

Ciência das Redes

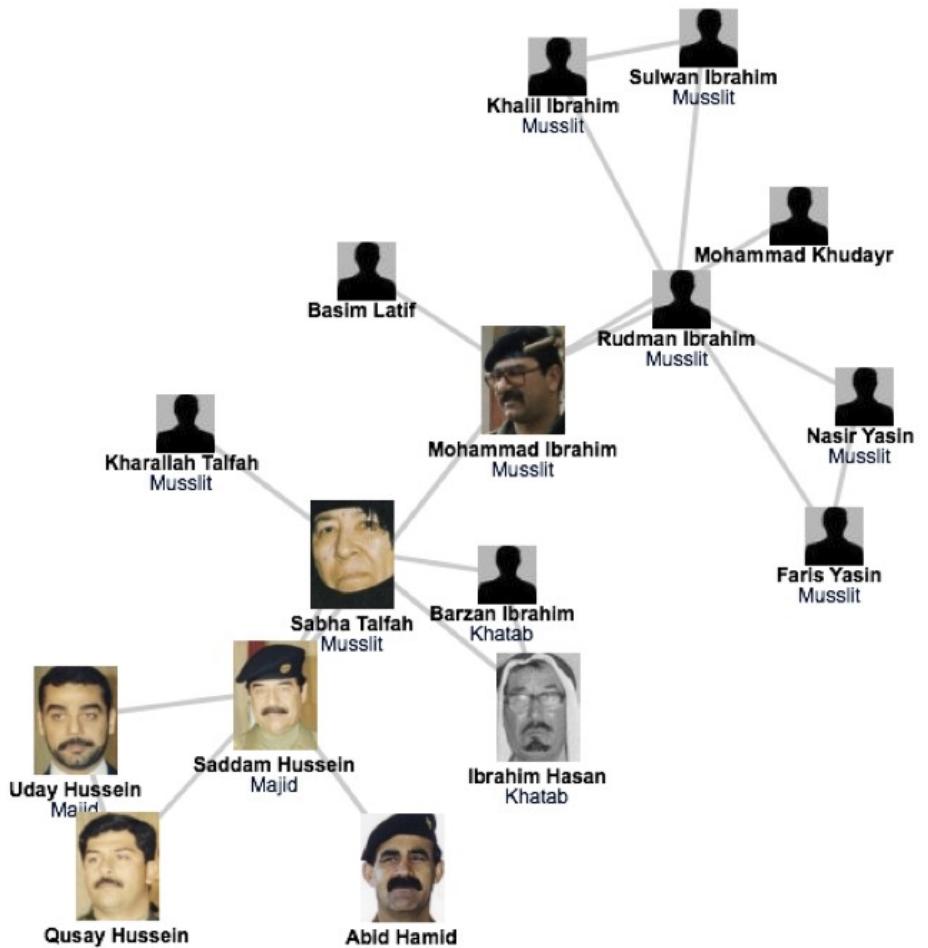
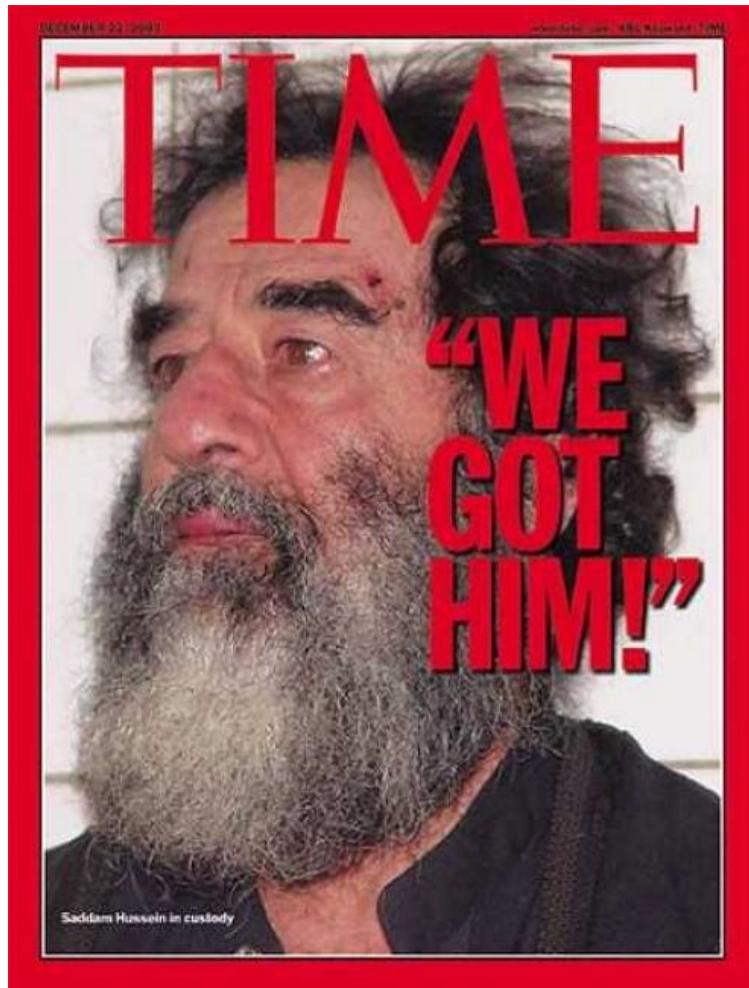
Introdução

Ricardo Luders
Thiago H Silva



A captura de Saddam Hussein

Ciência das redes é útil no estudo de vários problemas reais



2003

A captura de Saddam Hussein

Mostra o forte poder preditivo das redes.

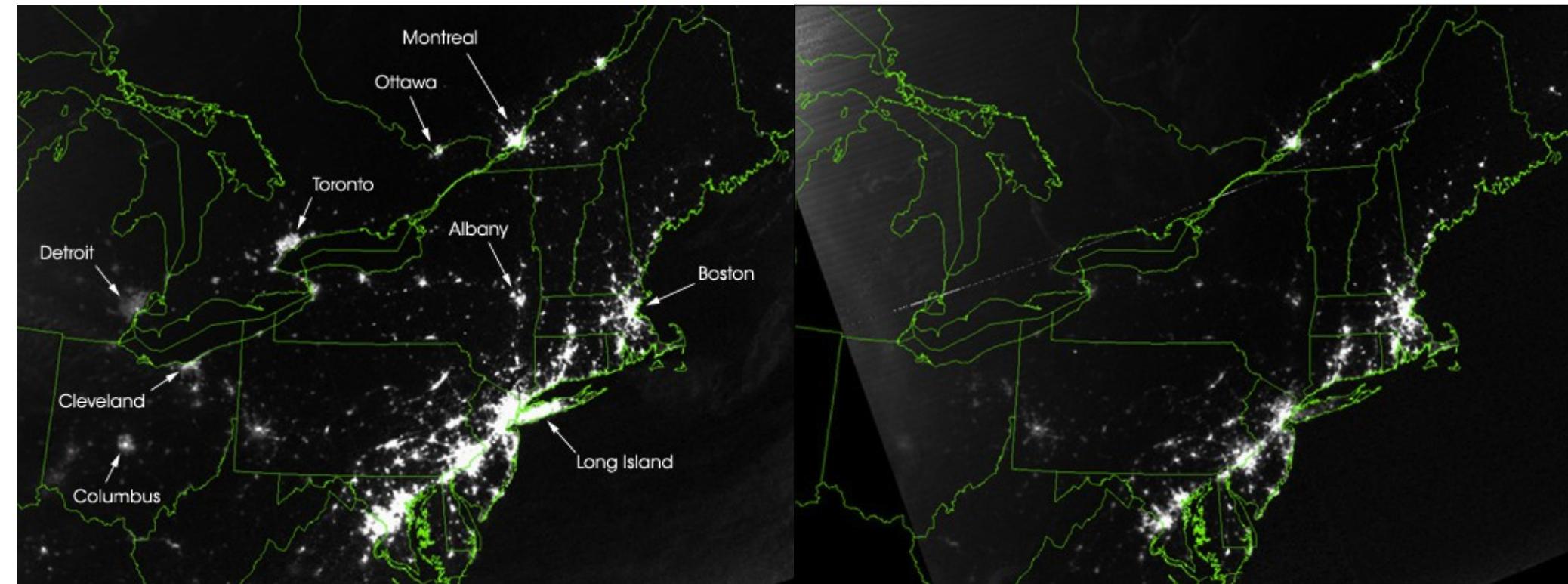
Ressalta a necessidade de obter mapas precisos das redes que pretendemos estudar; *e as dificuldades que encontramos durante o processo de mapeamento.*

Demonstra a notável estabilidade dessas redes: A captura de Hussein não foi baseada em informações recentes, mas sim em seus vínculos sociais pré invasão (fotos antigas)

Mostra que a escolha da rede em que focamos faz uma grande diferença: a árvore hierárquica, que capturou a organização oficial do governo iraquiano, não serviu para saber o paradeiro de Saddam Hussein.

Vulnerabilidade pela interconectividade

Blackout de 2003



14 de agosto, 2003: 19:29
20 horas antes

15 de agosto, 2003: 19:14
7 horas depois

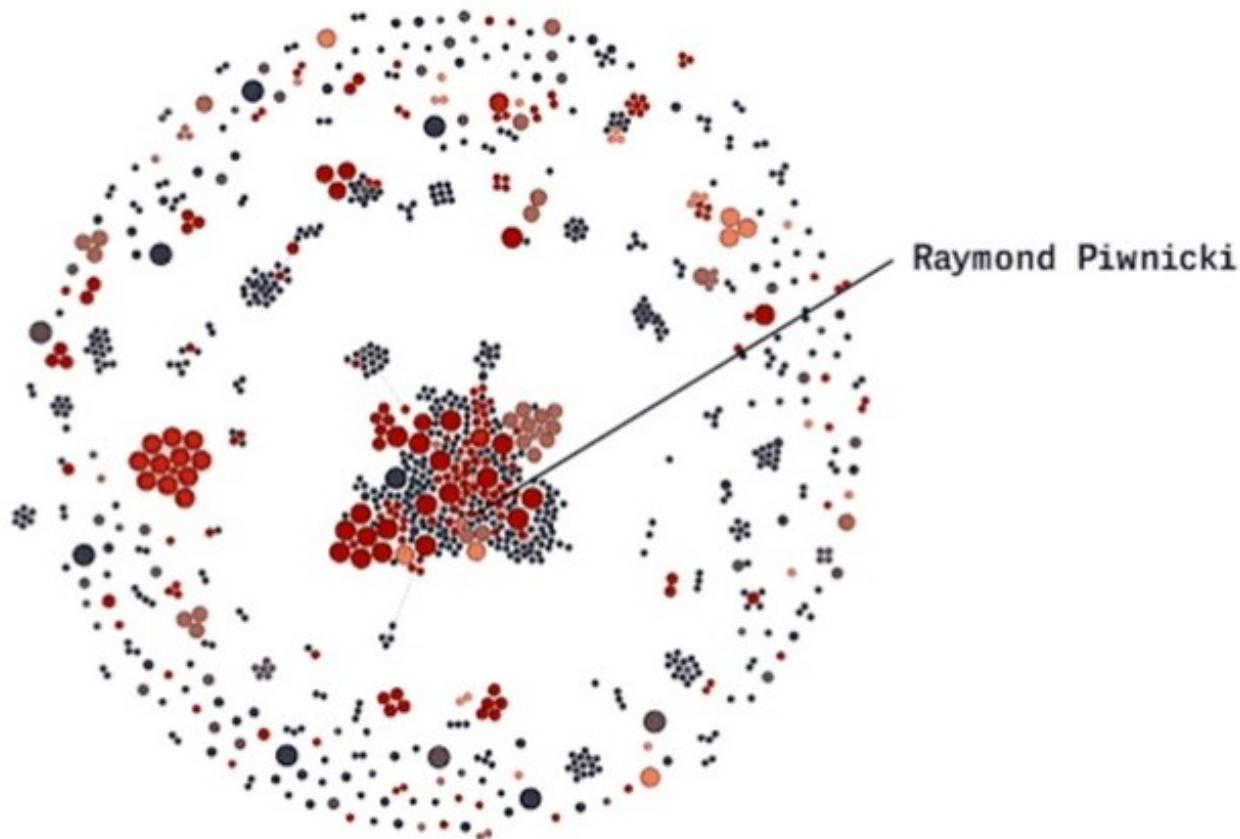
- Podemos entender como a estrutura da rede afeta a robustez de um sistema complexo.

The
Intercept_

BAD CHICAGO COPS SPREAD THEIR MISCONDUCT LIKE A DISEASE

Rob Arthur

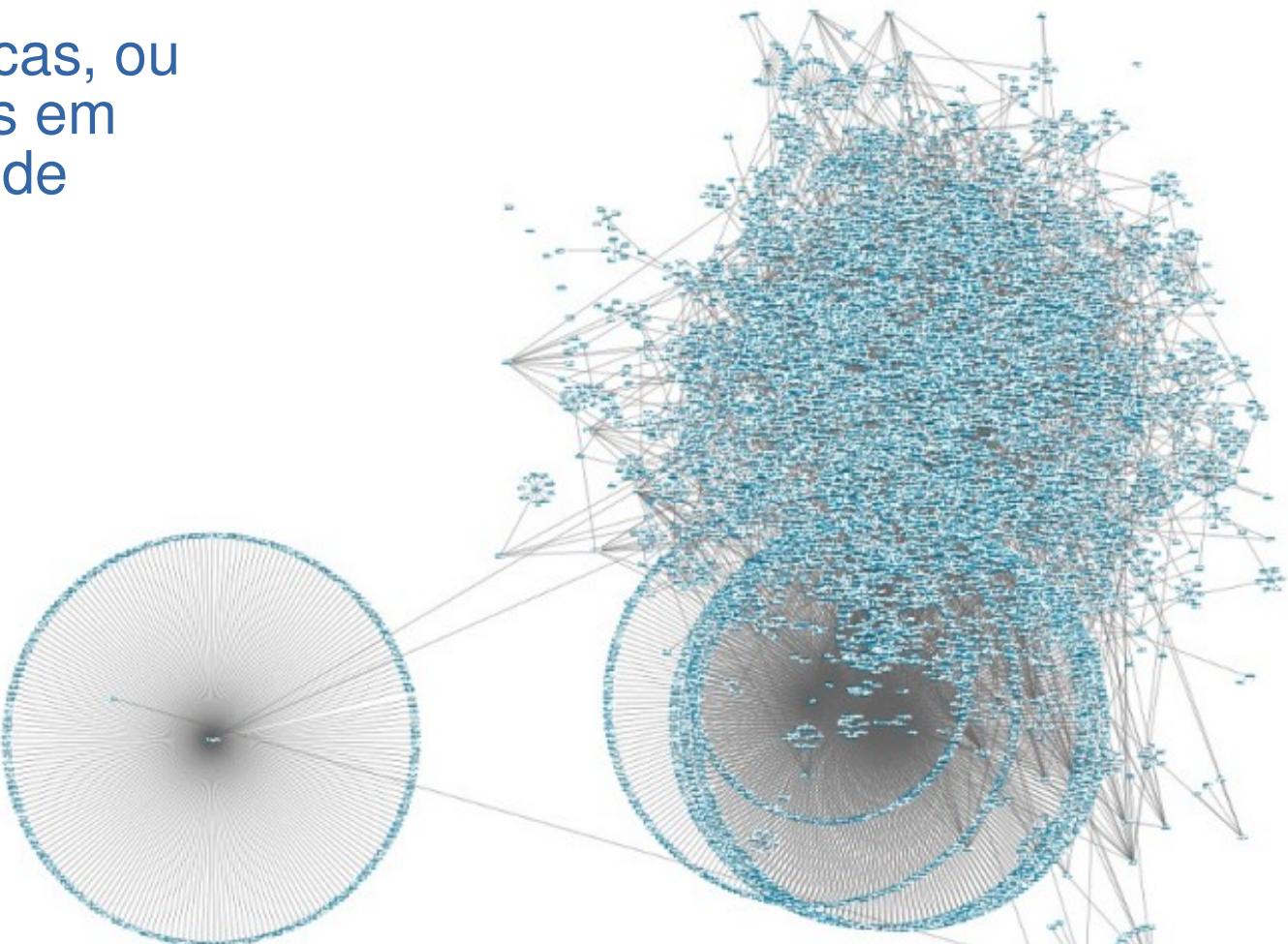
August 16 2018, 3:03 p.m.



- <https://theintercept.com/2018/08/16/chicago-police-misconduct-social-network>

Combater fake news e hate online

Contas não autênticas, ou bots, são anomalias em termos de padrões de conexão





*“I think the next century
will be the century
of complexity.”*

Stephen Hawking
23 de janeiro de 2000

Complexo

1

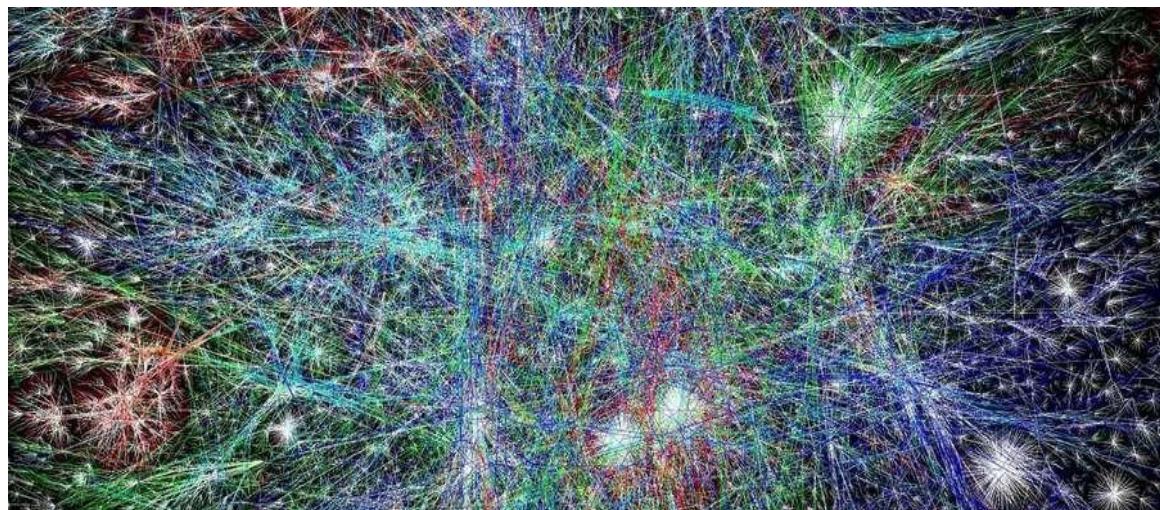
composto de muitas partes interconectadas;

2

caracterizado por um arranjo muito complicado;

3

tão complicado que é difícil de entender ou lidar com: um problema complexo.



Fonte: dictionary.com (simplificado)

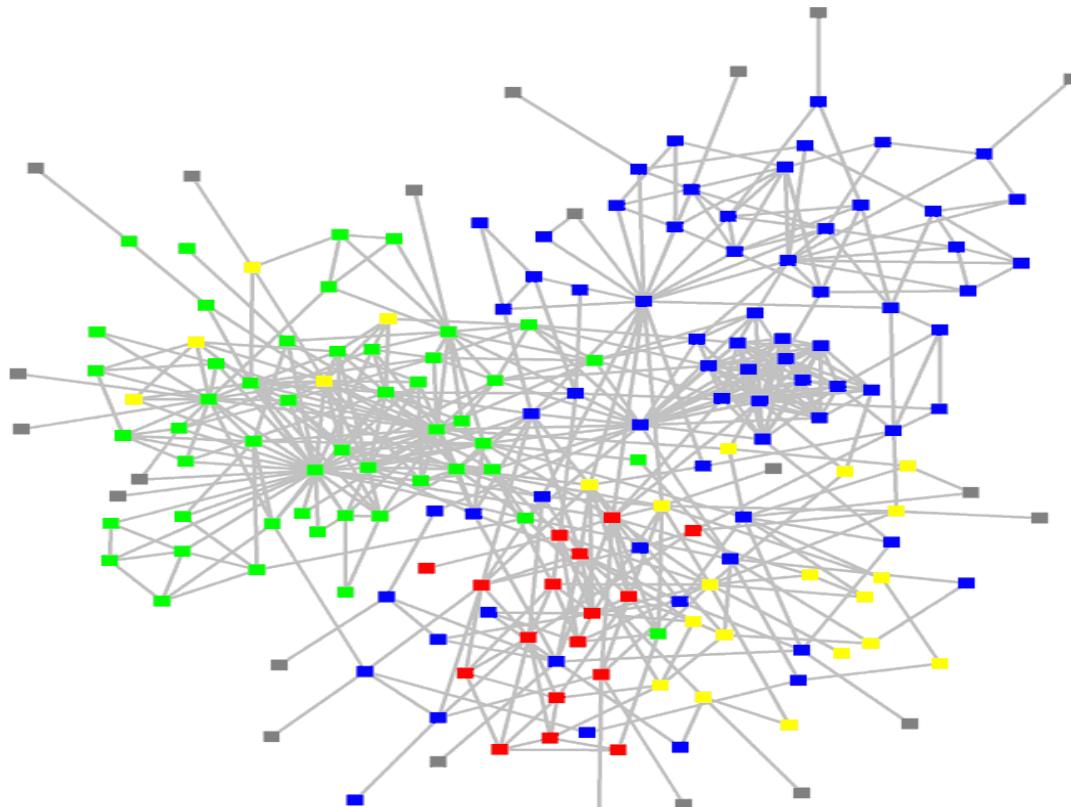
Atrás de cada sistema complexo existe uma rede, que define as interações entre os componentes.



O “Grafo Social” atrás do Facebook

Keith Shepherd's "Sunday Best". <http://baseballart.com/2010/07/shades-of-greatness-a-story-that-needed-to-be-told/>

Estrutura de uma organização



■ ■ ■ : departamentos

■ : consultores

■ : Especialistas externos

www.orgnet.com

Arestas no ramos de Biotech - EUA

Nós:

Companies

Investment

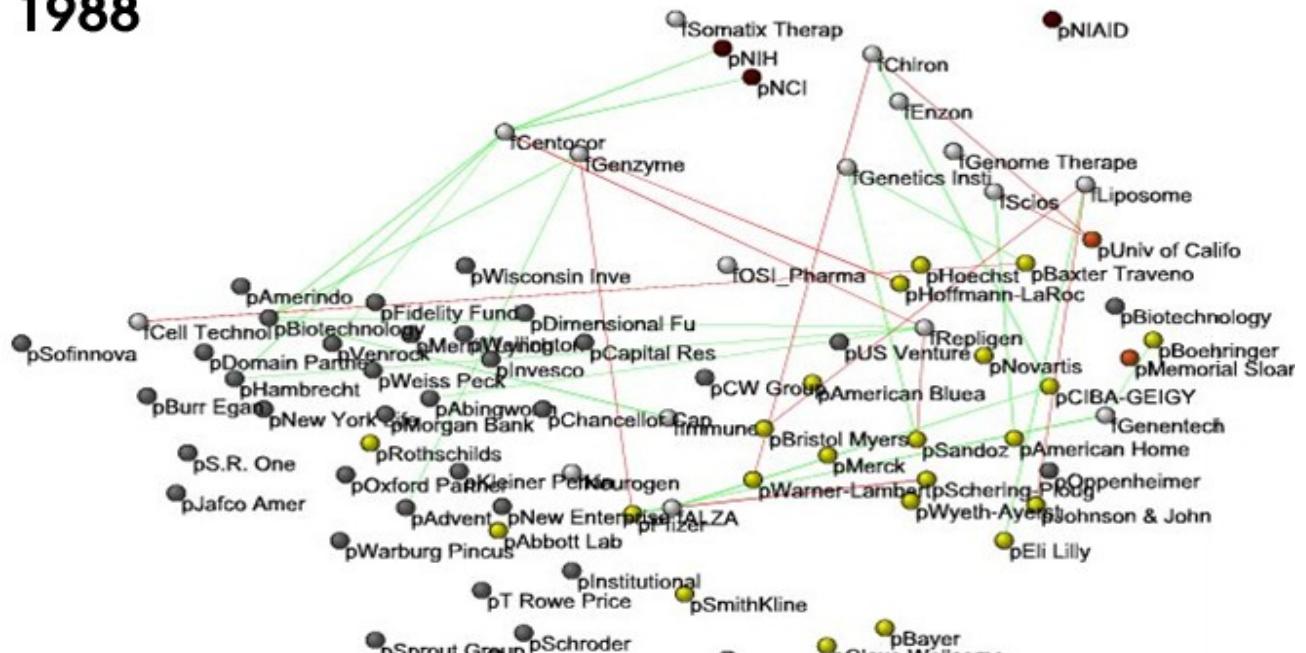
Pharma

Research Labs

Public

Biotechnology

1988



Arestas:

Collaborations

Financial

R&D

Arestas no ramos de Biotech - EUA

Nós:

Companies



Investment



Pharma



Research Labs



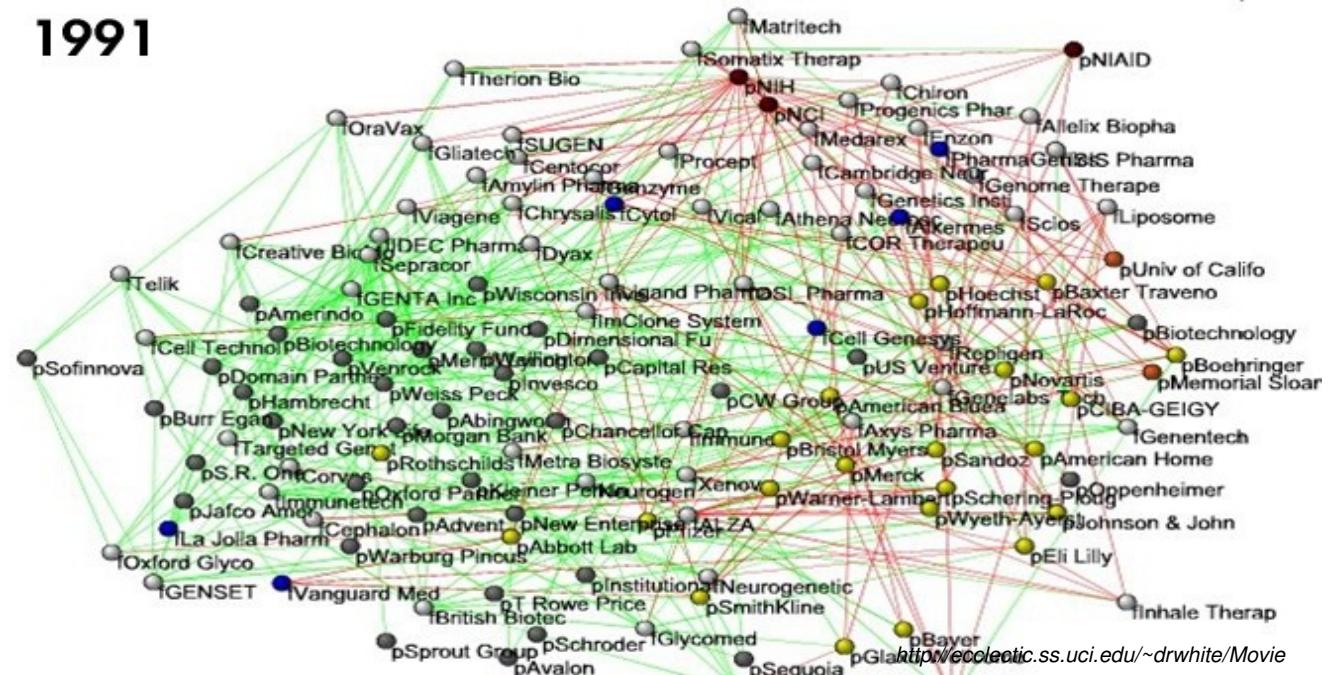
Public



Biotechnology



1991



Arestas:

Collaborations



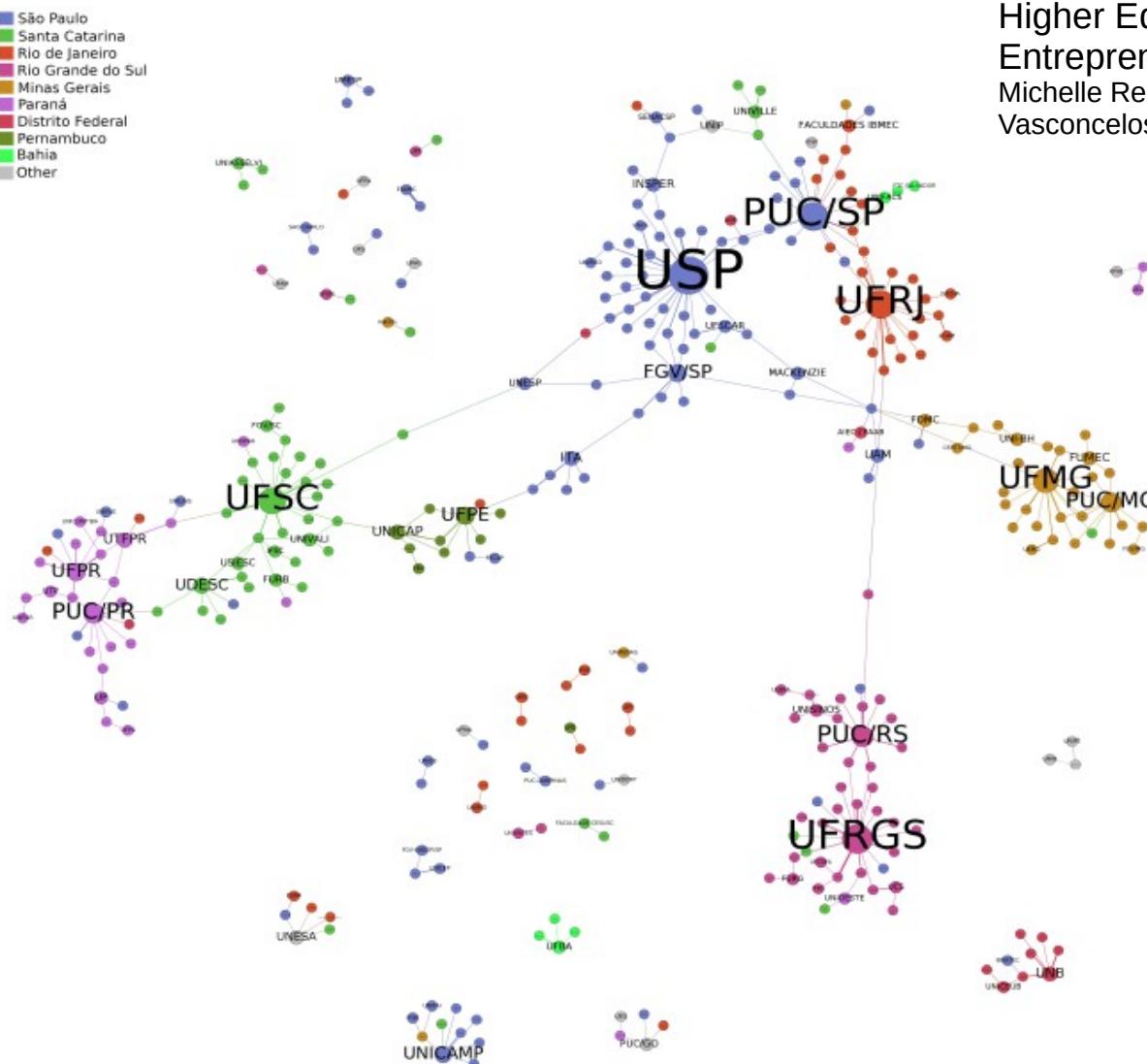
Financial



R&D



Redes de Startups

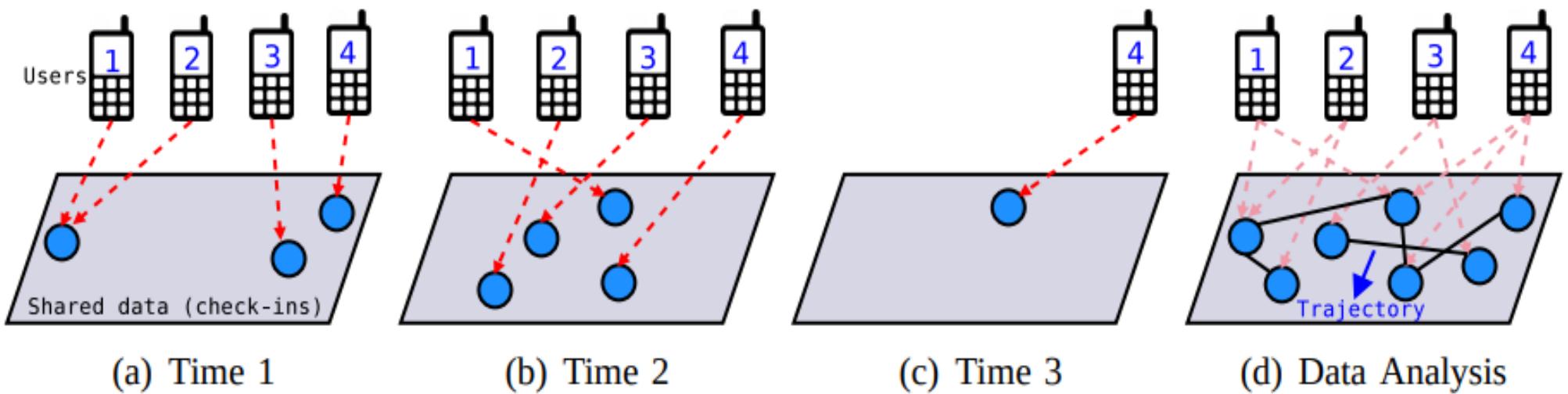


Higher Education's Influence on Social Networks and Entrepreneurship in Brazil

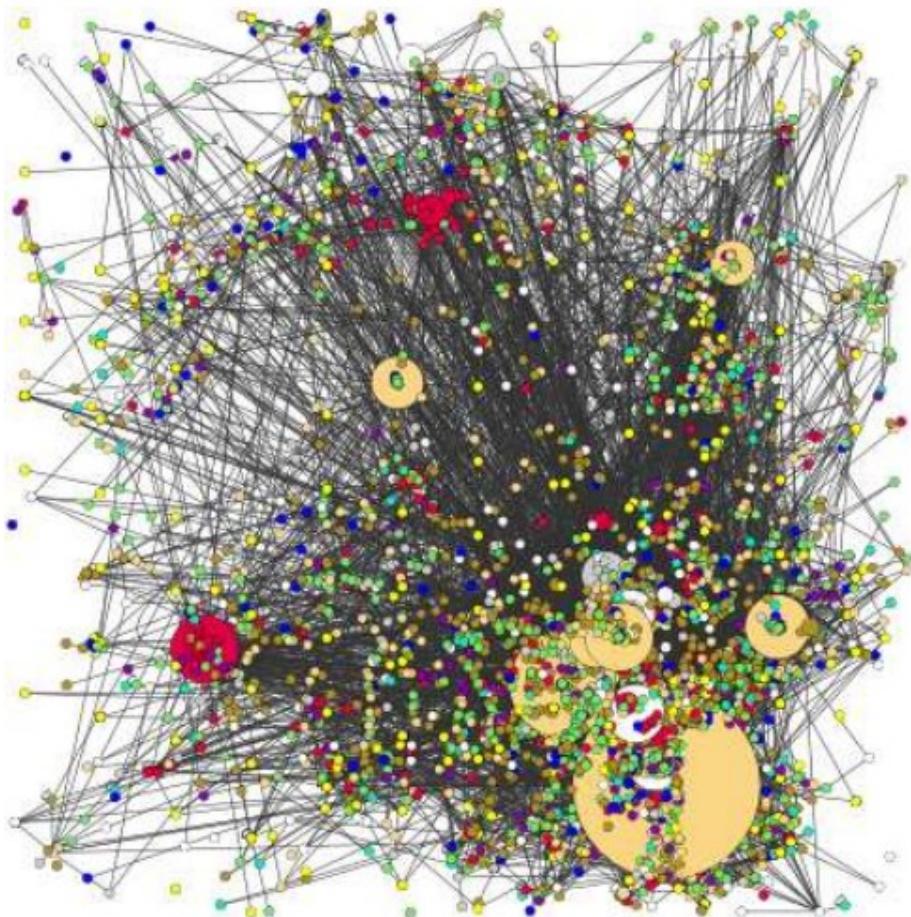
Michelle Reddy, Júlio C. Nardelli, Yuri L. Pereira, Marisa Vasconcelos, Thiago H. Silva, Leonardo B. Oliveira, Mark Horowitz

Malha aérea

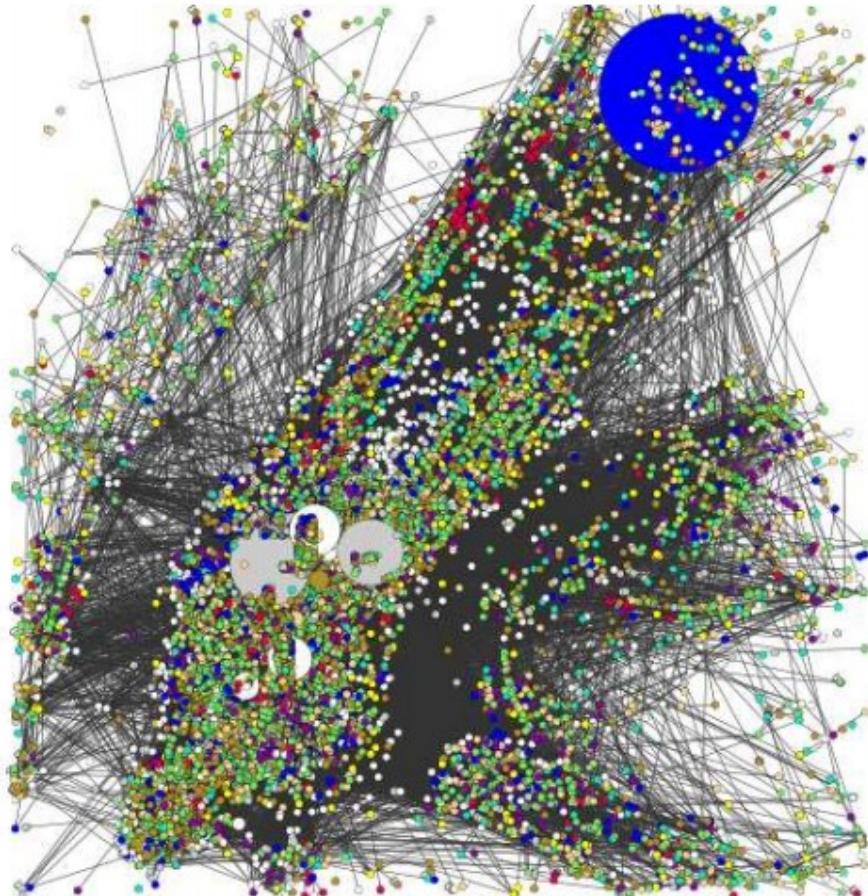




Check-ins



(a) BH - Day

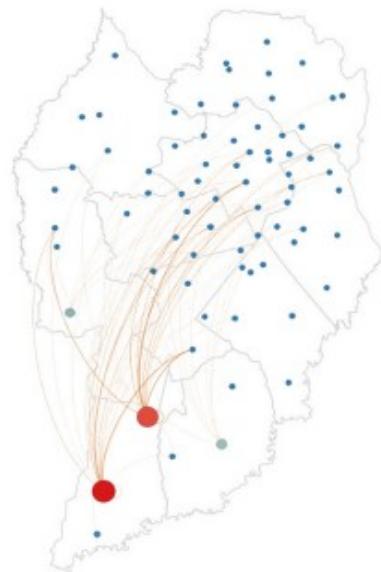


(b) NY - Day

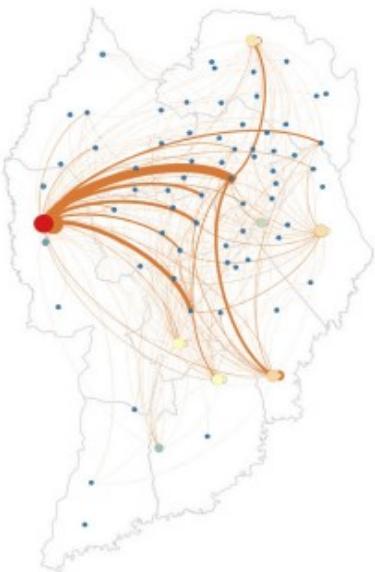
Revealing the City that We Cannot See

Thiago H Silva, Pedro O. S. Vaz de Melo, Jussara M. Almeida, Juliana Salles, Antonio A. F. Loureiro.
ACM Transactions on Internet Technology (TOIT). 2014.

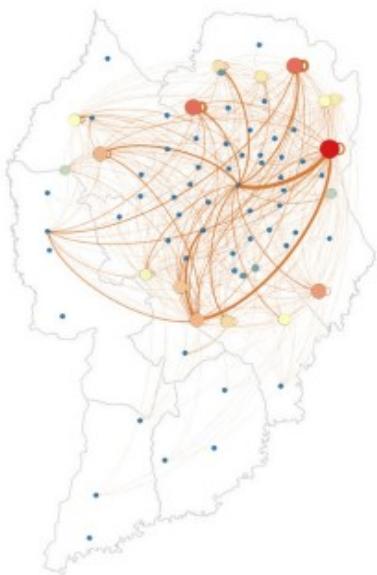
Uso de transporte público



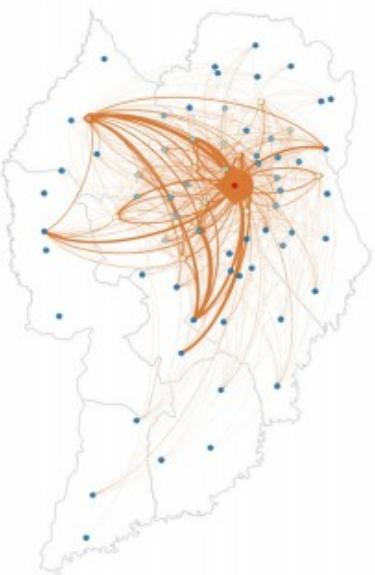
(a) Lower Middle Class—Class 4



(b) Middle Class—Class 5



(c) Upper Middle Class—Class 6



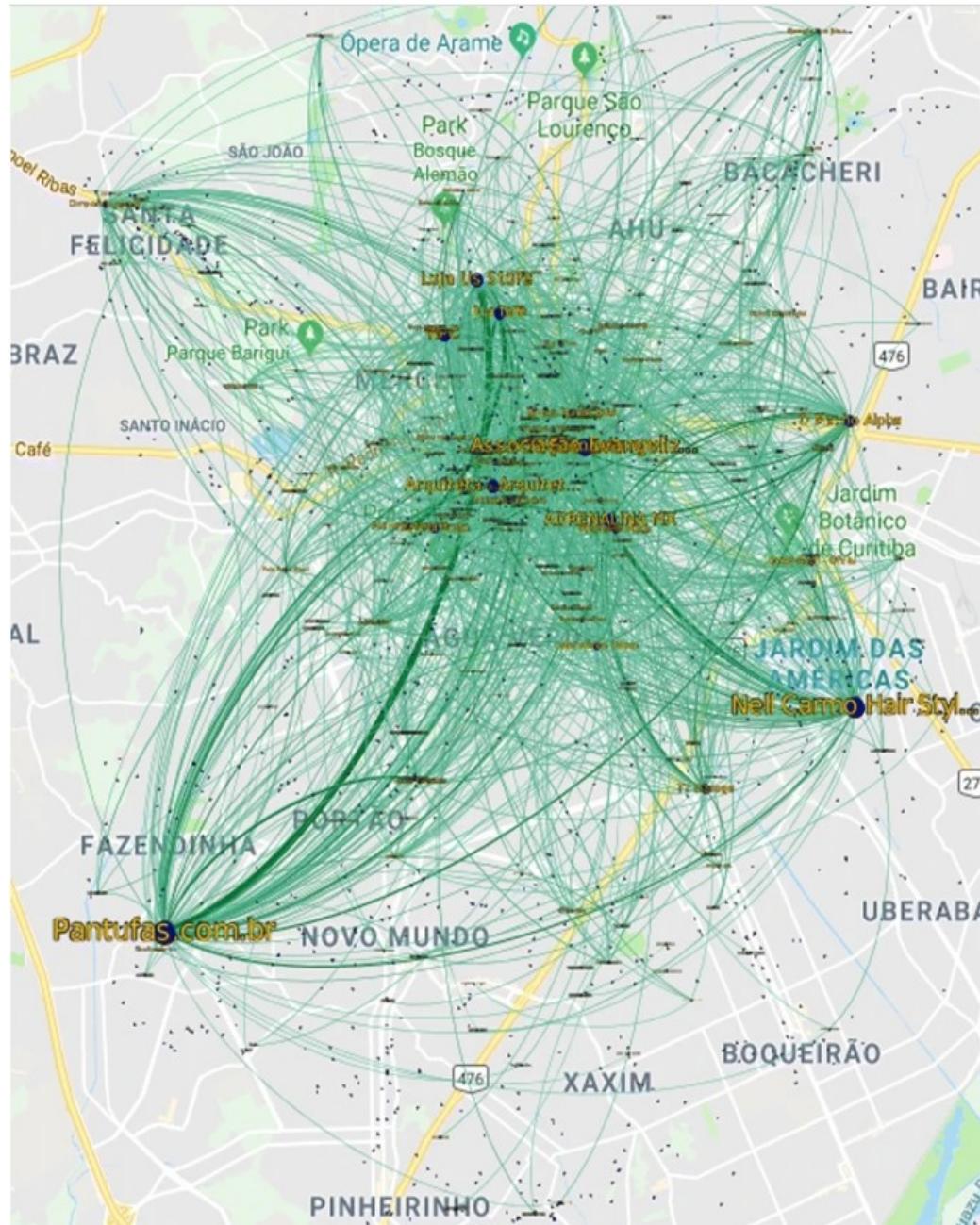
(d) Low High Class—Class 7

Characterization of Public Transit Mobility Patterns of Different Economic Classes

Priscila Santin, Fernanda Gubert, Mauro Fonseca,
Anelise Munaretto, Thiago Silva

Sustainability 2020

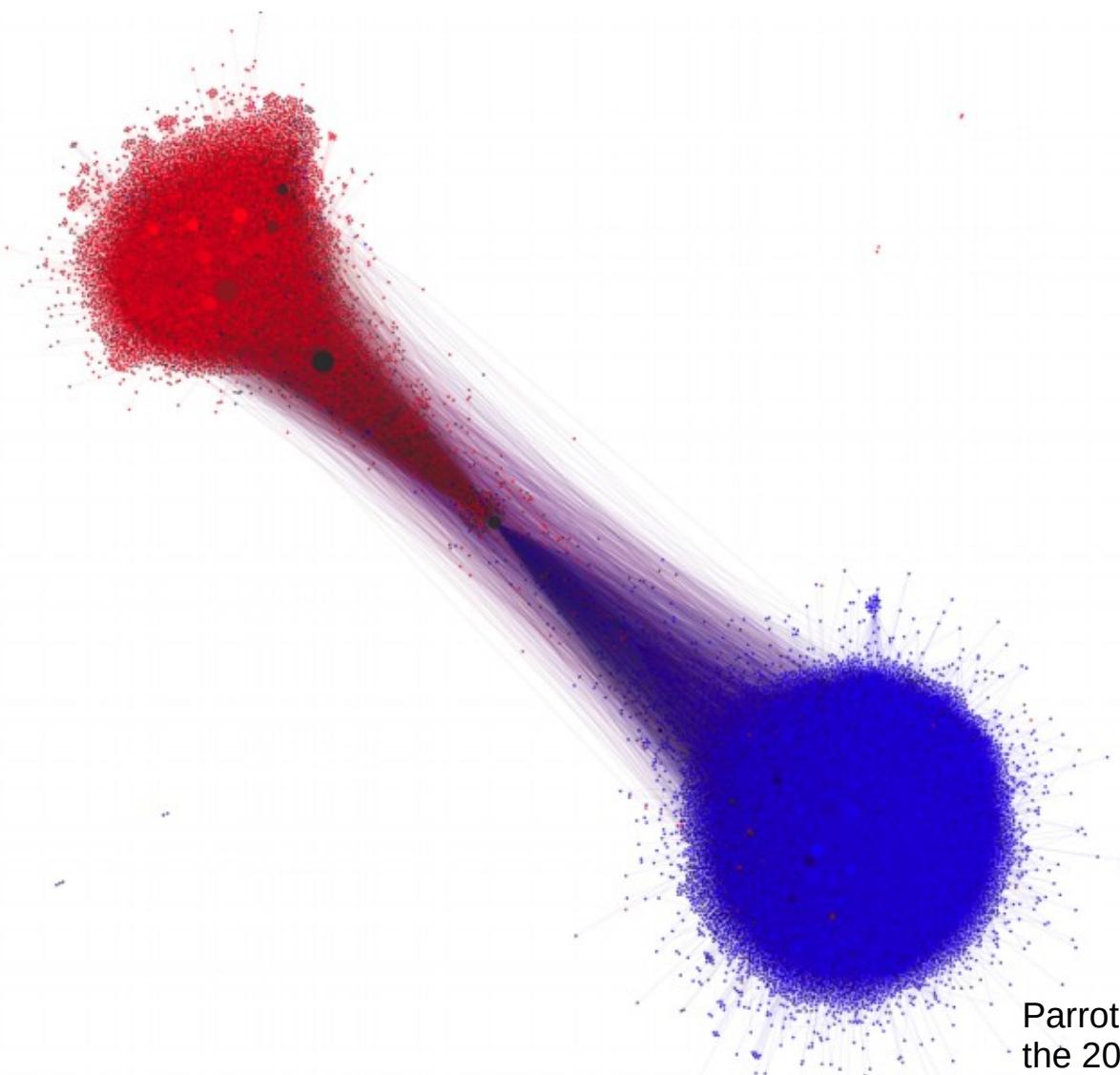
Preferências por negócios



Towards Business Partnership Recommendation
Using User Opinion on Facebook

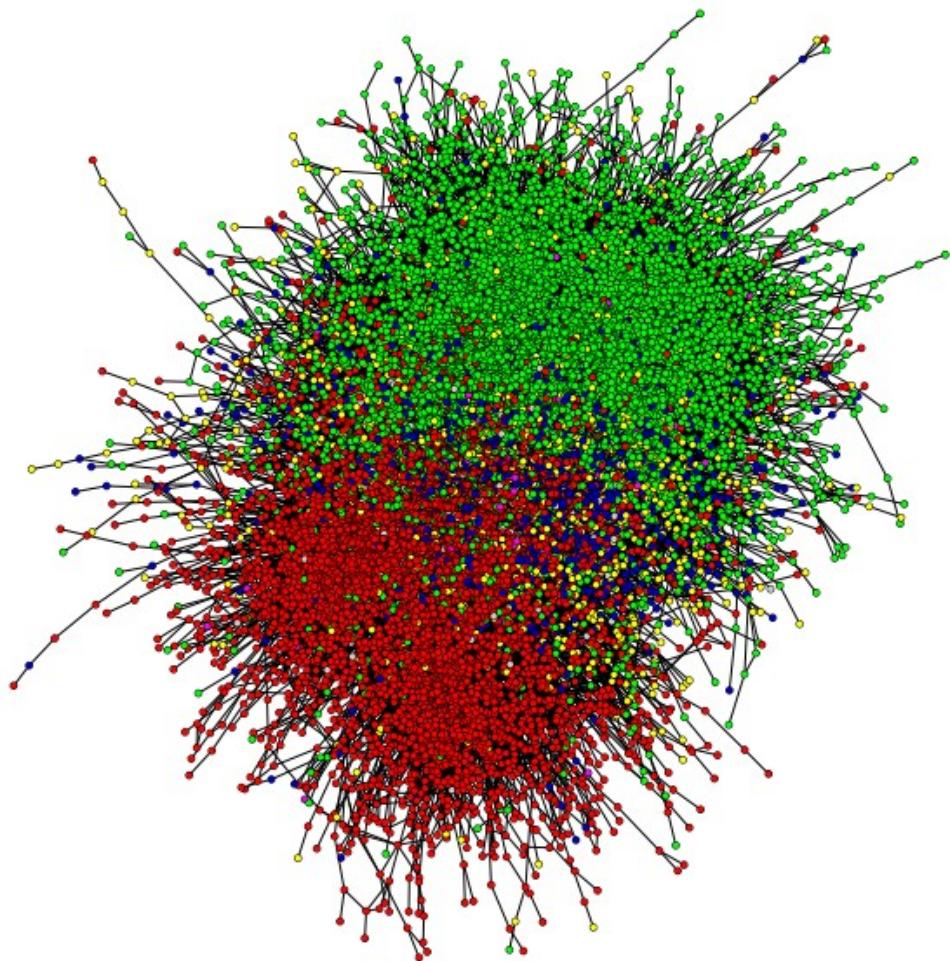
Diego P. Tsutsumi, Amanda T. Fenerich and Thiago H. Silva
Journal of Internet Services and Applications 2019

Retweets - política



Parrot Talk: Retweeting Among Twitter Users During
the 2018 Brazilian Presidential Election
Jordan K. Kobellarz, Alexandre R. Graeml, Michelle Reddy and
Thiago H. Silva

Rede de similaridade de usuários



(a) Largest component of G_s^1

Figure 4: [Better in color] Similarity network for the 0.65-network. Node colors: Africa (Pink), Asia (Red), Central and South America (Yellow), Europe (Blue), North America (Green), Oceania (Grey).

A Large-Scale Study of Cultural Differences
Using Urban Data About Eating and Drinking
Preferences

Thiago H Silva, Pedro O. S. Vaz de Melo, Jussara M. Almeida, Mirco Musolesi, Antonio A. F. Loureiro.
Elsevier Information Systems 2017

Rede de coautoria

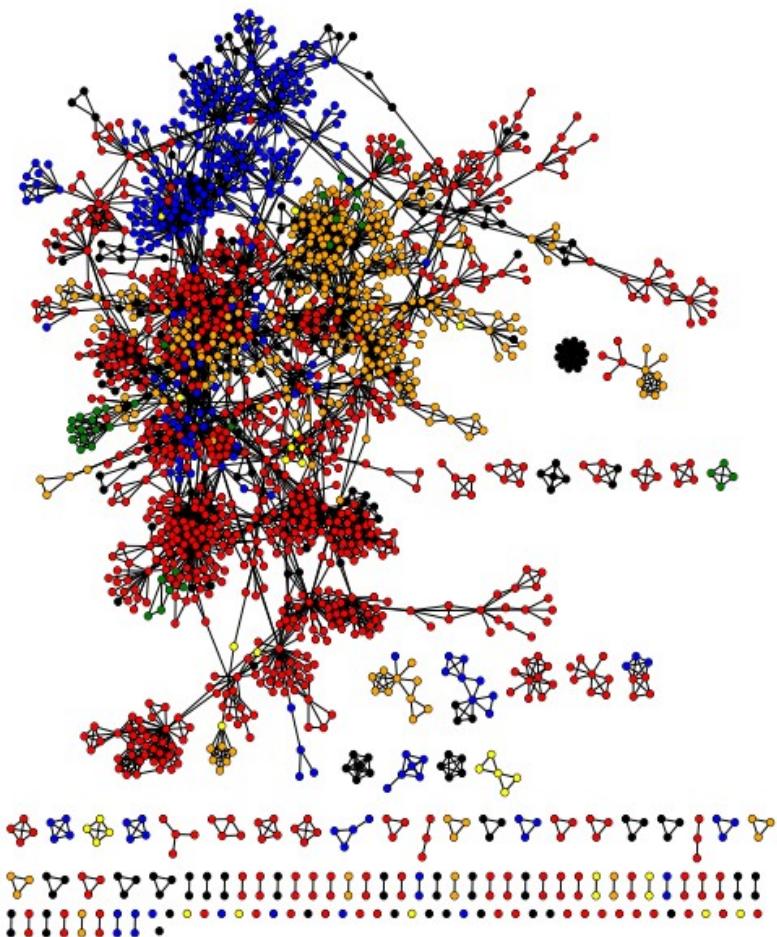


Fig. 1 The complete network as viewed in 2012. Nodes with the same color represent authors affiliated to universities located in a given region of Brazil. Green represents authors affiliated to universities located in the North region of Brazil, blue for the South, red for South-east, yellow for Center-west, orange for North-east and finally, black for authors affiliated to foreign universities. Notice that the colors used in this figure are the same as the ones used in Figure 4, where we show the Brazilian map.

On the analysis of the collaboration network of the Brazilian symposium on computer networks and distributed systems.

Guilherme Maia, Daniel Guidoni, Thiago H Silva, Fernanda Souza, Pedro Vaz de Melo, Cesar Soares, Jussara Almeida, Antonio Loureiro.

Journal of the Brazilian Computer Society. 2013.

Rede de coautoria

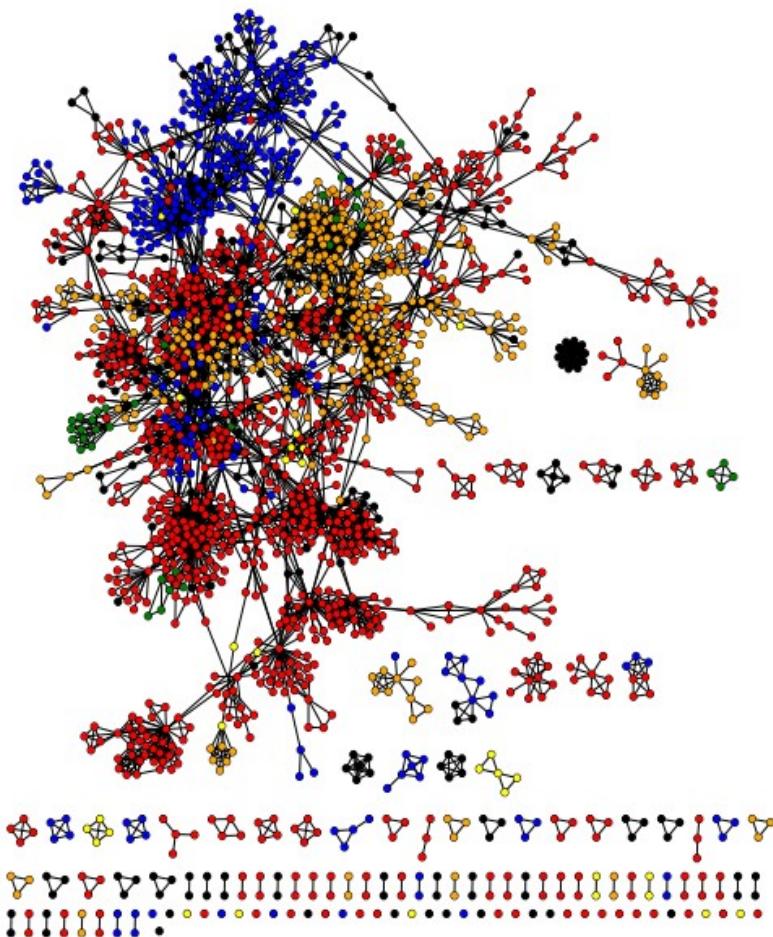


Fig. 1 The complete network as viewed in 2012. Nodes with the same color represent authors affiliated to universities located in a given region of Brazil. Green represents authors affiliated to universities located in the North region of Brazil, blue for the South, red for South-east, yellow for Center-west, orange for North-east and finally, black for authors affiliated to foreign universities. Notice that the colors used in this figure are the same as the ones used in Figure 4, where we show the Brazilian map.

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Journal of the Brazilian Computer Society. 2013.

Outros exemplos foram disponibilizados no Moodle

O papel das redes

Atrás de cada sistema complexo estudado, há uma rede que define as interações entre o componentes.

Difícil entender sistemas complexos sem que mapeemos e entendamos as redes por trás deles.

Tipos de redes

Quem fala com quem?

Quem é amigo de quem?

Quem é parente de quem?

Qual ingrediente vai junto com qual?

Quem envia mensagens para quem?

...

Interdisciplinar

Empírico, *data-driven*

Quantitativa

Computacional

O impacto de Ciência das Redes



Google
Market Cap
US\$189 bi.

Cisco Systems
Networking gear Market
cap:
US\$112 bi.

Facebook
market cap:
\$50 bi.

[www.bizjournals.com/austin/news/2010/11/15/facebook... - Cached](http://www.bizjournals.com/austin/news/2010/11/15/facebook...)

Network biology/ network medicine

WHAT IS NETWORK MEDICINE?

Network Medicine combines principles and approaches from network sciences, systems biology, and human dynamics to understand the causes of human diseases and develop new treatments.

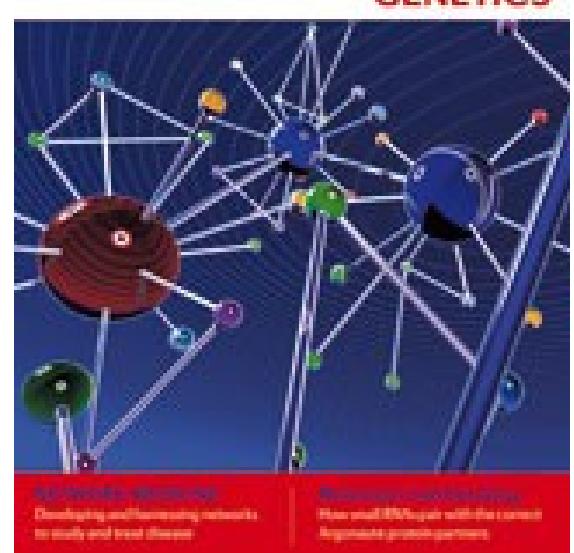
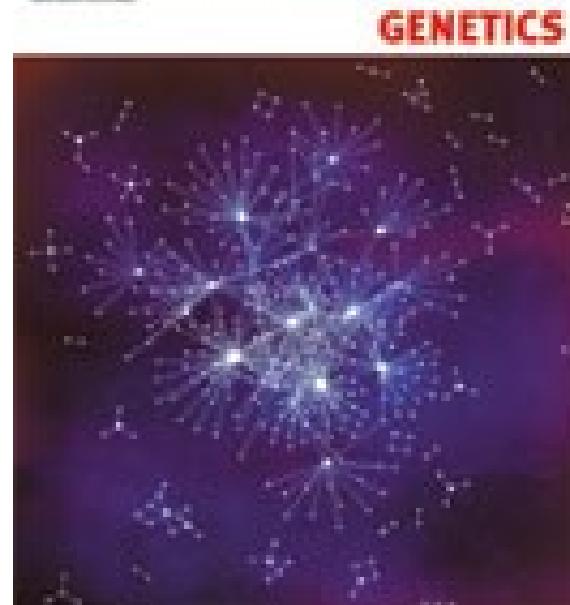


<https://www.network-medicine.org/>

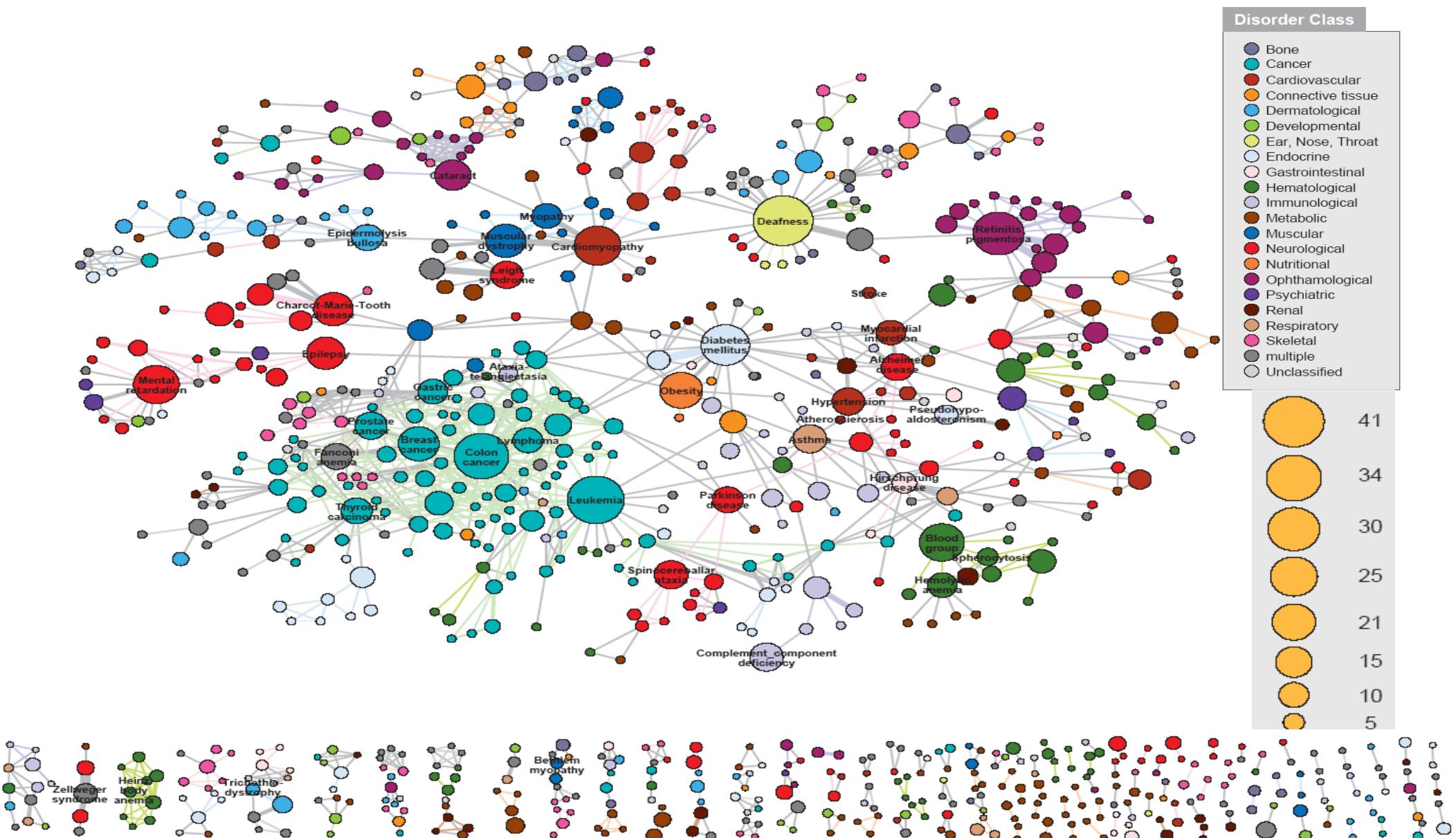
- Tratar pacientes
- Desenvolver novas curas

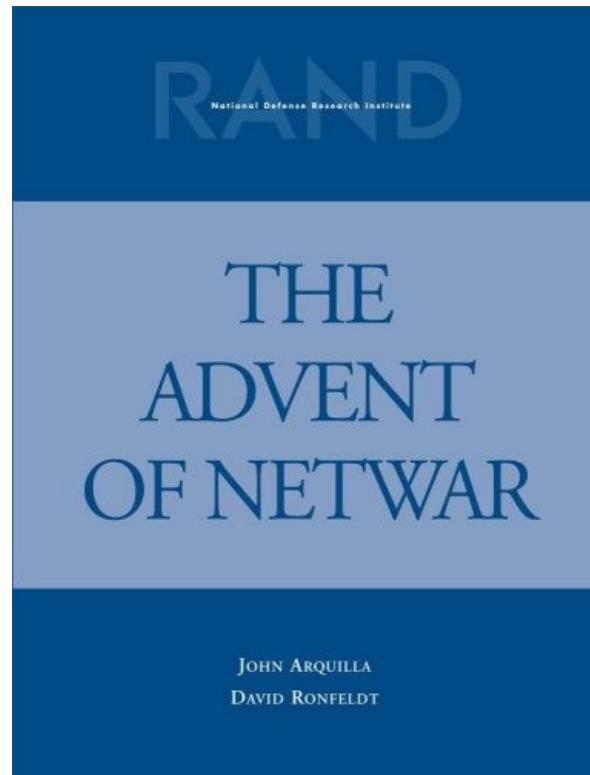
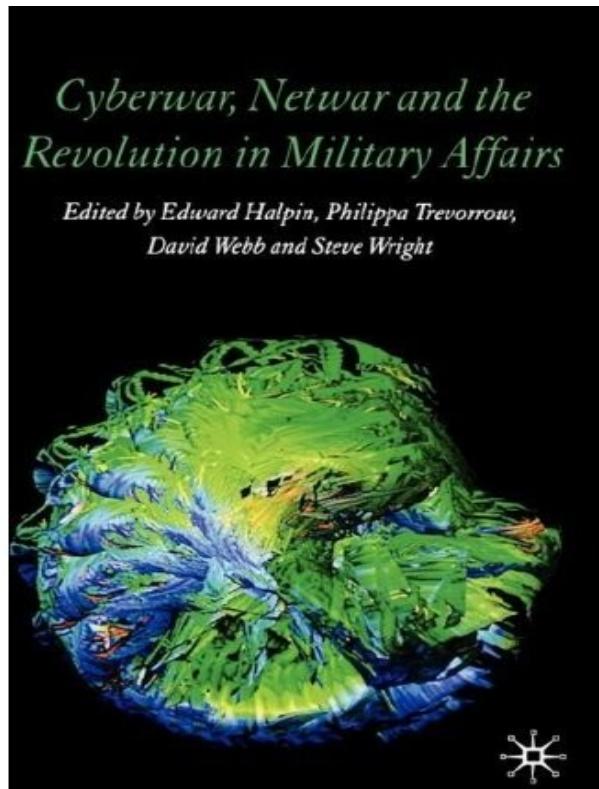
...

The image shows a screenshot of a Harvard Catalyst course page titled "Introduction to Network Medicine". The page features a dark background with a network graph of nodes and connections. The title "Introduction to Network Medicine" is prominently displayed in white text. Below it, a subtitle reads "Course on network science in biology and medicine". A "Train" button is visible in the top right corner. The URL <https://catalyst.harvard.edu/courses/netmed-intro/> is also present.

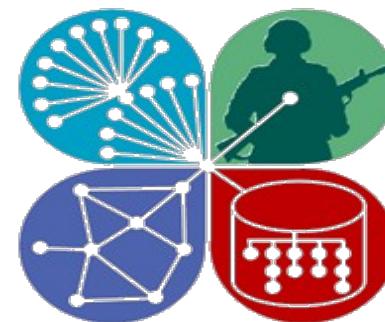


Rede de doenças humanas



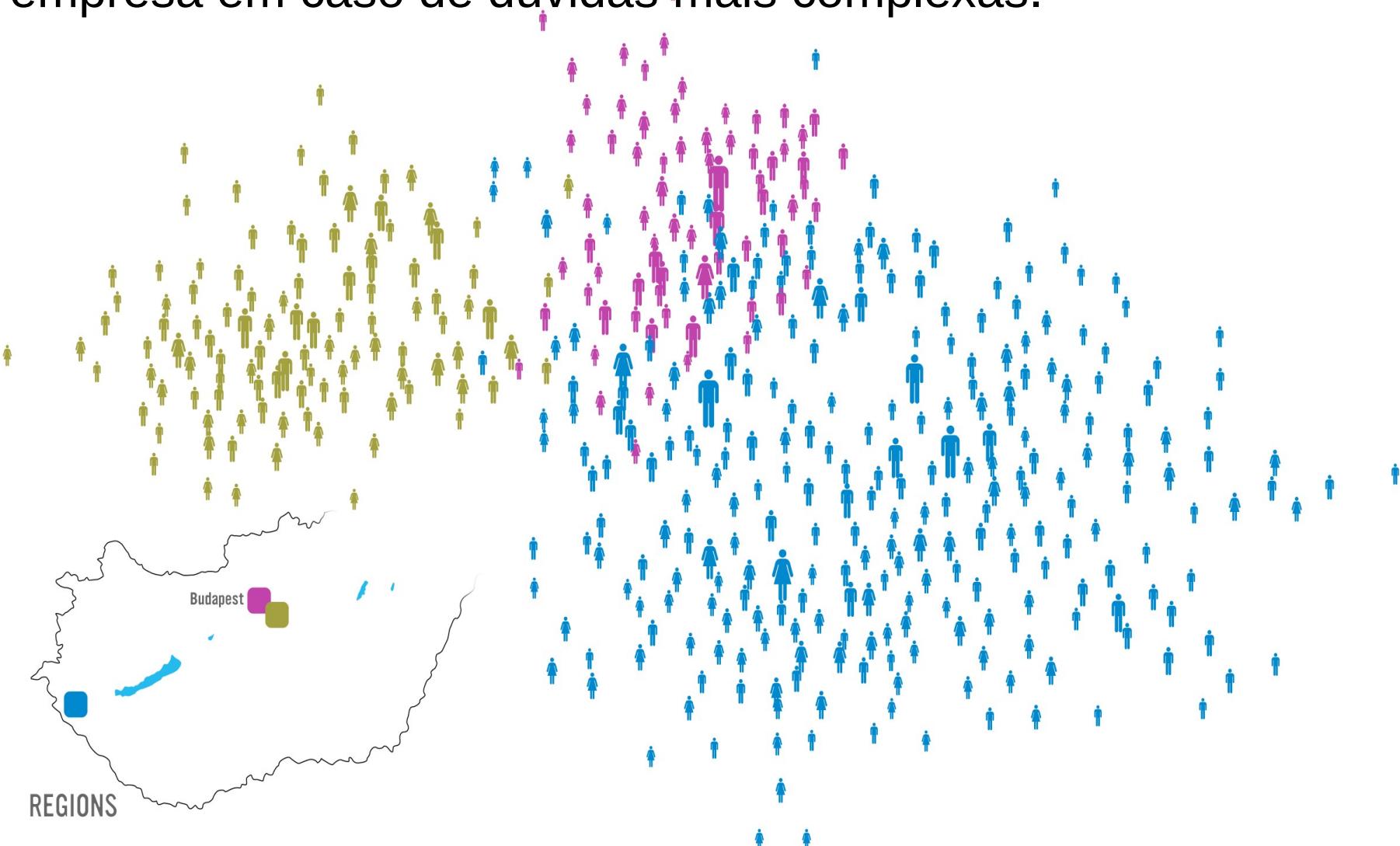


Network Science Center
West Point

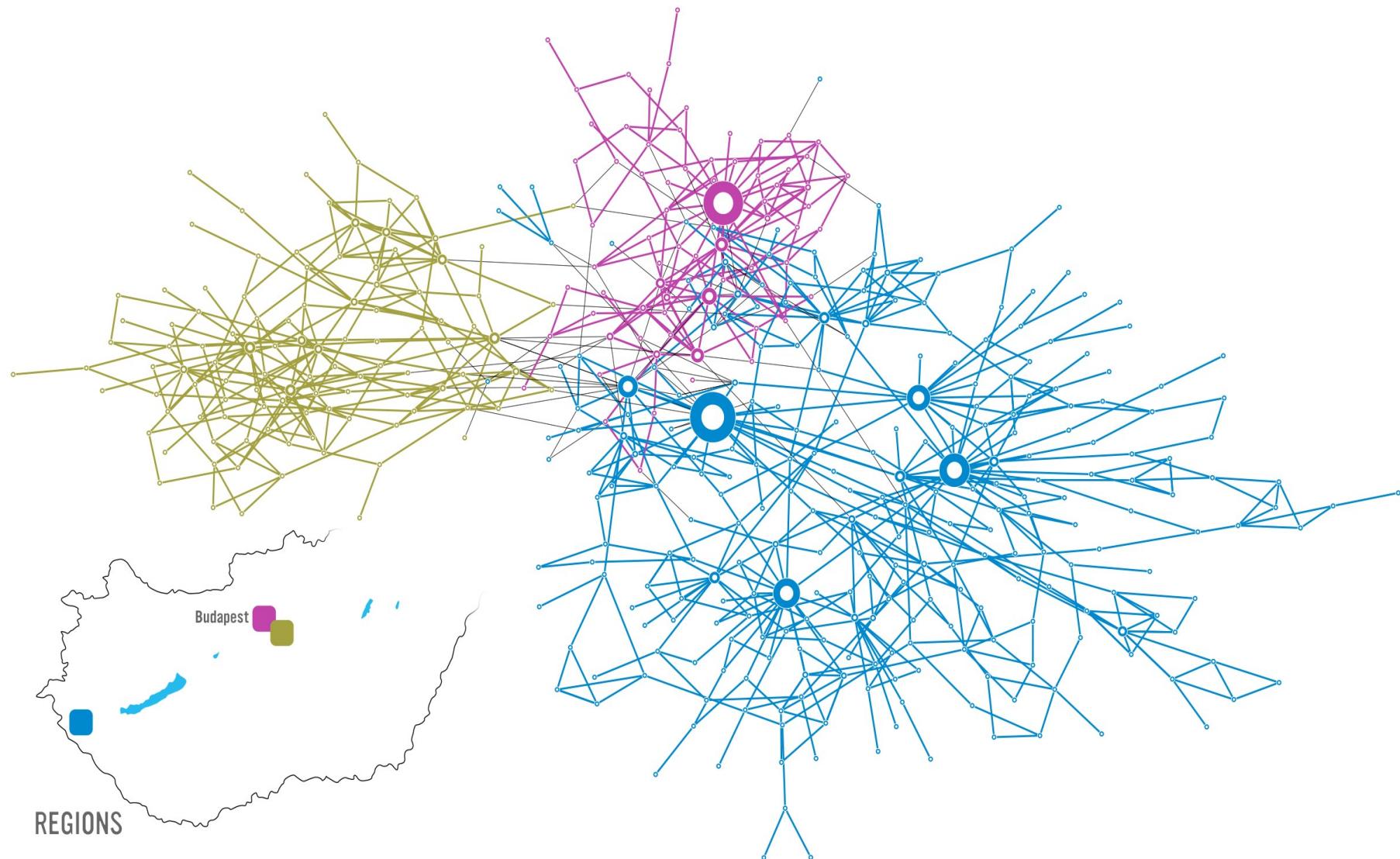


<http://www.ns-cta.org/ns-cta-blog/>

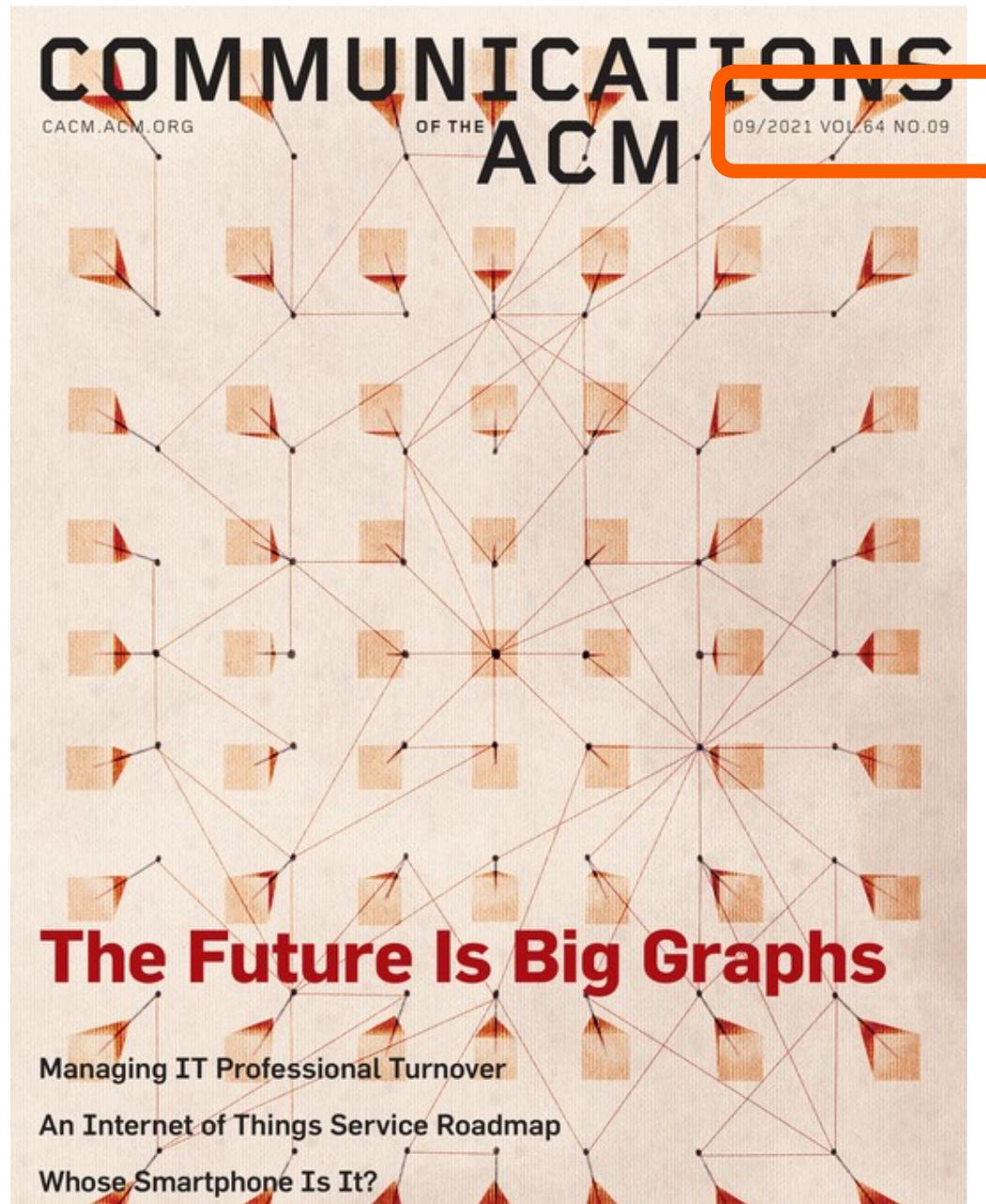
Estudo perguntou para os funcionários para quem eles pedem ajuda na empresa em caso de dúvidas mais complexas.



Gerenciamento







A comprehensive survey on graph neural networks

[PDF] ieee.org

Z Wu, S Pan, F Chen, G Long, C Zhang... - ... on neural networks ..., 2020 - ieeexplore.ieee.org

... The complexity of **graph** data has imposed significant challenges on the ... for **graph** data have emerged. In this article, we provide a comprehensive overview of **graph neural networks** (...

☆ Salvar 99 Citar Citado por 5214 Amigos relacionados Todas as 9 versões Importe para o BibTeX

[HTML] Graph neural networks: A review of methods and applications

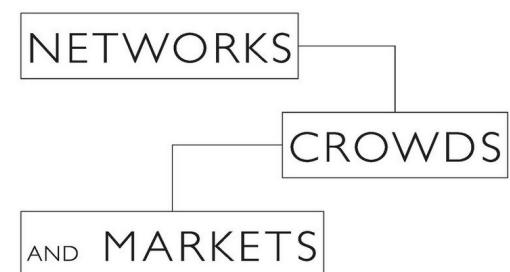
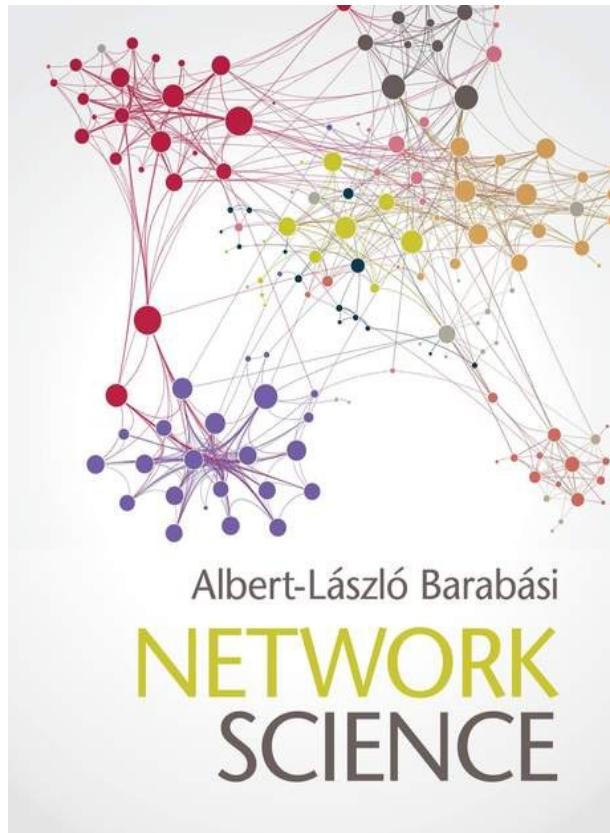
[HTML] sciencedirect.com

J Zhou, G Cui, S Hu, Z Zhang, C Yang, Z Liu, L Wang... - AI open, 2020 - Elsevier

... of **graph neural networks** applied to structural scenarios, non-structural scenarios and other scenarios. In Section 9, we propose four open problems of **graph neural networks** as well as ...

☆ Salvar 99 Citar Citado por 3080 Amigos relacionados Todas as 9 versões Importe para o BibTeX

Sobre o curso

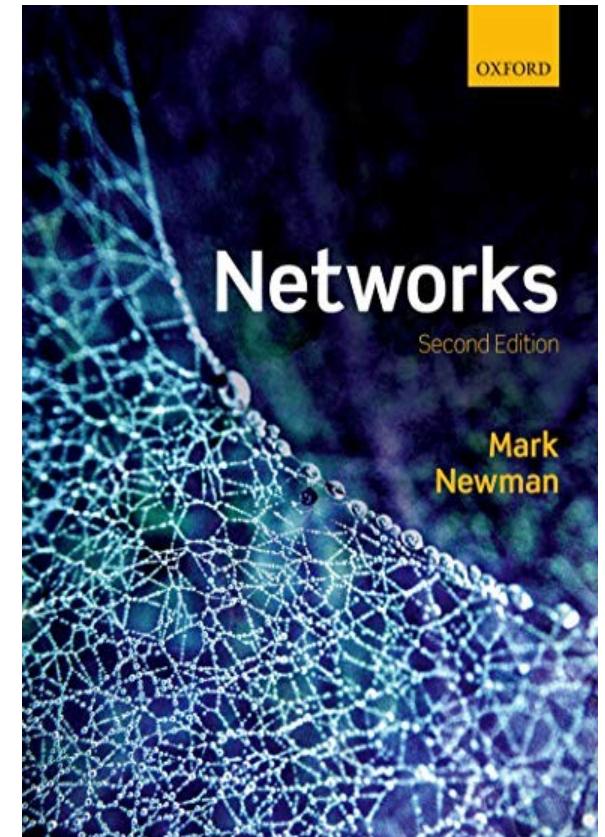
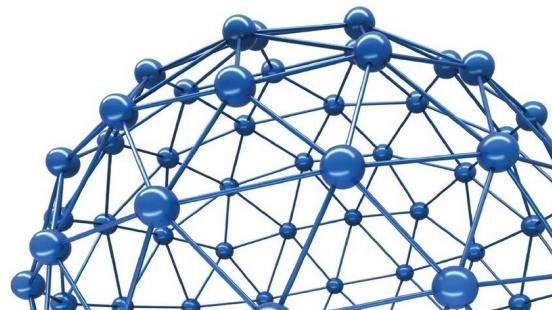


Reasoning about a Highly Connected World

DAVID EASLEY

and

JON KLEINBERG



HAMILTON, William Graph Representation Learning, McGill University, 2020.
(Disponível online).

NEWMAN, Mark. Networks: an introduction. OUP Oxford, 2010. 720p. ISBN 0199206651.

GOLDBARG, Marco Cesar; GOLDBARG, Elizabeth Ferreira Gouvêa. Grafos: conceitos, algoritmos e aplicações. Rio de Janeiro, RJ: Elsevier, 2012. 622 p. ISBN 9788535257168.

JAIN, Raj. The art of computer systems performance analysis: techniques for experimental design, measurement, simulation, and modeling. New York, NY: John Wiley & Sons, c1991. xxvi, 685p. ISBN 0-471-50336-3.

TAN, Pang-Ning; STEINBACH, Michael; KUMAR, Vipin. Introdução ao datamining: mineração de dados. Rio de Janeiro, RJ: Ciência Moderna, 2009. xxi , 900 p. ISBN 9788573937619.

RUSSELL, Matthew A. Mineração de dados da Web social. São Paulo, SP: Novatec, 2011. 357 p. ISBN 978-85-7522-245-4.

Materiais técnicos e científicos que serão disponibilizados

Avaliação

Listas de exercícios e atividades práticas em sala de aula (**LE**)

Desafio (**DES** - duas partes)

Trabalho prático (**APS**).

A nota final (**NF**) será:

$$NF = LE*0,20 + DES*0,35 + APS*0,45$$

Os(as) alunos(as) que obtiverem os dois melhores resultados no desafio ganharam 0,05 pontos extra cada.

Use esse link para obter os dados e enviar as suas respostas:
<https://www.kaggle.com/t/6c4d1673ebd4409e9e964e7921f53b56>

DES_1 (Entrega: 03/04): Análise da rede fornecida

DES_2 (Entrega: 28/04): Documento com códigos e descrição
da(s) estratégia(s) utilizada(s) (pelo menos uma das estratégias deve utilizar propriedades de rede de alguma forma).

A nota será de acordo com as estratégias utilizadas.

Critérios para a avaliação:

- Corretude
- Clareza e organização
- Amplitude de conhecimento utilizado (sofisticação)
- Criatividade



Community Prediction Competition

Predict missing links - UTFPR 2023-1

You have to predict links that are missing in a network

Host [Overview](#) Data Code Discussion Leaderboard Rules Team

Submissions

...

Overview

Edit

Description

Are you able to predict missing links in a provided mobility network?

Evaluation

+ Add Page

In this challenge, you are provided with a mobility network where each node is a specific venue, and there is an edge connecting each venue if the same user visited both of them. If the same user reviewed two venues, an edge is created connecting them in the mobility network. Thus, the edge weight represents how many times users visited two venues. The information used to build these networks is Yelp reviews in Pittsburgh, United States. Note that this network captures not just mobility, but the preferences of (groups) users.

Please note that this dataset is meant to be used only for academic purposes. More information will be provided during the class.

Acknowledgements

Thiago and Ricardo would like to thank Yelp for providing this dataset.

<https://www.kaggle.com/t/6c4d1673ebd4409e9e964e7921f53b56>

Trabalho completo (deve necessariamente envolver o uso de redes – problema livre).

Trabalho em dupla (em casos excepcionais, trios podem ser permitidos).

Definição do tema: 20/04

Apresentação: 25/05.

Entrega do trabalho (parte escrita): 16/06

Critérios para a avaliação:

- Corretude
- Clareza e organização
- Sofisticação das análises realizadas
- Interpretação dos resultados

Mais informações no Moodle.

Outros recursos

Moodle

<https://moodle.utfpr.edu.br/>

Curso: CAIA012/CAIA0022 Ciência das Redes

Senha: netsci

Discord

<https://discord.gg/bANjsvgn2s>

Google meet

meet.google.com/uuc-wubs-jdj

Outras informações

- Prof. Ricardo Luders
Contato: luders@utfpr.edu.br
- Prof. Thiago H Silva
Contato: thiagoh@utfpr.edu.br
Web: www.dainf.ct.utfpr.edu.br/~thiagohs

Agradecimentos

Barabasi, Albert-László. Network Science. Cambridge University Press, 2016, 475p. ISBN 1107076269. Disponível online.

Alguns dos slides foram adaptados com autorização do Prof. Barabasi.