Social Network Analysis and Social Roles

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What is SNA

- Analysis of networks from a social perspective
- Vizualisation
- Analysis
- Modelling
- Networks often small but can be large and complex

Node Types

- Persons
- Organizations
- Animals
- Words
- Web pages
- Families
- Etc etc

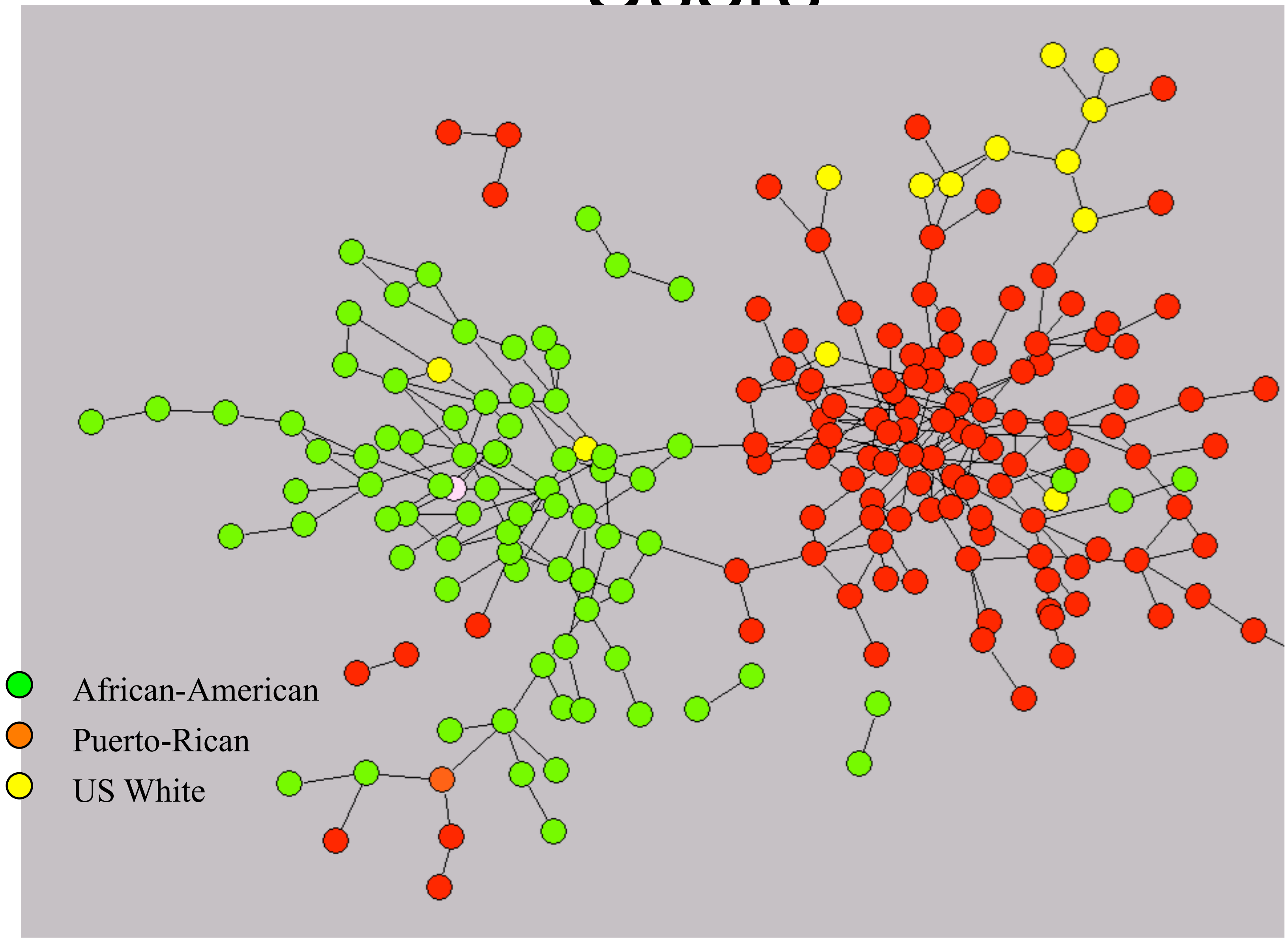
Relations

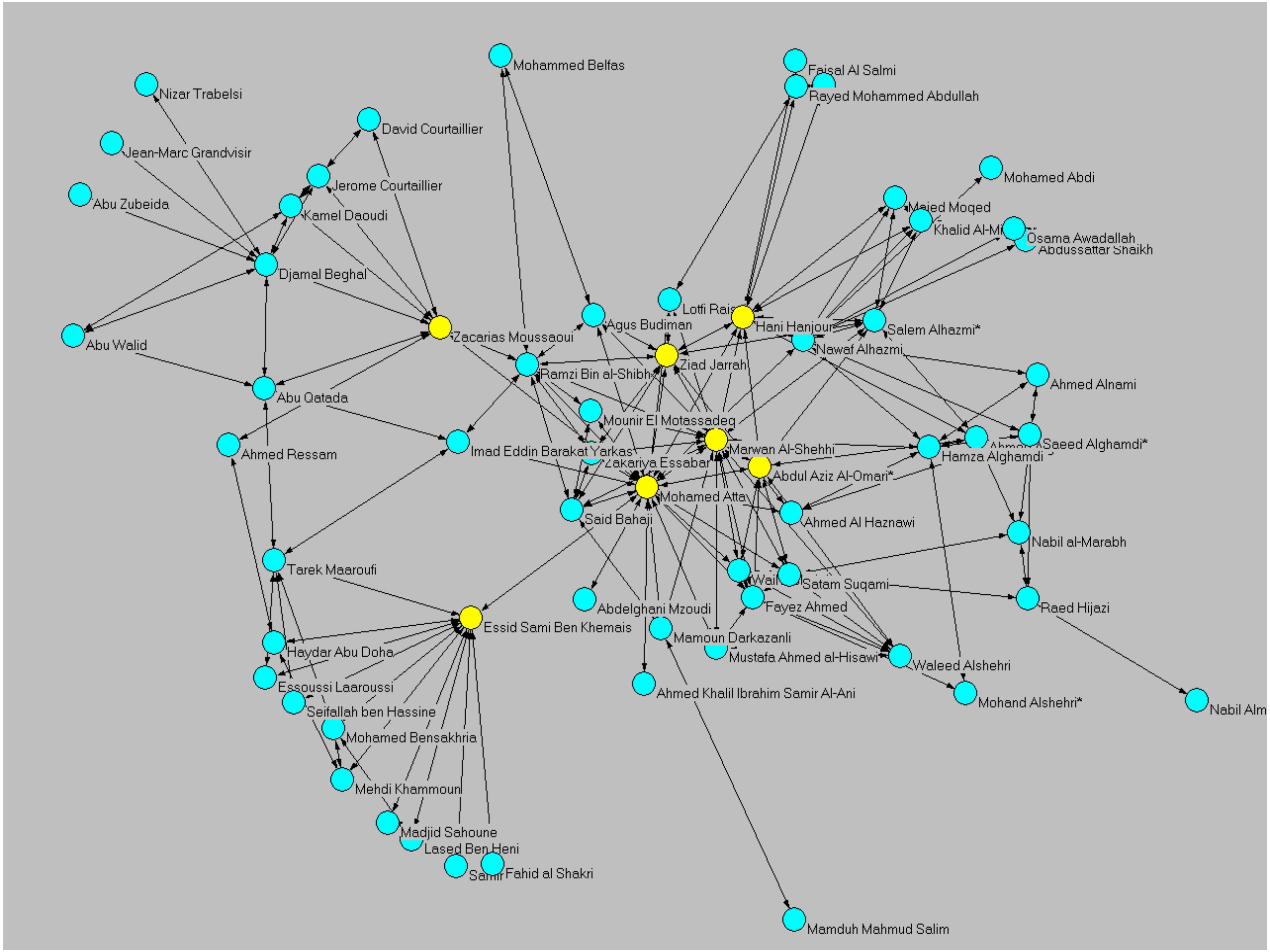
- Family ties
- Friendship
- Boss of
- Lend money to
- Has sex with
- Trusts
- Talks to
- Gives advice to
  - etc
- Trades with
- Collaborates with
- Hyperlink to
- In the same paragraph
- Eats
- Grooms
- Pecks
- Fights
  - etc

Data

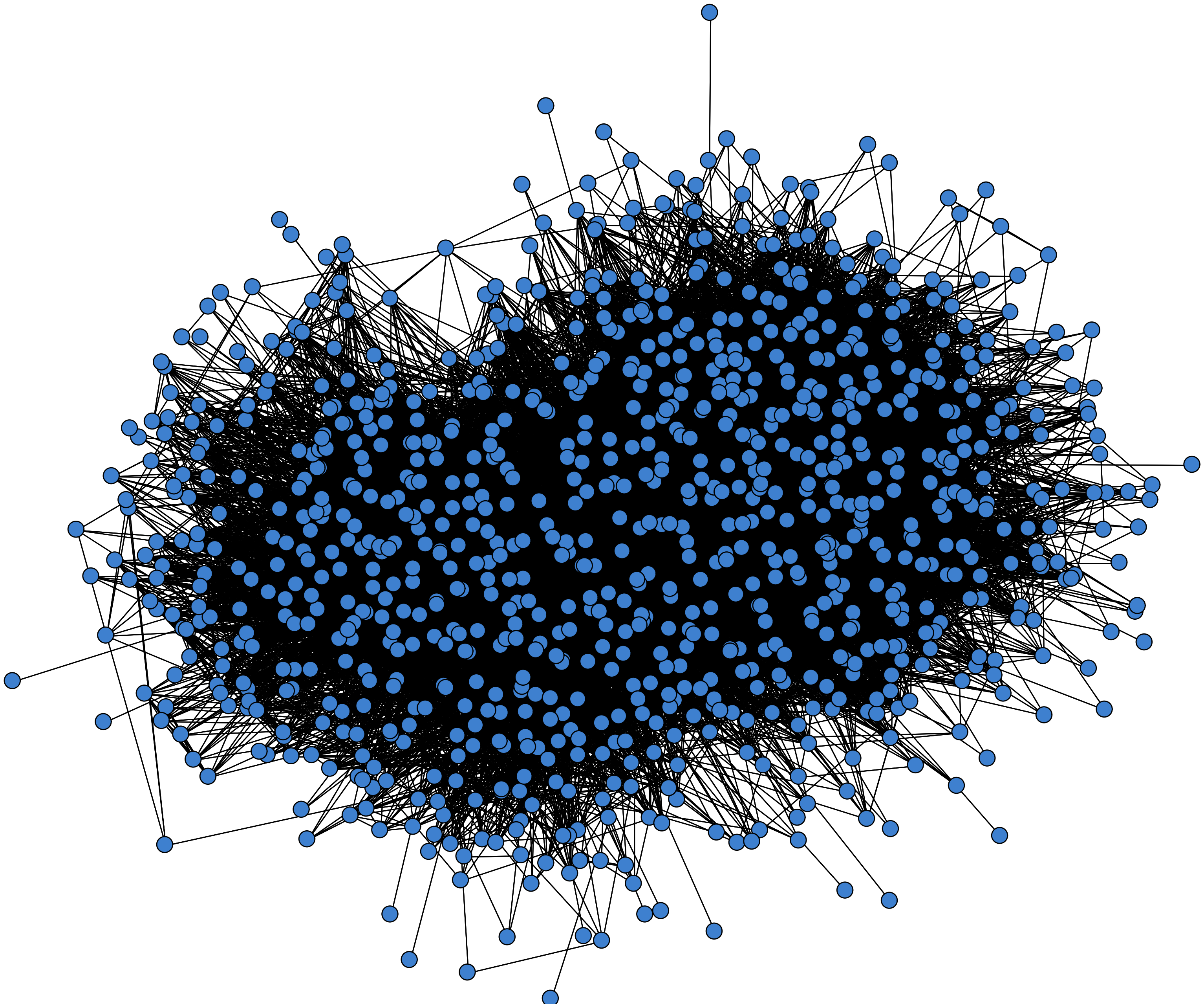
- Surveys
- Observation
- Electronic
  - Web crawlers
  - Mobile phone records
  - e-mail records
  - Social networking sites
- Written records

Acquaintances among Drug Users




Mohammed Belfas
Faisal Al Salmi
Rayed Mohammed Abdullah
Nizar Trabelsi
David Courtaillier
Jean-Marc Grandvisir
Jerome Courtaillier
Abu Zubeida
Kamel Daoudi
Mohamed Abdi
Majed Moqed
Osama Awadallah
Abdussattar Shaikh
Djamal Beghal
Lotfi Raissi
Hani Hanjour
Salem Alhazmi*
Abu Walid
Zacarias Moussaoui
Agus Budiman
Nawaf Alhazmi
Ziad Jarrah
Ramzi Bin al-Shibh
Ahmed Alnami
Abu Qatada
Mounir El Motassadeq
Ahmed Ressam
Imad Eddin Barakat Yarkas
Marwan Al-Shehhi
Saeed Alghamdi*
Hamza Alghamdi
Zakariya Essabar
Abdul Aziz Al-Omari*
Mohamed Atta
Said Bahaji
Ahmed Al Haznawi
Nabil al-Marabh
Tarek Maaroufi
Satam Suqami
Fayez Ahmed
Abdelghani Mzoudi
Raed Hijazi
Essid Sami Ben Khemais
Mamoun Darkazanli
Mustafa Ahmed al-Hisawi
Haydar Abu Doha
Waleed Alshehri
Ahmed Khalil Ibrahim Samir Al-Ani
Essoussi Laaroussi
Mohand Alshehri*
Seifallah ben Hassine
Mohamed Bensakhria
Mehdi Khammoun
Madjid Sahoune
Lased Ben Heni
Fahid al Shakri
Mamduh Mahmud Salim

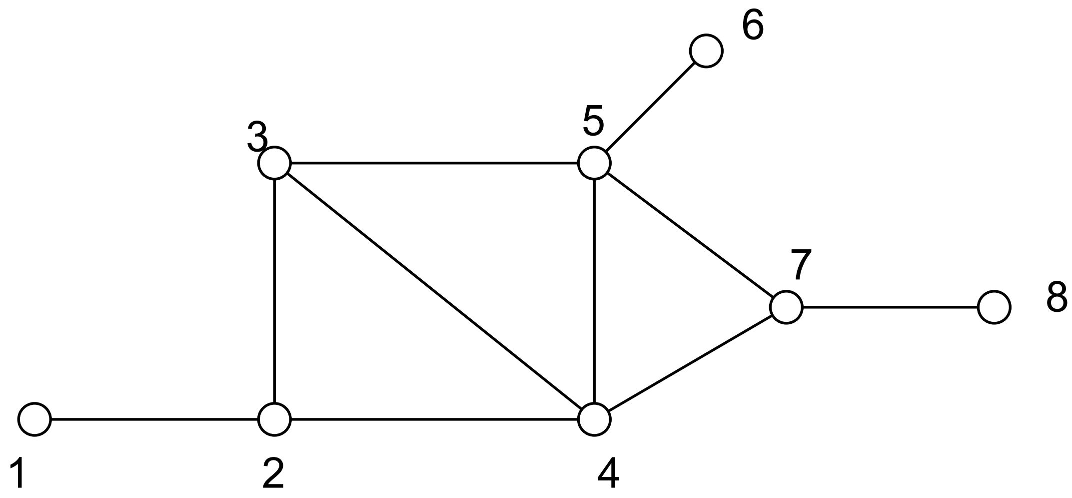
1.000 node network



Regular Coloration

- Sociologists like roles; the world is a stage we are actors and we play roles
- Try and capture a network version of social role
- Define role in terms of position in a network its not what you do it is where you are

Some simple concepts

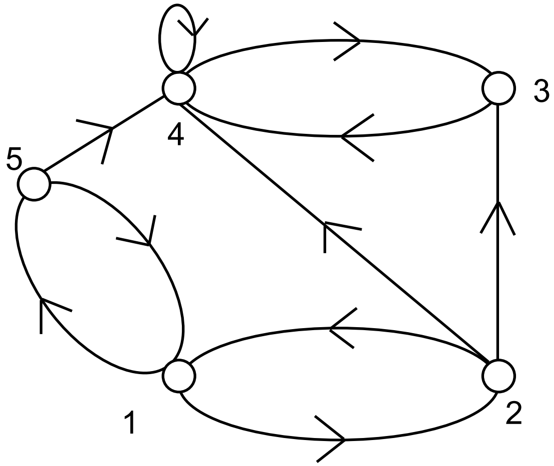


The neighborhood N(v) of a vertex v is the set of vertices it is connected to.

$N(3) = \{2,4,5\}$

$N(8) = \{7\}$

Digraphs we have two types

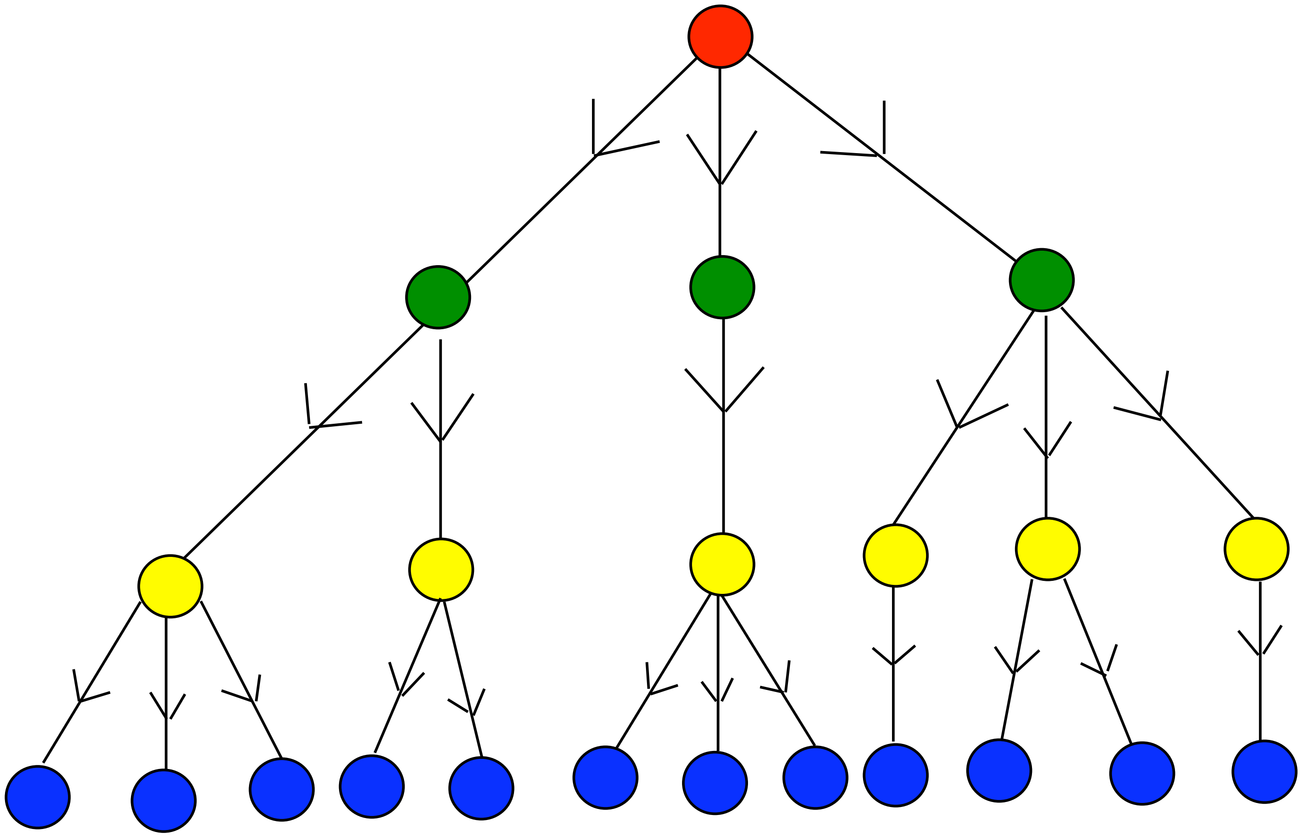


We have 'in' and 'out' neighborhoods denoted by N_i and N_o respectively.

$N_o(1) = \{2,5\}$

$N_i(4) = \{2,3,4,5\}$

Formal Role in an Organization

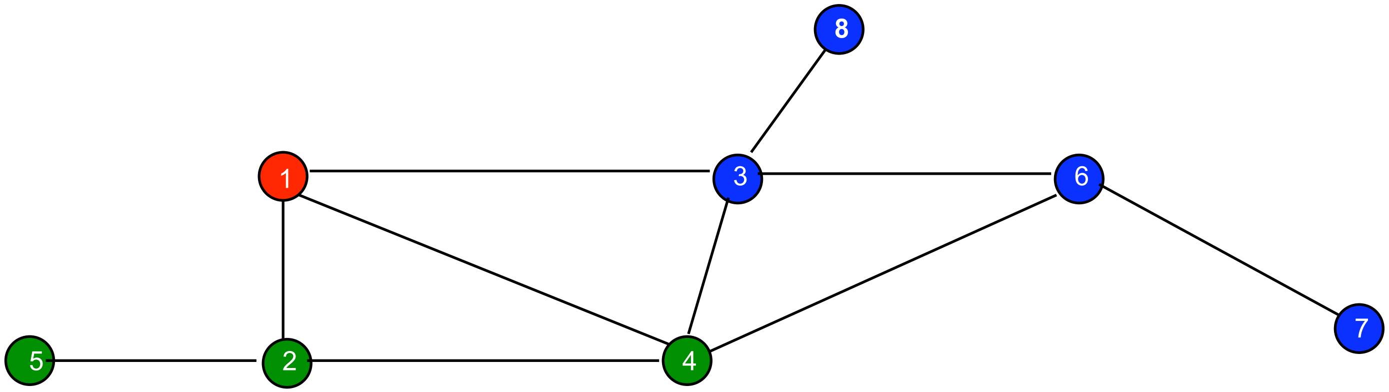


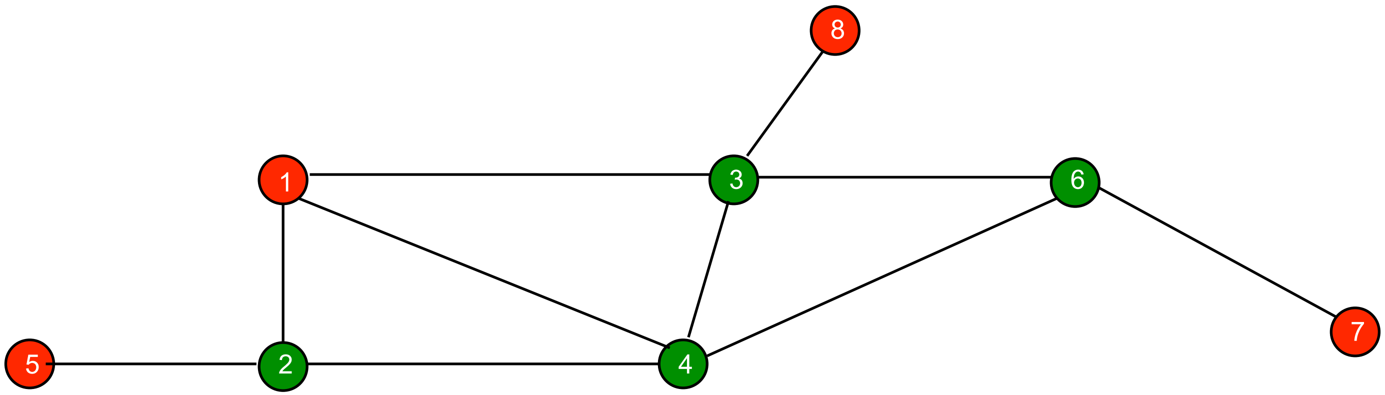
A coloration C of a graph is an assignment of colours to the vertices.

A coloration of a graph is regular if whenever

$$C(x) = C(y) \text{ then}$$

$$C(N(x)) = C(N(y))$$

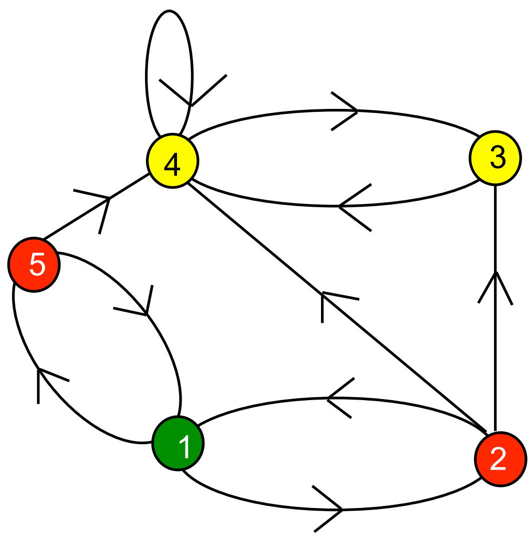




For a directed graph we consider in and out neighborhoods seperately if $C(x) = C(y)$ then

$$C(N_i(x)) = C(N_i(y)) \quad \text{and}$$

$$C(N_o(x)) = C(N_o(y))$$

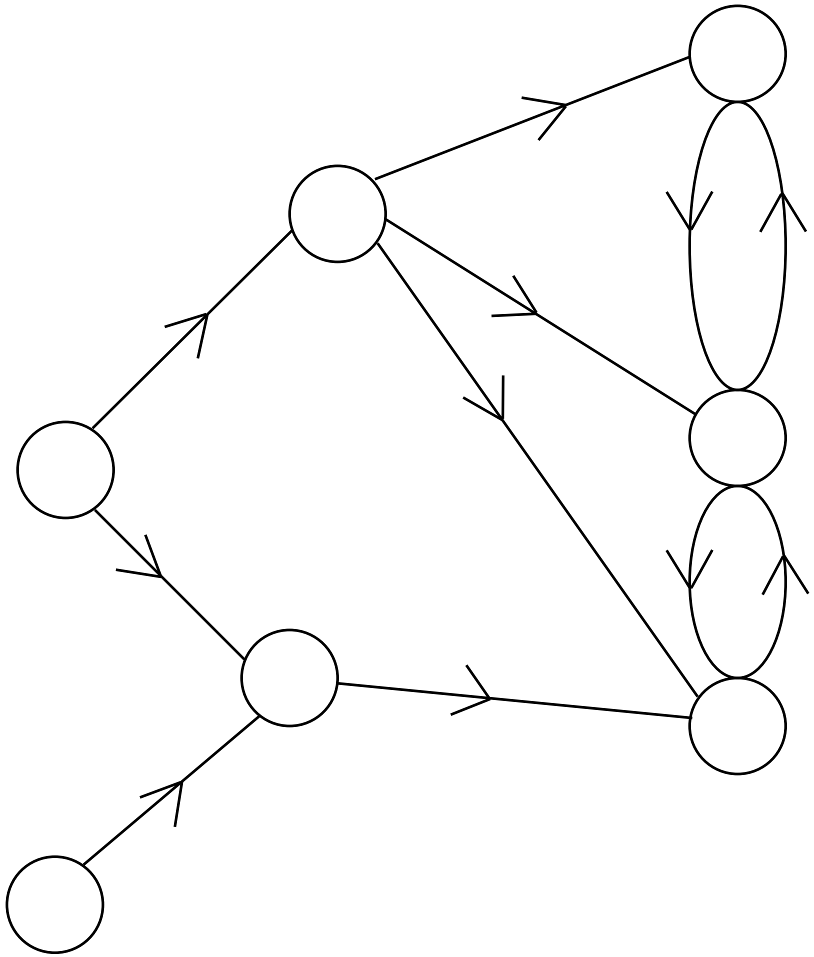


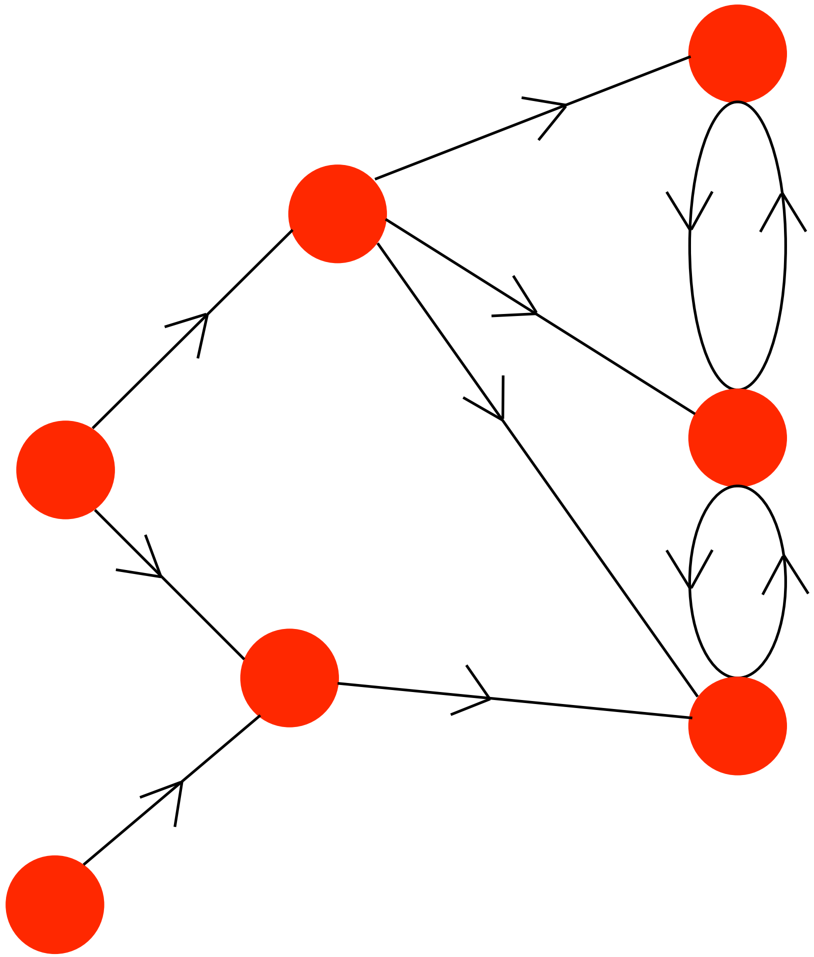
The regular coloration which uses the fewest colours is called the maximal regular coloration.

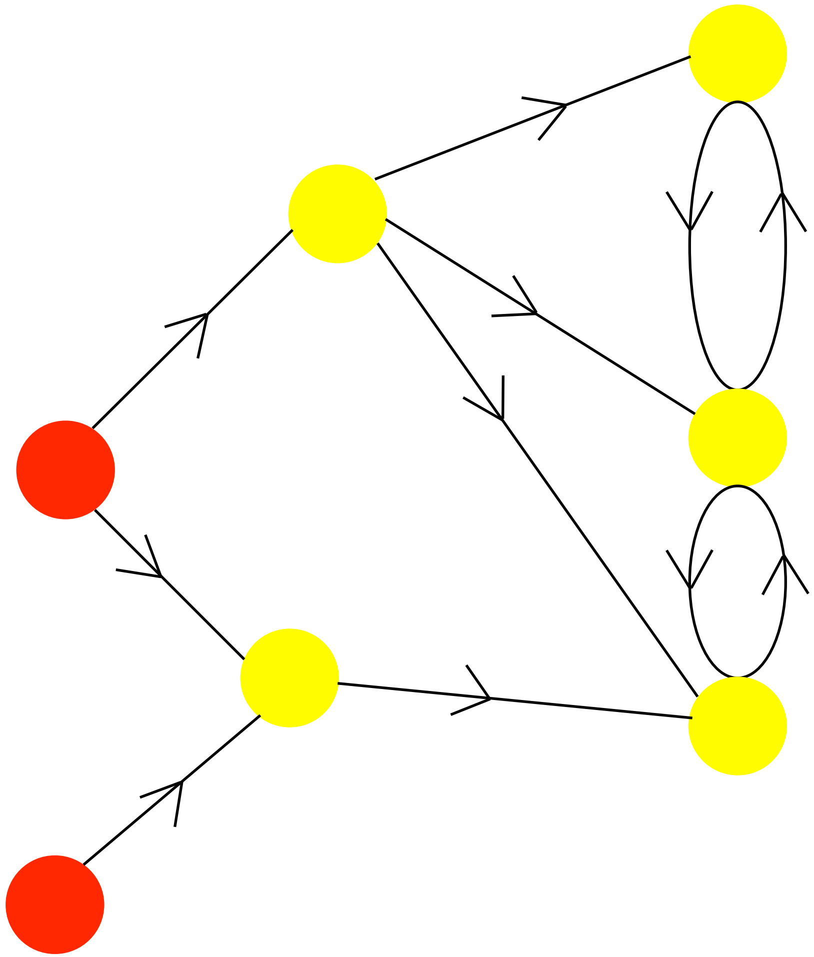
This is trivial for graphs with no sources or sinks- colour everyone the same

A concept of importance for digraphs with sources or sinks.

There is a simple algorithm which finds the maximal regular coloration.







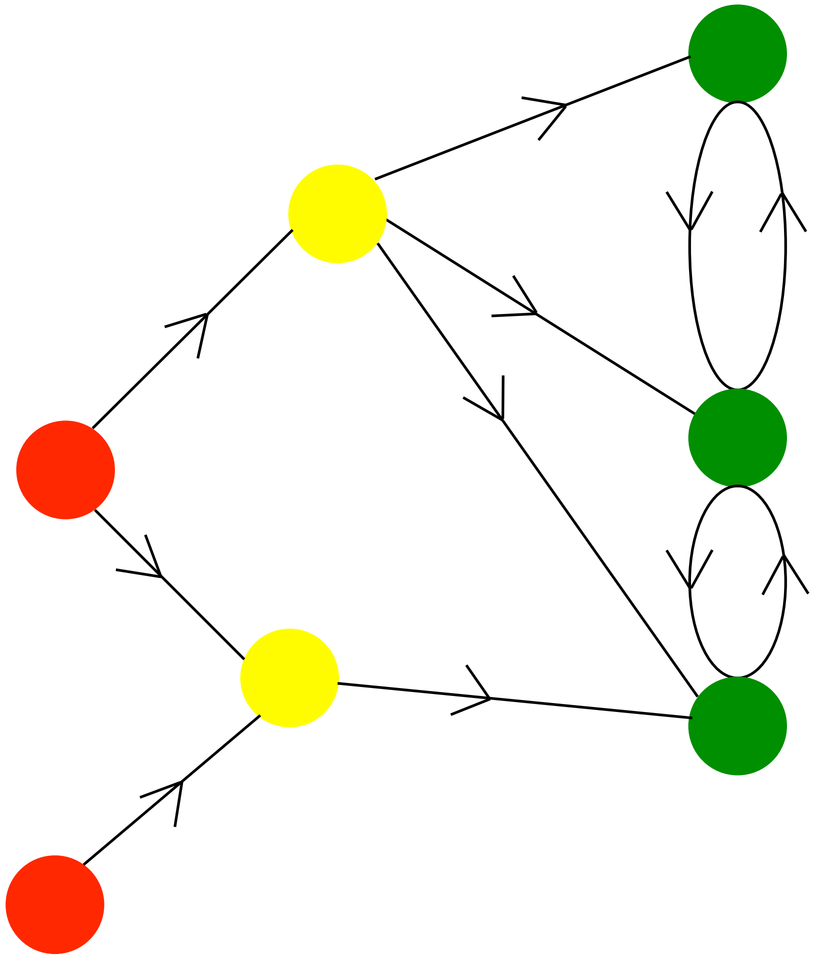
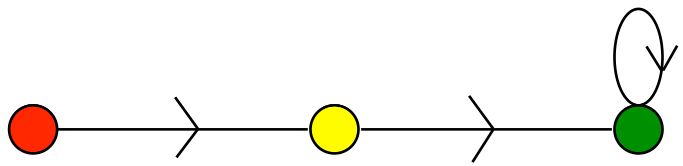


Image graph of a coloration has colours as vertices and an edge between two colours if there is is an edge connecting these colours in the original graph.



Note a coloration is regular iff

$$C(N(x)) = N(C(x))$$

Image graph captures the role structure.

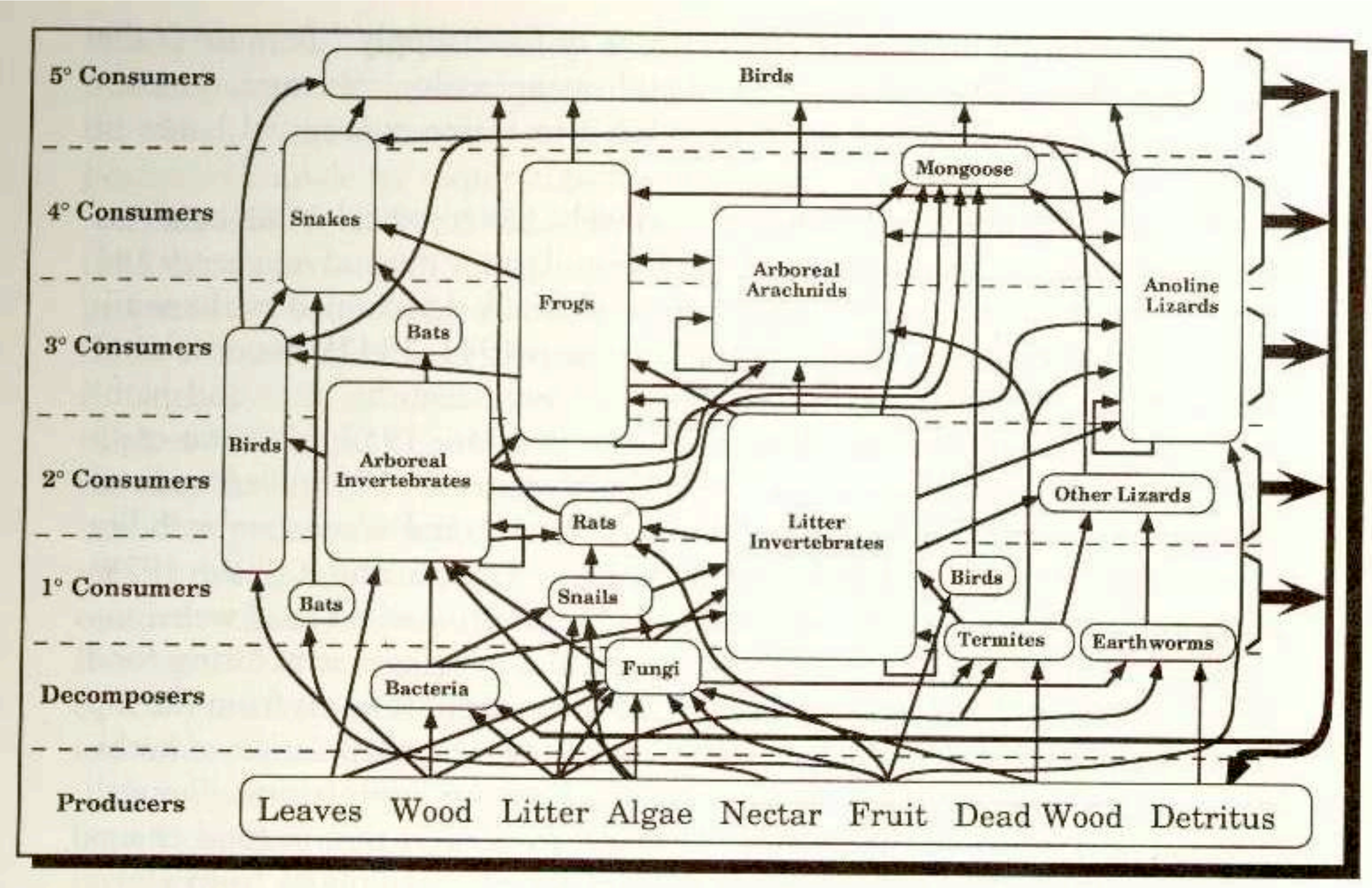
Problems

- Mathematically very elegant with many interesting theorems and results
- Does not work on real data
- Two commonly used methods
  - An optimization approach (not given here)

REGE

- A generalization of the algorithm that uses fuzzy logic
- Still needs directed data with sources or sinks
- Gives a proximity matrix of degree of equivalence

Food Webs


5° Consumers
4° Consumers
3° Consumers
2° Consumers
1° Consumers
Decomposers
Producers
Birds
Snakes
Frogs
Mongoose
Arboreal Arachnids
Anoline Lizards
Bats
Birds
Arboreal Invertebrates
Rats
Litter Invertebrates
Other Lizards
Snails
Bats
Birds
Termites
Earthworms
Fungi
Bacteria
Leaves Wood Litter Algae Nectar Fruit Dead Wood Detritus

Malaysian Pitcher Plant Food Web

Beaver (1985)

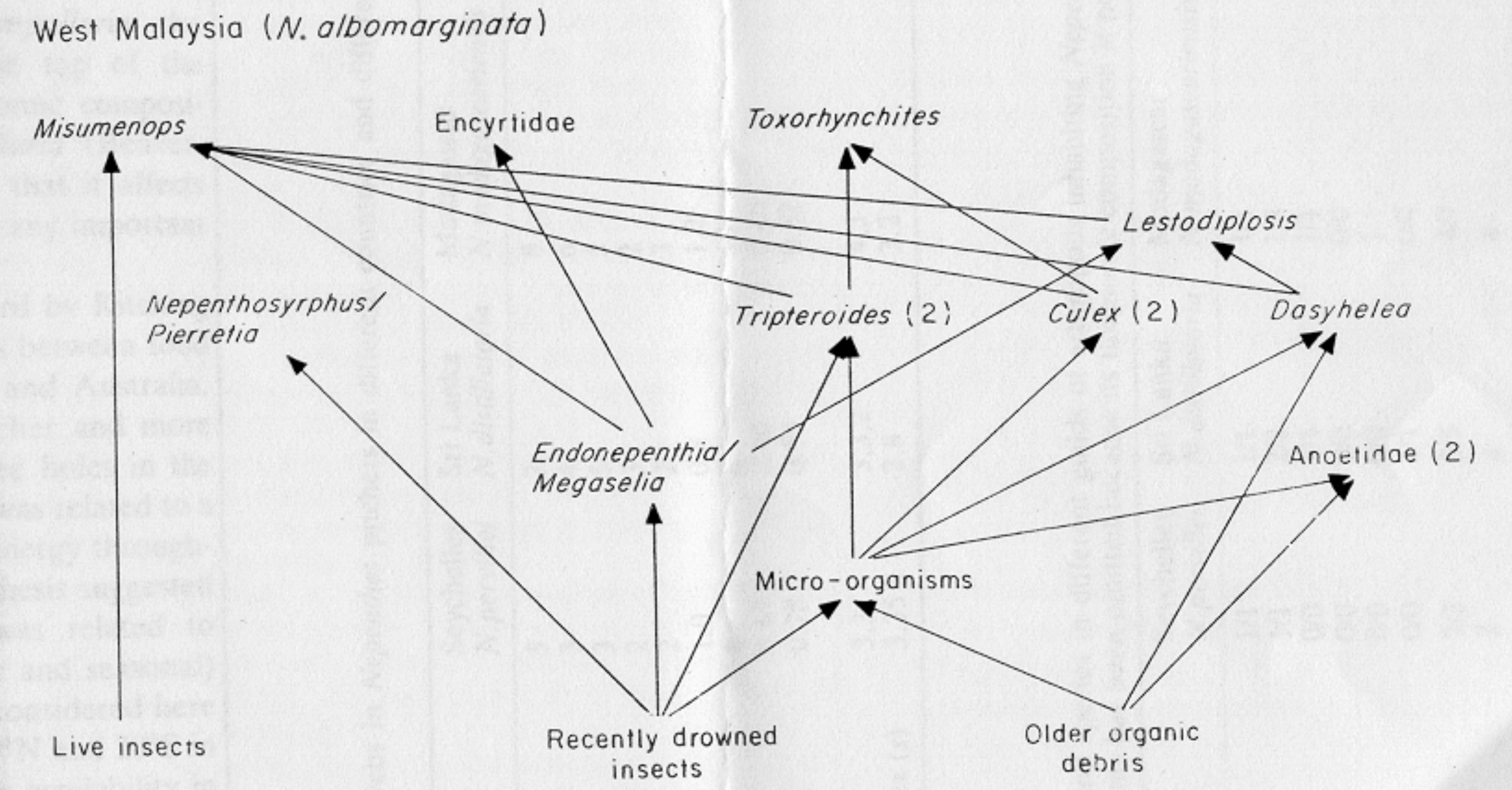
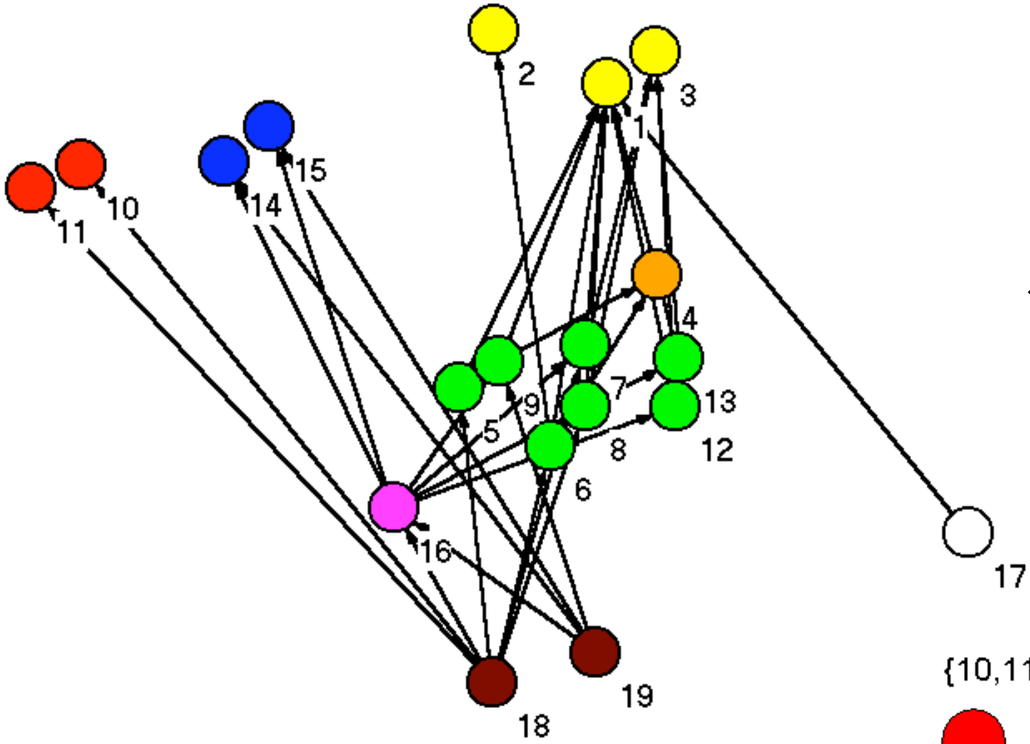


FIG. 1 (*continued*)



Multi-dimensional Scaling of the REGE coefficients, with color classes determined by clustering

Image Graph of the food web

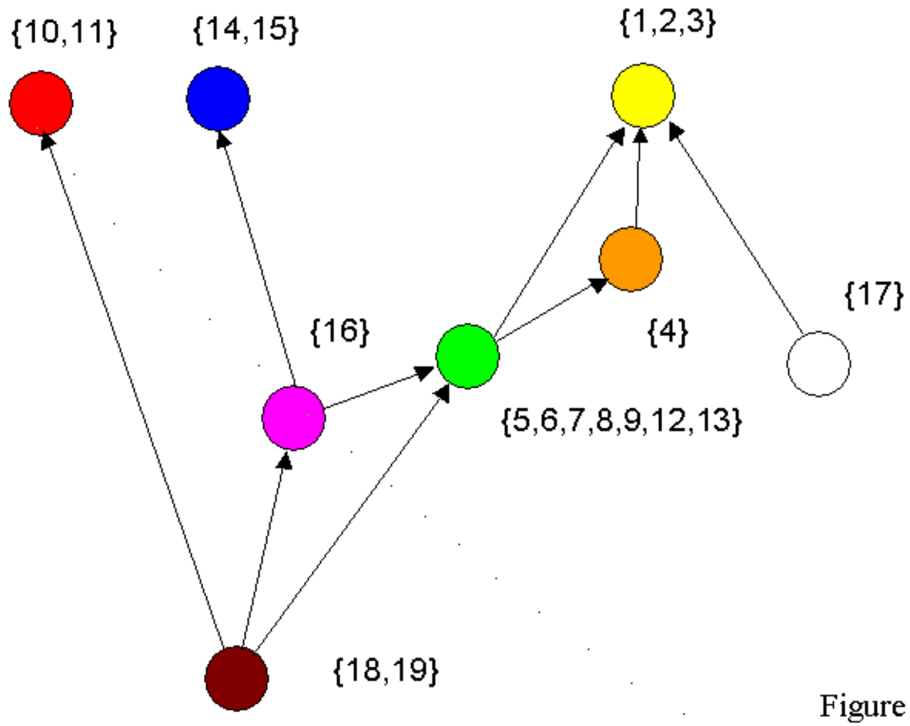
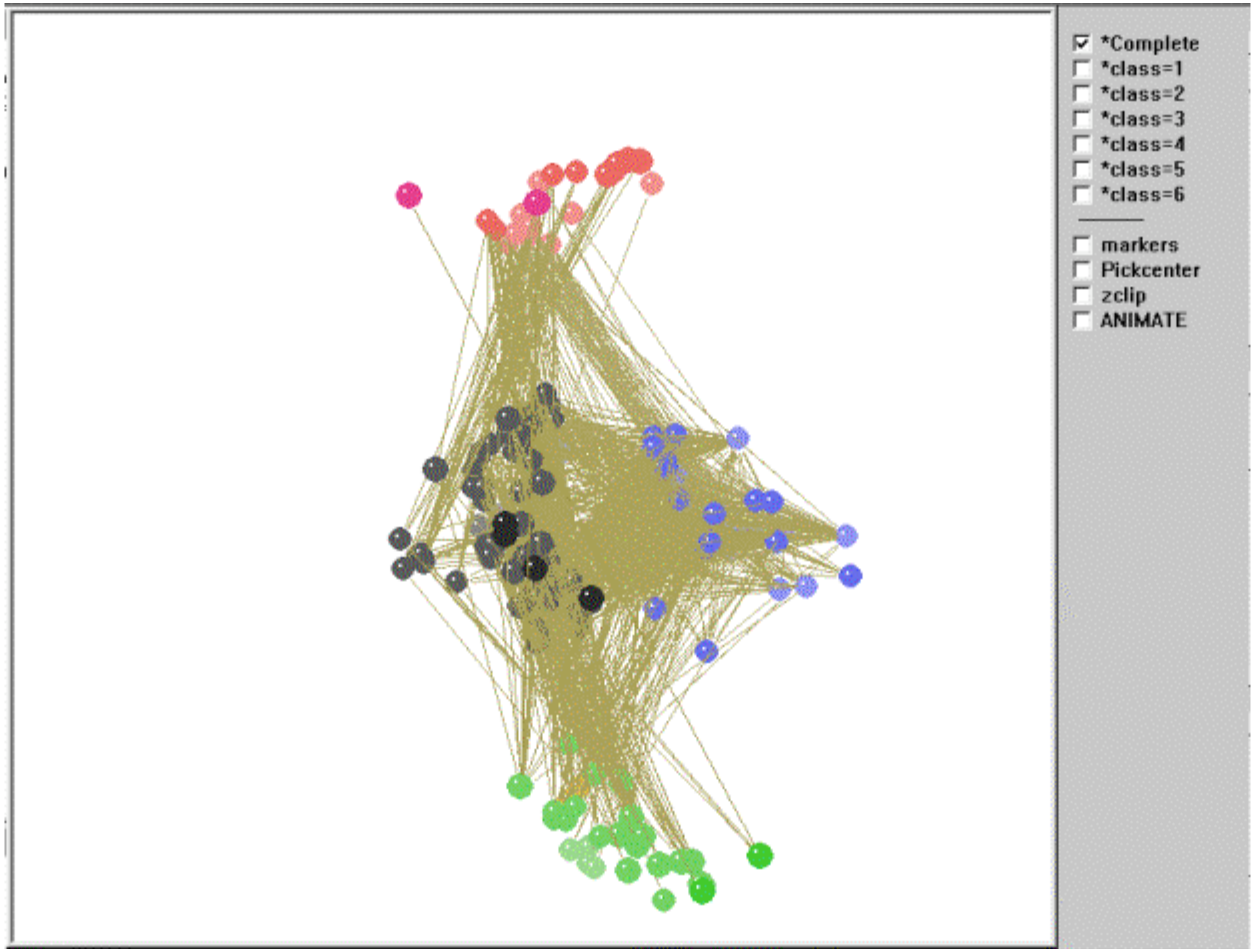


Figure 4



3-D MDS of REGE coefficients

Green – producers

Black - intermediaries Specialist herbivores and detritivores

Blue- Intermediaries Generalist omnivores

Red – top predators

We can use results to define trophic similarity
This is derived entirely from the data

Conclusion

- Social roles can be viewed as data driven
- Method has been successfully applied within social sciences
- But has found applications beyond the social science boundary