http://poloclub.gatech.edu/cse6242

CSE6242 / CX4242:

Data & Visual Analytics

Duen Horng (Polo) Chau
Assistant Professor
Associate Director, MS Analytics
Georgia Tech

Google “Polo Chau” (only one in the world)

Georgia Tech | College of Computing

Bio CV Students Papers Teaching Funding Design

POLO CHAU

Legal name:
Duen Horng Chau

Associate Director, MS in Analytics
Assistant Professor, School of Computational Science & Engineering

College of Computing
Georgia Tech

Admin: Carolyn Young Financial Manager: Arlene Washington
polo@gatech.edu www.cc.gatech.edu/~dchau
Office: Klaus 1324 404-385-7682
Google Scholar YouTube videos

LinkedIn profile Follow @PoloChau

POSITIONS

May 2014 -	Associate Director MS in Analytics, Georgia Tech
Aug 2012 -	Assistant Professor School of Computational Science & Engineering, Georgia Tech
Dec 2012 - Dec 2015	Adjunct Assistant Professor School of Interactive Computing, Georgia Tech

EDUCATION

Aug 2012	**Ph.D. Machine Learning** Carnegie Mellon University

I'm expanding my **Polo Club of Data Science** research group to work on **human-centered AI! Apply to our CS/CSE PhD program.** Strong interest and experience in visualization, HCI, deep learning, machine learning, or data mining are big pluses!

Research Group & GitHub

Polo Club of DATA SCIENCE

Students (see more)

Robert Pienta, CSE PhD
Minsuk (Brian) Kahng, CS PhD
Shang-Tse Chen, CS PhD
Fred Hohman, CSE PhD
Nilaksh Das, CSE PhD
Madhuri Shanbhogue, MS CS
Dezhi (Andy) Fang, CS UG
Siwei (Bob) Li, CS UG
Joon Kim, CS UG
Matthew Keezer, MS CS
Prasenjeet Biswal, MS CS
Varum Bezzam, MS CS

How to address Polo?

Grammatically correct

Prof. Chau

Dr. Chau

Grammatically incorrect, but popular

Prof. Polo

Dr. Polo

Course Registration

This class room seats 300. **Almost all physical seats have been filled.** If you are on the waitlist, please wait for seats to released (some students typically “drop” after today).

- As of 3pm today (Jan 9, 2018)
  - **CSE 6242 A**
    - 217/220 seats filled
    - 2/65 waitlist slots taken
  - **CX 4242 A**
    - 78/80 seats filled
    - 0/50 waitlist slots taken
  - **CSE 6242 Q** (distance-learning): 9 students

Course TAs **Be very very nice to them!**

Neetha Ravishankar

Jennifer Ma

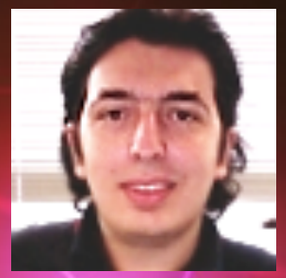
Mansi Mathur

Arathi Arivayutham

Vineet Vinayak Pasupulety

Siddharth Gulati

Office hours and locations (TBD) on course homepage
poloclub.gatech.edu/cse6242



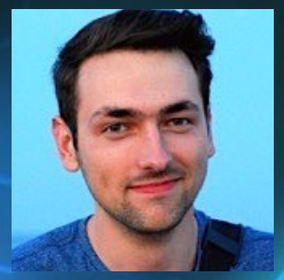
Acar
@Symantec

Robert

Brian

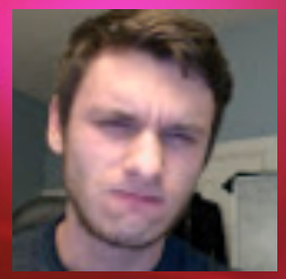
Chad
@Southwestern Univ

Shang

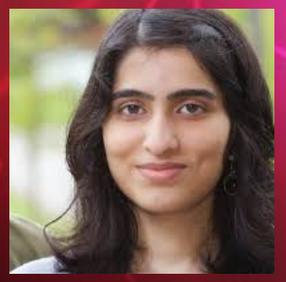


Fred

Nilaksh



Peter
UCLA PhD

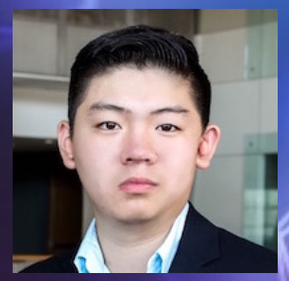


Meera
@Microsoft

Shan
@Oracle

Madhuri

Polo Club of DATA SCIENCE



Andy

Jerry
Stanford PhD

Matthew

Srishti
@Apple

Florian
@Facebook

Aakash
@Google

Bob

Paras
Berkeley PhD

Victor
@Facebook

Samuel
CMU Masters

poloclub.gatech.edu

RESEARCH MEMBERS SPONSORS

Polo Club of DATA SCIENCE

Scalable. Interactive. Interpretable.

At Georgia Tech, we innovate at the intersection of **data mining** and **human-computer interaction (HCI)** to synthesize **scalable, interactive, and interpretable** tools that amplify human's ability to understand and interact with billion-scale data and machine learning models. Our focus application areas include **cybersecurity** (e.g., fraud detection, malware detection, and adversarial machine learning), **health**, and **social good**.

Machine Learning Visualization & Interpretation

Interpretable deep learning and machine Learning through interactive visualization, with application in adversarial machine learning.

poloclub.gatech.edu

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Machine Learning Visualization & Interpretation

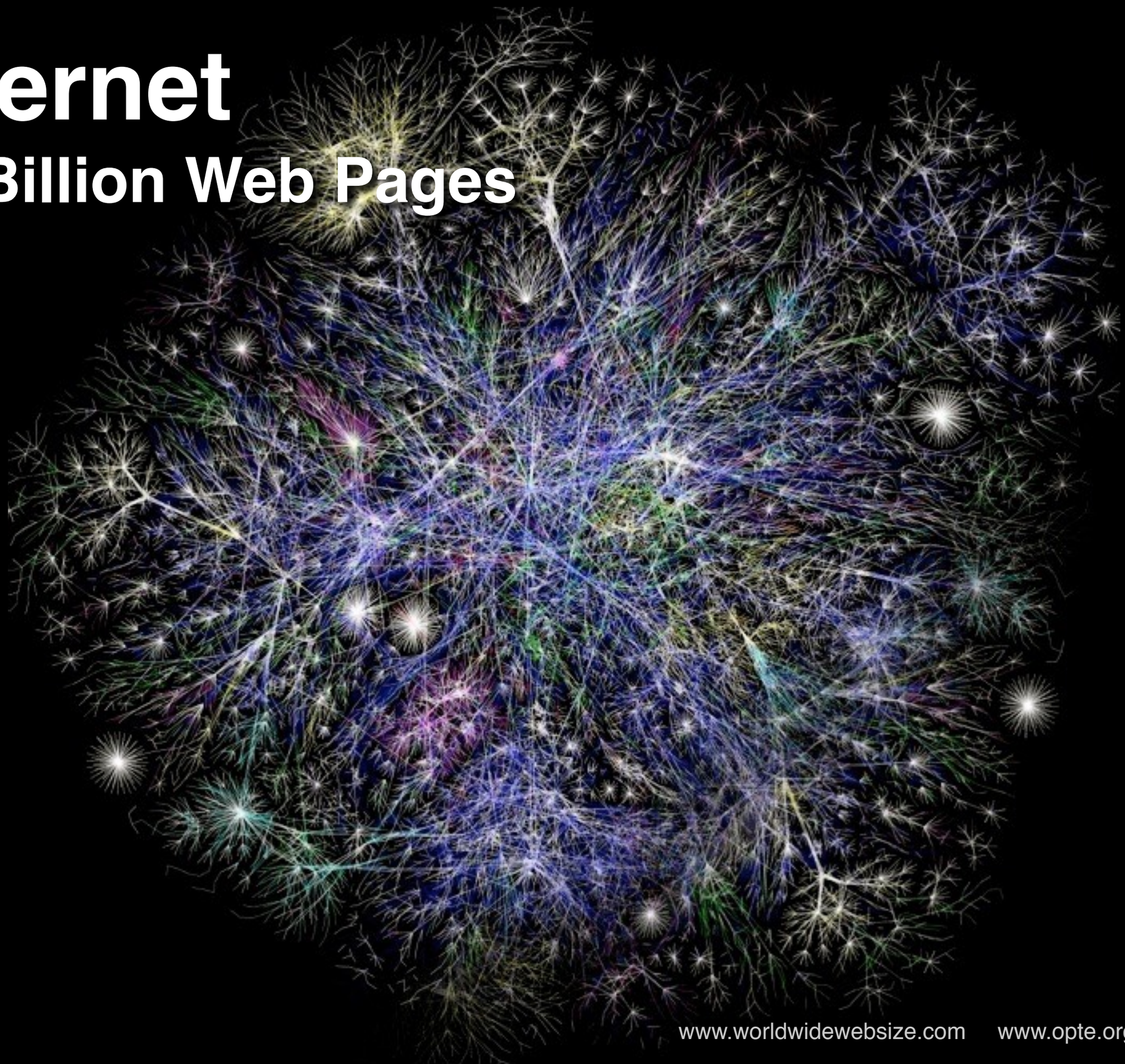
Interpretable deep learning and machine Learning through interactive visualization, with application in adversarial machine learning.

Polo Club
of
DATA SCIENCE

We work with (really) large data.

Internet

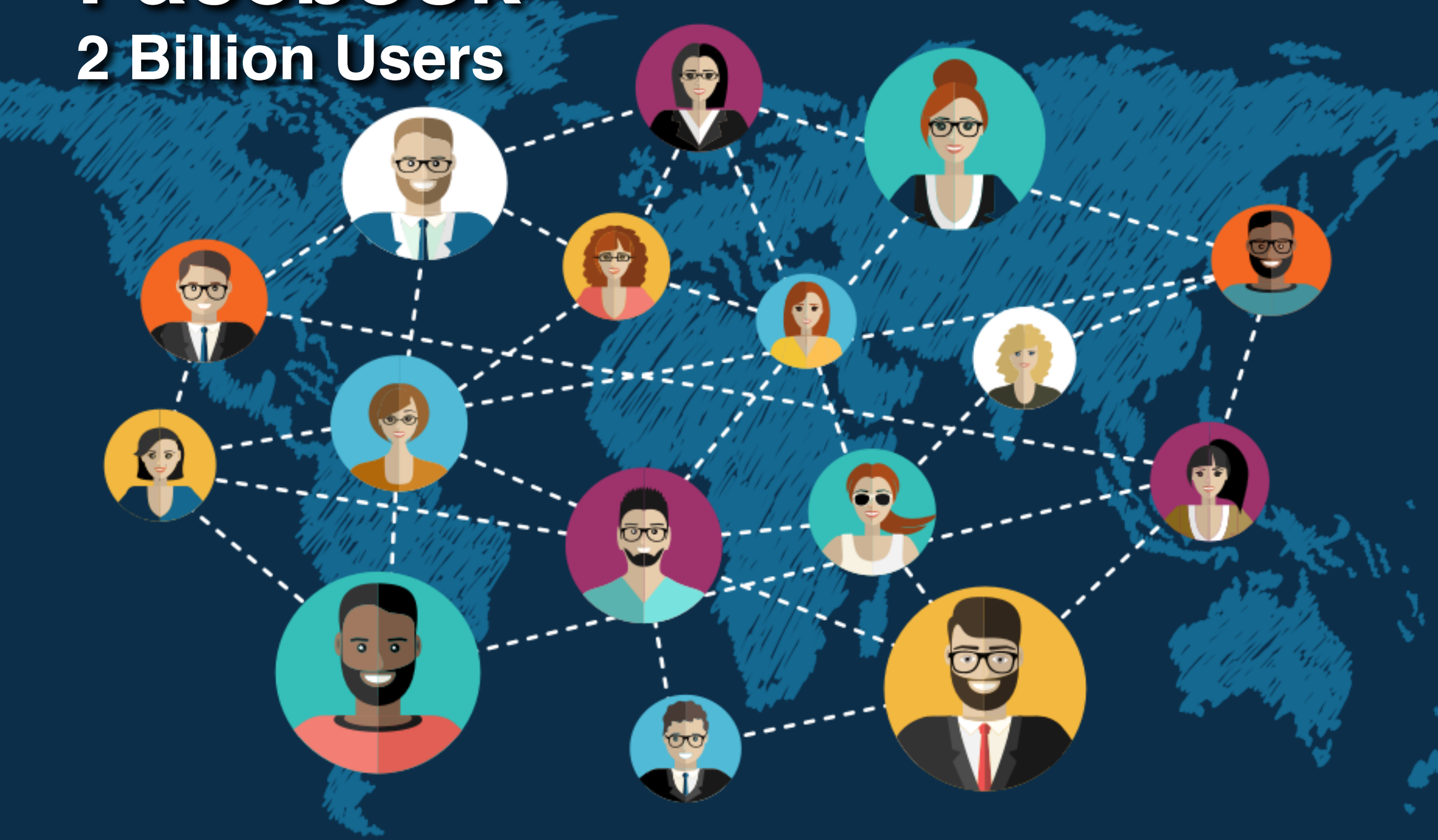
50 Billion Web Pages



www.worldwidewebsize.com www.opte.org

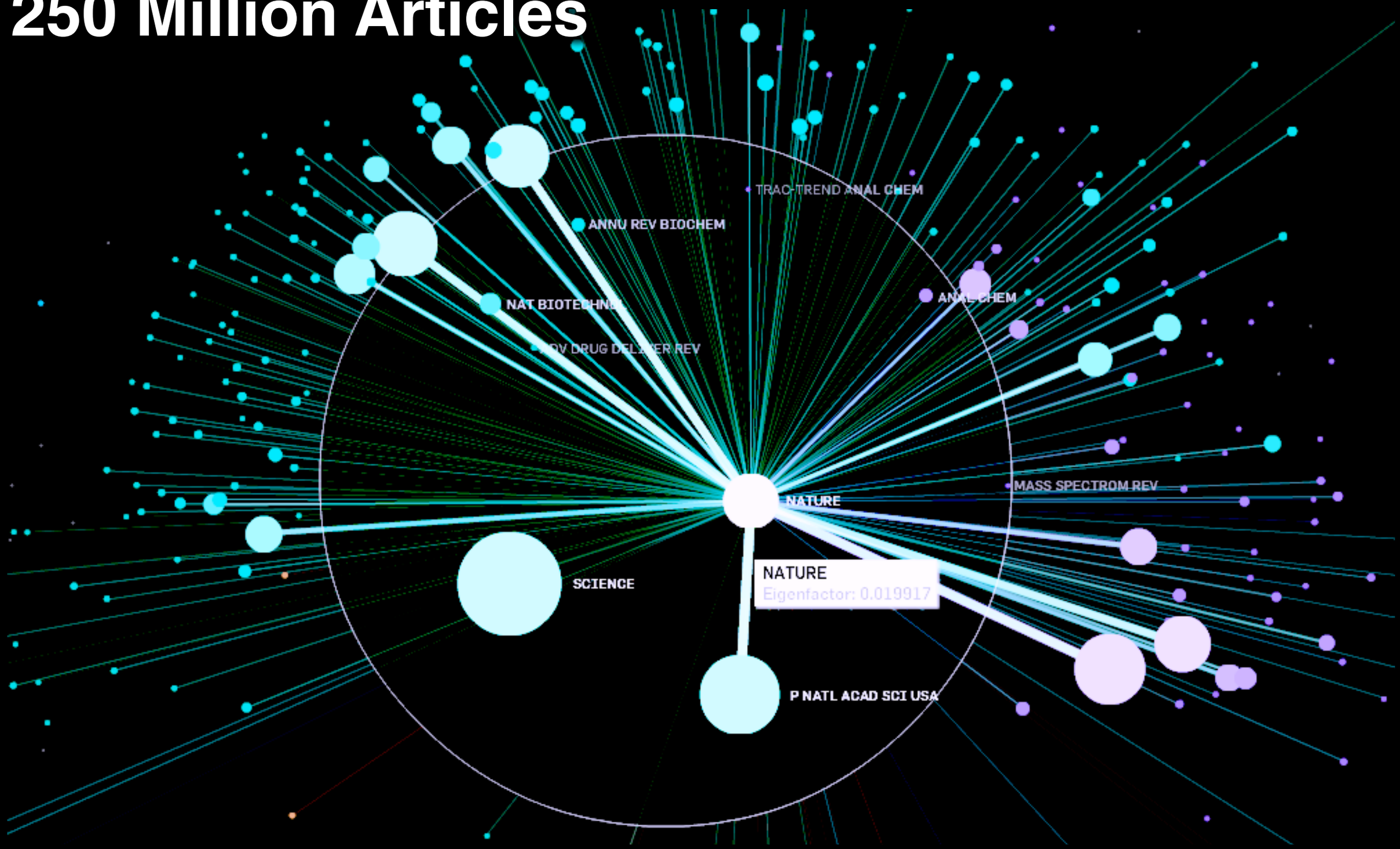
Facebook

2 Billion Users



Citation Network

250 Million Articles



www.scirus.com/press/html/feb_2006.html#2 Modified from well-formed.eigenfactor.org

Many More

twitter

Who-follows-whom (500 million users)

amazon

Who-buys-what (120 million users)

at&t **cellphone network**

Who-calls-whom (100 million users)

Protein-protein interactions

200 million possible interactions in human genome

Sources: www.selectscience.net www.phonedog.com www.mediabistro.com www.practicalecommerce.com/

“Big Data” Analyzed

Graph	Nodes	Edges
YahooWeb	1.4 Billion	6 Billion
Symantec Machine-File Graph	1 Billion	**37 Billion**
Twitter	104 Million	3.7 Billion
Phone call network	30 Million	260 Million

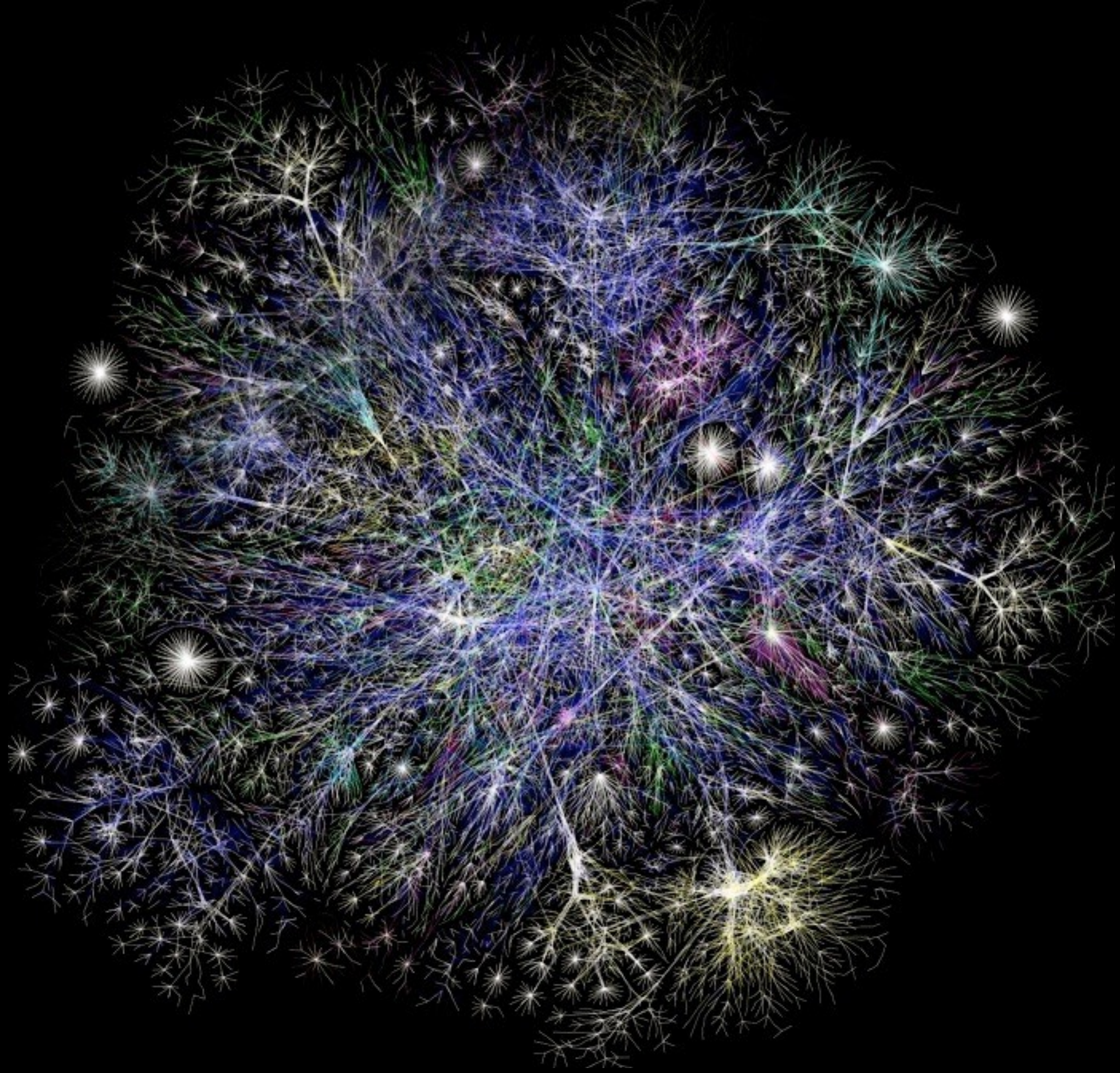
We also work with small data.
Small data also needs love.

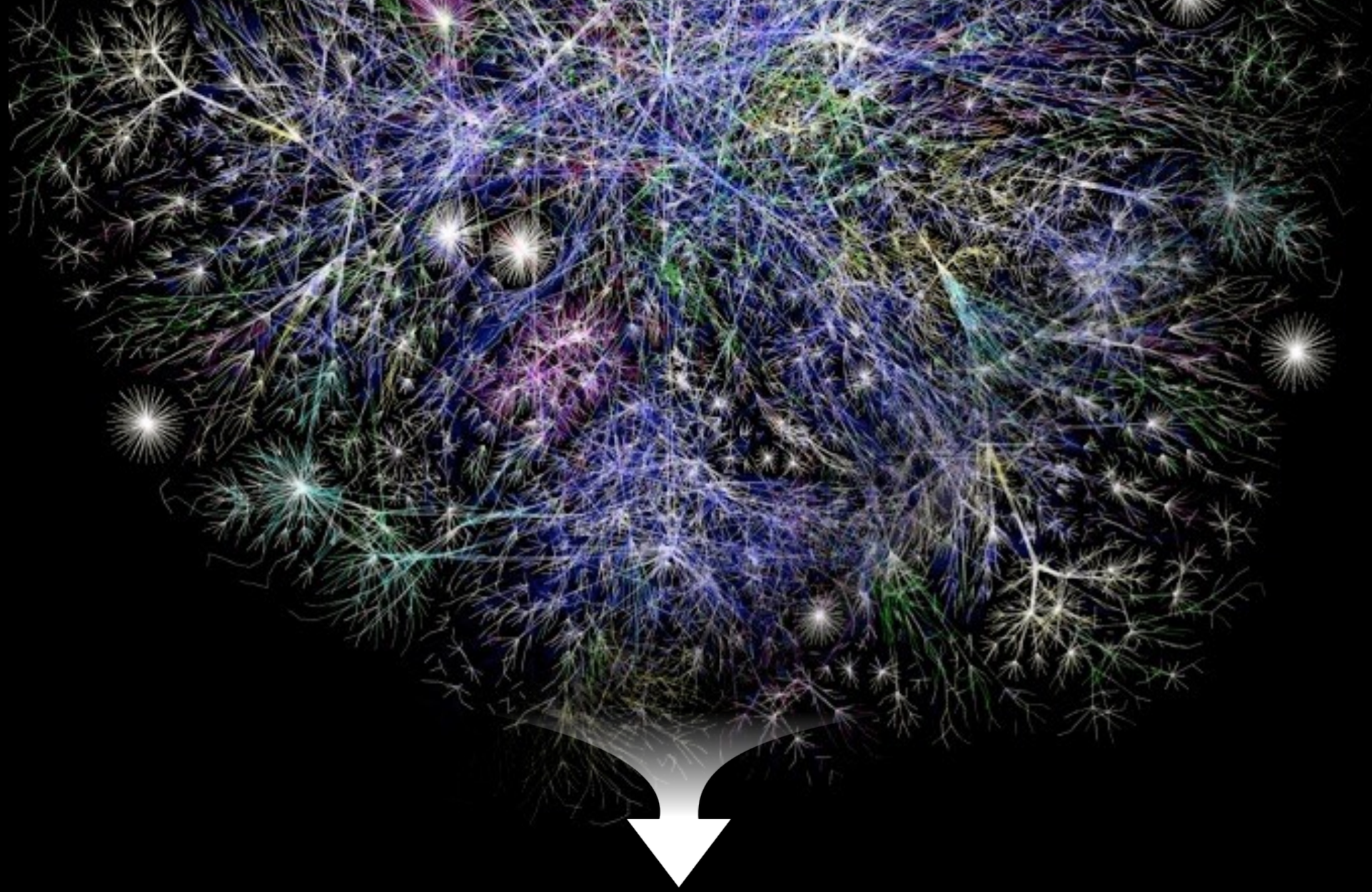
7

7±2

Number of items an average human holds in working memory

George Miller, 1956





7

Data

Insights

How to do that?

COMPUTATION
+
HUMAN INTUITION

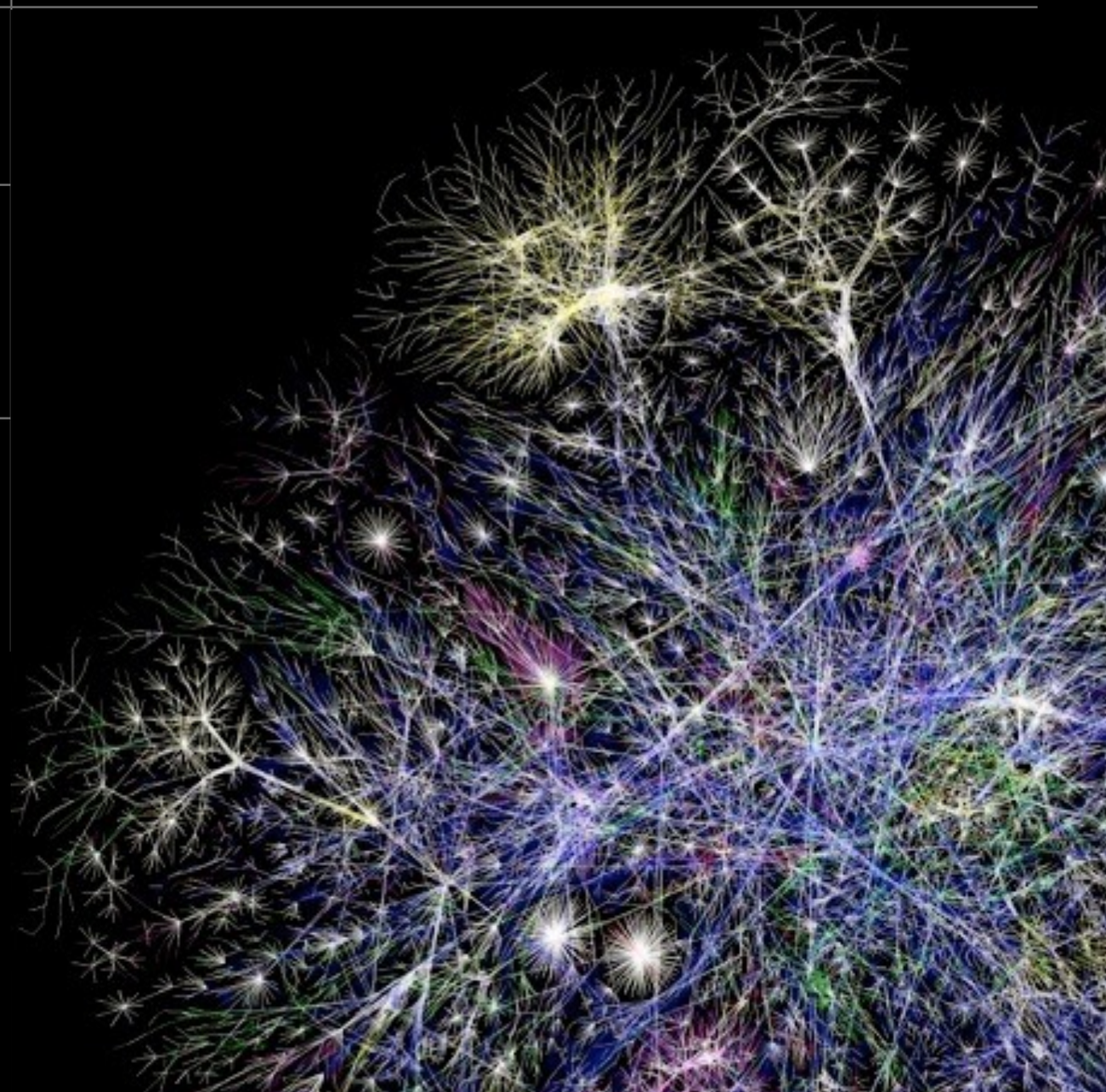
How to do that?

COMPUTATION	INTERACTIVE VIS
Automatic	User-driven; iterative
Summarization, clustering, classification	Interaction, visualization
>Millions of nodes	Thousands of nodes

Both develop methods for making sense of network data

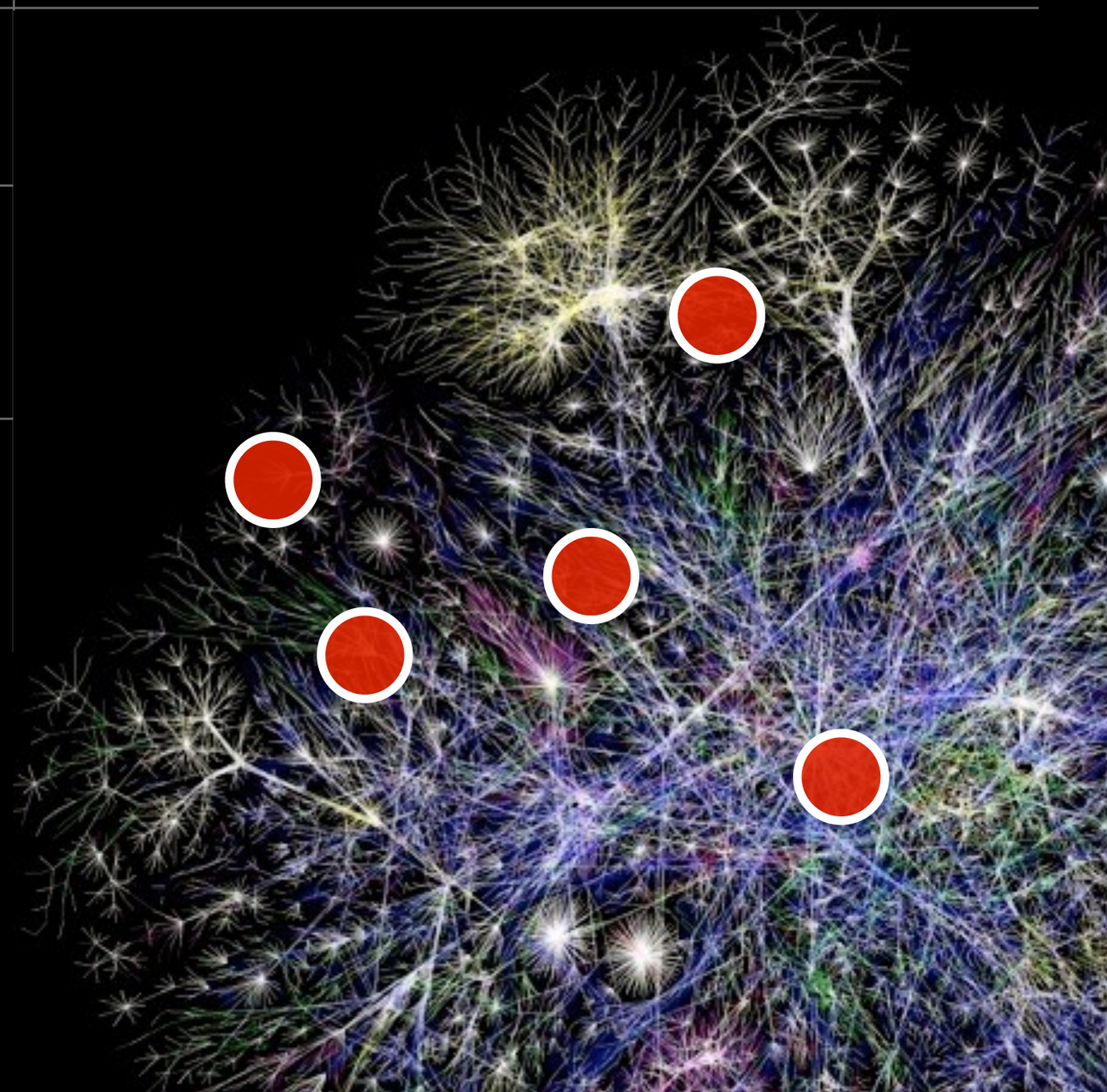
How to do that?

COMPUTATION	INTERACTIVE VIS
Automatic	
Summarization, clustering, classification	
>Millions of nodes	



How to do that?

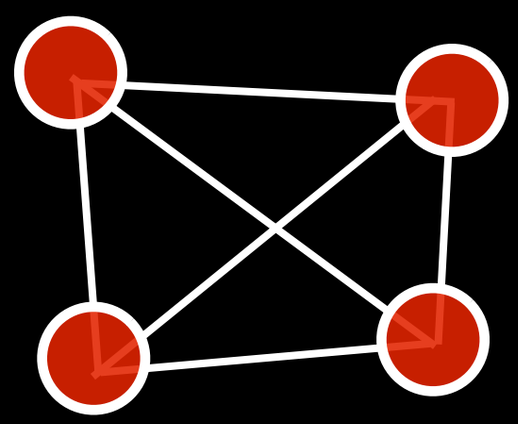
COMPUTATION	INTERACTIVE VIS
Automatic	
Summarization, clustering, classification	
>Millions of nodes	



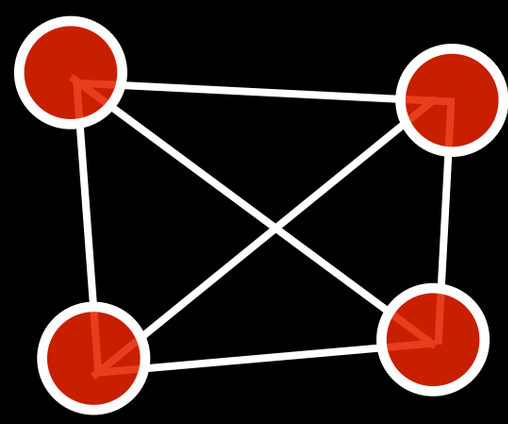
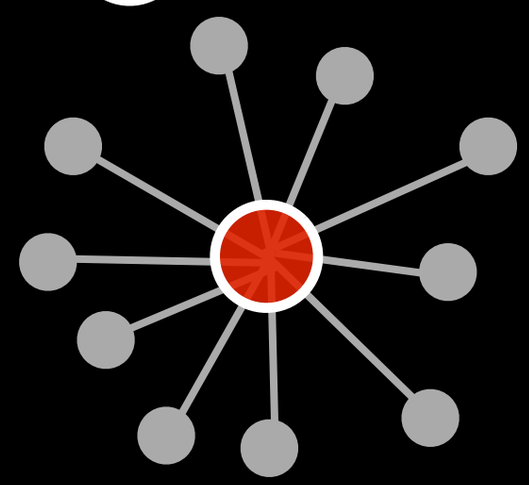
How to do that?

COMPUTATION	INTERACTIVE VIS
⋮	User-driven; iterative
	Interaction, visualization
	Thousands of nodes

How to do that?

COMPUTATION	INTERACTIVE VIS
	User-driven; iterative
	Interaction, visualization
	Thousands of nodes

How to do that?

COMPUTATION	INTERACTIVE VIS
	User-driven; iterative
	Interaction, visualization
	Thousands of nodes

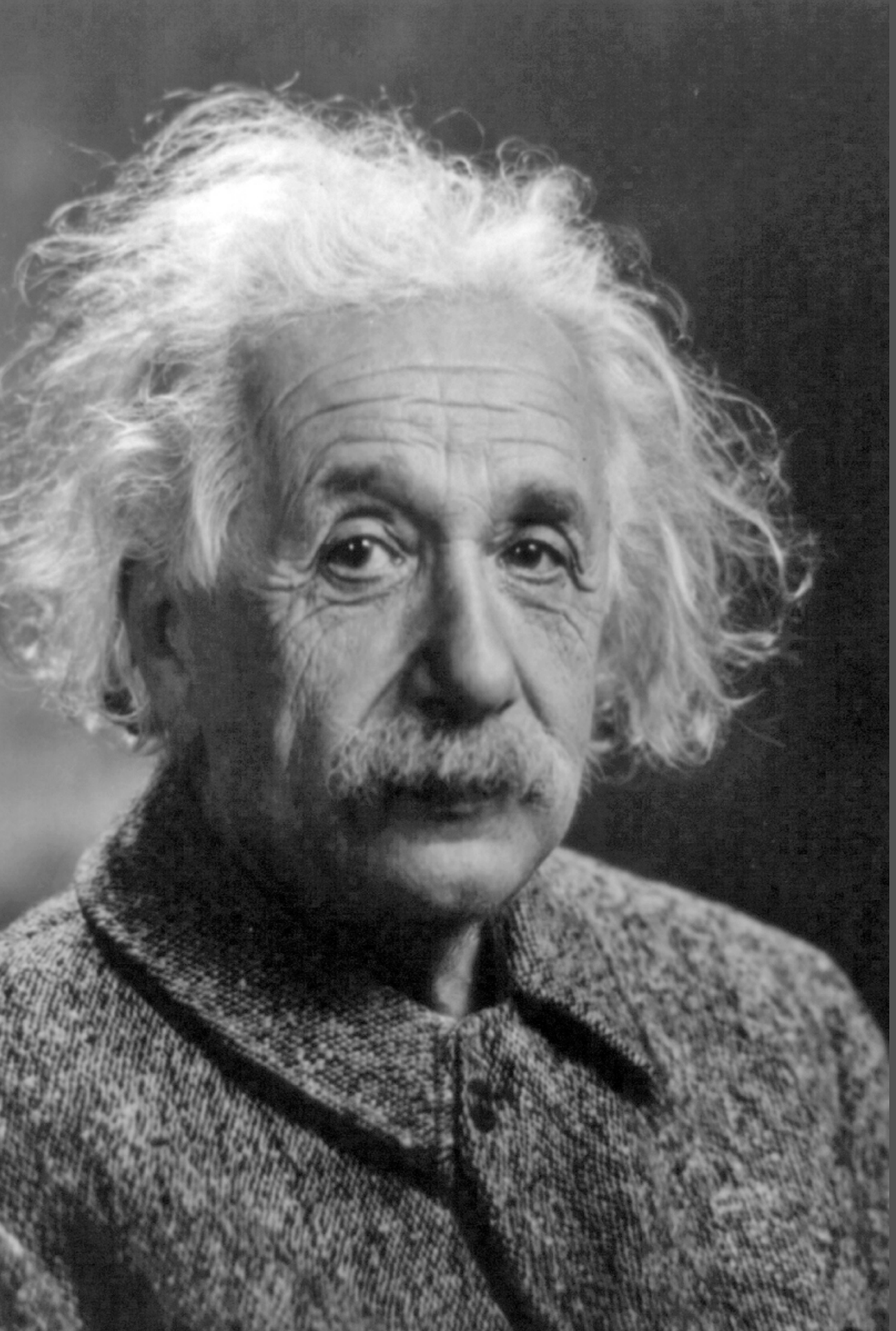
Our Approach for Big Data Analytics

DATA MINING	HCI Human-Computer Interaction
Automatic	User-driven; iterative
Summarization, clustering, classification	Interaction, visualization
>Millions of items	Thousands of items

Our research combines the
Best of Both Worlds

Our mission & vision:

Scalable, interactive, usable tools for big data analytics



“Computers are incredibly fast accurate, and stupid.

Human beings are incredibly slow, inaccurate, and brilliant.

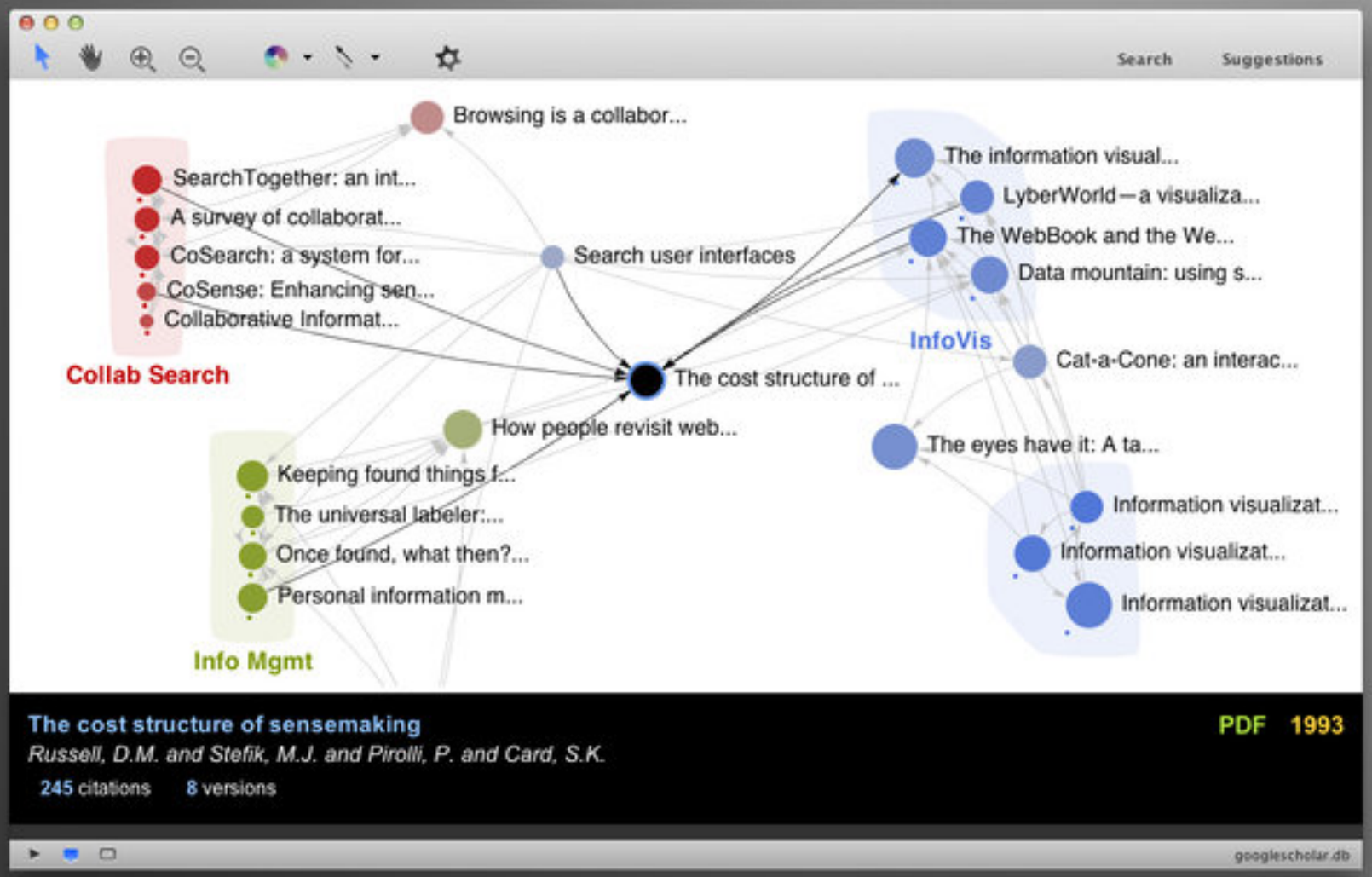
Together they are powerful beyond imagination.”

(Einstein might or might not have said this.)

Machine Learning + Visualization

Recently received $1.2 Million NSF award

http://www.scs.gatech.edu/news/522401/12m-nsf-award-helps-consumers-enter-age-big-data

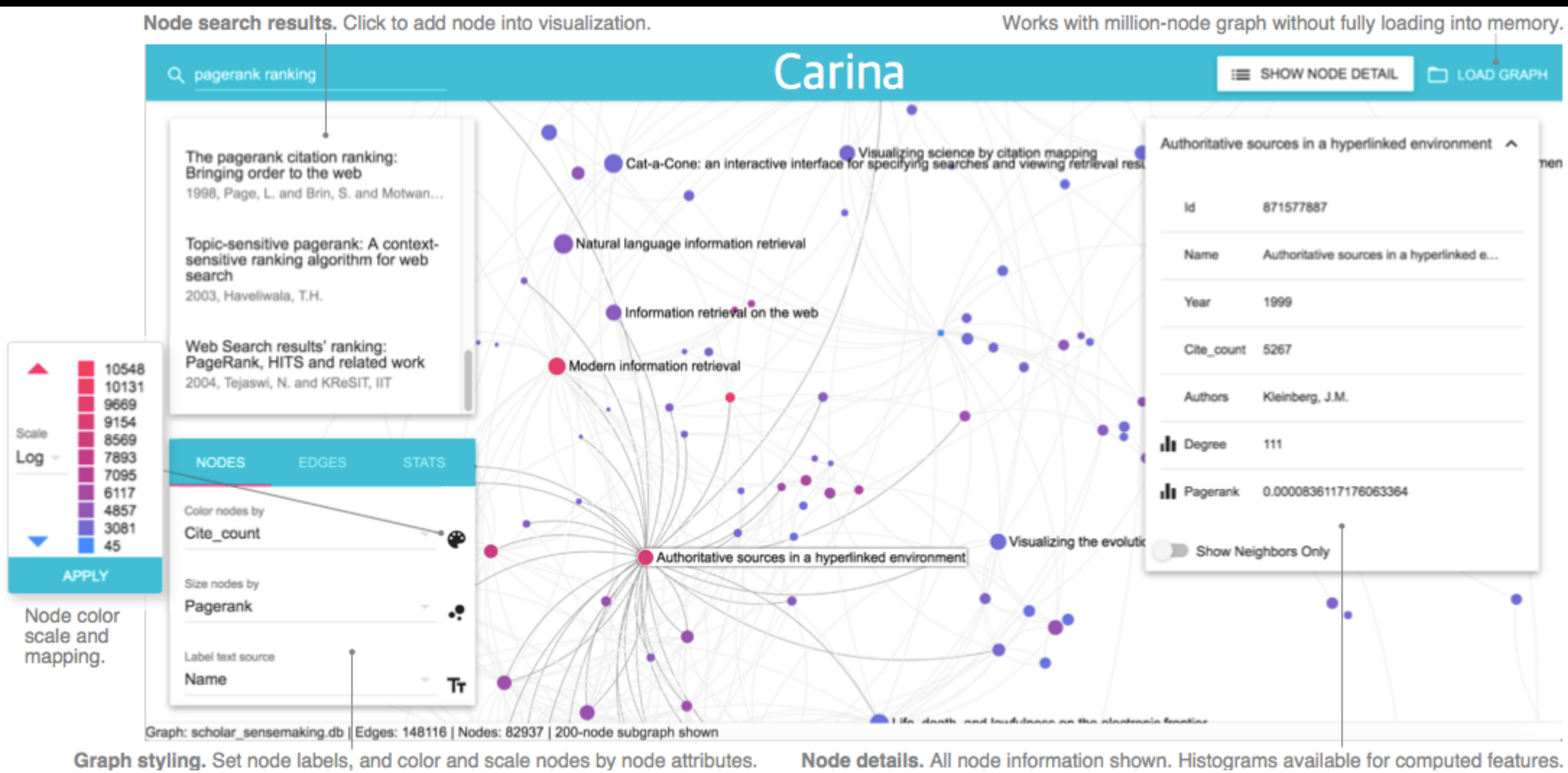


Apolo

Explore million-node graphs in real time

Apolo: Making Sense of Large Network Data by Combining Rich User Interaction and Machine Learning. CHI 2011.

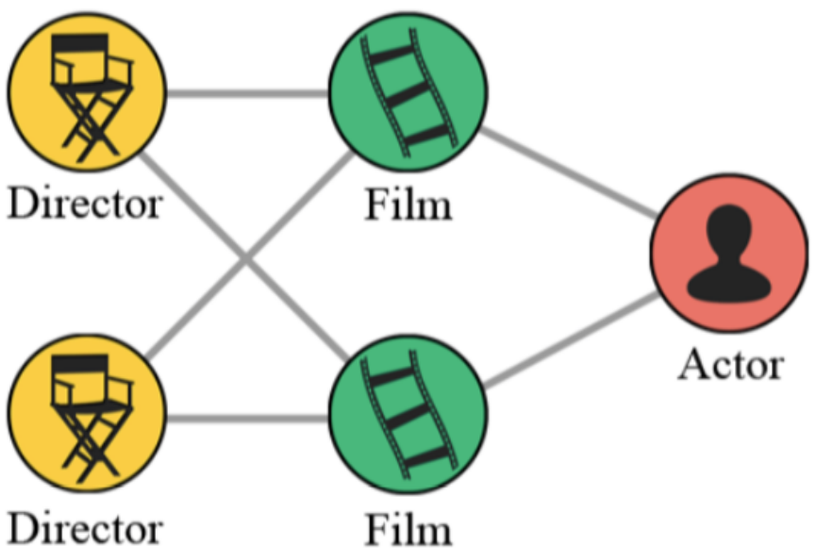
Carina: Million-node Graph Exploration in Web Browser [www'17]

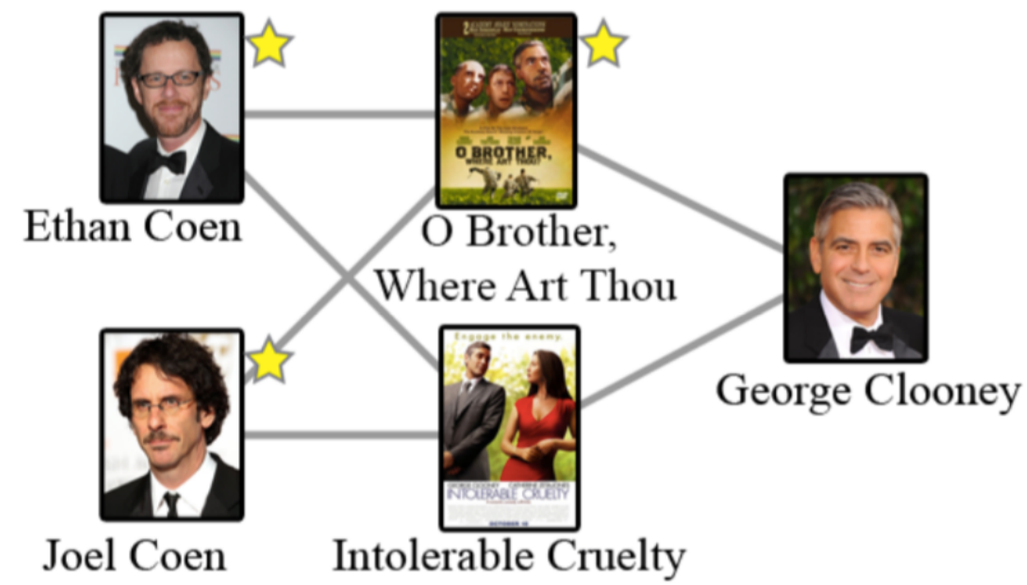


Carina: Interactive Million-Node Graph Visualization using Web Browser Technologies.
Dezhi (Andy) Fang, Mahew Keezer, Jacob Williams, Kshitij Kulkarni, Robert Pienta, Duen Horng (Polo) Chau.
WWW'17 Poster

VISAGE: Interactive Visual Graph Querying

SIGMOD'17 Best Demo, honorable mention





Find **co-directors** who made at least **two films** together, starring the same **actor**.

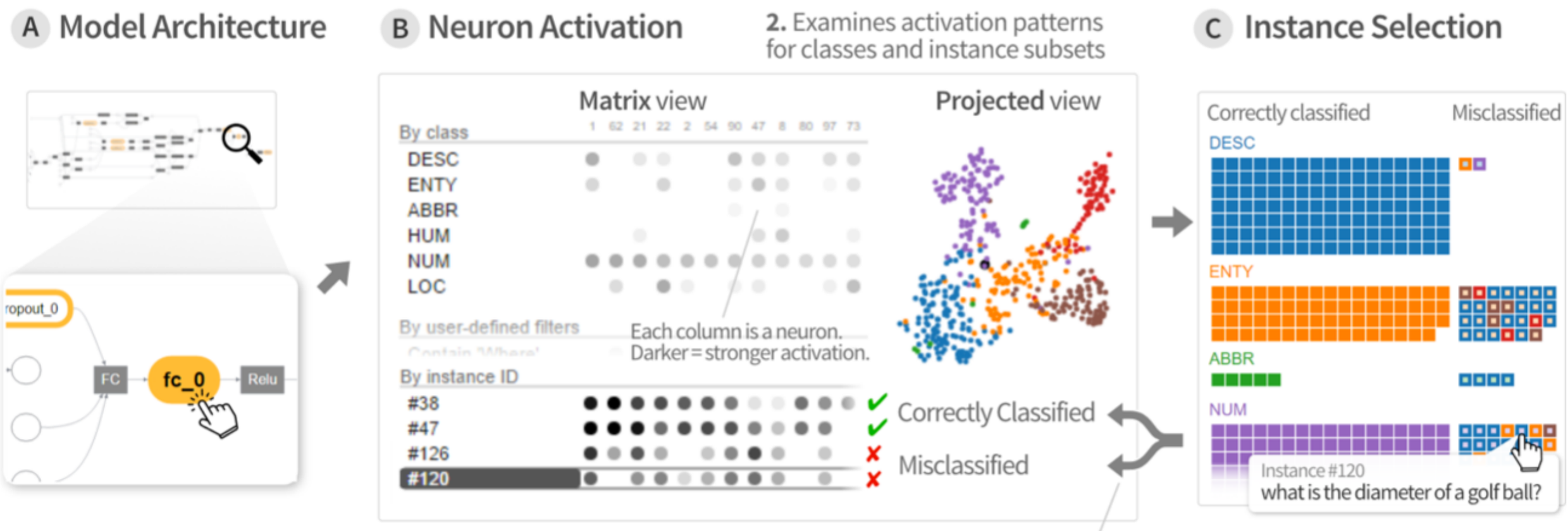
```
MATCH (d1:director)--(f1:film),
  (d1)--(f2:film), (d1)--(f3:film),
  (f1)--(d2:director)--(f2),
  (d2)--(f3),
  (f1)--(a:actor)--(f2), (a)--(f3)
WHERE f1.decade = 1990 AND d1 <> d2
RETURN d1, d2, f1, f2, f3, a
```

VISAGE: Interactive Visual Graph Querying.
Robert Pienta, Acar Tamersoy, Sham Navathe, Hanghang Tong, Alex Endert, Duen Horng Chau.
International Working Conference on Advanced Visual Interfaces (AVI 2016).

ActiVis

Visualization & Interpretation of Deep Learning Models

Deployed on ML platform of facebook



ActiVis: Visual Exploration of Industry-Scale Deep Neural Network Models.
Minsuk Kahng, Pierre Andrews, Aditya Kalro, Duen Horng (Polo) Chau.
IEEE Transactions on Visualization and Computer Graphics (Proc. VAST'17), Jan 2018.

Polo’s primary application area:

Cyber Security

Polonium & AESOP

Patented with Symantec

Finds malware from **37 billion** file relationships

Serving **120 million** users worldwide

Published at SDM'11, KDD'14

NetProbe

Auction Fraud Detection on eBay

THE WALL STREET JOURNAL.

MSNBC

CNNMoney.com
A Service of CNN, Fortune & Money

USA TODAY

KDKA 2

MARCO

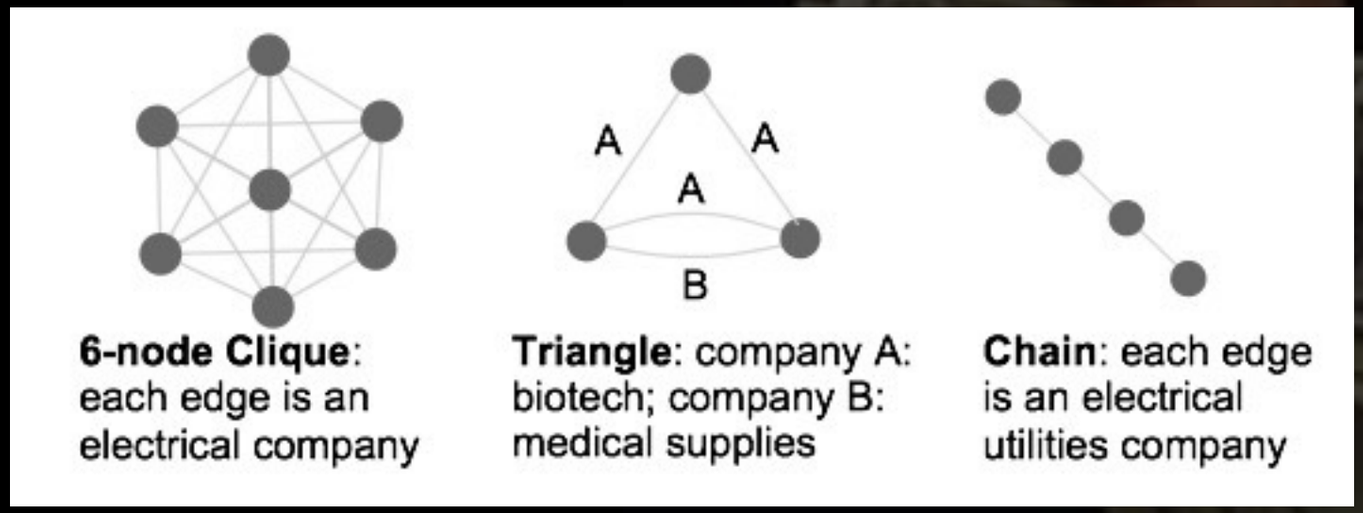
Detecting Fake Yelp Reviews

Best papers of SDM 2014

(top data mining conference)

Insider Trading Detection

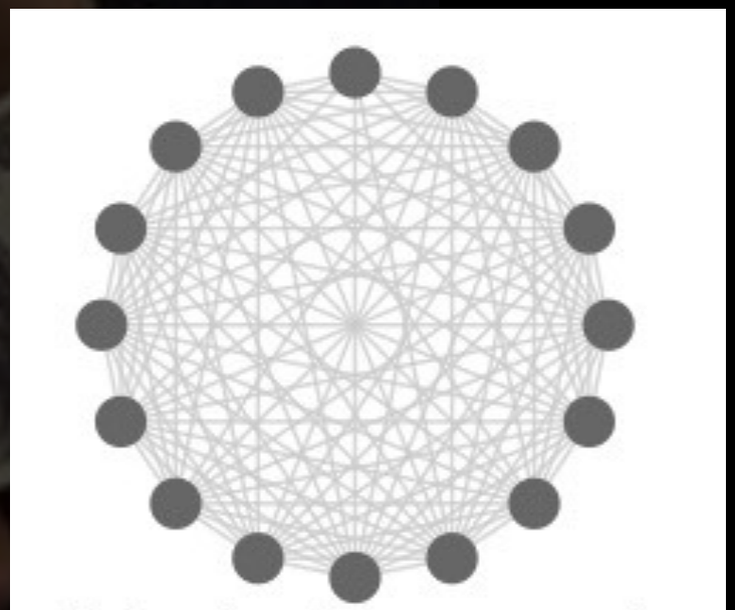
with Securities and Exchange Commission (SEC)



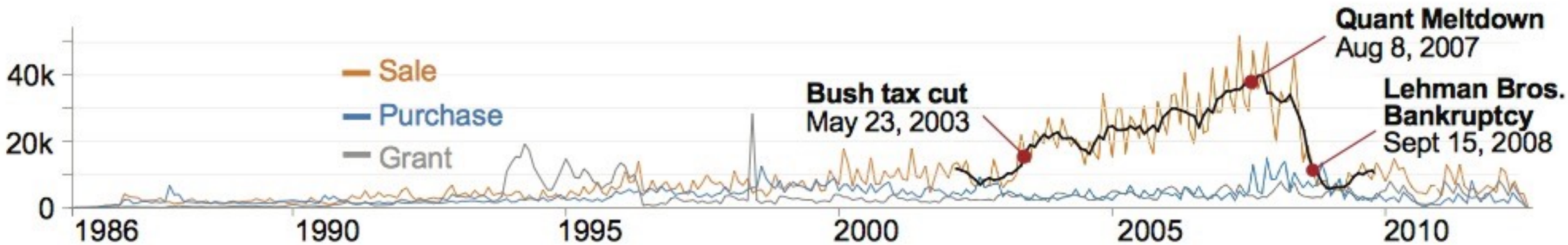
6-node Clique: each edge is an electrical company

Triangle: company A: biotech; company B: medical supplies

Chain: each edge is an electrical utilities company



Each edge above corresponds to an Electrical Utilities Company



Logistics

Course homepage
All assignments,
slides posted here

poloclub.gatech.edu/cse6242/

Discussion, Q&A,
find teammates

Piazza: **goo.gl/cGvHeE**

or piazza.com/gatech/spring2018/cse6242aqcx4242a

Make sure you're at the right Piazza!
(CSE-6242-O01, CSE-6242-OAN have
their Piazza forums too)

Assignment
Submission

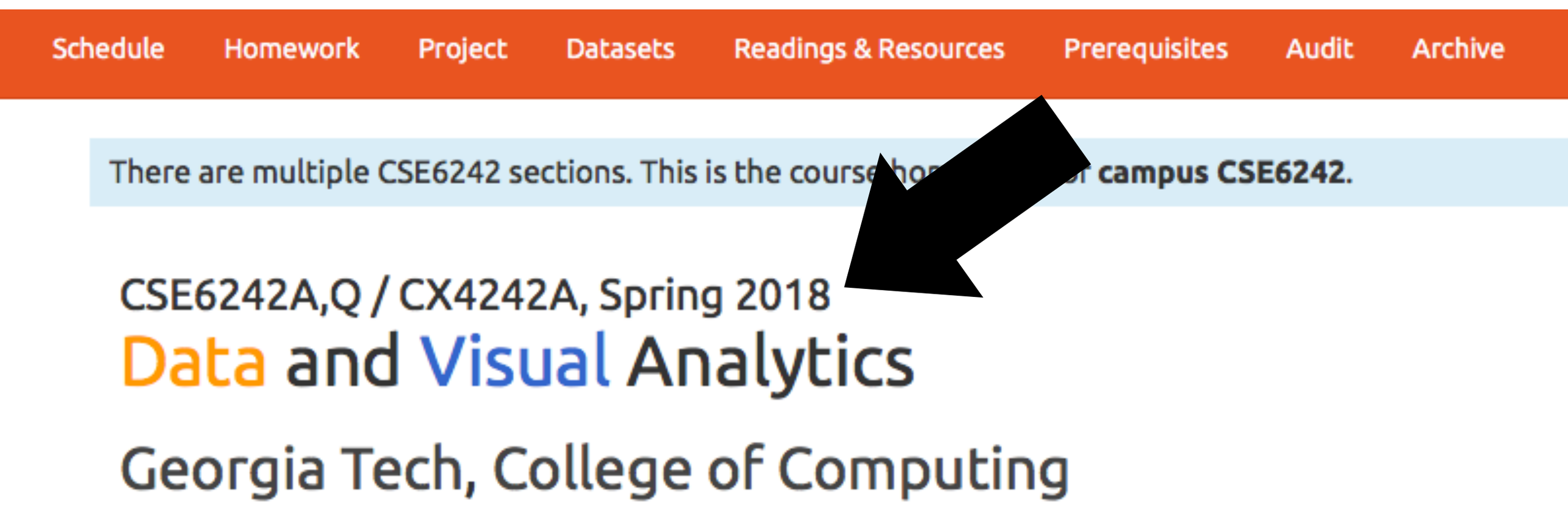
T-Square
(Use Piazza for discussion)

Course Homepage

For syllabus, HWs, projects, datasets, etc.

Google "cse6242"

poloclub.gatech.edu/cse6242/2018spring



Join Piazza ASAP

goo.gl/cGvHeE

Announcements and Discussion

We use Piazza for announcements and discussion.

Everyone must join this class's Piazza, at https://piazza.com/gatech/spring2018/cse6242aqcx4242a.

Double check that you are joining the right Piazza!

When you have questions about class, homework, project, etc., post your questions there. Our teachin
help answer them quickly. You can also use Piazza to find project teammates.

T-square will only be used for submission of assignments and projects.

While we welcome everyone to share their experiences in tackling issues and helping each other out, p
may affect the learning experience of your fellow classmates.

Important to join Piazza because…

The fastest way to get help with homework assignments is to post your questions on Piazza. If you prefer to address your questions to only our TAs and the instructor, you can use the *private post* feature (i.e., check the "Individual Students(s) / Instructors(s)" radio box).

Important to join Piazza because…

- Polo will announce events related to this class and data science in general
  - Distinguished lectures
  - Seminars
  - Hackathons (**free food**, prizes)
  - Company recruitment events (**free food**, swag)

Course Goals

What is Data & Visual Analytics?

What is Data & Visual Analytics?

No formal definition!

What is Data & Visual Analytics?

No formal definition!

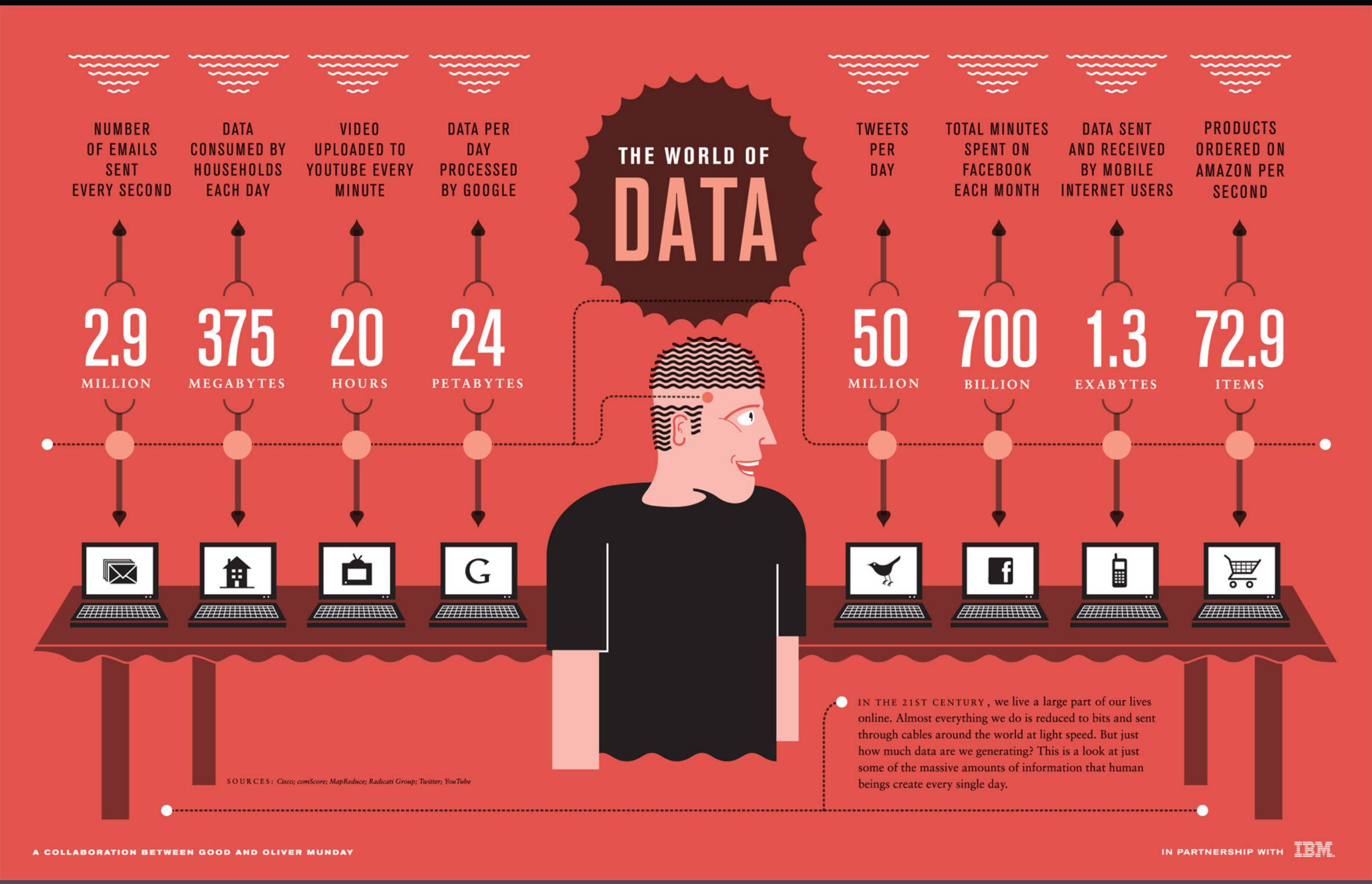
Polo's definition:
the *interdisciplinary* science of combining
computation techniques and
interactive visualization
to transform and model data to aid
discovery, decision making, etc.

What are the “ingredients”?

What are the “ingredients”?

Need to worry (a lot) about: storage, complex system design, scalability of algorithms, visualization techniques, interaction techniques, statistical tests, etc.

Wasn’t this complex before this big data era. Why?



http://spanning.com/blog/choosing-between-storage-based-and-unlimited-storage-for-cloud-data-backup/

What is **big data**? Why care?

Many businesses are based on big data.

Search engines: rank webpages, predict what you're going to type

Advertisement: infer what you like, based on what your friends like; show relevant ads

E-commerce: recommends movies/products (e.g., Netflix, Amazon)

Health IT: patient records (EMR)

Finance

Good news! Many jobs!

Most companies are looking for "data scientists"

The data scientist role is critical for organizations looking to extract insight from information assets for 'big data' initiatives and requires a ***broad combination*** *of skills that may be fulfilled better as a team*
- Gartner (http://www.gartner.com/it-glossary/data-scientist)

Breadth of knowledge is important.
This course helps you learn some important skills.

Course Schedule

(Analytics Building Blocks)

Collection

Cleaning

Integration

Analysis

Visualization

Presentation

Dissemination

Building blocks. Not Rigid “Steps”

Collection

Cleaning

Integration

Analysis

Visualization

Presentation

Dissemination

Can skip some

Can go back (two-way street)

- **Data types** inform **visualization** design
- **Data size** informs choice of **algorithms**
- **Visualization** motivates more **data cleaning**
- **Visualization** challenges algorithm assumptions
  e.g., user finds that results don’t make sense

Course Goals

- Learn **visual** and **computation** techniques and use them in **complementary** ways
- Gain a **breath** of knowledge
- Learn **practical** know-how by working on **real data & problems**

Grading

- [50%] 4 homework assignments
  - End-to-end analysis
  - Techniques (computation and vis)
  - “Big data” tools, e.g., Hadoop, Spark, etc.
- [50%] Group project -- 4 to 6 people
- [Bonus points] In-class pop quizzes
  - Each quiz is worth **1% course grade**
- **No exams**

Policies

Collaborating on homework
Late submission policy

Working on Homework

While collaboration is allowed for homework assignments, each student **must** write up their own answers. All GT students must observe the honor code. Any suspected plagiarism and academic misconduct will be reported and directly handled by the Office of Student Integrity (OSI).

WARNING

You'll be writing a lot of code

Q: Is it OK to copy and use code found on the web?
A: No

Q: Why?
A: Here's why…

WARNING: Do not plagiarize!

- Using code as reference does not mean copying and modifying it.
- To use example code as reference, you should go over it, understand what it is doing, and then try to accomplish what it is trying to do **using your own code**. And it's a good practice to cite the the sources (e.g., as part of your code comments).
- The analogy is like how you would write an essay or a speech. You can get inspirations from others, but you should **use your own words**, otherwise it will be considered plagiarism. **Plagiarism can lead to severe consequences**.
- http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/

Late Submissions Policy

- **Homework**: each student has *4 slip days* total. No questions asked.
- **Project**: each team has *3 slip days* total. No questions asked. Slip days may not be used on in-class activities (e.g., proposal presentation, poster presentation, etc.).
- To use slip days, **specify the number of days you have used in the textbox on T-Square** (when you submit your work).
- **Each slip day equals 24 hours**. E.g., if a submission is late for 30 hours, that counts as 2 slip days
- After all slip days are used up, **5% deduction for every 24 hours of delay**. (e.g., 5 points for a 100-point homework).
- We **will not consider late submission of any missing parts** of an homework assignment or project deliverable. To make sure you have submitted everything, download your submitted files to double check.
- We **will not accept** any submission that is more than 7 days late.
- No penalties for medical reasons or emergencies. And should they arise, you **must** contact the Dean of Students office. Doctor's notes, medical documentation, explanation of emergencies, etc. should be submitted to the Dean's office. After their office receives the information, we will notify me on your behalf.

Distance Learning Sections (Q & Q3)

A standard 3-day lag applies to all homework and project deliverables. For project presentation, a group that has DL student member can choose to:

1. Present in class without 3-day lag; or
2. Submit a video presentation with 3-day lag (e.g., screen capture)

Are You Ready to Take this Course?

- Require **a lot of programming**
- You need to **learn many new things in short amount of time**
- HW2 (D3 data vis) is most demanding: Javascript + CSS + HTML
- **Very common in industry**

Are You Ready to Take this Course?

The **best way** to find out is to check out previous semester's homework assignments

- poloclub.gatech.edu/cse6242/2017fall/
- poloclub.gatech.edu/cse6242/2017spring/
- poloclub.gatech.edu/cse6242/2016fall/
- poloclub.gatech.edu/cse6242/2016spring/

Prerequisites & Expectation

For both CSE 6242 (grad) and CX 4242 (undergrad)

Students are expected to complete **significant** programming assignments (homework, project) that may involve higher-level languages or scripting (e.g., Java, R, Matlab, Python, C++, etc.).
Some assignments may involve web programming and D3 (e.g., Javascript, CSS).

You are expected to quickly learn many new things. For example, an assignment on Hadoop programming may require you to learn some basic Java and Scala quickly, which should not be too challenging if you already know another high-level language like Python or C++. **Please make sure you are comfortable with this.**

Please take a look at the assignments (homework and project) of the previous offerings of this course, which will give you some idea about the difficulty level of the assignments.

Basic linear algebra, probability knowledge is expected.

e.g., http://poloclub.gatech.edu/cse6242/**2017fall**/

From Previous Classes…

- Class projects turned into papers at top conferences (KDD, IUI, etc.)
- Projects as portfolio pieces on CV
- Increased job and internship opportunities
  - Former students sent me “thank you” notes

Aurigo: An Interactive Tour Planner for Personalized Itineraries

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ABSTRACT

Planning personalized tour itineraries is a complex and challenging task for both humans and computers. Doing it manually is time-consuming; approaching it as an optimization problem is computationally NP hard. We present Aurigo, a tour planning system combining a recommendation algorithm with interactive visualization to create personalized itineraries. This hybrid approach enables Aurigo to take into account both quantitative and qualitative preferences of the user. We conducted a within-subject study with 10 participants, which demonstrated that Aurigo helped them find points of interest quickly. Most participants chose Aurigo over Google Maps as their preferred tools to create personalized itineraries. Aurigo may be integrated into review websites or social networks, to leverage their databases of reviews and ratings and provide better itinerary recommendations.

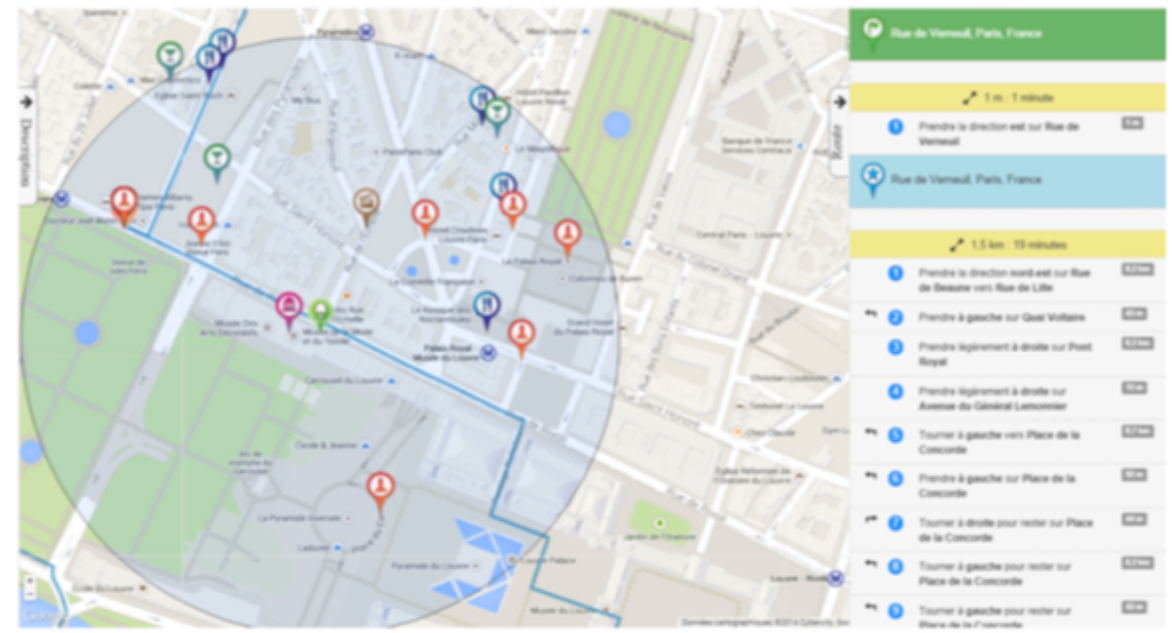
Author Keywords

User Interfaces; Visualization; Recommendation; Tour itinerary planning

ACM Classification Keywords

IUI Full conference paper

(e.g. HCI): User Interfaces



ISPARK: Interactive Visual Analytics for Fire Incidents and Station Placement

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ABSTRACT

In support of helping to reduce the response time of firefighters, and thus deaths, injuries, and property loss due to fires, we introduce ISPARK. The ISPARK system determines where fire stations should be located, analyzes the primary causes of fires, the existing infrastructure, and response times, by using visualizations which show the GIS mapping of fire stations on a dashboard. Incidents and response times are shown as additional layers, with clustering of fire incidents to determine predicted fire station locations, forecasting of fire incidents using regression, causal, infrastructure, and personnel analysis, creating an interactive, multi-faceted method for locating fire stations. A comparison of urban and rural fire incident response times is another dimension of this study. We demonstrate ISPARK's usage and benefits using a publicly available dataset describing 300,000 fire incidents in the states of Massachusetts and Maine. ISPARK is generalizable to other geographic areas

KDD Workshop paper

Figure 1: Screenshot of ISPARK showing actual (pink) and predicted (green) fire station locations n Maine determined by our approach, using coordiates with actual driving distances from fire stations o actual fire incidents. Fire incidents are shown as small yellow dots. ISPARK reduces the average

PASSAGE: A Travel Safety Assistant With Safe Path Recommendations For Pedestrians

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IUI Poster paper

Abstract

Atlanta has consistently ranked as one of the most dangerous cities in America with over 2.5 million crime events recorded within the past six years. People who commute by walking are highly susceptible to crime here. To address this probl has developed a mobile application, PASSAG crime data to find "safe pat Atlanta. user int

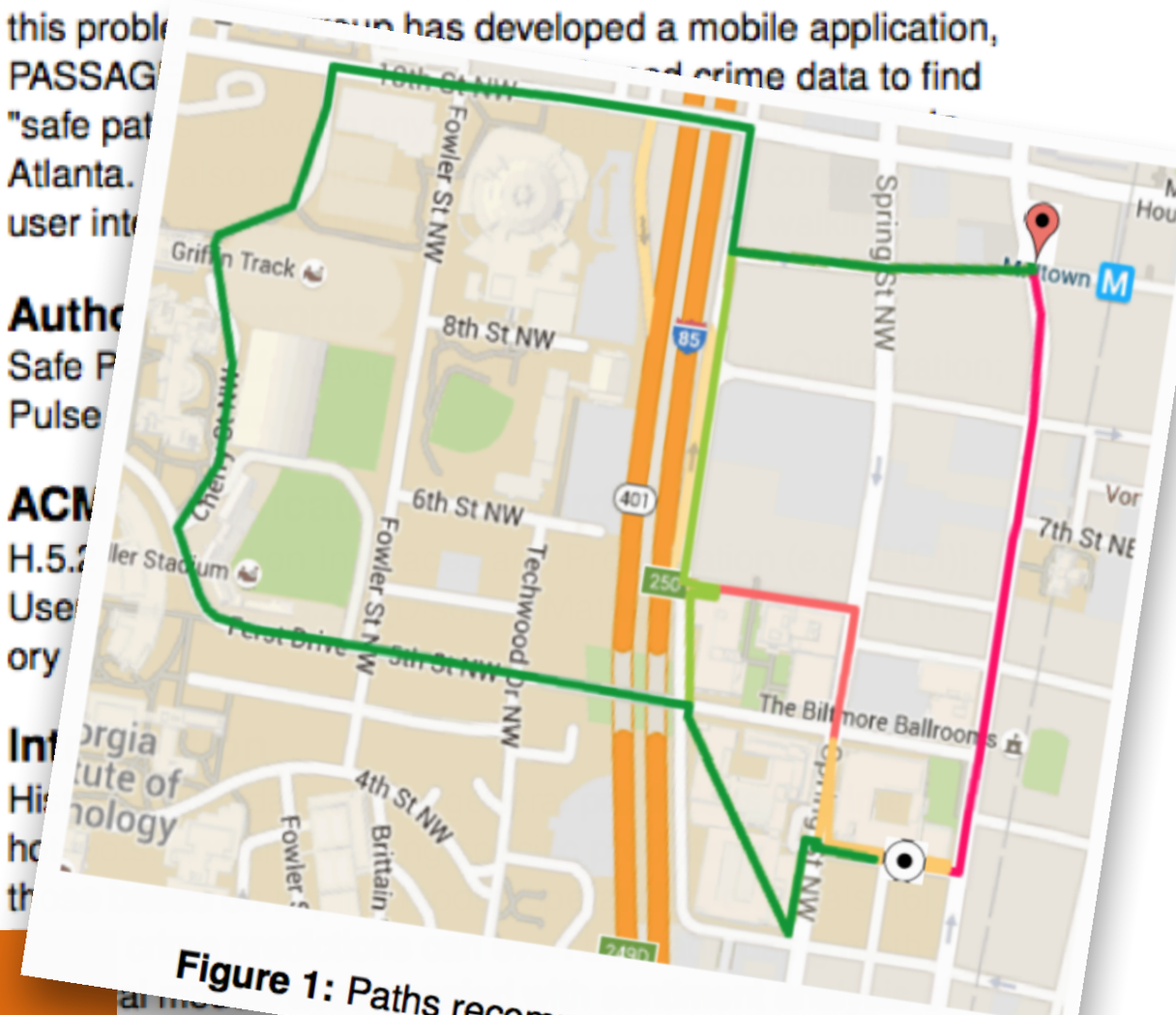

Figure 1: Paths recommended by PASSAGE

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"I feel like the concepts from your class are like a ***rite of passage for an aspiring data scientist****. Assignments lead to a feelings of accomplishment and truly progressing in my area of passion."*

"I really get more intuition about how to ***deal with data with some powerful tools in HW3*** *[uses AWS]. That feeling is beyond description for me."*

"I would like to say thank you for your class! Thanks to the skills I got from the class and the project, ***I got the offer****."*

What Polo expects from you

- Actively participate throughout the course!
- Ask questions **during class** and on **Piazza**
- Help out whenever you can, e.g., help answer questions on Piazza
- Polo reserves last few minutes of every class for Q&A

FREE After-class Coffee 

- After class, Polo randomly selects 5 students (+2 volunteers) for **FREE** after-class coffee
- Polo’s treat. You can order coffee, tea, pastries — whatever you want
- Very casual — you can ask me **ANYTHING**
- Will try doing this at least once a week, starting next week!