

ISE 599

Special Topics Applied Predictive Analytics

Mayank Kejriwal

Complex

[adj., v. kuh m-pleks, kom-pleks; n. kom-pleks]

—adjective

1.

composed of many interconnected parts; compound; composite: a complex highway system.

2.

characterized by a very complicated or involved arrangement of parts, units, etc.: complex machinery.

3.

so complicated or intricate as to be hard to understand or deal with: a complex problem.

Source:
Dictionary.com

Complexity, a **scientific theory** which asserts that some systems display behavioral phenomena that are completely inexplicable by any conventional analysis of the systems' constituent parts. These phenomena, commonly referred to as emergent behaviour, seem to occur in many complex systems involving living organisms, such as a stock market or the human brain.

*Source: John L. Casti, *Encyclopædia Britannica**

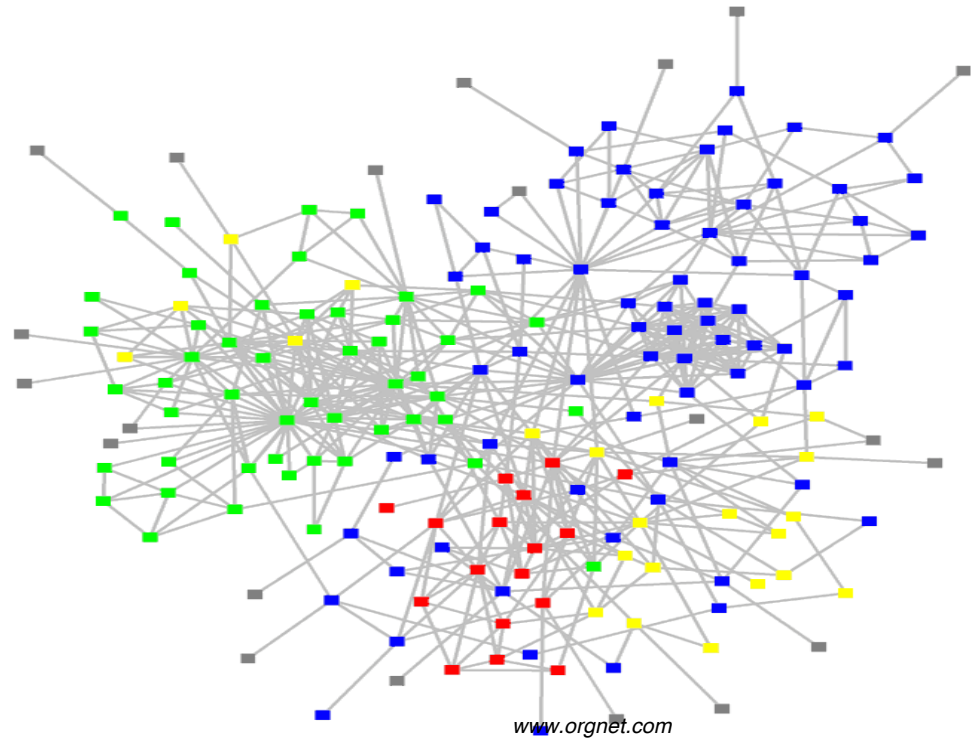
Complexity

Why networks?

- Behind each complex system there is a **network**, that defines the interactions between the component.

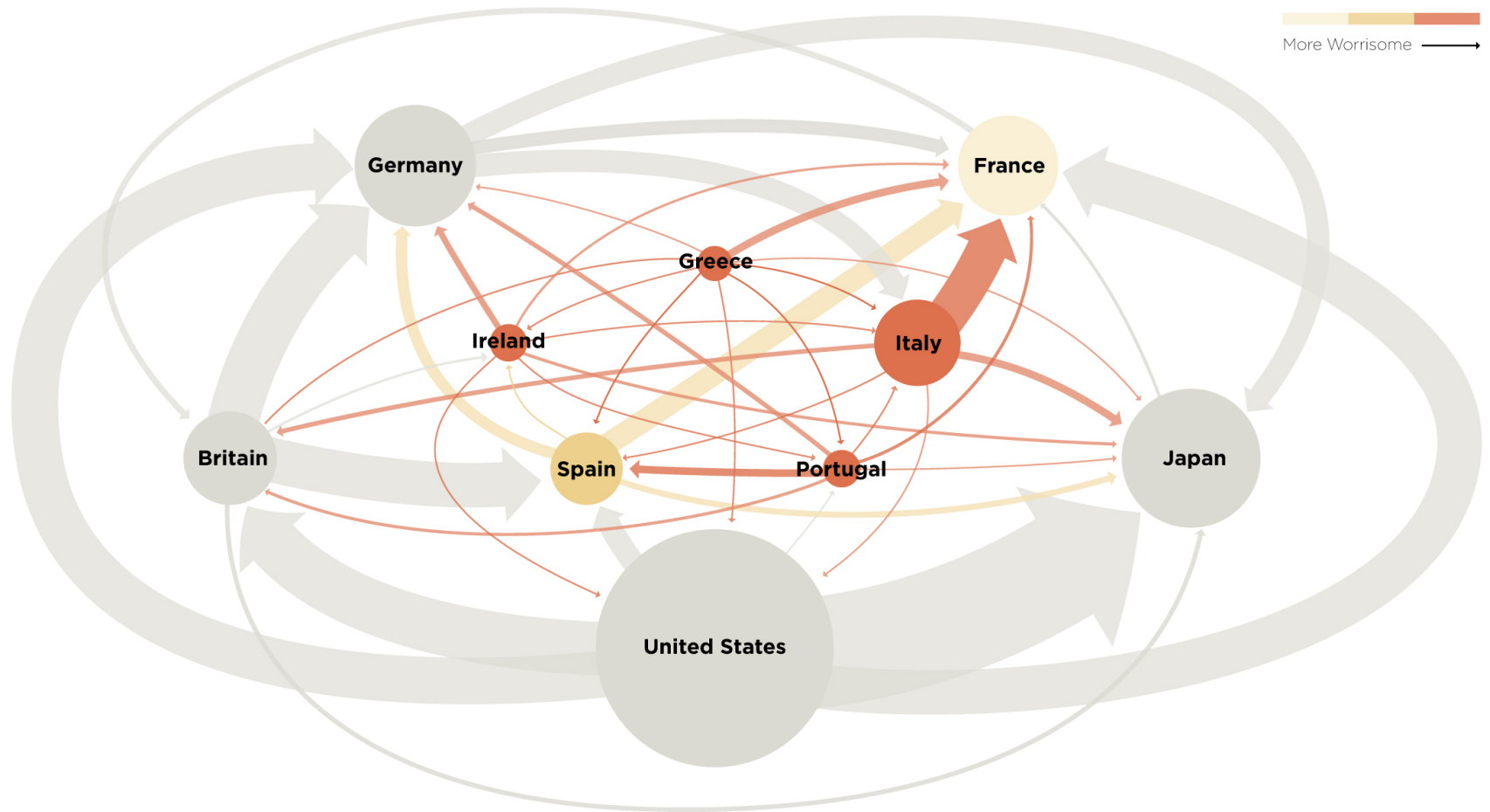
Networks: examples

STRUCTURE OF AN ORGANIZATION



- ■ ■ : departments
- : consultants
- : external experts

The not so subtle financial networks: 2011



Behind each system studied in complexity there is an intricate wiring diagram, or a **network**, that defines the interactions between the component.

We will never understand complex system unless we map out and understand the networks behind them.

Network science: a brief history

Graph theory: 1735, Euler

Social Network Research: 1930s, Moreno

Communication networks/internet: 1960s

Ecological Networks: May, 1979.

The emergence of network maps:

Movie Actor Network, 1998;

World Wide Web, 1999.

C elegans neural wiring diagram 1990

Citation Network, 1998

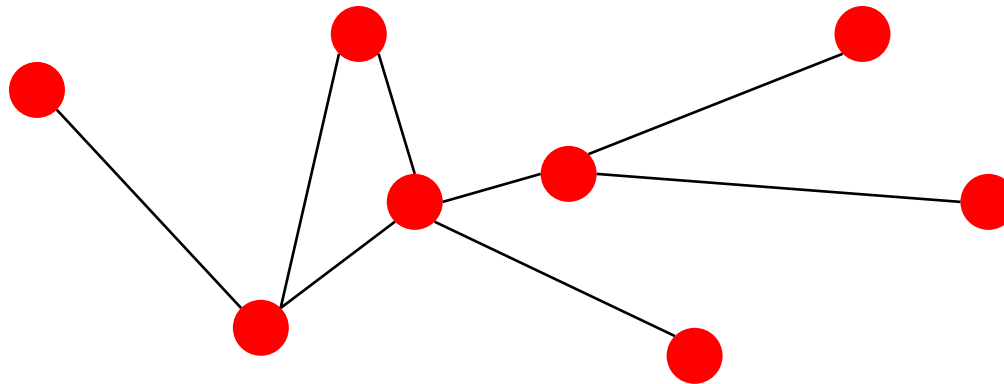
Metabolic Network, 2000;

PPI network, 2001

THE EMERGENCE OF NETWORK SCIENCE

The universality of network characteristics:

The architecture of networks emerging in various domains of science, nature, and technology are more similar to each other than one would have expected.



▪ **components:** nodes, vertices

N

▪ **interactions:** links, edges

L

▪ **system:** network, graph

(N,L)

network often refers to real systems

- www,
- social network
- metabolic network.

Language: (Network, node, link)

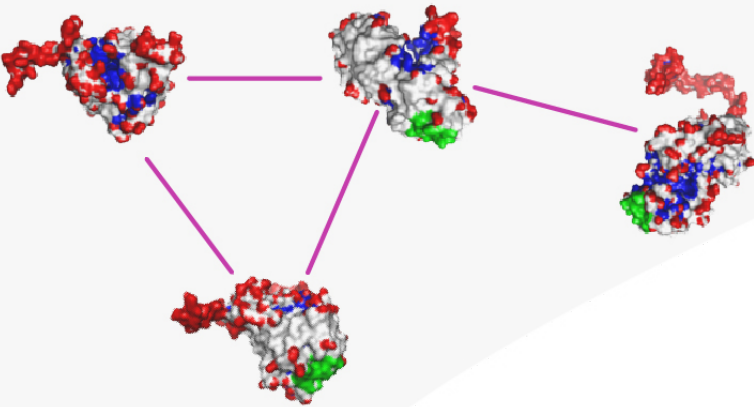
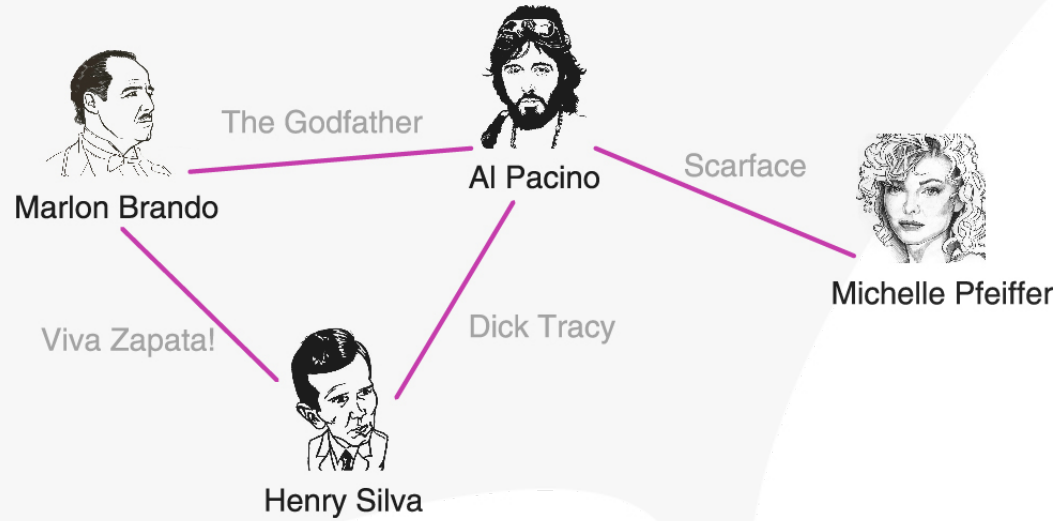
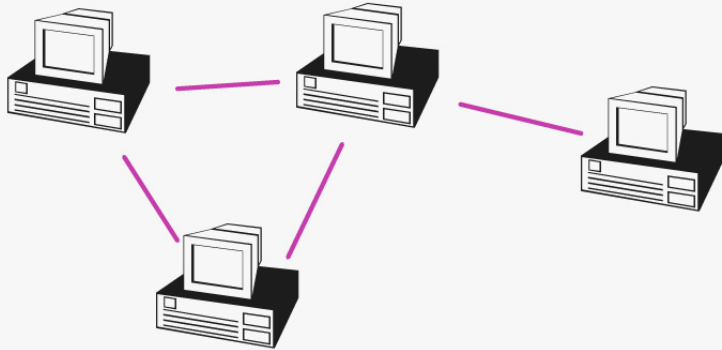
graph: mathematical representation of a network

- web graph,
- social graph (a Facebook term)

Language: (Graph, vertex, edge)

We will try to make this distinction whenever it is appropriate, but in most cases we will use the two terms interchangeably.

Networks give us a common language to study 'structure'...



$N=4$
 $L=4$

