

NETWORKS *and* MATRIX COMPUTATIONS

CS 59000-NMC

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T-Th 10:30-11:45

CIVL 2123

Course Teaser

17 August 2011

the social network

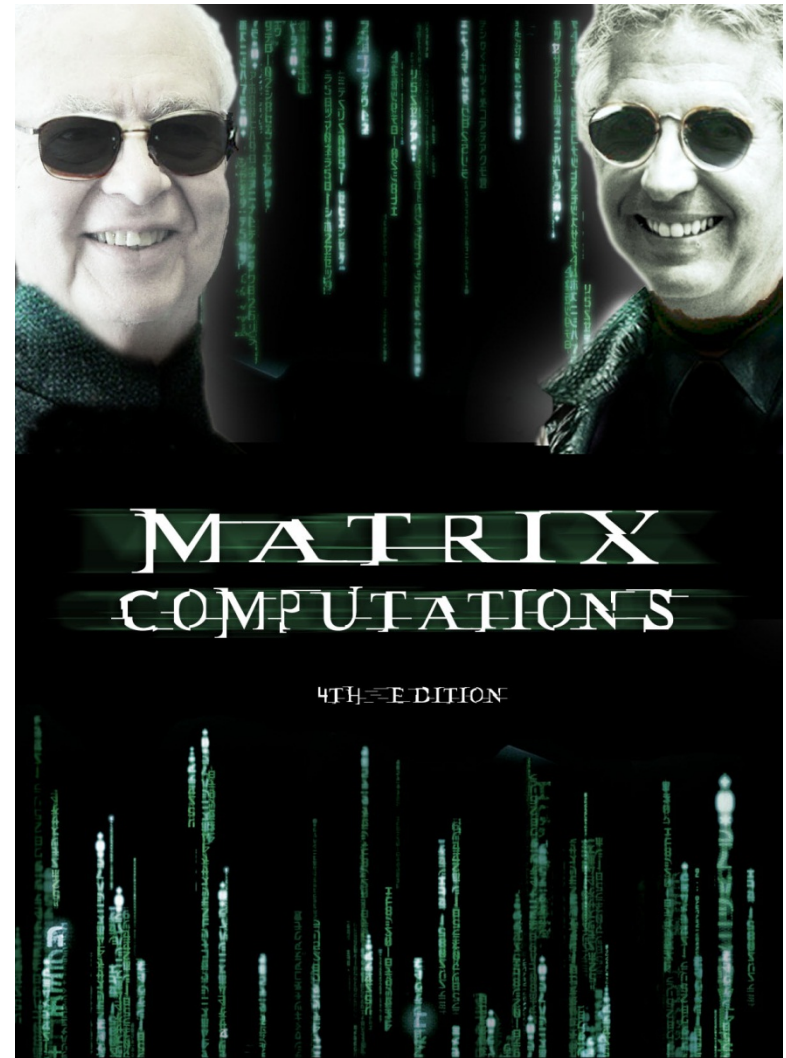
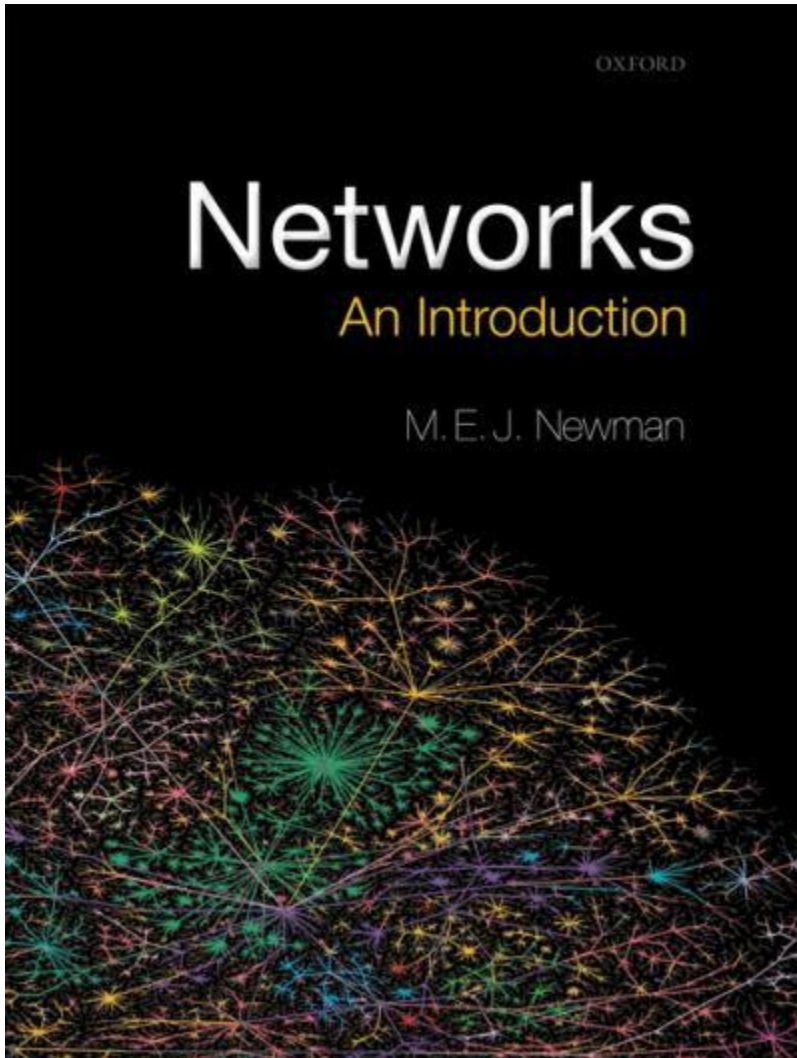


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We like books ...

Gene H. Golub

Charles van Loan



Networks cover copyright by Oxford Press

NETWORKS *and* MATRIX COMPUTATIONS

*Why looking at networks of data as a matrix
is a powerful and successful paradigm.*

Gleich's syndrome

From Wikipedia, the free encyclopedia

Gleich's syndrome or **episodic angioedema with eosinophilia** is a rare disease in which the body swells up episodically (**angioedema**), associated with raised antibodies of the **IgM** type and increased numbers of **eosinophil granulocytes**, a type of **white blood cells**, in the blood (**eosinophilia**). It was first described in 1984.^[1]

Its cause is unknown, but it is unrelated to **capillary leak syndrome** (which may cause similar swelling episodes) and **eosinophilia-myalgia syndrome** (which features eosinophilia but alternative symptoms). Moreover, it is not a form of **hypereosinophilic syndrome** as there is no evidence that it leads to organ damage. Some studies have shown that edema attacks are associated with degranulation (release of enzymes and mediators from eosinophils), and others have demonstrated **antibodies** against **endothelium** (cells lining blood vessels) in the condition.^[2]

Gleich syndrome has a good prognosis. Attack severity may improve with **steroid** treatment.^{[1][2]}

Eosinophilia

From Wikipedia, the free encyclopedia

Eosinophilia is the state of having a high concentration of **eosinophils** (**eosinophil granulocytes**) in the **blood**. The normal concentration is between 0 and 0.5×10^9 eosinophils per **litre** of blood. Eosinophilia can be *reactive* (in response to other stimuli such as allergy or infection) or *non reactive*.

The release of **interleukin 5** by **T cells**, **mast cells** and **macrophages** stimulates the production of eosinophils.

Causes

[edit]

Eosinophilia	
Classification and external resources	
ICD-10	D72.1 ↗
ICD-9	288.3 ↗
DiseasesDB	4328 ↗
eMedicine	med/685 ↗
MeSH	D004802 ↗

Diseases that feature eosinophilia:

Hypereosinophilic syndrome

From Wikipedia, the free encyclopedia

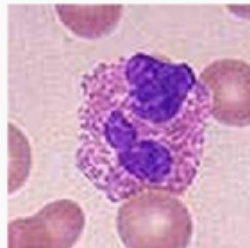
The **hypereosinophilic syndrome** (HS) is a disease characterized by a persistently elevated eosinophil count (≥ 1500 eosinophils/mm³) in the blood for at least six months without any recognizable cause, with involvement of either the **heart**, **nervous system**, or **bone marrow**.^[1]

HS is a diagnosis of exclusion, after clonal eosinophilia (such as leukemia) and reactive eosinophilia (in response to infection, autoimmune disease, atopy, hypoadrenalism or cancer) have been ruled out. ^[2]

There are some associations with **chronic**

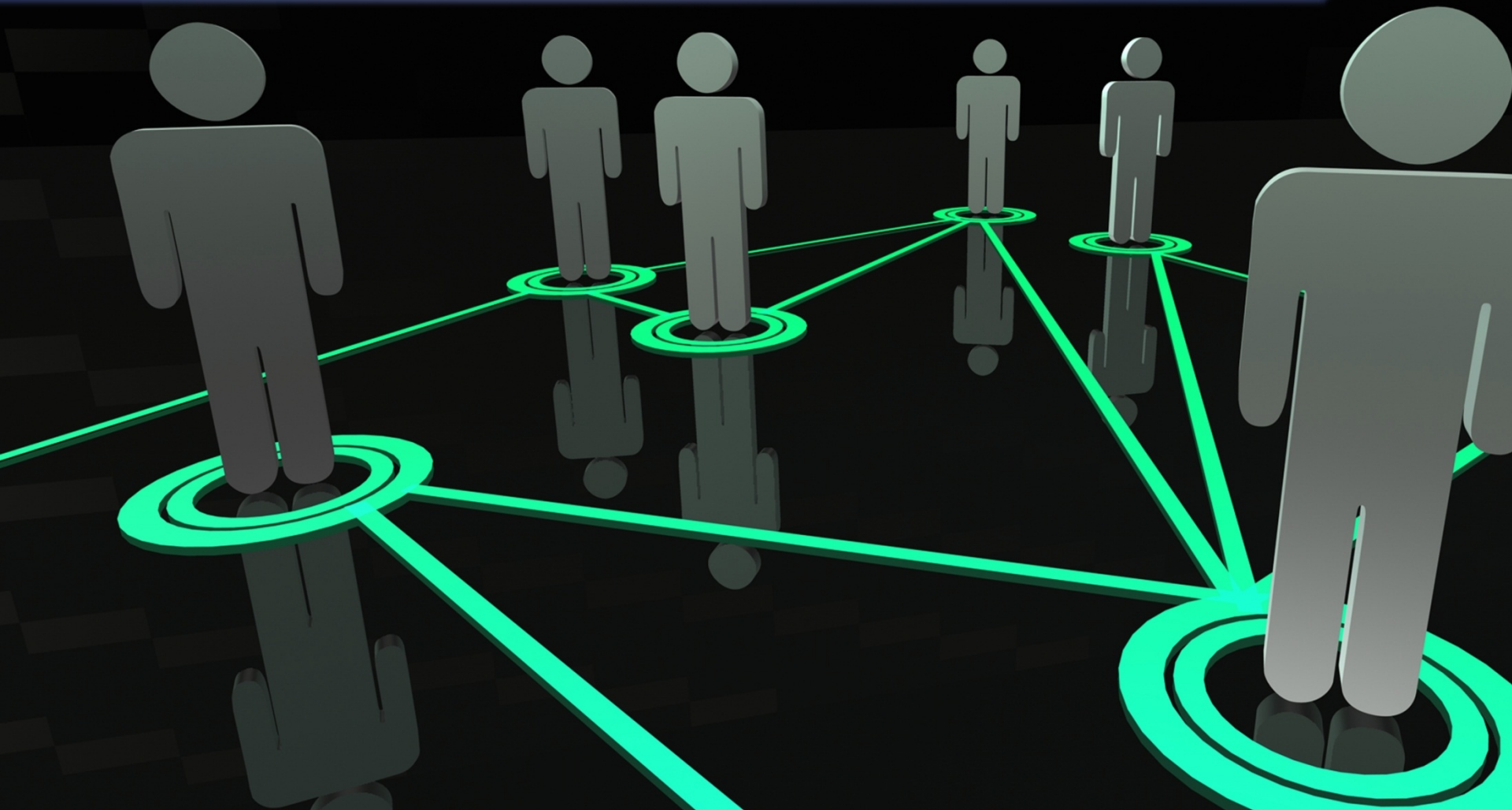
Hypereosinophilic syndrome

Classification and external resources

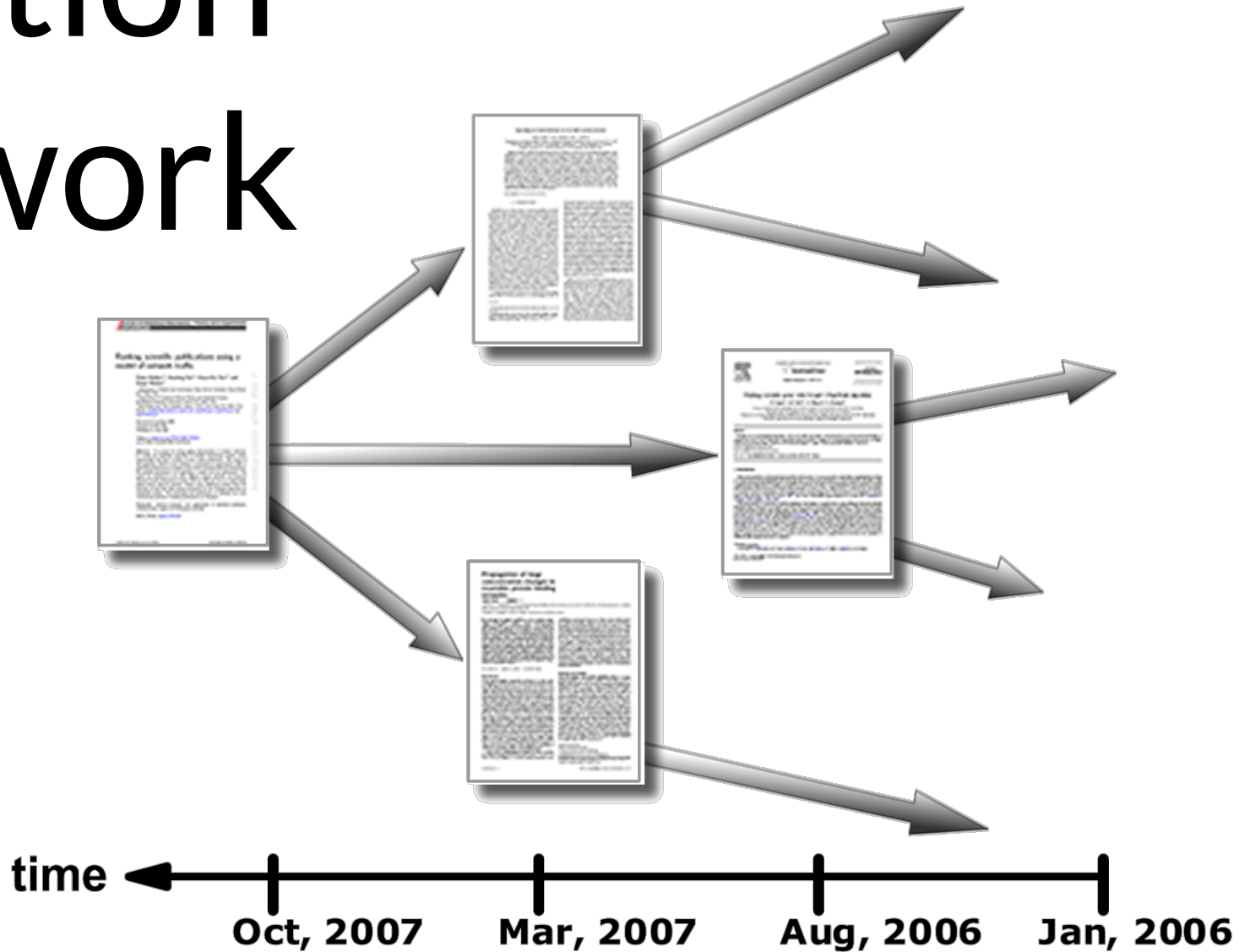


Web graph

the social network



Citation network



<Insert your favorite
network here>

TOPICS

BASICS

How to state network problems as matrix problems.

Matrices over a semi-ring and how this yields instant parallel algorithms!

Relationships with MapReduce computations.

Adjacency matrix

$$\mathbf{A} : n \times n, \mathbf{A} = \mathbf{A}^T$$

$$A_{i,j} = 1 \text{ if } (i,j) \in E$$

$$-d_{\max} \leq \lambda(\mathbf{A}) \leq d_{\max}$$

Laplacian matrix

$$\mathbf{D} = \text{diag}(\mathbf{A}\mathbf{e})$$

$$\mathbf{L} = \mathbf{D} - \mathbf{A}$$

$$0 \leq \lambda(\mathbf{L}) \leq 2d_{\max}$$

Normalized Laplacian matrix

$$\tilde{\mathbf{L}} = \mathbf{D}^{-1/2} \mathbf{L} \mathbf{D}^{-1/2} = \mathbf{I} - \mathbf{D}^{-1/2} \mathbf{A} \mathbf{D}^{-1/2}$$

$$0 \leq \lambda(\tilde{\mathbf{L}}) \leq 2$$

Random walk matrix

$$\mathbf{P} = \mathbf{D}^{-1} \mathbf{A}$$

Modularity matrix

$$\mathbf{d} = \mathbf{A}\mathbf{e}$$

$$\mathbf{M} = \mathbf{A} - 1/(2|E|)\mathbf{d}\mathbf{d}^T$$

Signless Laplacian matrix

Incidence matrix

(It is incidentally discussed)

Seidel matrix

Heat Kernel

Everything is undirected. Mostly connected components only too.

TROPICAL semi-rings



<http://www.ultimatebeachviews.com/wallpaper/Tropical-010/>

MARKOV CHAIN *theory*

Random walks on networks
Perron Frobenius theory
State space classification

How to “solve” a large linear system with a random walk.

How to “solve” Markov chain problems on compressed graphs

PAGERANK

Deep dive into one particular application. Is it a Markov chain or a linear system?

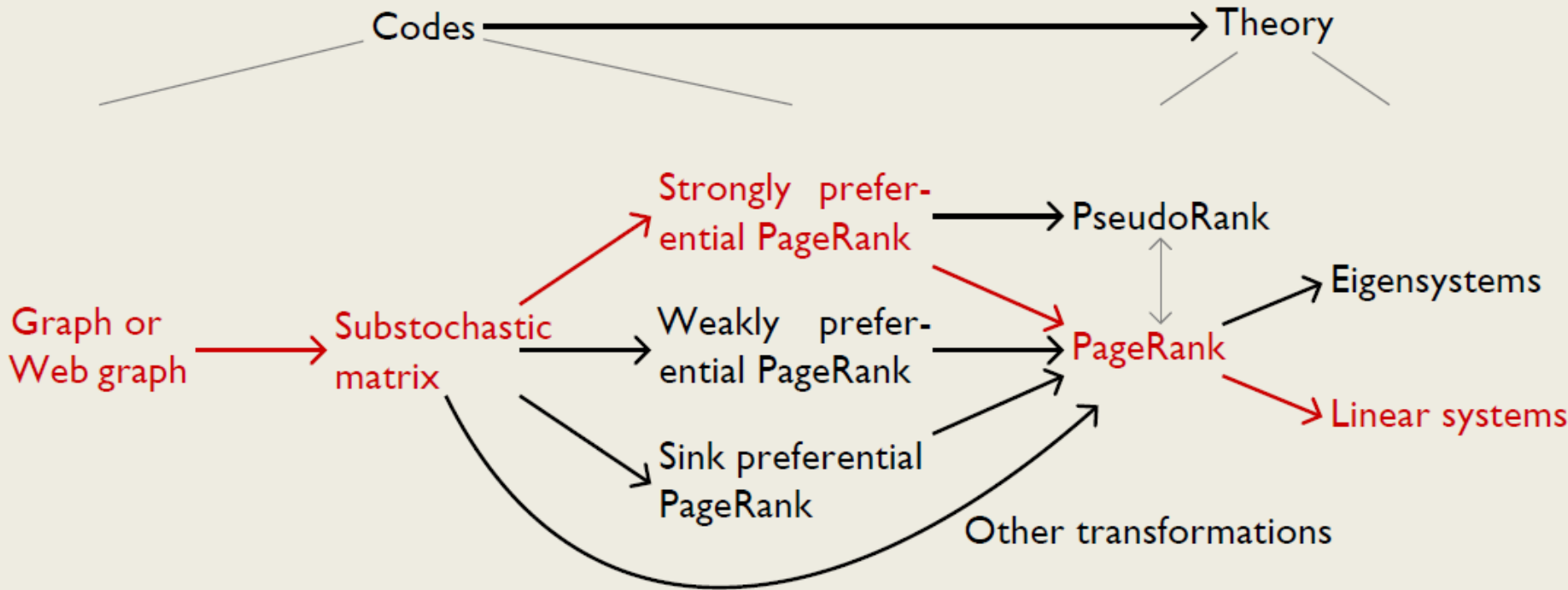
How to compute it, FAST.

How to manipulate PageRank.

Just PageRank?

SimRank
BlockRank
TrustRank
ObjectRank
HostRank
Random walk with restart
GeneRank
DiffusionRank
IsoRank
ItemRank
ProteinRank
SocialPageRank
FoodRank
FutureRank
TwitterRank

PageRank formulations and theory



- \mathbf{v} teleportation vector
- $\bar{\mathbf{P}}$ substochastic matrix (for algorithms)
- \mathbf{d} dangling node vector ($\mathbf{d} = \mathbf{e} - \mathbf{P}^T \mathbf{e}$)
- $\bar{\mathbf{P}} + \mathbf{v}\mathbf{d}^T \rightarrow \mathbf{P}$ Strongly preferential PageRank
- $\bar{\mathbf{P}} + \mathbf{u}\mathbf{d}^T \rightarrow \mathbf{P}$ Weakly preferential PageRank ($\mathbf{u} \neq \mathbf{v}$)
- \mathbf{P} PageRank stochastic matrix (for theory)
- $(\mathbf{I} - \alpha\mathbf{P})\mathbf{x} = (1 - \alpha)\mathbf{v}$ PageRank linear system

SPECTRAL GRAPH theory

The Fiedler vector, the
Laplacian matrix and
graph cuts

Semi-definite approximation
problems and properties

Local partitioning
*How to split a graph without
even seeing it all!*

QUITE A BIT MORE

Higher order graph analysis
with tensors.

Network alignment

Affine eigenvectors and
centrality

SVD graph analysis.

Matrix based graph models.

NETWORK ALIGNMENT

$$\text{maximize } \alpha \mathbf{w}^T \mathbf{x} + \frac{\beta}{2} \mathbf{x}^T \mathbf{S} \mathbf{x}$$

$$\text{subject to } \mathbf{A} \mathbf{x} \leq \mathbf{e}, x_i \in \{0, 1\}$$

History

- ▶ MAXIMUM COMMON SUBGRAPH
- ▶ PATTERN RECOGNITION
- ▶ ONTOLOGY MATCHING
- ▶ SIMILARITY FLOODING
- ▶ GRAPH SIMILARITY
- ▶ BIOINFORMATICS

Sparse problems

Sparse \mathcal{L} largely ignored (exception Klau)

Our paper tackles that case explicitly

<Insert your favorite
application/topic/area
here>

THE WORK

BIG ITEM **one**

A project.

A proposal

A paper

A presentation

BIG ITEM *two*

A lecture.

Take a paper and present it to the class using the matrix paradigm.

OR

Present a paper that uses the matrix paradigm.

OTHER WORK

Survey

Homework (2-4?)

Quizzes

Writing

Quizzes?

Taken/Missed

These are for me, not you.

QUESTIONS?

www.cs.purdue.edu/homes/dgleich/nmcomp