In[69]:=

```
<<"/Users/ethan/Desktop/WSS2017/saved_data/compData.mx"
<<"/Users/ethan/Desktop/WSS2017/saved_data/editInfo.mx"
<<"/Users/ethan/Desktop/WSS2017/saved_data/editDatesGraphs.mx"
```

Analyzing Computational Articles on Wikipedia

Goal

This project is designed to collect as much information on a specific set of Wikipedia articles as possible. For our set, we will look solely at articles that fall under the category of “Computational _” where “_” represents some field of study.

Gathering the Data

First, we need to generate a list of titles that fall into this Computational category.

In[4]:=

```
searchlink = "https://en.wikipedia.org/w/index.php?title=Special:Search&limit=500&offset=
xmlResults = Import[searchlink, "XMLObject"];
articles = Union[Flatten[Cases[xmlResults, XMLElement[_, {_, _,
    "title" → str_String/;
        ((StringMatchQ[str, StartOfString ~~"Computational"~~__])
            &&!(StringContainsQ[str, "Journal", IgnoreCase→True])),_},_]→{str}, Infinity]
```

The URL for the search was generated by using an Internet browser to search for the 500 top search results of “Computational”. We will then import this as an “XMLObject” where we extract just the titles of the search results. We will filter out any articles that don’t begin with “Computational” as well as articles that contain the substring “Journal” (not case sensitive). This provides us with a list of practically every Computational _ article on Wikipedia. Now we need the data.

In[7]:=

```
TitleToInfo[articleTitle_String]:=
    AssociationMap[WikipediaData[articleTitle, #]&,
        {"ArticlePlaintext", "ExternalLinks", "ArticleContributors", "PageID",
            "SummaryPlaintext", "LanguagesList", "LinksList", "BacklinksList"}];
```

This function takes a title and adds it to an association where its value is another association with the listed fields.

```
compData = AssociationMap[TitleToInfo, articles];
```

This is a good thing to DumpSave so that excess queries can be avoided.

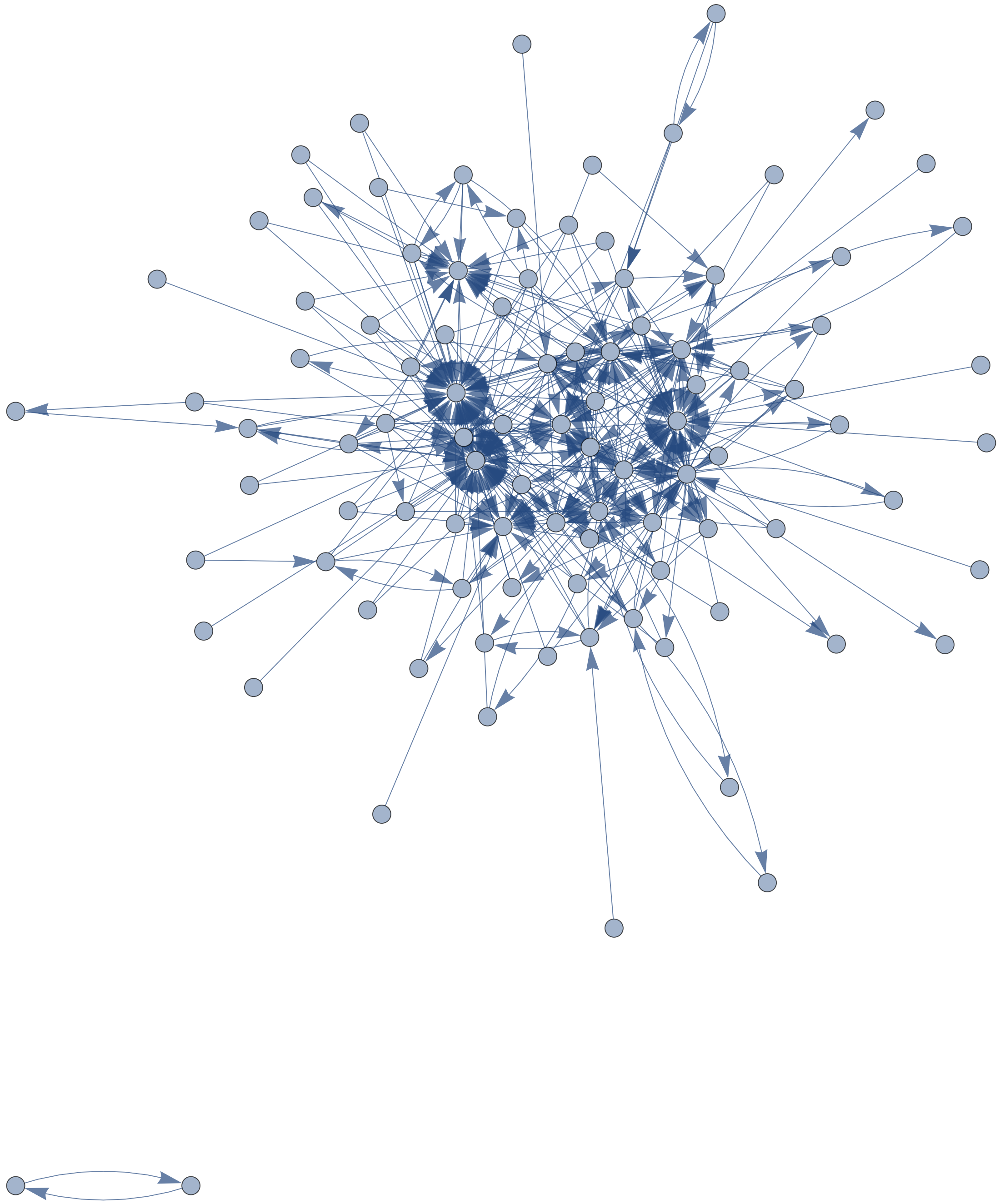
Link Analysis

We will now take our list of articles and make an association where each one is a key with its corresponding information. From here, we will look at link analysis.

In[8]:=

```
edgeSet = Flatten@Map[Thread, Normal@compData[[;;, "LinksList"]]];
theGraph = Graph[edgeSet];
verticesToKeep = Union[
    Keys@Select[AssociationThread[VertexList[theGraph],
    VertexInDegree[theGraph]], # ≥ 20 &
    ], Keys@compData];
filteredEdges = Select[Normal@edgeSet, And[
    MemberQ[verticesToKeep, #[[1]]], MemberQ[verticesToKeep, #[[2]]]
    ] &];
Graph[filteredEdges, VertexLabels → Placed[Automatic, Tooltip]]
```

Out[12]=



This will create a graph where an edge is defined as one article pointing to one other article that it links to. By changing the inequality on VertexInDegree, we can filter out articles that are not cited as frequently. By changing VertexInDegree to VertexOutDegree and making the inequality >= 1, we will generate a graph where vertices are just those articles found in compData as there is no link data for any articles referenced outside of this list. A list containing edges for just references between articles within our dataset can be found from:

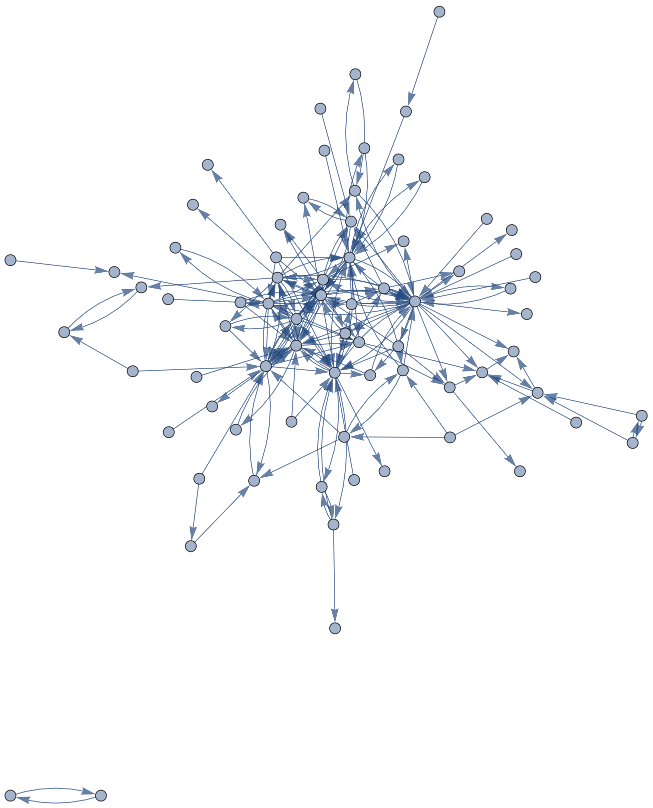
In[13]:=

```
compOnlyEdges = Flatten@Map[Thread, Table[Map[Thread, articles[[i]] → Intersection[Keys[c
    compData[[i]][["LinksList"]]]], {i, 1, 100}]];
```

In[14]:=

```
Graph[compOnlyEdges, VertexLabels → Placed[Automatic, Tooltip]]
```

Out[14]=

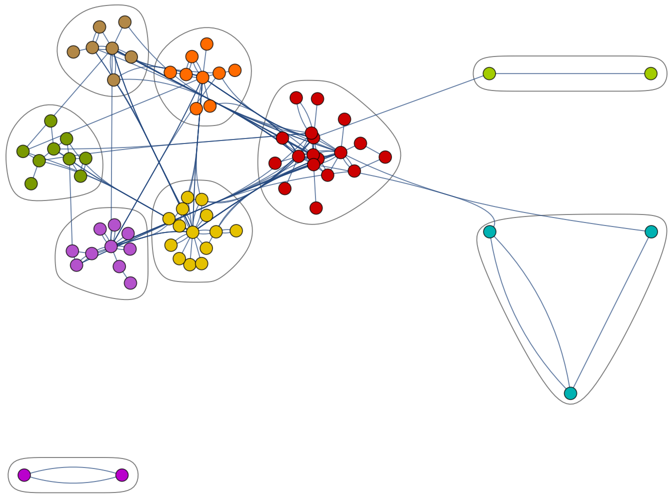


We can see how these articles relate with CommunityGraphPlot.

In[15]:=

```
CommunityGraphPlot[compOnlyEdges, VertexLabels → Placed[Automatic, Tooltip], Method → "Hi
```

Out[15]=



It’s important to note that this contains just 74 of the 100 articles in our set. That is because the other 26 articles neither cite nor are cited by any of the other articles in the set. We can see this from:

```
In[16]:=  Length@Flatten@FindGraphCommunities[compOnlyEdges]
```

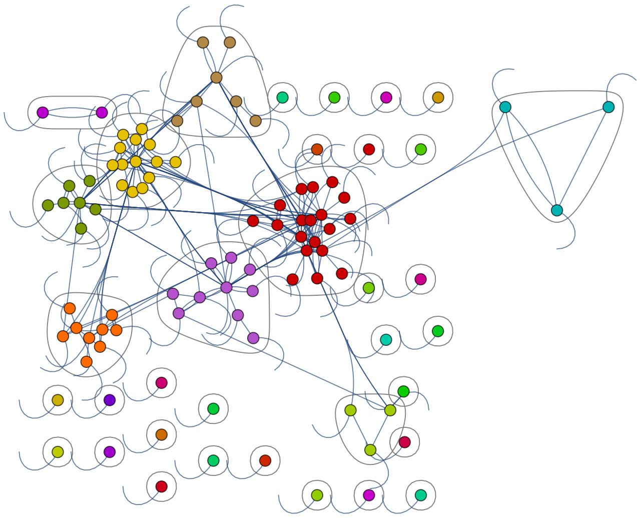
```
Out[16]=  74
```

To include all articles in our set, we can add to compOnlyEdges an extra 100 edges where each edge is self-referential.

```
In[17]:=  compOnlySingle = Union@Flatten@Append[compOnlyEdges,
              Table[Keys[compData][[i]] → Keys[compData][[i]], {i, Length[Keys[compData]]}]];
```

```
In[18]:=  CommunityGraphPlot[compOnlySingle, VertexLabels → Placed[Automatic, Tooltip], Method → "H
```

Out[18]=



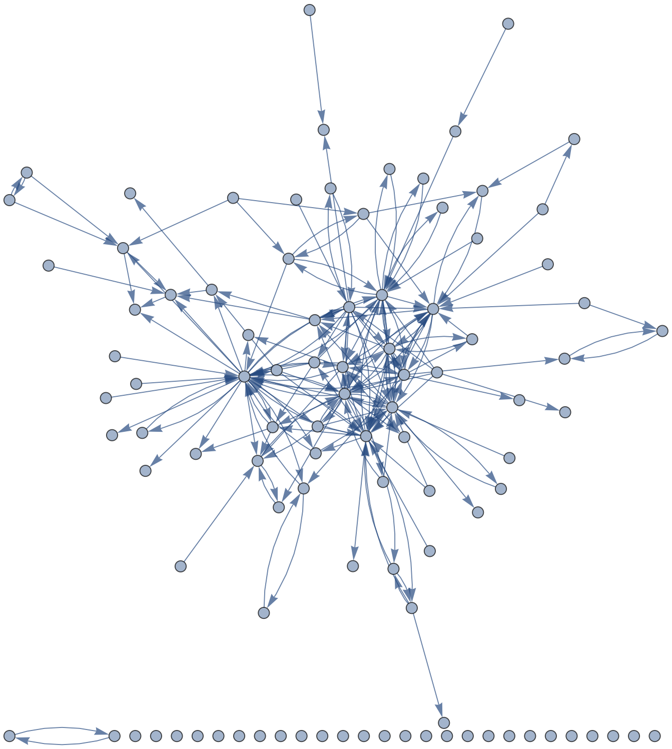
Let’s make some slight changes.

```
In[19]:=  Inlinks = Map[Select[#,MemberQ[Keys@compData,#]&]&,compData[[;;,"LinksList"]]];
          Inlinks = Flatten@KeyValueMap[Thread[#1→ #2]&,Inlinks];
```

In[21]:=

```
Graph[Keys@compData,Inlinks]
```

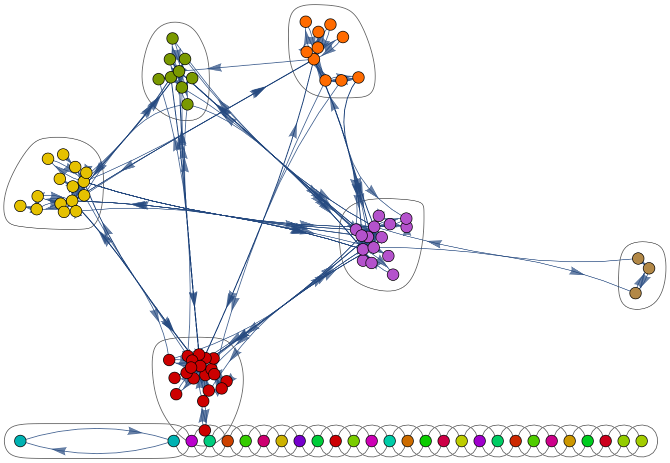
Out[21]=



In[22]:=

```
CommunityGraphPlot[Graph[Keys@compData,Inlinks]]
```

Out[22]=



Now we can see all the articles, but it’s not very helpful. Instead, we can maintain a list of articles that are not cited within our 100-article set.

In[23]:=

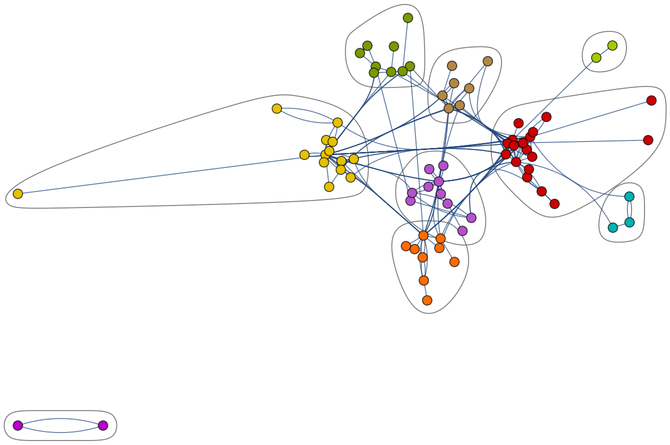
```
noLinks = Complement[Keys[compData], Flatten@FindGraphCommunities[compOnlyEdges]];
```

Using this,

In[24]:=

```
CommunityGraphPlot[compOnlyEdges, VertexLabels → Placed[Automatic, Tooltip]]
```

Out[24]=

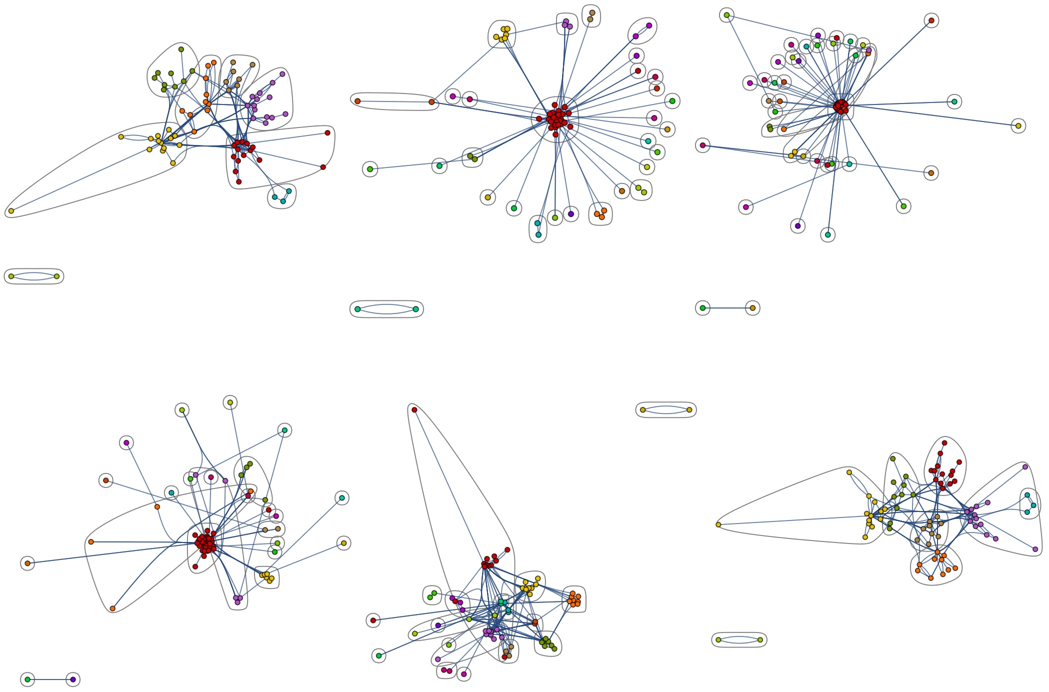


which is the same graph as that displayed at the beginning of this section but in a different layout, we can generate groups. CommunityGraphPlot takes the groupings generated by FindGraphCommunities and plots them. By running through the methods of FindGraphCommunities, we can determine that the “Modularity” model is the best.

In[25]:=

```
CommunityGraphPlot[compOnlyEdges,
    FindGraphCommunities[
        compOnlyEdges, Method→#
    ],
    VertexLabels → Placed[Automatic, Tooltip],
    ImageSize → Small
]&/@{
        "Modularity",
        "Centrality",
        "CliquePercolation",
        "Hierarchical",
        "Spectral",
        "VertexMoving"
    } //Row
```

Out[25]=



Since we can generate the communities, we can go through and label them manually. The order they appear is based off of the number of articles in the list from longest to shortest.

In[26]:=

```
groups = Association[
    Flatten[
        Map[
            Thread,
            Thread[
                FindGraphCommunities[compOnlyEdges]→
                {
                    "Computational Chemistry Group",
                    "Computational Science and Data Group",
                    "Computational Biology Group",
                    "Computational Thinking/Sentience Group",
                    "Computational Intelligence and Economics Group",
                    "Computational Physics Group",
                    "Computational Complexity Group",
                    "Computational Photography Group"
                }
            ]
        ]
    ]
];
```

Now that we have groups assigned we can go through compOnlyEdges and replace each item with its corresponding group.

In[27]:=

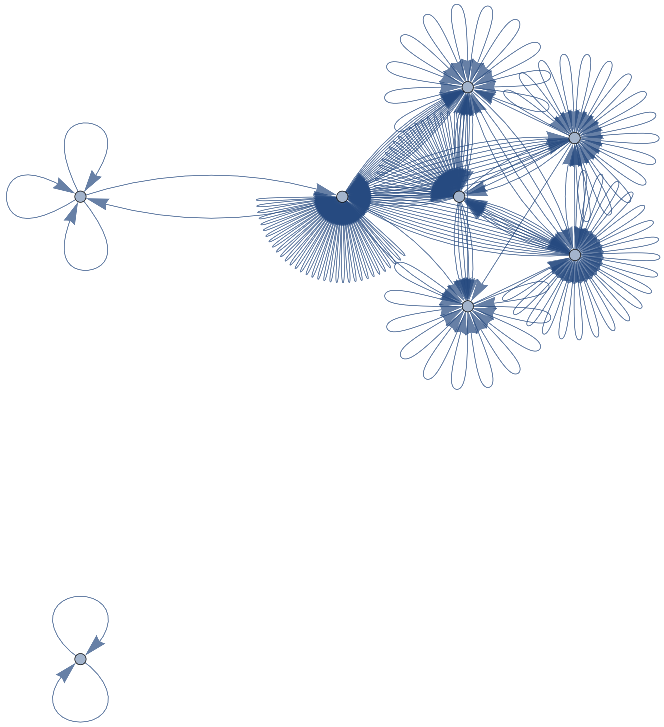
```
groupsEdges = Table[
    Replace[
        compOnlyEdges[[i]],
        compOnlyEdges[[i]] → (
            groups[compOnlyEdges[[i]][[1]]] → groups[compOnlyEdges[[i]][[2]]]
        )
    ],
    {i, Length[compOnlyEdges]}
];
```

We can look at what this graph looks like.

In[28]:=

```
Graph[groupsEdges, VertexLabels → Placed[Automatic, Tooltip]]
```

Out[28]=

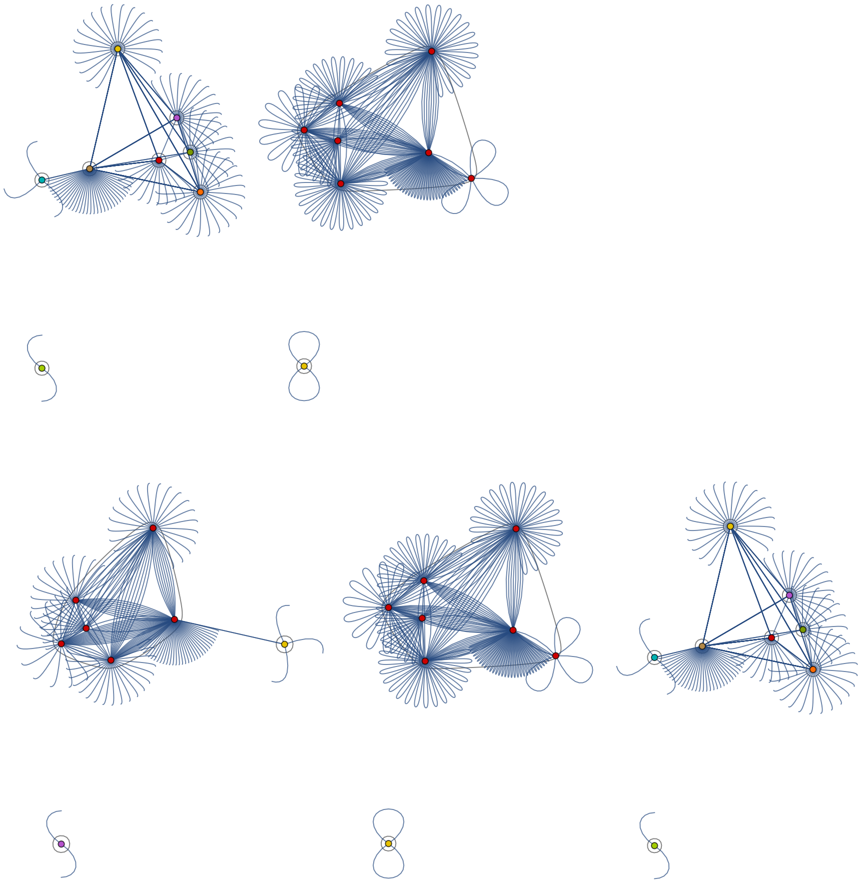


As expected, a CommunityGraphPlot using FindGraphCommunities of every model yields almost identical results as everything has already been grouped previously.

In[29]:=

```
CommunityGraphPlot[
    groupsEdges,
    FindGraphCommunities[groupsEdges, Method → #],
    VertexLabels → Placed[Automatic, Tooltip],
    ImageSize → Small
]&/@{"Modularity", "Centrality", "CliquePercolation", "Hierarchical", "Spectral"} //Row
```

Out[29]=

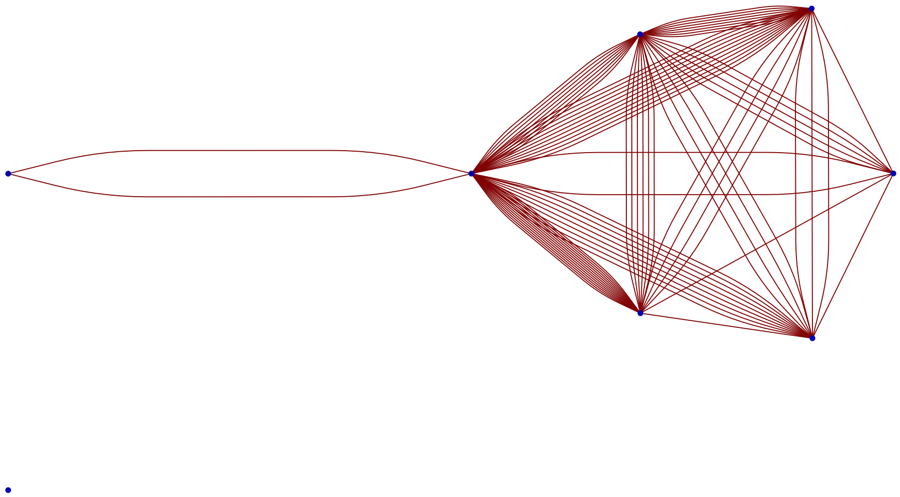


If we want to remove the self-referential loops, we use GraphPlot instead. Note the single point that is entirely self-referential, therefore not pointing in either direction to other groups.

In[30]:=

```
GraphPlot[groupsEdges, SelfLoopStyle → None, VertexLabeling → Tooltip, ImageSize → Large]
```

Out[30]=

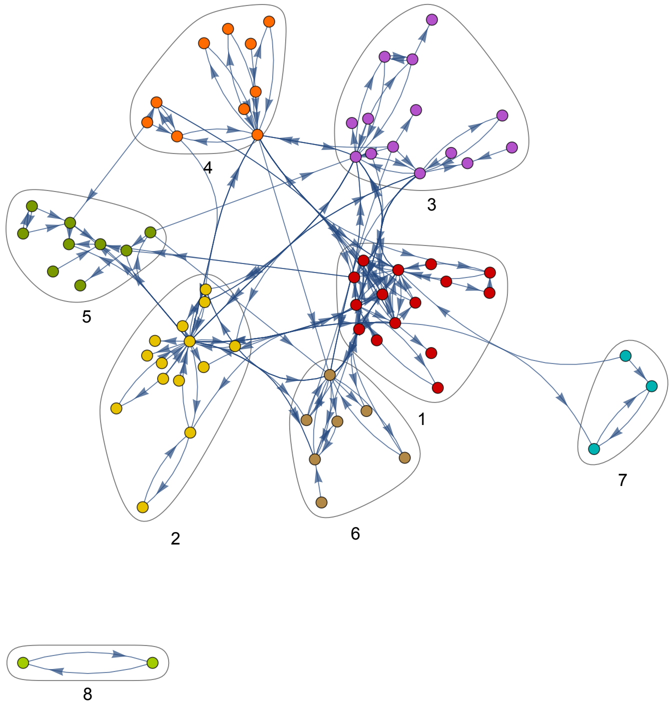


Let’s make a WordCloud.

In[31]:=

```
g = Graph[Inlinks];
CommunityGraphPlot[g,
    FindGraphCommunities[g, Method→"Modularity"],
    VertexLabels → Placed["Name", Tooltip],
    CommunityLabels → Placed[ToString/@Range[9], Below]]
```

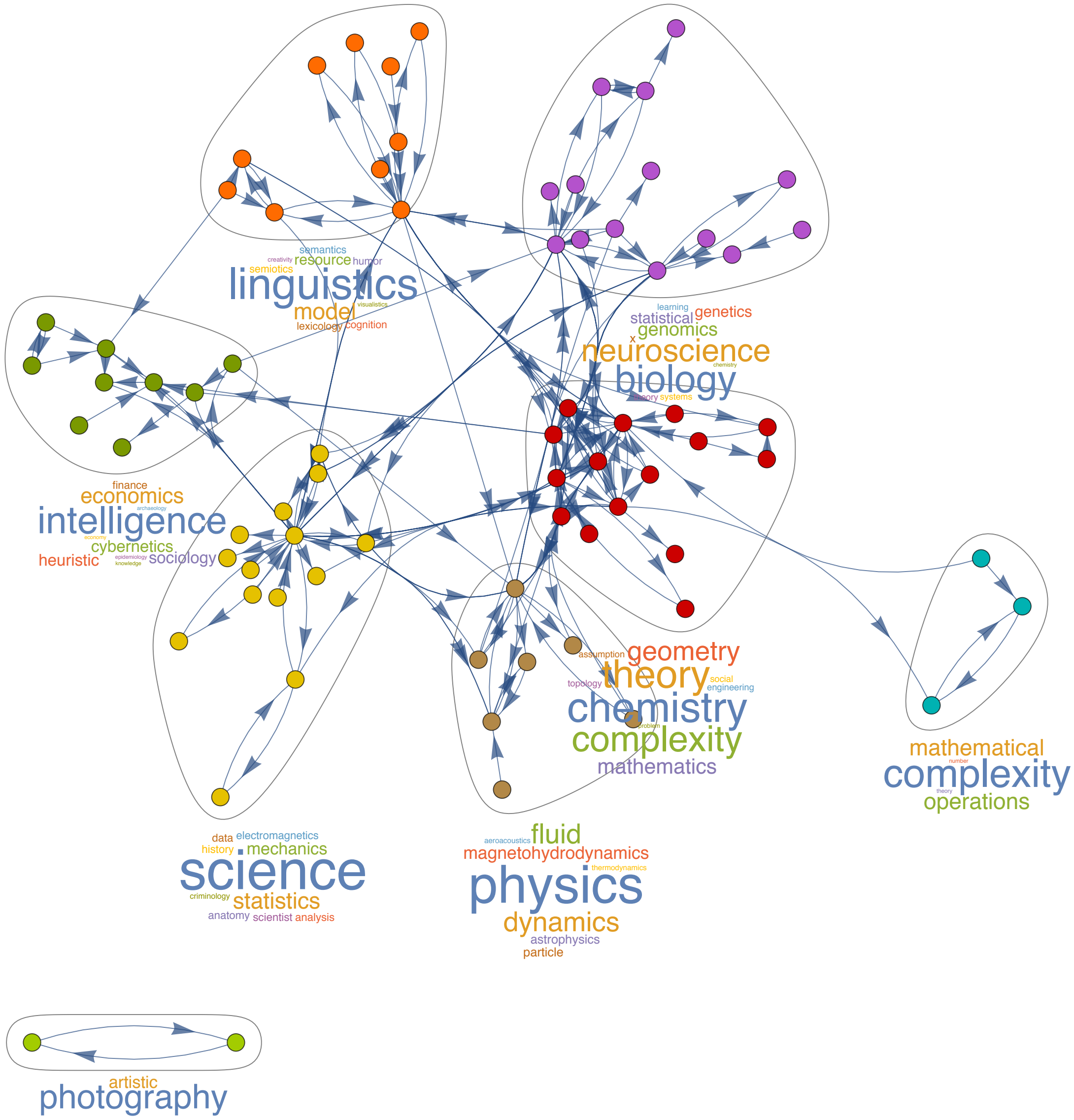
Out[32]=



In[33]:=

```
CommunityWordCloud = Function[{community, links},
    WordCloud[StringDelete["computational"]@
        ToLowerCase@StringRiffle[Flatten[Apply[
            List, Select[links,
                MemberQ[community, First[#]] &&
                MemberQ[community, Last[#]]&], 2]]],
        MaxItems → 10, ImageSize → Tiny]];
CommunityGraphPlot[g, FindGraphCommunities[g, Method→"Modularity"],
    VertexLabels → Placed["Name", Tooltip],
    EdgeLabels → Placed["Name", Tooltip],
    CommunityLabels → Placed[(CommunityWordCloud[#,Inlinks]&/@
        FindGraphCommunities[g, Method → "Modularity"]), Below],
    ImageSize → Large
]
```

Out[34]=



Edit Information

The site “tools.wmflabs.org” has much information about edit statistics of all articles on Wikipedia. To collect our data we take the template

In[35]:=

```
template = {
    "https://tools.wmflabs.org/xtools-articleinfo/?article=",
    "&project=en.wikipedia.org"
};
```

and insert our article title in between. However, our list of articles needs to have spaces replaced by “_” before we can call the data so we must do this:

```
In[36]:= urlForm = Flatten@Table[StringReplace[i, " "→ "_"], {i, Keys[compData]}];
```

This function will allow us to call the necessary information:

```
In[37]:= TitleToEdit[article_] := Block[{},
             (*Print[template[[1]]<> article <> template[[2]]]; *)
            Import[template[[1]]<> article <> template[[2]], "Data"]
          ]
```

Now we use TitleToEdit to get an association for all our articles. This is a good item to DumpSave.

```
editInfo = AssociationMap[TitleToEdit, urlForm];
```

We can use these two functions:

```
In[38]:= TotalRevisions[article_]:= editInfo[article][[2]][[1]][[1]][[4]][[2]]
         NumEditors[article_] := N[editInfo[article][[2]][[1]][[1]][[5]][[2]]]
```

To get the total number of revisions made to an article and the unique number of editors, respectively.

```
In[40]:= revCount = AssociationMap[Replace[s_String ⧴ ToExpression@StringDelete[s, ","]]@*TotalRev
         editorCount = AssociationMap[NumEditors, urlForm];
```

We can now map each article to each revision count and editor count, but we need to remove commas from the strings in revCount in order to convert to an integer. One interesting metric is revisions per editor for any given article, given by revPerEditor.

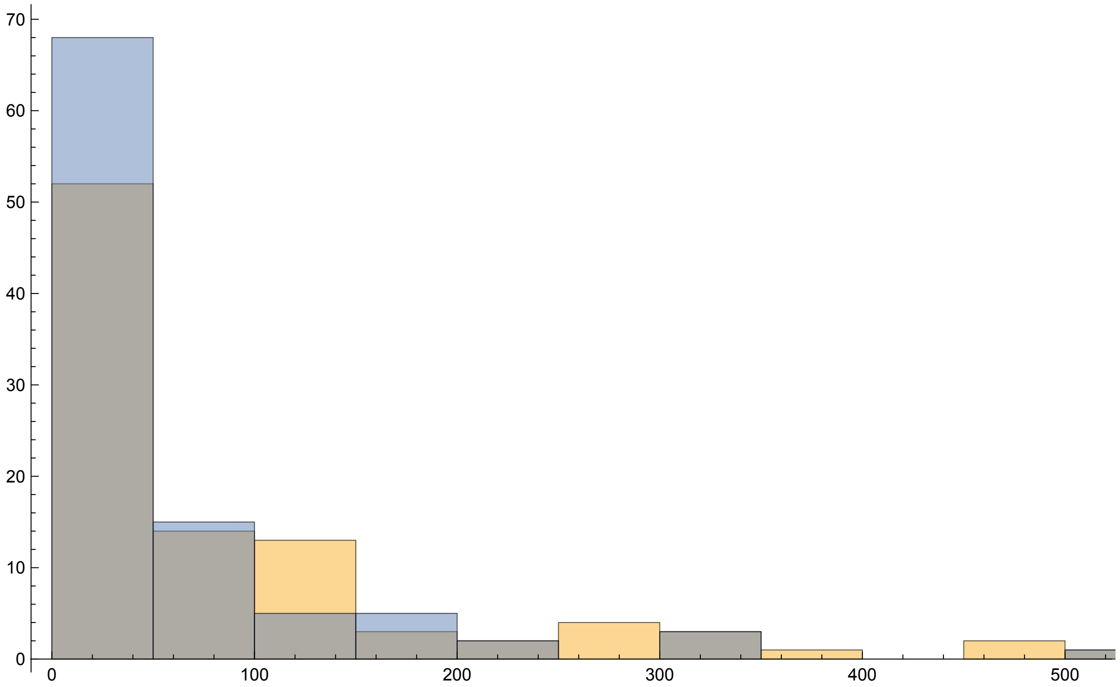
```
In[42]:= revPerEditor=Sort[revCount / editorCount, Greater];
```

A histogram shows that revCount and editorCount are generally correlated:

In[43]:=

```
Histogram[{revCount, editorCount}, {50}, ImageSize → Large, PlotRange → Automatic]
```

Out[43]=

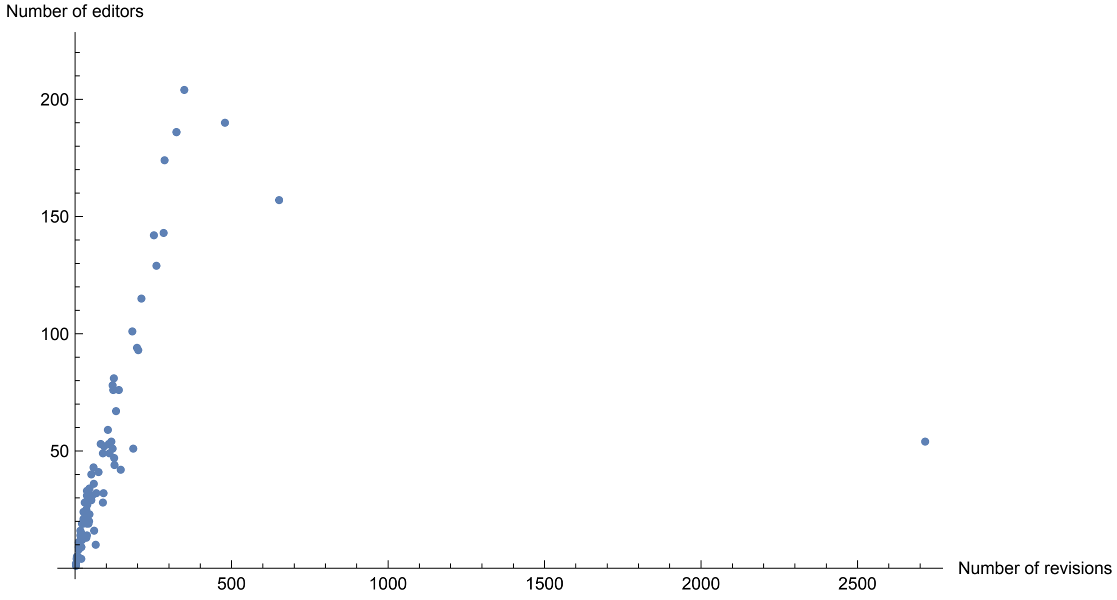


But a LinePlot clearly shows that most articles follow a trend of more editors with more revisions, as might be expected.

In[44]:=

```
revEditList = Table[{revCount[[i]], editorCount[[i]]}, {i, Length[revCount]}];
ListPlot[Tooltip[revEditList], LabelingFunction → None,
    AxesLabel → {"Number of revisions", "Number of editors"},
    PlotRange → {All, Automatic}, ImageSize → Large]
```

Out[45]=



Now we will remove outliers and focus just on articles with less than 400 revisions to make this more apparent.

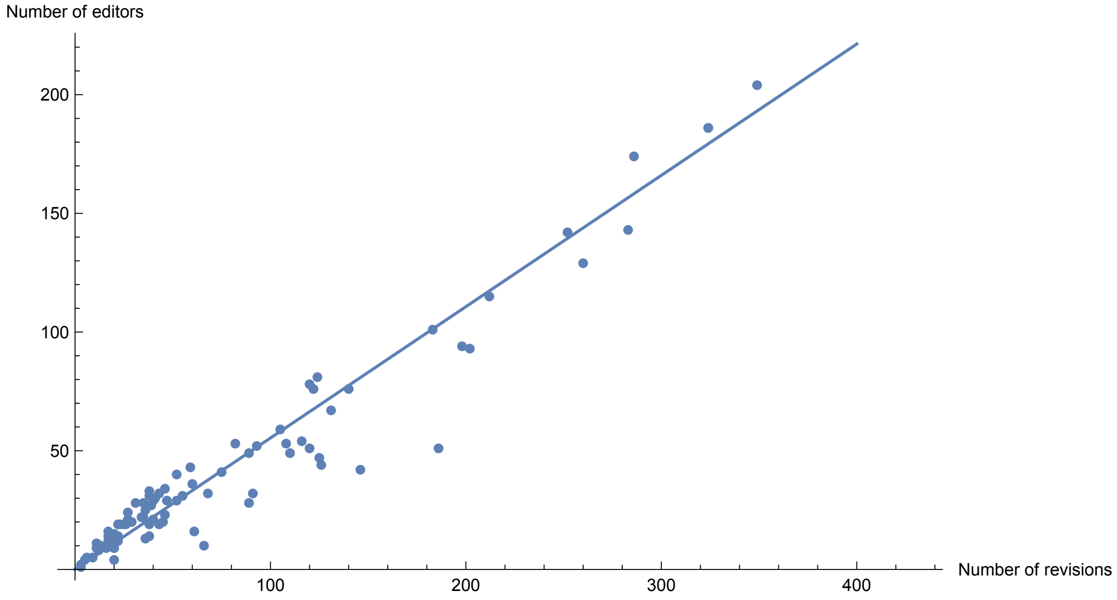
In[46]:=

```
cleanRevEdit = DeleteCases[DeleteCases[DeleteCases[revEditList, {2716,54.}],{652,157.}],{4
line = Fit[cleanRevEdit, {1, x}, x]
Show[ListPlot[Tooltip[cleanRevEdit], LabelingFunction → None,
    AxesLabel → {"Number of revisions", "Number of editors"},
    ImageSize → Large], Plot[line,{x, 0, 400}]]
```

Out[47]=

```
0.0472036 + 0.553218 x
```

Out[48]=



Edits Over Time

In order to see how an article has evolved over time in terms of edit activity, we will use the data to get number of edits in any given month since the article’s creation.

In[49]:=

```
header = {"month","Number of edits","IPs","IPs %","Minor edits",
    "Minor edits %"," All edits • IPs • Minor edits"};
months = DateRange[DateObject["2001 / 01"], DateObject["Today"]];
blankDates = Table[
    {months[[i]], 0},
    {i, Length@months}
];

EditDates[article_] :=
    Block[{finalList,newEditInfo},
        newEditInfo = DeleteCases[Table[
            If[i ≠ header,
                i, ""
            ],
            {i, editInfo[article][[2]][[6]]}
        ],""];

        finalList = blankDates;
        For[i = 1, i ≤ Length@newEditInfo, i++,
            finalList[[i + Length@months - Length@newEditInfo - 1]][[2]] = newEditInfo[[i
            (*{Print[newEditInfo[[i]][[1]]],
            Print[i + Length@months - Length@newEditInfo - 1]}*)
        ];
        Return[finalList]
    ]
```

In[53]:=

```
EditDatesPlot[article_] :=
    BarChart[
        EditDates[article][[All,2]],
        ChartLabels → (
            Rotate[DateString@#, Pi/2]&/@(
                ReplacePart[EditDates[article][[All,1 ]],
                    List/@Complement[Range@Length@EditDates[article],
                    Range[1, Length@EditDates[article], 12]] → ""]
            )
        ), PlotLabel → article, ImageSize → Large,
        AxesLabel → "Number of Edits"
    ]
```

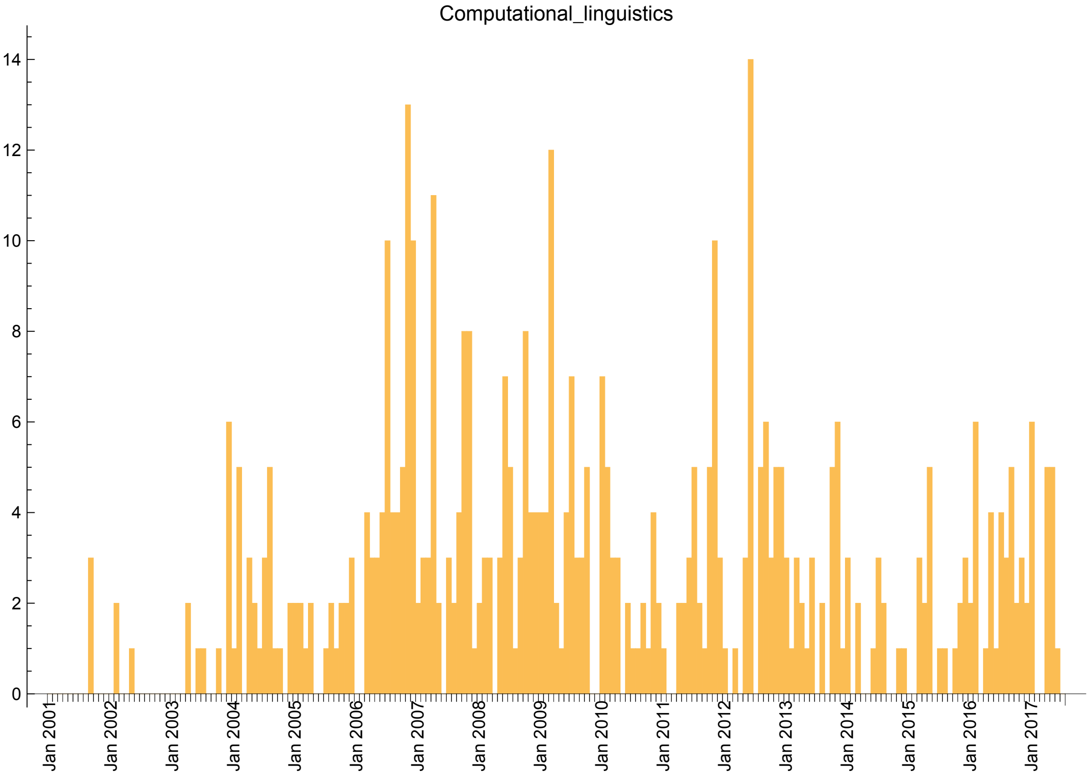
We can once again create an association to map this, and it is also an item that is good to DumpSave.

```
editDatesGraphs = AssociationMap[EditDatesPlot, urlForm];
```

In[54]:=

```
editDatesGraphs["Computational_linguistics"]
```

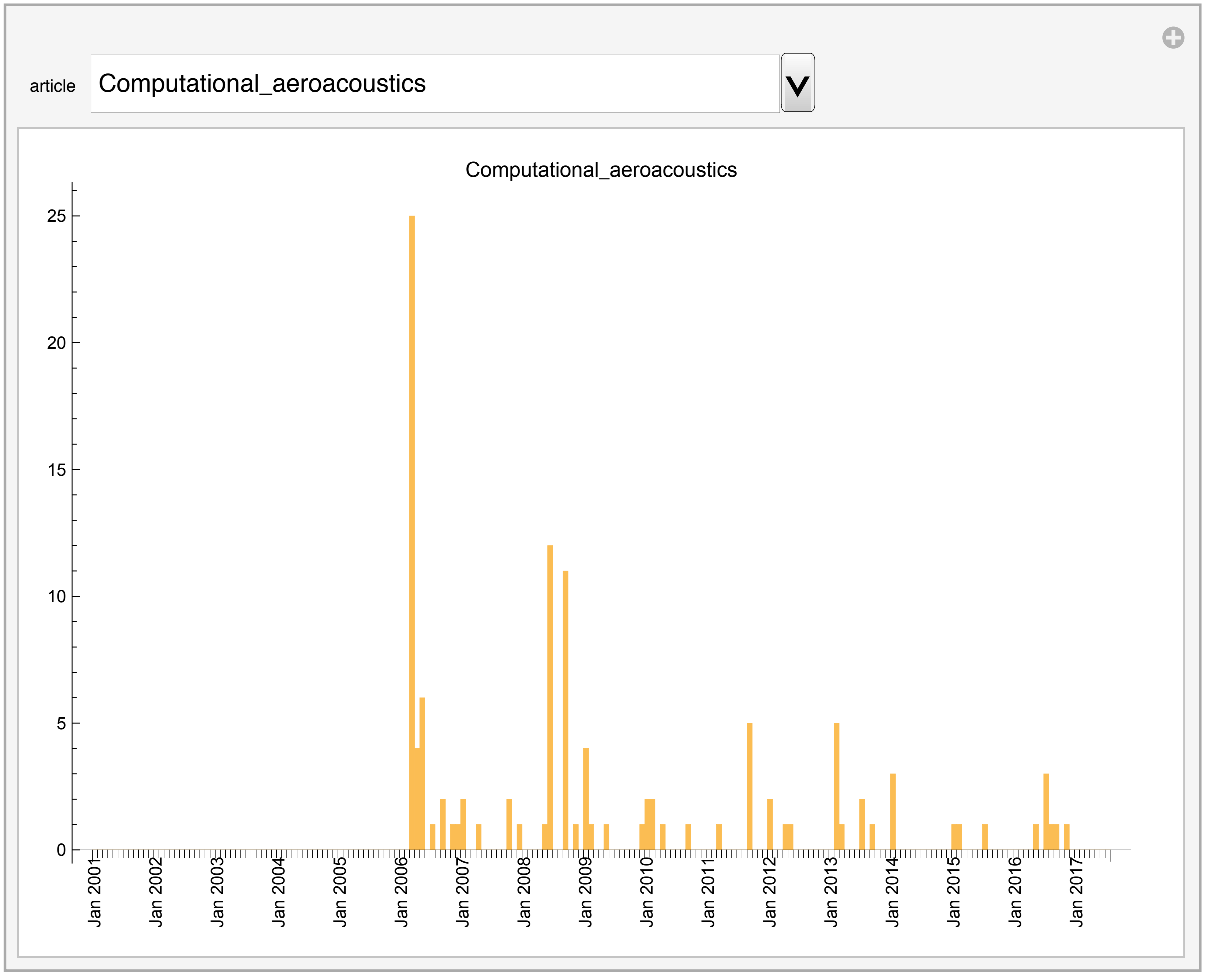
Out[54]=



In[55]:=

```
Manipulate[editDatesGraphs[article],{article, Keys@editDatesGraphs}]
```

Out[55]=



article Computational_aeroacoustics

Top Editors

Now we will extract statistics on top editors on each article.

```
In[56]:= EditorStats[article_]:=
           If[
             Length@editInfo[article][[2]][[3]][[1]][[2;;]] ≤ 30,
             {Table[
                editInfo[article][[2]][[3]][[1]][[i]][[3]],
                {i, 2, Length@editInfo[article][[2]][[3]][[1]]}
             ],
             Table[
                editInfo[article][[2]][[3]][[1]][[i]][[1]],
                {i, 2, Length@editInfo[article][[2]][[3]][[1]]}
             ]},
             {Table[
                editInfo[article][[2]][[3]][[1]][[i]][[3]], {i, 2, 31}
             ],
             Table[
                editInfo[article][[2]][[3]][[1]][[i]][[1]], {i, 2, 31}
             ],
             editInfo[article][[2]][[3]][[1]][[32]]
             }
           ]
```

We will then map this to each article.

```
In[57]:= editStats = AssociationMap[EditorStats, urlForm];
```

Here’s an example of the organization:

```
In[58]:= editStats["Computational_X"]

Out[58]= {{2, 1}, {Pleasantville, Missionedit}}
```

The first item in the first sublist aligns with the first item in the second sublist and so on. Make note that individualized statistics on editors is available for the top 30 contributors to each article. If there are more than 30 contributors, then a third sublist contains the additional number of editors beyond the top 30 and the cumulative number of edits those editors have made.

```
In[59]:= editStats["Computational_physics"]

Out[59]= {{40, 8, 7, 6, 5, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2},
          {Ema--or, 92.237.25.17, Nicoguaro, JJL, Bduke, Jorgecarleitao, Djr32, 81.133.28.241,
           FrescoBot, Fmadd, Hhhippo, David Schaich, Andrewwall, Zvelindovsky,
           196.10.121.2, 193.198.146.227, Michael Hardy, Philippojscherer, CBM, NeonMerlin,
           Berg0747, Tomtzigt, Oxymoron83, AlnoktaBOT, Chobot, Robbot, GrimFang4,
           Tim Starling, 51.37.104.97, 109.66.120.41}, {112 others, 121, -More-}}
```

If we look at a specific article, we can see what part each of the top 30 editors have made within all top 30 editors.

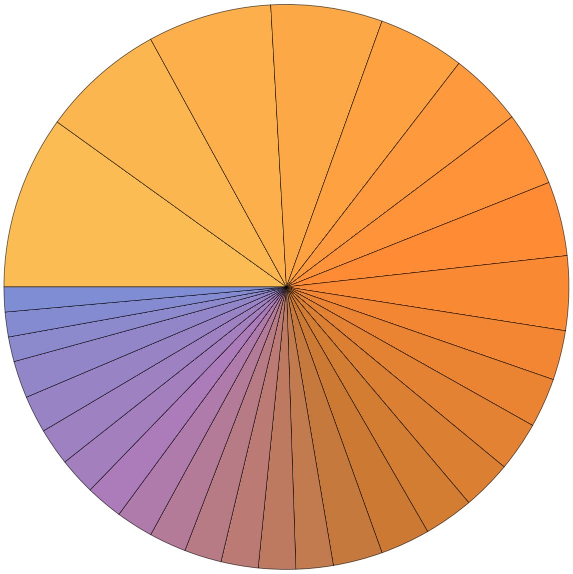
In[60]:=

```
PlotEditStats[article_] := PieChart[editStats[article][[1]]]
```

In[61]:=

```
PlotEditStats["Computational_biology"]
```

Out[61]=



If we want a basic text breakdown of how editors contribute, we can use:

In[62]:=

```
Block[{currentTotal},
    TopEditorsText[article_] :=
        If[Length@editStats[article] == 2,
            currentTotal := 0;
            For[i = 1, i ≤ Length@editStats[article][[1]], i++,
                If[N@currentTotal / Total[editStats[article][[1]]] ≤ 0.5,
                    currentTotal += editStats[article][[1]][[i]],
                    Return[ToString[i - 1] <> " of " <>
                        ToString[Length@editStats[article][[1]]] <>
                        " editors of made over 50% of "
                        <> ToString[Total[editStats[article][[1]]]]
                        <> " total edits on the article " <> article];
                    Break[]
                ]
            ],
            currentTotal := 0;
            For[i = 1, i ≤ Length@editStats[article][[1]], i++,
                If[N@currentTotal /
                    (Total[editStats[article][[1]]] + editStats[article][[3]][[2]]) ≤ 0.5
                    currentTotal += editStats[article][[1]][[i]],
                    Return[ToString[i - 1] <> " of " <>
                        ToString[
                            Length@editStats[article][[1]] +
                            ToExpression[StringTake[editStats[article][[3]][[1]],{1,-8}]]
                        ] <>
                        " editors of made over 50% of " <>
                        ToString[Total[editStats[article][[1]]] + editStats[article][[3]]
                        <> " edits on the article " <> article];
                    Break[]
                ];
                If[i == Length@editStats[article][[1]],
                        Return["The top 30 editors made " <>
                            ToString[100 * N@currentTotal /
                            (Total[editStats[article][[1]]] + editStats[article][[3]][[2]
                            <> "% of " <> ToString[
                            ToString[Total[editStats[article][[1]]] +
                            editStats[article][[3]][[2]]]]
                            <> " edits on the article " <> article
                        ]
                ]
            ]
        ]
]
```

In[63]:=

```
TopEditorsText["Computational_complexity"]
```

Out[63]=

```
6 of 11 editors of made over 50% of
  11 total edits on the article Computational_complexity
```

Now we will make a more useful version that we can use to graph.

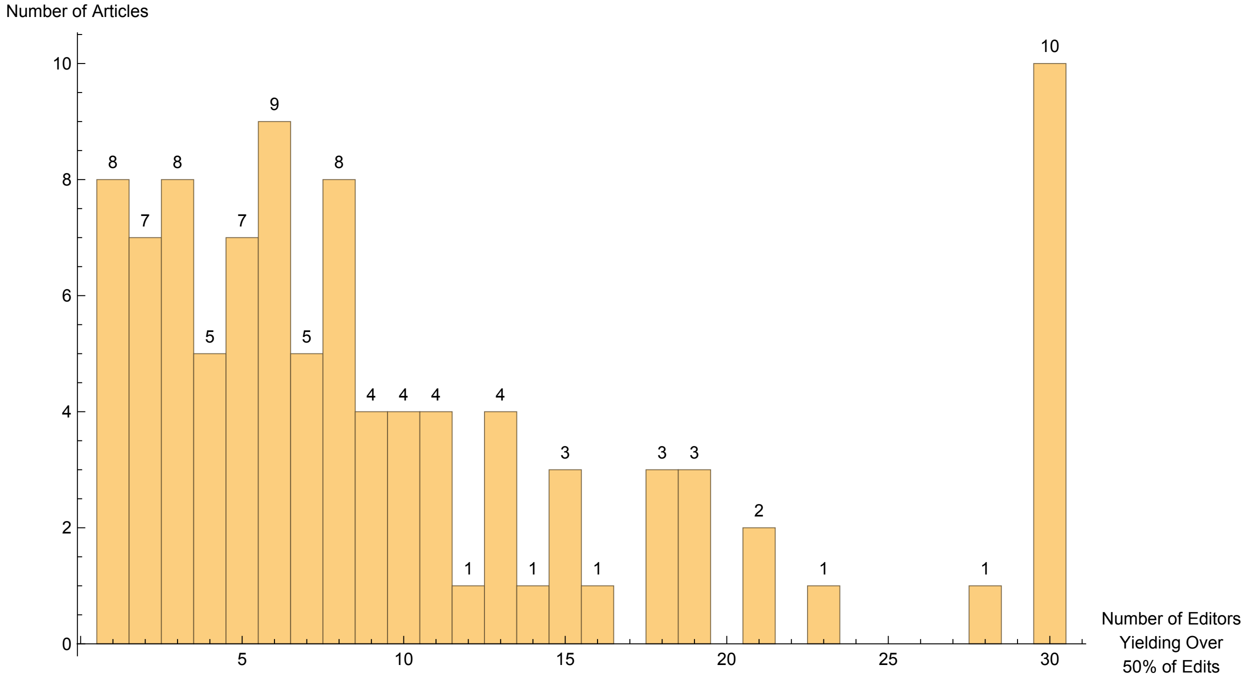
In[64]:=

```
Block[{currentTotal},
    TopEditorsFifty[article_] :=
        If[Length@editStats[article] ⩵ 2,
            currentTotal := 0;
            For[i = 1, i ≤ Length@editStats[article][[1]], i++,
                If[N@currentTotal / Total[editStats[article][[1]]] ≤ 0.5,
                    currentTotal += editStats[article][[1]][[i]],
                    Return[i-1];
                    Break[]
                ]
            ],
            currentTotal := 0;
            For[i = 1, i ≤ Length@editStats[article][[1]], i++,
                If[N@currentTotal /
                    (Total[editStats[article][[1]]] + editStats[article][[3]][[2]]) ≤ 0.5
                    currentTotal += editStats[article][[1]][[i]],
                    Return[i-1];
                    Break[]
                ];
                If[i ⩵ Length@editStats[article][[1]],
                    Return[30]
                ]
            ]
        ]
]
```

In[65]:=

```
Histogram[AssociationMap[TopEditorsFifty, urlForm], 30, LabelingFunction → Above,
    AxesLabel → {"Number of Editors\nYielding Over\n50% of Edits", "Number of Articles"}]
```

Out[65]=



Note that the category “30” is articles where the top 30 editors did not reach 50% of all contributions to an article. Data per editor beyond the top 30 editors is missing. Let’s look at how the top 30 editors contribute.

In[66]:=

```
TopEditors[article_] :=
    If[Length@editStats[article] == 3,
        Return[
            N[
                100 * Total[editStats[article][[1]]] /
                (Total[editStats[article][[1]]] + editStats[article][[3]][[2]])
            ]
        ]
    ]
```

For articles with 30 or less contributors, the top 30 contributors will always contribute 100% of an article’s edits. We can get the articles that have more than 30 contributors from:

In[67]:=

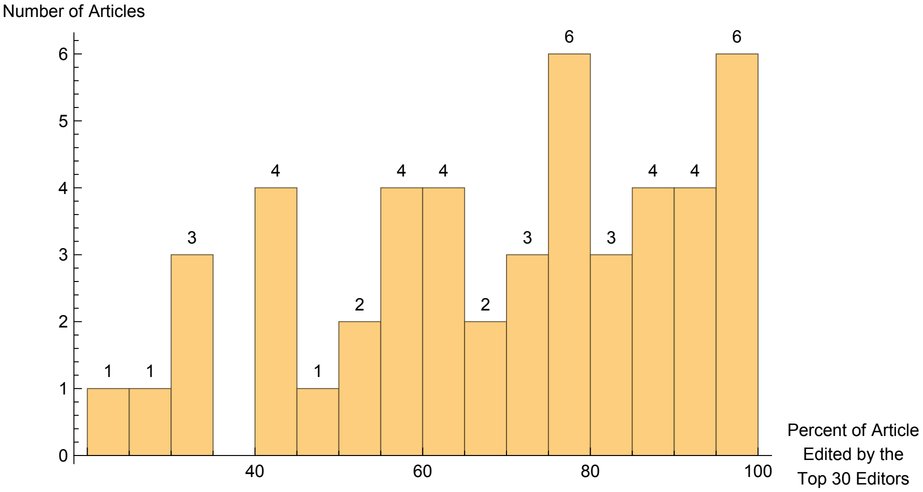
```
thirtyPlus = DeleteCases[Table[If[Length@editStats[i] == 3 && editStats[i][[3]][[2]] > 0,
    {i, urlForm}], ""];
```

Plotting it as a histogram will show show us where articles fall in terms of what percent of an article’s total edits were committed by the top 30 editors. One bin spans 5%.

In[68]:=

```
Histogram[AssociationMap[TopEditors, thirtyPlus], 20, LabelingFunction → Above,
   AxesLabel → {"Percent of Article\nEdited by the\nTop 30 Editors", "Number of Articles
```

Out[68]=


Number of Articles
Percent of Article
Edited by the
Top 30 Editors