CS249: SPECIAL TOPICS
MINING INFORMATION/SOCIAL NETWORKS

1: Introduction

Instructor: Yizhou Sun

yzsun@cs.ucla.edu

January 8, 2017

Course Information

- Course homepage: http://web.cs.ucla.edu/~yzsun/classes/2017Winter_CS249/index.htmlClass schedule
  - Slides
  - Papers to read
  - Announcement
  - …
- Piazza: https://piazza.com/ucla/winter2017/comsci2492/home

Meeting Time and Location

- When
  - Mondays 10:00-11:50am
  - Wednesdays 10:00-11:50am
- Where
  - PAB 1749

Instructor Information

- Instructor: Yizhou Sun
  - Homepage: http://web.cs.ucla.edu/~yzsun/
  - Email: yzsun@cs.ucla.edu
  - Office: BH 3531E
  - Office hour: M/W 1:00-2:00pm

Goal of the Course

- The goal of the course is to
  - learn the most cutting-edge topics, models and algorithms in information and social network mining, and to solve real problems on real-world large-scale information/social network data using these techniques.
  - The students are expected to read and present research papers, and work on a research project related to this topic.
    - Review paper
    - Presentation skills
    - Research ability

Prerequisites

- No official prerequisites
- However, this is a research-driven seminar course
  - The students are expected to have knowledge in data structures, algorithms, basic linear algebra, and basic statistics.
  - It will be highly recommended that you have already had some background in data mining, machine learning, and related courses.

Grading

- Paper reading and presentation: 40%
  - Review 10%
  - Presentation 30%
- Research project: 50%
- Participation: 10%

Grading: Paper Presentation

- Paper Reading and Presentation (40%):
  - Everyone is asked to register 1 research topic
  - Each research topic has 1-3 papers
  - Each topic is covered by 3 students, except "Embedding 4"
  - The students in charge of the research topic need to read all the papers and discuss with each other
    - Write a review about each paper in that topic (submit it on the day of your presentation)
    - Make presentations of all the papers in that topic
    - Answer questions from the audience
    - Lead the discussion
  - The papers are given, but you can choose other papers with my consent two weeks before your presentation

More about Paper Review

- Template
  1. Summary of the paper
  2. Write pros and cons for each of the following item
     1. Problem (novel, rigorous, interesting, useful?)
     2. Solution (solid, elegant, breakthrough, reasonable, significant, limitations?)
     3. Evaluation (datasets, evaluation tasks and metrics, baselines, support claims?)
     4. Related work (adequate, well-organized?)
     5. Writing (clear, grammar free, structure reasonable, easy to follow?)
  3. Discussions.
     1. What are the take-home messages?
     2. What are the alternative solutions?
     3. What are the open questions left?
     4. Is there any future work you want to propose?

More about Presentation

- Students in the same topic need to act as a team
- Use one set of slides
- Include all the papers in the same topic into one framework (logic coherence)
  - Background/Preliminary
  - Problem 1 (motivation, problem definition, solution, evaluation)
  - Problem 2 (motivation, problem definition, solution, evaluation)
  - Conclusion and discussion items
- Please provide enough details that everyone can learn and participate in the discussion

- Sign-up for paper reading and presentation due this Wednesday (1/11).
  - A sign-up wiki page will be set up soon
- Presentation starts next Wednesday (1/18)

Grading: Research Project

- Research project: 50%
  - Group project (2-3 people for one group)
    - We now have 40 students
  - It is a research project
    - A new problem?
    - A new method?
    - Improvement of an existing method?
  - You need to
    - Form group (By Jan 18.)
    - Proposal submission (By Feb. 1)
    - Presentation and peer review (Mar. 13/15)
    - Final report (Mar. 20) (hopefully it can be turned to a conference paper submission)

Grading: Participation

- Participation (10%)
  - This is a seminar course, so everyone needs to read or browse the papers in advance and ask questions in class
  - You can also raise and answer questions online (e.g., Piazza)

A Overview of Data Mining

- By data types:
  - matrix data
  - set data
  - sequence data
  - time series
  - graph and network
- By functions:
  - Classification
  - Clustering
  - Frequent pattern mining
  - Prediction
  - Similarity search
  - Ranking

Multi-Dimensional View of Data Mining

- **Data to be mined**
  - Database data (extended-relational, object-oriented, heterogeneous, legacy), data warehouse, transactional data, stream, spatiotemporal, time-series, sequence, text and web, multi-media, graphs & social and information networks
- **Knowledge to be mined (or: Data mining functions)**
  - Characterization, discrimination, association, classification, clustering, trend/deviation, outlier analysis, etc.
  - Descriptive vs. predictive data mining
  - Multiple/integrated functions and mining at multiple levels
- **Techniques utilized**
  - Data-intensive, data warehouse (OLAP), machine learning, statistics, pattern recognition, visualization, high-performance, etc.
- **Applications adapted**
  - Retail, telecommunication, banking, fraud analysis, bio-data mining, stock market analysis, text mining, Web mining, etc.

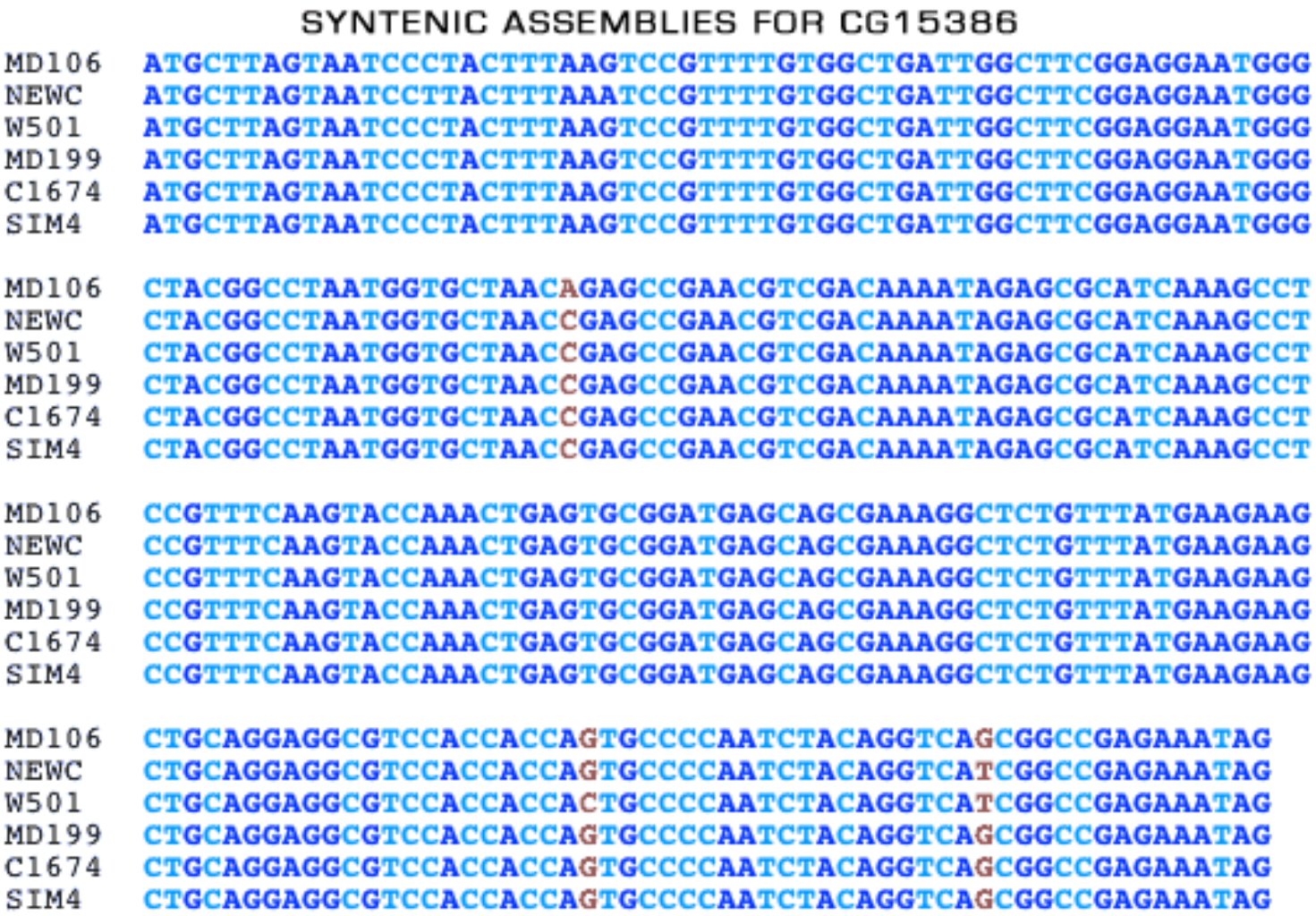
Matrix Data

	Sex	Race	Height	Income	Marital Status	Years of Educ.	Liberal-ness
R1001	M	1	70	50	1	12	1.73
R1002	M	2	72	100	2	20	4.53
R1003	F	1	55	250	1	16	2.99
R1004	M	2	65	20	2	16	1.13
R1005	F	1	60	10	3	12	3.81
R1006	M	1	68	30	1	9	4.76
R1007	F	5	66	25	2	21	2.01
R1008	F	4	61	43	1	18	1.27
R1009	M	1	69	67	1	12	3.25

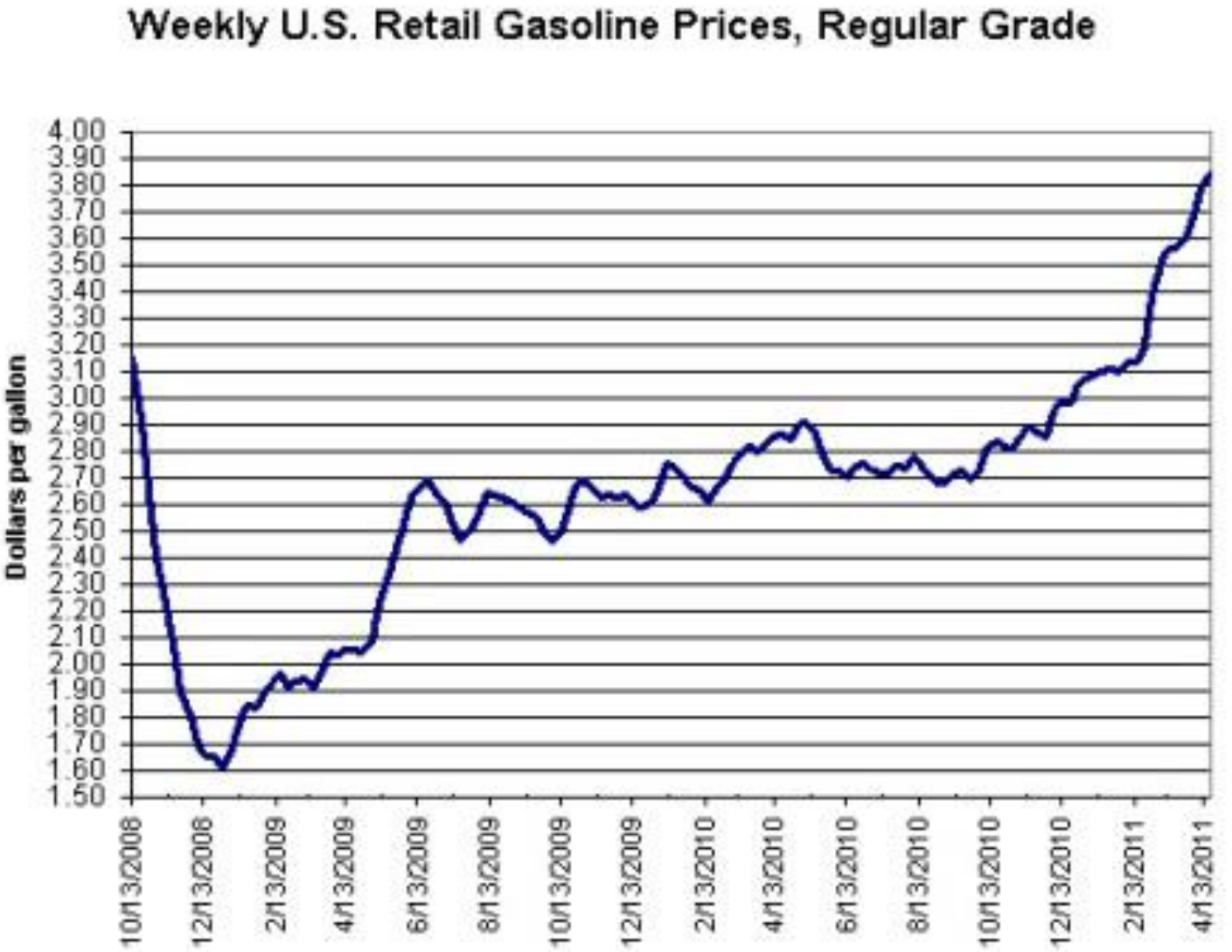
Set Data

TID	*Items*
1	Bread, Coke, Milk
2	Beer, Bread
3	Beer, Coke, Diaper, Milk
4	Beer, Bread, Diaper, Milk
5	Coke, Diaper, Milk

Sequence Data



Time Series


Weekly U.S. Retail Gasoline Prices, Regular Grade
Dollars per gallon
4.00
3.90
3.80
3.70
3.60
3.50
3.40
3.30
3.20
3.10
3.00
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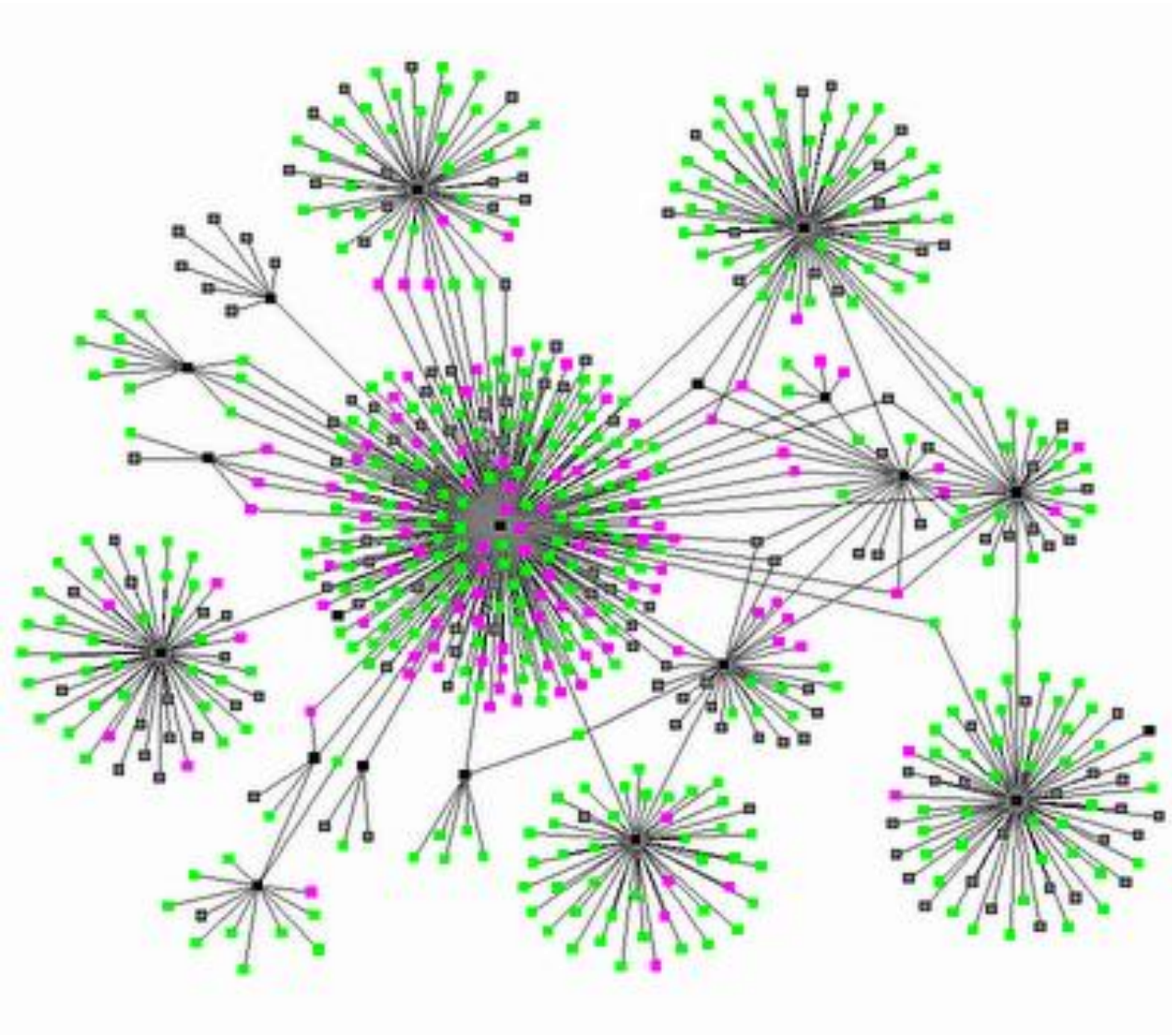
4/13/2011
Source: Energy Information Administration

Graph / Network

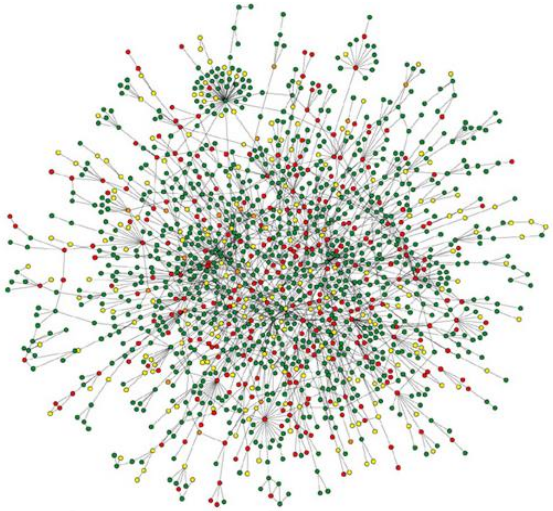


Course Overview

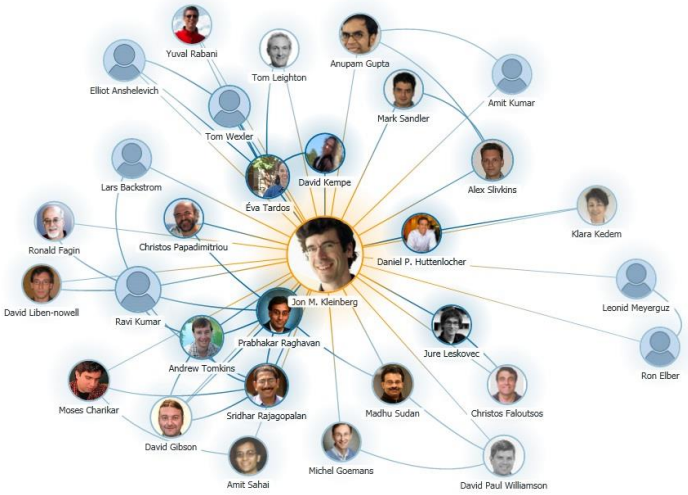
1. Introduction and Basics of Information/Social Networks (2 lectures)
2. Clustering / Community Detection (2)
3. Classification / Label Propagation (2)
4. Similarity Search (2)
5. Network Embedding (4)
6. K-Core Subgraph Decomposition and Its Applications (1)
7. Diffusion and Influence Maximization (1)
8. Recommendation (1)

Information Networks Are Everywhere

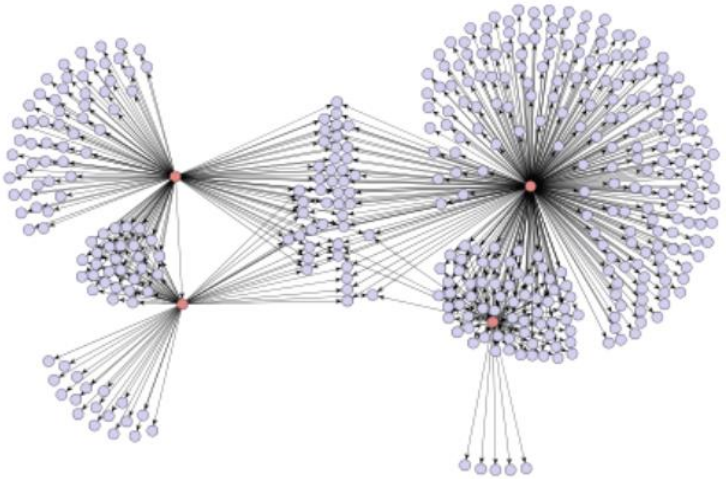
Social Networking Websites



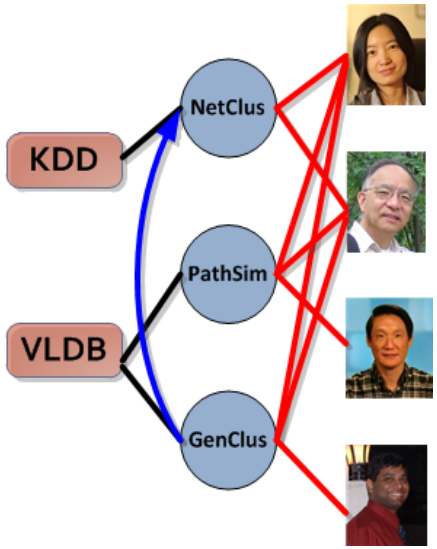
Biological Network: Protein Interaction



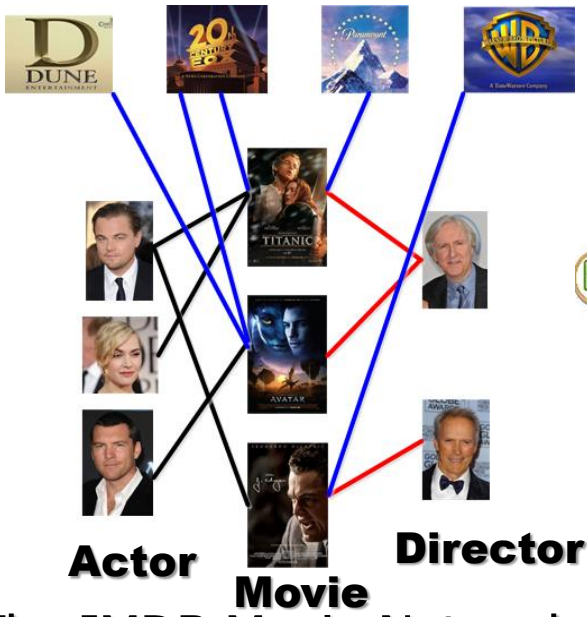
Research Collaboration Network



Product Recommendation Network via Emails



DBLP Bibliographic Network



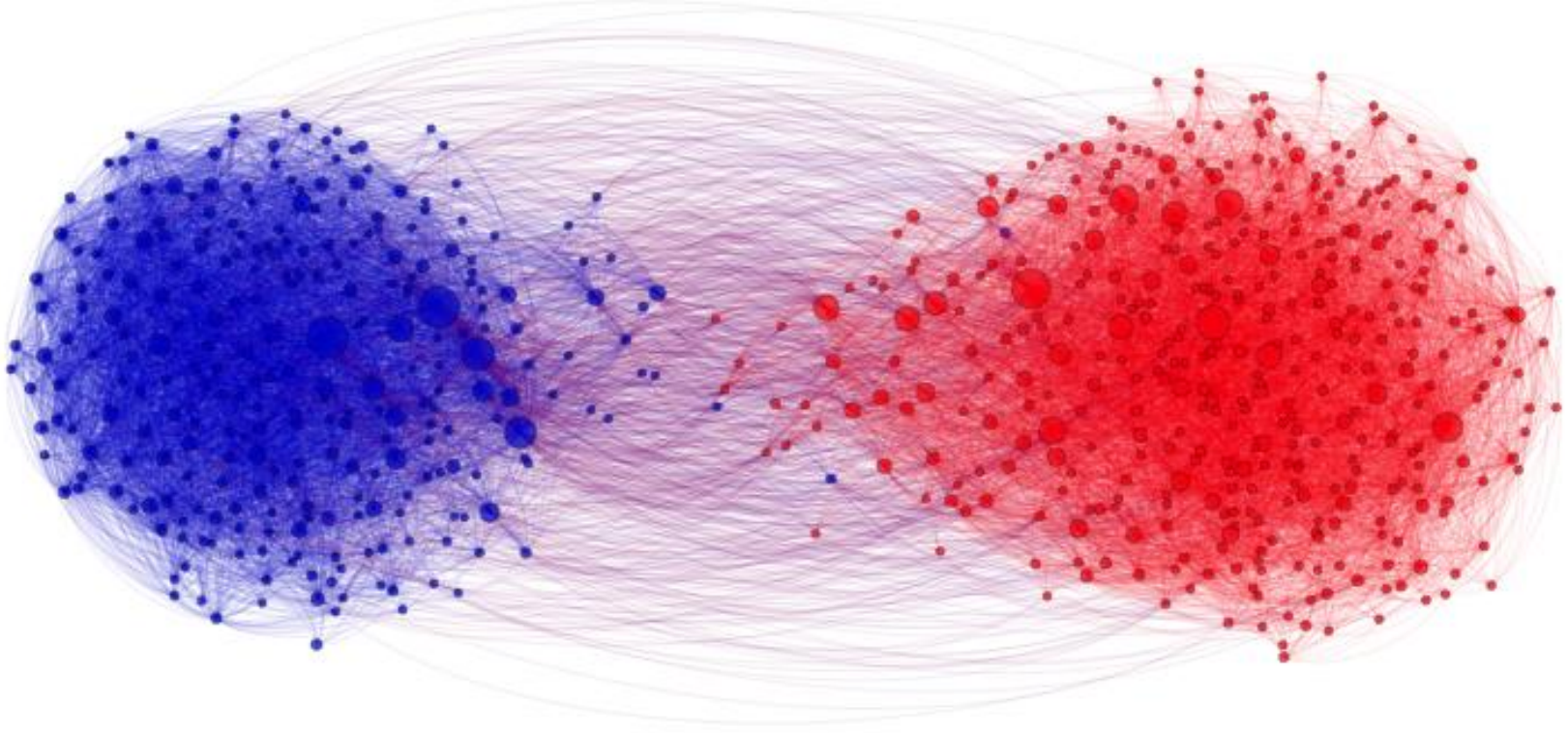
The IMDB Movie Network

The Facebook Network

Some Concepts

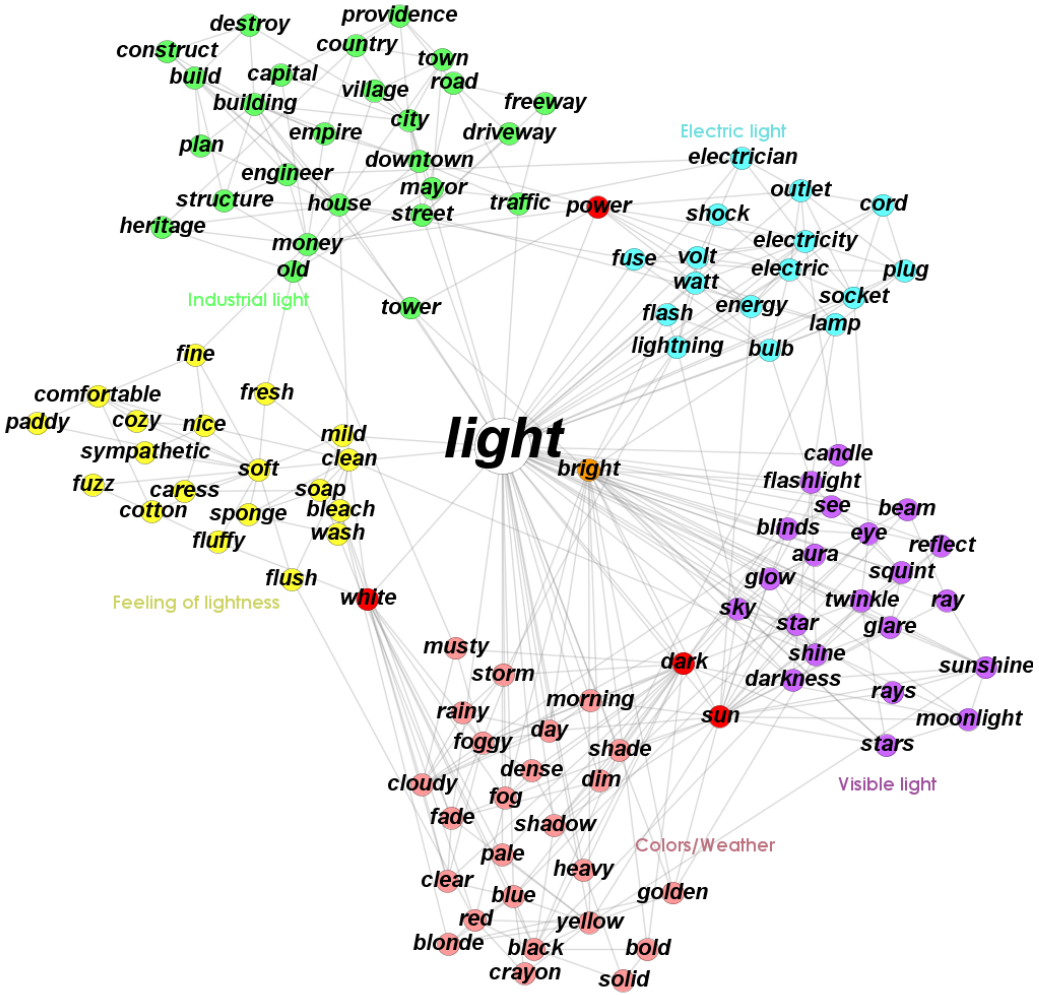
- Graph
- Social Network
- Information Network

Clustering / Community Detection



Dataset: political blog network by Lada Adamic
Source: http://allthingsgraphed.com/2014/10/09/visualizing-political-polarization/

- Source: http://snap.stanford.edu/agm/

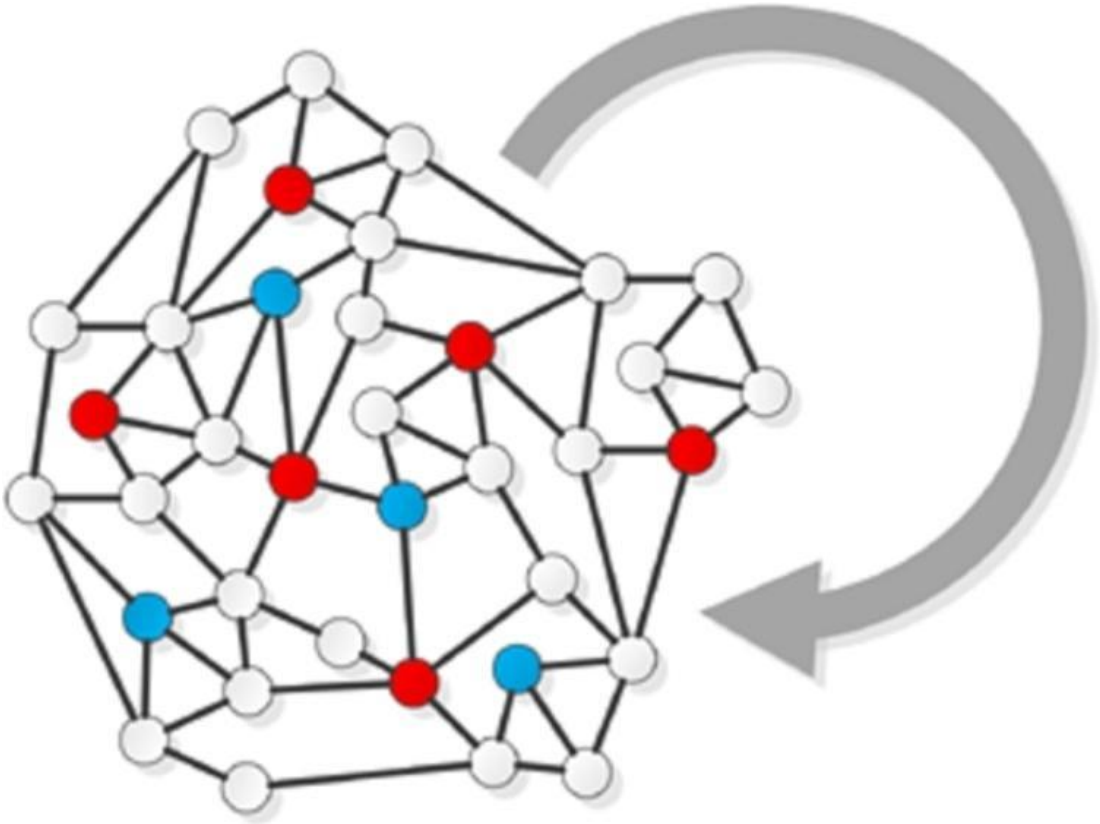


Papers

- Clustering 1
  - Modularity and community structure in networks. (PNAS'06)
  - Fast algorithm for detecting community structure in networks (arxiv'03)
- Clustering 2
  - Spectral methods for network community detection and graph partitioning (arxiv'13)

Classification / Label Propagation

- Source: http://content.iospress.com/articles/ai-communications/aic686



Papers

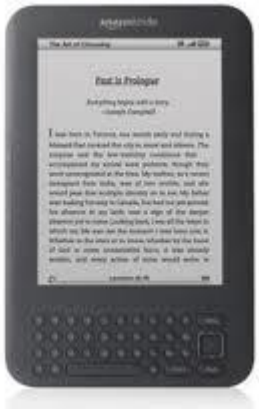
- Classification 1
  - Semi-supervised learning using gaussian fields and harmonic functions. (ICML'03)
  - Graph Regularized Transductive Classification on Heterogeneous Information Networks (ECMLPKDD'10)
- Classification 2
  - Hinge-loss Markov Random Fields: Convex Inference for Structured Prediction (UAI'13)

Similarity Search

- DBLP
  - Who are most similar to "Judea Pearl"?

- IMDB
  - Which movies are most similar to "Little Miss Sunshine"?

- E-Commerce
  - Which products are most similar to "Kindle"?

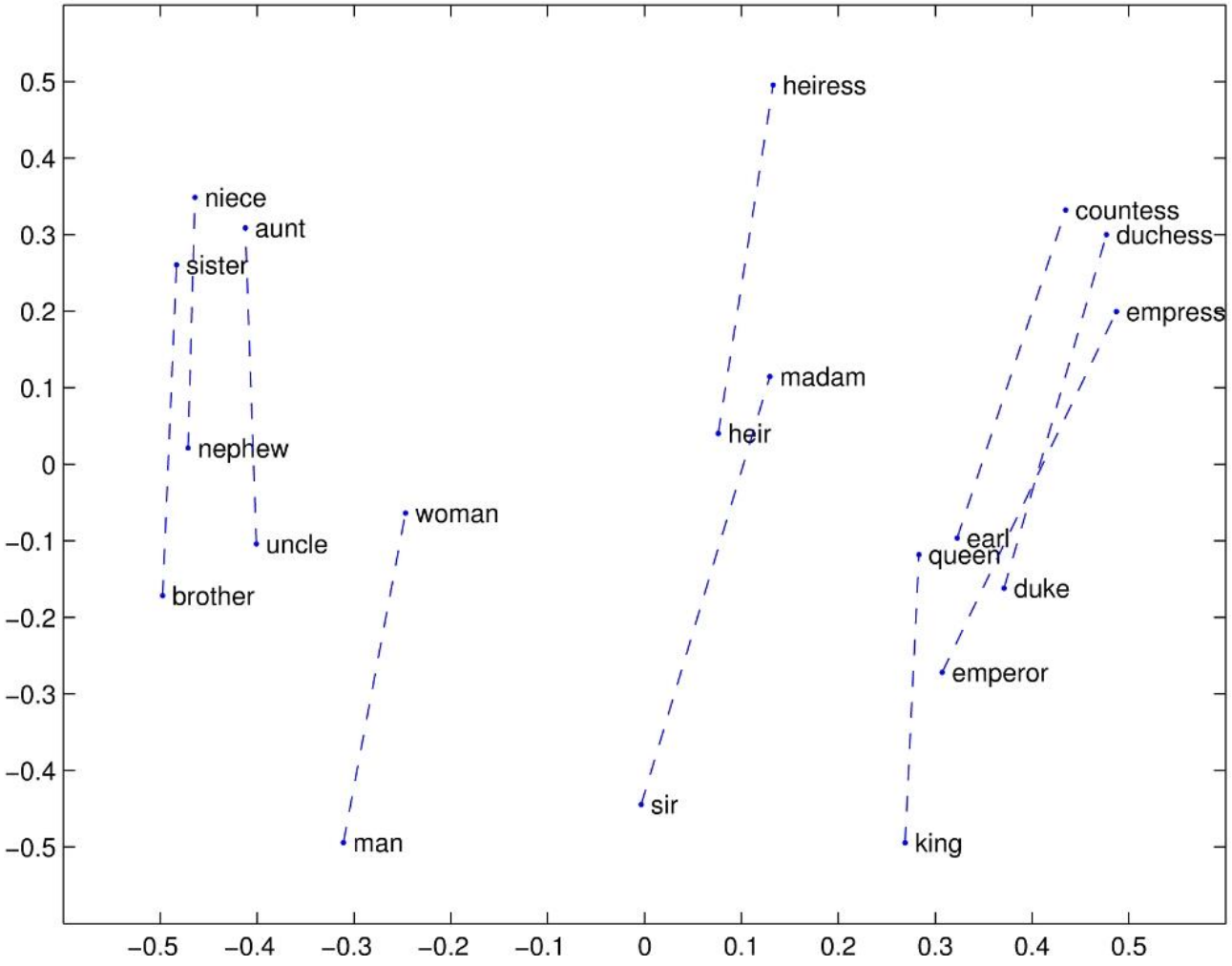


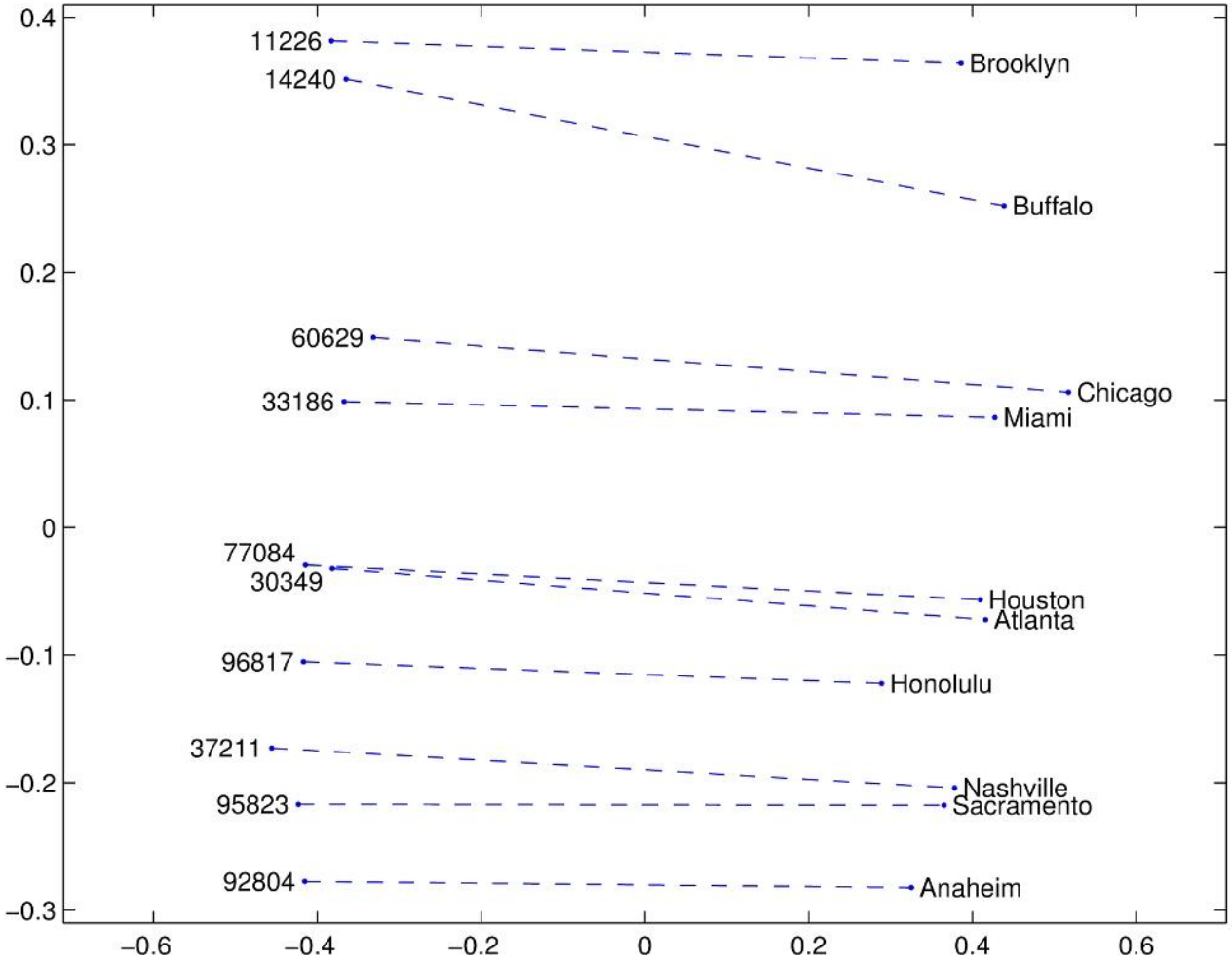
Papers

- Similarity Search 1
  - SimRank: a measure of structural-context similarity (KDD'02)
  - Fast Single-Pair SimRank Computation (SDM'10)
- Similarity Search 2
  - (PathSim) "*PathSim: Meta Path-Based Top-K Similarity Search in Heterogeneous Information Networks*" (VLDB'11)
  - Discovering Meta-Paths in Large Heterogeneous Information Networks (WWW'15)

Embedding

- Source: nlp.stanford.edu/projects/glove/




11226
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Miami
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30349
Houston
Atlanta
96817
Honolulu
37211
Nashville
95823
Sacramento
92804
Anaheim
0.4
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0.1
0
−0.1
−0.2
−0.3
−0.6
−0.4
−0.2
0
0.2
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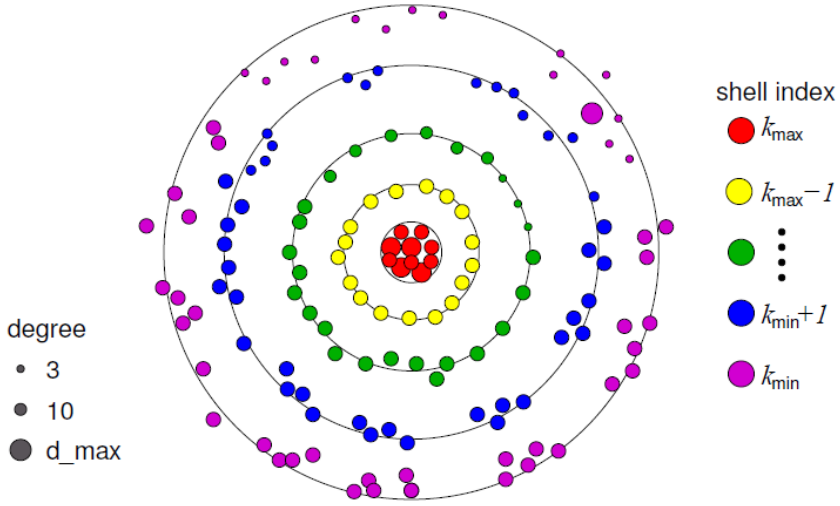
0.6

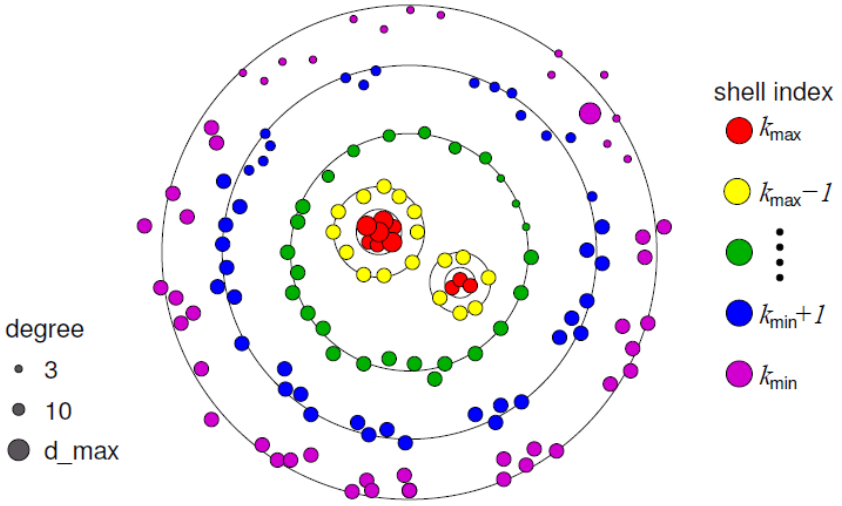
Papers

- Embedding 1
  - (Word2Vec) Distributed Representations of Words and Phrases and their Compositionality (NIPS'13)
  - (DeepWalk) DeepWalk: Online Learning of Social Representations (KDD'14)
- Embedding 2
  - GloVe: Global Vectors forWord Representation (EMNLP'14)
  - Node2Vec: node2vec: Scalable Feature Learning for Networks (KDD'16)
- Embedding 3
  - (LINE) LINE: Large-scale Information Network Embedding. (WWW'15)
  - (PTE) PTE: Predictive Text Embedding through Large-scale Heterogeneous Text Networks. (KDD'15)
- Embedding 4
  - (TransE) Translating Embeddings for Modeling Multi-relational Data. (NIPS'13)
  - (TransH) Knowledge Graph Embedding by Translating on Hyperplanes. (AAAI'14)
  - (TransR) Learning Entity and Relation Embeddings for Knowledge Graph Completion. (AAAI'15)

K-Core Decomposition

- Source: Large scale networks fingerprinting and visualization using the k-core decomposition (NIPS'05)





Papers

- Large scale networks fingerprinting and visualization using the k-core decomposition (NIPS'05)
- CoreScope: Graph Mining Using k-Core Analysis (ICDM'16)

Diffusion / Influence maximization

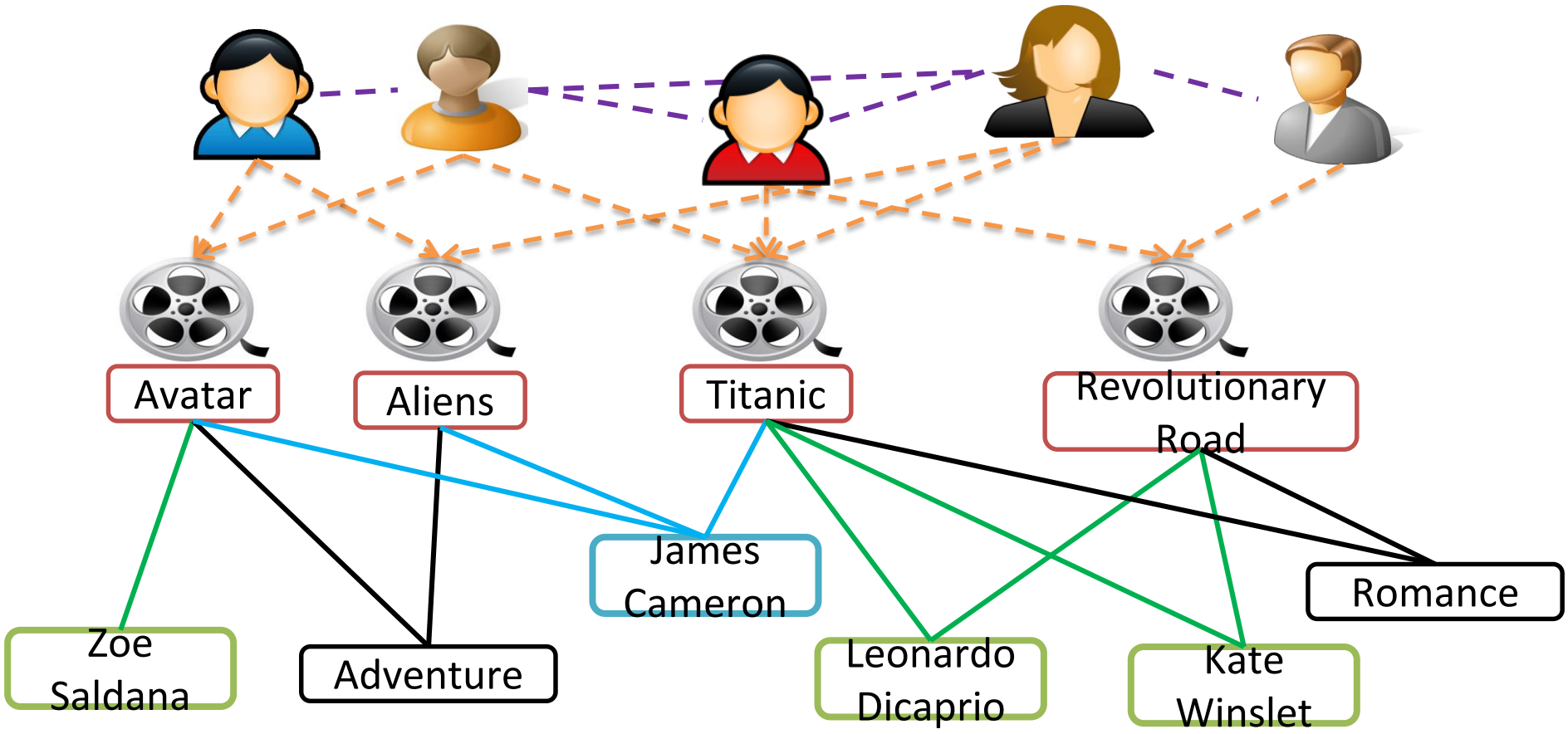
- Source: http://richardkim.me/influencemaximization/

Papers

- Maximizing the Spread of Influence through a Social Network (KDD'03)
- Efficient Influence Maximization in Social Networks (KDD'09)

Recommendation

- E.g., Movie recommendation



Papers

- M. Jamali and M. Ester. A matrix factorization technique with trust propagation for recommendation in social networks. (KDD'10)
- Personalized Entity Recommendation: A Heterogeneous Information Network Approach (WSDM'14)