Understanding social networks with F#

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NYC F# user group
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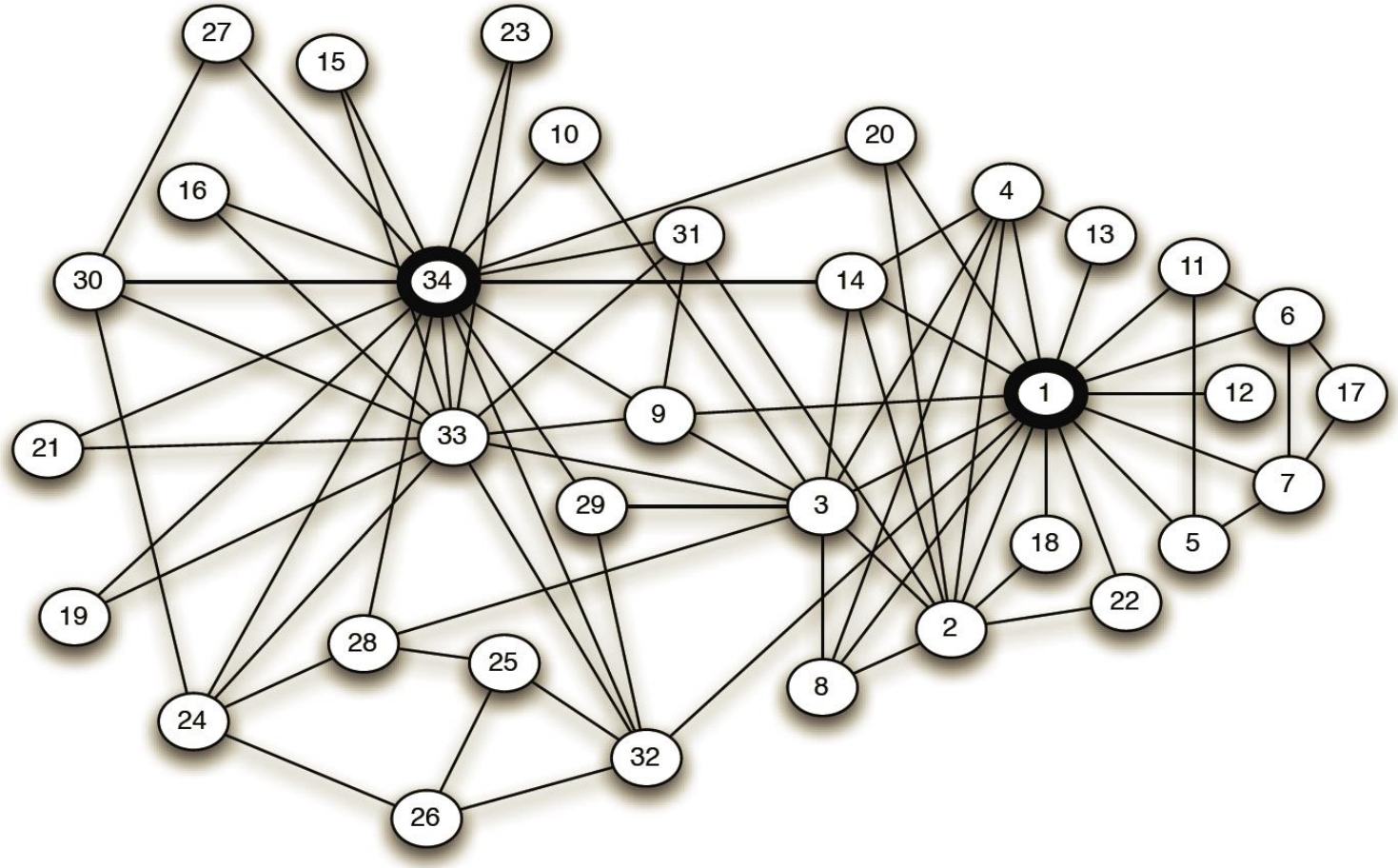
Why network science

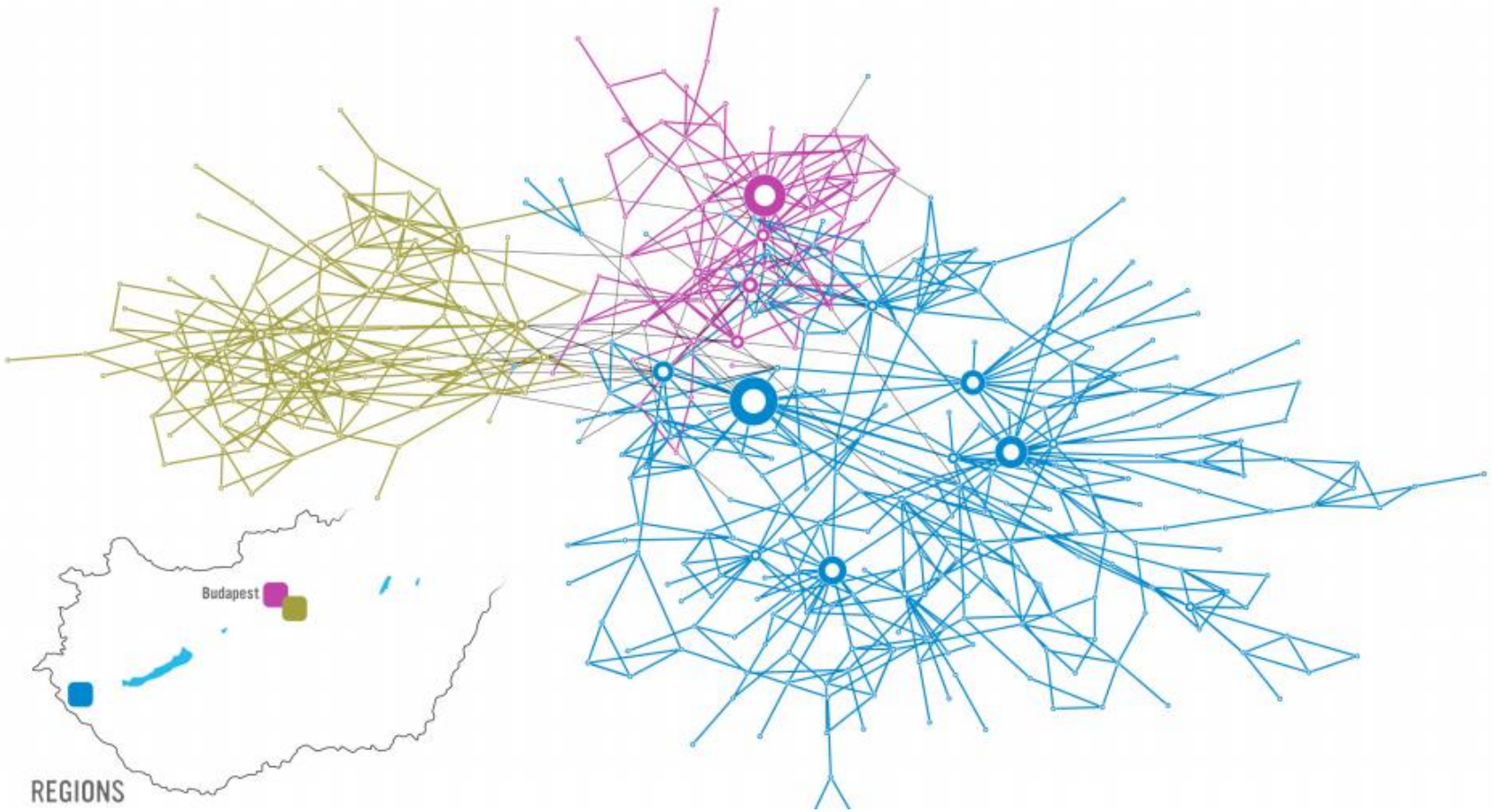
- gene interaction networks
- disease spreading
- balancing load in power grids
- brain connections
- software dependency networks
- social networks
- …

Social network analysis

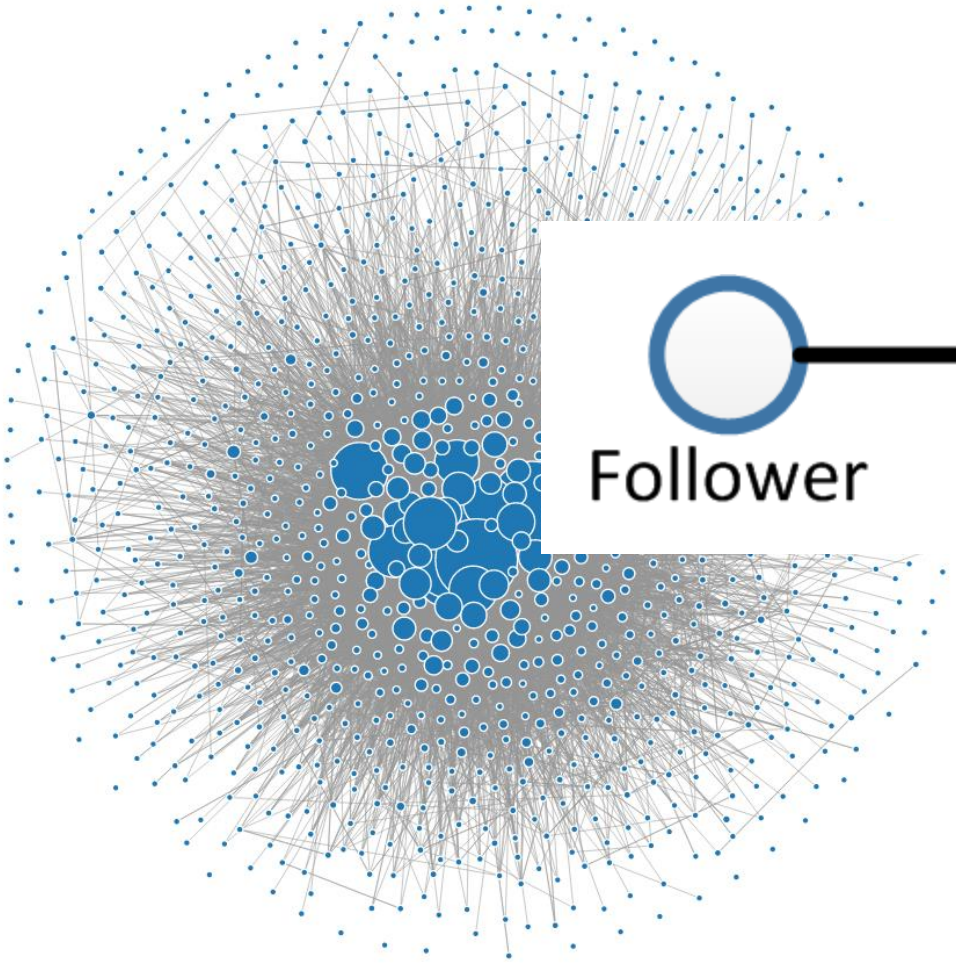
Karate club network

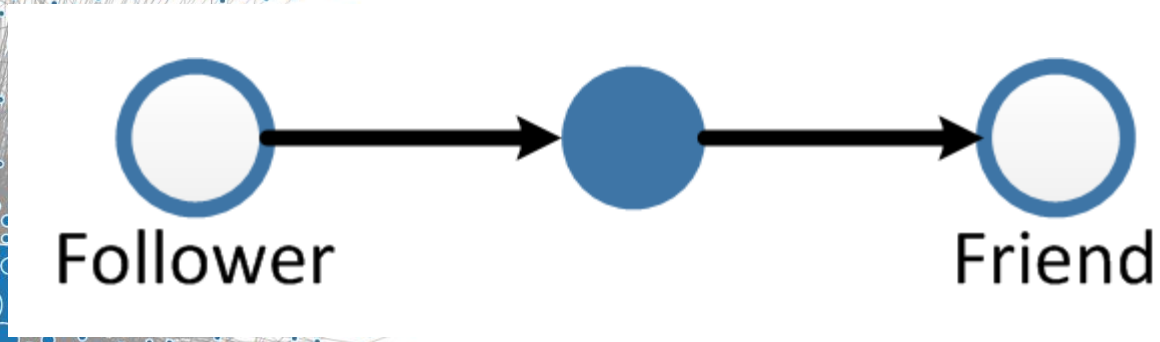


Insights from social networks

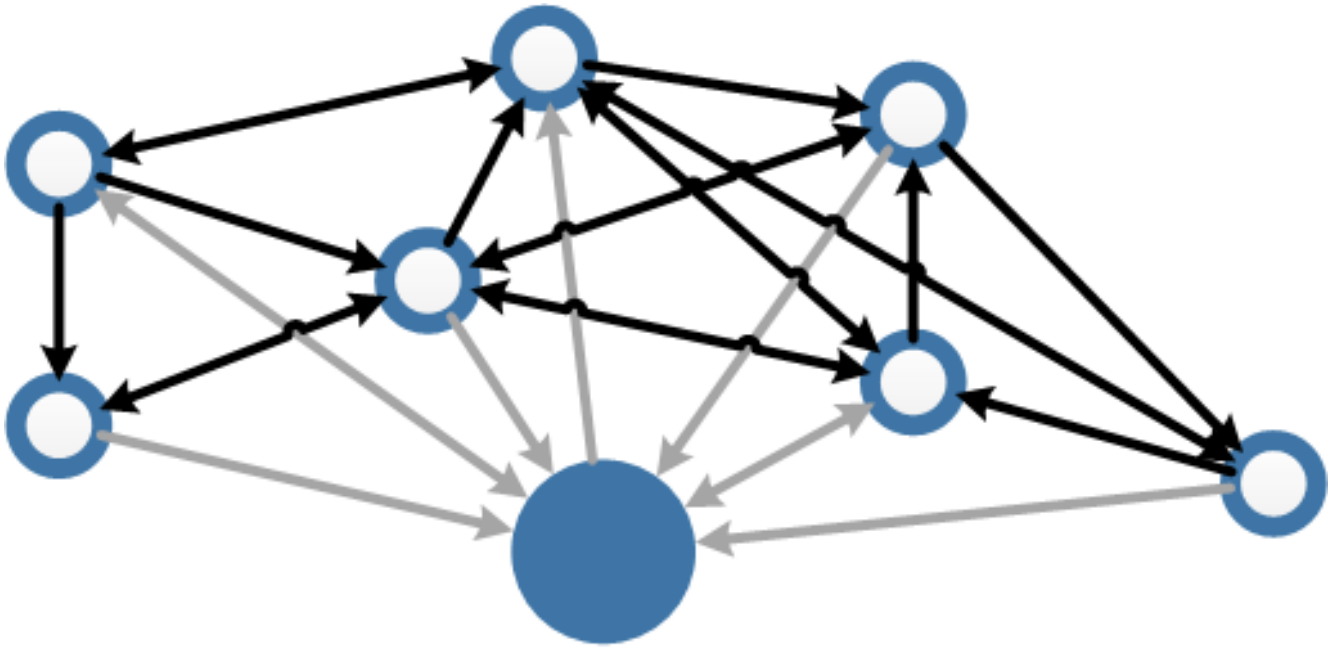


Twitter network





How large is your ego?



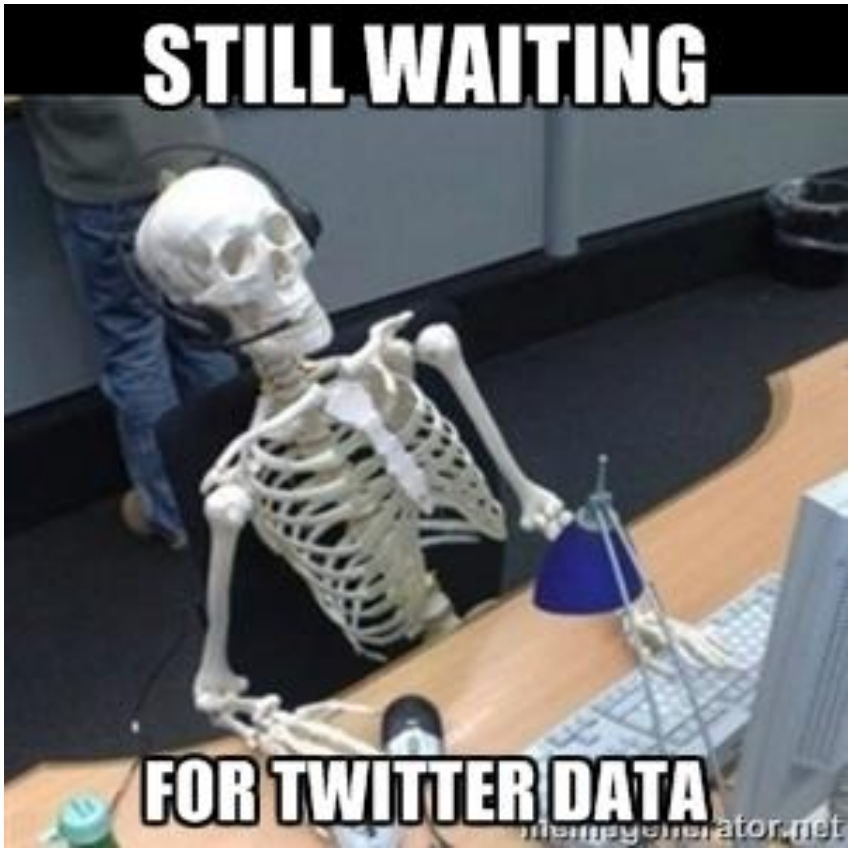
@fsharporg

Connecting to twitter

Interactions on Twitter

Retweets and Favorites

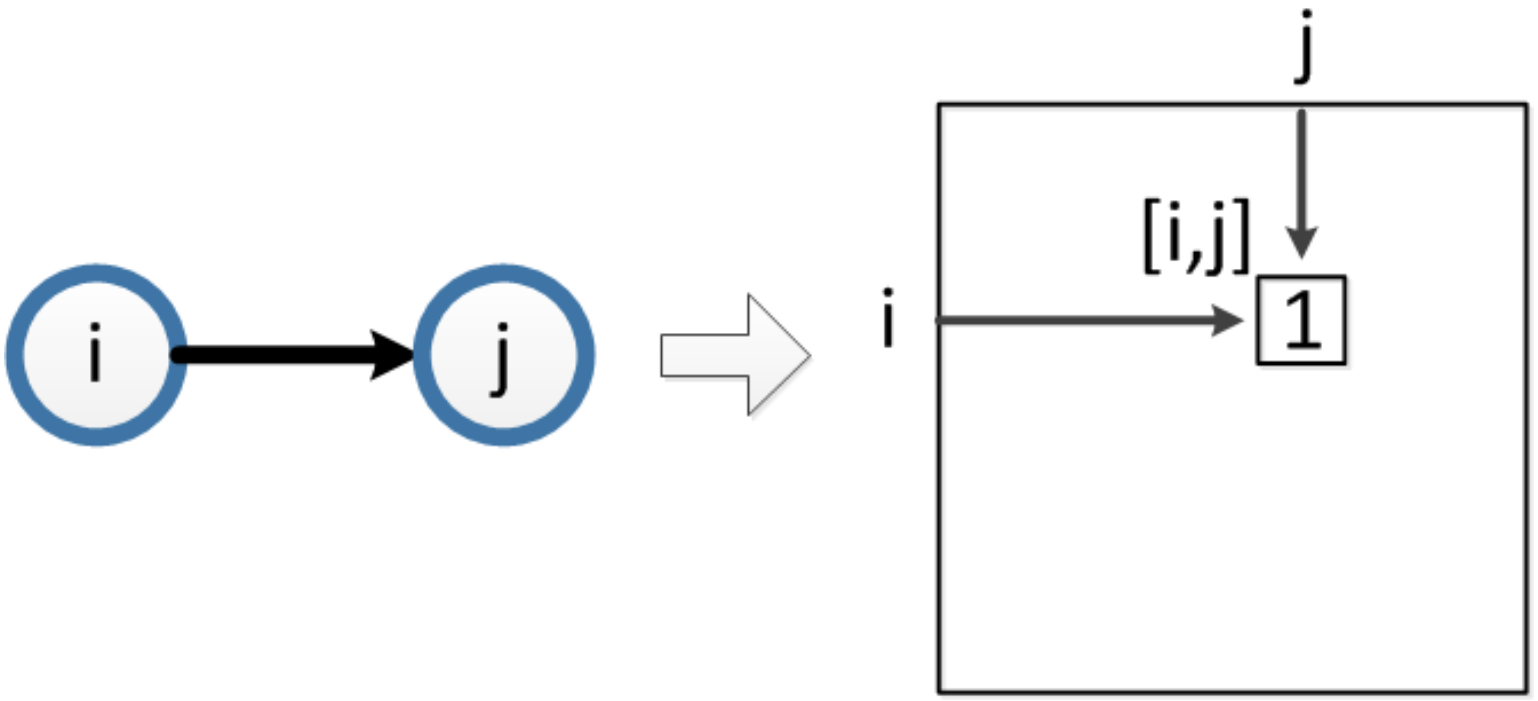
Downloading data



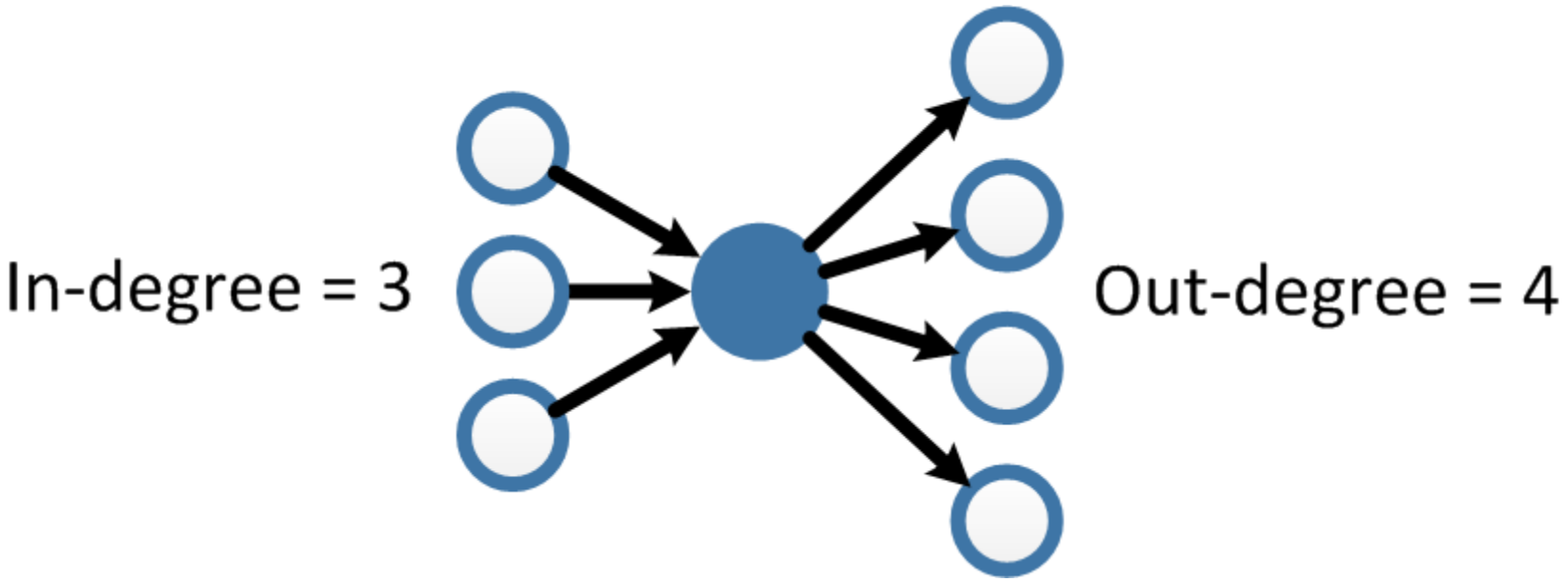
1) List of nodes
2) Connections between nodes

Twitter API allows only 15 requests every 15 minutes to list connections.

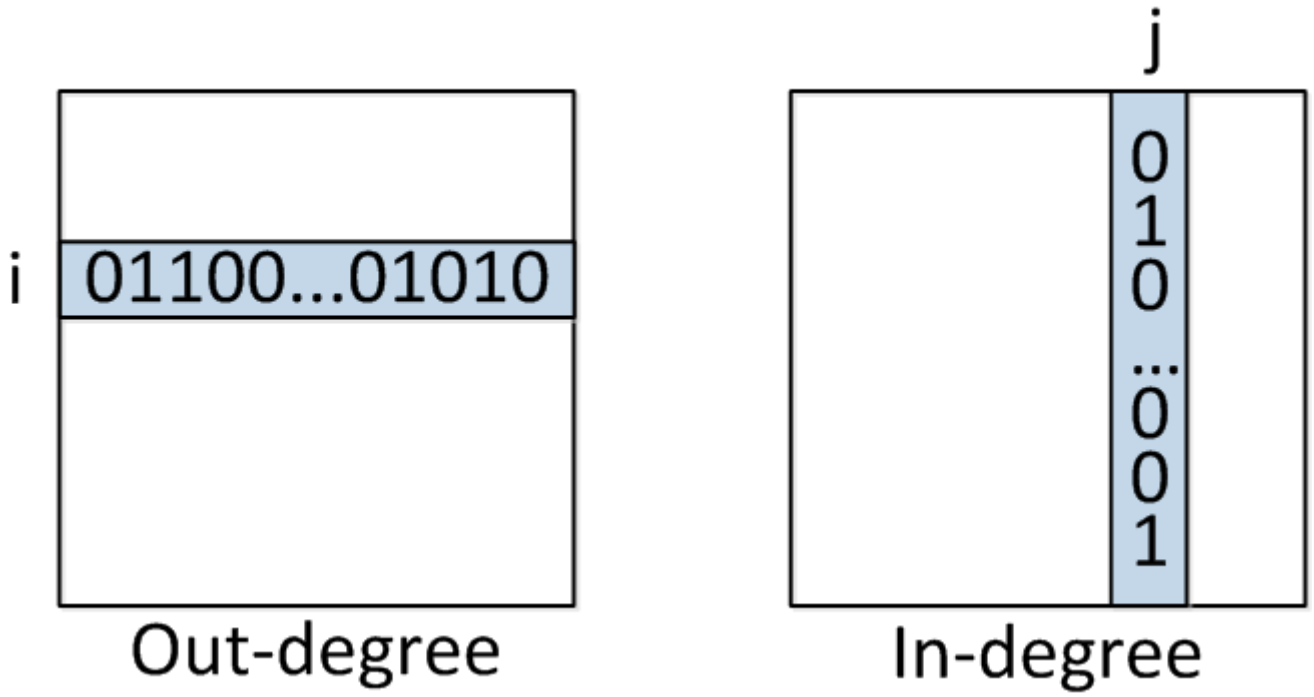
Adjacency matrix



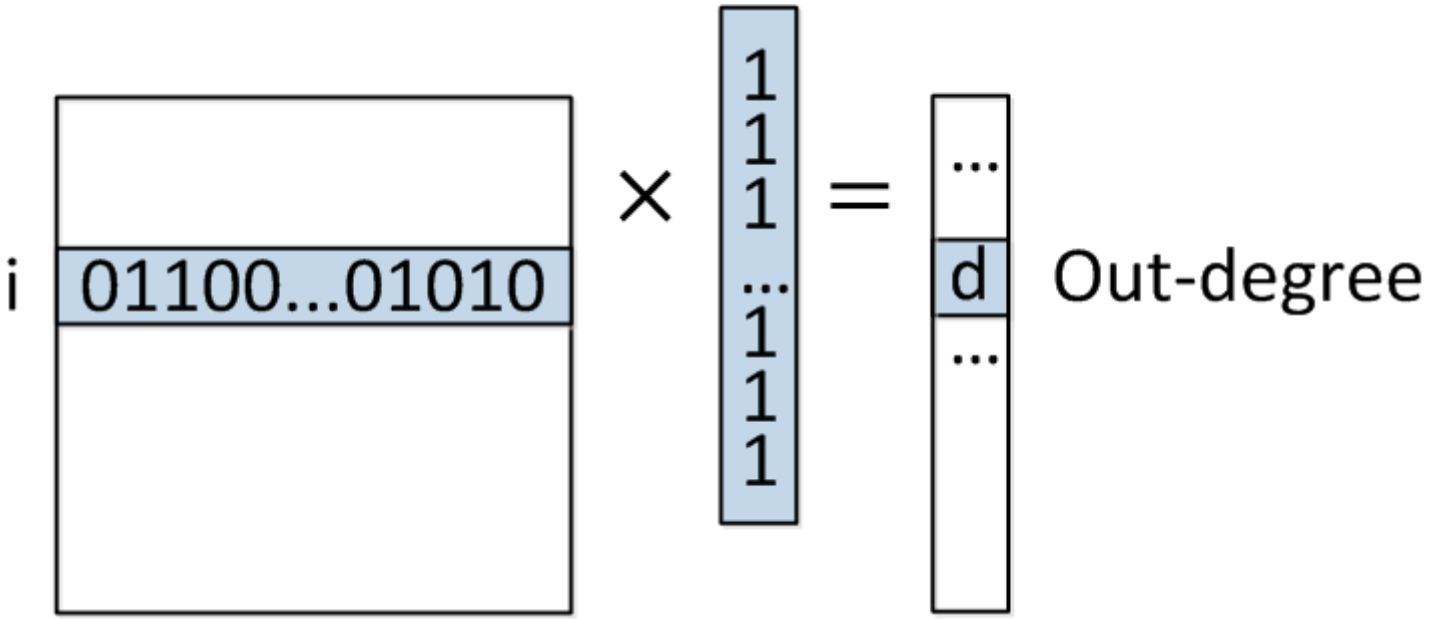
Degrees



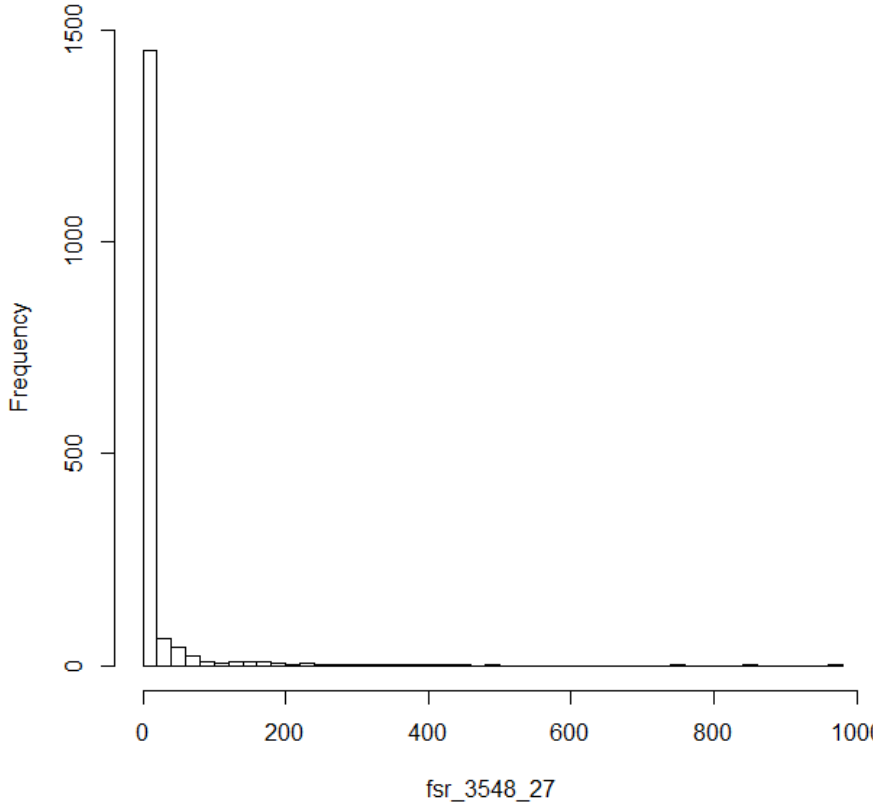
Degrees

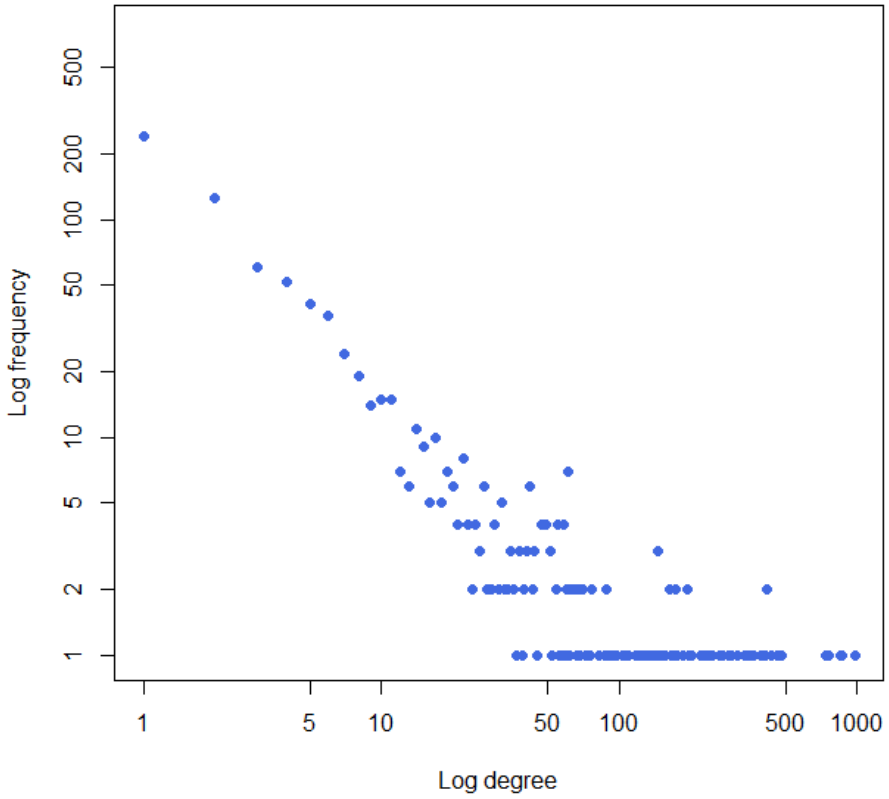


Degrees



Degree distribution



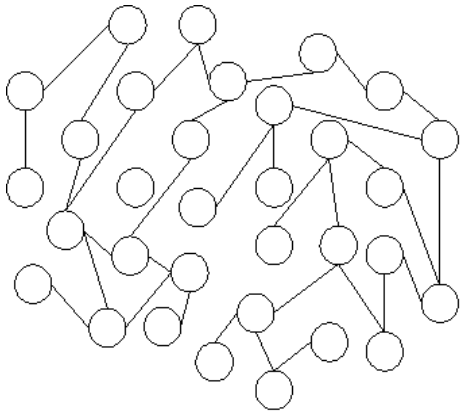


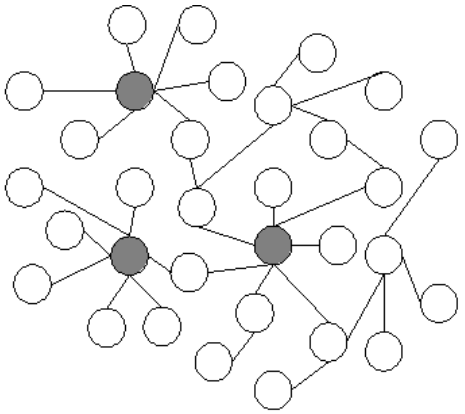
Scale-free networks

- Power law

$$P(d) \sim d^{-\gamma}$$

- Networks growing over time with preferential attachment
- Hubs
- Robustness





- Your friends have more friends than you have.

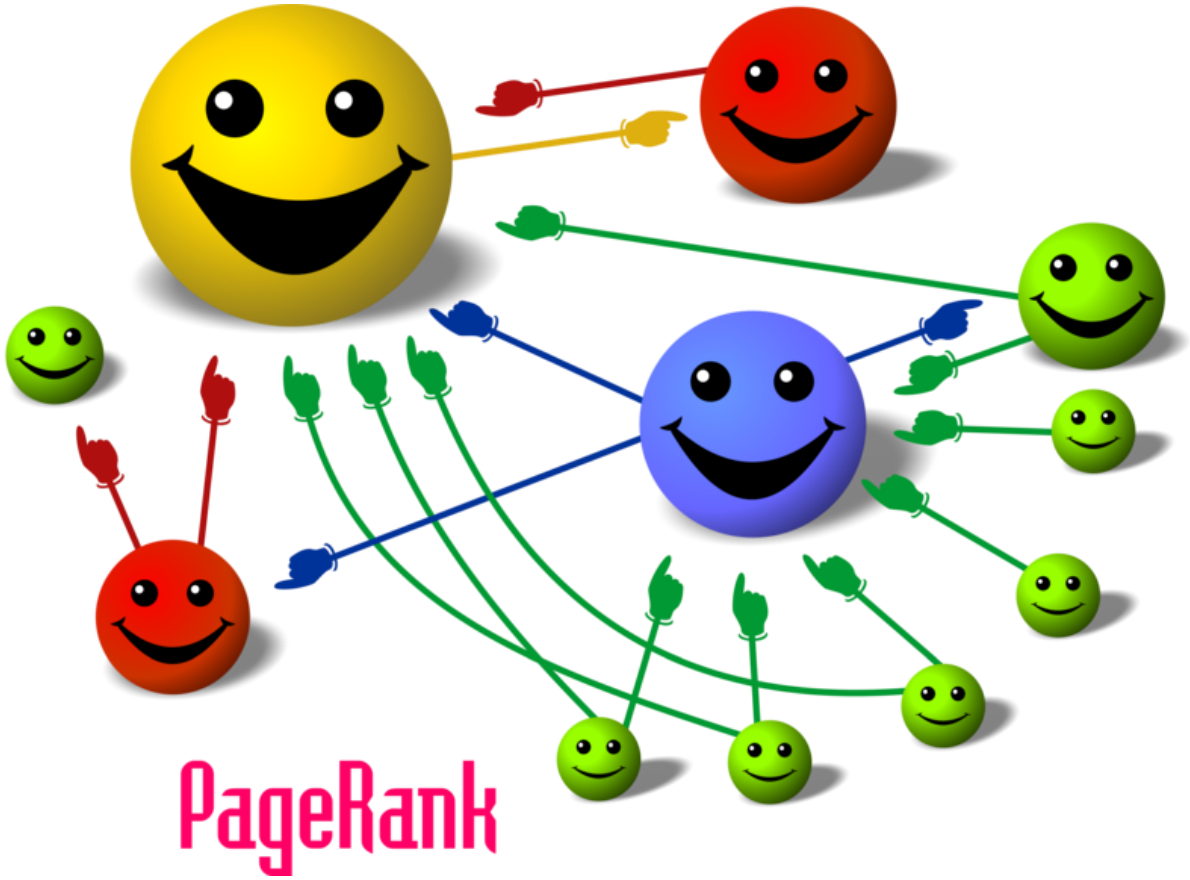
Hubs in networks

How to identify most

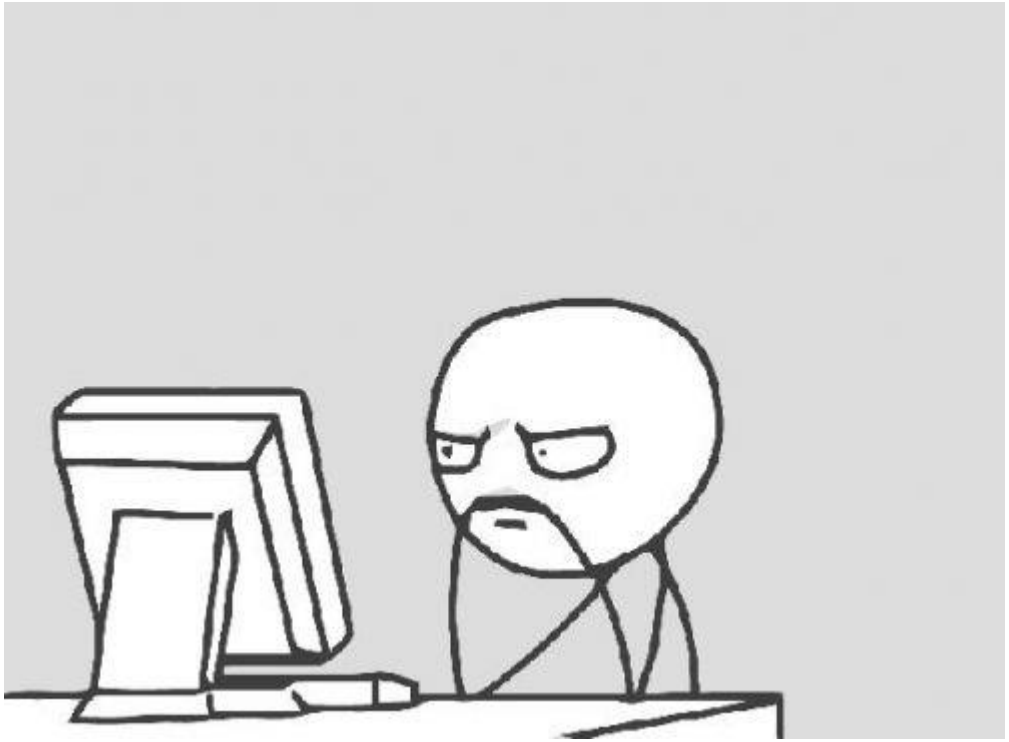
important nodes in a network?

Centrality with PageRank

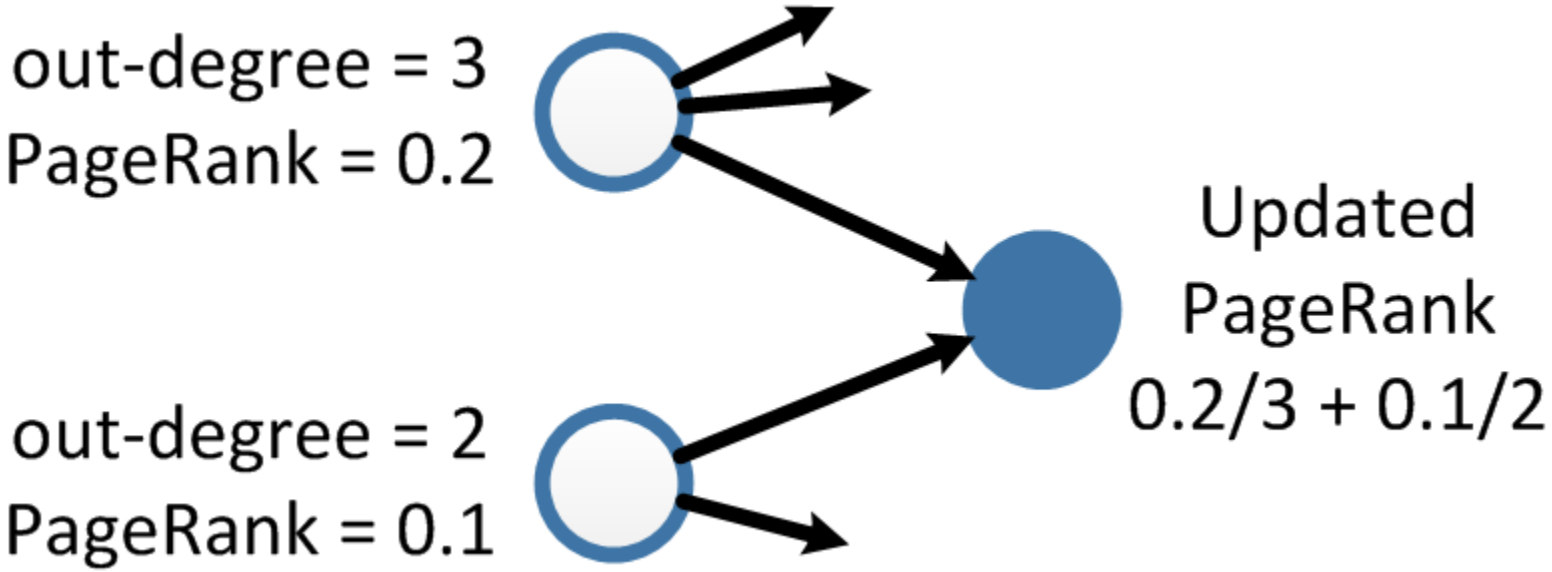
Your followers are not created equal.



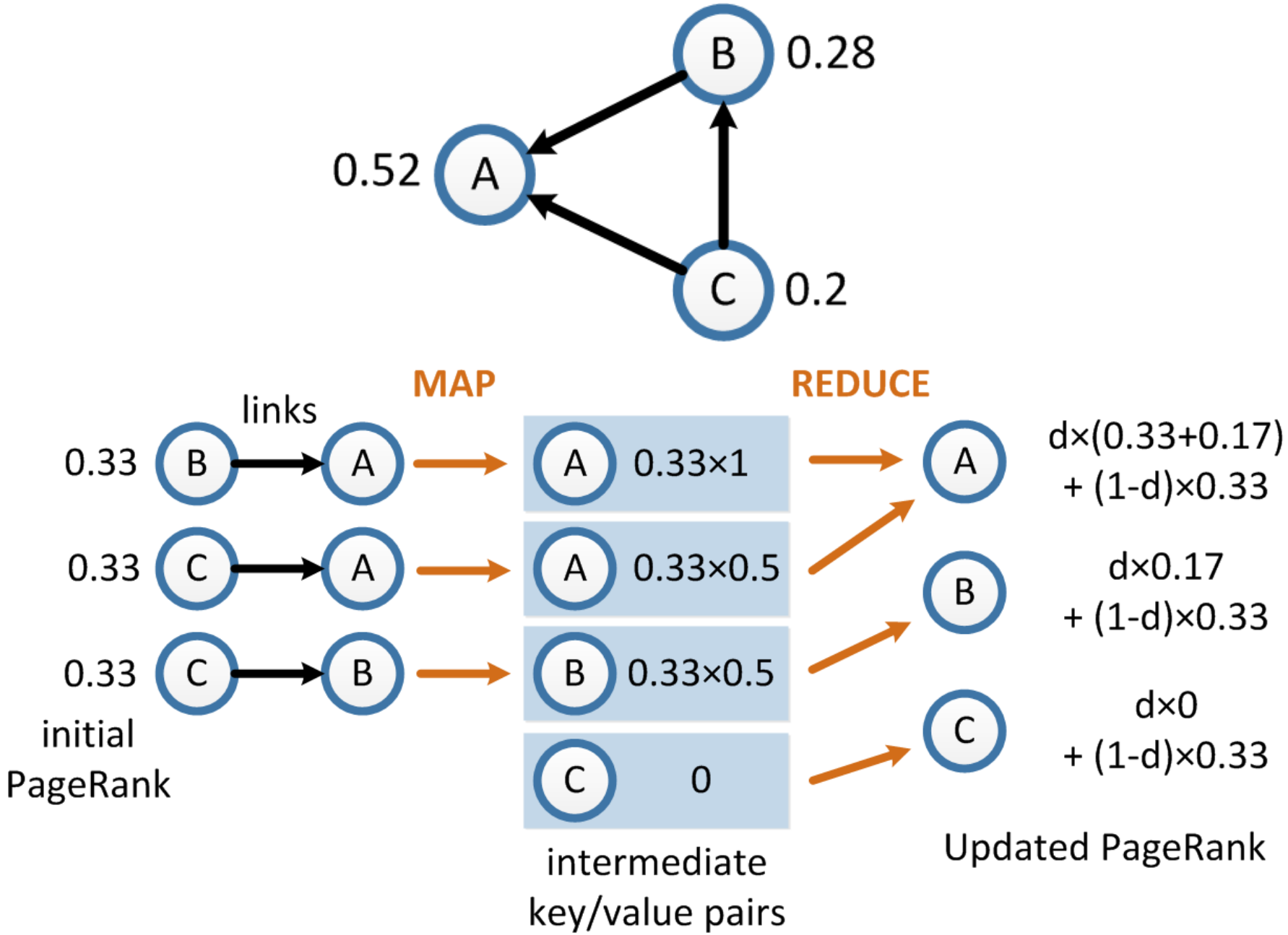
Random surfer model



Centrality with PageRank



+ random jumps


B
0.28
0.52
A
C
0.2
MAP
REDUCE
links
0.33
B
A
A
0.33×1
A
d×(0.33+0.17)
+ (1-d)×0.33
0.33
C
A
A
0.33×0.5
B
d×0.17
+ (1-d)×0.33
0.33
C
B
B
0.33×0.5
C
d×0
+ (1-d)×0.33
initial
PageRank
C
0
intermediate
key/value pairs
Updated PageRank

PageRank changes

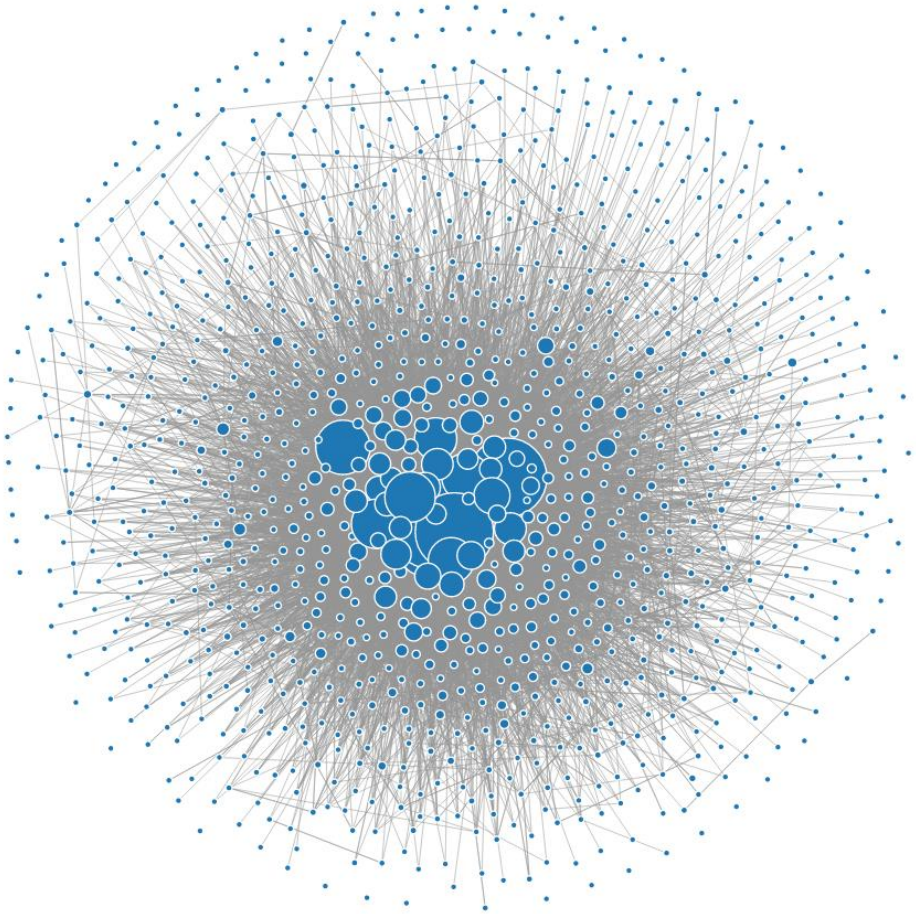
February

1. migueldeicaza (0.033130)
2. dsyme (0.032783)
3. tomaspetricek (0.027756)
4. LincolnAtkinson (0.021993)
5. VisualFSharp (0.020233)
6. c4fsharp (0.019720)
7. rickasaurus (0.019189)
8. ptrelford (0.018099)
9. 1tgr (0.016525)
10. sforkmann (0.014970)

November

1. dsyme (0.026928)
2. VisualFSharp (0.023572)
3. migueldeicaza (0.023111)
4. tomaspetricek (0.019736)
5. c4fsharp (0.018511)
6. rickasaurus (0.012992)
7. FSPowerTools (0.012077)
8. sforkmann (0.011950)
9. ptrelford (0.011787)
10. 1tgr (0.011256)

Visualization with D3.js



Spectral analysis

Eigenvalue decomposition

$$Av = \lambda v$$

Eigenvectors show centrality and community structure

Non-backtracking matrix

Spectral analysis

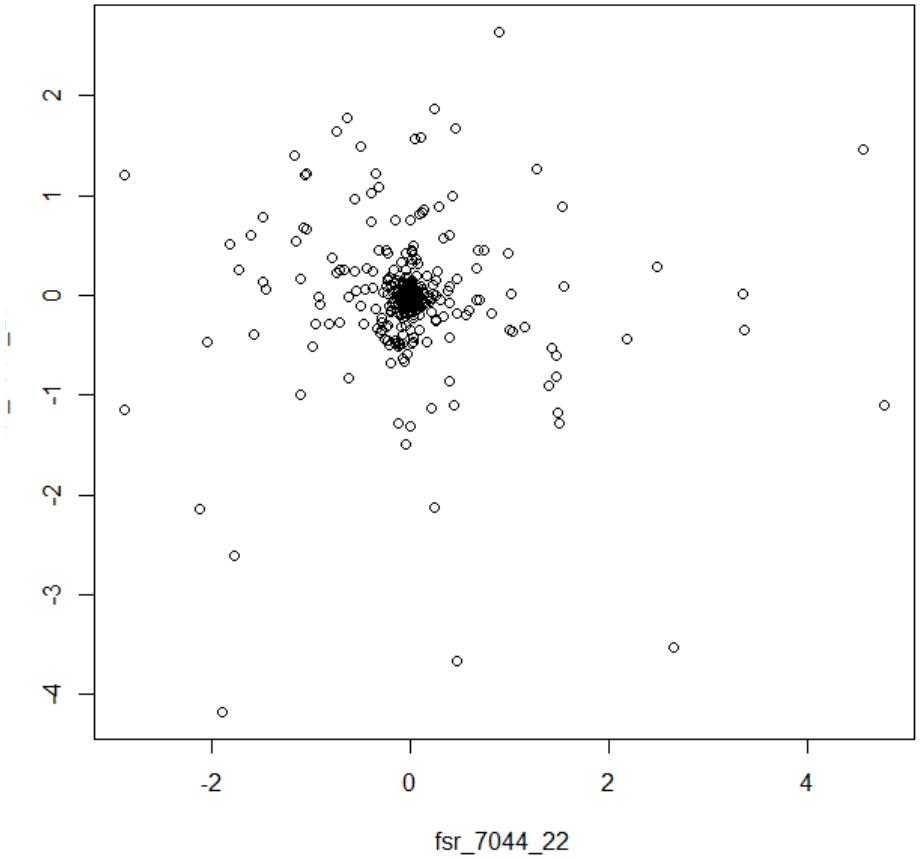
PageRank

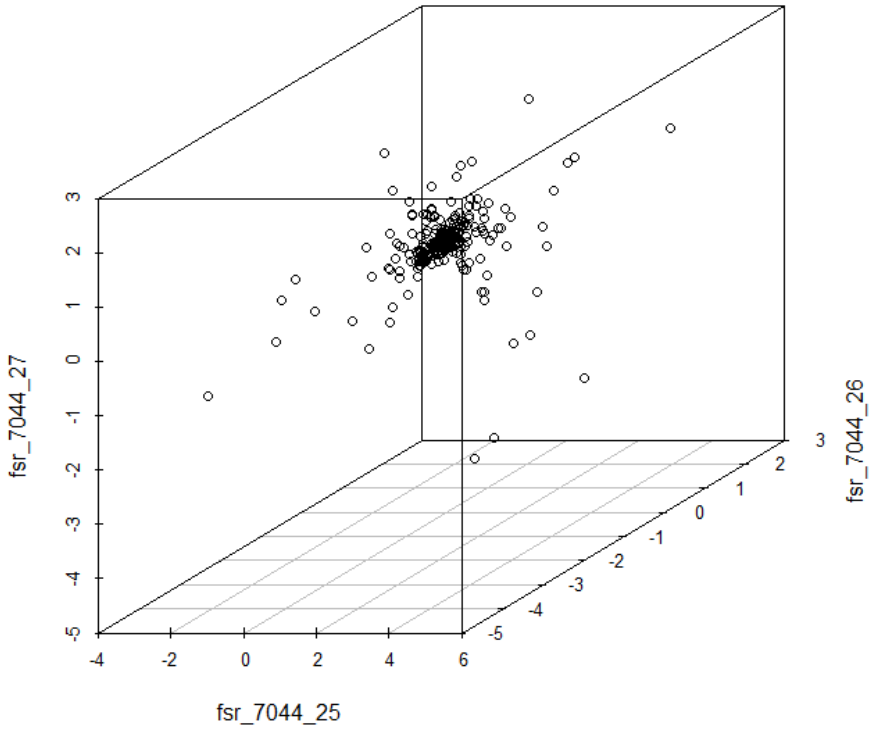
1. dsyme
2. VisualFSharp
3. migueldeicaza
4. tomaspetricek
5. c4fsharp
6. rickasaurus
7. FSPowerTools
8. sforkmann
9. ptrelford
10. 1tgr

1st eigenvector

1. dsyme
2. c4fsharp
3. sforkmann
4. ptrelford
5. tomaspetricek
6. brandewinder
7. foxyjackfox
8. rickasaurus
9. sergey_tihon
10. panesofglass

Spectral analysis





Go play
with data

Why F#?

```
    Lp = lapply(logL, exp)
for(m in 1:M){
    for(i in 1:N) L[[m]][i,] = rmultinom(1,1,Lp[[m]][i,]) #Generate L from Lp
    if(w>1) L[[m]] = AlignClusters(C,L[[m]], type = 'mat') #Helps to align indices
    n[m,] = colSums(L[[m]])
    for(k in 1:K){ ###Update cluster parameters based on normal-gamma distribution
        if(d[m]==1&n[m,k]>1){
            S[[m]][,k] = sd(X[[m]][,L[[m]][,k]==1])^2
            PostMean = sum(X[[m]][,L[[m]][,k]==1])/(n[m,k]+1)
            B[[m]][,k] = b0[[m]]+0.5*(n[m,k]*S[[m]][,k]+n[m,k]*(mean(X[[m]][,L[[m]][,k]==1])-mu0[[m]])^2
        if(d[m]>1&n[m,k]>1){
            PostMean = (mu0[[m]]+rowSums(X[[m]][,L[[m]][,k]==1]))/(n[m,k]+1)
            S[[m]][,k] = apply(X[[m]][,L[[m]][,k]==1],MARGIN=1,FUN='sd')^2
        B[[m]][,k] = b0[[m]]+0.5*(n[m,k]*S[[m]][,k]+n[m,k]*(rowMeans(X[[m]][,L[[m]][,k]==1])-mu0[[m]])^2
        if(n[m,k]==1){
            PostMean = (mu0[[m]]+X[[m]][,L[[m]][,k]==1])/2
        B[[m]][,k] = b0[[m]]+0.5*(X[[m]][,L[[m]][,k]==1]-mu0[[m]])^2/2}
        if(n[m,k]==0){
            PostMean = mu0[[m]]
            B[[m]][,k] = b0[[m]]}
        Lambda = 1+n[m,k]
        A[[m]][,k] = a0[[m]]+n[m,k]/2
        Tau[[m]][,k] = rgamma(d[m],shape=A[[m]][,k],rate=B[[m]][,k])
        mu[[m]][,k] = rnorm(d[m],PostMean,sqrt(1/(Tau[[m]][,k]*Lambda)))
        Sigma[[m]][,k] = sqrt(1/Tau[[m]][,k])}
}
```

Thank you

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fsharp.org

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17 April, London