http://poloclub.gatech.edu/cse6242

CSE6242 / CX4242:

Data & Visual Analytics

Duen Horng (Polo) Chau
Associate Professor, College of Computing
Associate Director, MS Analytics
Machine Learning Area Leader, College of Computing
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

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

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

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. If you are on the waitlist, please wait for seats to released (some students typically “drop” after today).

- As of 3pm today
  - **CSE 6242 A**
    - 186/202 seats filled
    - 81/250 waitlist slots taken
  - **CX 4242 A**
    - 50/68 seats filled
    - 4/100 waitlist slots taken
  - **CSE 6242 Q** (distance-learning): 6 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

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

RESEARCH MEMBERS SPONSORS

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Machine Learning Visualization & Interpretation

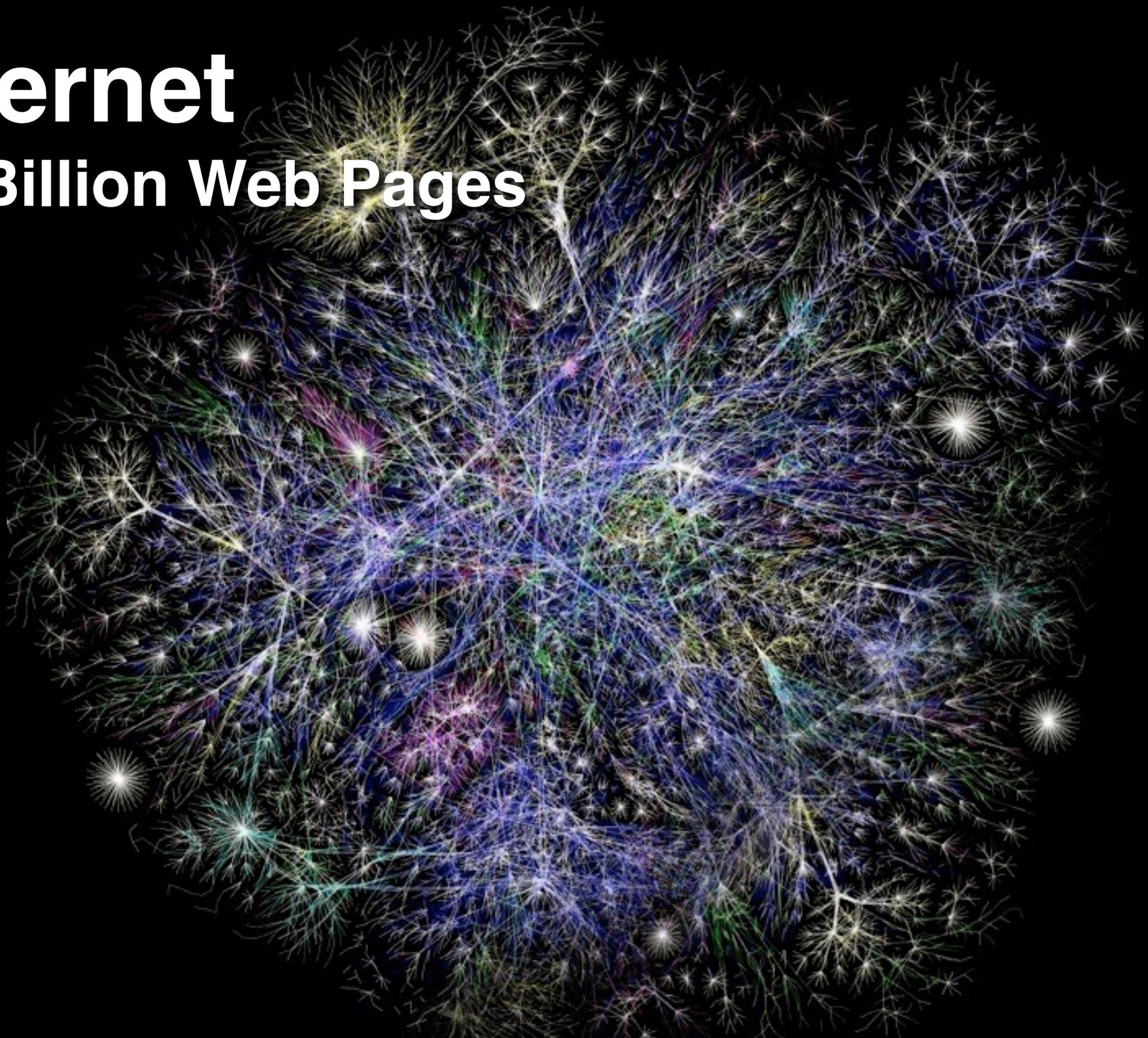
Interpretable deep learning and machine Learning through interactive visualization, with application in adversarial machine learning.

Polo Club
of
DATA SCIENCE

We work with (really) large data.

Internet

50 Billion Web Pages

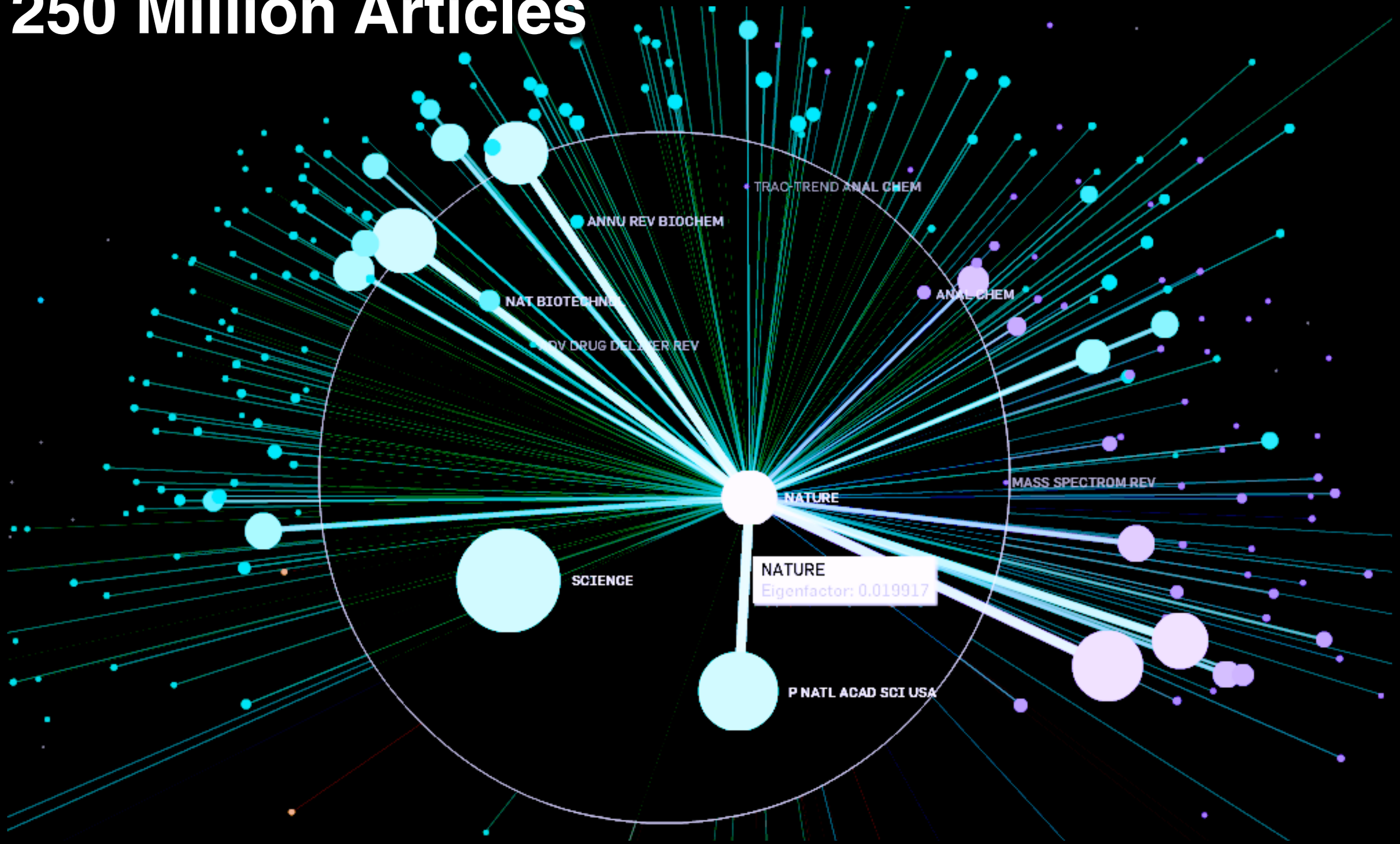


Facebook

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

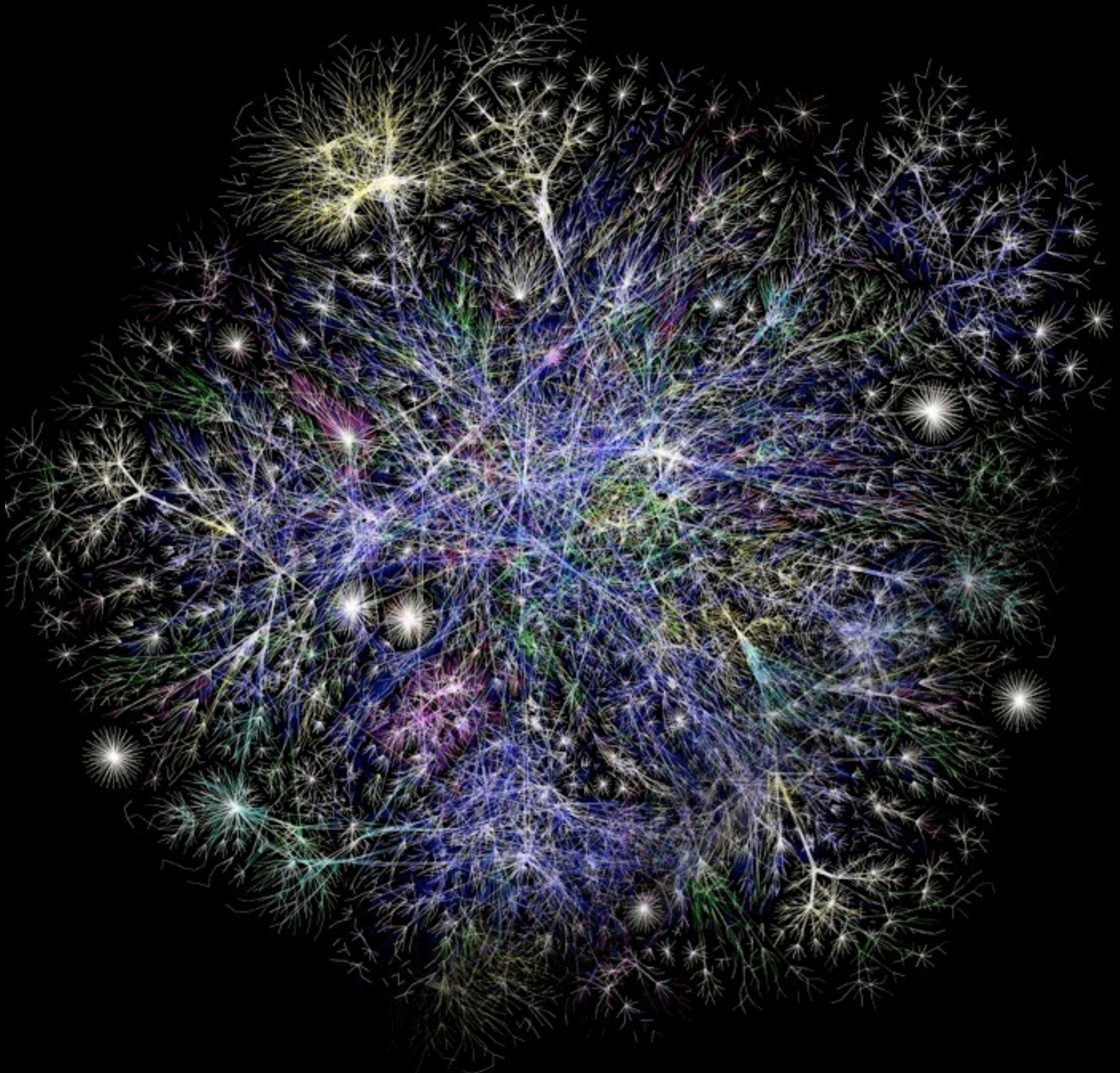
We also work with small data.
Small data also needs love.

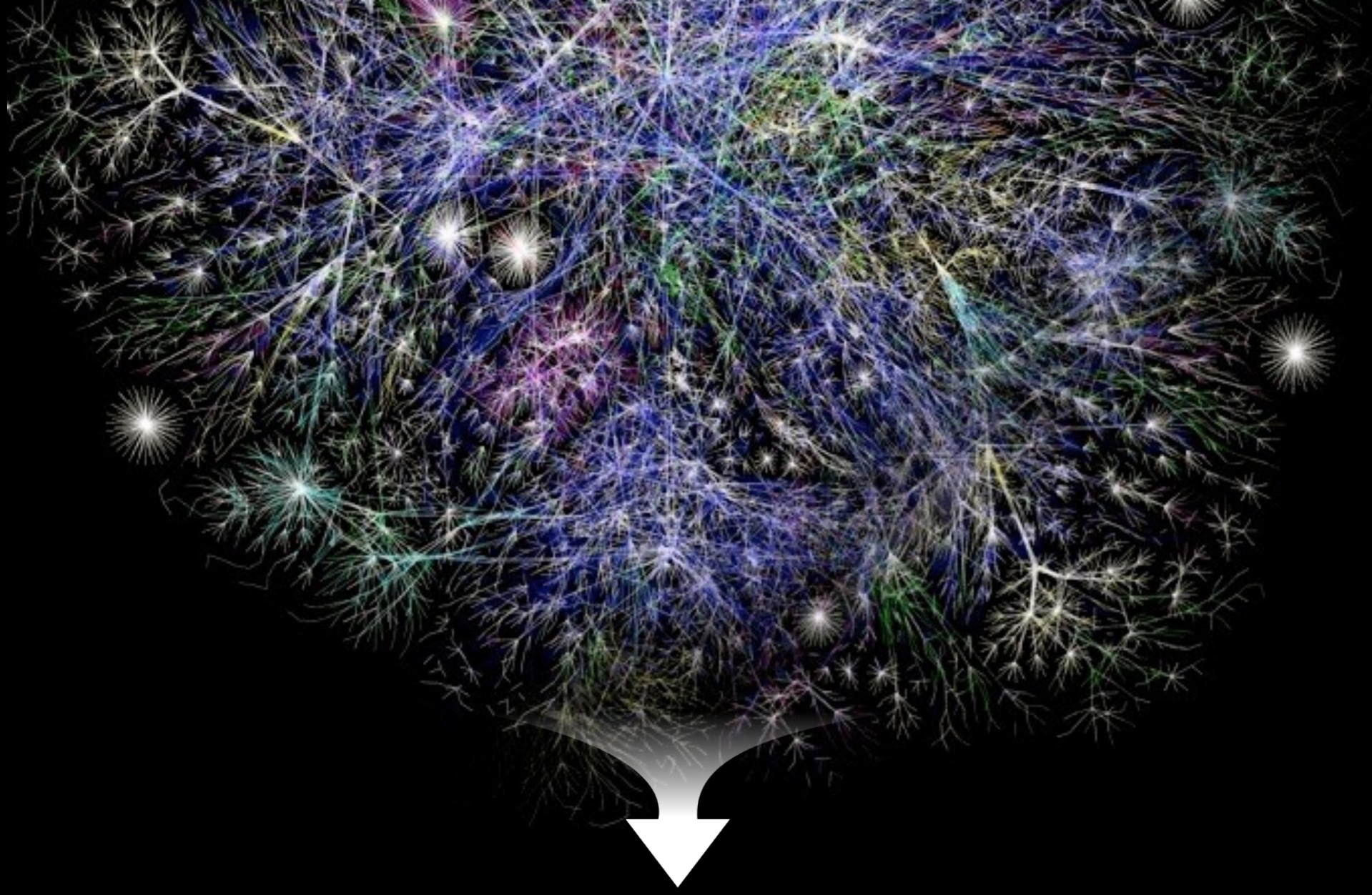
7

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

Or, to ride the AI wave…

ARTIFICIAL INTELLIGENCE

+

HUMAN INTELLIGENCE

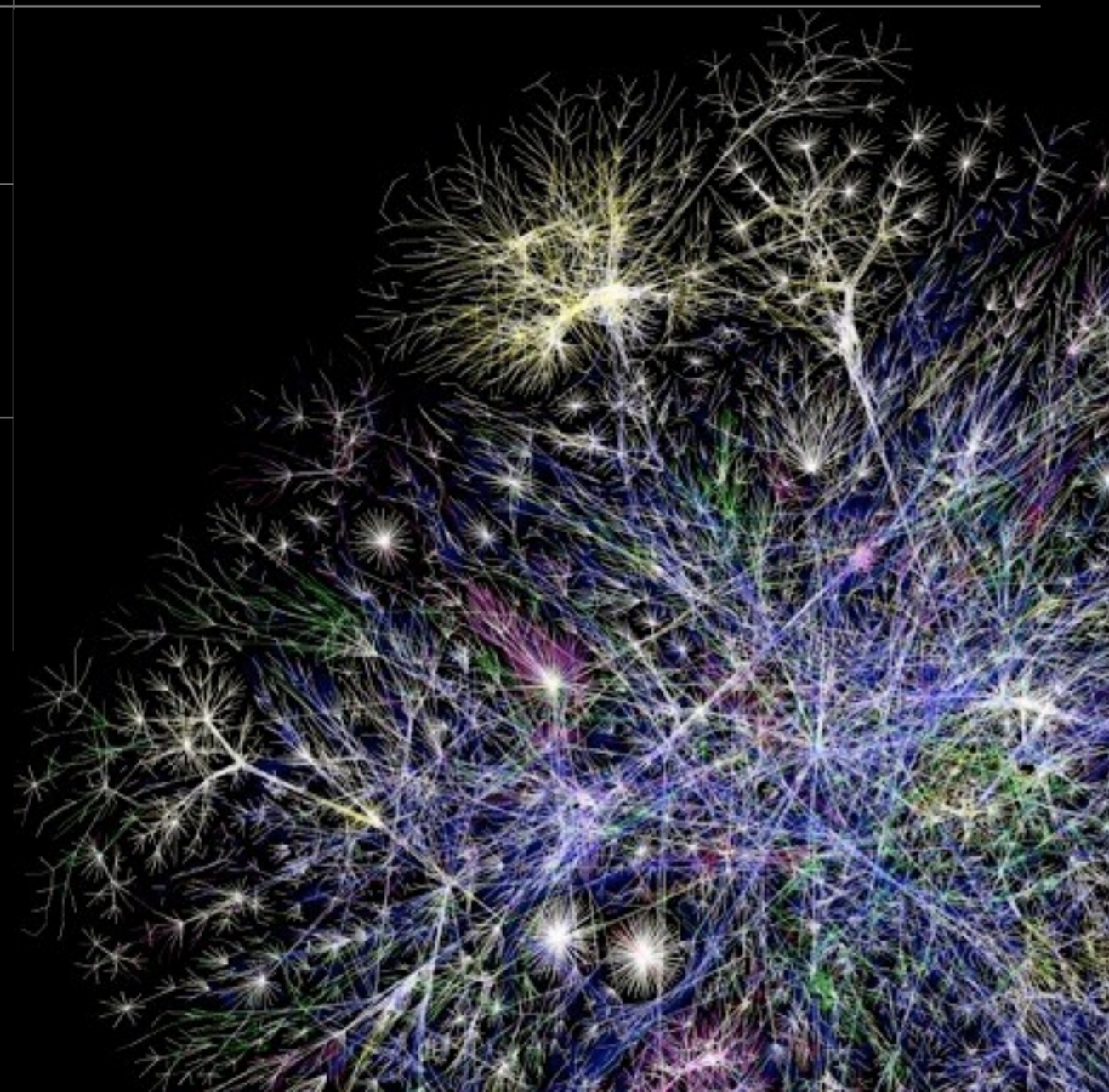
How to do that?

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

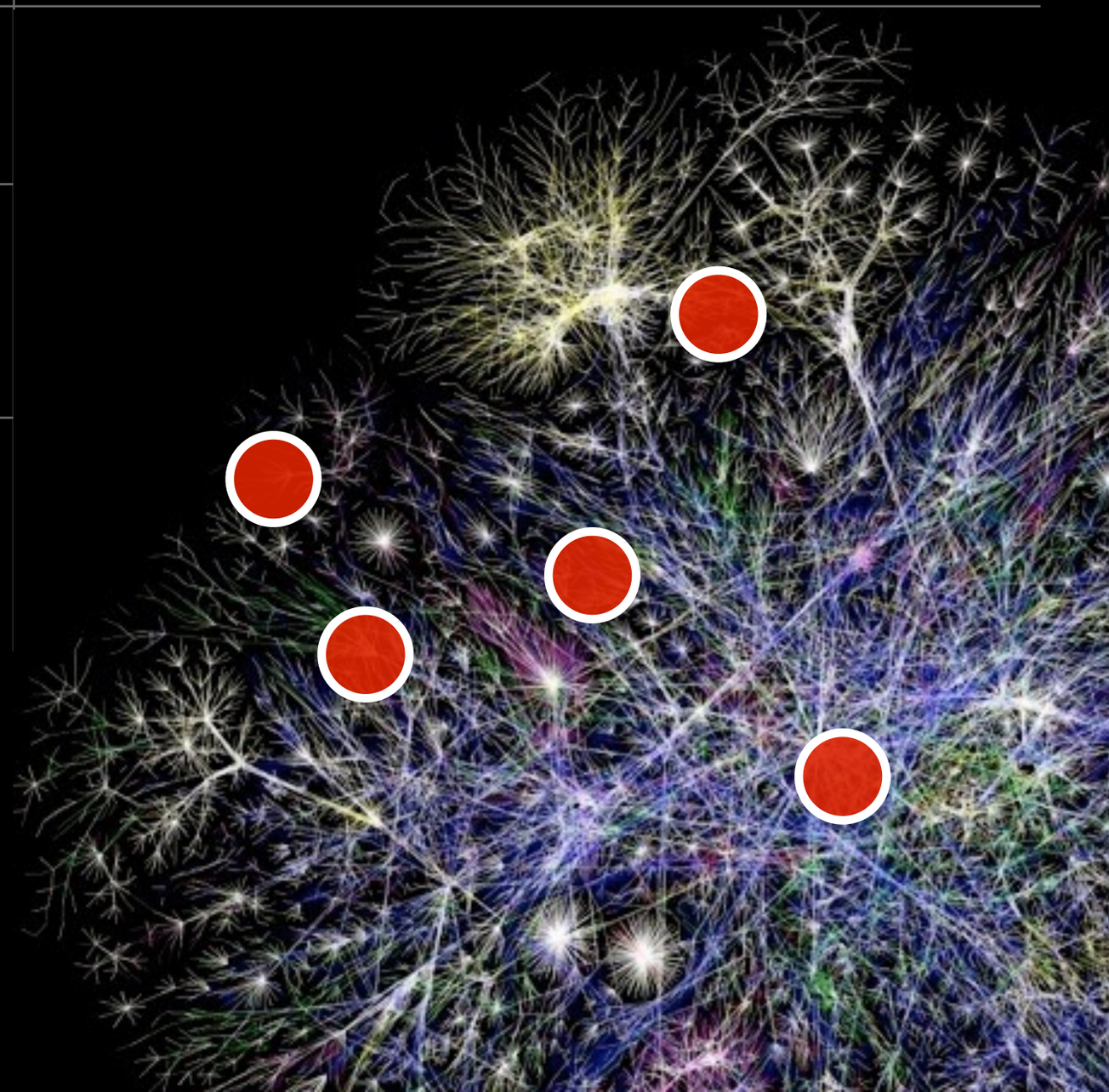
How to do that?

Computation	Interactive Vis
Automatic	
Summarization, clustering, classification	
>Millions of nodes	



How to do that?

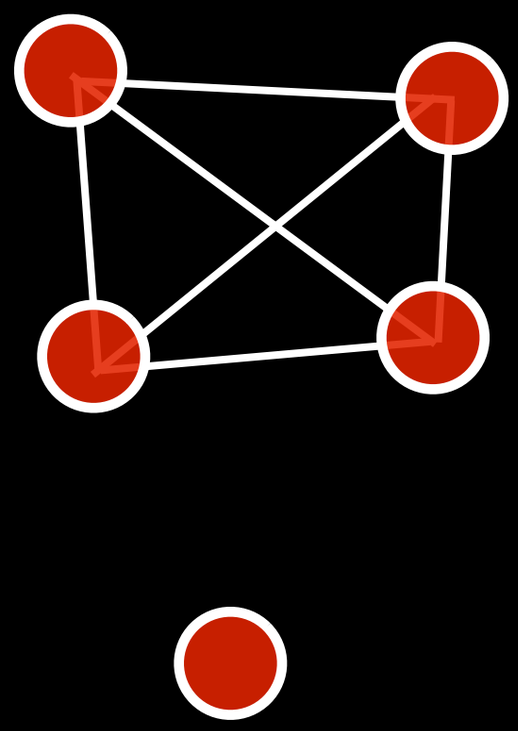
Computation	Interactive Vis
Automatic	
Summarization, clustering, classification	
>Millions of nodes	



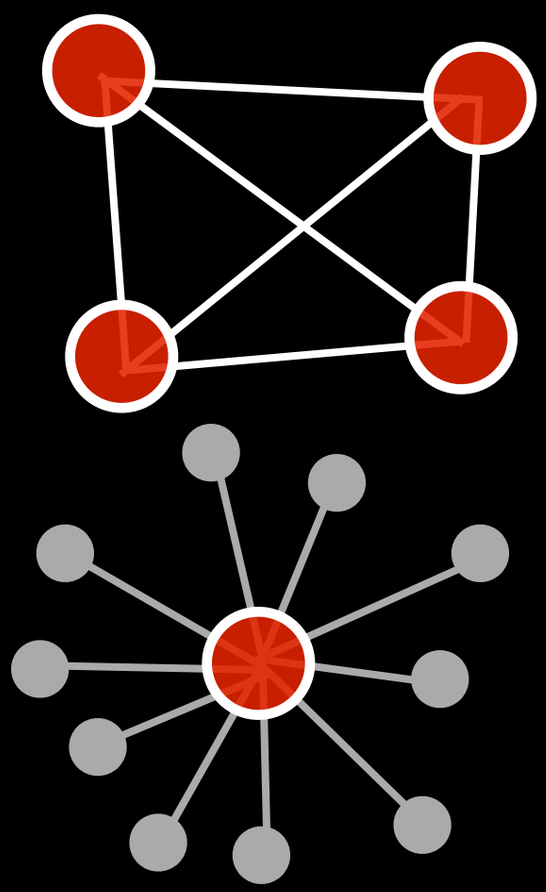
How to do that?

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

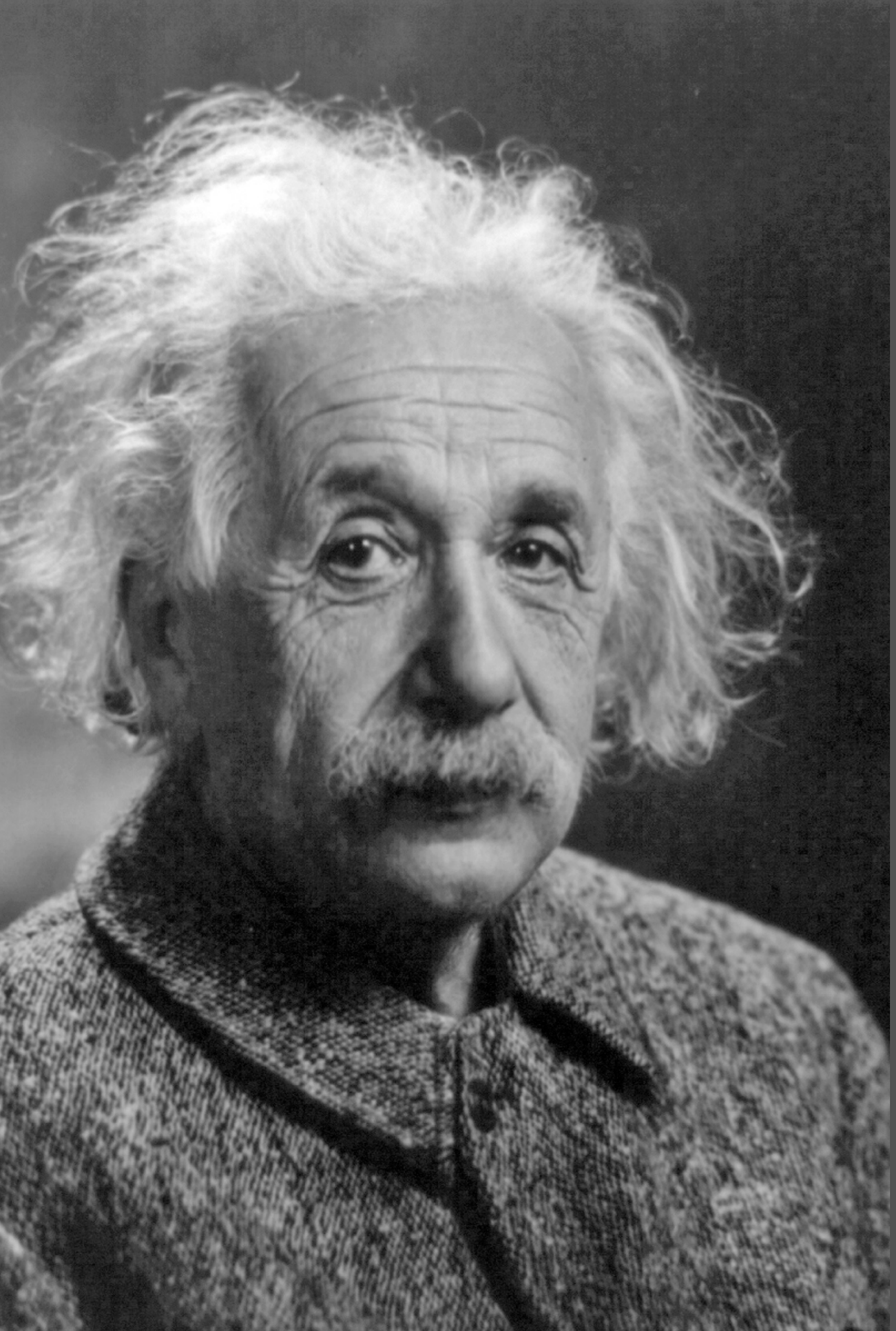
Our Approach for Big Data Analytics

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.)

Polo Club of Data Science poloclub.github.io

AI Interpretation & Protection

ActiVis

Visual Exploration of Facebook Deep Neural Network Models

Deployed Facebook

SHIELD

Fast, practical defense for deep learning

Intel

Cyber Security

Cyber MoneyBall

Predicting Cyber Threats with Virtual Security Products

Symantec

MARCO

Fake Review Detection

SDM'14 Best Student Paper

Large Graph Mining & Visualization

MMap

Easy billion-scale graph computation on a PC using virtual memory

Apolo

Explore million-node graphs in real time

Social Good & Health

DeepPop

Deep Learning on Satellite Imagery for Population Estimation

Microsoft AI for Earth

Firebird

Predicting Fire Risk in Atlanta

KDD'16 Best Student Paper, runner-up

Deployed Atlanta Fire Rescue Department

Logistics

Course homepage
All assignments, slides posted here

poloclub.gatech.edu/cse6242/

Discussion, Q&A, find teammates

Piazza: link available on canvas.gatech.edu

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

Assignment Submission

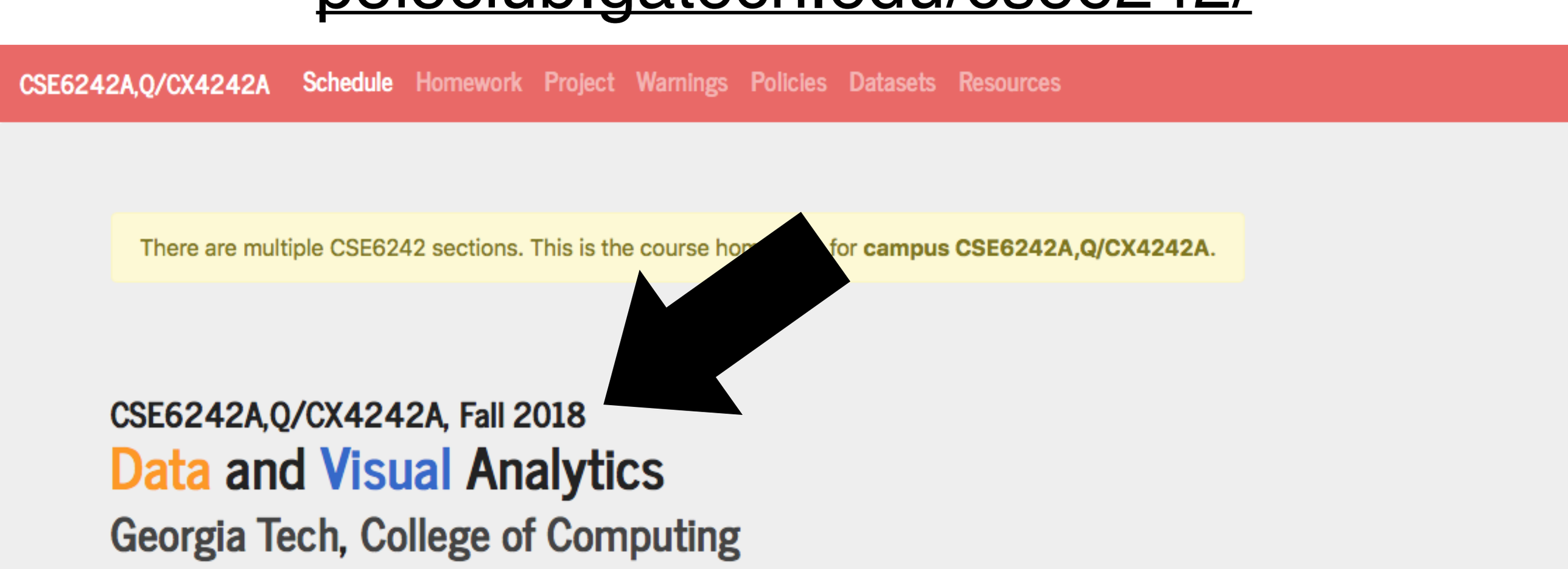
Canvas
(Use Piazza for discussion)

Course Homepage

For syllabus, HWs, projects, datasets, etc.

Google "cse6242"

poloclub.gatech.edu/cse6242/



Join Piazza ASAP

(via canvas.gatech.edu)

Announcements and Discussion

We use Piazza for all announcements and discussion. Everyone must join this class's Piazza (link available on Canvas). Double check that you are joining the correct Piazza!
There are multiple concurrent course sections with the same name and course number taking place, e.g., online for OMSA and OMSCS, and campus for Atlanta-based students.

The fastest way to get help with homework assignments is to post your questions on Piazza. That way, only our TAs and instructor can help, your peers can too.

If you prefer that your question addresses 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).

While we welcome everyone to share their experiences in tackling issues and helping each other out, but please do not post your answers, as that may affect the learning experience of your fellow classmates.

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?

THE WORLD OF DATA

NUMBER OF EMAILS SENT EVERY SECOND

2.9 MILLION

DATA CONSUMED BY HOUSEHOLDS EACH DAY

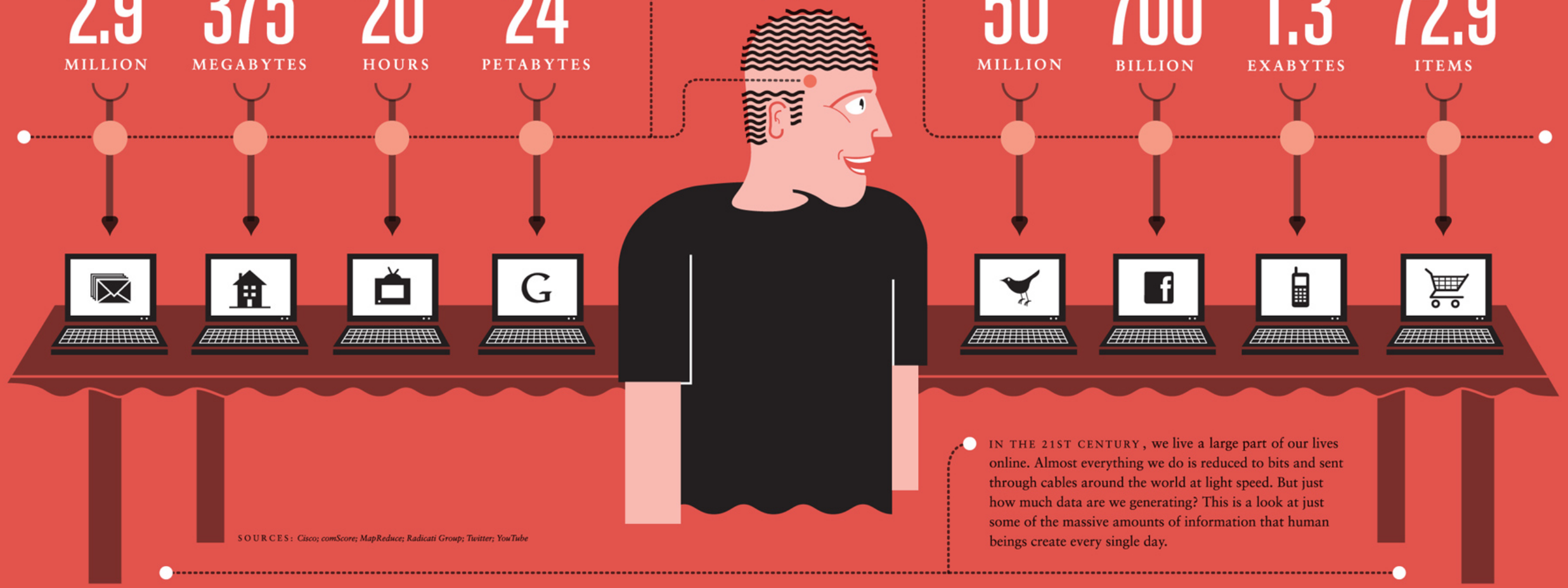
375 MEGABYTES

VIDEO UPLOADED TO YOUTUBE EVERY MINUTE

20 HOURS

DATA PER DAY PROCESSED BY GOOGLE

24 PETABYTES



TWEETS PER DAY

50 MILLION

TOTAL MINUTES SPENT ON FACEBOOK EACH MONTH

700 BILLION

DATA SENT AND RECEIVED BY MOBILE INTERNET USERS

1.3 EXABYTES

PRODUCTS ORDERED ON AMAZON PER SECOND

72.9 ITEMS

SOURCES: *Cisco; comScore; MapReduce; Radicati Group; Twitter; YouTube*

IN THE 21ST CENTURY, we live a large part of our lives online. Almost everything we do is reduced to bits and sent through cables around the world at light speed. But just how much data are we generating? This is a look at just some of the massive amounts of information that human beings create every single day.

A COLLABORATION BETWEEN GOOD AND OLIVER MUNDAY

IN PARTNERSHIP WITH IBM

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 **breadth** 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

On website; we go through them now

Grading, plagiarism, collaboration, late submission, and the **“warning”** about the difficulty this course

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

Alexandre Yahi; Antoine Chassang; Louis Raynaud; Hugo Duthil; Duen Horng (Polo) Chau
Georgia Institute of Technology
{alexandre.yahi, antoine.chassang, l.raynaud, hduthil, polo}@gatech.edu

ABSTRACT

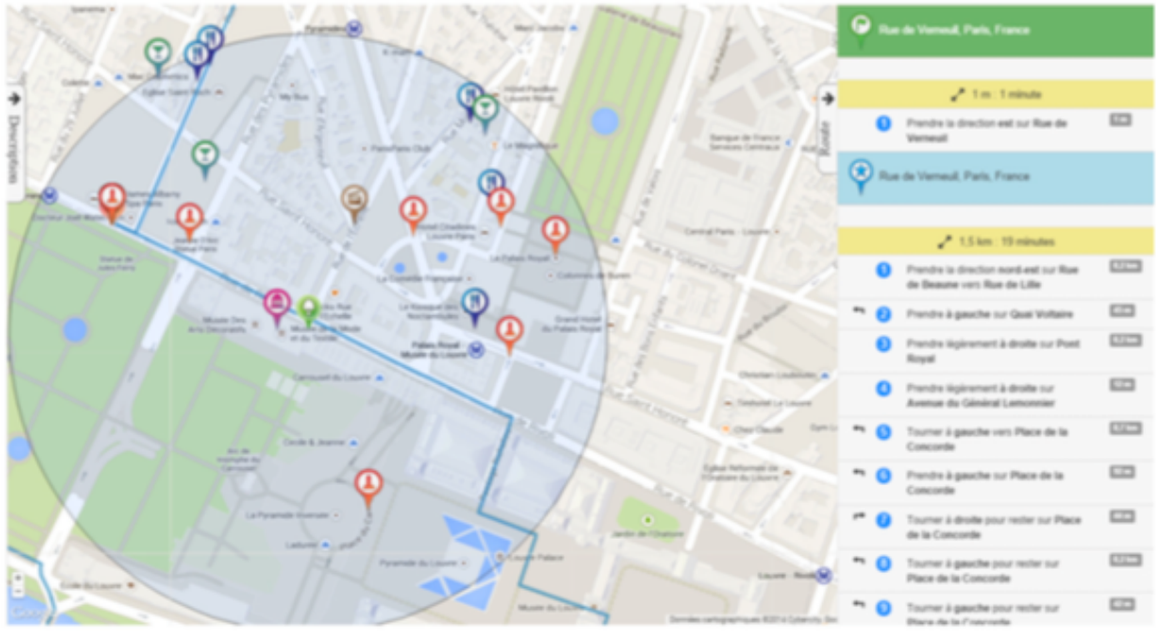
Planning personalized tour itineraries is a complex and challenging task for both humans and computers. Doing it manually is time-consuming; approaching it as an optimization problem is computationally NP hard. We present Aurigo, a tour planning system combining a recommendation algorithm with interactive 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

(e.g. HCI): User interfaces



IUI Full conference paper

ISPARK: Interactive Visual Analytics for Fire Incidents and Station Placement

Subhajit Das, Andrea McCarter, Joe Minieri, Nandita Damaraju, Sriram Padmanabhan, Duen Horng (Polo) Chau
Georgia Tech
Atlanta, GA, USA
{das, andream, jminieri, nandita, sriramp, polo}@gatech.edu

ABSTRACT

In support of helping to reduce the response time of fire-fighters, 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 coordi-ates 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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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 proble[illegible]up has developed a mobile application, PASSAG[illegible]d crime data to find "safe pat[illegible] Atlanta. [illegible] user inte[illegible]

Autho[illegible] Safe P[illegible] Pulse[illegible]

ACM[illegible] H.5.2[illegible] Use[illegible] ory[illegible]

Int[illegible] His[illegible] ho[illegible] th[illegible] [illegible] made on social media pl[illegible]

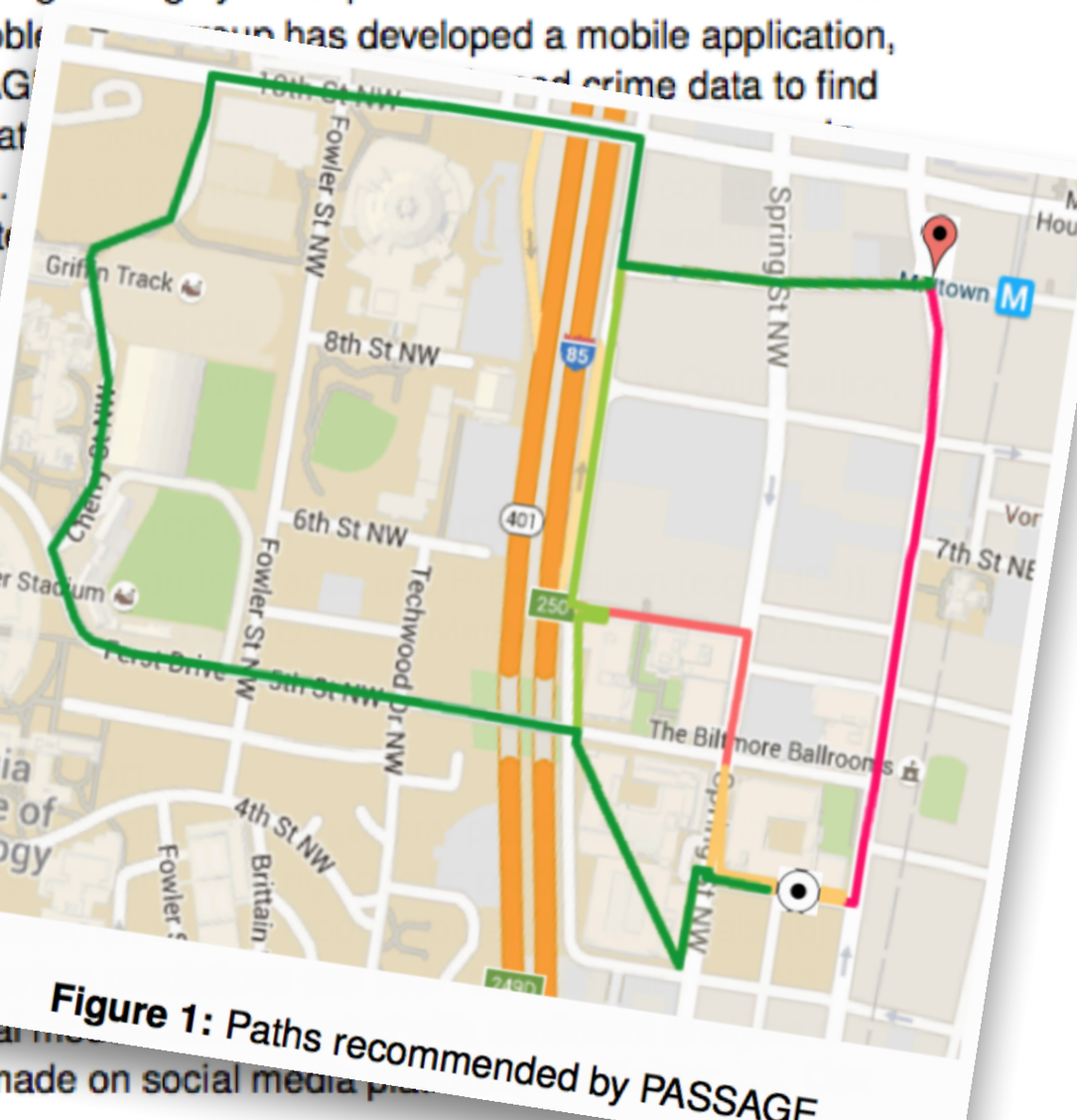

Figure 1: Paths recommended by PASSAGE

IUI Poster paper

*"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!