Real-time network analysis in R using Twitter

Drew Conway

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Standing on the shoulders of giants

Collection and parsing of Twitter data

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Data visualization

- ggplot2
- Hadley Wickham, Dept. of Statistics — Rice University

A bit on tools

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  - **Intent** - consumers and producer of SNA come from a wide range of technical expertise and/or need, therefore, there exist simple tools for data collection and basic analysis, as well as complex suites for advanced research

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Basic	- ORA (Windows) - Analyst Notebook (Windows) - KrakPlot (Windows)	- libSNA (Python) - UrlNet (Python) - NodeXL (MS Excel)
Advanced	- UCINet (Windows) - Pajek (Multi) - Network Workbench (Multi)	- NetworkX (Python) - JUNG (Java) - igraph (Python, R & Ruby)

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Pros and Cons of SNA in R

Pros

Diversity of tools available in R

- Analysis - sna: sociometric data; `RBGL`: Binding to Boost Graph Lib
- Simulation - `ergm`: exponential random graph; `networksis`: bipartite networks
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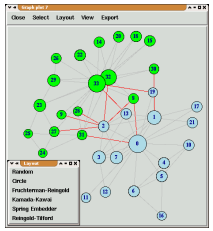
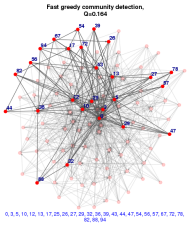
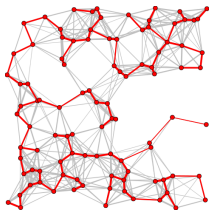
- Take advantage of R's built-in graphics tools







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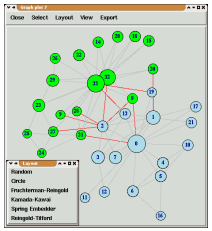

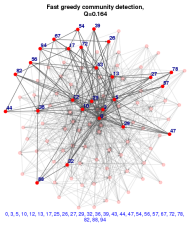

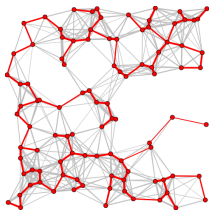

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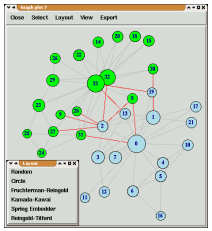

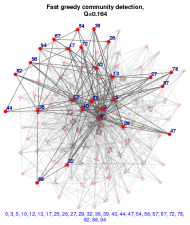

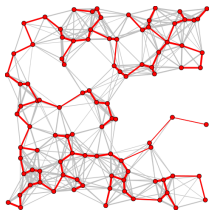

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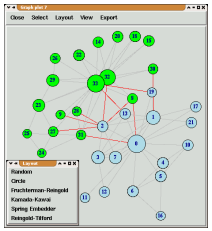

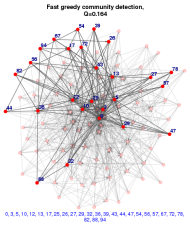

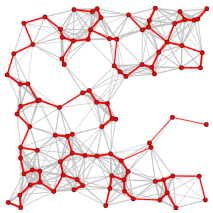

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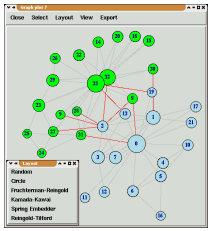

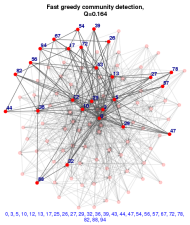

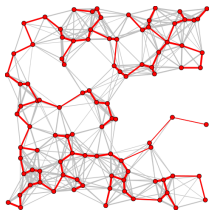

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In ability to exchange data between other network analysis packages

- `statnet` library powerful for modeling
- `igraph` and `statnet` represent networks in different ways
- Difficult to exchange data between libraries

Comparing two network metrics to find key actors

Often social network analysis is used to identify key actors within a social group. To identify these actors, various centrality metrics can be computed based on a network's structure

- Degree (number of connections)
- Betweenness (number of shortest paths an actor is on)
- Closeness (relative distance to all other actors)
- Eigenvector centrality (leading eigenvector of sociomatrix)

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One method for using these metrics to identify key actors is to plot actors' scores for Eigenvector centrality versus Betweenness. Theoretically, these metrics should be approximately linear; therefore, any non-linear outliers will be of note.

- An actor with very high betweenness but low EC may be a critical gatekeeper to a central actor
- Likewise, an actor with low betweenness but high EC may have unique access to central actors

Finding Key Actors with R

For this example, we will use the main component of the social network collected on drug users in Hartford, CT.[1] The network has 194 nodes and 273 edges.

[1] Weeks, et al (2002) http://dx.doi.org/10.1023/A:1015457400897

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Load the data into igraph

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library(igraph)
G<-read.graph("drug_main.txt",format="edgelist")
G<-as.undirected(G)
# By default, igraph inputs edgelist data as a directed graph.
# In this step, we undo this and assume that all relationships are reciprocal.
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Store metrics in new data frame

```
cent<-data.frame(bet=betweenness(G),eig=evcent(G)$vector)
# evcent returns lots of data associated with the EC, but we only need the
# leading eigenvector
res<-lm(eig~bet,data=cent)$residuals
cent<-transform(cent,res=res)
# We will use the residuals in the next step
```

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Finding Key Actors with R

Plot the data

```
library(ggplot2)
# We use ggplot2 to make things a
# bit prettier
p<-ggplot(cent,aes(x=bet,y=eig,
    label=rownames(cent),colour=res,
    size=abs(res)))+xlab("Betweenness
    Centrality")+ylab("Eigenvector
    Centrality")
# We use the residuals to color and
# shape the points of our plot,
# making it easier to spot outliers.
p+geom_text()+opts(title="Key Actor
    Analysis for Hartford Drug Users")
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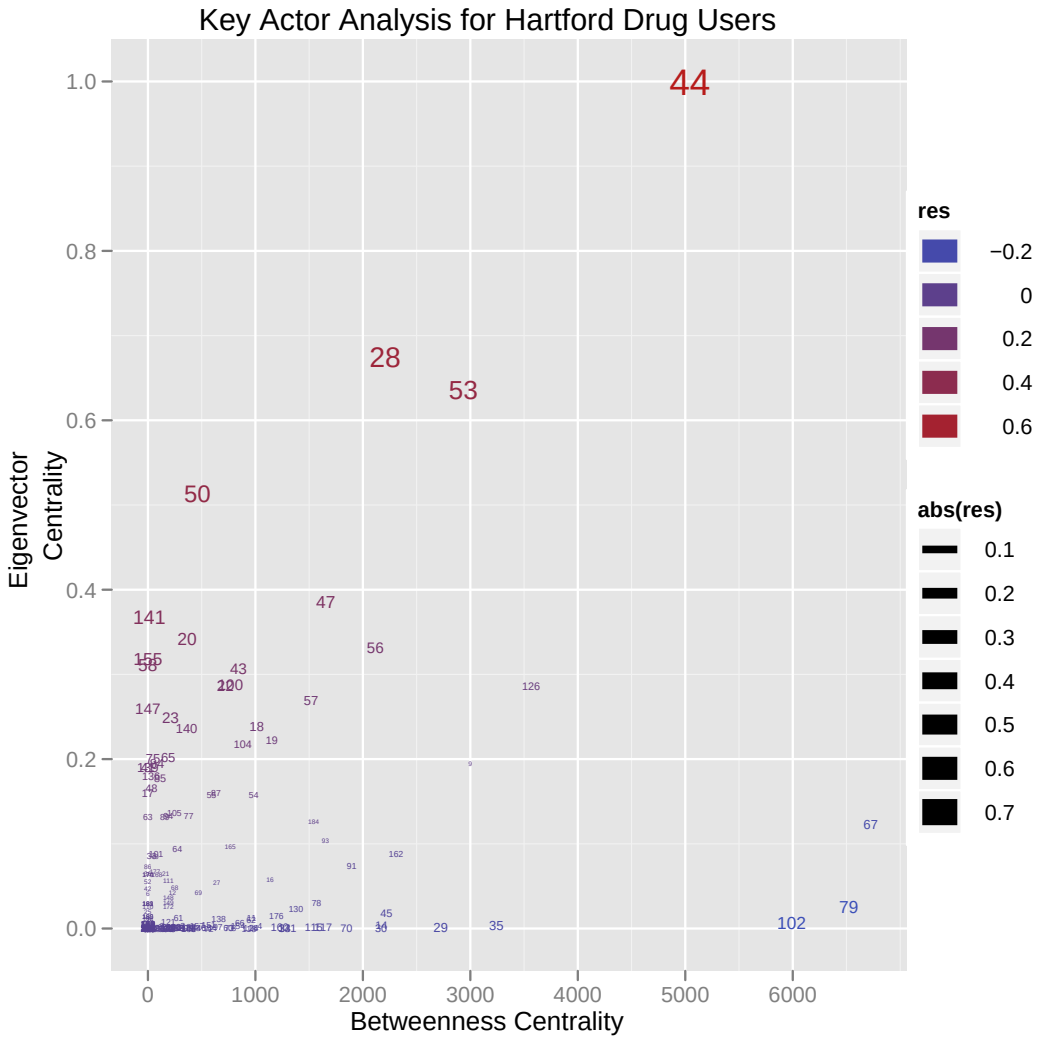

Where to get social graph data

Recently, there has been an explosion of resources for scraping social graph

Service	Data	API Docs
twitter	Following(ers), @-replies, date/time/geo	http://apiwiki.twitter.com/
facebook	Friends, Wall Posts, date/time	http://developers.facebook.com/docs/api
Google	All SocialGraph relationships	http://code.google.com/apis/socialgraph/
foursquare	Friends, Check-ins	http://foursquare.com/developers/
hunch	"Taste graph", recommendations	http://hunch.com/developers/
The New York Times	Congressional votes, campaign finance	http://developer.nytimes.com/docs

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facebook	Friends, Wall Posts, date/time	http://developers.facebook.com/docs/api
Google	All SocialGraph relationships	http://code.google.com/apis/socialgraph/
foursquare	Friends, Check-ins	http://foursquare.com/developers/
hunch	"Taste graph", recommendations	http://hunch.com/developers/
The New York Times	Congressional votes, campaign finance	http://developer.nytimes.com/docs

There is clearly no shortage of data

- Each service provides different relational context
- Data formats are generally JSON, Atom, XML, or some combination
- For a more extensive list of API resources, see HackNY wiki of local startups

Why use Twitter for analyzing networks?

Unprecedented scale and accessibility

- Twitter provides free and open (rate-limited) access to their data
- The amount of data pushed to daily is enormous
- "Following" structure natural social network

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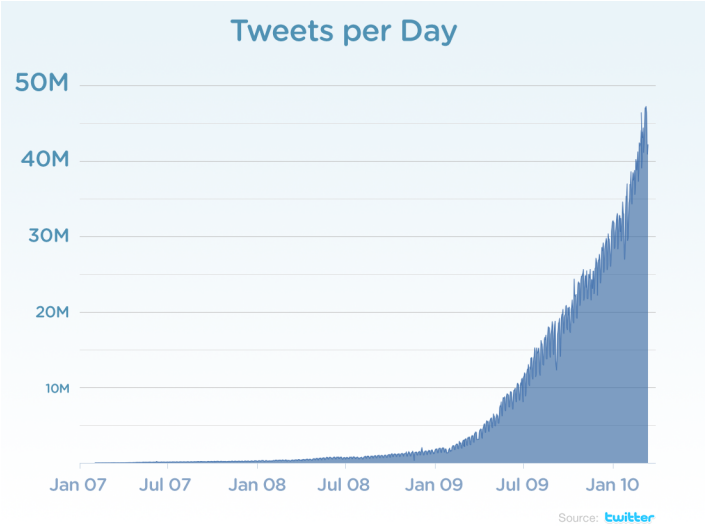

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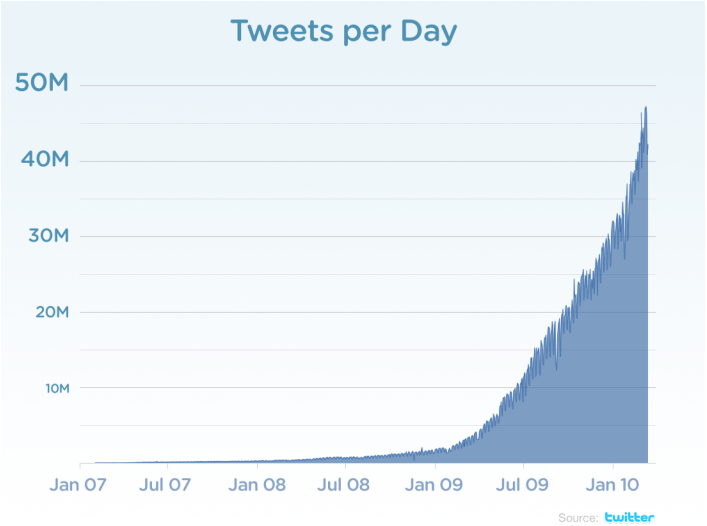

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- Many Tweets contain geospatial data

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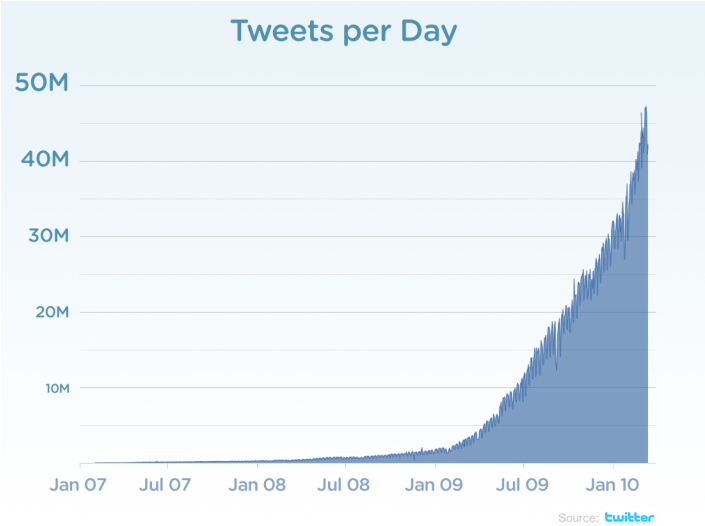

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Easy integration into R

- Data easily parsed with `twitteR` library (@geoffjentry)
- Quickly build edgelist structures
- Can use libraries such as `tm` and `ts` for text and longitudinal analysis

Infochimps.org

In addition to pulling the data yourself, Infochimps.org also offers large data sets for download (for a fee)

- Monthly Twitter census data

Infochimps also has a set of internally defined Twitter metrics that can be accessed freely via an API (`http://api.infochimps.com/`)

- `trstrank` — a version of Google's PageRank for Twitter
- Influence metrics — Twitter user "retweets" and @ replies

Getting started

Load libraries and initialize Twitter session

```
# We will use ggplot2 for later visualization
library(twitteR)
library(igraph)
library(ggplot2)

# Initialize a session to gather dat
user<-"your.name"
pass<-"your.pass"
twit<-initSession(user,pass)

# Get all the users from the last 100 tweets containing some hashtag
hashtag<-"my.hashtag"
hash.tweets<-get.hashtag(hashtag)
hash.users<-users.from.statuses(hash.tweets)
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Create several helper functions to generate network data from Twitter

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# Function for converting twitteR object data to vector
friend.vector<-function(friends) {
    v<-c()
    for(i in 1:length(friends)) {v<-append(v,as.character(screenName(friends[[i]])))}
    return(v)}
# Function for generating edgelists
create.adj<-function(seed) {
    u<-getUser(seed)
    # Cannot create network data from protected accts
    if(protected(u)==FALSE) {
        outdegree<-userFriends(u,twit)
        friends<-friend.vector(outdegree)
        return(list(adj.list=cbind(seed,friends),seed.friends=friends))
    }
    else {
        return(list(adj.list=NA,seed.friends=NA))
    }}
# Get the last 100 tweets containing the given hashtag
get.hashtag<-function(hashtag,session=getCurlHandle()) {
    search.url<-paste("http://search.twitter.com/search.json?q=%23",hashtag,"&rpp=100",sep="")
    out <- getURL(search.url, curl = session)
    jsonList <- twFromJSON(out)[[1]]
    return(sapply(jsonList, buildStatus))}
# Get the users from a list of tweets
users.from.statuses<-function(status.list) {
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    return(unique(users))}
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        users<-append(users,(screenName(status.list[[i]])))
    }
    return(unique(users))}
```

Create several helper functions to generate network data from Twitter

```
# Function for converting twitteR object data to vector
friend.vector<-function(friends) {
    v<-c()
    for(i in 1:length(friends)) {v<-append(v,as.character(screenName(friends[[i]])))}
    return(v)}
# Function for generating edgelists
create.adj<-function(seed) {
    u<-getUser(seed)
    # Cannot create network data from protected accts
    if(protected(u)==FALSE) {
        outdegree<-userFriends(u,twit)
        friends<-friend.vector(outdegree)
        return(list(adj.list=cbind(seed,friends),seed.friends=friends))
    }
    else {
        return(list(adj.list=NA,seed.friends=NA))
    }}
# Get the last 100 tweets containing the given hashtag
get.hashtag<-function(hashtag,session=getCurlHandle()) {
    search.url<-paste("http://search.twitter.com/search.json?q=%23",hashtag,"&rpp=100",sep="")
    out <- getURL(search.url, curl = session)
    jsonList <- twFromJSON(out)[[1]]
    return(sapply(jsonList, buildStatus))}
# Get the users from a list of tweets
users.from.statuses<-function(status.list) {
    users<-c()
    for(i in 1:length(status.list)) {
        users<-append(users,(screenName(status.list[[i]])))
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    return(unique(users))}
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Build the network

```
# We now build the network, but we have to make sure the initial seed is not protected
seed.user<-1
while(protected(getUser(hash.users[seed.user]))) {seed.user<-seed.user+1}
# Now create the edgelists for all uses
for(u in seed.user:length(hash.users)) {
    if(u==seed.user) {
        hash.list<-create.adj(hash.users[u])
        hash.el<-hash.list$adj.list
    }
    else {
        current.list<-create.adj(hash.users[u])
        current.el<-current.list$adj.list
        if(is.na(current.el)) {
            print(paste(hash.users[u]), ``has a protected account--ignoring'')
        }
        else {
            hash.el<-rbind(hash.el,current.el)
        }
    }
}
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    }
}
```

Live demo

~~Live~~Pre-loaded demonstration time!
#user2010

All code available at `http://www.drewconway.com/zia`