Determining Key Contributors to Feelings of Insecurity for Public Transportation Users

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Anatomy of Network Graphs

- Element of a system [Node] represented as a circle
- Interaction between two elements [Edge] represented as a line or arrow connecting respective nodes
- Level of influence of a connection [Weight] represented as the thickness of the edge connecting two nodes

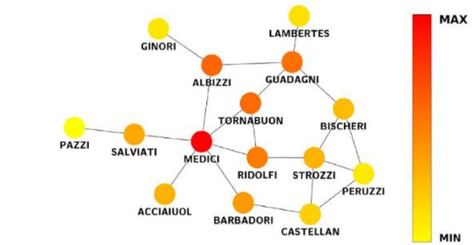

Figure: Florentine Marriages (Alvarez-Socorro, 2015 DOI: 10.1038/srep17095)

Anatomy of Network Matrices

- Columns [j] represent in-coming influence
- Rows [i] represent outgoing influence
- Number in [ij] represents the weight of influence that node I has on node j

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
A	0	0	3	-1	0	0	0	0	0	1	5	1	1	1	0	-1	1	-1	1	-1	2	0	11	0	7	0	-1	0	0	0	0
B	0	0	0	2	1	0	7	0	0	0	1	0	3	0	1	0	0	1	0	3	2	0	0	1	2	0	0	1	0	6	0
C	0	11	0	5	0	0	1	0	0	9	0	0	0	0	0	0	0	0	1	0	0	4	0	6	0	1	1	0	4	1	
D	0	0	0	0	0	-1	0	0	-1	0	0	0	1	0	0	0	0	0	0	-1	1	0	0	-3	0	0	0	0	0	0	0
E	0	2	0	4	0	-1	2	0	0	0	2	0	1	0	0	1	0	0	1	-1	0	0	0	26	0	0	4	0	3	0	
F	0	2	0	8	1	0	0	0	0	0	2	2	0	2	0	0	-1	1	1	3	1	0	0	28	0	0	12	0	0	0	
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
I	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
J	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
K	0	0	0	-2	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	32	0	2	1	3	3	
L	0	7	0	-4	1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	1	0
M	0	1	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	0	0	2	0	1	
N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	1	
O	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	
P	0	9	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	
Q	0	2	0	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	0	0	3	0	1	
R	0	-1	1	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	1	0	0	
S	0	2	0	6	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	27	0	2	4	0	-1	
T	0	2	1	15	2	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	1	0	2	
U	0	-1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
V	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	
W	0	1	1	15	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	1	-1	0	0
X	0	0	0	3	0	5	0	0	0	0	5	0	4	0	2	0	0	-1	0	0	-3	0	0	0	7	0	0	0	0	0	1
Y	0	1	0	1	0	0	17	0	0	1	2	0	0	1	4	0	0	0	0	0	5	0	-3	0	0	0	0	0	0	-1	0
Z	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
AA	0	-1	2	12	0	1	0	1	0	1	1	0	-1	0	1	0	0	0	3	1	1	0	2	0	14	0	0	0	1	0	0
AB	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0
AC	0	1	0	1	2	0	2	0	0	0	5	0	0	0	0	0	0	0	0	-1	1	0	0	-1	0	24	1	0	1	0	1
AD	0	4	0	3	0	-2	0	0	-1	0	4	9	-2	0	1	0	0	0	0	1	1	0	0	0	12	0	0	0	0	0	-2
AE	0	0	0	2	3	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	

Figure: Weighted Adjacency Matrix

Centrality Measures

- Different metrics that can be used on a network to determine which elements are most influential to the state of the system
- Identifying most influential elements is extremely important in driving the system to a desired state

Types of Centrality Measures

- Degree Centrality
  - Two sub-types: In-Degree, Out-Degree
  - Identifies node with most connections as the most influential
  - Used in transportation networks and computer networks
- Eigen-Centrality
  - Identifies node connected to the most influential nodes as the most influential
  - Used in Epidemiology, webpage ranking, and network security

Study Details and the "No-Duh" Node

- Analyzing factors that impact rider perceptions of insecurity when using public transportation
  - Want to identify influencers of perceptions
  - Aim to find leverage point to reduce feelings of insecurity and increase ridership
- Focus of study is a component of social system and is included in the network
  - Analytical bias is introduced since outcome is part of the model
  - Node Y is our "No-Duh" Node, the concept we are measuring, and represents "Feelings of Insecurity".
  - Want to find the greatest influencer of Node Y

In-degree Centrality

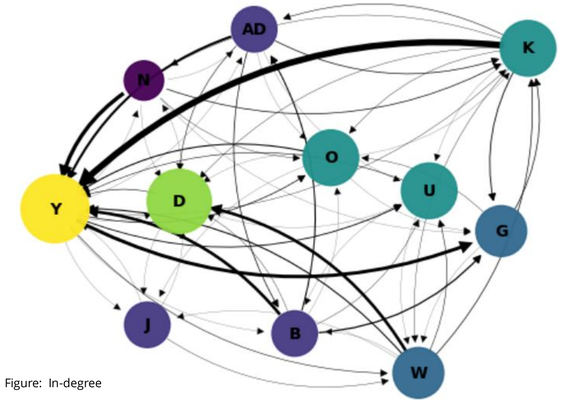

Figure: In-degree

- Node D shows greatest incoming influence having inbound connections from 8 nodes
- This shows that Node D is the most dependent in the system and receives the most influence from other nodes

Out-degree Centrality

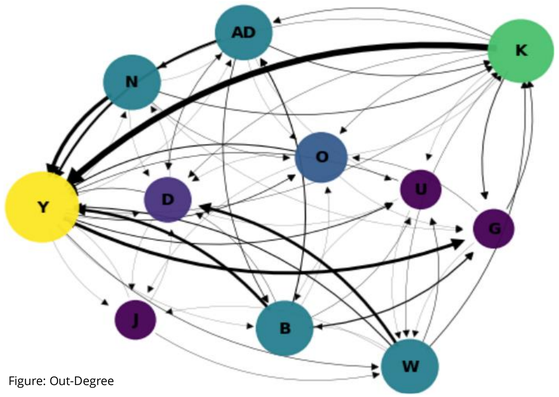

Figure: Out-Degree

- Node K has greatest outbound influence with outbound connections to 6 nodes
- Shows Node K is most independent in the system and influences the most nodes
- Heaviest connection weight in the system is from Node K to Node Y

Eigencentrality

- Node D has the most connections to other highly influential nodes within the system
- Numerically, Node K has 2nd highest Eigencentrality and is also connected to other influential nodes

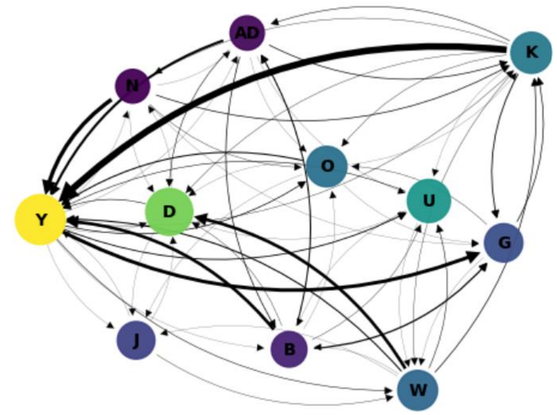

Figure: Eigencentrality

B	D	G	J	K	N	O	U	W	Y	AD
Harassment	Service Quality	Preventative Behavior	Driver Shortage	Crime	Stereotypes	Social Exclusion	Alt. Transport	Transport Operation	Perception of Insecurity	Surveillance

Figure: Node table for ego graphs

Conclusions and Future Considerations

- Centrality for Node D stems from connection to Node K and Node Y.
- Node K has more influence over other nodes and its strongest connection is with Node Y.
- Node K 3rd most Eigencentric in the system but should be considered the most influential element in the system.
- Continued research will involve
  - Sensitivity analysis of the data
  - Exploration of other analytical methods
  - Search for a "Rule-of-Thumb" for similar studies

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