Programska podpora za delo z "zapletenimi" omrežji

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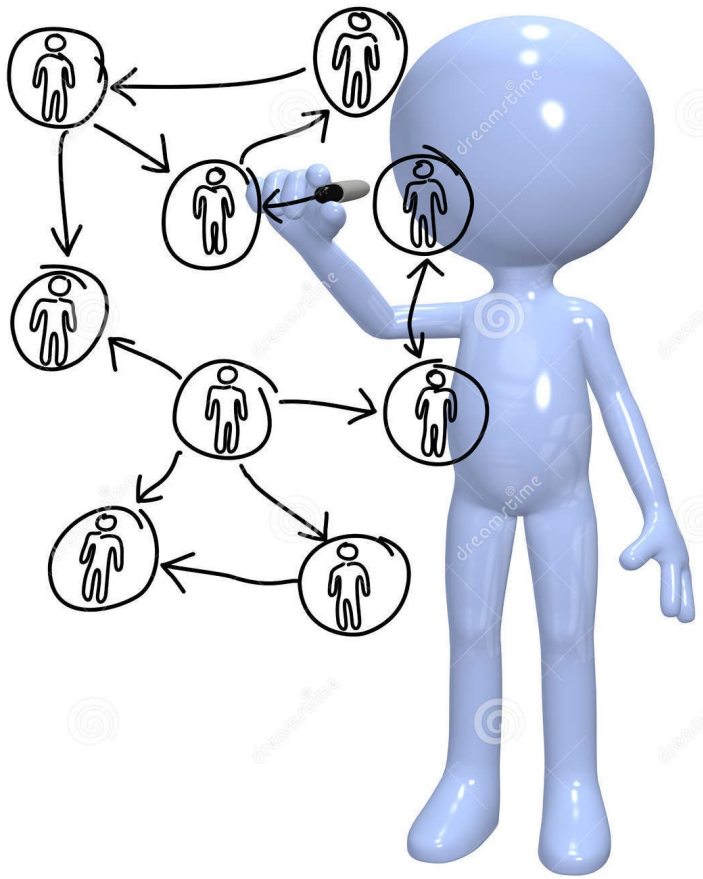
Kazalo



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Zadnja različica teh prosojnic (7. oktober 2016 ob 07 : 18):
sreda1263.pdf

Omrežja

Zgradba *omrežja* temelji na dveh množicah – množici *vozlišč* (točk), ki predstavljajo izbrane *enote*, in množici *povezav*, ki predstavljajo *odnose* med enotami. Skupaj določata *graf*. Posamezna povezava je lahko ali *usmerjena* ali pa *neusmerjena*.
O vozliščih in povezavah lahko imamo še dodatne podatke – *lastnosti* vozlišč in *uteži* na povezavah.

omrežje = Graf+ Podatki

Omrežje $\mathcal{N} = (\mathcal{V}, \mathcal{L}, \mathcal{P}, \mathcal{W})$ sestavljajo:

- *graf* $\mathcal{G} = (\mathcal{V}, \mathcal{L})$, kjer sta $\mathcal{V}$ množica vozlišč in $\mathcal{L} = \mathcal{E} \cup \mathcal{A}$ množica povezav. $\mathcal{A}$ je množica usmerjenih povezav in $\mathcal{E}$ je množica neusmerjenih povezav. $n = |\mathcal{V}|$, $m = |\mathcal{L}|$
- $\mathcal{P}$ *lastnosti vozlišč*: $p : \mathcal{V} \to A$
- $\mathcal{W}$ *uteži*: $w : \mathcal{L} \to B$

Omrežja

V *dvovrstnem omrežju* $\mathcal{N} = ((\mathcal{V}_1, \mathcal{V}_2), \mathcal{L}, \mathcal{P}, \mathcal{W})$ je množica vozlišč razbita na dve podmnožici. Vsaka povezava ima po eno krajišče v obeh podmnožicah.

V *večrelacijskem omrežju* $\mathcal{N} = (\mathcal{V}, (\mathcal{L}_i, i \in I), \mathcal{P}, \mathcal{W})$ je množica povezav razbita na več podmnožic – relacij.
(Osebek Povedek Predmet).

V *časovnem omrežju* $\mathcal{N} = (\mathcal{V}, \mathcal{L}, \mathcal{T}, \mathcal{P}, \mathcal{W})$ je omrežju dodan čas $\mathcal{T}$. Vsakemu vozlišču in povezavi je prirejena množica (trenutkov) dejavnosti ali prisotnosti. Tudi vrednosti posameznih lastnosti in uteži se laho spreminjajo skozi čas – časovne količine.

Zbirko omrežij sestavljajo omrežja s skupnimi podmnožicami vozlišč..

Te vrste omrežij se lahko prepletajo. Tako, na primer, lahko imamo časovno dvovrstno večrelacijsko omrežje.

Opis omrežij

Kako opisati omrežje $\mathcal{N}$? Načeloma je odgovor preprost – naštejemo sestavine – množice, ki ga sestavljajo $\mathcal{V}$,$\mathcal{L}$,$\mathcal{P}$, in $\mathcal{W}$.

Najbrž najenostavneje opišemo omrežje $\mathcal{N}$ tako da $(\mathcal{V}, \mathcal{P})$ in $(\mathcal{L}, \mathcal{W})$ podamo v obliki dveh razpredelnic.

Za primer opišimo omrežje določeno z naslednjimi deli:
Generalized blockmodeling, Clustering with relational constraint, Partitioning signed social networks, The Strength of Weak Ties

Obstajajo vozlišča različnih vrst: osebe, članki, knjige, zbirke, revije, založbe; in različni odnosi med njimi: author_of, editor_of, contained_in, cites, published_by.

Take razpredelnice običajno pripravimo in vzdržujemo s programi kot je Excel. Shranimo jih lahko v znakovno datoteko v obliki CSV (Comma Separated Values).

bibNodes.csv

```
name;mode;country;sex;year;vol;num;fPage;lPage;x;y
"Batagelj, Vladimir";person;SI;m;;;;;;809.1;653.7
"Doreian, Patrick";person;US;m;;;;;;358.5;679.1
"Ferligoj, Anuška";person;SI;f;;;;;;619.5;680.7
"Granovetter, Mark";person;US;m;;;;;;145.6;660.5
"Moustaki, Irini";person;UK;f;;;;;;783.0;228.0
"Mrvar, Andrej";person;SI;m;;;;;;478.0;630.1
"Clustering with relational constraint";paper;;;1982;47;;413;426;684.1;3
"The Strength of Weak Ties";paper;;;1973;78;6;1360;1380;111.3;329.4
"Partitioning signed social networks";paper;;;2009;31;1;1;11;408.0;337.8
"Generalized Blockmodeling";book;;;2005;24;;1;385;533.0;445.9
"Psychometrika";journal;;;;;;;;741.8;086.1
"Social Networks";journal;;;;;;;;321.4;236.5
"The American Journal of Sociology";journal;;;;;;;;111.3;168.9
"Structural Analysis in the Social Sciences";series;;;;;;;;310.4;082.8
"Cambridge University Press";publisher;UK;;;;;;;534.3;238.2
"Springer";publisher;US;;;;;;;884.6;174.0
```

bibNodes.csv

bibLinks.csv

```
from;relation;to
"Batagelj, Vladimir";authorOf;"Generalized Blockmodeling"
"Doreian, Patrick";authorOf;"Generalized Blockmodeling"
"Ferligoj, Anuška";authorOf;"Generalized Blockmodeling"
"Batagelj, Vladimir";authorOf;"Clustering with relational constraint"
"Ferligoj, Anuška";authorOf;"Clustering with relational constraint"
"Granovetter, Mark";authorOf;"The Strength of Weak Ties"
"Granovetter, Mark";editorOf;"Structural Analysis in the Social Sciences
"Doreian, Patrick";authorOf;"Partitioning signed social networks"
"Mrvar, Andrej";authorOf;"Partitioning signed social networks"
"Moustaki, Irini";editorOf;"Psychometrika"
"Doreian, Patrick";editorOf;"Social Networks"
"Generalized Blockmodeling";containedIn;"Structural Analysis in the Soci
"Clustering with relational constraint";containedIn;"Psychometrika"
"The Strength of Weak Ties";containedIn;"The American Journal of Sociolo
"Partitioning signed social networks";containedIn;"Social Networks"
"Partitioning signed social networks";cites;"Generalized Blockmodeling"
"Generalized Blockmodeling";cites;"Clustering with relational constraint
"Structural Analysis in the Social Sciences";publishedBy;"Cambridge Univ
"Psychometrika";publishedBy;"Springer"
```

bibLinks.csv

Opisi omrežij

Faktorizacija
Zaradi varčevanja s prostorom in učinkovitejše obdelave pogosto vrenosti imenskih spremenljivk zakodiramo – v R-ju temu postopku pravimo faktorizacija.
Najprej vse možne vrednosti spremenljivke zbremo v oštevilčen seznam nato pa vsako imensko vrednost v spremenljivki zamenjamo z njeno številko.
Ta pristop je uporabljen v večini programov, ki delajo z velikimi omrežji – žal pogosto "kodne tabele" niso programsko dostopne.

CSV2Pajek.R

```
# transforming CSV file to Pajek files
# by Vladimir Batagelj, June 2016
setwd("C:/Users/batagelj/work/Python/graph/SVG/EUSN")
colC <- c(rep("character",4),rep("integer",7)); nas <- c("","NA","NaN")
nodes <- read.csv2("bibNodes.csv",encoding='UTF-8',colClasses=colC,na.strings=nas)
n <- nrow(nodes); M <- factor(nodes$mode); S <- factor(nodes$sex)
mod <- levels(M); sx <- levels(S); S <- as.numeric(S); S[is.na(S)] <- 0
links <- read.csv2("bibLinks.csv",encoding='UTF-8',colClasses="character")
F <- factor(links$from,levels=nodes$name,ordered=TRUE)
T <- factor(links$to,levels=nodes$name,ordered=TRUE)
R <- factor(links$relation); rel <- levels(R)
net <- file("bib.net","w"); cat('*vertices ',n,'\n',file=net)
clu <- file("bibMode.clu","w"); sex <- file("bibSex.clu","w")
cat('%',file=clu); cat('%',file=sex)
for(i in 1:length(mod)) cat(' ',i,mod[i],file=clu)
cat('\n*vertices ',n,'\n',file=clu)
for(i in 1:length(sx)) cat(' ',i,sx[i],file=sex)
cat('\n*vertices ',n,'\n',file=sex)
for(v in 1:n) {
  cat(v,' "',nodes$name[v],'"\n',sep='',file=net);
  cat(M[v],'\n',file=clu); cat(S[v],'\n',file=sex)
}
for(r in 1:length(rel)) cat('*arcs :',r,' "',rel[r],'"\n',sep='',file=net)
cat('*arcs\n',file=net)
for(a in 1:nrow(links))
  cat(R[a],': ',F[a],' ',T[a],' 1 1 "',rel[R[a]],'"\n',sep='',file=net)
close(net); close(clu); close(sex)
```

CSV2Pajek.R

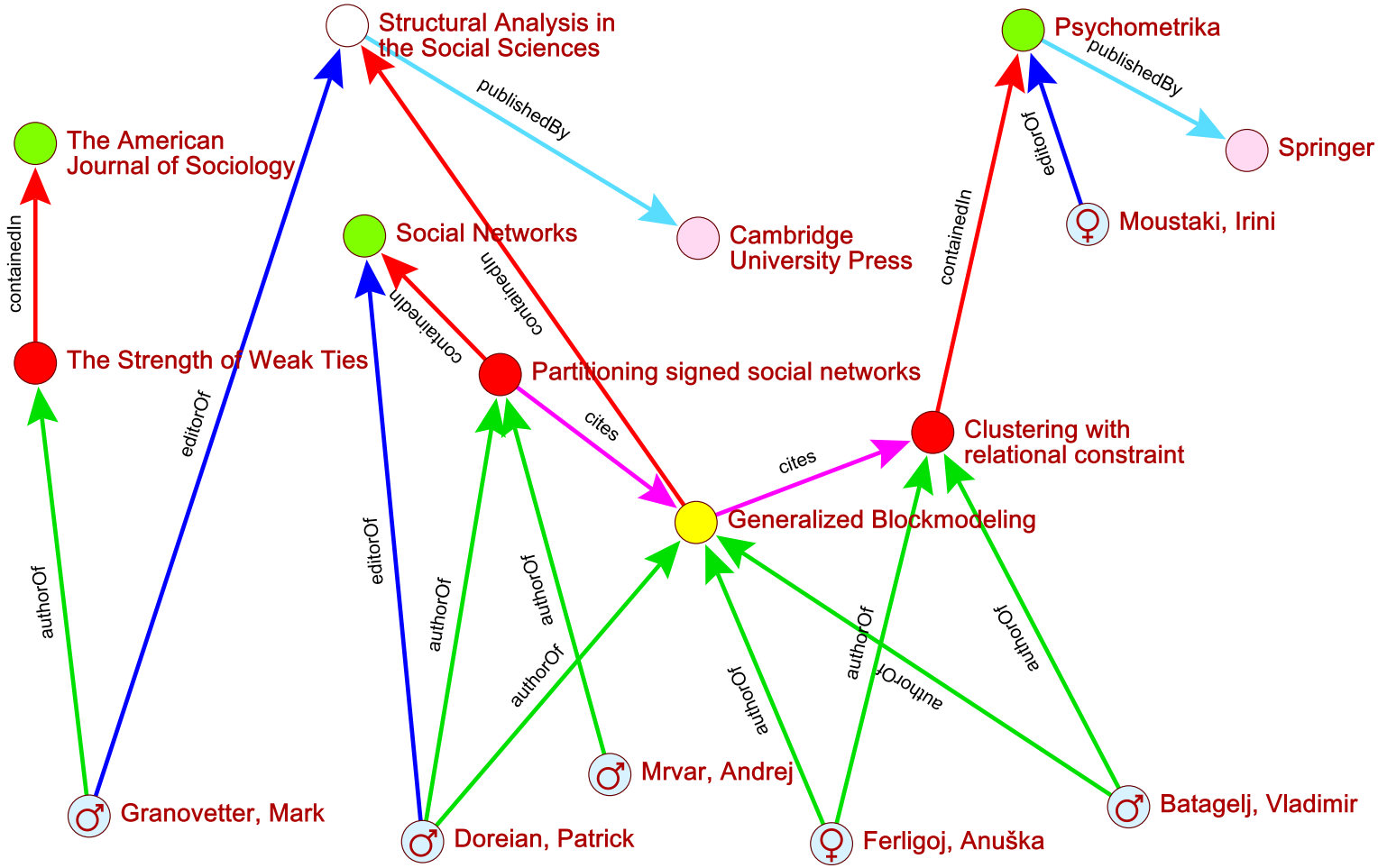
bib.net

```
*vertices  16
1 "Batagelj, Vladimir"
2 "Doreian, Patrick"
3 "Ferligoj, Anuška"
4 "Granovetter, Mark"
5 "Moustaki, Irini"
6 "Mrvar, Andrej"
7 "Clustering with relational constraint"
8 "The Strength of Weak Ties"
9 "Partitioning signed social networks"
10 "Generalized Blockmodeling"
11 "Psychometrika"
12 "Social Networks"
13 "The American Journal of Sociology"
14 "Structural Analysis in the Social Sciences"
15 "Cambridge University Press"
16 "Springer"
*arcs :1 "authorOf"
*arcs :2 "cites"
*arcs :3 "containedIn"
*arcs :4 "editorOf"
*arcs :5 "publishedBy"
```

```
*arcs
1: 1 10 1 l "authorOf"
1: 2 10 1 l "authorOf"
1: 3 10 1 l "authorOf"
1: 1 7 1 l "authorOf"
1: 3 7 1 l "authorOf"
1: 4 8 1 l "authorOf"
4: 4 14 1 l "editorOf"
1: 2 9 1 l "authorOf"
1: 6 9 1 l "authorOf"
4: 5 11 1 l "editorOf"
4: 2 12 1 l "editorOf"
3: 10 14 1 l "containedIn"
3: 7 11 1 l "containedIn"
3: 8 13 1 l "containedIn"
3: 9 12 1 l "containedIn"
2: 9 10 1 l "cites"
2: 10 7 1 l "cites"
5: 14 15 1 l "publishedBy"
5: 11 16 1 l "publishedBy"
```

bib.net, bibMode.clu, bibSex.clu,

Slika omrežja `bib` / Pajek



netJSON / basic

```
{
"netJSON": "basic",
"info": {
   "network":fName, "title":title,
   "org":1, "nNodes":n, "nArcs":mA, "nEdges":mE,
   "simple":TF, "directed":TF, "multirel":TF, "temporal":TF,
   "mode":m, "dim":[nr,nc],
   "time": { "Tmin":tm, "Tmax":tM, "Tlabs": {labs} },
   "meta": [events], "checksum'': cs,
   "trace": [tree], "legend": {prop:{dict}},
   "required": { "nodes": [fields], "links": [fields] }, ...
   },
"nodes": [
   { "id":nodeId, "lab":label, "x":x, "y":y, ... },
   ***
   ]
"links": [
   { "type":arc/edge, "n1":nodeID1, "n2":nodeID2, "rel":r, ... }
   ***
   ]
}
```

... user defined properties

*** sequence of such elements

netJSON / basic

Posamezni `event` iz polja `meta` je slovar s ključi: `date`, `author`, `title`, `desc` (description), `url`, `cite`, ...

Drevo `tree` iz polja `trace` je opisano z gnezdenim seznamom
[date location package procedure [params] [traceP1 traceP2 ...]]

Polje `location` ima za vrednost seznam [computer workDir]

Omrežje v obliki JSON / basic netJSON

class.json

```
{ "netJSON": "basic",
  "info":{ "network": "class", "org": 1, "nNodes": 15, "mode": 1,
     "nArcs" : 30, "nEdges": 13, "nWeak" : 1, "multirel": false,
     "title" : "borrowing study materials", "temporal": false,
     "meta"  : [{ "date": "October 2015", "author": "V. Batagelj" }]
  },
  "nodes": [
     { "id":  1, "lab": "m02", "x": 0.1857, "y": 0.2781, "size": 1 },
     { "id":  2, "lab": "m03", "x": 0.5482, "y": 0.6169, "size": 1 },
     { "id":  3, "lab": "w07", "x": 0.2219, "y": 0.4526, "size": 2 },
     { "id":  4, "lab": "w09", "x": 0.8078, "y": 0.3223, "size": 2 },
...
     { "id": 14, "lab": "m89", "x": 0.4000, "y": 0.8469, "size": 1 },
     { "id": 15, "lab": "m96", "x": 0.3482, "y": 0.1778, "size": 1 }
  ],
  "links": [
     { "type": "arc",  "n1": 6, "n2": 15, "weight": 1 },
     { "type": "arc",  "n1": 2, "n2":  7, "weight": 1 },
...
     { "type": "arc",  "n1":15, "n2":  3, "weight": 1 },
     { "type": "edge", "n1": 6, "n2": 12, "weight": 1 },
...
     { "type": "edge", "n1": 4, "n2": 12, "weight": 1 },
     { "type": "edge", "n1": 6, "n2": 13, "weight": 1 }
  ]
}
```

JSON in R

Predelava Pajek-ovih datotek NET in CLU v netJSON

```
{"nodes":[{"name":"Myriel","group":1},{"name":"Napoleon","group":1}, ...
    {"name":"Brujon","group":4},{"name":"Mme.Hucheloup","group":8}],
 "links":[{"source":1,"target":0,"value":1},{"source":2,"target":0,"value":8}, ...
    {"source":76,"target":48,"value":1},{"source":76,"target":58,"value":1}]}
```

```
setwd("C:/Users/Batagelj/test/python/2012/amazon")
library(rjson)

net2json <- function(netF,cluF,jsonF){
  net <- file(netF,"r");  clu <- file(cluF,"r")
  b <- unlist(strsplit(readLines(net,n=1)," "))
  n <- as.integer(b[length(b)])
  N <- readLines(net,n=n);  nam <- character(n)
  for(i in 1:n) nam[i] <- unlist(strsplit(N[i],'"'))[2]
  skip <- readLines(clu,n=1);  C <- as.integer(readLines(clu,n=n))
  skip <- readLines(net,n=1);  L <- readLines(net,n=-1)
  M <- matrix(as.integer(unlist(strsplit(sub('^\\s+','',L),'\\s+'))),ncol=3,byrow=TRUE)
  nods <- vector('list',n)
  for(i in 1:n) nods[[i]] <- list(name=nam[i],group=C[i])
  m <- nrow(M); lnks <- vector('list',m)
  for(i in 1:m) lnks[[i]] <- list(source=M[i,1]-1,target=M[i,2]-1,value=M[i,3])
  data <- list(nodes=nods,links=lnks)
  jstr <- toJSON(data)
  json <- file(jsonF,"w");  cat(jstr,file=json)
  close(json);  close(net); close(clu)
}

net2json("islands.net","islands.clu","islands.json")
```

islands, island 1, island 4, force: islands

CSV2JSON.R

```
# transforming CSV files to JSON file
# by Vladimir Batagelj, June 2016
setwd("C:/Users/batagelj/work/Python/graph/SVG/EUSN")
library(rjson)
colC <- c(rep("character",4),rep("numeric",5)); nas <- c("","NA","NaN")
nodes <- read.csv2("bibNodesXY.csv",encoding='UTF-8',colClasses=colC,na.
M <- factor(nodes$mode); mod <- levels(M); M <- as.numeric(M)
S <- factor(nodes$sex); sx <- levels(S); S <- as.numeric(S); S[is.na(S)]
links <- read.csv2("bibLinks.csv",encoding='UTF-8',colClasses="character
F <- as.numeric(factor(links$from,levels=nodes$name,ordered=TRUE))
T <- as.numeric(factor(links$to,levels=nodes$name,ordered=TRUE))
R <- factor(links$relation); rel <-levels(R); R <- as.numeric(R)
n <- nrow(nodes); nods <- vector('list',n)
for(i in 1:n) nods[[i]] <- list(id=i,name=nodes$name[i],mode=M[i],
   sex=S[i],x=as.numeric(nodes$x[i])/1000,y=as.numeric(nodes$y[i])/1000)
m <- nrow(links); lnks <- vector('list',m)
for(i in 1:m) lnks[[i]] <- list(type="arc",source=F[i],target=T[i],
   rel=R[i],weight=1)
meta <- list(date="June 11,2016",author="Vladimir Batagelj")
leg <- list(mode=mod,sex=sx,rel=rel)
inf <- list(network="bib",org=1,nNodes=n,nArcs=m,
  title="Example for EUSN'16",legend=leg,meta=meta)
data <- list(netJSON="basic",info=inf,nodes=nods,links=lnks)
json <- file("bib.json","w"); cat(toJSON(data),file=json); close(json)
```

bib.json


```
{"netJSON":"basic",
 "info":{"network":"bib","org":1,"nNodes":16,"nArcs":19,"title":"Example for EUSN'16",
  "legend":{
   "mode":["book","journal","paper","person","publisher","series"],
   "sex":["f","m"],
   "rel":["authorOf","cites","containedIn","editorOf","publishedBy"]},
  "meta":{"date":"June 11,2016","author":"Vladimir Batagelj"}},
 "nodes":[
  {"id":1,"name":"Batagelj, Vladimir","mode":4,"sex":2,"x":0.8091,"y":0.6537},
  {"id":2,"name":"Doreian, Patrick","mode":4,"sex":2,"x":0.3585,"y":0.6791},
  {"id":3,"name":"Ferligoj, Anu\u0161ka","mode":4,"sex":1,"x":0.6195,"y":0.6807},
  {"id":4,"name":"Granovetter, Mark","mode":4,"sex":2,"x":0.1456,"y":0.6605},
  {"id":5,"name":"Moustaki, Irini","mode":4,"sex":1,"x":0.783,"y":0.228},
  {"id":6,"name":"Mrvar, Andrej","mode":4,"sex":2,"x":0.478,"y":0.6301},
  {"id":7,"name":"Clustering with relational constraint","mode":3,"sex":0,"x":0.6841,"y":0.3801}
...
  {"id":15,"name":"Cambridge University Press","mode":5,"sex":0,"x":0.5343,"y":0.2382},
  {"id":16,"name":"Springer","mode":5,"sex":0,"x":0.8846,"y":0.174}],
 "links":[
  {"type":"arc","n1":1,"n2":10,"rel":1,"weight":1},
  {"type":"arc","n1":2,"n2":10,"rel":1,"weight":1},
  {"type":"arc","n1":3,"n2":10,"rel":1,"weight":1},
  {"type":"arc","n1":1,"n2":7,"rel":1,"weight":1},
  {"type":"arc","n1":3,"n2":7,"rel":1,"weight":1},
  {"type":"arc","n1":4,"n2":8,"rel":1,"weight":1},
  {"type":"arc","n1":4,"n2":14,"rel":4,"weight":1},
...
  {"type":"arc","n1":10,"n2":7,"rel":2,"weight":1},
  {"type":"arc","n1":14,"n2":15,"rel":5,"weight":1},
  {"type":"arc","n1":11,"n2":16,"rel":5,"weight":1}
]}
```


bib.json, picture: bib

Objekt Graph

V knjižnici **Graph** ima vsako vozlišče/povezava svoj izkaznik (id). Če ga za povezavo ne določi uporabnik, ga določi **Graph**.
Knjižnica **Graph** temelji na objektu, ki ga sestavljajo trije slovarji:

- `graph` – ključi so lastnosti celotnega omrežja. Nekaj lastnosti je sistemskih: `network`, `title`, `simple`, `directed`, `multirel`, `mode`, `temporal`, `meta`, `nNodes`, `nArcs`, `nEdges`, `time`, itd. Uporabnik lahko doda svoje lastnosti, npr.: `nWeak`, `planar`, itd.
- `nodes` – ključi so izkazniki vozlišč. Vrednost pa je seznam štirih slovarjev:
  [edgeStar, inArcStar, outArcStar, nodeProperties]
  Vsaka zvezda ima za ključe izkaznike sosednjih vozlišč in za vrednosti sezname izkaznikov povezav.
- `links` – ključi so izkazniki povezav. Vrednost je seznam
  [nodeId1, nodeId2, directed, relId, linkProperties]
  kjer je linkProperties slovar lastnosti (uteži).

Funkcije knjižnice **Graph**

V pripravi !!!

V novi različici **GraphNew.py** je spremenjena izvedba večkratnih povezav med vozlišči. Pozor!!! Iahko se zgodi, da kje "škripne" – kaka funkcija še ni posodobljena.

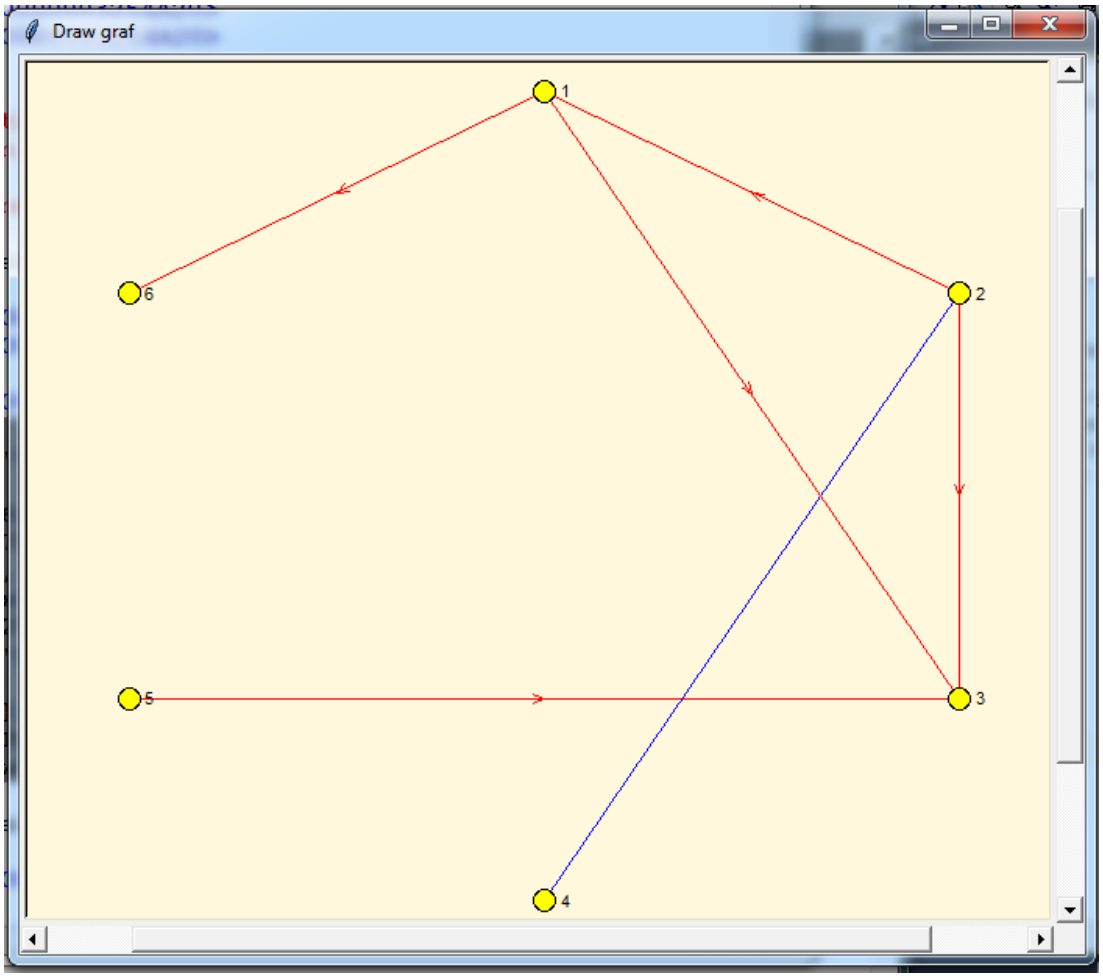
Oglejte si programsko kodo.

GitHub / Graph

Nekaj osnovnih funkcij za izgradnjo omrežja


```
from GraphNew import Graph
def TestAdd():
    G = Graph()
    G.addNode(2); G.addNode(1); G.addNode(3); G.addNode(4)
    G.addEdge(2,4,{'w':3}); G.addArc(2,1,{'w':5});
    G.addArc(1,3,{'w':4}); G.addArc(2,3,{'w':6})
    G.addNode(5); G.addNode(6)
    i=G.addArc(5,3,{'w':5}); j=G.addEdge(2,4,{'w':7});
    G.addArc(1,6,{'w':8});G.addArc(1,3,{'w':5})
    G.onCircle()
    print(G)
    G.draw(800,800,"Cornsilk")
    G.savePajek('test.net')
    G.delLink(j); G.delLink(i)
    print(G)
    return G
```

Slika omrežja



Predstavitev omrežja

```
>>> G._graph
{'mode': 1, 'multirel': False, 'temporal': False, 'simple': False}
>>> G._nodes
{
1: [{}, {2: [2]}, {3: [3, 8], 6: [7]}, {'x': 0.5, 'y': 0.95}],
2: [{4: [1]}, {}, {1: [2], 3: [4]}, {'x': 0.88971, 'y': 0.725}],
3: [{}, {1: [3, 8], 2: [4], 5: []}, {}, {'x': 0.88971, 'y': 0.275}],
4: [{2: [1]}, {}, {}, {'x': 0.5, 'y': 0.045}],
5: [{}, {}, {3: []}, {'x': 0.11029, 'y': 0.275}],
6: [{}, {1: [7]}, {}, {'x': 0.11029, 'y': 0.725}]
}
>>> G._links
{
1: [2, 4, False, None, {'w': 3}],
2: [2, 1, True, None, {'w': 5}],
3: [1, 3, True, None, {'w': 4}],
4: [2, 3, True, None, {'w': 6}],
7: [1, 6, True, None, {'w': 8}],
8: [1, 3, True, None, {'w': 5}]
}
```

Nekaj novih funkcij in programov

```
TQ.Ianus2netJSON(N,fileJSON="test.json",indent=None)
twoMode2netJSON(yFile,netFile,jsonFile,instant=True)

Graph.TQmultiply(A,B,oneMode=False)
Graph.TQtwo2oneRows(self)
Graph.TQtwo2oneCols(self)
Graph.TQnetDeg(self,u)
Graph.TQnetInDeg(self,u)
Graph.TQnetOutDeg(self,u)
Graph.TQnetSum(self,u)
Graph.TQnetInSum(self,u)
Graph.TQnetOutSum(self,u)
Graph.TQnetBin(self)
Graph.loadNetJSON(file, encoding='utf-8')
multiply.py
```

Omrežje sodelovanj SN5

BibTime

SN5 (2008)

	W	A	K	J
raw	193376	75930	29267	14651
DC=1	7950	12458		

V Pajku pripravimo podomrežje **WAc** in ustrezno razbitje **SN5yearC** ter ju s programom `twoMode2netJSON` predelamo v časovno omrežje v obliki netJSON. Program bi bilo dobro predalati tako, da se izogne obliki lanus.

Bibliografska omrežja so praviloma redka. Omrežje **WAcInst** ima le 19488 povezav. Omrežje sodelovanj **CoInst** $=$ **WAcInst**^{T} $*$ **WAcInst** ima 64980 povezav; ustrezna matrika v knjižnici **TQ** pa $12458^2 = 155201764$ členov. S knjižnico **Graph** je izračunano v sekundi in pol, kar je velika pohitritev.

multiply.py

```
gdir = 'c:/users/batagelj/work/python/graph/graph'
wdir = 'c:/users/batagelj/work/python/graph/JSON'
import sys, os, datetime, json
sys.path = [gdir]+sys.path; os.chdir(wdir)
import TQ
from GraphNew import Graph
# file = 'C:/Users/batagelj/work/Python/graph/JSON/WAtest.json'
# file = 'C:/Users/batagelj/work/Python/graph/JSON/SN5/WAInst.json'
file = 'C:/Users/batagelj/work/Python/graph/JSON/SN5/WAcInst.json'
# file = 'C:/Users/batagelj/work/Python/graph/JSON/Gisela/papInst.json'
t1 = datetime.datetime.now()
print("started: ",t1.ctime(),"\n")
G = Graph.loadNetJSON(file)
t2 = datetime.datetime.now()
print("\nloaded: ",t2.ctime(),"\ntime used: ", t2-t1)
# T = G.transpose()
# Co = Graph.TQmultiply(T,G,True)
# CR = G.TQtwo2oneRows()
CC = G.TQtwo2oneCols()
t3 = datetime.datetime.now()
print("\ncomputed: ",t3.ctime(),"\ntime used: ", t3-t2)
ia = { v[3]['lab']: k for k,v in CC._nodes.items() }
# CC._links[(ia['BORGATTI_S'],ia['EVERETT_M'])][4]['tq']
# CC._links[(ia['IDI/B'],ia['HCL/B'])][4]['tq']
```

Omrežje sodelovanj SN5

```
>>>
======= RESTART: C:\Users\batagelj\work\Python\graph\graph\multiply.py =
started:  Wed Oct  5 15:12:49 2016
loaded:  Wed Oct  5 15:12:49 2016
time used:  0:00:00.410023
computed:  Wed Oct  5 15:12:51 2016
time used:  0:00:01.468084
>>> len(CC)
12458
>>> CC._links[(ia['BORGATTI_S'],ia['EVERETT_M'])][4]['tq']
[(1988, 1989, 1), (1989, 1990, 2), (1990, 1991, 4), (1991, 1992, 1),
 (1992, 1995, 2), (1996, 1998, 1), (1999, 2000, 3), (2003, 2004, 1),
 (2005, 2007, 1)]
>>> CC._links[(ia['BORGATTI_S'],ia['BORGATTI_S'])][4]['tq']
[(1988, 1990, 2), (1990, 1991, 4), (1991, 1992, 2), (1992, 1993, 4),
 (1993, 1994, 2), (1994, 1995, 3), (1996, 1997, 1), (1997, 1998, 2),
 (1998, 1999, 1), (1999, 2000, 3), (2001, 2002, 2), (2002, 2003, 1),
 (2003, 2004, 4), (2005, 2006, 3), (2006, 2007, 2), (2007, 2008, 3)]
>>> CC._links[(ia['NEWMAN_M'],ia['NEWMAN_M'])][4]['tq']
[(1999, 2000, 2), (2000, 2001, 4), (2001, 2002, 7), (2002, 2003, 8),
 (2003, 2004, 7), (2004, 2005, 11), (2005, 2006, 7), (2006, 2007, 11),
 (2007, 2008, 3)]
>>>
```

Načrti

- izpopolniti funkcije za množenje: diag, upper, edge
- dodati normalizacije in druga izpeljana omrežja
- analiza dobljenih omrežij: pomembna vozlišča/povezave, sredice (Monika), otoki?
- prikazi rezultatov
- uporaba za resno analizo
- igranje s funkcijami v vozliščih/povezavah