Food webs

DSTA

1 Data Science and Complex Networks

1.1 Basic concepts

The study of how objects(entities) connect to each other and the properties of their connection.

Possible understanding: a relationship istance.

1.2 Terminology

- $G = \langle V, E \rangle$ where $E \subseteq V \times V$
- $|V| = n$, $|E| = m$, density is $|E|/|V|^2$

. . .

- vertex v is adjacent to u if $(u, v) \in E$; $(v, v) \notin E$.
- neigh. of v, N(v): the set of adjacent vertices; $deg(v) = |N(v)|$

. . .

- The adjacency matrix $A_{n \times n}$ of G: $(u, v) \in E \leftrightarrow a_{ij} = 1$

. . .

- [incidence matrix $I_{n \times m}$ of G:]

1.3 Paths, connectedness

- A path $u \to v$ is a *sequence* of edges $\langle (u, c_1), (c_1, c_2), \ldots (c_k, v) \rangle$
- its lenght (k+1) is the cardinatility of the path.

. . .

- Two vertices are connected if $\exists$ a path betw. them.
- A graph is connected if all its vertices are.

1.4 Distances, I

- Distance is the lenght of the (possibly non-unique) shortest path connecting them, ∞ otherwise.
- The diameter of a graph is the maximum distance between any two pairs

1.5 Distances, II

Average distances are also important

> [. . .] the first world-scale social-network graph-distance computations, using the entire Facebook network of active users (~721 million users, ~69 billion friendship links). The average distance [. . .] is 4.74, corresponding to 3.74 intermediaries or "degrees of separation."

1.6 Weighted, Directed, Multiplex

$G = \langle V, E, w \rangle$ where $w : E \to \mathbb{R}$

Path lenght: sum of the weights of the arcs.

. . .

$G = \langle V, E \rangle$ where $v \in V$ are **nodes** and $\langle u, v \rangle \in E$ are **arcs.** $w : E \to \mathbb{R}$

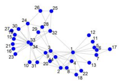
Out-neigh. and In-neigh.

. . .

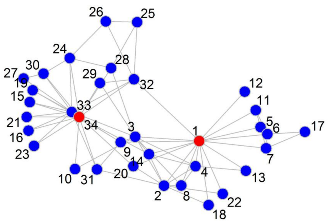
$G = \langle V, E, D \rangle$ where V are **nodes** D are **dimensions/layers** and $\langle u, v, d \rangle \in E$ are **arcs**

2 Interesting questions

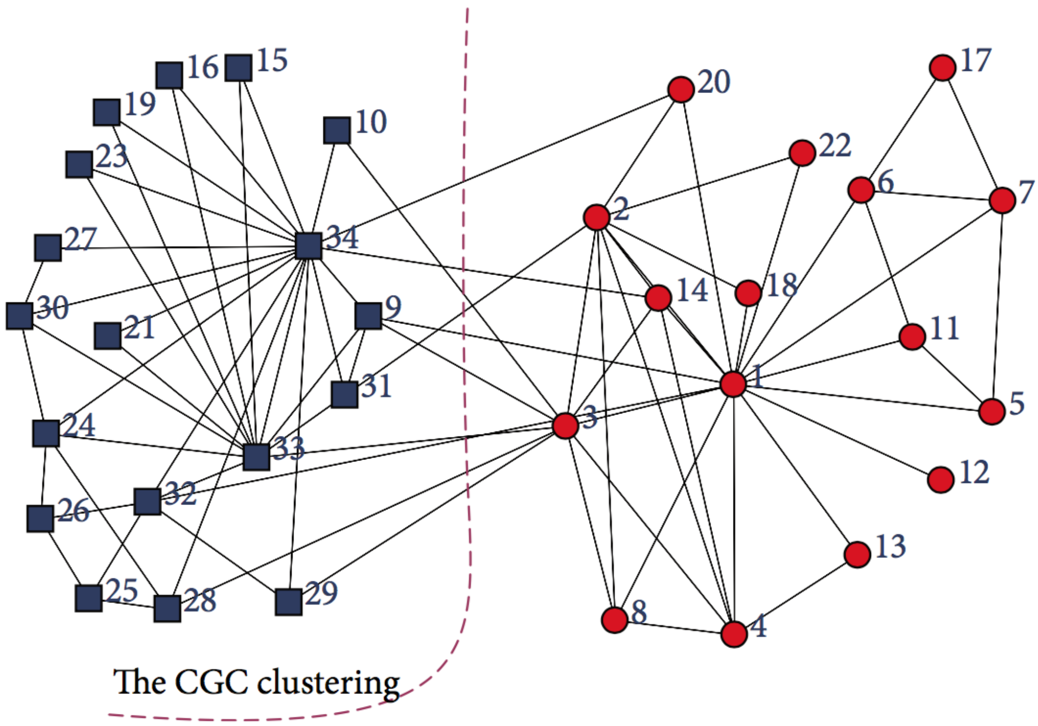
2.1 interesting questions I: paths and *oflow*



2.2 interesting questions II: centralities



2.3 interesting questions III: clustering

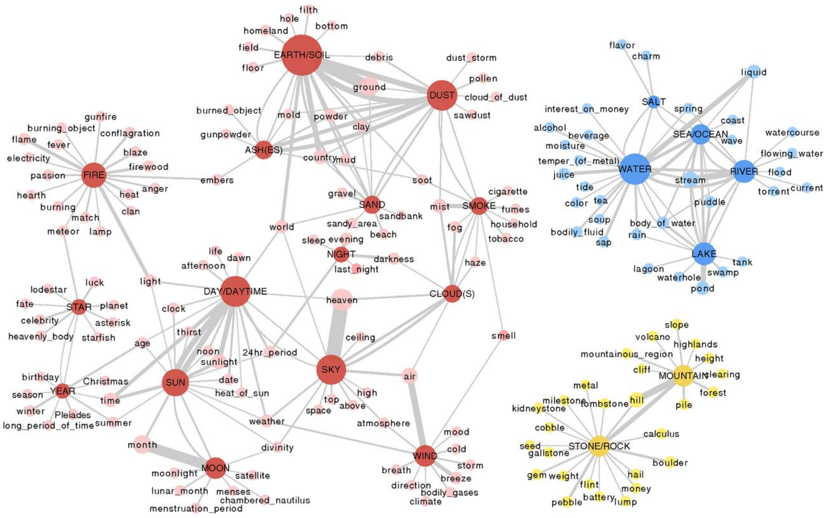


```
import networkx as nx

G = nx.karate_club_graph()

print("Node Degree")

for v in G:
    print('%s %s' % (v, G.degree(v)))
```

3 Visualization

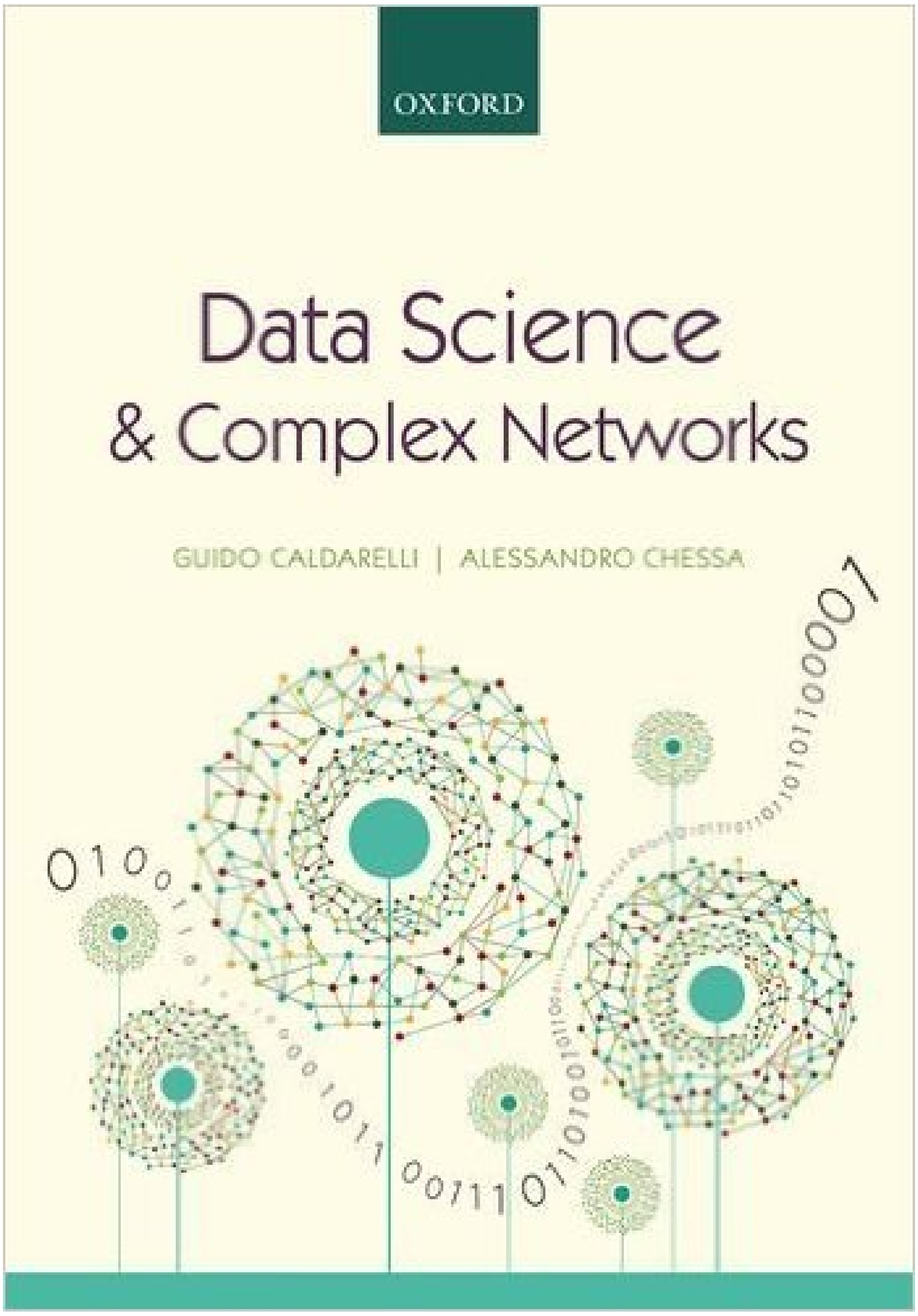
3.1 Visualizing frequencies by graphs

Polisemy:



filth
hole
bottom
homeland
field
EARTH/SOIL
debris
dust_storm
floor
ground
pollen
DUST
cloud_of_dust
burned_object
mold
powder
sawdust
gunfire
clay
burning_object
conflagration
gunpowder
flame
fever
ASH(ES)
blaze
country
mud
electricity
firewood
passion
FIRE
embers
soot
anger
hearth
heat
gravel
cigarette
burning
SAND
mist
SMOKE
fumes
clan
match
sandbank
meteor
lamp
world
sandy_area
fog
household
beach
sleep
evening
tobacco
life
NIGHT
darkness
dawn
haze
afternoon
last_night
luck
light
lodestar
DAY/DAYTIME
CLOUD(S)
fate
STAR
planet
heaven
clock
celebrity
asterisk
thirst
ceiling
smell
heavenly_body
starfish
age
noon
24hr_period
sunlight
SKY
birthday
Christmas
date
air
SUN
season
YEAR
heat_of_sun
high
time
top
winter
above
Pleiades
space
weather
atmosphere
long_period_of_time
summer
mood
month
divinity
cold
WIND
moonlight
MOON
storm
satellite
breath
breeze
lunar_month
direction
menses
bodily_gases
chambered_nautilus
climate
menstruation_period
flavor
charm
liquid
SALT
interest_on_money
spring
coast
alcohol
SEA/OCEAN
watercourse
beverage
wave
moisture
flowing_water
temper_(of_metal)
WATER
RIVER
flood
juice
stream
tide
torrent
current
color
tea
puddle
soup
body_of_water
bodily_fluid
rain
sap
LAKE
tank
lagoon
swamp
waterhole
pond
slope
volcano
highlands
height
mountainous_region
cliff
MOUNTAIN
clearing
metal
forest
milestone
tombstone
hill
pile
kidneystone
cobble
calculus
seed
STONE/ROCK
gallstone
boulder
gem
weight
hail
flint
money
pebble
battery
lump

3.2 More on Graphs/Networks



. . .

The Python 2 code can be cloned from Github

From the same author, a summary of the main concepts

4 Ch. 1: Food Webs

4.1 Important concepts

- load data and organise it in a **networkx** data structure

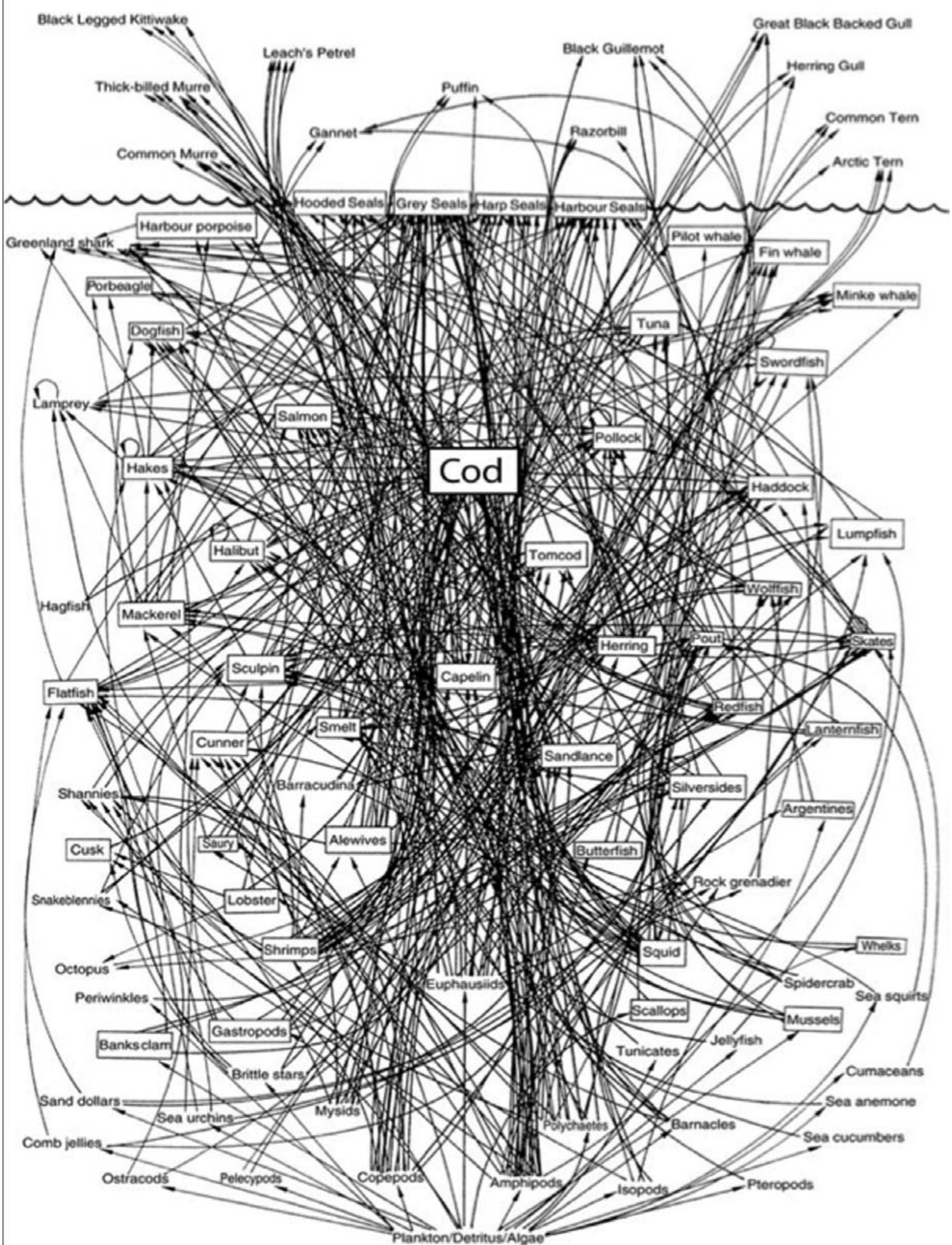
. . .

- modeling tip: it is ok to have a special node representing “nature”
- modeling tip: look for *invariants*

. . .

- find the connected component (the **bowtie**):

source, connect and sink.



A simplified food web for the Northwest Atlantic. © IMMA

4.2 Method

- study degree distribution
- find properties of a network in terms of the *degree organization*

. . .

- study *clustering coefficient:* why is it so much better than plain network density?