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DEPARTMENT OF MEDIA AND COMMUNICATION (COM),
COLLEGE OF LIBERAL ARTS AND SOCIAL SCIENCES (CLASS)

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GE2234 Social Networks

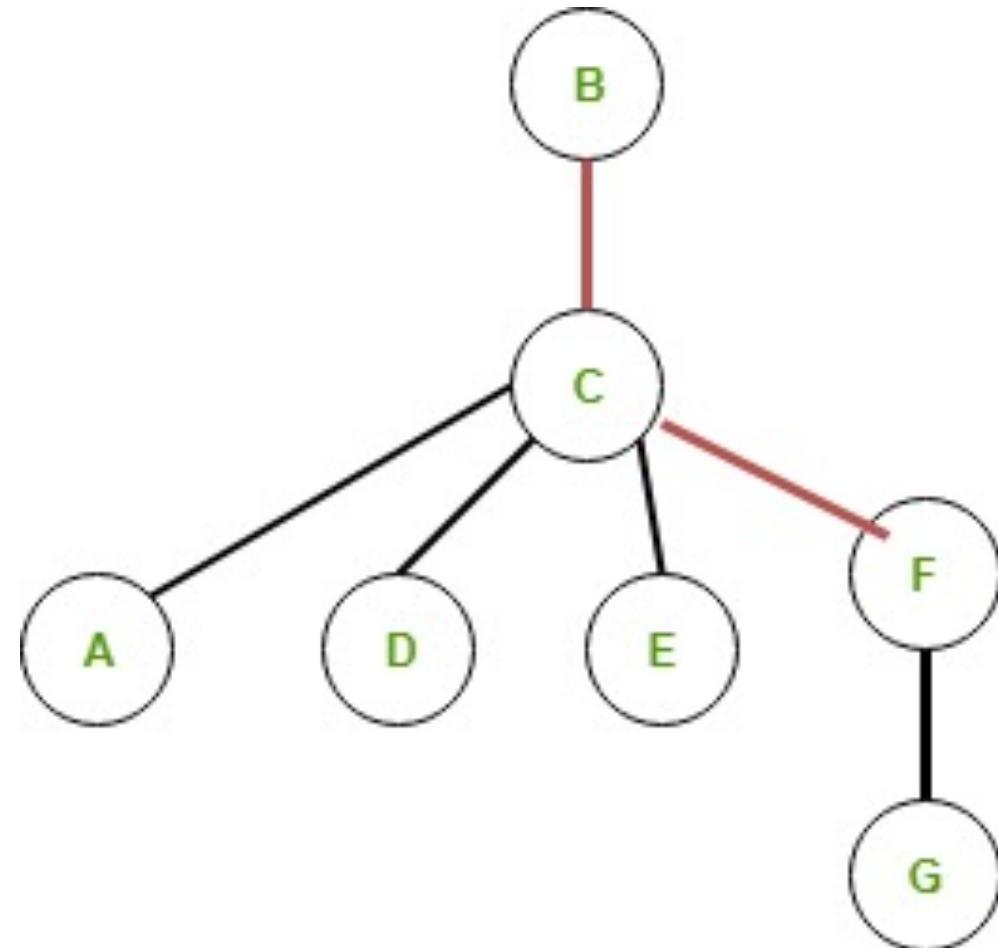
for Media, Business and Technological Applications

Lecture Note 3: Centrality Measures

By Dr. Wang Xiaohui, Vincent

Recap

- Types of networks
- Network representations: Diagram, edgelist, and adjacency matrix
- Geodesic Distance / Diameter / Average Path Length



Network Basics: Individual Level Metrics

- Degree centrality (indegree & outdegree)
- Closeness Centrality
- Betweenness Centrality
- Others (e.g., Eigenvector Centrality)

Who are the Most Prestigious Users on Twitter?



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United States government official
46th President of the United States, husband to @FLOTUS, proud dad & pop.
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[WhiteHouse.gov](https://whitehouse.gov)  Joined January 2021
12 Following 13.9M Followers



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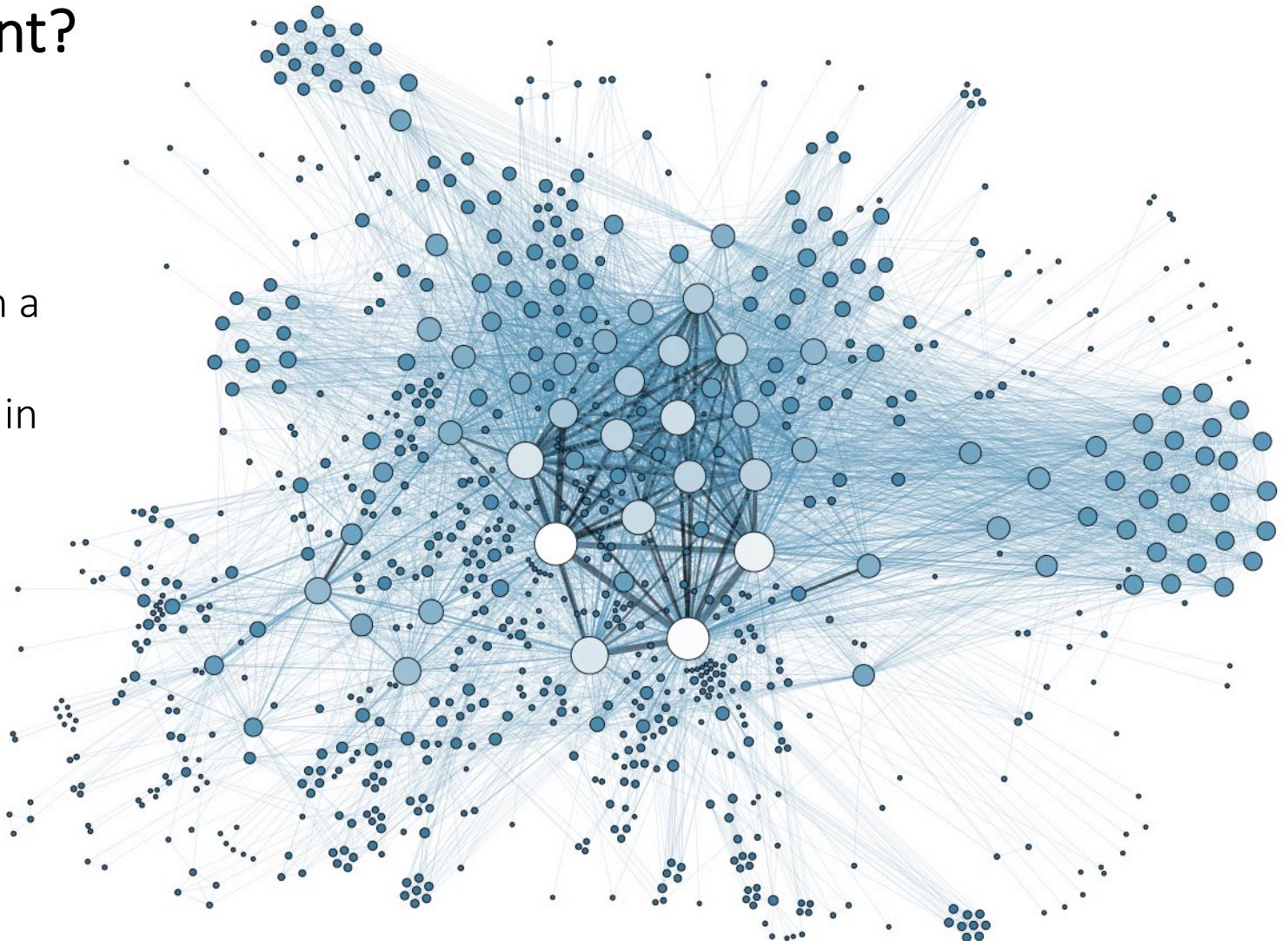


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Which vertices are important?

- Who is the most popular one in hall parties?
- Who is the most visible employee in a company?
- Who is the most important student in student communities?

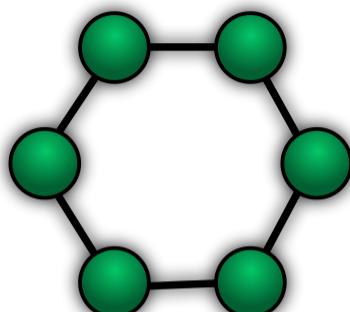


What will make them more
prestigious/important/informed/visible?

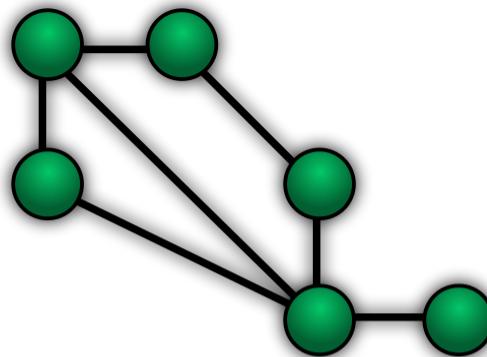
- Individual characteristics
- Handsome/Beautiful
- Charisma
- Sociability
- Education
- Media use
-

Beyond those individual attributes...

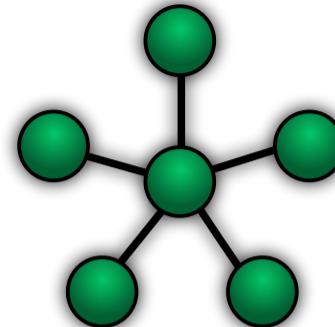
- Nodes' positions in networks matter a lot



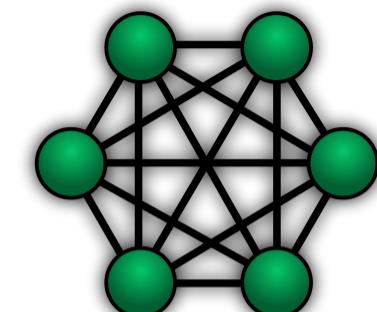
Ring



Mesh



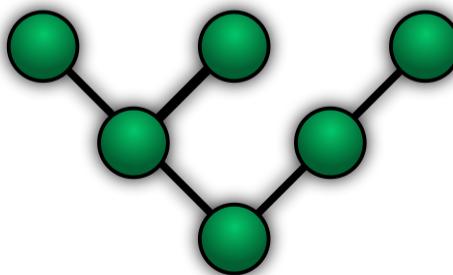
Star



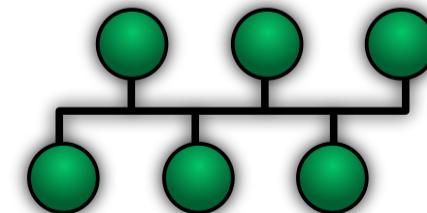
Fully Connected



Line



Tree



Bus

Centrality in a Network

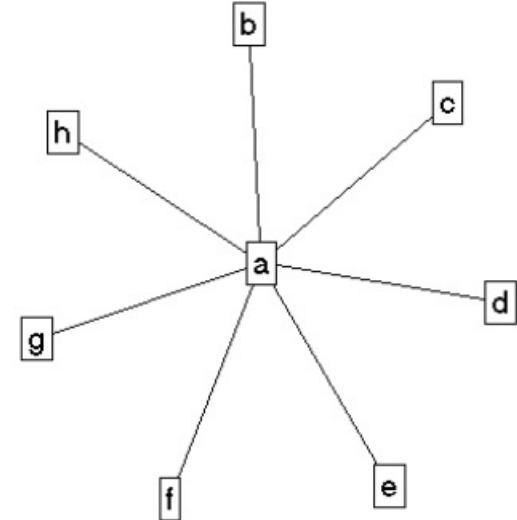
- Most "important" actors: actor location in the social network
 - Centrality is a property of a node's position in a network
 - It is not one thing but rather a family of concepts
 - Centrality can be conceptualized in different ways
- Types of Centrality
 - Degree centrality
 - Closeness centrality
 - Betweenness centrality
 - Eigenvector Centrality

Degree Centrality

- The number of ties of a given type that a node has or number of neighbors a node is directly connected
 - Indicates how well the node is connected within the network

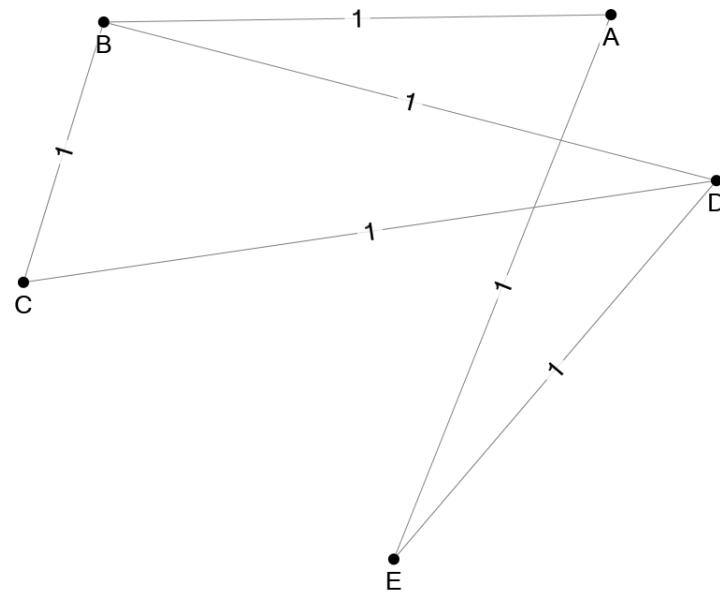
$$C_D(i) = k(i) = \sum_j A_{ij} = \sum_j A_{ji}$$

- High degree centrality - directly contact with many other actors
- Low degree - not active, peripheral actor



An Illustration on Undirected and Unweighted Network

- In the adjacency matrix X of an undirected network, degree centrality is simply the row (or column) sums of the adjacency matrix.



	A	B	C	D	E
A	0	1	0	0	1
B	1	0	1	1	0
C	0	1	0	1	0
D	0	1	1	0	1
E	1	0	0	1	0

Nodes	degree
A	2
B	3
C	2
D	3
E	2

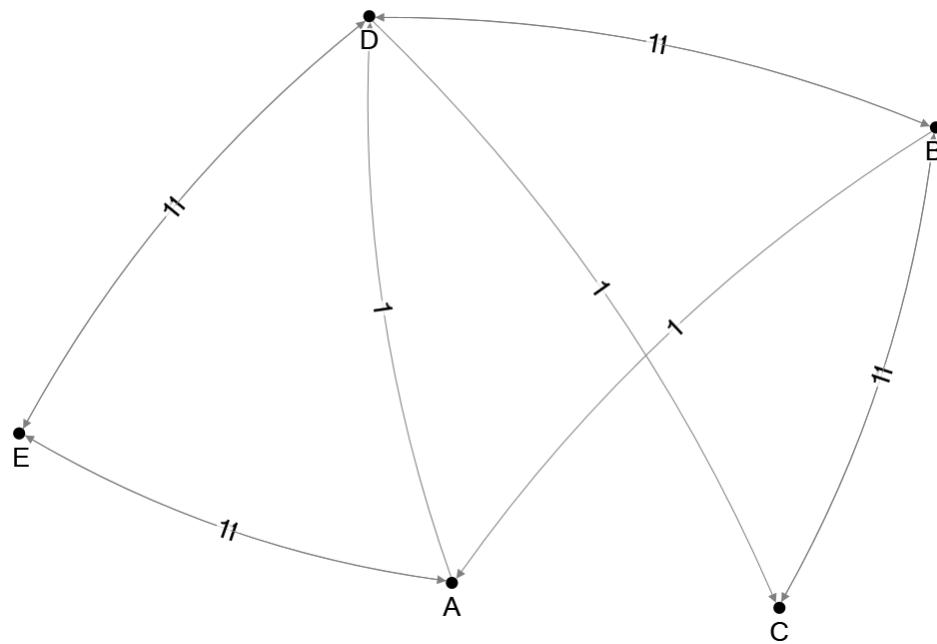
Degree Centrality in a Directed Network

- In undirected networks, the adjacency matrix is symmetric, while in directed networks the adjacency matrix is asymmetric

$$A_{ij} \neq A_{ji}$$

- Indegree and Outdegree
 - The column sums in adjacency matrix as indegree
 - The row sums in adjacency matrix as outdegree

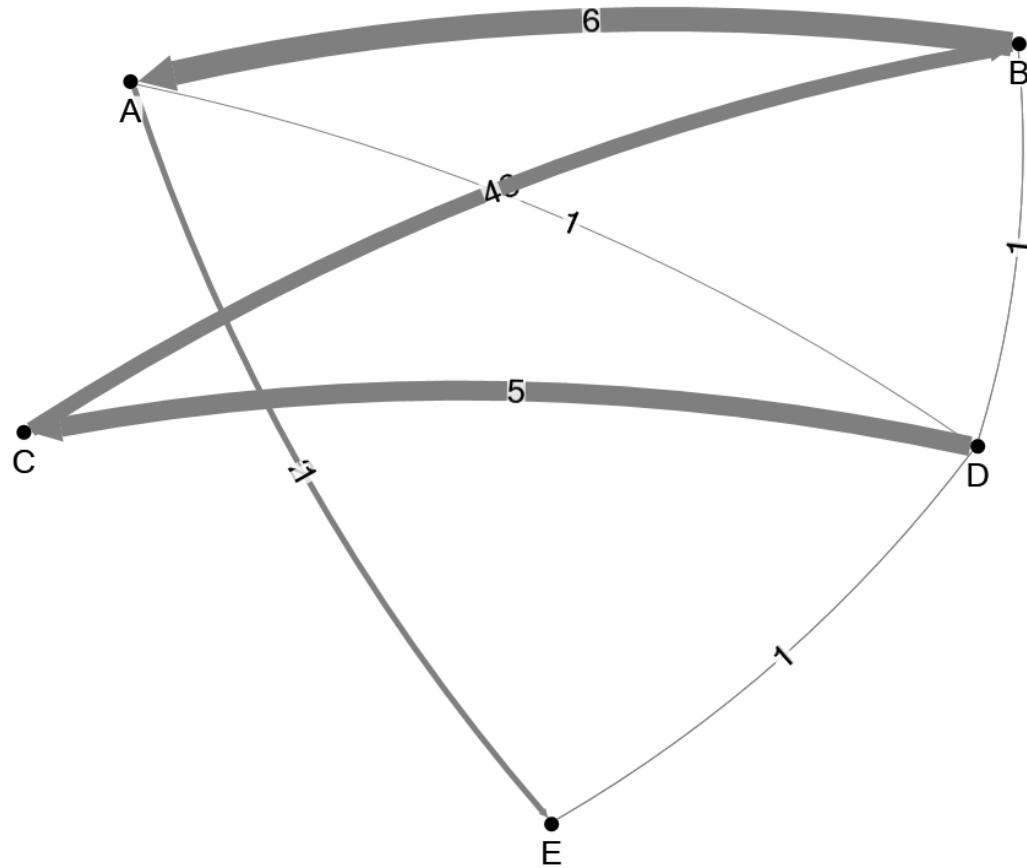
An Illustration on Directed and Unweighted Network



	A	B	C	D	E
A	0	0	0	1	1
B	1	0	1	1	0
C	0	1	0	0	0
D	0	1	1	0	1
E	1	0	0	1	0

Nodes	Indegree	Outdegree
A	2	2
B	2	3
C	2	1
D	3	3
E	2	2

An Illustration on Directed and Weighted Network



	A	B	C	D	E
A	0	0	0	1	2
B	6	0	3	1	0
C	0	4	0	0	0
D	0	1	5	0	1
E	1	0	0	1	0

Nodes	Indegree	Outdegree
A	7	3
B	5	10
C	8	4
D	3	7
E	3	2

How to Interpret Degree Centrality?

- If the tie is friendship, degree centrality can be
 - The number of friends a node has
 - The amount of emotional support available to the person
 - The opportunities to attend social events
 -
- If the tie is trust, degree centrality can be
 - The number of people that the node is in a position to influence directly
- If we assume things (e.g., gossip, viral marketing messages and infections) flow through ties, degree centrality can be
 - The risk/chances of receiving whatever is flowing through the network

Closeness Centrality

- A node is considered important if he/she is relatively close to all other actors.
- Closeness centrality refers to the sum of the number of steps along the shortest path from the focal node to all other node
 - The steps of the shortest path connecting two nodes in a network is called as **geodesic distance**
- Closeness centrality: how close an actor to all the other actors in network

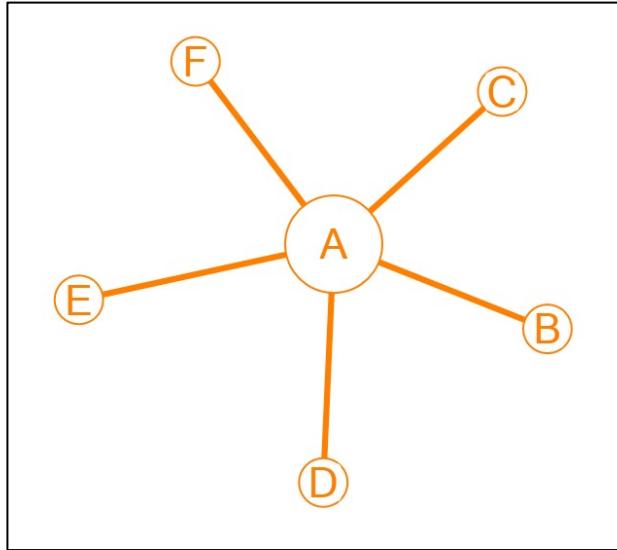
$$C_c(i) = \frac{1}{\sum_j d(i,j)}$$

Railway map of People's Republic of China

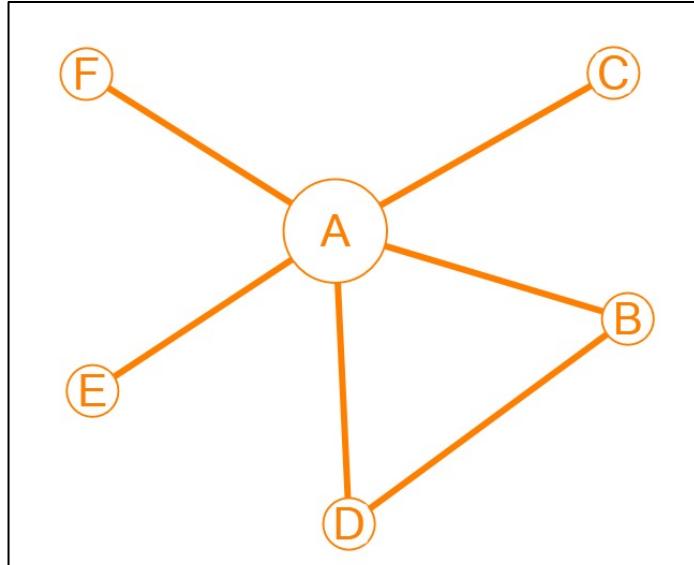
Colored lines showing CRH and other high speed rail services

Last update: 2020-02-29





Nodes	Sum of Distance	Closeness Centrality
A	5	0.2
B	9	0.111
C	9	0.111
D	9	0.111
E	9	0.111
F	9	0.111



Nodes	Sum of Distance	Closeness Centrality
A	5	0.2
B	8	0.125
C	9	0.111
D	8	0.125
E	9	0.111
F	9	0.111

How to Interpret Closeness Centrality?

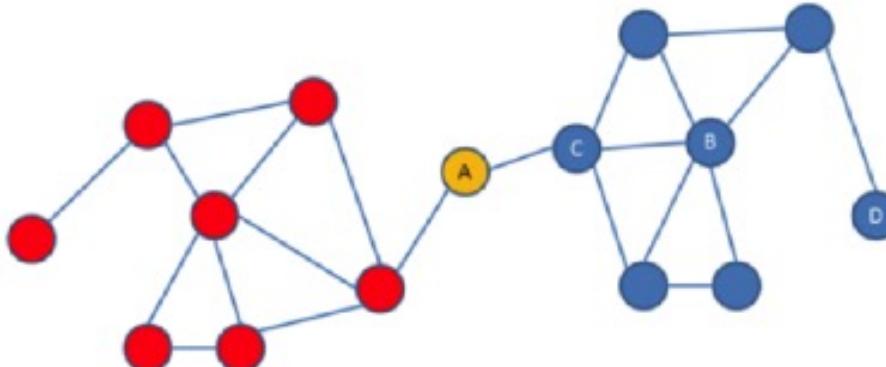
- In a communication network, actors in the center can quickly interact with others (minimal number of steps to reach other nodes)
- In flow context, closeness centrality indicates how quickly information travels between the node and anyone else in the graph
 - A node that has a high closeness centrality has a short distance from most others, so information originating at a random node can potentially reach the central node very quickly
- In information diffusion, the information received by the central nodes is expected to have higher fidelity on average, as more diffusion steps will involve more serious distortion
 - A rumor is one thing that gets thicker instead of thinner as it is spread

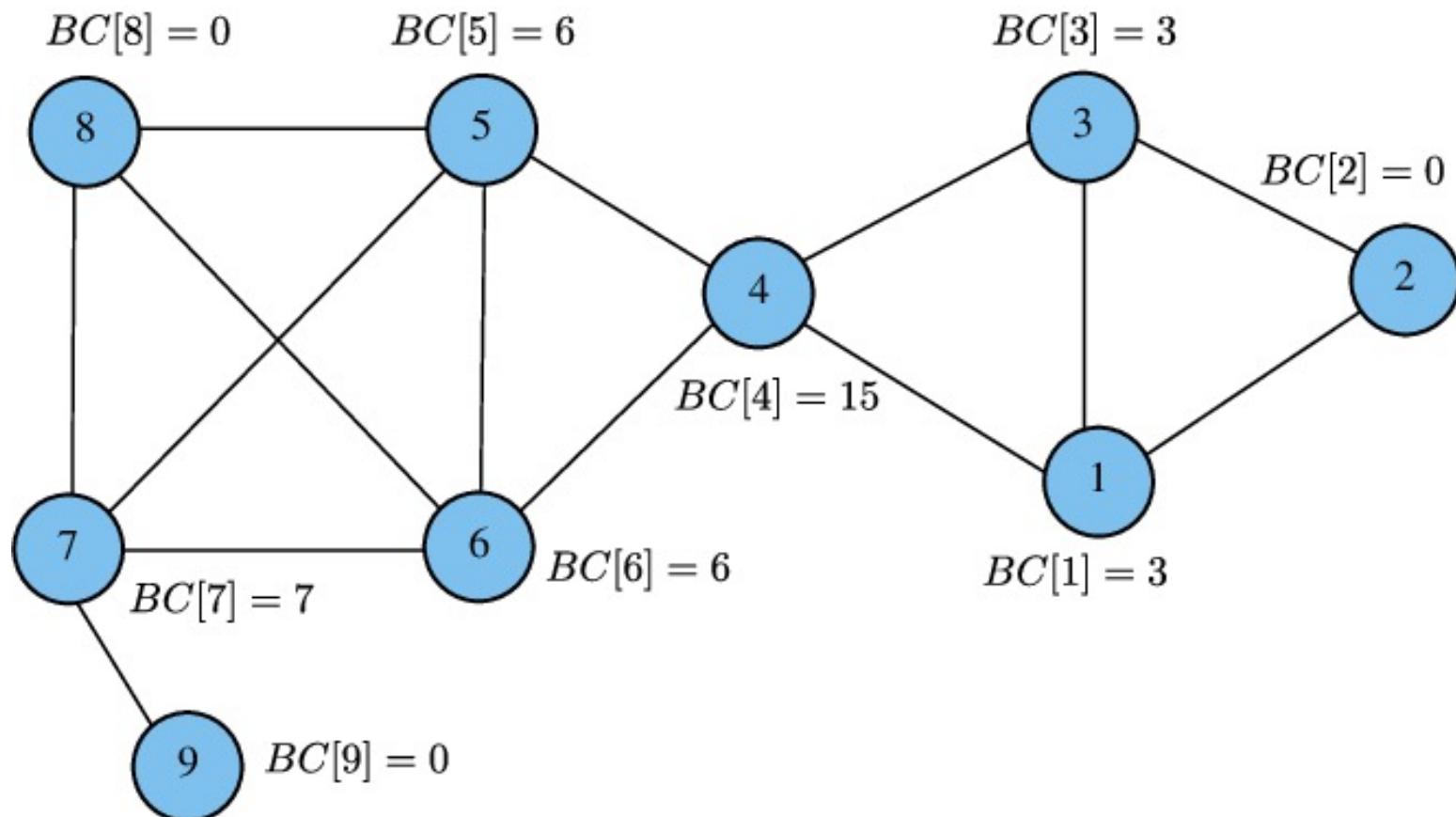
Betweenness Centrality

- Betweenness centrality is a measure of how often a given node falls along the shortest path between two other nodes
- Betweenness centrality counts the number of shortest paths between s and t that actor i resides on.

$$C_B(i) = \sum_{s \neq t \neq i} \frac{\sigma_{st}(i)}{\sigma_{st}}$$

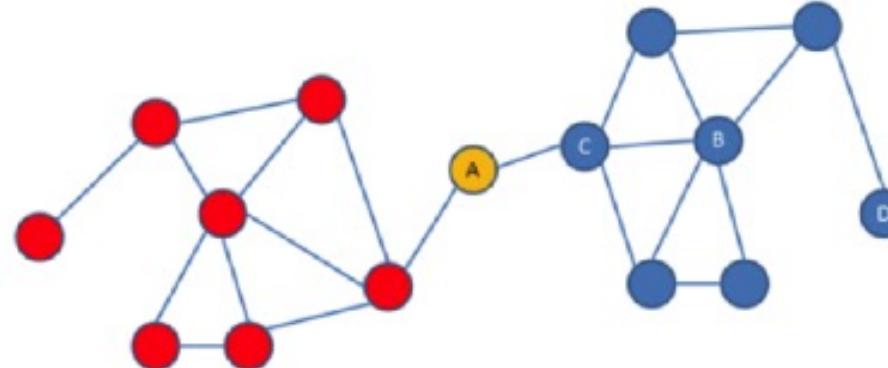
- Closeness centrality: crucial in controlling the flows





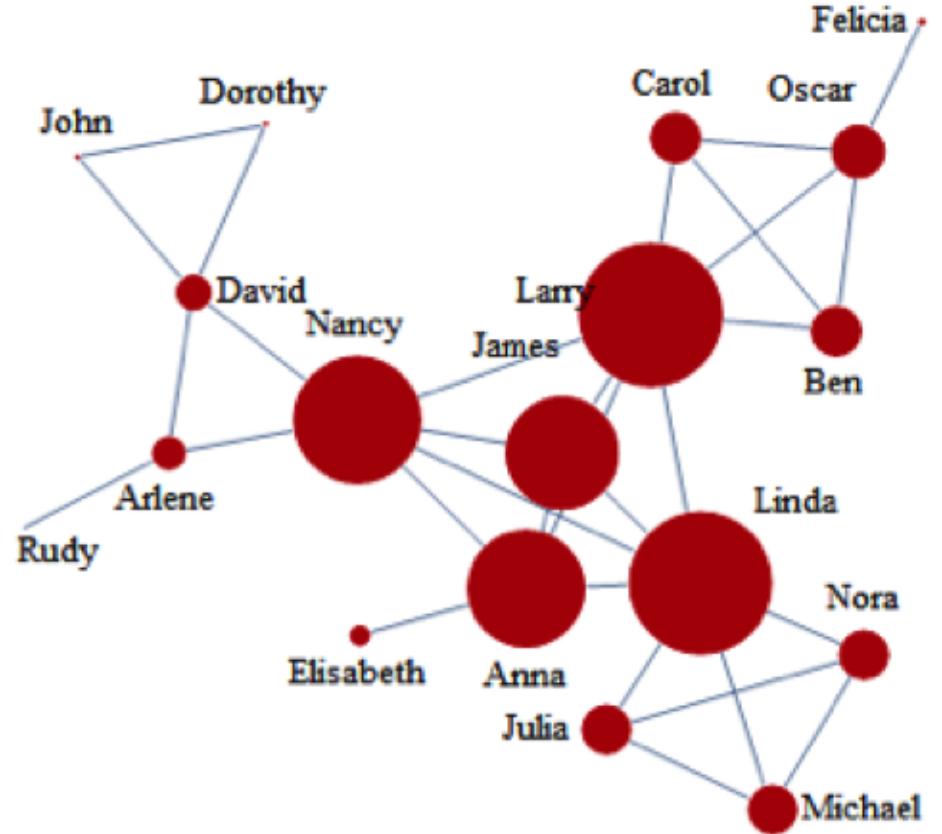
Interpreting Betweenness Centrality

- Indicates how critical the node is to the flow of information or resource in the graph
- Betweenness is typically interpreted in terms of the potential for controlling flows through the network ---- that is, playing a gatekeeping or toll-taking role
 - High-betweenness nodes are in a position to filter information and to color or distort it as they pass it along

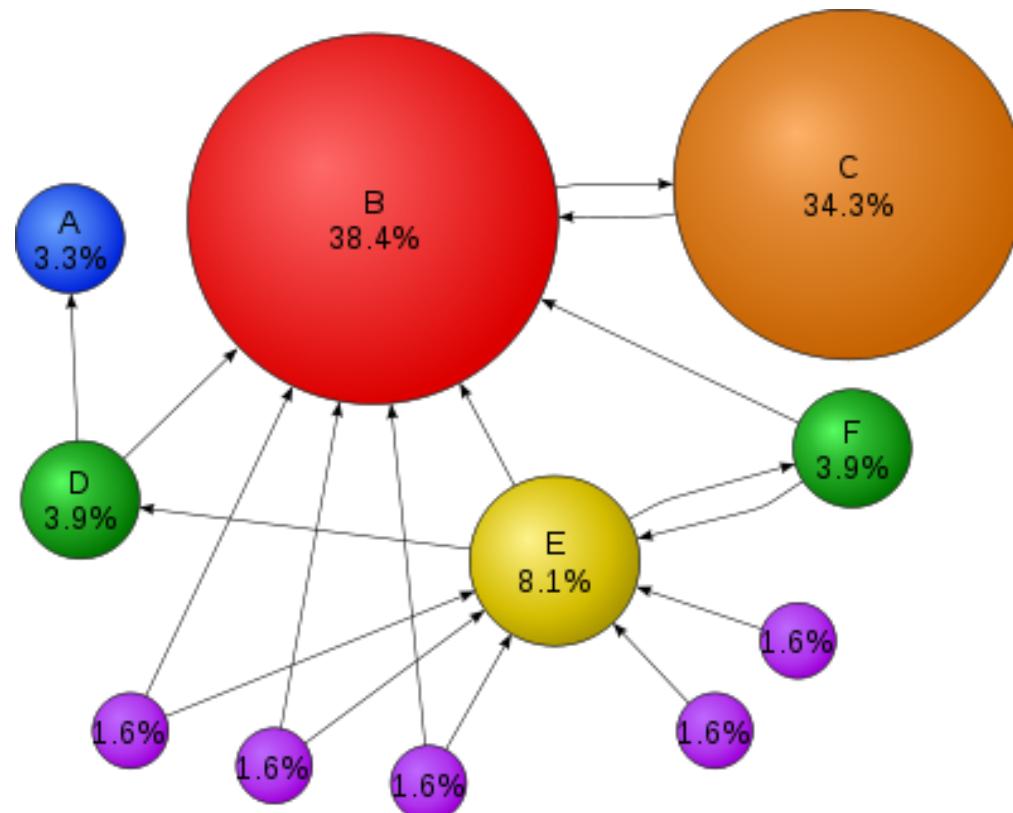


Eigenvector Centrality

- Importance of a node depends on the importance of its neighbors (recursive definition)
- Eigenvector centrality is a variation of degree centrality in which we count the number of nodes adjacent to a given node (just like degree centrality), but weight each adjacent node by its centrality



Eigenvector Centrality and PageRank



Example - Closeness Centrality



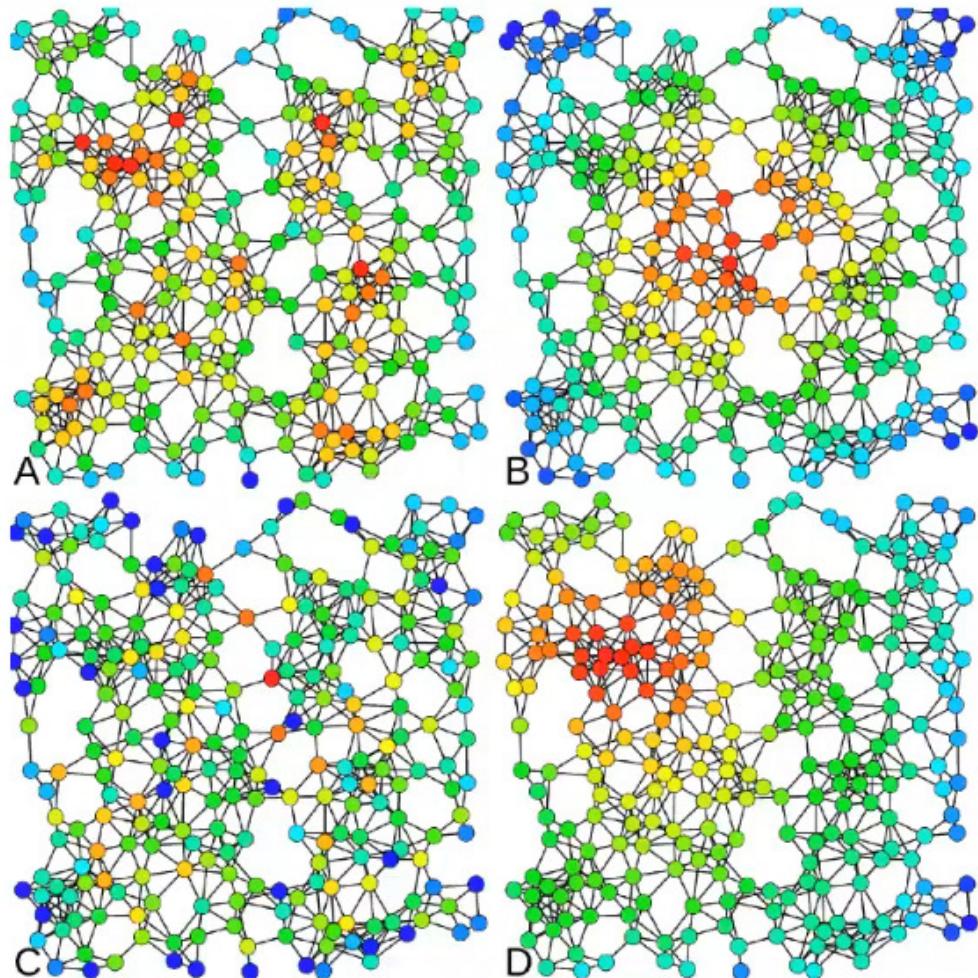
Example - Betweenness Centrality



Example - Eigenvector Centrality



Centrality Examples - Wikipedia



- A) Degree centrality
- B) Closeness centrality
- C) Betweenness centrality
- D) Eigenvector centrality

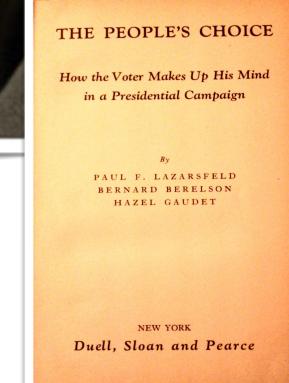
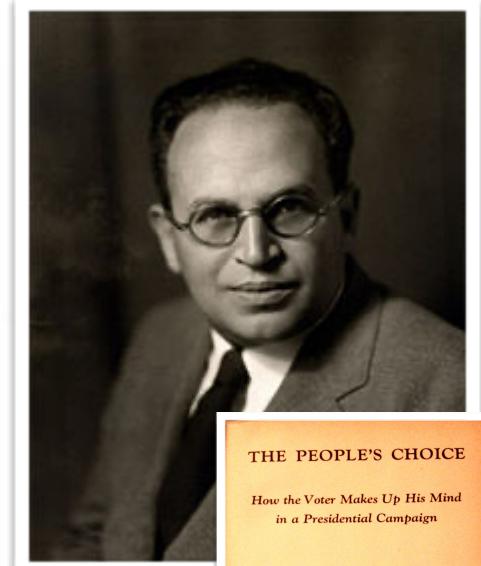
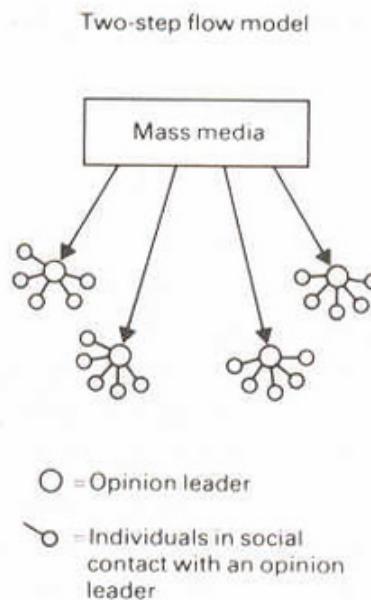
Group Discussion

- Is High Centrality always good?
- What are the indices that can be used to measure the influence of an account on social media?

Opinion Leaders on Social Media

Opinion Leader

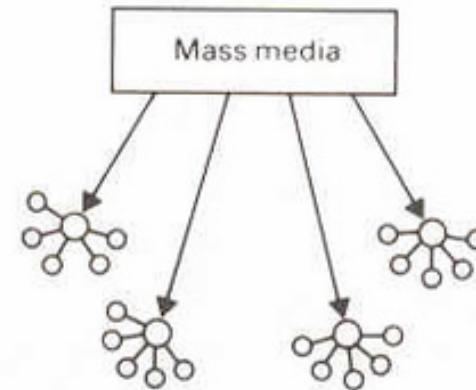
- The two-step flow of communication hypothesis suggests that opinion leaders are individuals who directly receive information from mass media and, in turn, pass on what they know to their everyday associates through interpersonal communication (Katz, 1957; Katz & Lazarsfeld, 1955).



Opinion Leader

- opinion leader is a special source of social influence
- who acts as an information broker between the mass media and the opinions and behaviors of an individual or group
- Opinion leaders have some position, expertise, or first-hand knowledge that makes them particularly important sources of relevant and credible information

Two-step flow model



○ = Opinion leader

—○— = Individuals in social contact with an opinion leader

What are the predictors of personal influence?

According to Katz (1957), individuals' influence is related

- 1) to the personification of certain values (who one is);
- 2) to competence (what one knows);
- 3) to strategic social location (whom one knows).

What are the predictors of personal influence?

1) the personification of certain values (who one is)

- Personal attributes: Gender, Age, Ethnicity, Activeness, ...
- E.g., That the young, unmarried are fashion leaders can be understood easily in a culture where youth and youthfulness are supreme values. This is an example where "who one is" counts very heavily.

What are the predictors of personal influence?

2) competence (what one knows);

- An individual's expertise or knowledge about a social issue has long been regarded as a critical contributor to his or her stature as an opinion leader on the topic.
- E.g., The research on product diffusion has found that opinion leaders are more knowledgeable about the product than non-leaders and that individuals.
- The influence of young people in the realm of movie-going can also be understood best in terms of their familiarity with the motion picture world.

What are the predictors of personal influence?

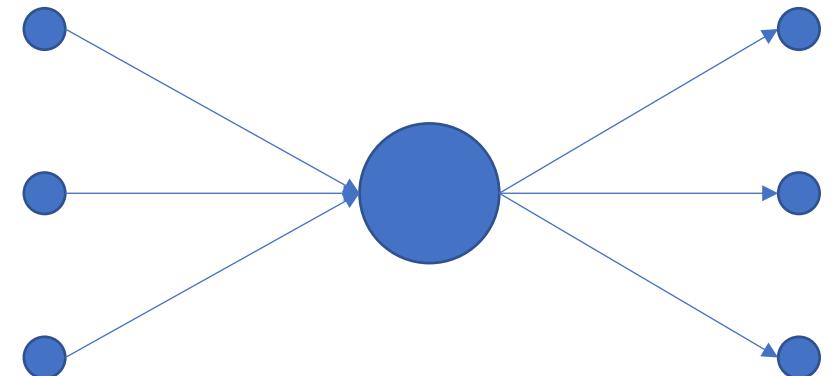
3) strategic social location (whom one knows).

- An individual may be influential not only because people within his group advice but also because of whom he knows outside his group.
- E.g., Researchers found that influential doctors could be characterized in terms of such things as their more frequent attendance at out-of-town meetings and the diversity of places with which they maintained contact, particularly far-away places.

Opinion Leader

are not necessarily well-known people; they may be friends and acquaintances or professionals like doctors, dentists, or lawyers

- simply because opinion leaders serve as information brokers does not mean that information only flows from opinion leaders to consumers. Indeed, opinion leaders often get information by seeking it from consumers, manufacturers, and retailers.



Opinion Leaders in Social Media Campaigns

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Ministry of Finance pays for Instagram 'influencers' to promote Budget 2018

17 Jan, 2018

<http://www.straitstimes.com/singapore/mof-pays-for-instagram-influencers-to-promote-budget-2018>

A spokesman for the Ministry of Finance did not mention how much they were spending on the campaign.



MOF pays for Instagram 'influencers' to promote Budget 2018

SINGAPORE - What do pretty pictures and financial planning have in common? Read more at straitstimes.com.

STRAITSTIMES.COM

Opinion Leaders in Social Media Campaigns



kaitinghearts Before we penned down our signatures to seal our union for [#KenTingWeds](#), there was a lot of planning done to make sure we worked within our budget and planned our finances well for our future together. 📈 Similarly, the Singapore government has to plan the [#SGBudget](#) ahead to help us Singaporeans and support our businesses in the next Financial Year, and our President will pen down her signature as assent for the enactment of the Supply Bill. ✒ If you didn't know, the [#SGBudget2018](#) is a strategic financial plan to position Singapore & Singaporeans; and you can actually voice your thoughts & needs to help the Government plan this!💡 Read more on the Budget 2018 at <http://bit.ly/kaitinghearts> ➡ [#sp](#) [#MOFSG](#) [#ministryoffinance](#) [#MOFxStarNgage](#)

Singaporeans; and you can actually voice your thoughts & needs to help the Government plan this!💡 Read more on the Budget 2018 at

An Instagram post from the account shanelkiehls. The profile picture shows a woman with long hair. The post features a photo of a woman with long brown hair, wearing a white dress with a black and white graphic on the front, a necklace, and a headband. She is standing in a room with a white wall and a vent. The Instagram interface shows a 'Follow' button in the top right corner. The caption reads: "shanelkiehls Monday 🌿 Hey, are you concerned about your pockets & future? 💰 ministry of finance are asking for citizen's feedback to better understand our concerns and aspirations so as to help us create a better future together! 🤝☀️ they are also giving us a hand in suggesting opportunities for improvement! Join me if you're keen to know more about Budget 2018 on 9th Jan; 1130am-2pm @ covered area close to multi purpose hall at Tanjong Pagar Complex! See you! 😊 if not, you can also give your feedback through REACH Budget 2018 by 12th Jan! 📱💡 (link in bio) #shanelkiehls #SGBudget2018 #MOFSG #sponsored #REACHSingapore #MOFSGxStarNgage" The post includes hashtags like #REACHSingapore, #MOFSGxStarNgage, and #SGBudget2018. It also includes mentions of #shanelkiehls, #MOFSG, and #sponsored. The post was made 2 months ago. The Instagram logo is in the bottom right corner of the post frame.

Opinion Leaders in Social Media Campaigns

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SINGAPORE POLITICS ASIA WORLD VIDEOS MULTIMEDIA LIFESTYLE FOOD FORUM OPINION BUSINESS SPORT TECH



Can influencers create the right Budget buzz?

PUBLISHED JAN 21, 2018, 5:00 AM SGT



Critics say they may not be the best people to raise awareness

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Singapore sparks mockery with Instagram 'influencers' for budget

By AFP
PUBLISHED: 11:54 BST, 19 January 2018 | UPDATED: 11:54 BST, 19 January 2018

Terence Lim I don't even know any single of them! 

Like · Reply · 9w
10 Replies

Dave Tan Financial planning? In the past, you earn \$2,000, HDB was \$40,000. Now you earn \$3000, HDB is \$300,000. 

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24 Replies

Rave Simpson For the Ministry of Finance, they don't really know how to use their money 

Like · Reply · 9w
5 Replies

Mohsien Hanafi Word of advice: If you want to "influence" the general public, make sure your "Influencer" has a wide reach (a lot of followers). If less than 10K followers, you wanna influence what? 😂 

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6 Replies

Philip Lim No wonder need tax hikes.
Our govt spend \$\$ like this.... See More 

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劉德華挺填海造地 挨轟「害死下一代」

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2018-10-05 13:14 世界日報 香港新聞組／香港5日電

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團結香港基金提倡填海造地，並請來被譽為「民間特首」的藝人劉德華為短片配上旁白，表態相挺。結果劉德華遭到大批網友砲轟「害死下一代」，指他8月才支持香港海洋公園保育基地，10月就挺在東大嶼山填海造地，破壞海洋生態，根本言行不一。

Opinion Leaders in Social Media Campaigns