# Amazon Referral Network

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# Problem Statement

- Collect data for books from www.amazon.com
  - For each book, data includes :
    - Title
    - Authors
    - Ratings
    - List of books bought together
- Analyze the properties of network of books derived from data
  - Network has
    - Nodes : Books
    - Edges : Relations such as
      - same author
      - bought together

# Questions to be answered

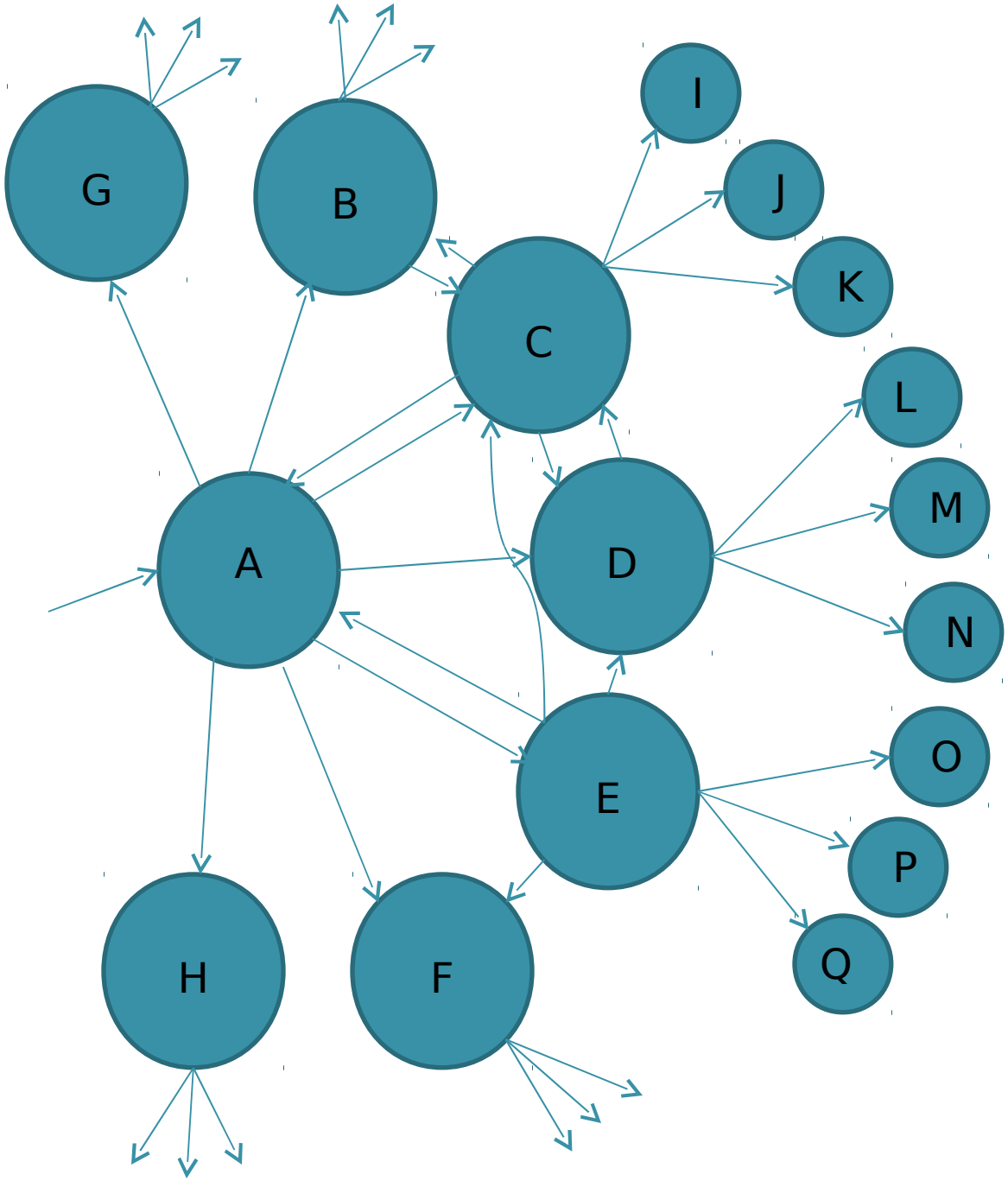
- Will a book likely to be popular if any one of its author is popular?
- Books co-authored by popular authors are likely to be more popular than books written by a single popular author?
- For co-author network and co-customer network, discuss:
  - Degree Distribution
  - Clustering Co-efficient
  - Assortativity

# Network Topology

- Each book recommends 7 other books bought by the same customers.
- Each other books recommend a set of 7 books themselves. The process repeats.
- Multiple instances of the same book being encountered.
- Book already exists – Discard
- Book doesn’t exist in the graph - Add

# Network Topology(contd..)

- Edges between books with a common feature.
- In this case, feature refers to
  - a same author (or)
  - a recommendation of one book on another's page.
- An example looks like,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B
I
J
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C
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M
A
D
N
E
O
P
H
F
Q

# Will a book likely to be popular if any one of its author is popular?

- r = #(popular books with popular authors) / #(popular books)

| Rating Threshold for popularity (out of 5) | Ratio (r) |
|---|---|
| 3.5 | 0.992 |
| 4.0 | 0.948 |
| 4.5 | 0.870 |
| 4.7 | 0.784 |
| 4.8 | 0.768 |

**From the above data, it can be concluded that as there are many books which are highly popular and yet do not have an already popular author.**

# Books co-authored by popular authors are likely to be more popular than books written by a single popular author?

- r1 = #(popular books by multiple popular authors) /#(books by multiple popular authors)
- r2 = #(popular books by single popular author) /#(books by single popular author)

| Rating Threshold for popularity | Multiple Popular Authors (r1) | Single Popular Author (r2) | Difference \|(r1-r2)\| |
|---|---|---|---|
| 4.0 | 0.968 | 0.881 | 0.087 |
| 4.5 | 0.935 | 0.801 | 0.134 |
| 4.7 | 0.957 | 0.893 | 0.064 |
| 4.8 | 0.902 | 0.920 | 0.018 |

- An interesting observation
  - The difference between the two ratios rises a bit and falls.
  - From the observation it can be concluded that
    - Books with less ratings need multiple authors to get popular.
    - Books with very high ratings have no such constraint.
    - Hence, for books of high ratings, it doesn’t matter that they have a single author or multiple authors.

# Analysis of the book popularity given a single popular author vs. many less-popular authors

- r1 = #(popular books by single popular author) /#(books by single popular author)
- r2 = #(popular books by multiple less-popular author) / #(books by multiple less-popular author)

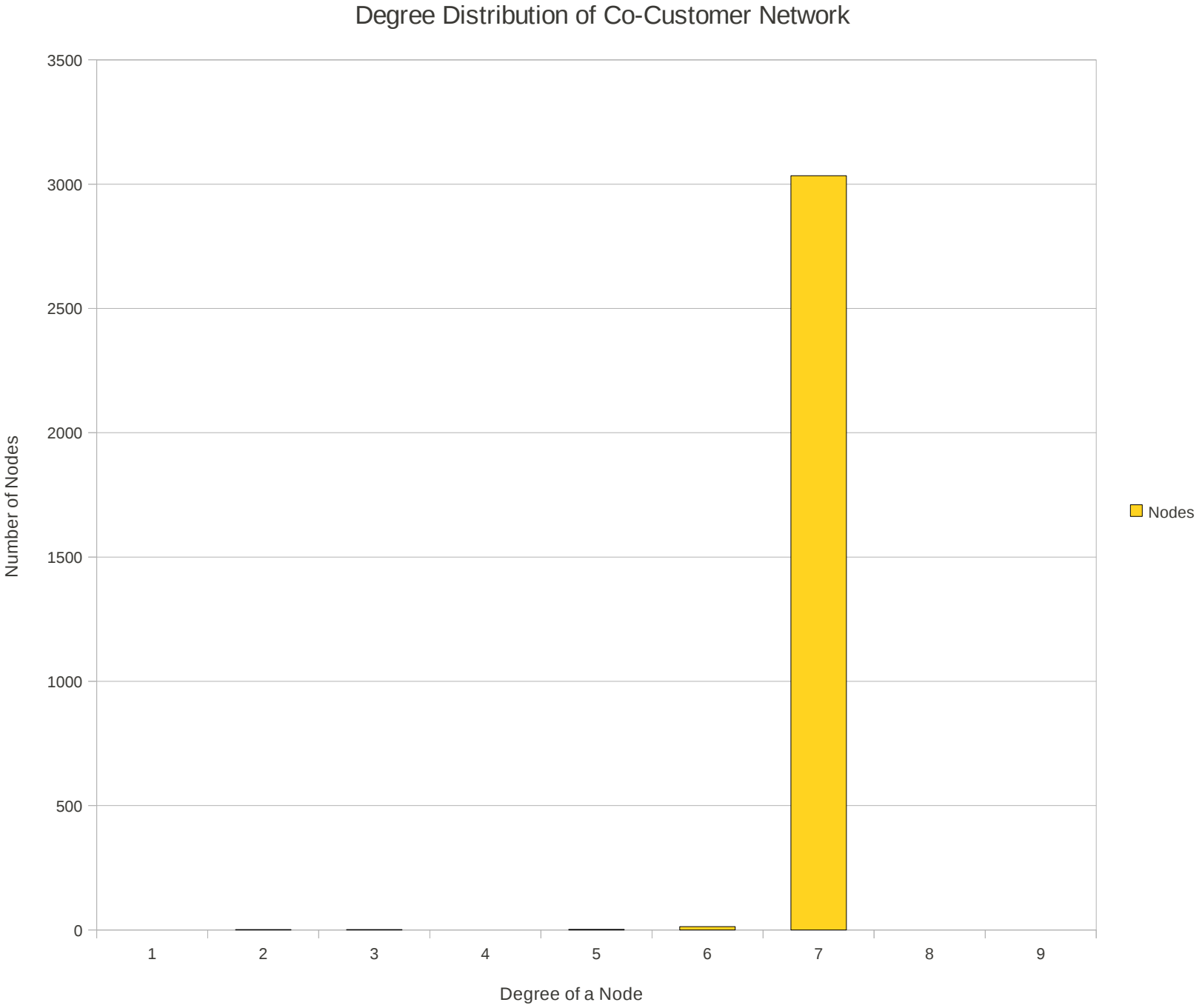
| Rating Threshold for popularity | Single Popular Author (r1) | Multiple Less-Popular Authors (r2) |
|---|---|---|
| 4.0 | 0.881 | 0.062 |
| 4.5 | 0.801 | 0.025 |
| 4.7 | 0.893 | 0.041 |
| 4.8 | 0.920 | 0.029 |

From the data, it is evident that,

- Single popular author makes a book more popular than many less-popular co-authors.

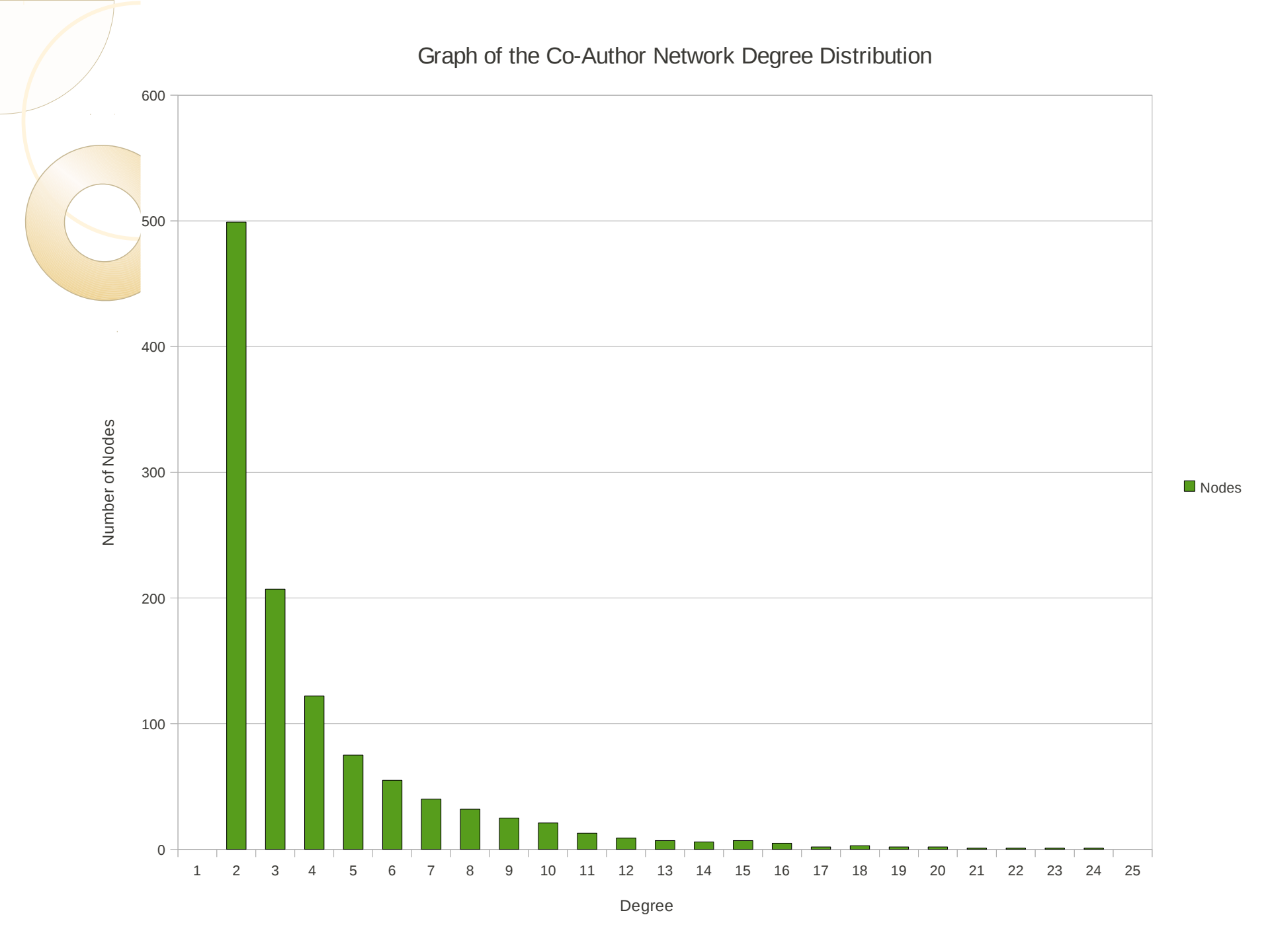
# Degree Distribution

- Co-customer network :
  - Amazon gives 7 “also recommended books” for each book entry.
  - Thus, a degree of 7 for more than 99% of the nodes.
  - Interesting fact :
    - **Amazon prevents the existence of a 3-edged loop spanning over 3 layers in this graph.**
  - This may be a part of Amazon's strategy for some suitable content discovery.
  - Thus, contributing to the growing network, but hiding the underlying actual network.


Degree Distribution of Co-Customer Network
Number of Nodes
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
Degree of a Node
Nodes

# Degree Distribution

- Co-author network :
  - Different from the co-customer network.
  - The degree falls gradually from a large value and goes into oblivion.
  - Inference:
    - Number of books with less co-authored books is hugely more than the number of books with more co-authored books.


Graph of the Co-Author Network Degree Distribution
Number of Nodes
600
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Degree
Nodes

# Clustering Co-efficient:

- Co-author network :
  - Observed to be around 0.779.
  - Many nodes have individual CC values of 1.
  - Inference:
    - It can be inferred that the graph is a set of cliques connected by edges.
    - The nodes with less value of CC are the nodes which form connections between two cliques.

# Clustering Co-efficient (Contd.)

- Co-customer network :
  - Neighborhood of each node is almost same due to typical topology of the graph.
  - CC for each node is approx 0.714
  - Hence, CC for whole graph is also approx 0.714

# Assortativity

- Co-author network :
  - Observed assortativity = 0.785394
  - Inference:
    - any book co-authored with a high degree book is likely to have high degree too.
    - similarly, any book co-authored with low degree books is likely to have a low degree.

# E[i][j] : fraction of edges between nodes of degree i and j

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>>> print_Eij( E )
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# Assortativity (Contd..)

- Co-customer network :
  - Observed assortativity is approximately equal to 0.
  - The graph is a well connected graph with almost all nodes having the same neighborhood connectivity pattern.
  - Inference:
    - any book recommended by the users of a popular book need not be popular.

# Tools Used

- Data Collection
  - Python module mechanize to ignore robot.txt
  - Python module BeatifulSoup and pyparsing to parse html content
- sqlite3 database to store crawled data and as data structure for network.

# Problems Faced

- Amazon discourages crawling by
  - malforming html tags
  - introducing unrecognized Unicode characters
- Unstable internet
- Hence slow data collection.

Thank You.
Any Questions??