

Real-time network analysis in R using Twitter

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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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 - ▶ **Type** - many SNA tools are developed to be standalone applications, while others are language specific packages
 - ▶ **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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	<i>Standalone Apps</i>	<i>Modules & Packages</i>
<i>Basic</i>	<ul style="list-style-type: none">- ORA (Windows)- Analyst Notebook (Windows)- KrakPlot (Windows)	<ul style="list-style-type: none">- libSNA (Python)- UrINet (Python)- NodeXL (MS Excel)
<i>Advanced</i>	<ul style="list-style-type: none">- UCINet (Windows)- Pajek (Multi)- Network Workbench (Multi)	<ul style="list-style-type: none">- 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
- ▶ Specific use - `degreenet`: degree distribution; `tnet`: weighted networks

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Pros and Cons of SNA in R

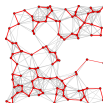
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- ▶ Perform SNA and network based econometrics "under the same roof"

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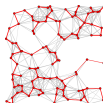
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- As with most things in R, the network analysis packages were designed by analysts for analysts
- These tools require at least a moderate familiarity with network structures and basic metrics

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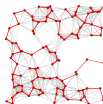
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In ability to exchange data between other network analysis packages

- `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.

¹Weeks, 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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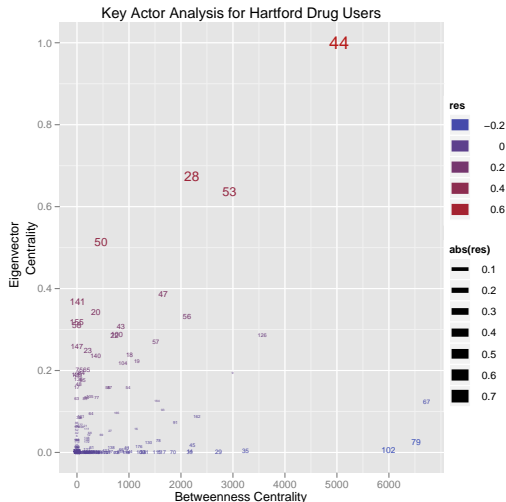
Plot the data

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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")
# We use the geom_text function to plot
# the actors' ID's rather than points
# so we know who is who
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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
	Following(ers), @-replies, date/time/geo	http://apiwiki.twitter.com/
	Friends, Wall Posts, date/time	http://developers.facebook.com/docs/api
	All SocialGraph relationships	http://code.google.com/apis/socialgraph/
	Friends, Check-ins	http://foursquare.com/developers/
	"Taste graph", recommendations	http://hunch.com/developers/
	Congressional votes, campaign finance	http://developer.nytimes.com/docs

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	Friends, Wall Posts, date/time	http://developers.facebook.com/docs/api
	All SocialGraph relationships	http://code.google.com/apis/socialgraph/
	Friends, Check-ins	http://foursquare.com/developers/
	"Taste graph", recommendations	http://hunch.com/developers/
	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?

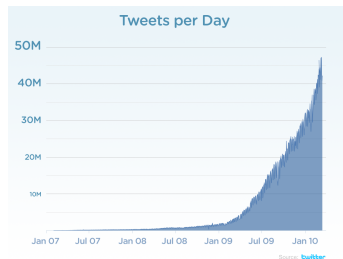
Unprecedented scale and accessibility

- ▶ 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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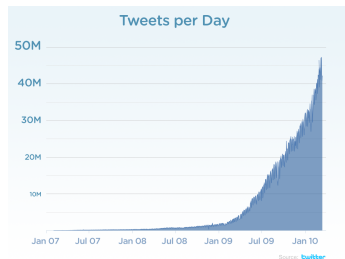
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- ▶ All relationships longitudinal
- ▶ Many Tweets contain geospatial data



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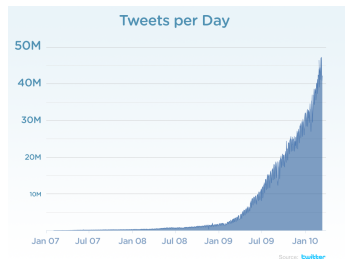
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Easy integration into R

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



Infochimps.org

The screenshot shows the Infochimps.org homepage. At the top, there's a navigation bar with links: Home, Search, Log out, Blog, Gallery, About, Help. The main header features the Infochimps logo and the tagline "Find the world's data". Below this, a welcome message states: "Welcome to the world's largest open platform for data". The page is divided into several sections: "Infochimps lets you Discover, Share and Sell data of any size, shape or topic. Once you find an interesting dataset, see what connects to it by category, tags, sources and more."; "Open source knowledge. Our data commons lets anyone post data under an open license for the world to share, forever, at no cost to you or to them. Sign up for a beta tester invitation"; "The first open marketplace for data. For anything from polling surveys to market research to fantasy sports calculations, we can connect your data to a massive audience of customers, and to every other dataset in our collection. You control the terms, you set the price, we handle storage, distribution and billing. Register now!"; "Some Interesting Datasets" with a list of datasets including "Word List - 1000 Most Frequent Words from an Internet Corpus", "Oil Spills in U.S. Water - Number and Volume: 2000 to 2004", "Infant, Neonatal, and National Mortality Rates by Race: 1970 to 2004", "Word List - 100,000 official crossword words", "Voting Age Population, Percent Reporting Registered, and Voted: 1972 to 2006", "Relation of GDP, GNP, Net National Product, National Income, Personal Income, Disposable Personal Income", "Daily 1970 Current Open, Close, H, Low and Volume (NASDAQ exchange)", "Word List - 1,000 Most Frequently Used English Words by Frequency", "Household Debt-Service Payments and Financial Obligations as a Percentage of Disposable Personal Inc", "Global Daily Weather Data from the National Climate Data Center (NCDC)", "Teenagers - Births and Birth Rates, by Age, Race, and Hispanic Origin: 1990 to 2005", and "Article Search API - NYTimes.com"; "Meta-Meta-Metadata" with a link to "Datasets to find: 5630"; "Top Tags" with a grid of tags including government, census, population, america, demographics, state, selected, olympics, type, e-transparency, team, character, jwlink, race, access-mobility, finance, statistics, country, industry, summary, age, corpus, income, characteristics, number, science, party, language, sales, sex, notes, school, expenditures, public, federal, name, access-www, employment, player, retail, and and; "Sign up" button with text "as a user to edit or share data (Learn more...)"; and "Vendors" button with text "Register as a vendor to sell data (Learn more...)".

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(twitterR)
library(igraph)
library(ggplot2)

# Initialize a session to gather data
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 twitterR 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 edgelist
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))
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get.hashtag<-function(hashtag,session=getCurlHandle()) {
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  jsonList <- twFromJSON(out)[[1]]
  return(sapply(jsonList, buildStatus))}

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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]])))
  }
  return(unique(users))}
```

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 edgelist 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

LivePre-loaded demonstration time!
#user2010

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