Social Media Analytics

Community Detection
Bi-partite Networks
Cliques and cores

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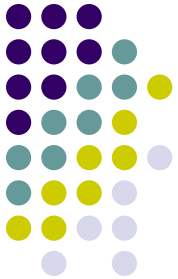
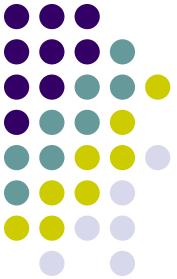
Community Detection: Why Bother?

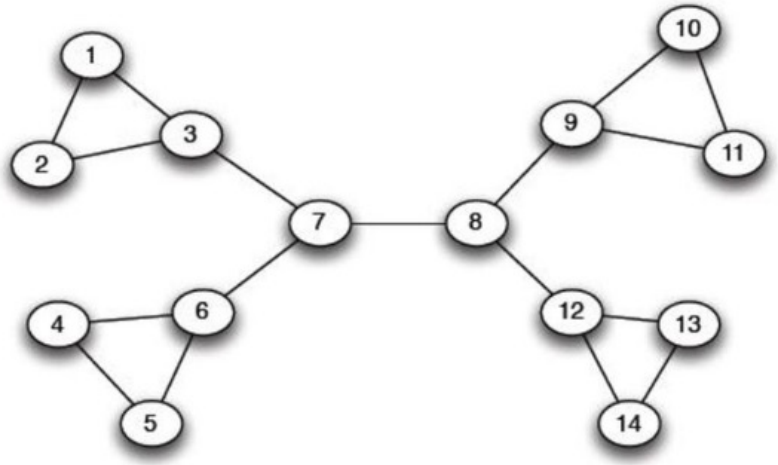


- Detecting networks of fraudulent/rogue websites
  - Many use JavaScript redirects to link to each other to avoid detection through scraping
- Estimating unknown features of users in social networks
- Clustering similar users together
  - Enhance meaningful communication
- Can be a network of products
  - E.g., to show the effect of recommender systems on competition
  - Show that a "community" has products from very different parts of the demand curve
  - https://joshbarua2002.medium.com/who-is-your-competitor-in-the-era-of-the-long-tail-d0ac24fedde8

How to Detect Communities Within Networks



- Common for uni-partite (1-mode) networks
- Girvan-Newman algorithm (divisive algorithm)
- Calculate betweenness centrality of "links"
- How?



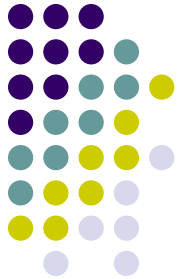
Betweenness(7, 8)= 7x7 = 49

Betweenness(1, 3) = 1X12=12

Betweenness(3, 7) = Betweenness(6, 7) =
Betweenness(8, 9) = Betweenness(8, 12)= 3X11=33

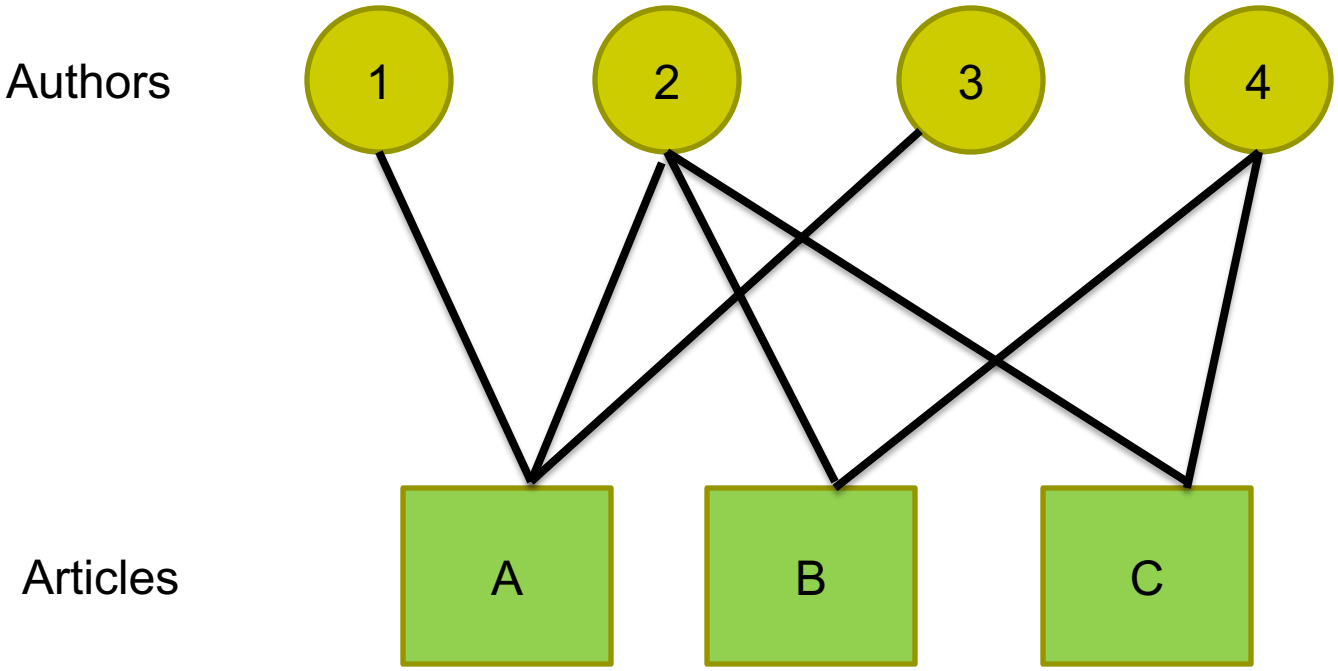
- (i) Cut the link with highest betweenness centrality
- (ii) Recalculate betweenness for all remaining links
- (iii) Cut the link with highest betweenness
- (iv) Repeat (ii) and (iii) until the network disintegrates into disjoint parts
- Excellent article: https://www.analyticsvidhya.com/blog/2020/04/community-detection-graphs-networks/

Types of Networks



- Uni-partite, bi-partite, tri-partite (or multi-partite) networks
- Also called 1-mode, 2-mode, etc.
- Uni-partite: Only one type of nodes (e.g., people)
- Bi-partite: E.g., authors & articles, actors & movies, FB users and their group memberships, etc.

Bi-partite Networks: An Example



No connections between nodes of the same type

Can we reduce this network to 1-mode? How?

2-mode to 1-mode Networks

- 2-mode: Congress(wo)man & age
- How to reduce to 1-mode (person-to-person)?

	Coble	Franks	Goodlatt	Hartzler	McGove	Nadler	Pingree	Polis	Roby	Waters
Coble	0	26	21	29	28	16	24	44	45	7
Franks	26	0	5	3	2	10	2	18	19	19
Goodlatte	21	5	0	8	7	5	3	23	24	14
Hartzler	29	3	8	0	1	13	5	15	16	22
McGovern	28	2	7	1	0	12	4	16	17	21
Nadler	16	10	5	13	12	0	8	28	29	9
Pingree	24	2	3	5	4	8	0	20	21	17
Polis	44	18	23	15	16	28	20	0	1	37
Roby	45	19	24	16	17	29	21	1	0	38
Waters	7	19	14	22	21	9	17	37	38	0

Source: http://www.umasocialmedia.com/socialnetworks/networks-lecture-13-qap-correlation/

Gender & Committees

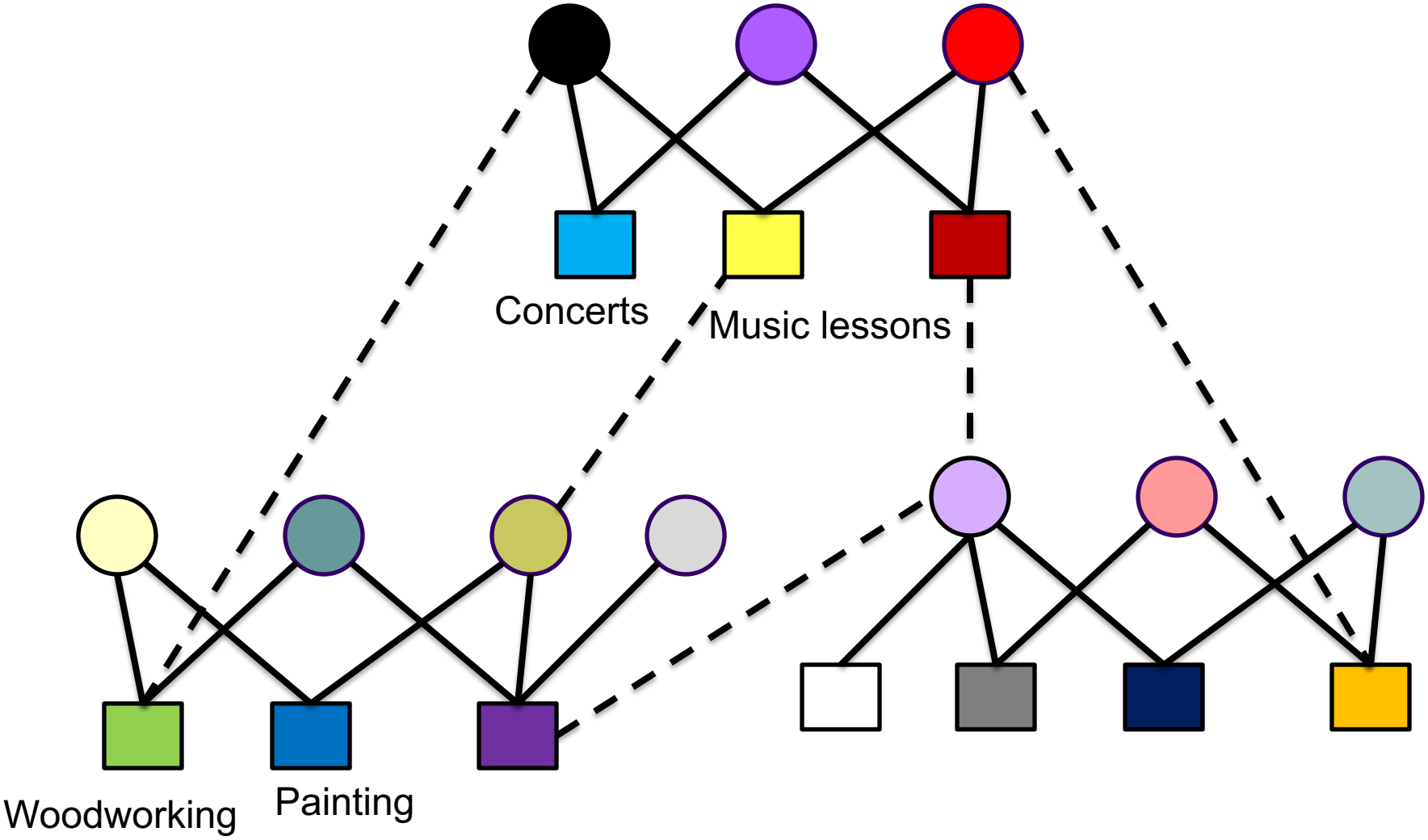
	Coble	Franks	Goodlatt	Hartzler	McGove	Nadler	Pingree	Polis	Roby	Waters
Coble	1	1	1	0	1	1	0	1	0	0
Franks	1	1	1	0	1	1	0	1	0	0
Goodlatte	1	1	1	0	1	1	0	1	0	0
Hartzler	0	0	0	1	0	0	1	0	1	1
McGovern	1	1	1	0	1	1	0	1	0	0
Nadler	1	1	1	0	1	1	0	1	0	0
Pingree	0	0	0	1	0	0	1	0	1	1
Polis	1	1	1	0	1	1	0	1	0	0
Roby	0	0	0	1	0	0	1	0	1	1
Waters	0	0	0	1	0	0	1	0	1	1

	Coble	Franks	Goodlatt	Hartzler	McGove	Nadler	Pingree	Polis	Roby	Waters
Coble	1	1	1	0	0	1	0	1	0	1
Franks	1	2	2	1	0	1	1	1	1	1
Goodlatte	1	2	2	1	0	1	1	1	1	1
Hartzler	0	1	1	2	1	0	2	0	2	0
McGovern	0	0	0	1	2	0	1	1	1	0
Nadler	1	1	1	0	0	1	0	1	0	1
Pingree	0	1	1	2	1	0	2	0	2	0
Polis	1	1	1	0	1	1	0	2	0	1
Roby	0	1	1	2	1	0	2	0	2	0
Waters	1	1	1	0	0	1	0	1	0	1

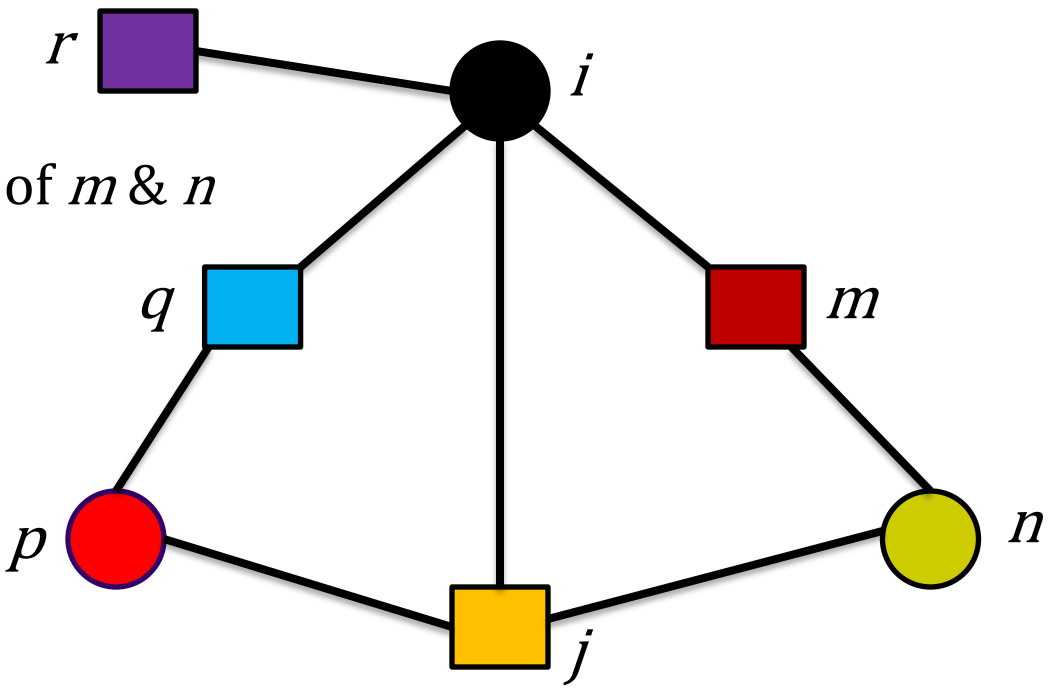
Source: http://www.umasocialmedia.com/socialnetworks/networks-lecture-13-qap-correlation/

Communities in Bi-partite Networks

- Densely linked parts of a bi-partite network constitute communities
- E.g., people's memberships in a set of activities



Detecting Communities in Bi-partite Networks



k_m & k_n degrees of m & n

For a pair of nodes, *i* and *j*, let *m* and *n* be neighbors of *i* and *j* respectively

q_{ijmn} = 1 if *m* and *n* are connected, 0 otherwise. θ_{ijmn} has the opposite definition.

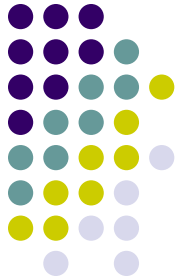
Edge clustering coefficient $C(i,j) =$

squares that currently include *i-j* / possible # squares that include *i-j*

$$\frac{\sum_{m=1}^{k_i}\sum_{n=1}^{k_j} q_{ijmn}}{\sum_{m=1}^{k_i}\sum_{n=1}^{k_j} \theta_{ijmn} + \sum_{m=1}^{k_i}(k_m - 1) + \sum_{n=1}^{k_j}(k_n - 1) - \sum_{m=1}^{k_i}\sum_{n=1}^{k_j} q_{ijmn}}$$

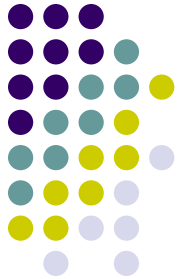
Source: P. Zhang et al. 2013

Detecting Communities in Bi-Partite Networks



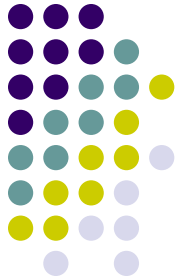
- Start dropping links with smallest clustering coefficient
- Network will start splitting up
- But much easier to first divide into two 1-mode networks
- The apply G-N or other algorithms to detect communities within 1-mode networks
- We do lose some information
- Example: https://medium.com/@adibarua2002/creating-smarter-online-communities-with-nlp-and-network-analytics-147810d3cee5?source=friends_link&sk=d7f5809dfa0e7cc774448615e9287de5

Sample Project on Bi-Partite Networks



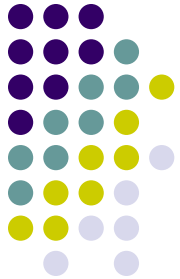
- Readers and books
- How to create a manageable network
- Compare recommendations based on
  - Book-to-book similarity (uni-partite)
  - Person-to-person and then recommending books that similar readers have read but not the focal reader.
- Does the second method provide more variety?

Identifying Trolls, Spammers and Fake Content Creators



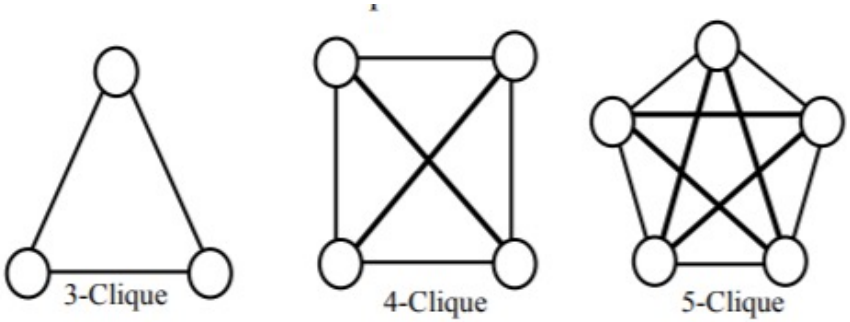
- Trolls, spammers, bots
- Creators of fake content
- Is there anything common across them?
- Was not too difficult to detect fake content (e.g., reviews) from content in the past
- Why is it difficult to detect now?
- Network analytics may help

They Come in Many Flavors



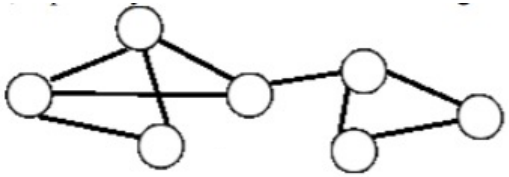
- ~ 19 million bot accounts tweeted in support of either Trump or Clinton in 2016
- > 1,000 paid Russian trolls spread “fake news” on Hillary Clinton
- CNN mobile app received 100s of thousands of 1-star reviews after the network’s treatment of a certain Reddit user
- The Boca Raton Resort hotel got a huge number of negative reviews (1000s) after a Youtube star angry at his treatment rallied his fanbase to retaliate online
- **<u>But may be more connected than regular users!</u>**

Of “Cliques” and “Cores”



- Definition of an n-clique?
- What is the significance of a clique?
- A large network will consist of many cliques
- Often the largest clique is of interest

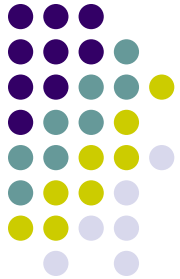
K-core



A 2-core

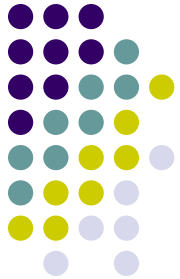
- Definition of a k-core?
- What is the significance?
- Largest k for a network is of special interest

Hypotheses (Can be Tested)



- Spammers have larger k-cores than non-spammers
- Spammers have larger n-cliques than non-spammers
- Spammers have higher network density

Calculating Cliques and k-cores



- Lots of python code available on GitHub and other sites
- https://www.kaggle.com/mayeesha/network-analysis-for-dummies-stackoverflow-data
- https://s3.amazonaws.com/assets.datacamp.com/production/course_3286/slides/ch3_slides.pdf
- https://towardsdatascience.com/intro-to-graphs-in-python-using-networkx-cfc84d1df31f
- Maximum value of k in k-cores within a network
  - https://github.com/chibuta/k-core-subgraph

Data Issues

- If collecting primary data
  - Twitter → Find out important hashtags (e.g., anti- vs. pro-vaxxer, anti-climate change vs. pro)

Stance	Hashtags
Pro-vaccination	*VaccinesSaveLives, VaccinesWork, WorldImmunizationWeek, VaxWithMe, HealthForAll, WiW, ThankYouLaura*
Anti-vaccination	*LearnTheRisk, VaccineInjury, VaccineDeath, VaccineDamage, VaccinesCauseAutism, CDCFraud, CDCWhistleBlower, CDCTruth, WakeUpAmerica, HearUs, HealthFreedom*
Unidentified	*Vaccine, Vaccines, Vaccinate, VaccinateUS*

  - Other sources (like discussion forum): Separate source and target during scraping.
    - E.g., creator of an original post in one column
    - Person (or people) commenting in another column
- Many useful sources of archived network data
  - https://github.com/benedekrozemberczki/datasets
  - Other sources on GitHub, some on Kaggle