



# One and Two Mode Metrics, Folding

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School of Computer Science, Carnegie Mellon  
Summer Institute 2020



Center for Computational Analysis of  
Social and Organizational Systems  
<http://www.casos.cs.cmu.edu/>



## Agenda

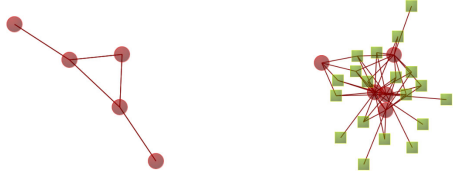
- Concepts
  - Types of networks
  - Types of metrics
- Network Metrics in ORA
  - Overview
  - Common one/two mode metrics
- Experiments
  - Color nodes by network metrics
  - Generate one/two mode network metrics from ORA report
  - Hiding Network type Information from ORA Metrics
- Folding Networks



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## Concepts-Types of Networks

- One mode networks
  - Networks consist of only one node class
  - E.g. Social Networks (Agent by Agent), Transportation networks (Location by Location)
- Two mode networks
  - Networks consist of two node classes
  - E.g. Travel Networks (Agent by Location), Expert Networks (Agent by Knowledge)



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## Concepts-Types of Networks

- Binary/Weighted Networks
  - Binary Networks only contain 0/1 information on links
  - Weighted Networks contain additional information of links. E.g. cost of a path, the amount of knowledge one have.
- Self-loop/No Self-loop Networks
  - Self-loop Networks contains links that point to the source.
  - E.g. social interaction networks are free from self loops.
  - E.g. company interaction networks may have self loops.
- Symmetric/asymmetric Networks
  - Symmetric networks assume both directions of a link contain the same information.
  - E.g. Facebook friend network is symmetric. Email network is not.

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## Concepts-Types of Metrics

- Network Metrics
  - Measure the networks based on a specific standard
  - One mode metrics. e.g. Centralizations
  - Two mode metrics, e.g. Knowledge Exclusiveness

High in Centrality

High in Knowledge Exclusiveness

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## Network Metrics in ORA-Overview

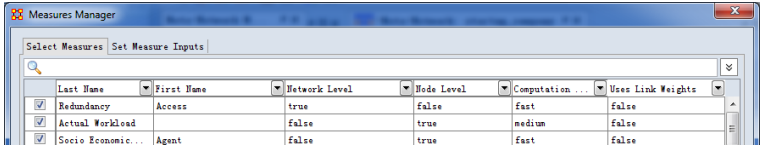
- 170 + metrics in ORA
  - Metrics are grouped. Similar metrics have the same “last name”. E.g. centrality
  - In every group, each metric has a unique “first name”. E.g. betweenness, closeness.
- Input of metrics
  - Metrics may have network level version, node level version or both versions in ORA.
- Computation time
  - Labeled with Fast/Medium/Slow

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## Network Metrics in ORA-Overview

- Based on whether the metrics use weighted information
  - Some metrics are designed to utilize weighted information while others are not.
  - Metrics do not use weighted information will treat weighted networks as binary ones.
- Normalizations of metrics
  - Normalizations maps the metrics into a 0 to 1 space
  - All node level metrics have normalized versions in ORA



Last Name	First Name	Network Level	Node Level	Computation ...	Uses Link Weights	
<input checked="" type="checkbox"/>	Redundancy	Access	true	false	fast	false
<input checked="" type="checkbox"/>	Actual Workload		false	true	medium	false
<input checked="" type="checkbox"/>	Socio Economic ...	Agent	false	true	fast	false

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## Common One/Two Mode Metrics

### One Mode Metrics

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## Common One Mode Metrics

- 1. Degree Centrality
  - Measures the number of connections of a node in the network

$$C_D(u) = \begin{cases} \sum_{v=1, v \geq u}^{|N|} w_{v,u} & \text{allow self-loops} \\ \sum_{v=1, v > u}^{|N|} w_{v,u} & \text{ignore self-loops} \end{cases}$$

- Implementations in ORA:
  - Centrality, In degree . Counts only in-links.
  - Centrality, Out degree . Counts only out-links
  - Centrality, Total degree . Counts both in-links and out-links
- Input:
  - Uses node level information
  - Utilizes weighted information



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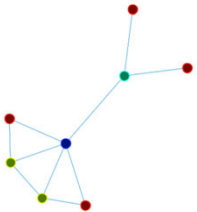
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## Common One Mode Metrics

- 2. Betweenness Centrality
  - counts the number of shortest paths through a specific node

$$C_B(k) = \begin{cases} \sum_{u=1}^{|V|} \sum_{v=u+1}^{|V|} \frac{g_{u,v}(k)}{g_{u,v}} & \text{symmetric networks} \\ \sum_{u=1}^{|V|} \sum_{v \neq u}^{|V|} \frac{g_{u,v}(k)}{g_{u,v}} & \text{asymmetric networks} \end{cases}$$

- Implementations in ORA
  - Centrality, Betweenness
- Input:
  - Uses node level information
  - Utilizes weighted information

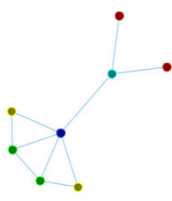


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## Common One Mode Metrics


- 3. Closeness Centrality
  - calculates the inverse of shortest path from one node to all other nodes
$$C_c(k) = \frac{1}{\sum_{u=1}^{|V|} d_{k,u}}$$
  - Implementations in ORA
    - Centrality, Closeness . Utilizes only out-links.
    - Centrality, Inverse Closeness . The inverse of closeness centrality.
    - Centrality, In-Closeness . Utilizes only in-links
  - Input:
    - Uses node level information
    - Utilizes weighted information

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## Common One Mode Metrics

- 4. Eigenvector Centrality
  - Measures influence of nodes
  - Nodes get high scores if they are connected to other high score nodes
- Implementations in ORA
  - Centrality, Eigenvector
- Input:
  - Uses node level information
  - Utilizes weighted information



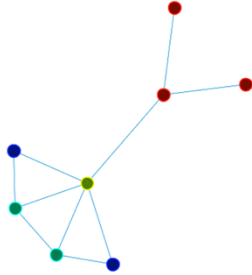
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## Common One Mode Metrics

- 5. Clustering Coefficients
  - Measure the proportion of network cliques one node participated
$$C_C = \frac{\sum_{u=1}^{u=|N|} C'_c(u^*) - C'_c(u)}{\max(\sum_{u=1}^{u=|N|} C'_c(u^*) - C'_c(u))}$$
- Implementations in ORA:
  - Density, Clustering Coefficients
- Inputs
  - Uses node level information
  - Do not utilizes weighted information



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## Common One Mode Metrics

- 6. Network Centrality
  - Measure the network level centrality
$$C_D = \frac{\sum_{u=1}^{u=|N|} C_D(u^*) - C_D(u)}{\max(\sum_{u=1}^{u=|N|} C_D(u^*) - C_D(u))} \quad C_B = \frac{\sum_{u=1}^{u=|N|} C_B(u^*) - C_B(u)}{\max(\sum_{u=1}^{u=|N|} C_B(u^*) - C_B(u))}$$

$$C_C = \frac{\sum_{u=1}^{u=|N|} C'_c(u^*) - C'_c(u)}{\max(\sum_{u=1}^{u=|N|} C'_c(u^*) - C'_c(u))}$$
- Implementations in ORA:
  - Network centrality, In degree
  - Network centrality, Out degree
  - Network centrality, Total degree
  - Network centrality, Betweenness
  - Network centrality, Closeness

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## Common One Mode Metrics

- Input:
  - Uses network level information
  - Utilizes weighted information

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## Reference for Implementation Details

- Wei Wei, Jürgen Pfeffer, Jeffrey Reminga, and Kathleen M Carley. Handling weighted, asymmetric, self-looped, and disconnected networks in ora. Technical Report CMU- ISR-11-113, Carnegie Mellon University, 2011.

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## Common One Mode Metrics

Some of the One Mode Network Metrics in ORA

Measure Title		Measure Title		Measure Title		Measure Title	
Potential	Boundary Spanner	Total Degree	Centrality	Local	Efficiency	Weak	Component Members
Betweenness	Centrality	Bonacich Power	Centrality	Lateral	Link Count	Burt	Constraint Network
Edge Betweenness	Centrality	Eigenvector	Centrality	Pooled	Link Count	Eigenvector	Centralization Network
Authority	Centrality	Node	Count	Reciprocal	Link Count	In-Closeness	Centralization Network
Closeness	Centrality	Classic SNA	Density	Sequential	Link Count	Total Degree Eigenvector Per Component	Centralization
Hub	Centrality	Clustering Coefficient	Density Effective Network Size	Skip	Link Count Component Count	Information	Centrality Network
In-Closeness	Centrality	Burt	Network Size	Strong	Component Count	Information	Centrality Network
Inverse Closeness	Centrality	Global	Efficiency	Weak	Component Count	Betweenness	Centralization

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## Common One/Two Mode Metrics

Two Mode Metrics


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## Common two mode metrics


- Two mode Networks
  - Use two initials of node class to denote the two mode networks
  - E.g. AK (Agent by Knowledge) network, AL (Agent by Location) network
  - Without lose of generality, we use AK as an example.
- Notations
  - AK- the adjacent matrix of AK networks
  - $A_iK_j$  - the element of the adjacent matrix located in ith row and jth column
  - $|A|$ - the number of agents in the networks
  - $|K|$ - the number of knowledge in the networks

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## Common two mode metrics

- Categories of Two Mode Network Metrics:
  - Quantity
    - Metrics in this category count or average the entries of the adjacent matrix
  - Variance
    - Metrics in this category create network level indices that describe the distributions of connections in Networks
  - Correlation
    - Metrics in this category describe similarities/dissimilarities between all pair of agents
  - Specialization
    - Metrics in this category identify agents that have either exclusive or redundant connections to other node class entities.

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## Common two mode metrics

- 1. Load
  - A quantity category metric measures the average amount of resources (Knowledge) per agents
$$L = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|K|} A_i K_j}{|A|}$$
  - Implantations in ORA
    - Load, Knowledge
    - Load, Resource
  - Input
    - Network level information
    - Treat all networks as binary

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## Common two mode metrics

- 2. Diversity
  - A variance category metric measures whether the Knowledge is equally distributed.
$$w_j = \sum_{i=1}^{|A|} A_i K_j \quad W = \sum_{j=1}^{|K|} w_j \quad D = 1 - \sum_{j=1}^{|K|} \frac{w_j^2}{W}$$
  - Implementations in ORA
    - Diversity, Knowledge
    - Diversity, Resource
  - Input
    - Network level information
    - Treat all networks as binary

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## Common two mode metrics

- 3. Expertise
  - A correlation category metric measures the degree of dissimilarity between agents based on shared knowledge
  - $E(\sim AK \cdot AK')$  with  $E(i, i) = 0$   $E(i, :) = \frac{E(i, :)}{\sum E(i, :)}$   
$$e_i = \frac{\sum_{j=1, j \neq i}^{|A|} E(i, j)}{|A| - 1}$$
- Implementations in ORA
  - Correlation, Expertise
- Input:
  - Node level information
  - Treat all networks as binary

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## Common two mode metrics

- 4. Redundancy
  - A specialization category metric measures whether there are different agents sharing the same knowledge
  - $d_j = \max[0, \sum AK(:, j) - 1]$   $r = \frac{\sum_{j=1}^n d_j}{|K|}$
- Implementations in ORA
  - Redundancy, Knowledge
  - Redundancy, Resource
- Input:
  - Network level information
  - Treat all networks as binary

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## Common two mode metrics

Some of the Two Mode Network Metrics in ORA

Measure Title		Measure Title		Measure Title		Measure Title	
Knowledge Based	AccessIndex	Similarity	Correlation	Resource	Exclusivity	Row	Redundancy
Resource Based	AccessIndex	Relative	CognitiveDistinctiveness	Task	Exclusivity	Knowledge	Redundancy
Social Technical	Congruence	Knowledge	Diversity	Relative	CognitiveExpertise	Access	Redundancy
Distinctiveness	correlation	Resource	Diversity	Knowledge	Load	Resource	Redundancy
Expertise	correlation	Complete	Exclusivity	Resource	Load	Assignment	Redundancy
Resemblance	correlation	Knowledge	Exclusivity	Column	Redundancy	Relative	CognitiveResemblance

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## Generate A Simple Network

Nodeset Class	Nodeset Name	Initial Size
Agent	Agent	8

Source Nodeset Name	Target Nodeset Name
Agent	Agent

1. Name whatever you want  
2. Choose "Agent" and select 8 as size  
3. Create an "Agent X Agent" network  
4. Hit "Finish"

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## Generate A Simple Network

1. Click to expand your meta-network  
2. Choose your Agent X Agent network  
3. Select "Symmetric", "No Self-Loops", and "Binary Link Values"  
4. Hit Visualize Network

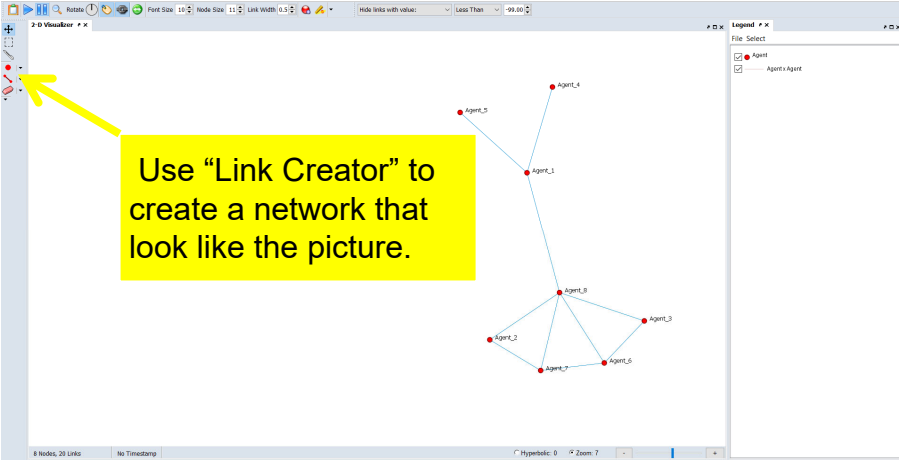
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## Generate A Simple Network



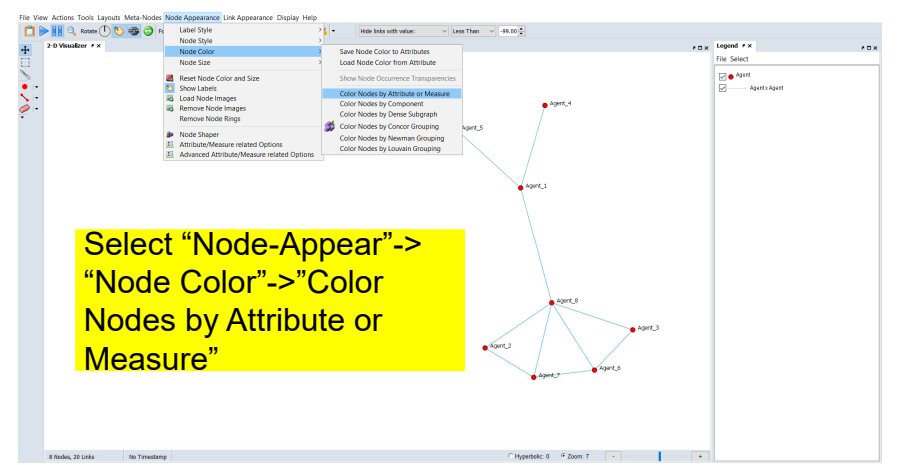
Use "Link Creator" to create a network that look like the picture.

8 Nodes, 20 Links No Timestamp Hypertopic: 0 Zoom: 7

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## Color Network By Metrics (One Mode)



Select "Node-Appear"-> "Node Color"-> "Color Nodes by Attribute or Measure"

8 Nodes, 20 Links No Timestamp Hypertopic: 0 Zoom: 7

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# Color Network By Metrics (One Mode)

**Total Degree Centrality**

Node Color Selector

Select an attribute: <no attribute available>

Select a measure: Centrality, Total Degree

Invert links for geographic measures

Geographic measure radius: 1

0.142857 (blue)

0.285714 (green)

0.428571 (yellow)

0.571428 (orange)

0.714286 (red)

Apply Changes Close

Centrality, Total Degree Values: (0.142857,0.714286)

8 Nodes, 20 Links No Timestamp Hyperbolic: 0 Zoom: 7

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# Color Network By Metrics (One Mode)

**Betweenness Centrality**

Node Color Selector

Select an attribute: <no attribute available>

Select a measure: Centrality, Betweenness

Invert links for geographic measures

Geographic measure radius: 1

0.0 (blue)

0.02381 (green)

0.04762 (yellow)

0.09524 (orange)

0.14286 (red)

0.19048 (purple)

0.2381 (brown)

0.28571 (pink)

0.33333 (grey)

0.38095 (black)

0.42857 (dark blue)

0.47619 (dark green)

0.52381 (dark yellow)

0.57143 (dark orange)

0.61905 (dark red)

0.66667 (red)

Apply Changes Close

Centrality, Betweenness Values: [0.0,0.66667]

8 Nodes, 20 Links No Timestamp Hyperbolic: 0 Zoom: 7

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# Color Network By Metrics (One Mode)

Closeness Centrality

Node Color Selector

Select a measure: Closeness Centrality

Centrality, Closeness Values: [0.411785,0.777778]

8 Nodes, 20 Links No Timestamp

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# Color Network By Metrics (One Mode)

Eigenvector Centrality

Node Color Selector

Select a measure: Centrality, Eigenvector

Centrality, Eigenvector Values: [0.109484,0.338423]

8 Nodes, 20 Links No Timestamp

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## Color Network By Metrics (One Mode)

Clustering Coefficients

Node Color Selector

Select an attribute: -no attributes available-

Select a measure: Density, Clustering Coefficient

Invert links for geodesic measures

Geodesic measure radius: 1

0.0 [Blue]

0.3 [Green]

0.666667 [Yellow]

1.0 [Red]

Apply Changes Close

Density, Clustering Coefficient Values: [0.0,1.0]

8 Nodes, 20 Links No Timestamp Hypostatic: 0 Zoom: 7

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# Experiment 2a

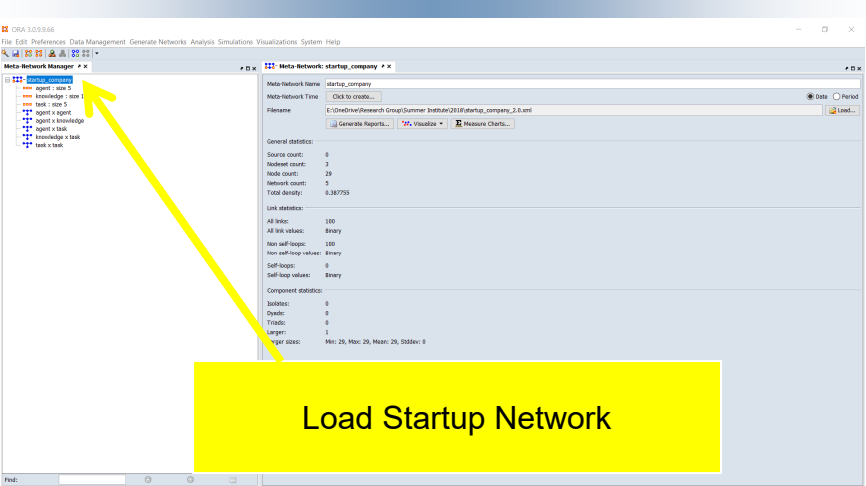
Generate one mode network metrics from  
ORA report

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# Generate one mode metrics from ORA



ORA 10/9/66  
File Edit Preferences Data Management Generate Networks Analysis Simulations Visualizations System Help

Meta-Network Manager

- agent x size 5
- knowledge x size
- task x size 5
- agent x agent
- agent x knowledge
- agent x task
- knowledge x task
- task x task

Meta-Network Name: startup\_company  
Meta-Network Time: Click to create...

Filename: E:\OneDrive\Research Group\Summer\betabeta\2019\startup\_company\_2.0.xml  
Generate Reports... Visualize Measure Charts...

General statistics:

Source count:	0
Node count:	3
Node count:	29
Network count:	5
Total density:	6.387755

Link statistics:

All links:	100
All link values:	Binary
Non self-loops:	100
Non self-loop values:	Binary
Self-loops:	0
Self-loop values:	Binary

Component statistics:

Isolates:	0
Dynids:	0
Trails:	0
Larger:	1
Major sizes:	Min: 26, Max: 29, Mean: 29, StdDev: 0

Load Startup Network

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# Generate one mode metrics from ORA

ORA 3.0.9.66  
File Edit Preferences Data Management Generate Networks Analysis Simulations Visualizations System Help

Meta-Network Manager

- agent : size 5
- knowledge : size 19
- task : size 5
- agent x agent
- agent x knowledge
- agent x task
- knowledge x task
- task x task

Meta-Network: startup\_company

Meta-Network Name: startup\_company  
Meta-Network Time: Click to create...  
Filename: E:\OneDrive\Research Group\Summer Institute\2018\startup\_company\_3.0.xml

General statistics:

- Source count: 0
- Nodelet count: 3
- Node count: 29
- Network count: 5
- Total density: 0.38777

Link statistics:

- All links: 100
- All link values: 84
- Non self-loops: 5
- Non self-loop values: many
- Self-loops: 0
- Self-loop values: Binary

Component statistics:

- Solubles: 0
- Dryads: 0
- Trails: 0
- Target: 1
- LL: Min: 29, Max: 29, Mean: 29, StdDev: 0

1. Select meta network  
2. Click generate reports

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# Generate one mode metrics from ORA

Generate Reports - Custom

Select Report: Custom

Filter Data: Custom

Measure: Custom

Reports: select a report to run from the list or by category.

Description: Input Requirements | Output Formats

Computes a custom report with user selected measures and output tables, pictures, and figures.

1. Use Custom report  
2. Click Filter Data

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1. Type centrality  
2. Select Centrality, Betweenness  
3. Select Centrality, Closeeness  
4. Select Centrality, Total-degree

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1. Type Network centralization  
2. Select Network Centralization, Betweenness  
3. Select Network Centralization, Closeeness  
4. Select Network Centralization, Total-degree  
5. Click Next and save file to location

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# Generate one mode metrics from ORA

1. Click Next on this and following screens and select location to save

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# Generate one mode metrics from ORA

## CUSTOM REPORT

Input data: startup\_company  
Start time: Fri May 25 15:33:46

[Data Description](#)

### Table of Contents

- [Analysis for network\\_agent x agent](#)
- [Analysis for nodeset\\_agent](#)

View Analysis node class agent

Produced by ORA, a joint product of the CASOS center at Carnegie Mellon University and Netanomics

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# Generate one mode metrics from ORA

## Agent-level Measures

Input data: startup\_company  
Start time: Fri May 25 15:33:46 2018  
[Return to previous page](#)

Node-Level Measure / Input	AvgStdDev	Min/Max	Min-Nodes/Max-Nodes
Centrality-Betweenness	0.200	0	Andres, Chuck, Larry
Input: agent x agent	0.245	0.500	Andres, Chuck
Centrality-Betweenness	1.200	0	Andres, Chuck, Larry
Input: agent x agent	1.470	3	Andres, Chuck
Centrality-Betweenness [inverted=true]	0.200	0	Andres, Chuck, Larry
Input: agent x agent [inverted=true]	0.245	0.500	Andres, Chuck
Centrality-Betweenness [inverted=true]	1.200	0	Andres, Chuck, Larry
Input: agent x agent [inverted=true]	1.470	3	Andres, Chuck
Centrality-Closeness	0.653	0.500	Andres, Chuck
Input: agent x agent	0.134	0.800	Andres, Chuck
Centrality-Closeness	0.163	0.125	Andres, Chuck
Input: agent x agent	0.034	0.200	Andres, Chuck
Centrality-Closeness [inverted=true]	0.653	0.500	Andres, Chuck
Input: agent x agent [inverted=true]	0.134	0.800	Andres, Chuck
Centrality-Closeness [inverted=true]	0.163	0.125	Andres, Chuck
Input: agent x agent [inverted=true]	0.034	0.200	Andres, Chuck
Centrality-Eccentricity	2.400	2	Andres, Chuck, Larry
Input: agent x agent	0.490	3	Andres, Chuck
Centrality-Eccentricity [inverted=true]	2.400	2	Andres, Chuck, Larry
Input: agent x agent [inverted=true]	0.490	3	Andres, Chuck
Centrality-In-Closeness	0.046	0.045	Andres, Chuck
Input: agent x agent	7.247e-04	0.047	Andres, Chuck
Centrality-In-Closeness	0.012	0.011	Andres, Chuck
Input: agent x agent	1.812e-04	0.012	Andres, Chuck
Centrality-In-Closeness [inverted=true]	0.046	0.045	Andres, Chuck

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# Generate one mode metrics from ORA

## CUSTOM REPORT

Input data: startup\_company  
Start time: Fri May 25 15:33:46 2018

[Data Description](#)

[View Analysis for network Agent by Agent](#)

### Table of Contents

- [Analysis for network agent x agent](#)
- [Analysis for nodeset agent](#)

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# Generate one mode metrics from ORA

**Network Agent x agent**

Input data: agent x agent  
Start time: Fri May 25 15:33:46 2018  
[Return to previous slide](#)

These measures take as input only the network agent x agent and output a single value (network-level measures) or a collection of values (node-level).  
These measures output a single value.

Network-Level Measure	Value
Centrality-Radiality [inverted=true]	0
Centrality-Radiality	0
Characteristic Path Length	1.600
Characteristic Path Length [inverted=true]	1.600
Diameter [inverted=true]	3
Diameter	3
Diameter-Reachable	3
Diameter-Reachable [inverted=true]	3
Network Centralization-Betweenness [inverted=true]	0.375
Network Centralization-Betweenness	0.375
Network Centralization-Closeness [inverted=true]	0.428
Network Centralization-Closeness	0.428
Network Centralization-In Closeness	0.002
Network Centralization-In Closeness [inverted=true]	0.002
Network Centralization-Total Degree	0.417
Speed-Average [inverted=true]	0.625
Speed-Average	0.625
Speed-Minimum	0.333
Speed-Minimum [inverted=true]	0.333

Node-Level Measure	Arg/StdDev	Min/Max	Min-Nodes/Max-Nodes
Boundary Spanner-Potential	0.200	0	Andrea, Chuck, Larry
Centrality-Betweenness	0.245	0.500	Andrea, Chuck
Centrality-Betweenness	0.200	0	Andrea, Chuck, Larry

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# Experiment 2b

## Generate two mode network metrics from ORA report

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# Generate two mode metrics from ORA

The screenshot shows the ORA 3.0.9.66 interface. On the left, the 'Meta Network Manager' tree is expanded to show 'startup\_company'. A yellow arrow points from the 'startup\_company' node to a yellow box at the bottom containing the text 'Load Startup Network'. The main window displays the 'Meta Network: startup\_company' details, including general statistics, link statistics, and component statistics.

Category	Item	Value
General statistics:	Source count:	0
	Nodelet count:	3
	Node count:	29
	Network count:	5
Link statistics:	Total density:	0.38775
	All links:	100
	All link values:	Binary
	Non self-loops:	100
	Non self-loop values:	Binary
Component statistics:	Self-loops:	0
	Self-loop values:	Binary
	Isolates:	0
	Dynals:	0
	Treads:	0

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# Generate two mode metrics from ORA

The screenshot shows the ORA 3.0.9.66 interface. A yellow arrow labeled '1' points to the 'startup\_company' node in the 'Meta Network Manager' tree. Another yellow arrow labeled '2' points to the 'Generate Reports...' button in the 'Meta Network: startup\_company' details window. A yellow box at the bottom contains the text '1. Select meta network 2. Click generate reports'.

Category	Item	Value
General statistics:	Source count:	0
	Nodelet count:	3
	Node count:	29
	Network count:	5
Link statistics:	Total density:	0.38775
	All links:	100
	All link values:	Binary
	Non self-loops:	100
	Non self-loop values:	Binary
Component statistics:	Self-loops:	0
	Self-loop values:	Binary
	Isolates:	0
	Dynals:	0
	Treads:	0

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## Generate two mode metrics from ORA

1. Use Custom report  
2. Click Filter Data

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## Generate two mode metrics from ORA

1. Choose agent and knowledge  
2. Choose only agent by knowledge  
3. Select Measures

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## Generate two mode metrics from ORA

Generate Reports - All Measures by Category

Select Report  
Filter Data  
**Measures**  
Negative Links  
Union by Thirds  
Transform Data  
Remove Nodes

Measures: select which measures to allow the reports to use in analysis. A report does not necessarily use all measures.

Run with all measures  
 Run with fast and normal measures  
 Run with only fast measures  
 Run with specific measures

Select Measures | Set Measure Inputs

Measure Title	Network L...	Node Level
<input type="checkbox"/> Access Index, Knowledge Based	false	true
<input type="checkbox"/> Access Index, Resource Based	false	true
<input type="checkbox"/> Actual Workload	false	true
<input type="checkbox"/> Actual Workload, Knowledge	false	true
<input type="checkbox"/> Availat		
<input type="checkbox"/> Availat		
<input type="checkbox"/> Availat		
<input type="checkbox"/> Availability, Role Knowledge	false	true
<input type="checkbox"/> Availability, Role Resource	false	true
<input type="checkbox"/> Average Neighbor, Degree	false	true
<input type="checkbox"/> Average Neighbor, Out-Degree	false	true
<input type="checkbox"/> Average Neighbor, Total-Degree	false	true
<input type="checkbox"/> Bou		

1. Select Run with specific measure  
2. Click Select/Clear All

0 / 177 Selected, 177 / 177 Visible

< Back Next > Cancel

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## Generate two mode metrics from ORA

Generate Reports - All Measures by Category

Select Report  
Filter Data  
**Measures**  
Negative Links  
Union by Thirds  
Transform Data  
Remove Nodes

Measures: select which measures to allow the reports to use in analysis. A report does not necessarily use all measures.

Run with all measures  
 Run with fast and normal measures  
 Run with only fast measures  
 Run with specific measures

Select Measures | Set Measure Inputs

load

Measure Title	Network L...	Node Level	Computa...	Use
<input type="checkbox"/> Actual Workload	false	true	normal	false
<input checked="" type="checkbox"/> Actual Workload, Knowledge	false	true	normal	false
<input type="checkbox"/> Actual Workload, Resource	false	true	normal	false
<input type="checkbox"/> Potential Workload	false	true	normal	false
<input type="checkbox"/> Potential Workload, Knowledge	false	true	normal	false
<input type="checkbox"/> Potential Workload, Resource	false	true	normal	false

1. Type Load  
2. Check Actual Load, Knowledge  
3. Repeat for: Correlation, Expertise and Redundancy, Column.  
4. Click Next and select location to save

1 / 177 Selected, 177 Visible

< Back Next > Cancel

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# Generate two mode metrics from ORA

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## CUSTOM REPORT

Input data: startup\_company  
Start time: Fri May 25 15:49:28

[Data Description](#)      **View Analysis nodeset agent**

### Table of Contents

- [Analysis for network agent x knowledge](#)
- [Analysis for nodeset agent](#)

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# Generate two mode metrics from ORA

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### Agent-level Measures

Input data: startup\_company  
Start time: Fri May 25 15:49:28 2018  
[Return to previous page](#)

Node-Level Measure / Input	Arg/Soldev	Min/Max	Min-Nodes/Max-Nodes
Correlation-Cosine Similarity	0.495	0.372	Andrea
Input: agent x knowledge	0.071	0.577	Andrea
Correlation-Distinctiveness	0.495	0.461	Andrea
Input: agent x knowledge	0.018	0.513	Andrea
Correlation-Expertise	0.476	0.417	Andrea
Input: agent x knowledge	0.046	0.550	Andrea
Correlation-Resemblance	0.505	0.487	Andrea
Input: agent x knowledge	0.018	0.539	Andrea
Correlation-Jaccard Similarity	0.523	0.202	Andrea
Input: agent x knowledge	0.065	0.383	Andrea

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# Generate two mode metrics from ORA

## CUSTOM REPORT

Input data: startup\_company  
Start time: Fri May 25 15:49

[Data Description](#)

**Table of Contents**

- [Analysis for network agent x knowledge](#)
- [Analysis for nodeset agent](#)

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View Analysis for network Agent by Knowledge

Analysis for network agent x knowledge

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# Generate two mode metrics from ORA

## Network Agent x knowledge

Input data: agent x knowledge  
Start time: Fri May 25 15:49:29 2018

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These measures take as input only the network agent x knowledge and output a single value (network-level measure) or a collection of values (node-level).

These measures output a single value.

Network-Level Measure	Avg/StdDev	Min/Max	Min-Nodes/Max-Nodes	Value
Redundancy-column				0.368
Correlation-Cosine Similarity	0.495	0.372	Andrea	
	0.071	0.577	Andrea	
Correlation-Distinctiveness	0.495	0.461	Andrea	
	0.018	0.513	Andrea	
Correlation-Expertise	0.476	0.417	Andrea	
	0.046	0.550	Andrea	
Correlation-Jaccard Similarity	0.323	0.202	Andrea	
	0.065	0.383	Andrea	
Correlation-Resemblance	0.505	0.487	Andrea	
	0.018	0.539	Andrea	

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## Agenda

- Concepts
  - Types of networks
  - Types of metrics
- Network Metrics in ORA
  - Overview
  - Common one/two mode metrics
- Experiments
  - Color nodes by network metrics
  - Generate one/two mode network metrics from ORA report
  - Hiding Network type Information from ORA Metrics
- Folding Networks

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## Hiding Network type Information from ORA Metrics

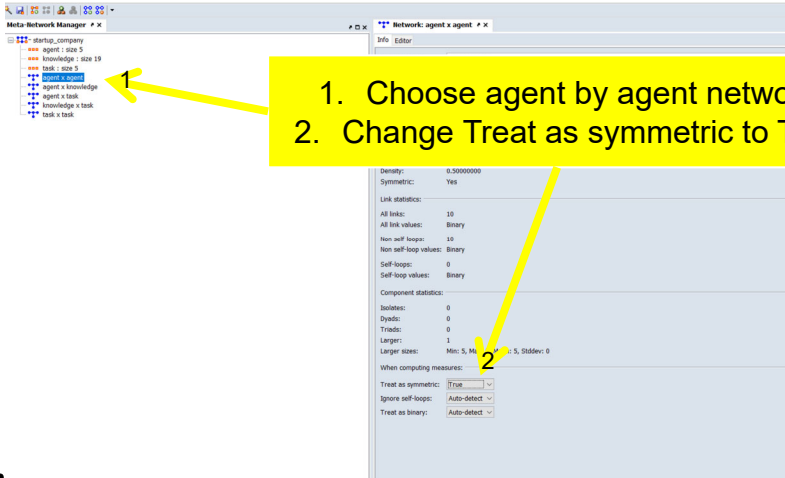
- When do you want to hide information from ORA metrics?
  - When you have a weighted network but want the ORA metrics to treat it as a binary network.
  - When you have a network with self-loop but want ORA to treat it as a no self-loop network.
  - When you have an asymmetric network but want ORA to treat it as a symmetric network.
- Why that matters?
  - Some measures have different implementations when network types are different.
  - ORA choose the versions of metrics by automatically detecting the network type.

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## Hiding Network type Information from ORA Metrics



1. Choose agent by agent network  
2. Change Treat as symmetric to True

Density: 0.5000000  
Symmetric: Yes  
Link statistics:  
All links: 10  
All link values: Binary  
Non self-loops: 10  
Non self-loop values: Binary  
Self-loops: 0  
Self-loop values: Binary  
Component statistics:  
Isolates: 0  
Dyads: 0  
Treads: 0  
Larger: 1  
Larger sizes: Min: 5, Max: 5, Stdev: 0  
When computing measures:  
Treat as symmetric: True  
Ignore self-loops: Auto-detect  
Treat as binary: Auto-detect

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## Agenda

- Concepts
  - Types of networks
  - Types of metrics
- Network Metrics in ORA
  - Overview
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## Folding Networks (1/2)

- What is networks folding?
  - Convert a two mode network into a one model network by aggregating resources over a specific node class.
  - Folding an agent by knowledge network will yield an agent by agent network with each link represents the shared knowledge between them
  - Mathematically, For a specific two mode network M, Folded Network  $F=M*M'$
- Why do we fold networks?
  - To eliminate an additional dimension.
  - To calculate indirect relations

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## Folding Networks (2/2)

Person	Avg. Shared Knowledge
Larry	3.50
Terry	3.00
Chuck	2.75
Andrea	2.00
Meindl	1.75

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## Folding Networks in ORA (1/4)

1. Right click Agent by Knowledge Network  
2. Choose Fold Networks

Target Network: Knowledge  
Properties:  Symmetric (undirected links)  No self-loops  Binary link values

General statistics:  
Source count: 5  
Target count: 19  
Density: 0.49473694  
Symmetric: N/A

Link statistics:  
All links: 47  
All link values: Binary  
Non self-loops: 47  
Non self-loop values: Binary  
Self-loops: N/A  
Self-loop values: N/A

Component statistics:  
Isolates: 0  
Dyads: 0  
Triads: 0  
Larger: 1  
Larger sizes: Min: 24, Max: 24, Mean: 24, Stdev: 0

When computing measures:  
Treat as symmetric: Auto-detect  
Ignore self-loops: Auto-detect  
Treat as binary: Auto-detect

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## Folding Networks in ORA (2/4)

Link statistics:  
All links: 47  
All link values: Binary  
Non self-loops: 47  
Non self-loop values: Binary  
Self-loops: N/A  
Self-loop values: N/A

Component statistics:  
Isolates: 0  
Dyads: 0  
Triads: 0  
Larger: 1  
Larger sizes: Min: 24, Max: 24, Mean: 24, Stdev: 0

When computing measures:  
Treat as symmetric: Auto-detect  
Ignore self-loops: Auto-detect  
Treat as binary: Auto-detect

Fold Network - agent x knowledge  
Creates a new network whose links record the commonality of nodes. Folding a binary-valued network yields a network with the link value  $(i,j)$  indicating the quantity of shared neighbors for nodes  $i$  and  $j$ .

Choose whether to compare network rows or columns:  
Rows (agent) 1  
 Use link weights 2  
 Return only top-valued links  
Output network:  
agent x agent - shared knowledge 3

1. Choose Rows (agent)  
2. Check Use link weights  
3. Click Fold

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## Folding Networks in ORA (3/4)

ORA 3.0.0.66  
File Edit Preferences Data Management Generate Networks Analysis Simulations Visualizations System Help

Meta-Network Manager

Network Editor: agent \* agent - shared knowledge

Network Name: agent \* agent - shared knowledge  
Source NodeSet: agent  
Target NodeSet: agent

Properties:  
 Visualize this Network  
 Visualize Only this Network  
 Symmetric (undirected links)  
 No self-loops  
 Binary link values

General statistics:  
Source count: 5  
Target count: 5  
Density: 1.00000000  
Symmetric: Yes

Link statistics:  
All links: 25  
All link values: Min: 1, Max: 11, Mean: 5.64, StdDev: 2.024107, Sum: 141, Mean + StdDev: 8.064107  
Non self-loops: 20  
Non self-loop values: Min: 1, Max: 7, Mean: 4.7, StdDev: 2.002498, Sum: 94, Mean + StdDev: 6.702498

Treat as symmetric: Auto-detect  
Ignore self-loops: Auto-detect  
Treat as binary: Auto-detect

A new network with name ending with “shared knowledge” will appear

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## Folding Networks in ORA (4/4)

startup\_company - ORA Network Visualizer

File View Actions Tools Layouts Meta-Nodes Node Appearance Link

2-D Visualizer

cloud andrea terry mario larry

5 Nodes, 20 Links No Timestamp Hypertable: 0 Zoom: 31

Visualization shows the agent by agent network with links represent shared knowledge

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# Questions?

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