



Accelerating Your Mission.

# *Analyst's Notebook 8* **Social Network Analysis**

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## Who should read this white paper?

This white paper is intended for users who are familiar with *Analyst's Notebook 7* and wish to learn about the new Social Network Analysis functionality delivered by *Analyst's Notebook 8*. Managers will also benefit from learning about these new features so that they can assign tasks to their analysts more effectively.

This whitepaper includes functionality that has been included in *Analyst's Notebook 8.5*. The table below gives an overview of the release history for the Social Network Analysis capabilities in *Analyst's Notebook*.

Version	Date	SNA Capabilities Added
<i>Analyst's Notebook 8.0.1</i>	June 2009	First release including betweenness, closeness and degree centrality measures
<i>Analyst's Notebook 8.0.5 (SP1)</i>	November 2009	Enhanced Analysis and normalization options added SNA calculations can be run in the background
<i>Analyst's Notebook 8.5.1</i>	May 2010	Eigenvector (hubs and authorities) centrality measures added Weightings options moved to separate tab in the SNA Task Pane

## Introduction to Analyst's Notebook 8

*Analyst's Notebook 8*, part of the i2 Intelligence-Led Operations Platform, delivers powerful new assisted analysis and visualization capabilities that increase analyst productivity and reduce the time required to deliver high value intelligence within quickly growing data sets. *Analyst's Notebook 8* is a major new product version which benefits from new functional requirements driven by the analytical community.

i2 has implemented Social Network Analysis capabilities within *Analyst's Notebook 8*. These can be used alongside existing *Analyst's Notebook* functionality to examine and analyze group structures and communication flows within networks to enable users to better understand relationships between entities in *Analyst's Notebook* charts.

A brief background on the origins of Social Network Analysis, how it may be of use to people conducting intelligence analysis, a description of the SNA measures implemented in *Analyst's Notebook 8* and where the key features of this functionality are located, are described in this white paper.

## The Background of Social Network Analysis

Social Network Analysis (SNA) emerged from Social Sciences as a useful method to enable academics to study how and why social groups operate, interact and behave in particular ways. This quantitative technique enables people to map and measure complex networks of entities such as people and organizations, by measuring the interactions between them. It is suggested that SNA may help people to understand and predict future network behaviors, such as their likely courses of actions and intentions in certain situations.

SNA combines organizational theories with mathematical models to help people to better understand the dynamics of groups and organizations in which they are interested. The structure of a network can determine:

- The performance of the network as a whole and its ability to achieve its key goals.
- Characteristics of the network that are not immediately obvious, such as the existence of smaller sub-networks operating within the network.
- The relationships between prominent people of interest whose position may provide the greatest influence over the rest of the network.
- How directly and quickly information flows between people in different parts of the network.

## Why use Social Network Analysis?

During conversations with customers, a number of real-world problems have been noted by i2. They include:

- Issues around data deluge – Users are having to deal with ever-growing data sets, which means that they need capabilities that can help to filter network information faster and more efficiently
- A need to better understand target networks - Due to the dynamism of target networks, they need to quickly identify potential key individuals/groups for better prioritization of often limited resources.
- Having to look beyond the network structure into its dynamics - To identify characteristics of networks that are not immediately apparent and to also analyze how those networks change over time.
- Finally, our users recognize that in social networks not all connections are equal, and they need to be able to use methods such as weighting relationships between entities to take account of how such links affect a network.

Social Network Analysis techniques may help to overcome such issues by providing users with the means to maximize their understanding of the data that they collect. This may then enable them to better evaluate future courses of action against target networks such as how best to disrupt and destabilize networks in the most efficient way possible.

## Social Network Analysis – An Analytical Tool, Not An Answer

SNA is an analytical tool in the intelligence analysis toolbox, not a “Silver-Bullet”. It merely provides users with a starting point for areas that warrant further analysis. The use of SNA can be extremely effective when used as an aid to human analytical judgement, but users need to be mindful that their data could be incomplete and may not take into account the wider context of those networks.

## A description of the SNA measures implemented in *Analyst's Notebook 8*

### Centrality

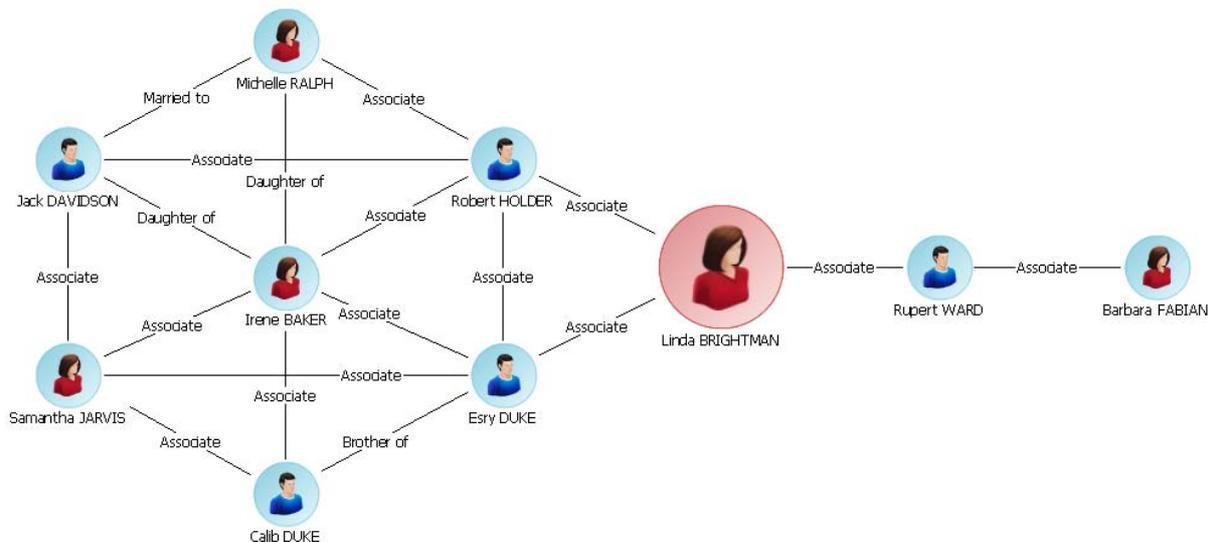
Centrality is a key concept in Social Network Analysis. A highly centralized network is dominated by one person who controls information flow and may become a single point of communication failure. A less centralized network has no single point of failure, so people can still pass on information even if some communication channels are blocked.

*Analyst's Notebook* allows users to calculate betweenness, closeness, degree and eigenvector (including hubs and authorities) centrality measures to provide different perspectives on the social relationships within the network. It is also possible to further refine centrality measures by taking into account the direction of links and the weightings applied to them.

### Betweenness

Betweenness centrality measures the number of paths that pass through each entity. This may identify entities with the ability to control information flow between different parts of the network. These are called gatekeeper entities. Gatekeepers may have many paths running through them, allowing them to channel information to most of the others in the network. Alternatively, they may have few paths running through them but still play a powerful communication role if they exist between different network clusters.

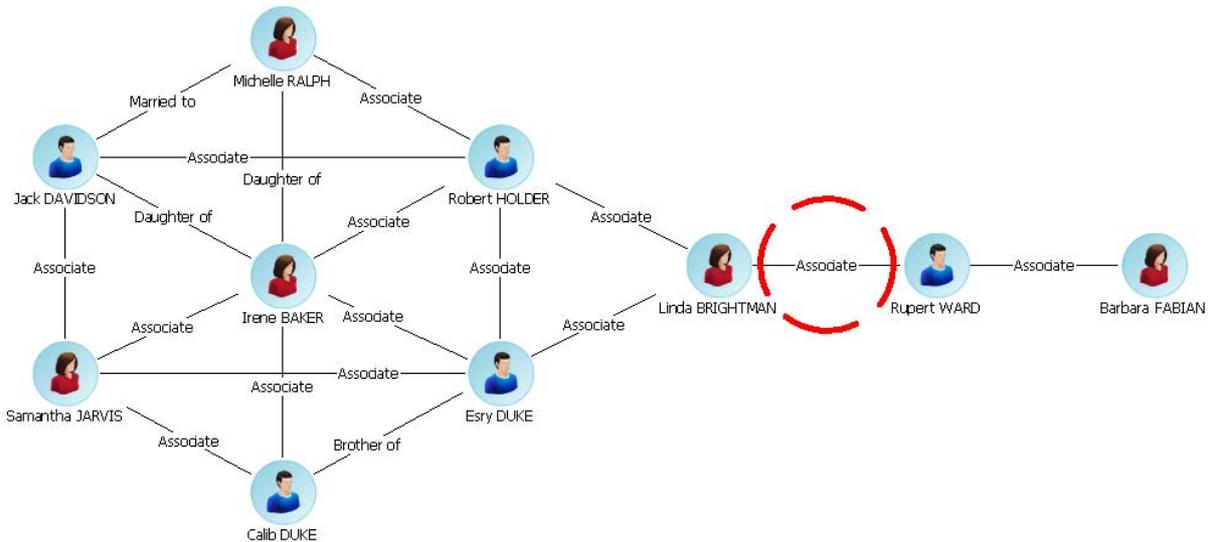
In the example below, Linda BRIGHTMAN is the person with the highest betweenness score as she is the link between two distinct parts of the network.



### Link Betweenness

Link betweenness centrality measures the number of paths that pass through each link. This can help to identify key connections of influence within the network. A link through which many paths pass may be a significant route for information exchange between entities.

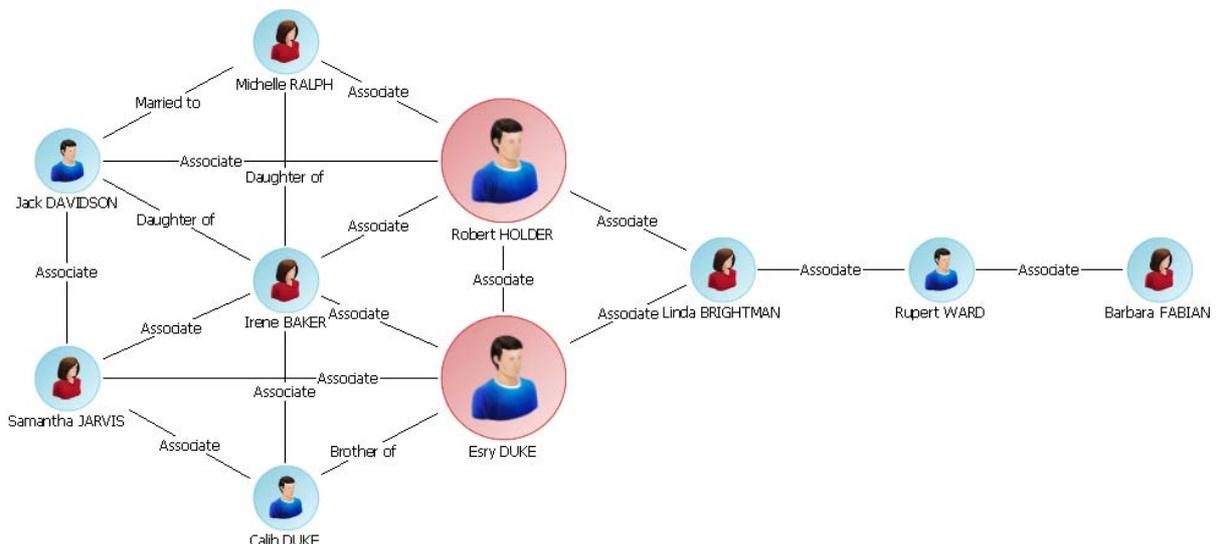
In the example below, the key connection of influence is highlighted in red. If this link were broken, a key channel for information exchange may no longer operate and the network could be separated into two distinct parts.



### Closeness

Closeness centrality measures the proximity of an entity to the other entities in the social network. An entity with a high measure of closeness centrality has the shortest paths to the other entities, allowing them to pass on and receive communications more quickly than anybody else in the organization. Information has to travel much further to and from an entity on the edge of a network that is attached to few other entities, so they will have a lower measure of closeness centrality. Closeness centrality measures both direct and indirect closeness:

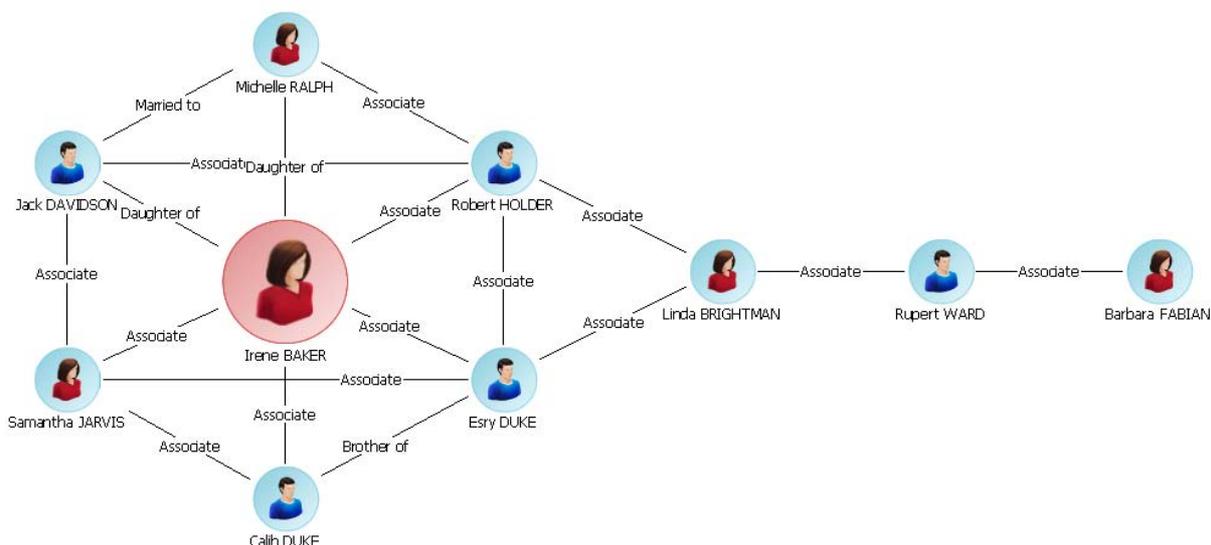
- Direct closeness is when two entities are connected by a link.
- Indirect closeness exists when information can only pass from one entity to another via a path that runs through one or more entities.



In the example on the previous page, Esry DUKE and Robert HOLDER have the highest closeness score; they have the best access to the majority of other members of the network.

### Degree

Degree centrality measures how well connected an entity is by counting the number of direct links each entity has to others in the network. This can reveal how much activity is going on and who are its most active members.



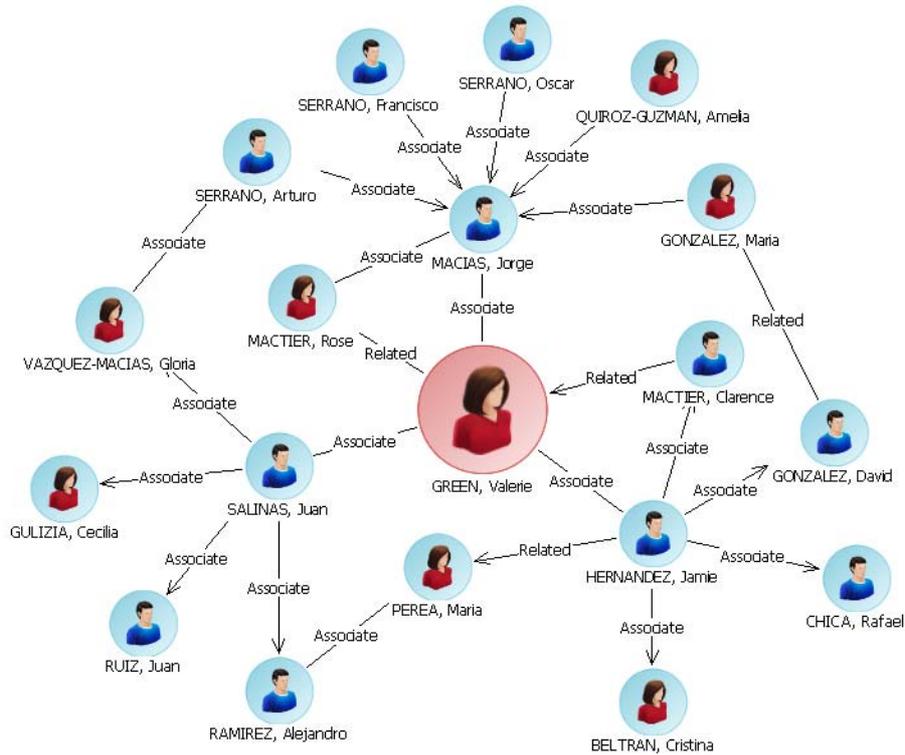
In the example above, Irene BAKER is the most central person in the network; she has the highest number of connections to other people in the network.

### Eigenvector

Eigenvector centrality measures how well connected an entity is and how much direct influence it may have over the most active entities in the network. It does this by taking into consideration the centrality scores of the entities it is connected to. For example, a person with high eigenvector centrality is likely to be at the center of a cluster of key entities that also have high centrality. That person can communicate directly with those key entities compared with a person with a low eigenvector score on the periphery of the network.

Hubs and authorities are the terms used to describe the two eigenvector centrality scores calculated in networks containing directed links. Hubs refer to the scores for outbound links, and authorities refer to the scores for inbound links. There is a reciprocal relationship between the two; a high-scoring hub has many outbound links to high-scoring authorities, and a high-scoring authority has many inbound links from high-scoring hubs.

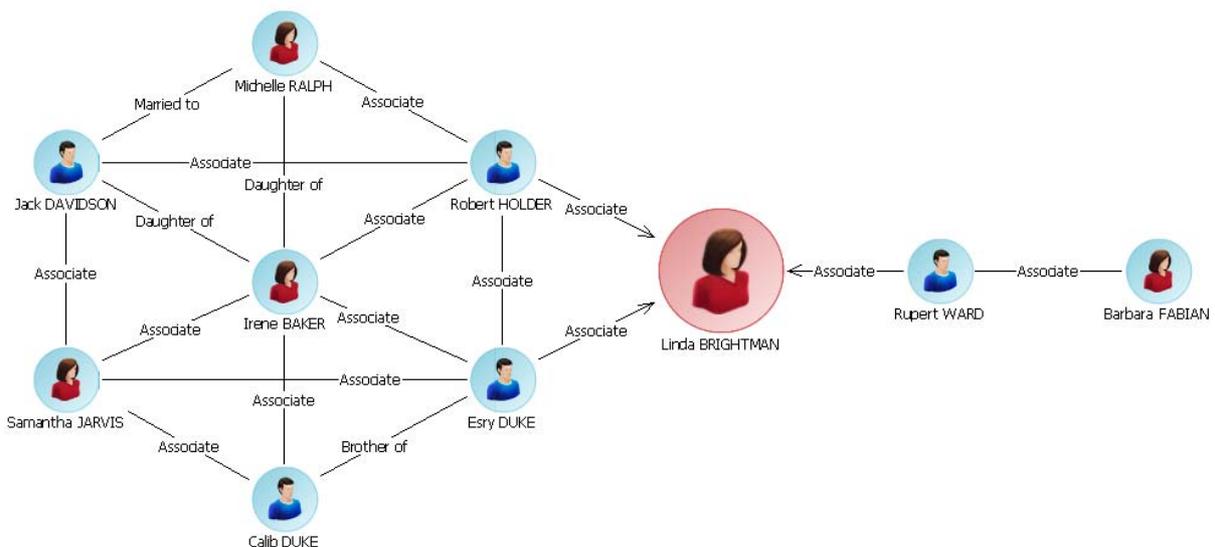
In the example on the following page, Valerie Green has the highest measure of eigenvector centrality because she is connected to entities that are the most active in the network. Her position at the heart of the central cluster in the network means that she has more direct links to key entities than any other entity. She may exercise influence over them more quickly than anyone else.



**Link Direction**

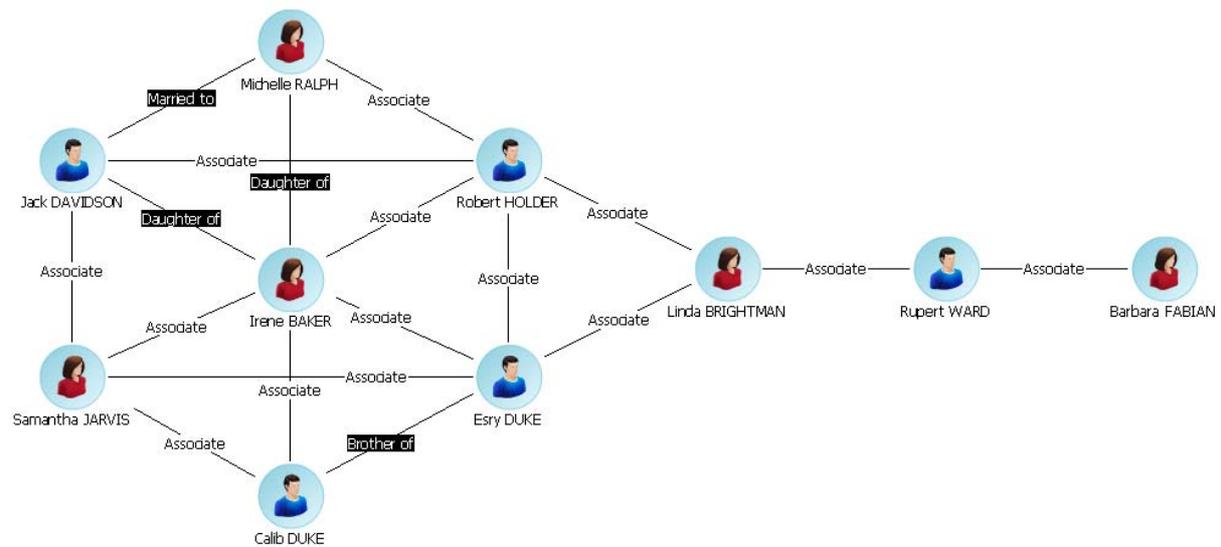
The use of link direction on a chart is often useful in assessing how information and commodities flow through a network. A link with arrows added to it represents the directed flow of information between entities; either in a single direction or in both directions. This may have an important bearing on how quickly information is passed from one part of the network to another. For example, a person may receive information from many others in the network but only send information to a select few. The centrality measures for an entity through which information is channeled in both directions will be higher than the measures for an entity through which information is channeled one way. Directed links can be included in the calculation of centrality measures against network charts.

In the example below, Linda BRIGHTMAN appears to be capable of receiving information from others, but is not passing it on to other parts of the network.



### Link Weightings

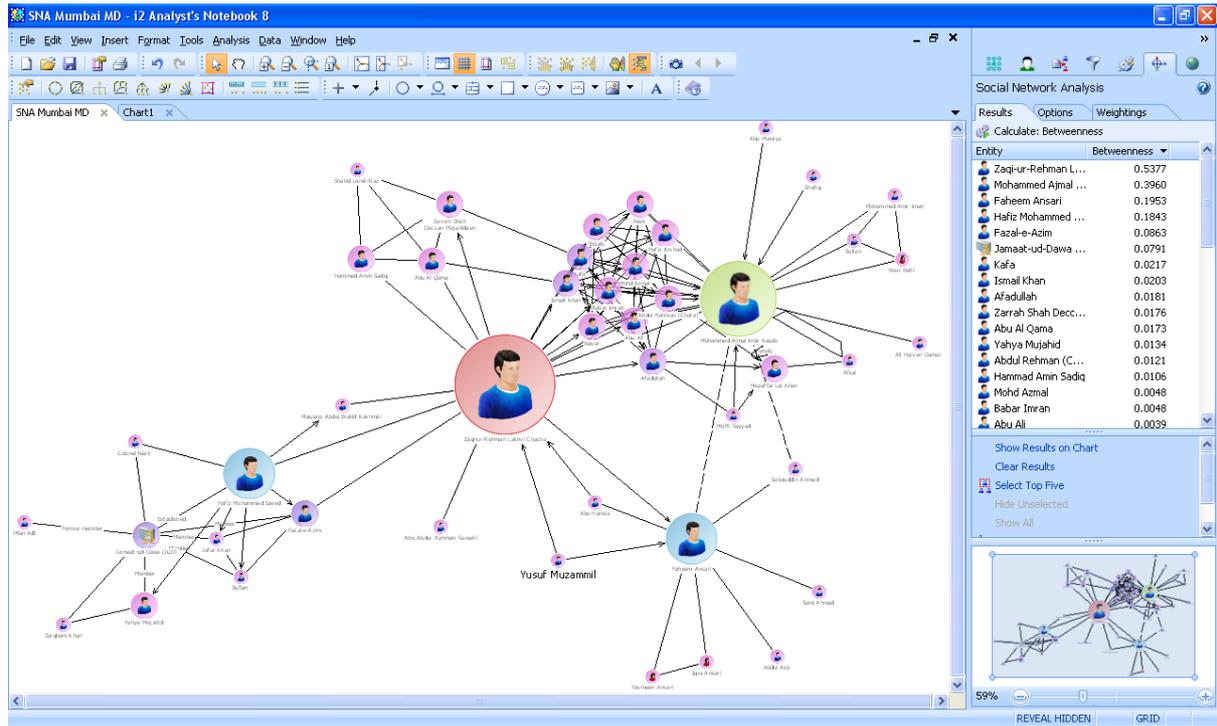
Social Network Analysis can also be enhanced by the use of weightings to indicate the strength of differing relationships (links), all of which has an effect on a target network. This helps to deliver a more real-world indication of the dynamics and structure of a given target network. As discussed earlier in this white paper, not all relationships in a network are equal. For example, qualitatively, the link between two people connected through a family relationship may be stronger than a link between two business associates. These links can be weighted so that they represent real-world strengths when carrying out Social Network Analysis. Weighting key paths in the network may also infer that the entities using them to channel information have key roles to play. For this reason, centrality measure results are affected by link weightings.



### Conditional Formatting

Once SNA calculations have been run against a chart, users may wish to emphasise certain pieces of that information within it. This is especially helpful if the chart is visually complex. The new conditional formatting capability in *Analyst's Notebook 8* can be used for example to illustrate key entities in a social network. Formatting rules can be created and then run against the data held in the chart to highlight key entities and links by enlarging their size, thickening and colouring their links so they clearly stand out in complex charts.

This example below shows how the use of conditional formatting can help to easily visualize who and where potential key individuals are placed in a network and how a network is structured. The larger the circle (Icon Frame) on an entity, the higher its' betweenness score is.



## Where Social Network Analysis functionality is located in *Analyst's Notebook 8* and how it may be used

To carry out Social Network Analysis you need to select the Social Network Analysis tab  in the Task Pane.

### The Options Page

To set the centrality measures you want to run, select the **Options** tab to display the Options Page. From here, you can select single or multiple centrality measures and choose to take into account directed links.

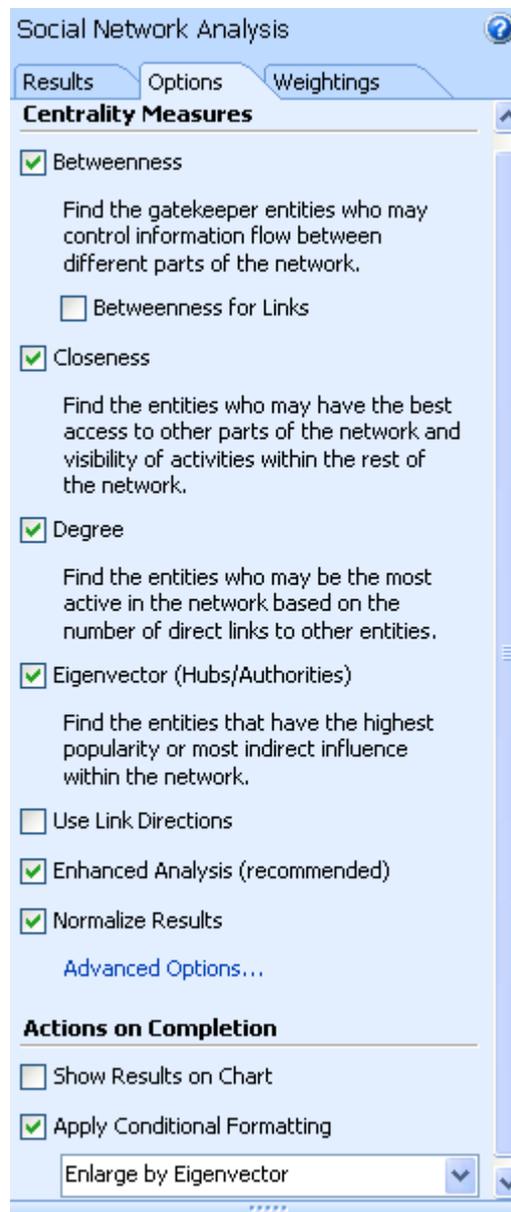
The **Enhanced Analysis** option provides user control over how *Analyst's Notebook* deals with charts with several unconnected networks, or directed links that block paths between certain entities.

**Normalize Results** to adjust the calculations and display them as percentages in the Results table. If you turn off this option, no adjustment is made to the calculations and results are displayed as raw data. Normalizing the results makes it easier to compare the centrality results of items in different networks and charts.

### Actions on Completion

Different actions can be run on completion of Social Network Analysis calculations to aid results visualization:

- They can also show results on the chart by choosing **Show Results on Chart**
- **Conditional Formatting** can also be applied on completion, to emphasize information such as enlarging and coloring icons by betweenness. To apply this select the **Apply Conditional Formatting** option, then select a Conditional Formatting specification from the drop-down list.



## The Weightings Page

Social Network Analysis can be enhanced by the use of weightings to indicate the strength of differing relationships (links), in social networks. In *Analyst's Notebook 8*, weightings can be manually set on a chart by chart basis, or can be implemented by using pre-configured weightings file.

Weightings can be used by selecting the **Use Link Weightings** option on the Options Page, and then:

- Selecting entities and using the **Manually Set Value** option to enter a specific weighting value.
- Selecting an existing numeric **Custom Attribute** and using that attribute value as the weighting value.
- Selecting details **From a Weightings File**. Click the **Create a New File** option to create a new weightings file, or **Select a File** to import an existing one.
- Users can opt to display the weightings that they have used on the chart by selecting **Show Weightings on chart**

Social Network Analysis

Results Options Weightings

**Link Weightings**

Use Link Weightings

Look for a Weighting in These Places:

1. Manually Set Value:

Set Weighting for Selection to:

1

Delete Weightings from Selection

2. Custom Attribute:

3. From a Weightings File

Create a New File...

Select a File...

C:\Documents and S...\SNA Family.xwgt

Edit File...

Show in Explorer

Show Weightings on Chart

## The Results Page

To calculate and analyze your Social Network Analysis results, select the **Results** tab to display the Results Page.

### Calculating Results

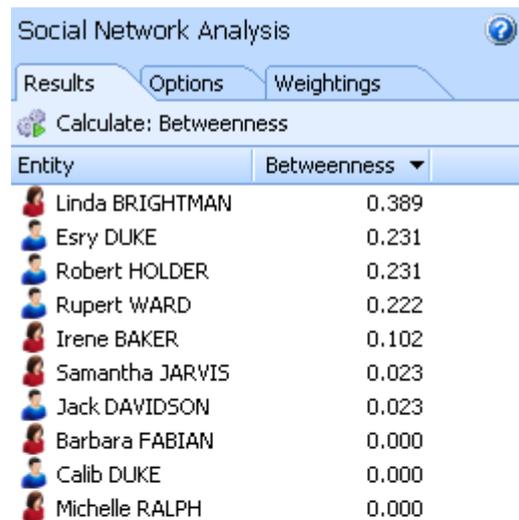
Start generating Social Network Analysis results by clicking the  **Calculate:** button.

Once results have been generated they are automatically displayed in the Results table. Results for entities and links are displayed in different tables, with the entity Results table displayed by default. In the list view the SNA results will then be displayed. You can resort the data by clicking on one of the column headers.

### Actions Panel

After generating results, users have several options that they can choose from regarding what they wish to do with their results:

- They can show the results on their chart by selecting **Show Results on Chart**
- It is also possible to select the top 5 results in the list, so that they are highlighted on the chart by choosing **Select Top Five**, and opt to **Hide Unselected items** from here too
- Finally, users can also copy the results table for inclusion into other applications such as Microsoft Word or Excel by selecting **Copy Results Table**



Social Network Analysis		
Results Options Weightings		
Calculate: Betweenness		
Entity	Betweenness	
 Linda BRIGHTMAN	0.389	
 Esry DUKE	0.231	
 Robert HOLDER	0.231	
 Rupert WARD	0.222	
 Irene BAKER	0.102	
 Samantha JARVIS	0.023	
 Jack DAVIDSON	0.023	
 Barbara FABIAN	0.000	
 Calib DUKE	0.000	
 Michelle RALPH	0.000	



**SNA Glossary:**

Entity	The entity icon followed by the label.
Betweenness	<p>A value representing how many of the shortest paths pass through each entity. For example, an entity with the lowest betweenness value has the lowest number of shortest paths running through it compared with the other entities in the network.</p> <p>If Use Link Direction was selected in the Options page, the arrow direction will determine which paths can be measured between entities.</p> <p>There are no separate columns for In and Out betweenness results because the number of directed inbound paths would be identical to the number of directed outbound paths if the arrows were reversed. This is because the same connecting paths are used for the betweenness calculation regardless of direction.</p>
Closeness	<p>A value representing how close each entity is to the others in the network. For example, an entity with the highest closeness value has the shortest paths to the majority of other entities in the network. If Use Link Direction was selected in the Options page, the closeness result is displayed in two separate columns:</p> <ul style="list-style-type: none"> <li>• Closeness (In): how close an entity is based on the number of inbound paths</li> <li>• Closeness (Out): how close an entity is based on the number of outbound paths</li> </ul>
Degree	<p>The number of links each entity has to others in the network. If Use Link Direction was selected in the Options page, the degree result is displayed in two separate columns:</p> <ul style="list-style-type: none"> <li>• Degree (In): the total number of inbound links</li> <li>• Degree (Out): the total number of outbound links</li> </ul> <p>An entity's degree result is affected if the links connecting it have been weighted. For example, a link with a weighting of four is classed as four times more important than a link without a weighting. It counts as four links, whereas a link without an assigned weighting counts as one by default. The degree for an entity connected by two links, where one link has no weighting and the other has a weighting of four, would be five.</p>
Eigenvector	<p>A value representing how well connected or influential an entity is based on its direct links to the other active entities in the network. An entity with the highest eigenvector score is directly connected to many other entities with high centrality scores. If Use Link Direction was selected in the Options page, two eigenvector results are calculated and displayed in two separate columns:</p> <ul style="list-style-type: none"> <li>• Authority (In): how well connected an entity is based on its inbound links</li> <li>• Hub (Out): how well connected an entity is based on its outbound links</li> </ul> <p>An entity's eigenvector centrality result is affected if the links connecting it to other entities have been weighted. For example, a link weighting of three means that the link is treated as three times more important than a link with no weighting.</p> <p><b>Please Note: Hub and authority results cannot be calculated for charts containing certain configurations of entities and links. In such instances, a warning message is displayed. You may be able to calculate hub and authority results if you change your configuration, or edit your link weightings.</b></p>

Link The link icon followed by a summary of the link in the format:

Entity A label <arrow> link label <arrow> Entity B label

Link Betweenness

A value representing how many of the shortest paths pass through each link. For example, a link with the highest betweenness value has the highest number of paths running through it compared with the other links in the network.

Weighting

The weighting value assigned to each link.

Selecting a result in the table also selects and zooms to the corresponding entity or link on the chart. Results can be selected and columns resized and sorted in the usual way. Results can also be displayed on chart items.

## Technical description

### Product architecture

*Analyst's Notebook* is a standalone desktop product designed to provide users with a powerful visualization and analytical tool.

*Analyst's Notebook* has an API to enable programmatic control of the application via the *Analyst's Notebook* SDK

### What prerequisites are required to install and use the product?

The application does not require the presence of any other i2 products on the installation computer. It does however have 3rd party software prerequisites. Guidance on current minimum hardware, operating system and third party software requirements is provided on the i2 Web site at:

<http://www.i2group.com/products/system-requirements>

### Microsoft .NET Framework

*Analyst's Notebook* requires that Microsoft .NET Framework 2.0 SP1 or .NET Framework 3.5 is present on the installation system. The version of .NET you require will depend on the operating system you are running. Microsoft .NET Framework 2.0 SP1 is included on the CD. Microsoft .NET Framework 3.5 can be downloaded from the Microsoft Download Center

<http://www.microsoft.com/downloads/details.aspx?FamilyId=333325fd-ae52-4e35-b531-508d977d32a6&displaylang=en>

### PDF Viewer

The documentation provided with the product CD can be viewed electronically. In order to display the documentation a PDF viewer must be present on the installation system.

## Licensing

*Analyst's Notebook* is a licensed product and requires a dongle containing a valid permit in order to run the application. The use of *Analyst's Notebook* software is subject to the i2 Software License Agreement.

The *Analyst's Notebook* permit authorizes the execution of the application. It is available on the following dongle types:

- Network Dongle (HASP)
- Local Dongle (Hardlock)

## What documentation is provided?

The documentation supplied with *Analyst's Notebook* is as follows:

*Analyst's Notebook 8 - User Guide: Creating Charts*

*Analyst's Notebook 8 - User Guide Importing*

*Analyst's Notebook 8 - User Guide Customizing & Analyzing*

*Analyst's Notebook 8 Quick Start Guide*

*Analyst's Notebook 8 Release Notes*

The documentation provided with *Analyst's Notebook* has three main components; these are the Quick Start Guide, User Guides and Online Help. The Quick Start Guide will be available in both printed and electronic format whereas the User Guides will only be available in PDF format.

## Is *Analyst's Notebook 8* available in languages other than English?

*Analyst's Notebook* is available in US English. It is supported on Western Europe & USA, Central Europe, Baltic, Cyrillic, Turkic, Arabic, Japanese, Simplified Chinese and Traditional Chinese regional versions of the supported operating systems. Localized versions will be available after the initial release. More details on the available languages are available from your regional sales contact.

Standard templates for the US and UK market will be shipped at initial release.

## How does *Analyst's Notebook 8* integrate with other i2 products?

*Analyst's Notebook* is part of the i2 Intelligence-Led Operation Platform and provides a rich set of analytical and visualization capabilities

For more information relating to how the i2 Intelligence-Led Operations Platform could benefit your organization please visit [www.i2group.com](http://www.i2group.com) or contact your local distributor.

## Implementation and training

i2 offers standard training courses for *Analyst's Notebook 8*. These are designed to help your staff get immediate time-saving and analytical benefits from your new system. Consulting options are also available to support your deployment.

## References

If you are interested in learning more about *Analyst's Notebook* the following white papers provide valuable reference information:

Description	Issue Number	Published
<i>Analyst's Notebook 8 Product Overview</i>	2.0	June 2010
<i>Analyst's Notebook 8 What's New</i>	1.0	June 2009
<i>Analyst's Notebook 8.5 What's New</i>	1.0	June 2010
<i>Upgrading to Analyst's Notebook 8</i>	2.0	June 2010

## Contact information

If you need more information about *Analyst's Notebook 8* or any i2 product, please visit our Web site: <http://www.i2group.com>, or contact us at one of the following addresses:

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