Data Import

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

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

In[ ]:= datafull = Import["../data/cgl_manipulated_27147_rev1.csv"];
        productionline = "CGL5";
        stepsizewidth = 11;
        stepsizethickness = 0.05;
```

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[ ]:=
```
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[ ]= {36.758, 80}

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[ ]= {46.8937, 84}

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[ ]= {55.115, 86}
```

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[ ]=
```
{471.883, {80, 80, 80, 79, 80, 80, 79, 80, 79, 80}}
```

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[ ]=
```
{549.872, {83, 84, 83, 83, 84, 80, 84, 83, 84, 83}}
```

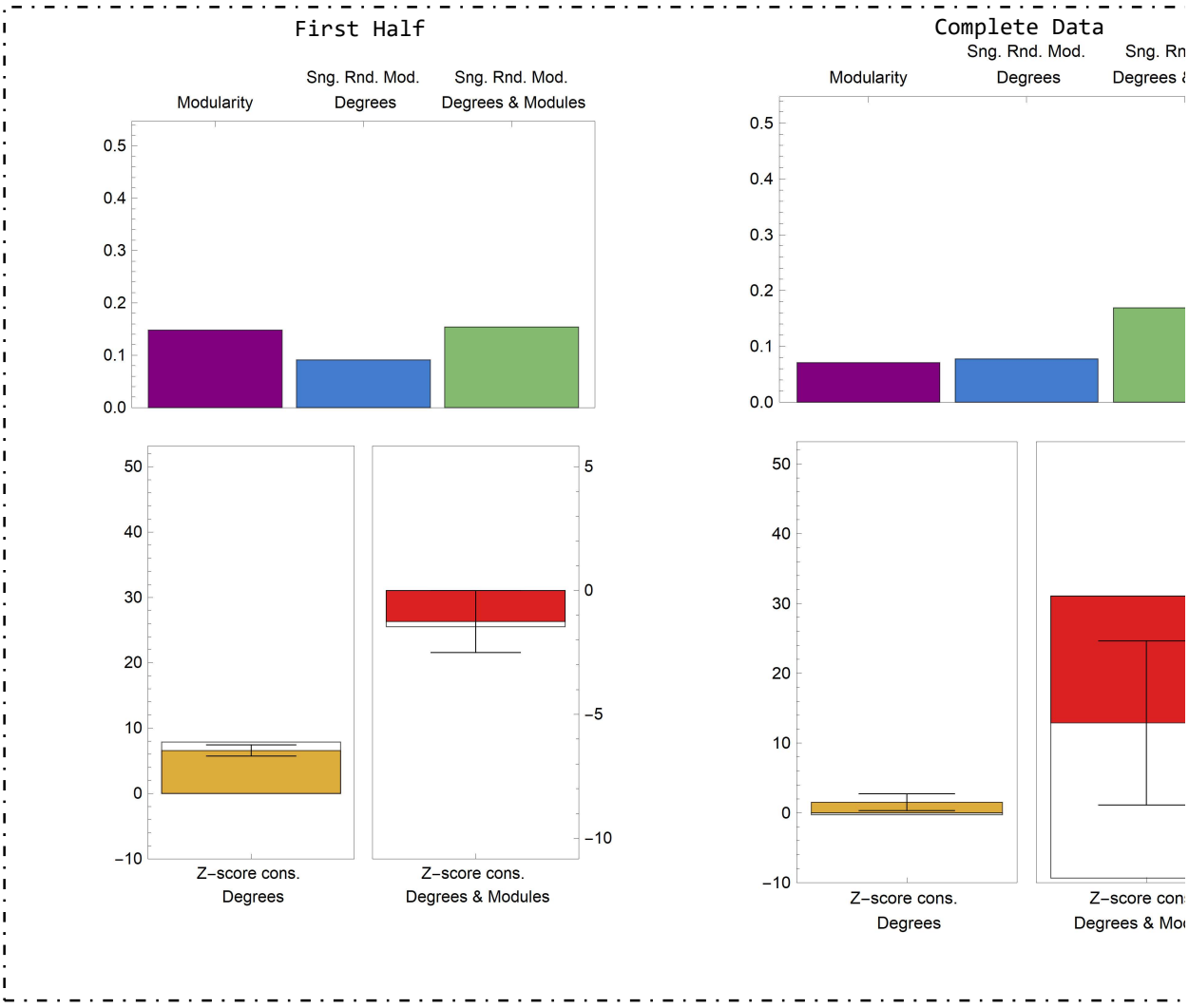
```
In[ ]:= AbsoluteTiming[ewidthdataFixedstep3 =
          Table[snetworkdatabinned[9, stepsizewidth, i], {i, reduceddatafulllist}];
        egraphsandnodenumbers13 = Table[snetworkgraph[ewidthdataFixedstep3[[i, 1]],
           ewidthdataFixedstep3[[i, 2]], 2, 7, 400, Green], {i, Length@reduceddatafulllist}];
        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[ ]= {738.357, {86, 85, 86, 86, 86, 86, 84, 85, 86, 85}}

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}]}]
```

Out[ ]=



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[ ]= {46.5545, 53}

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[ ]= {41.2535, 48}

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[ ]= {59.7857, 54}

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[•]=
```
{358.439, {52, 52, 52, 52, 53, 53, 52, 53, 52, 51}}
```

In[ ]:=
```
AbsoluteTiming[ethicknessdataFixedstep2 =
  Table[snetworkdatabinned[10, stepsizethickness, i], {i, reduceddata2ndhalflist}];
 egraphsandnodenumbers22 = Table[snetworkgraph[ethicknessdataFixedstep2[[i, 1]],
    ethicknessdataFixedstep2[[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[ ]= {375.38, {46, 48, 48, 47, 48, 48, 48, 47, 48, 48}}

In[ ]:=
```
AbsoluteTiming[ethicknessdataFixedstep3 =
  Table[snetworkdatabinned[10, stepsizethickness, i], {i, reduceddatafulllist}];
 egraphsandnodenumbers23 =
  Table[snetworkgraph[ethicknessdataFixedstep3[[i, 1]], ethicknessdataFixedstep3[[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}]]
```

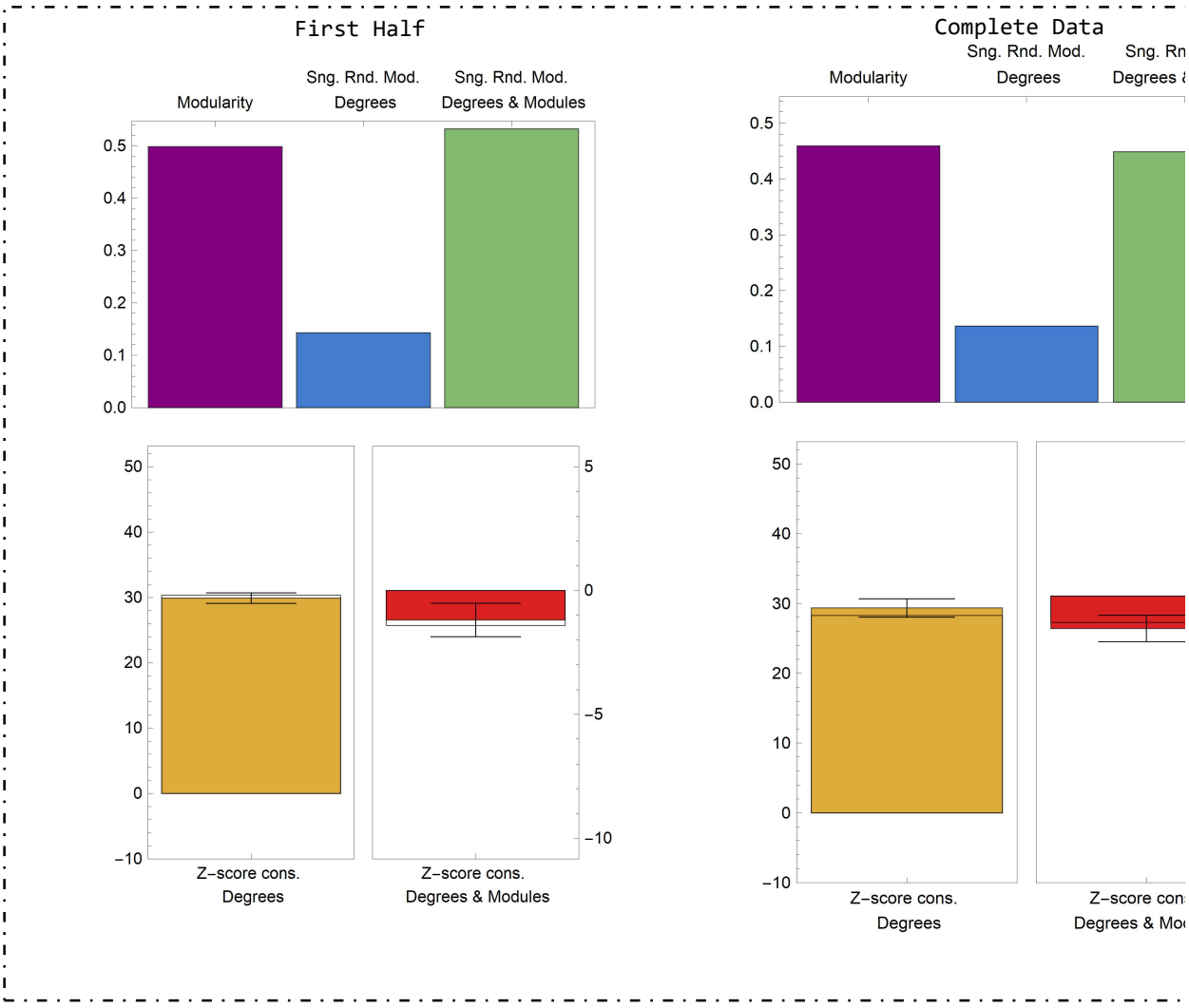
Out[ ]= {322.009, {54, 54, 54, 54, 54, 54, 53, 54, 54, 54}}

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}]}]
```

Out[ ]=



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[ ]= {30.7015, Null}

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

Out[ ]= {170}

In[ ]:=
```
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[ ]= {33.8302, Null}

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

Out[ ]= {162}

In[ ]:=
```
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[ ]= {42.7652, Null}

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

Out[ ]= {316}

Error Bars and Charts

In[ ]:=
```
AbsoluteTiming[ewidthdataFixedbucket1 = Table[snetworkdatafxdbucket[9, i[[1]], i[[2]]],
   {i, MapThread[{#1, #2} &, {ebucketnode11, reduceddata1sthalflist}]}];
 egraphsandnodenumbers3 = Table[snetworkgraph[ewidthdataFixedbucket1[[i, 1]],
    ewidthdataFixedbucket1[[i, 2]], 2, 7, 400, Green],
   {i, Length@reduceddata1sthalflist}];
 emodularityvalues3 = Table[N@GraphAssortativity[egraphsandnodenumbers3[[i, 1]],
     FindGraphCommunities[egraphsandnodenumbers3[[i, 1]]], "Normalized" → False],
   {i, Length@reduceddata1sthalflist}];
 esinglerandomgraphsdegfxd3 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers3[[i, 1]]], {i, Length@reduceddata1sthalflist}];
 esinglerandomerdrenmodularityvalues3 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd3[[i]],
     FindGraphCommunities[esinglerandomgraphsdegfxd3[[i]]], "Normalized" -> False],
   {i, Length@reduceddata1sthalflist}];
 esinglerandomgraphscomm3 = Table[randomizinggraphmod[egraphsandnodenumbers3[[i, 1]]],
   {i, Length@reduceddata1sthalflist}];
 esinglerandomcommmodularityvalues3 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm3[[i]],
     FindGraphCommunities[esinglerandomgraphscomm3[[i]]], "Normalized" -> False],
   {i, Length@reduceddata1sthalflist}];
 eZscoresmodularity3 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers3[[i, 1]]], {i, Length@reduceddata1sthalflist}];]
```

Out[ ]= {367.81, Null}

In[ ]:=
```
AbsoluteTiming[ewidthdataFixedbucket2 = Table[snetworkdatafxdbucket[9, i[[1]], i[[2]]],
   {i, MapThread[{#1, #2} &, {ebucketnode12, reduceddata2ndhalflist}]}];
 egraphsandnodenumbers32 = Table[snetworkgraph[ewidthdataFixedbucket2[[i, 1]],
    ewidthdataFixedbucket2[[i, 2]], 2, 7, 400, Green],
   {i, Length@reduceddata2ndhalflist}];
 emodularityvalues32 = Table[N@GraphAssortativity[egraphsandnodenumbers32[[i, 1]],
     FindGraphCommunities[egraphsandnodenumbers32[[i, 1]]], "Normalized" → False],
   {i, Length@reduceddata2ndhalflist}];
 esinglerandomgraphsdegfxd32 = Table[randomizinggraphdegfxd[
    egraphsandnodenumbers32[[i, 1]]], {i, Length@reduceddata2ndhalflist}];
 esinglerandomerdrenmodularityvalues32 =
  Table[N@GraphAssortativity[esinglerandomgraphsdegfxd32[[i]],
     FindGraphCommunities[esinglerandomgraphsdegfxd32[[i]]], "Normalized" -> False],
   {i, Length@reduceddata2ndhalflist}];
 esinglerandomgraphscomm32 = Table[randomizinggraphmod[egraphsandnodenumbers32[[i, 1]]],
   {i, Length@reduceddata2ndhalflist}];
 esinglerandomcommmodularityvalues32 =
  Table[N@GraphAssortativity[esinglerandomgraphscomm32[[i]],
     FindGraphCommunities[esinglerandomgraphscomm32[[i]]], "Normalized" -> False],
   {i, Length@reduceddata2ndhalflist}];
 eZscoresmodularity32 = Table[zscorefunctionfortwonullmodels[
    egraphsandnodenumbers32[[i, 1]]], {i, Length@reduceddata2ndhalflist}];]
```

Out[•]= {561.721, 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}];]
```

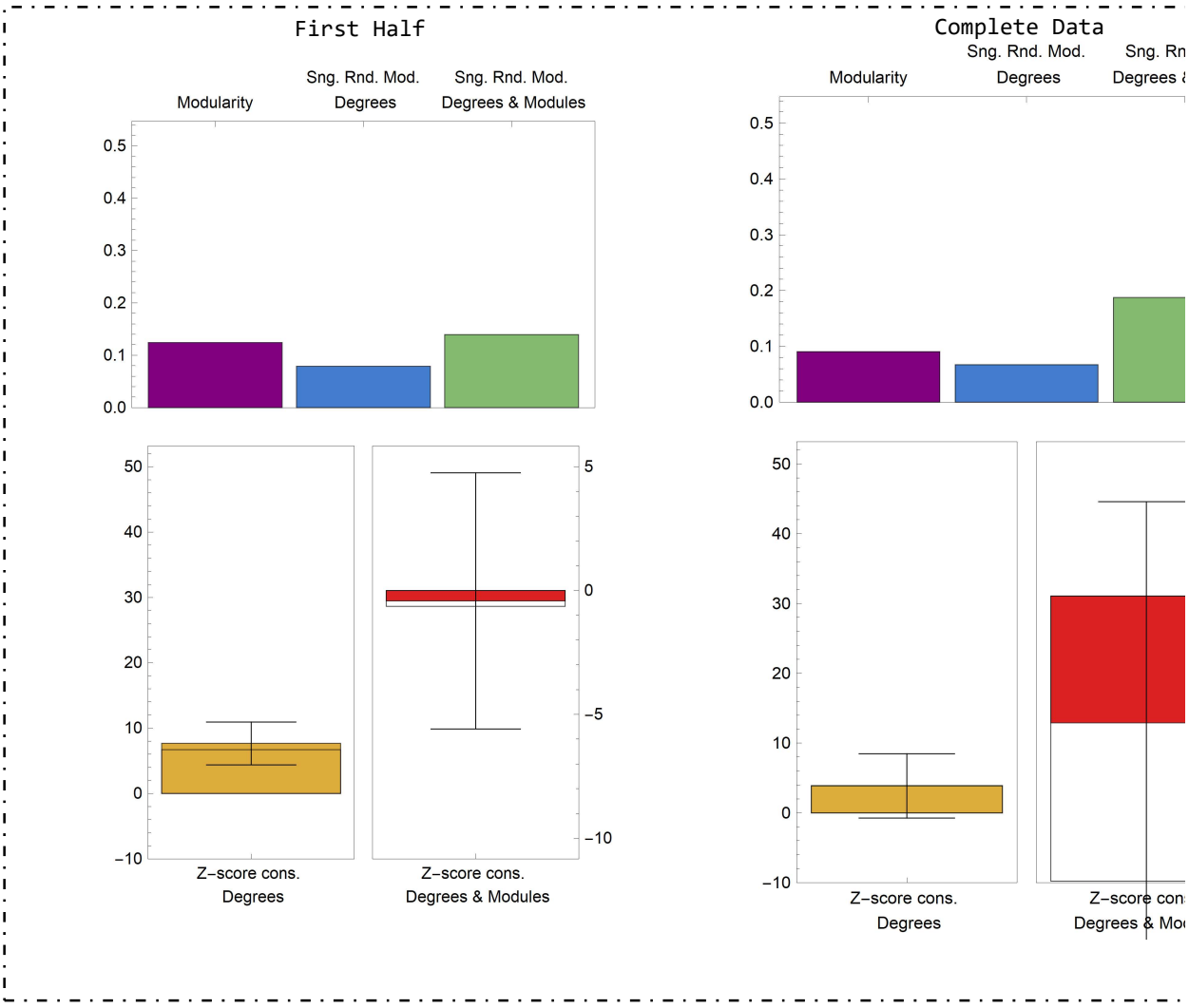
Out[•]= {522.669, Null}

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}]}]
```

Out[•]=



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[•]= {18.986, Null}

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

```
Out[ ]= {257}
```

```
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[ ]= {11.4602, Null}
```

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

```
Out[ ]= {283}
```

```
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[ ]= {21.0062, Null}
```

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

```
Out[ ]= {503}
```

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[ ]= {408.034, 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[ ]= {228.985, Null}

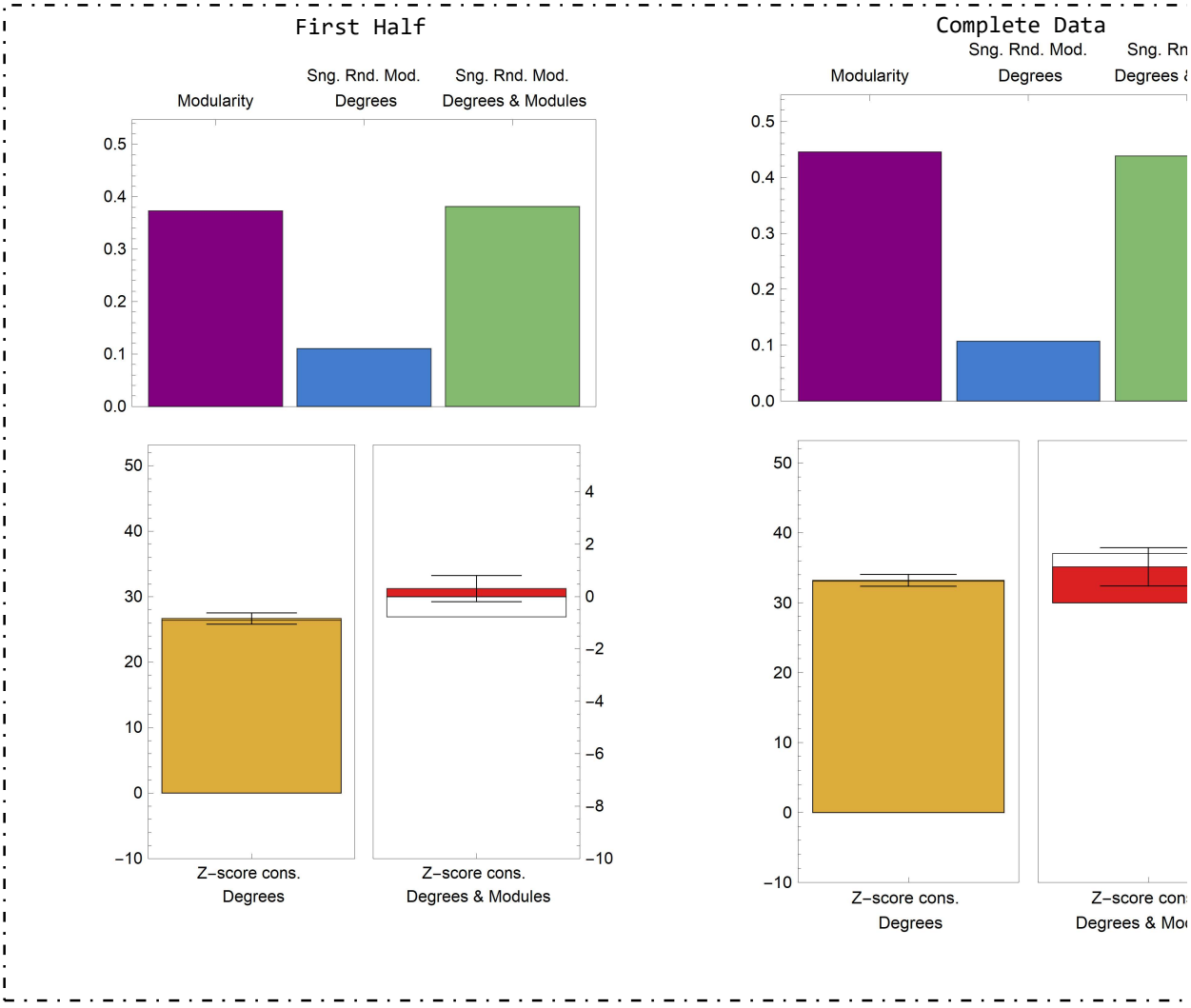
```
In[ ]:= AbsoluteTiming[
 ethicknessdataFixedbucket3 = Table[snetworkdatafxdbucket[10, i[[1]], i[[2]]],
   {i, MapThread[{#1, #2} &, {ebucketnode23, reduceddatafulllist}]}];
 egraphsandnodenumbers43 = Table[snetworkgraph[ethicknessdataFixedbucket3[[i, 1]],
    ethicknessdataFixedbucket3[[i, 2]], 2, 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[ ]= {416.355, 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[•]=


First Half
Modularity
Sng. Rnd. Mod. Degrees
Sng. Rnd. Mod. Degrees & Modules
0.5
0.4
0.3
0.2
0.1
0.0
50
40
30
20
10
0
−10
4
2
0
−2
−4
−6
−8
−10
Z−score cons. Degrees
Z−score cons. Degrees & Modules
Complete Data
Modularity
Sng. Rnd. Mod. Degrees
Sng. Rn
Degrees &
Z−score cons. Degrees
Z−score con
Degrees & Mo