

Small World Networks

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REDES



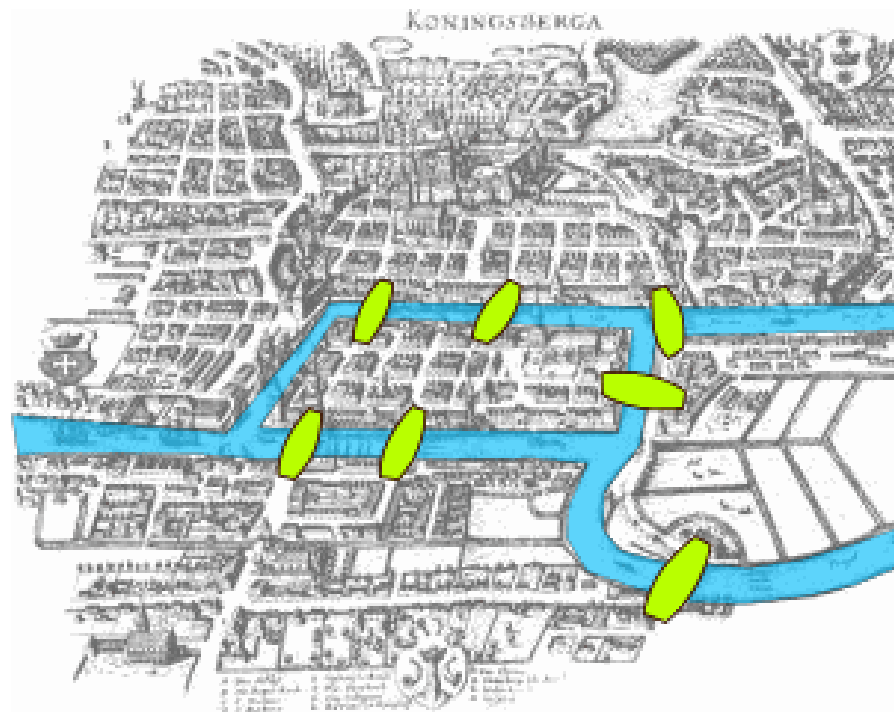
madrid institute for advanced studies

Overview of the talk

- Graphs and networks.
- Small world networks.
- Applications.

Origin of the Study of Networks

Königsberg bridges (Kaliningrad), XVIIIth century.



Is there a cycle crossing each bridge only once?

Euler to the Rescue!

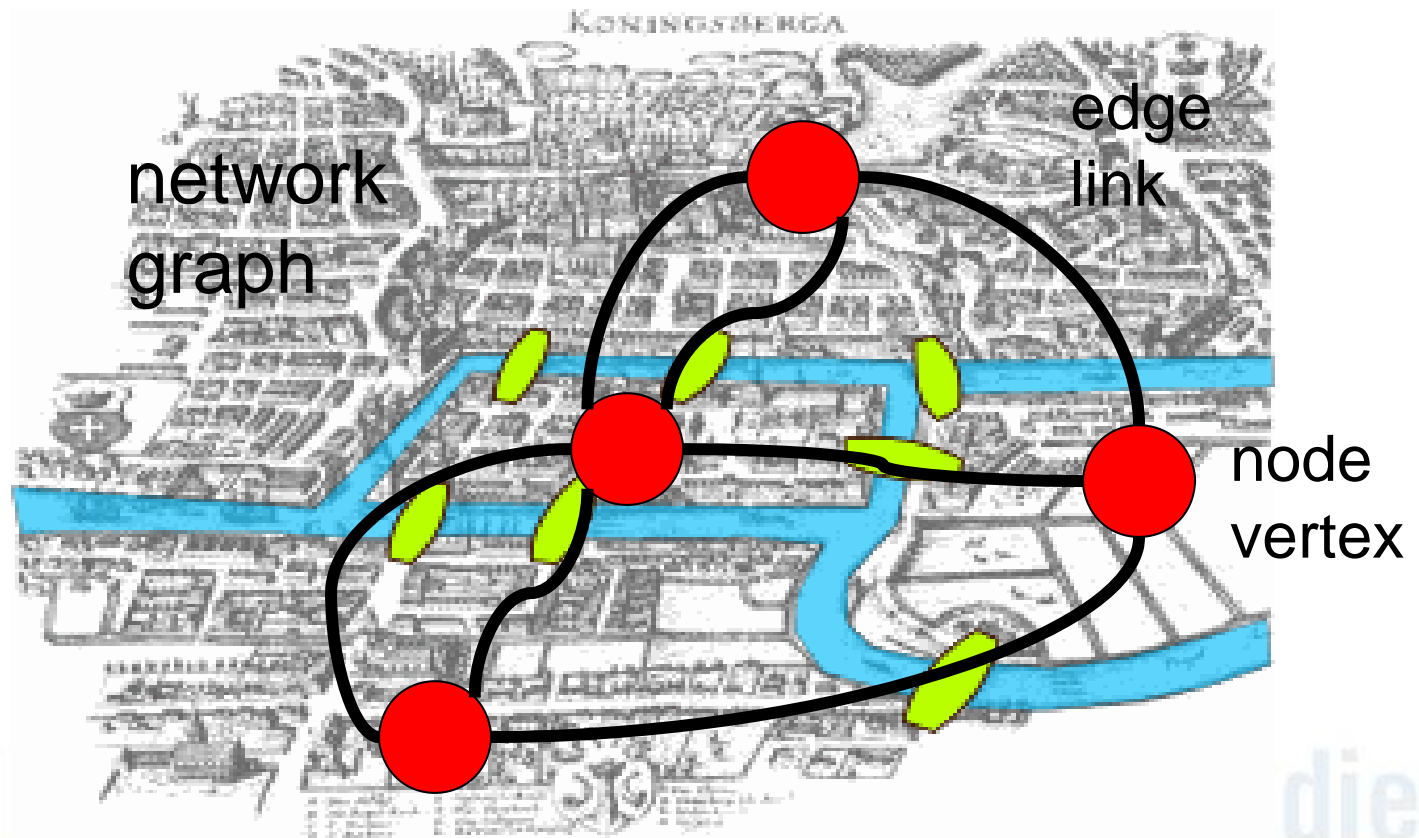
Leonhar Euler solved this
brainteaser in 1736.

Trick: think out of the box.



First step: model

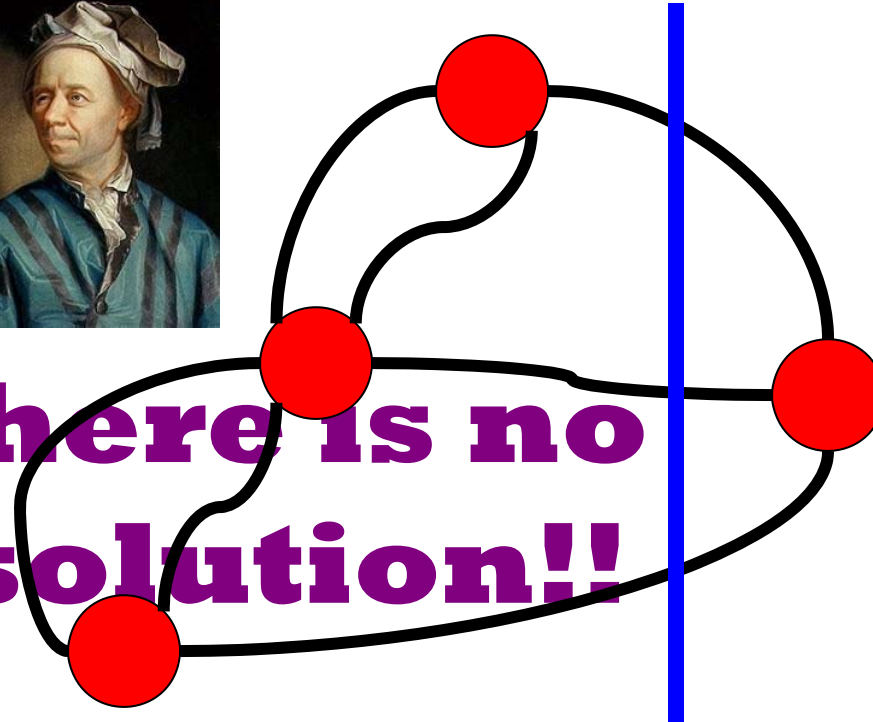
Problem modeling



Second step: solve

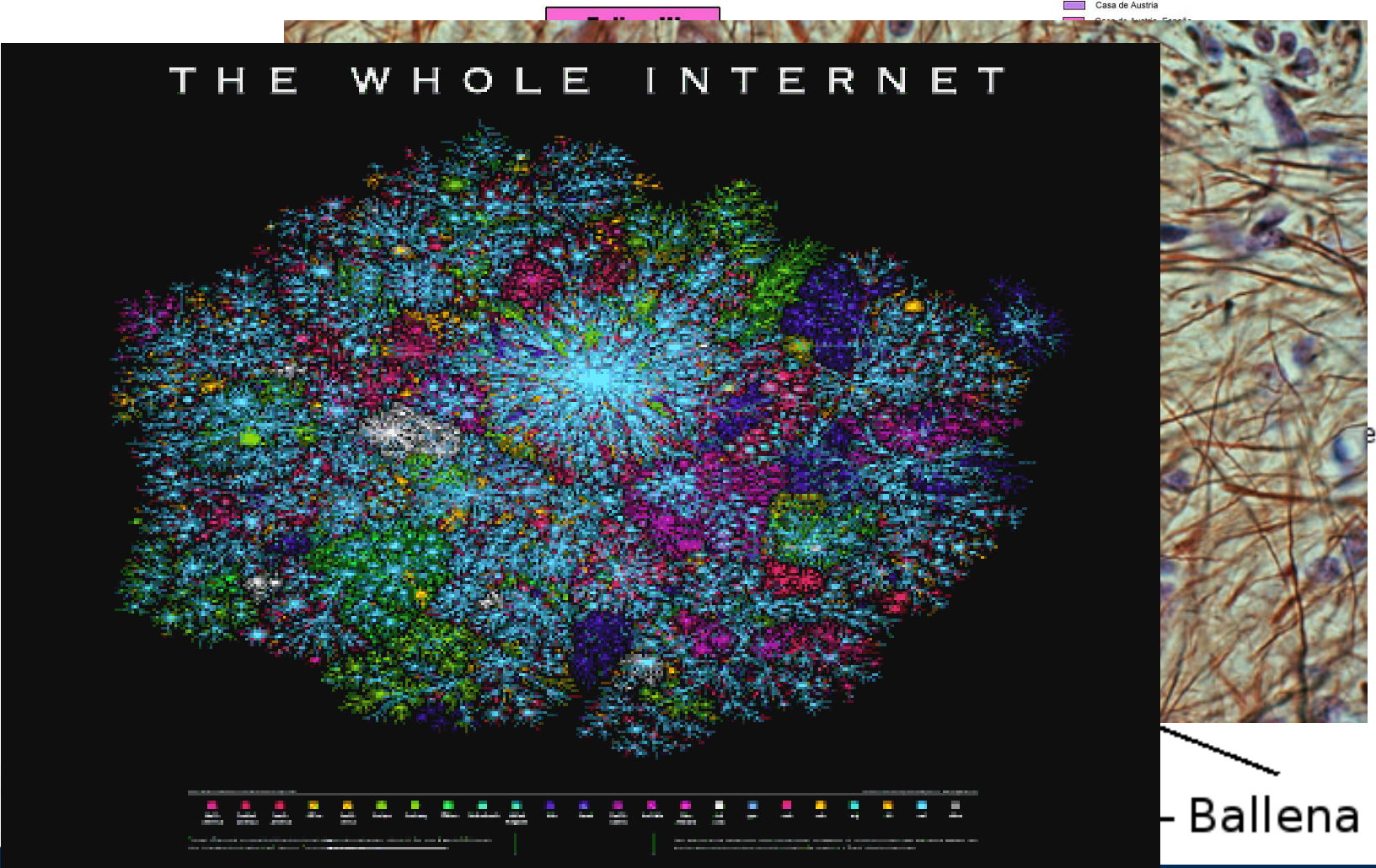


**There is no
solution!!**



No network with odd degree nodes can be traversed with a cycle.

Networks Everywhere!!

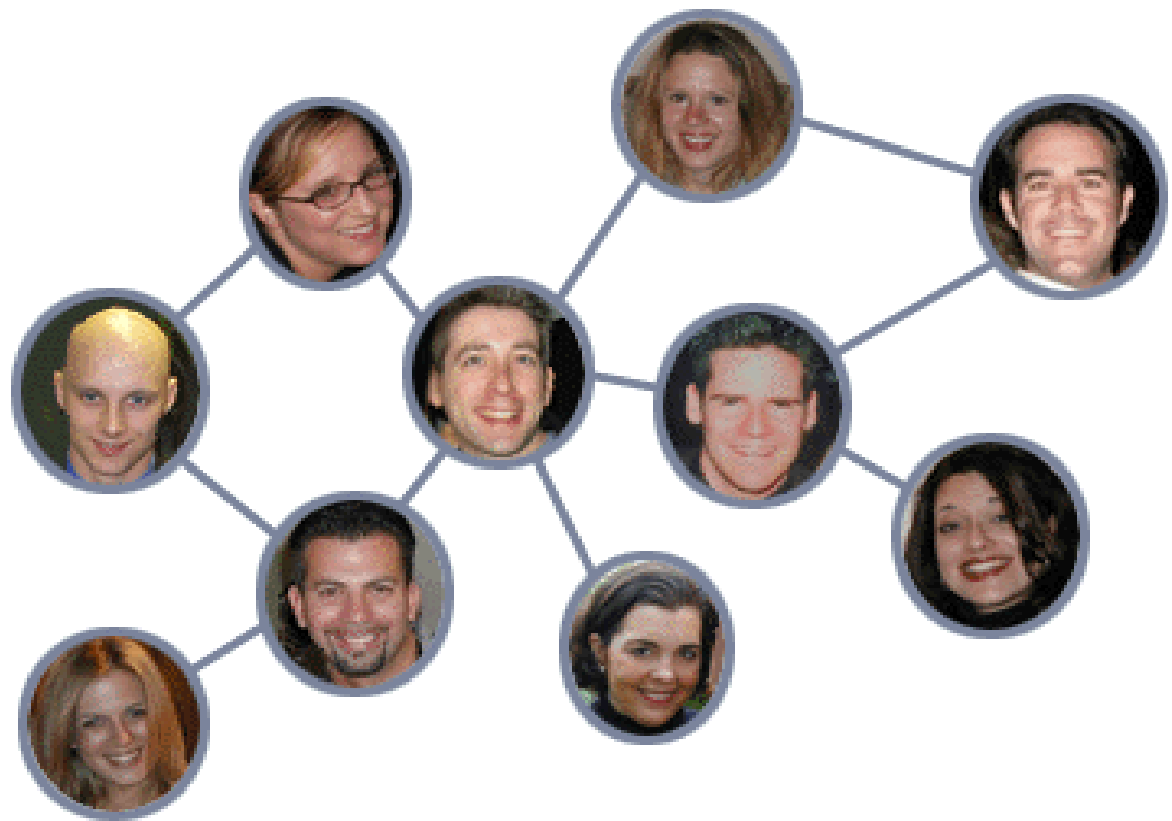


Maps Are Networks



How would you find the best route for a salesperson?

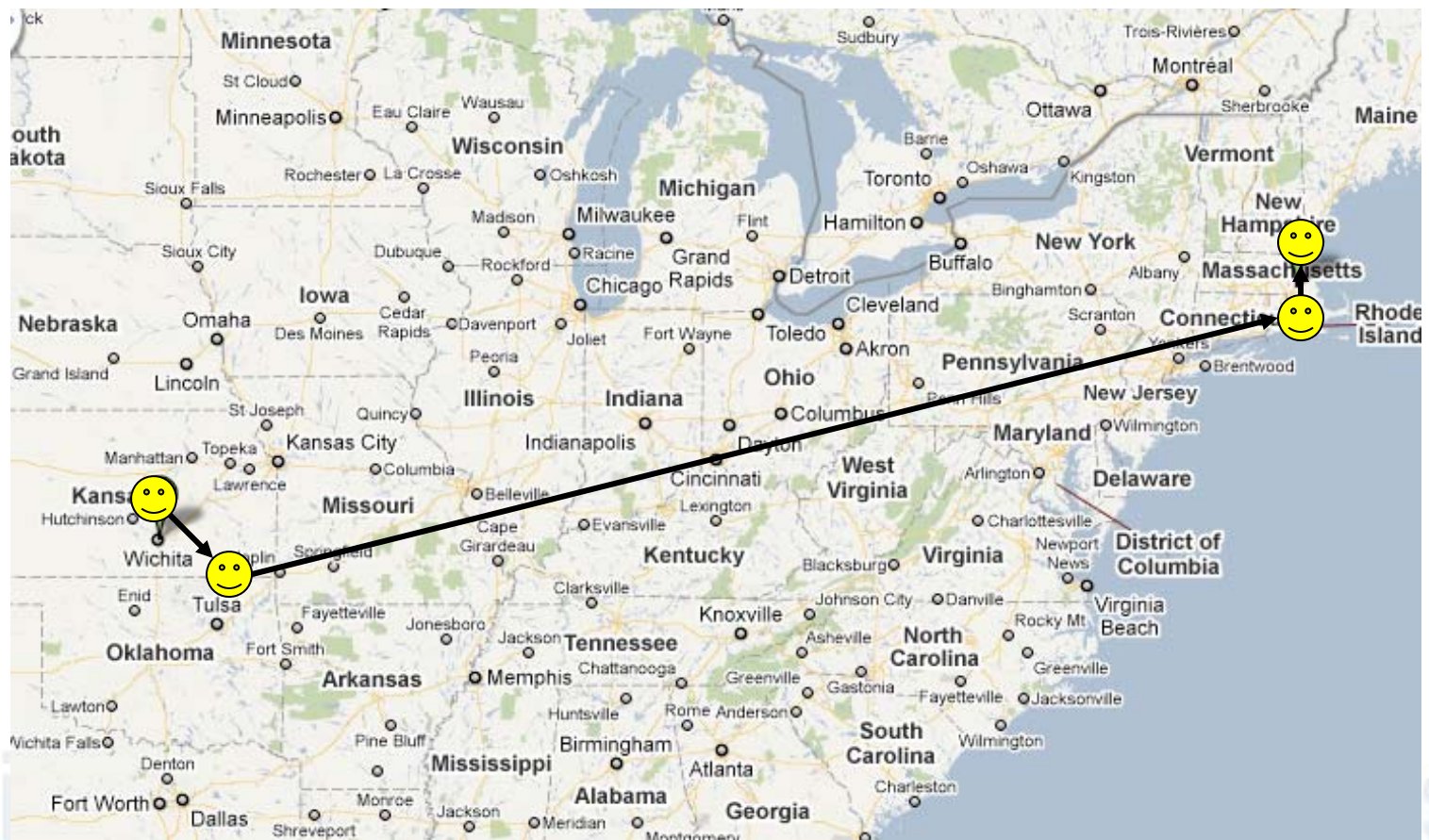
Social Networks



How many hops from me to Obama?

Small World

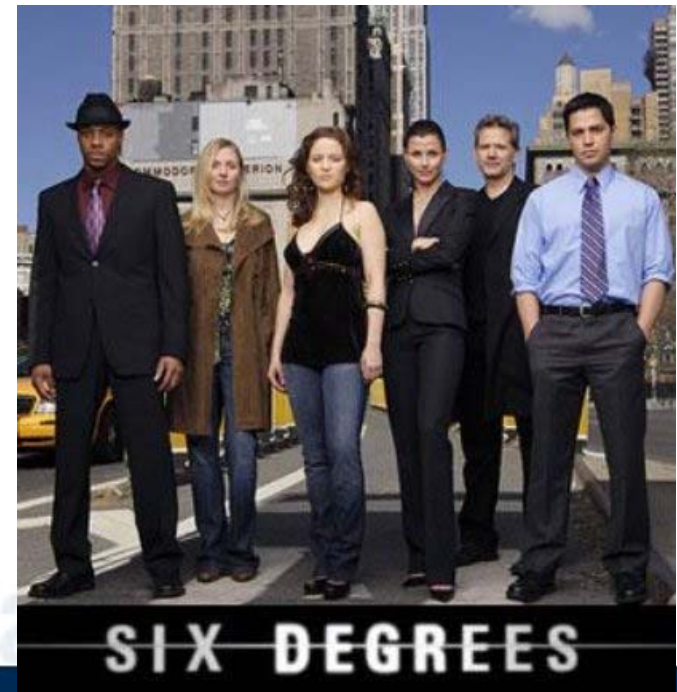
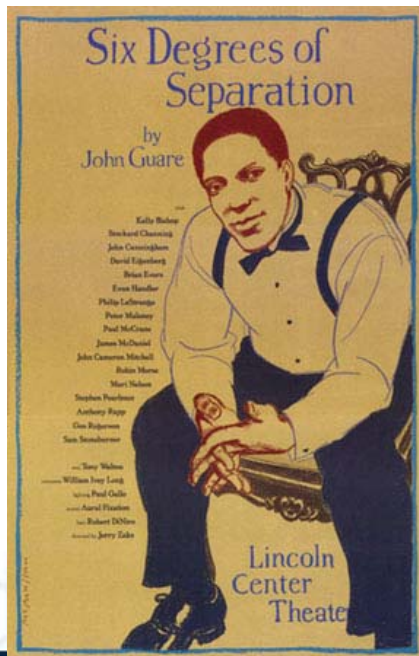
Milgram explored (1967) social distances in US



Six Degrees of Separation

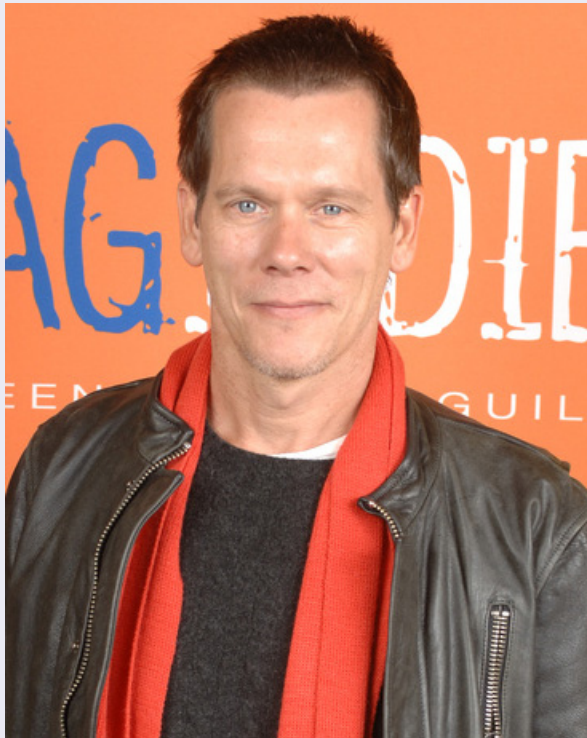
On average, the target person was reached in 6 hops.

It is a small world!!



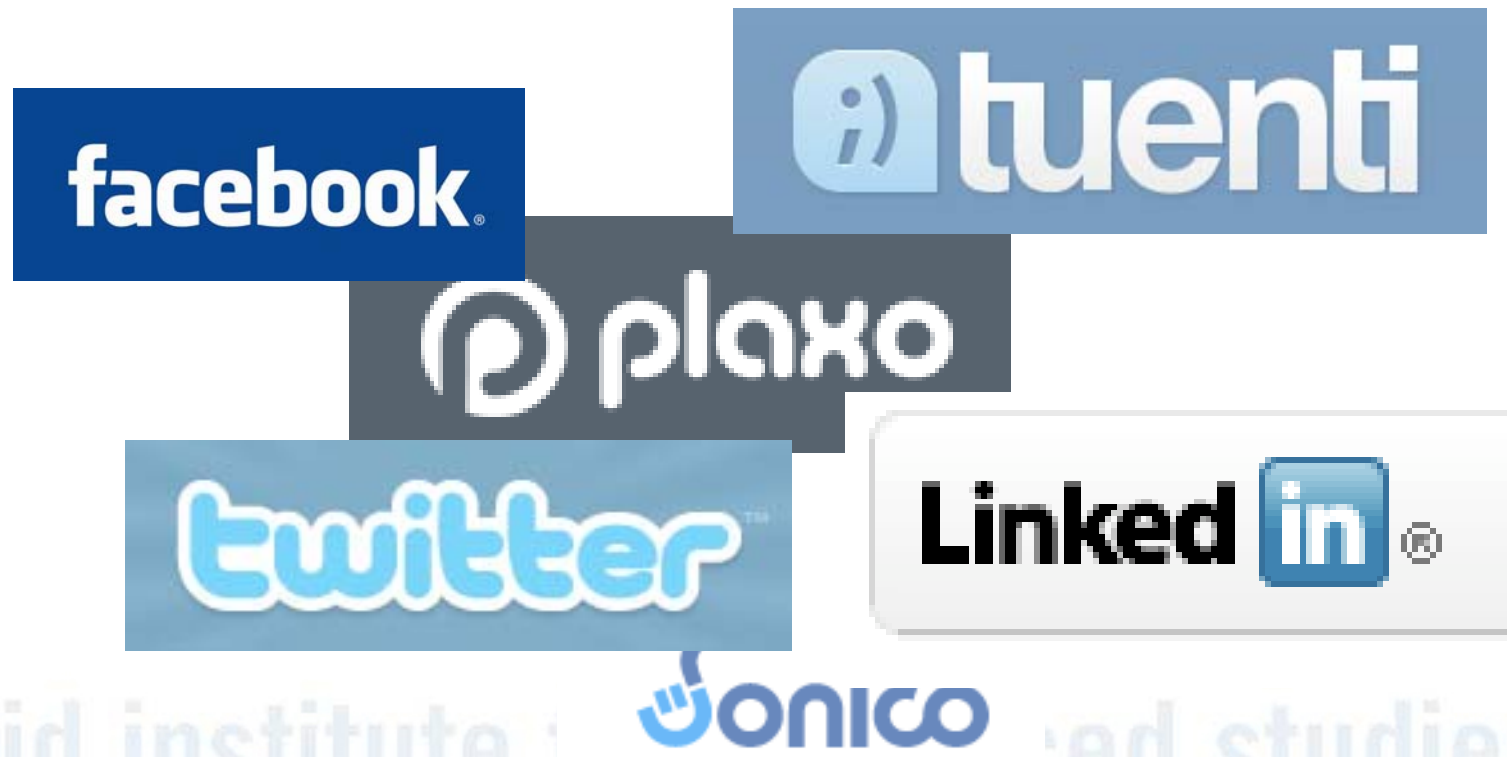
Bacon Number

Paco Martínez Soria has a
Bacon number of 3.




Social Networks

They connect many people with a few hops



Example: Linkedin


Linked  [Home](#) [Profile](#) [Contacts](#) [Groups](#) [Jobs](#) [Inbox \(13\)](#) [More...](#)

[Edit My Profile](#) [View My Profile](#)

Antonio Fernández Anta [\[Edit \]](#)

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Madrid Area, Spain [\[Edit \]](#) | Research [\[Edit \]](#)



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Post an update

Current	<ul style="list-style-type: none"> • Professor at Universidad Rey Juan Carlos [Edit] ✚ Add Current Position
Past	<ul style="list-style-type: none"> • Visiting Researcher at Bell Labs at Alcatel-Lucent • Associate Professor at Universidad Rey Juan Carlos • Associate Professor at Universidad Politécnica de Madrid <p style="text-align: right;">see all...</p>
Education	<ul style="list-style-type: none"> • Massachusetts Institute of Technology • University of Louisiana at Lafayette • Universidad Politécnica de Madrid
Recommended	1 person has recommended you
Connections	292 connections

My Network

Your Network of Trusted Professionals

You are at the center of your network. Your connections can introduce you to 1,854,500+ professionals — here's how your network breaks down:

 1 Your Connections Your trusted friends and colleagues	291
 2 Two degrees away Friends of friends; each connected to one of your connections	23,200+
 3 Three degrees away Reach these users through a friend and one of their friends	1,830,900+
Total users you can contact through an Introduction	1,854,500+

10,986 new people in your network since August 2

The LinkedIn Network

The total of all LinkedIn users, who can be contacted directly through [InMail](#).

Total users you can contact directly — try a search now!	75,000,000+
--	--------------------

Distances



Forward email to phone? - Outlook M

People

Tim Berners-Lee 3rd

Professor of Engineering

Greater Boston Area | Research

Current	<ul style="list-style-type: none"> • Senior Research Scier
Past	<ul style="list-style-type: none"> • Fellow, then staff memt
Connections	29 connections
Websites	<ul style="list-style-type: none"> • My Website • URI for me • FOAF page
Public Profile	http://www.linkedin.com/ir

How you're connected to Tim



Barack Obama 3rd

President of the United States of America

Washington D.C. Metro Area | Government Administration



Current

- **President at United States of America**

Past

- US Senator
- State Senat
- Senior Lect School

Education

- Harvard Uni
- Columbia U
- Occidental

Connections

500+ connect

Websites

- White Hous
- Join Barack
- My RSS Fe

Public Profile

<http://www.lin>

How you're connected to Barack

You



- Balaji Rengarajan
- Sophie Hamel
- Juan Pavón
- Milani Alessia
- David Rios
- ... and 59 others



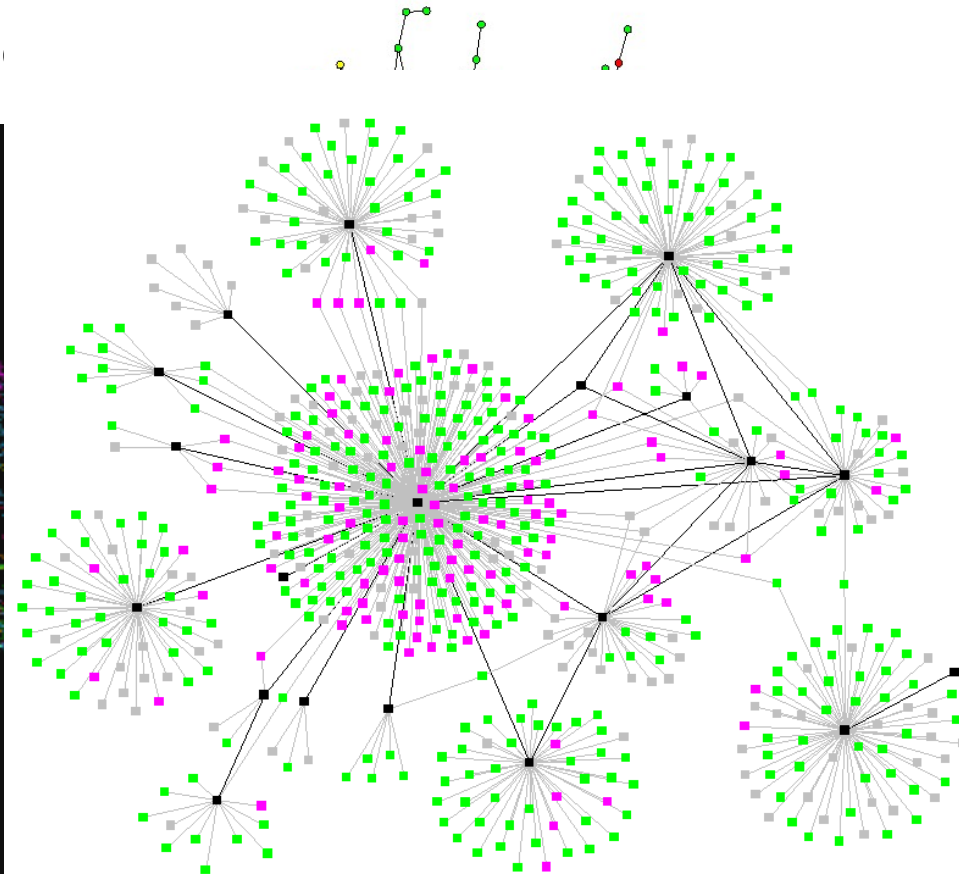
Barack's connections



3rd Barack Obama

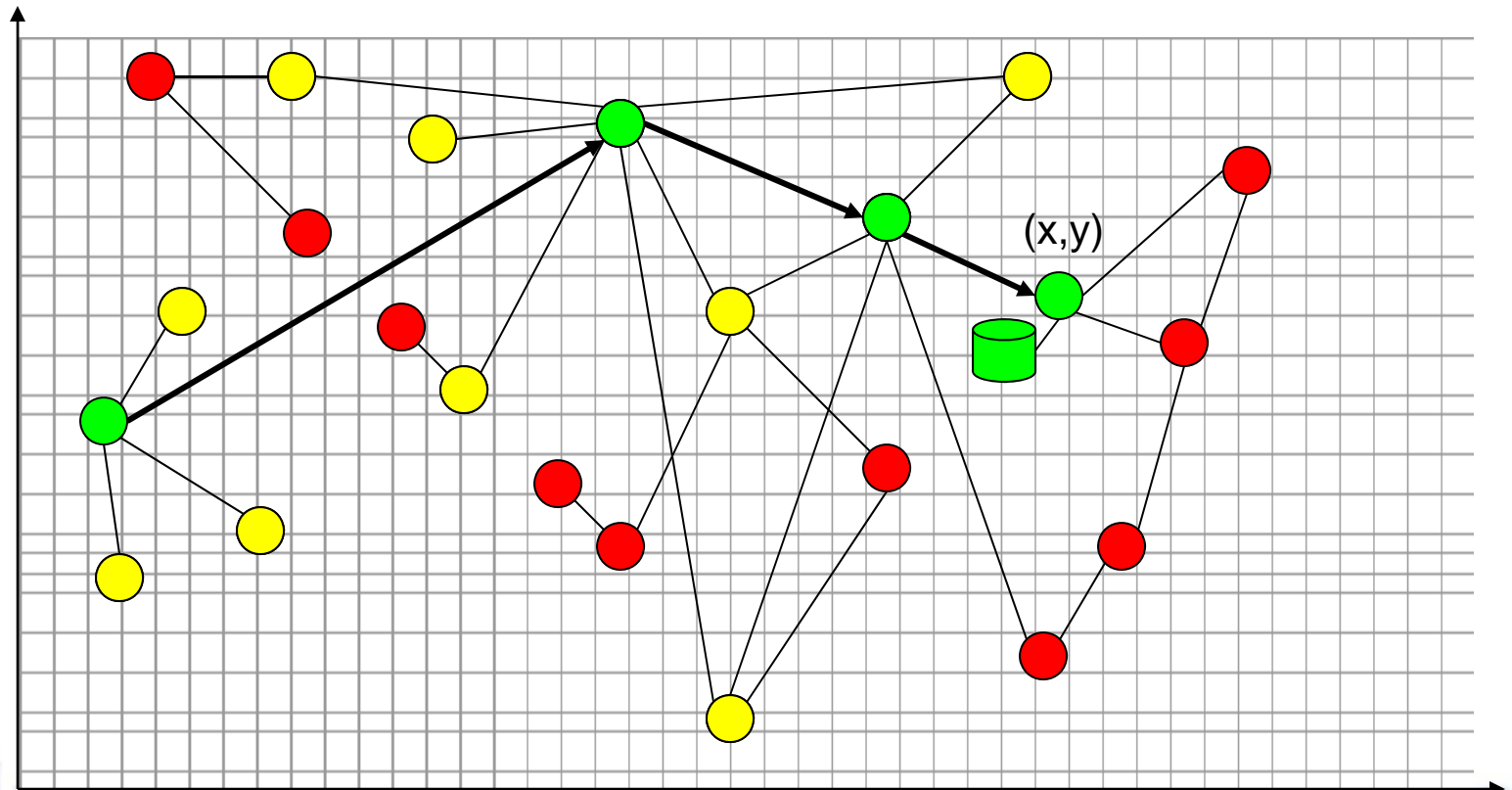
Small World Networks

- Networks with small distances
- Beyond social networks:
 - Internet and the w
 - Neurons
 - Infection
 - The grid
 - Metabolic
 -



Applications

Search of resources (files)



Conclusions

- Networks are everywhere
- Many of them have small world properties
- We would like to use these properties for our benefit

That's all :-)

Questions?

Second step: solve

“I have crossed 3 times over the Atlantic”

