularityvalues42, singlerandomerdrenmodularityvalues42,
  singlerandomcommmodularityvalues42, Zscoresmodularity42[[1]],
  Zscoresmodularity42[[2]], eZscores4[[2]]];
set43 = plotcolumn[modularityvalues43, singlerandomerdrenmodularityvalues43,
  singlerandomcommmodularityvalues43, Zscoresmodularity43[[1]],
  Zscoresmodularity43[[2]], eZscores4[[3]]];
Legended[Framed[GraphicsRow[{set41, Magnify[set43, 1.03], set42}, ImageSize → 1093],
  FrameMargins → 5, FrameStyle → DotDashed], {Placed["First Half", {0.155, 0.99}],
  Placed["Complete Data", {0.505, 0.99}], Placed["Second Half", {0.86, 0.99}]}]

```

Out[*i*]=

