

Graph Theory and MaplePrimes

Introduction

[MaplePrimes](#) is a discussion forum for Maple users. Users interact with each other by asking and answering questions, or posting interesting content that others comment on. Some users are motivated to post often, while others take a more relaxed attitude to the forum.

This means that some users create a bigger ripple than others. Graph theory can help identify these influencers, and track the relationships between users.

MaplePrimes has many questions or a posts, hereinafter known as a thread. Users contribute messages to each thread, either as the original poster, or with a subsequent response.

The spreadsheet attached to this workbook contains interaction data for every MaplePrimes thread from 15th May 2018 to 15th May 2019 (only those threads with more than one contributing user are counted).

- Each row contains a unique pair of usernames (or users), and the number of times they have interacted.
- An "interaction" is the total number of times both users have contributed to a thread (multiple contributions to a single thread is counted as one interaction)

For example, the users [AQ](#) and [acer](#) interacted 2 times from 15th May 2018 to 15th May 2019, in these two threads: [thread 1](#) and [thread 2](#).

This data can be used to create a graph where

- a vertex is a unique user,
- two vertices are connected with an edge if they have interacted 1 or more times (basically, one for each row of the data file),
- and the weight of the edge is the number of interactions for the pair of users.

This application uses this data to

- identify the maximum clique
- find the most influential users as determined by the [PageRank Centrality](#), [Eigenvector Centrality](#), [Katz Centrality](#) and [Degree Centrality](#).
- and plot the overall interaction graph.

```
> restart:
with(GraphTheory):
```

Import Data

```
> data := ExcelTools:-Import(
  "this://MaplePrimes_Interaction_Datadata.xls" )
```

<i>data</i> :=	{"AQ", "acer"}"	2.0
	{"AQ", "vv"}"	1.0
	{"AQ", "tomleslie"}"	2.0
	{"Aidin", "nm"}"	1.0
	{"Aidin", "Mariusz Iwaniuk"}"	1.0
	{"Aissam", "Kitonum"}"	1.0
	{"Al86", "vv"}"	2.0
	{"Al86", "Carl Love"}"	1.0
	{"Al86", "ecterrab"}"	1.0
	{"Al86", "tomleslie"}"	1.0
	⋮	⋮

2820 × 2 Matrix

(2.1)

List of vertices (i.e. all the unique usernames)

```
> vertices := [ { seq( parse( data[i, 1] )[], i = 1..2820 ) }[] ]:
```

Weights for each pair of vertices

```
> edges_weights := { seq( [ parse( data[ i, 1 ] ), data[ i, 2 ] ], i
  = 1..2820 ) }:
```

Overall graph

```
> G := Graph( vertices, edges_weights );
      G := Graph 1: an undirected weighted graph with 738 vertices and 2820 edge(s) (2.2)
```

Maximum Clique

```
> cl := MaximumClique( UnderlyingGraph( G ) )
cl := ["Ronan", "acer", "djc", "itsme", "samlin", "vv", "Christopher2222", "Daniel Skoog",
      "J F Ogilvie", "Mariusz Iwaniuk", "Pascal4QM", "Samir Khan", "Scot Gould", "Spinosaurus",
      "peter2108", "student_md", "Fereydoon_Shekofte", "Rouben Rostamian",
      "Venkat Subramanian"] (3.1)
```

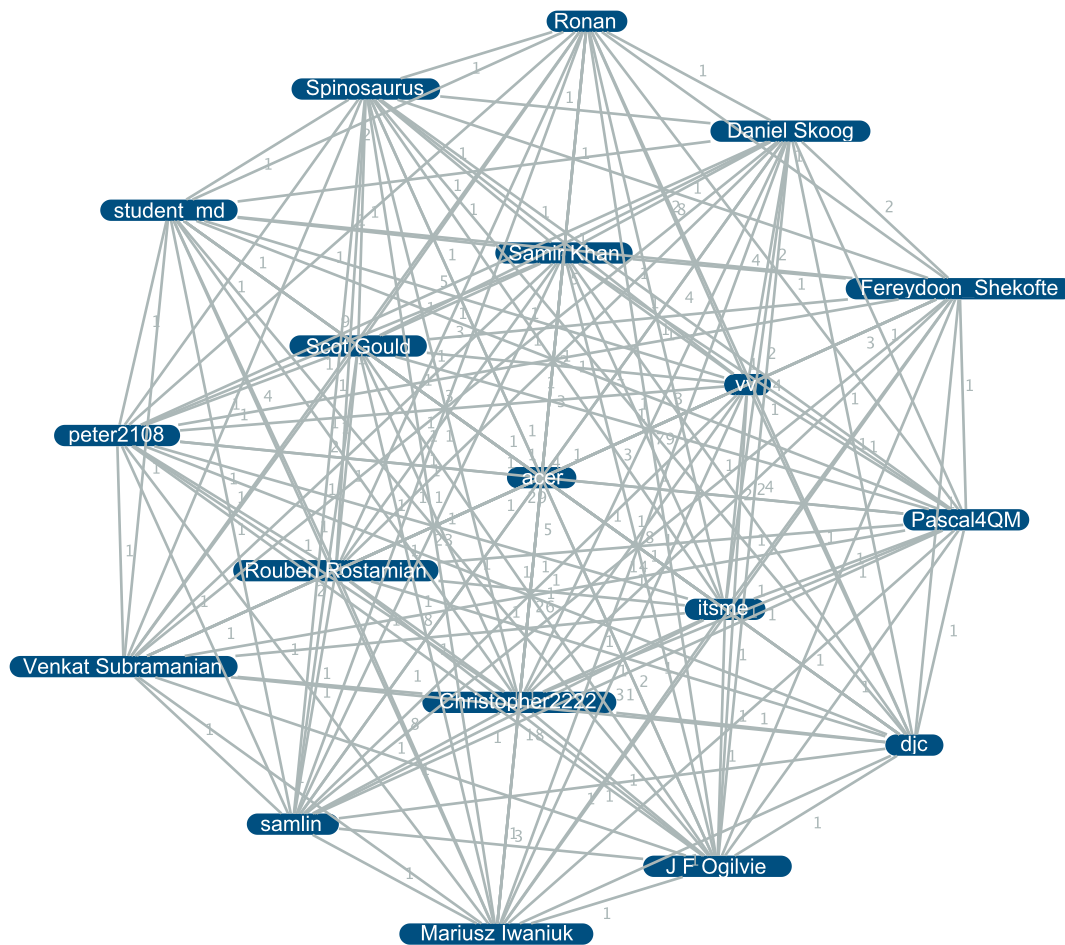
```
> G2 := InducedSubgraph( G, cl)
      G2 := Graph 2: an undirected weighted graph with 19 vertices and 171 edge(s) (3.2)
```

```
> DrawGraph(G2, style = spring, size = [ 800, 800 ], stylesheet = [
  vertexcolor = ColorTools:-Color( "RGB", [ 0/255, 79/255,
  128/255 ] )
```

```

,vertexfontcolor = white
,vertexborder    = false
,vertexshape     = "stadium"
,vertexfont      = [ "Arial", 12 ]
,vertexpadding   = 2
,edgethickness   = 0
,edgecolor       = ColorTools:-Color( "RGB", [ 171/255, 183/255,
183/255 ] )
] )

```



Rank Users by Importance

PageRank Centrality

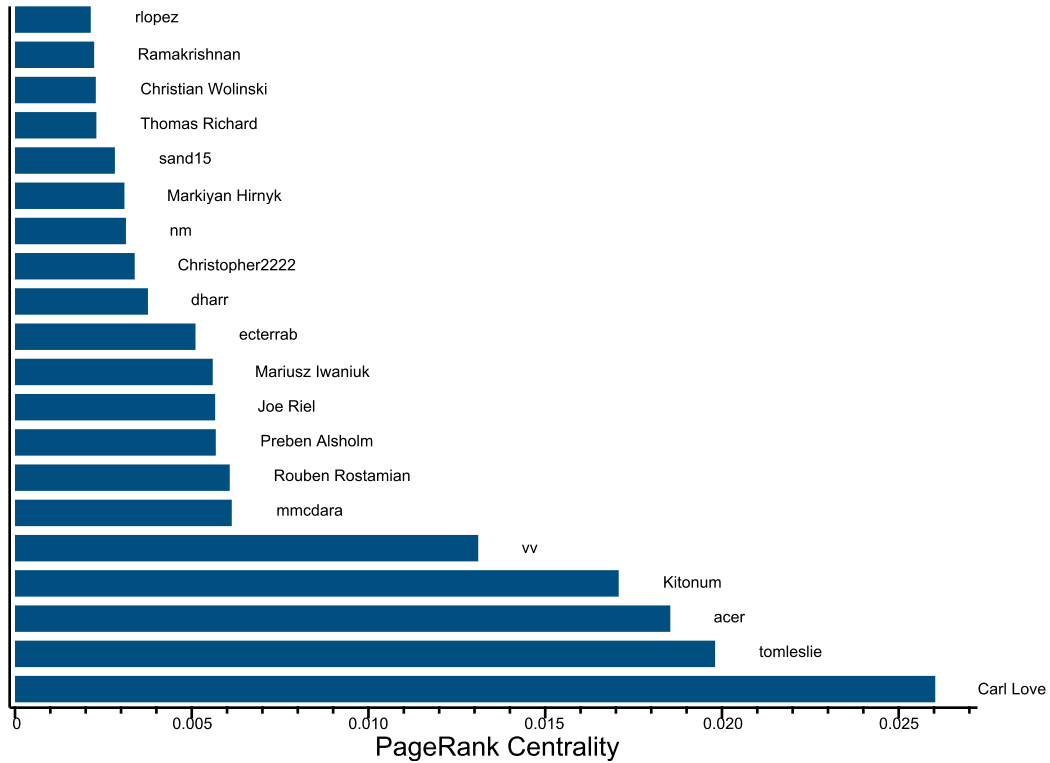
```

> pagerank Centrality := PageRankCentrality( G, 0.1 ):
  pagerank_ind := sort(pagerank Centrality, output = permutation):
> Statistics:-BarChart( [ seq( vertices[ pagerank_ind[ -i ] ] =
  pagerank Centrality[ pagerank_ind[ -i ] ], i = 1..20 ) ], size = [
  800, 800 ], style = surface, title = "Most Influential Users on
  MaplePrimes", titlefont = [ Arial, 20 ], font = [ Arial, 10 ],
  axesfont = [ Arial, 10 ], labels = [ "PageRank Centrality", "" ],
  labelfont = [ Arial, 16 ], axes = frame, size = [ 800, 600 ],

```

```
color = ColorTools:-Color( "RGB", [ 0/255, 79/255, 128/255] )
```

Most Influential Users on MaplePrimes

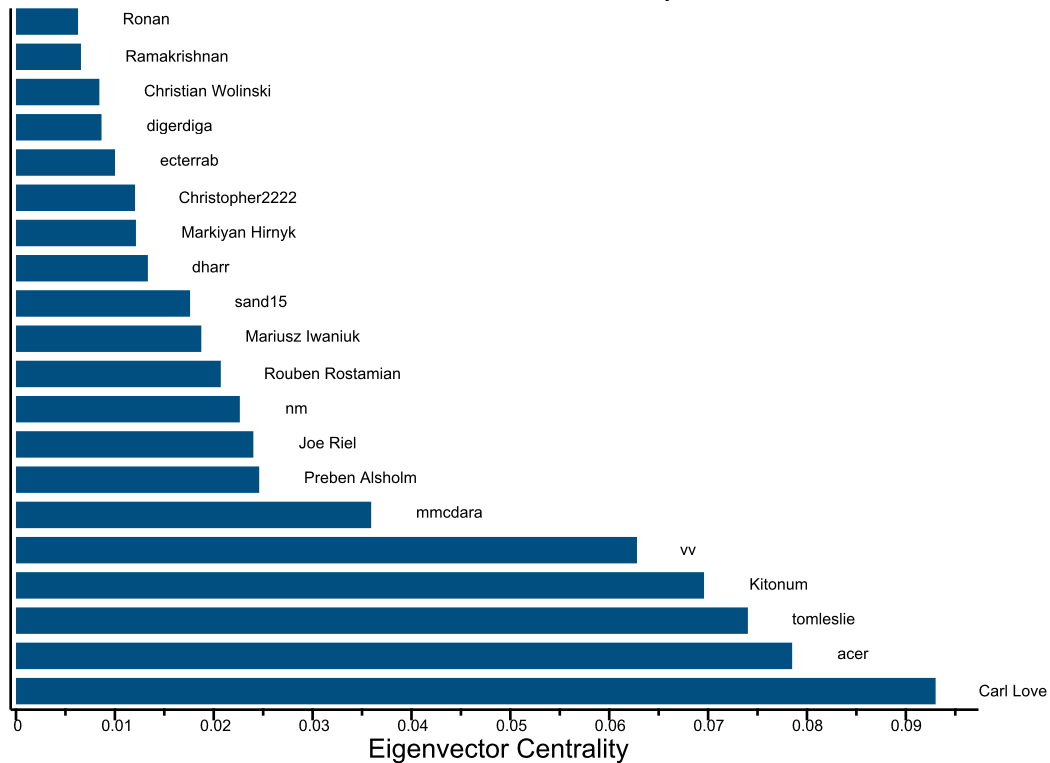


Eigenvector Centrality

```
> eig_centrality := EigenvectorCentrality( G ):
   eig_ind := sort(eig_centrality, output = permutation):

> Statistics:-BarChart( [ seq( vertices[ eig_ind[ -i ] ] =
   eig_centrality[ eig_ind[ -i ] ], i = 1..20 ) ], size = [ 800, 800
], style = surface, title = "Most Influential Users on
MaplePrimes", titlefont = [ Arial, 20 ], font = [ Arial, 10 ],
axesfont = [ Arial, 10 ], labels = [ "Eigenvector Centrality", ""
], labelfont = [ Arial, 16 ], axes = frame, size = [ 800, 600 ],
color = ColorTools:-Color( "RGB", [ 0/255, 79/255, 128/255] ) )
```

Most Influential Users on MaplePrimes

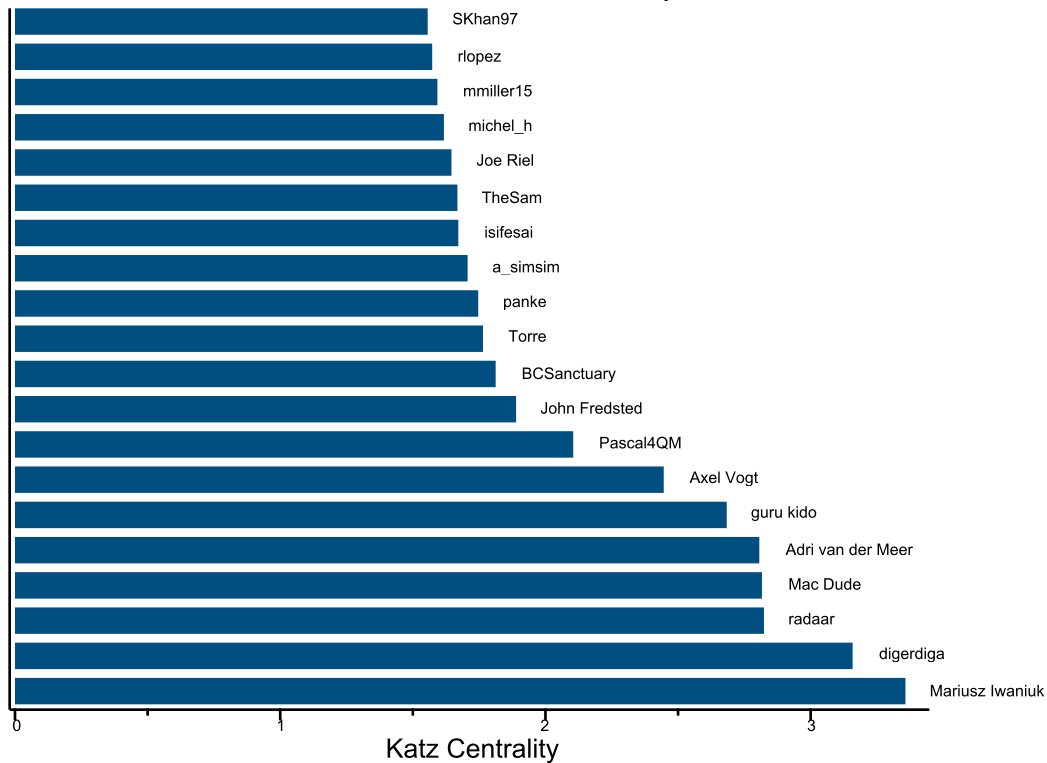


Katz Centrality

```
> katz Centrality := KatzCentrality( G, 0.1 ):
   katz_ind := sort(katz Centrality, output = permutation):

> Statistics:-BarChart( [ seq( vertices[ katz_ind[ -i ] ] =
   katz Centrality[ katz_ind[ -i ] ], i = 1..20 ) ], size = [ 800,
   800 ], style = surface, title = "Most Influential Users on
   MaplePrimes", titlefont = [ Arial, 20 ], font = [ Arial, 10 ],
   axesfont = [ Arial, 10 ], labels = [ "Katz Centrality", "" ],
   labelfont = [ Arial, 16 ], axes = frame, size = [ 800, 600 ],
   color = ColorTools:-Color( "RGB", [ 0/255, 79/255, 128/255] ) )
```

Most Influential Users on MaplePrimes

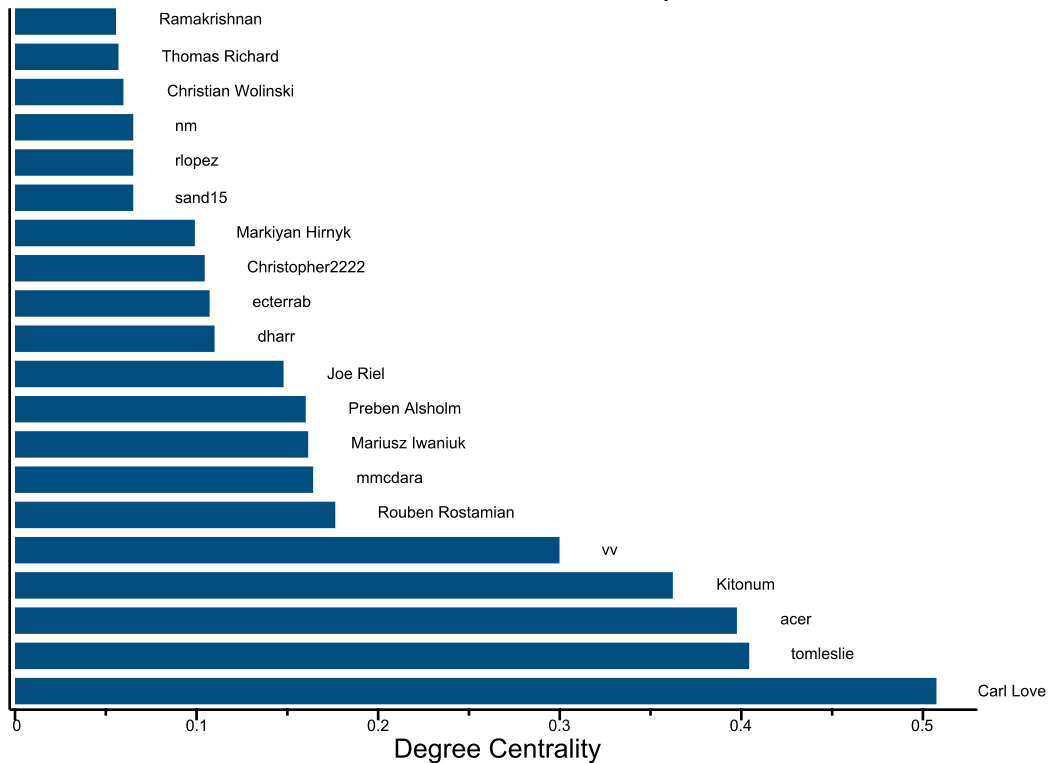


Degree Centrality

```
> degree centrality := DegreeCentrality( G ):
  degree_ind := sort(degree centrality, output = permutation):

> Statistics:-BarChart( [ seq( vertices[ degree_ind[ -i ] ] =
  degree centrality[ degree_ind[ -i ] ], i = 1..20 ) ], size = [
  800, 800 ], style = surface, title = "Most Influential Users on
  MaplePrimes", titlefont = [ Arial, 20 ], font = [ Arial, 10 ],
  axesfont = [ Arial, 10 ], labels = [ "Degree Centrality", "" ],
  labelfont = [ Arial, 16 ], axes = frame, size = [ 800, 600 ],
  color = ColorTools:-Color( "RGB", [ 0/255, 79/255, 128/255 ] ) )
```

Most Influential Users on MaplePrimes



Draw Graph

A graph of the 15 most important users as given by their PageRank Centrality

```

> lowImportanceUsers := convert ( vertices, set ) minus { seq (
  vertices [pagerank_ind [ -i ] ], i = 1 .. 10 ) };
G2 := DeleteVertex(G, lowImportanceUsers)
      G2 := Graph 3: an undirected weighted graph with 10 vertices and 45 edge(s)
(5.1)

> c1 := ColorTools:-Color("RGB",[30/255, 130/255, 76/255]);
c2 := ColorTools:-Color("RGB",[144/255, 198/255, 149/255]);

StyleVerticesByProperty( G2, PageRankCentrality, 0.1,
  fontsizescheme = [24, 10], colorscheme = [c1, c2] );

StyleEdgesByProperty( G2, WeightMatrix, thicknessscheme = [ 1, 6
], colorscheme = [ c2, c1 ] );

> DrawGraph( G2, showlabels = true, size = [ 800, 800 ], layout =
  spring, showweights = false, stylesheet = [
  vertexfontcolor = white
,vertexcolor      = white
,vertexborder    = false
,vertexshape     = "stadium"
,vertexfont      = [ "Arial", 12 ]
,vertexpadding   = 1
,edgethickness   = 0
] )

```

