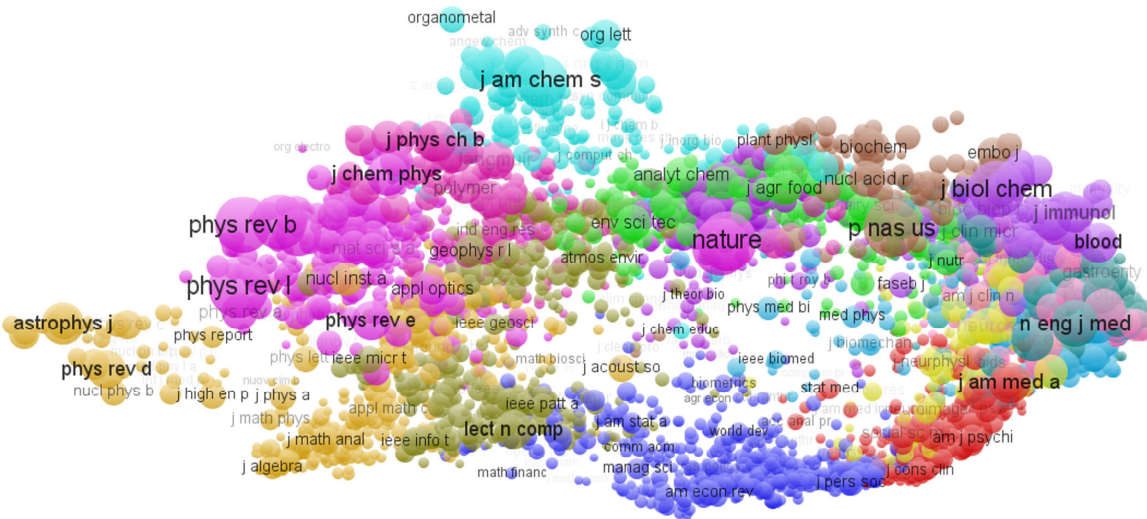


VOSviewer Manual

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Manual for VOSviewer version 1.3.0



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1 Introduction

VOSviewer is a computer program that can be used for the following purposes:

- VOSviewer can be used to construct maps based on network data. Maps are constructed using the VOS mapping technique and the VOS clustering technique.¹
- VOSviewer can be used to view and explore maps. It can show a map in various different ways, each emphasizing a different aspect of the map. It offers functionality such as zooming, scrolling, and searching, which facilitates the detailed examination of a map. The viewing capabilities of VOSviewer are especially useful when working with maps containing at least a moderately large number of items (e.g., at least 100 or 200 items).

VOSviewer is primarily intended to be used for analyzing bibliometric networks. The program can for example be used to construct maps of publications, authors, or journals based on a co-citation or bibliographic coupling network or to construct maps of keywords based on a co-occurrence network. However, the use of VOSviewer is not restricted to bibliometric networks. In fact, VOSviewer can be used to construct maps based on any type of network.

VOSviewer has been written in the Java programming language and runs on most hardware and operating system platforms. VOSviewer can be obtained from the web site www.vosviewer.com. The program can be used freely for any purpose.

In this manual, we are concerned with version 1.3.0 of VOSviewer. We explain the functionality of VOSviewer in Section 2, and we discuss the file types used by VOSviewer in Section 3. For additional information about VOSviewer, we refer to a paper that we have written (Van Eck & Waltman, 2010). In this paper, we provide a general introduction to VOSviewer and we describe in considerable detail the technical implementation of specific parts of the program.

¹ Together, these two techniques provide a unified framework for mapping and clustering. For more information about the techniques, we refer to Van Eck, Waltman, Dekker, and Van den Berg (2010) and Waltman, Van Eck, and Noyons (2010).

2 Functionality

In this section, we explain the functionality of VOSviewer. We begin by discussing the **Open Map** dialog box. This dialog box, which is shown in Figure 1, appears when VOSviewer is started. There are basically two ways to open a map using the **Open Map** dialog box. Which way to choose depends on one's purpose:

- If one's purpose is both to construct a map and to view it, one needs to provide the name of a network file. The network file contains the adjacency matrix of a network. This matrix indicates for each pair of items in the network the strength of the link between the items. Based on the adjacency matrix, VOSviewer will construct a map. In addition to the name of a network file, one may also provide the name of a map file. The map file may for example contain labels and descriptions of items. Given the purpose of constructing a new map, the map file should not contain coordinates and clusters of items.
- If one already has a map and one's purpose is to view the map, one needs to provide the name of a map file. The map file should contain coordinates of items. The map file may also contain, for example, labels, descriptions, weights, and clusters of items. In addition to the name of a map file, one may also provide the name of a network file. The network file contains the adjacency matrix of a network. Based on this matrix, VOSviewer can display lines between items.

The ... buttons in the **Open Map** dialog box can be used to browse for a file. The **Import** button can be used to open a map by importing a Pajek file. For a detailed discussion of map files and network files, we refer to Section 3.

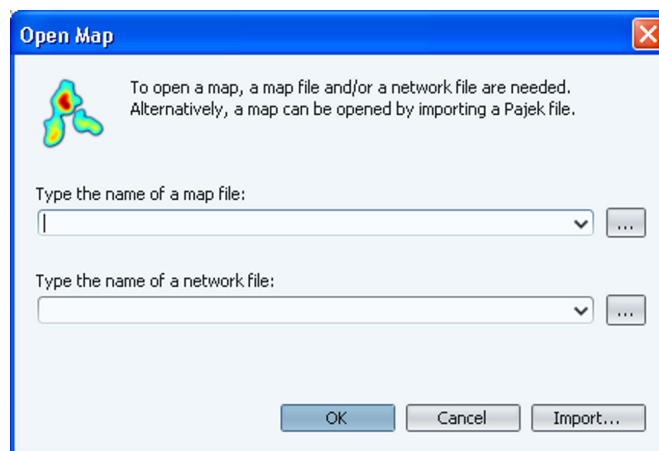


Figure 1. The Open Map dialog box.

After opening a map, one arrives in the main window of VOSviewer. This window is shown in Figure 2.² As can be seen in the figure, the main window of VOSviewer consists of the following four panels:

- *Main panel.* In this panel, a selected area of the currently active map is shown. The zoom and scroll functionality of VOSviewer can be used to select the area of the currently active map that is shown in the main panel.
- *Information panel.* In this panel, information about an item in the currently active map can be shown.
- *Overview panel.* In this panel, an overview of the currently active map is shown. A rectangular frame is displayed in the overview panel to indicate the area of the currently active map that is shown in the main panel.

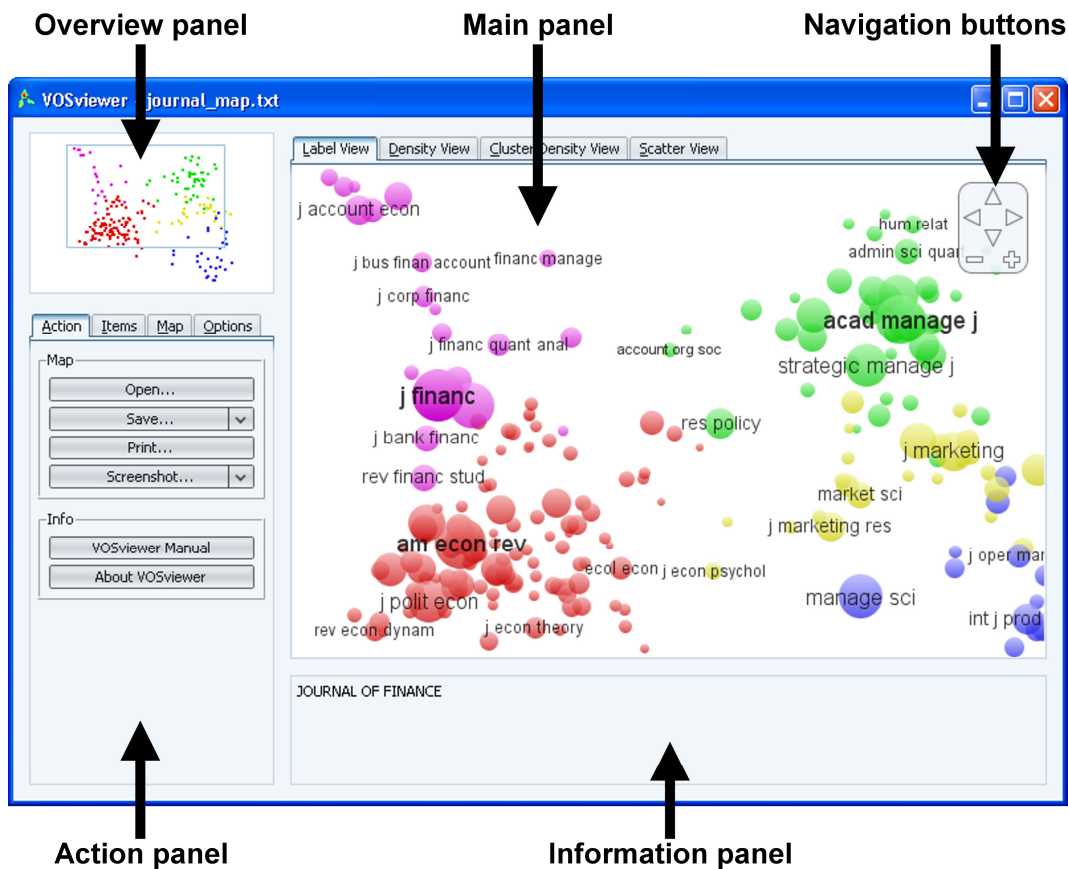


Figure 2. The main window of VOSviewer.

² To reproduce Figure 2, use the map file `journal_map.txt`. This file is distributed together with VOSviewer. The file can also be used to reproduce other figures in this section. For a brief discussion of the data set, we refer to Van Eck and Waltman (2010).

- *Action panel*. This panel can be used to undertake a large number of actions, such as opening or saving a map, making a screenshot, locating an item, constructing or transforming a map, and changing settings.

In the next subsections, we discuss each of the panels in more detail.

2.1 Main panel

As can be seen in Figure 2, the main panel of VOSviewer is used to show a selected area of the currently active map. The zoom and scroll functionality of VOSviewer can be used to determine which area of the currently active map is shown. Depending on the available data, the main panel consists of three or four tabs. Each tab provides a different view on the currently active map. We now discuss each of the tabs:

- **Label View**. In the label view, items are indicated by their label and, by default, also by a circle. For each item, the font size of the item's label and the size of the item's circle depend on the weight of the item.³ If items have been assigned to clusters, each item's circle is displayed in the color of the cluster to which the item belongs. Alternatively, if colors have been specified for each item individually (using the *red*, *green*, and *blue* columns in a map file; see Subsection 3.1), each item's circle is displayed in the color of the item. By default, to avoid overlapping labels, only a subset of all labels is visible. Also, by default, no lines between items are displayed. However, this can be changed on the **Options** tab in the action panel. The label view is particularly useful for a detailed examination of a map. An example of the label view is shown in Figure 3.
- **Density View**. In the density view, items are indicated by their label in a similar way as in the label view. Each point in a map has a color that depends on the density of items at that point. By default, this color is somewhere in between red and blue. The larger the number of items in the neighborhood of a point and the higher the weights of the items, the closer the color of the point is to red. Conversely, the smaller the number of items in the neighborhood of a point and the lower the weights of the items, the closer the color of the point is

³ The weights of items are determined as follows. If a map file has been loaded and this map file has a *weight* column (see Subsection 3.1), the weight of an item is determined by this column. If a network file has been loaded (and no map file with a *weight* column has been loaded), the weight of an item is set equal to the total strength of all links of the item with other items. If neither of the above two conditions is satisfied, all items are given the same weight.

to blue. The density view is particularly useful to get a quick overview of the important areas of a map. We refer to Van Eck and Waltman (2009a, 2009b) for a detailed description of the technical implementation of the density view. An example of the density view is shown in Figure 4.

- **Cluster Density View.** The cluster density view is available only if items have been assigned to clusters. The cluster density view is similar to the ordinary density view except that the density of items is displayed separately for each cluster of items. In the cluster density view, the color of a point in a map is close to the color of a certain cluster if there are a large number of items belonging to that cluster in the neighborhood of the point. Like in the ordinary density view, items with high weights count more heavily than items with low weights. The cluster density view is particularly useful to get a quick overview, for each cluster separately, of the important areas of a map. We refer to Van Eck and Waltman (2009a, 2009b) for a detailed description of the technical implementation of the cluster density view. An example of the cluster density view is shown in Figure 5.
- **Scatter View.** In the scatter view, items are indicated by a small circle. If items have been assigned to clusters, each item's circle is displayed in the color of the cluster to which the item belongs. Alternatively, if colors have been specified for each item individually (using the *red*, *green*, and *blue* columns in a map file; see Subsection 3.1), each item's circle is displayed in the color of the item. No labels are displayed in the scatter view. By default, lines between items are not displayed either, but this can be changed on the **Options** tab in the action panel. The scatter view can be useful to get an overview of the general structure of a map. The way in which a map is shown in the scatter view is similar to the way in which a map is shown in the overview panel discussed below. An example of the scatter view is shown in Figure 6.

To facilitate the detailed examination of a map, VOSviewer offers zoom and scroll functionality. In the main panel, zooming and scrolling can be done in the following three ways:

- *Using the mouse.* To zoom in, move the mouse upwards while keeping the right mouse button pressed. Conversely, to zoom out, move the mouse downwards while keeping the right mouse button pressed. As an alternative, the mouse wheel can also be used to zoom in and out. To scroll through a map, move the mouse while keeping the left mouse button pressed.

- *Using the navigation buttons in the upper right corner of the main panel (see Figure 2).* Use the plus and minus buttons to zoom in and out. Use the arrow buttons to scroll through a map.
- *Using the keyboard.* Use the plus and minus keys to zoom in and out. Use the arrow keys to scroll through a map.

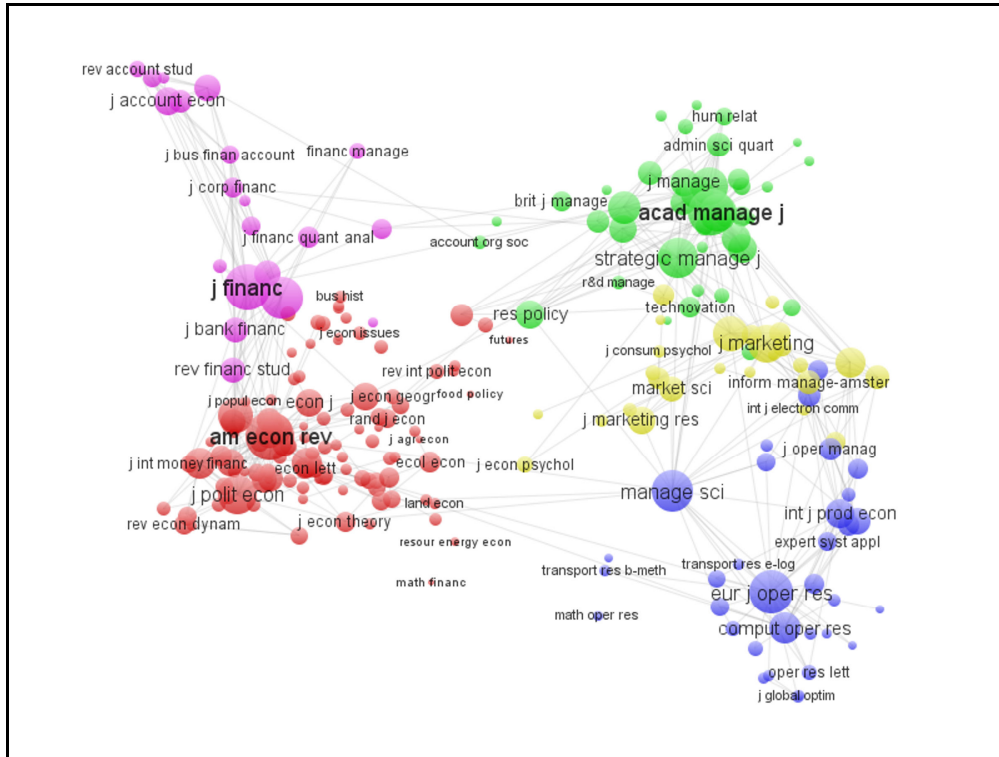


Figure 3. The label view.

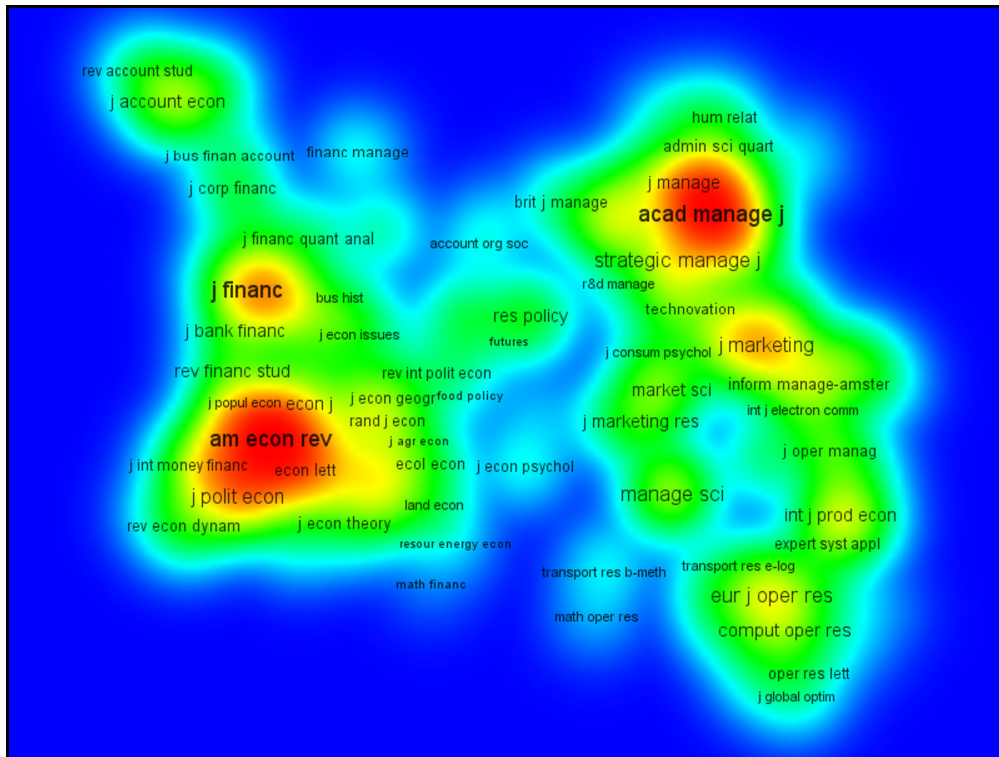


Figure 4. The density view.

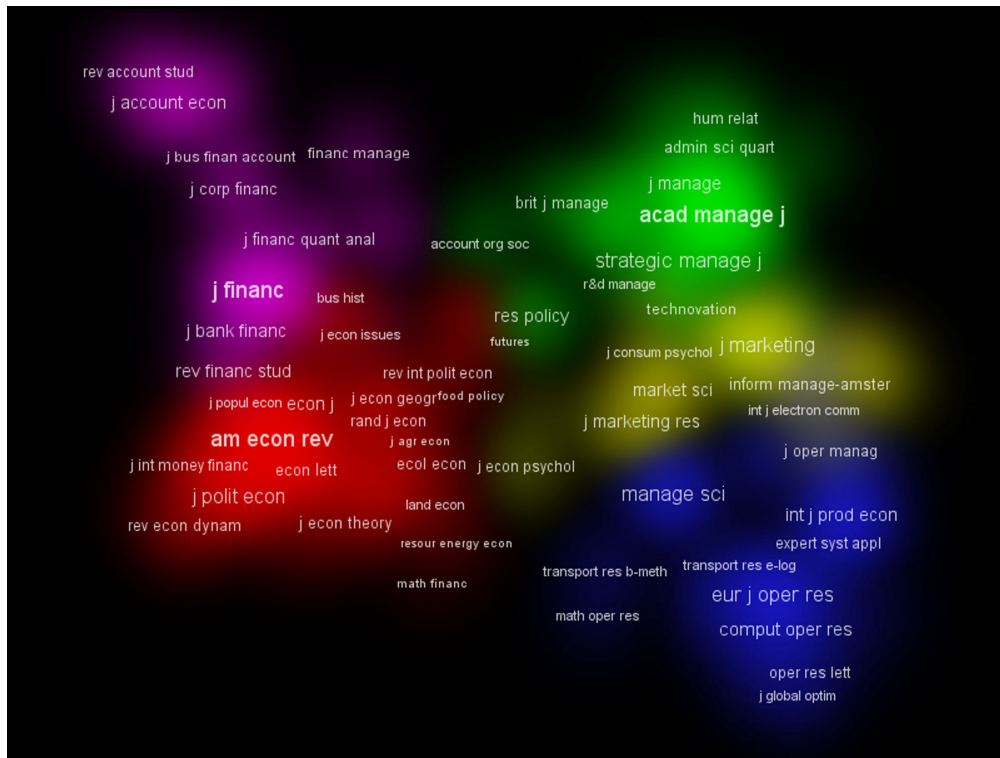


Figure 5. The cluster density view.

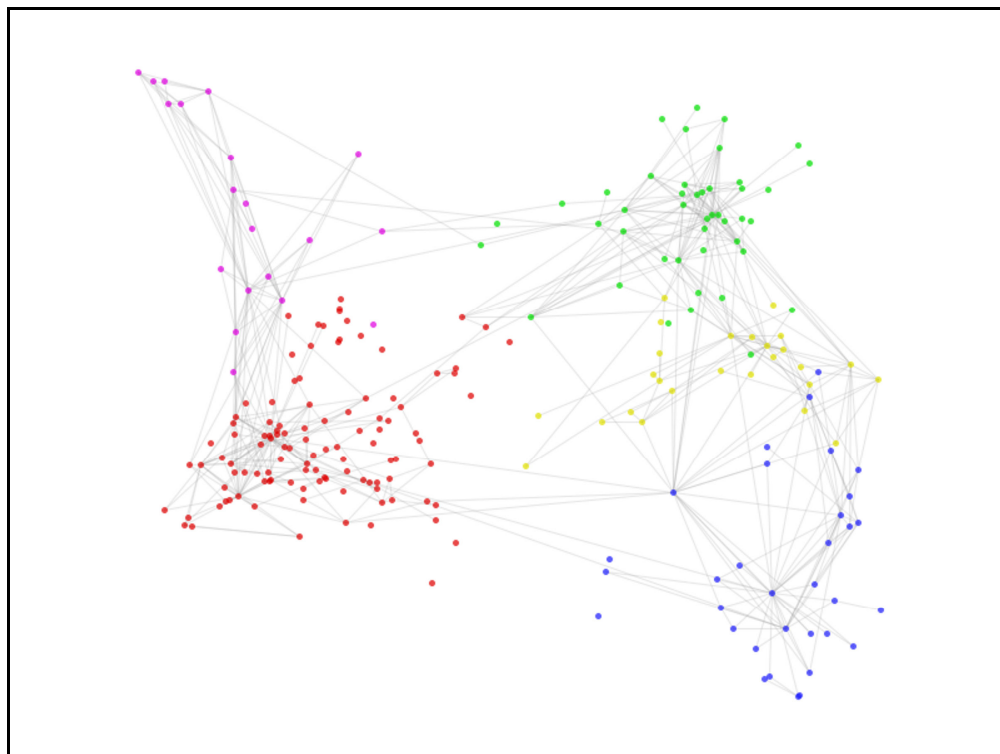


Figure 6. The scatter view.

2.2 Information panel

In the information panel of VOSviewer, information about an item in the currently active map can be shown. For example, when one moves the mouse cursor over the label of an item in the main panel, information about the item will be shown in the information panel. If item descriptions have been provided (using the *description* column in a map file; see Subsection 3.1), the description of the item will be shown. If no item descriptions have been provided, the label and the cluster of the item will be shown.

Information about a link between two items can also be shown in the information panel. This is possible only if lines are displayed in the main panel. When one moves the mouse cursor over the line between two items, information about the link between the items will be shown in the information panel. The labels of the items and the strength of the link will be shown.

The height of the information panel can be adjusted. This can be done by dragging the area between the information panel and the main panel using the mouse.

2.3 Overview panel

In the overview panel of VOSviewer, an overview of the currently active map is shown. Each item in the map is indicated by a small colored dot. A rectangular frame is displayed in the overview panel to indicate the area of the currently active map that is shown in the main panel. By left-clicking in the overview panel, the area of the currently active map that is shown in the main panel can be changed.

2.4 Action panel

The action panel of VOSviewer can be used to undertake a large number of actions. The panel consists of four tabs, namely the **Action** tab, the **Items** tab, the **Map** tab, and the **Options** tab. We now discuss each of these tabs.

2.4.1 Action tab

The **Action** tab can be used to perform a number of basic actions. The following buttons are available on the **Action** tab:

- **Map.**
 - **Open.** Use this button to open a map. The button brings up the **Open Map** dialog box discussed in the beginning of this section. When a map is opened, the currently active map will be closed.

- **Save.** This split button offers three options:
 - **Save map.** This option is the default choice. Choose this option to save the currently active map in a map file. Map files are discussed in Subsection 3.1.
 - **Save network.** This option is available only if a network file has been loaded. Choose this option to save the network underlying the currently active map in a network file. Network files are discussed in Subsection 3.2.
 - **Save normalized network.** This option is available only if a network file has been loaded. Choose this option to save the network underlying the currently active map in a network file. Using this option, the normalized adjacency matrix of the network rather than the original adjacency matrix is stored in the network file. Network files are discussed in Subsection 3.2.
- **Print.** Use this button to print a screenshot of the main panel.
- **Screenshot.** This split button offers two options:
 - **Save to file.** This option is the default choice. Choose this option to save a screenshot of the main panel. The screenshot resembles the main panel as closely as possible. However, the navigation buttons in the upper right corner of the main panel are not shown in the screenshot. If the **Optimized screenshots** check box on the **Options** tab is checked, the number of labels visible in the screenshot is optimized. This means that some labels not visible in the main panel may be visible in the screenshot. Screenshots can be saved in a number of graphic file formats. For most applications, we recommend the PNG format. Some formats, such as EPS, PDF, and SVG, make use of vector graphics when saving a screenshot. This has the advantage that the screenshot can be resized without loss of quality. We note that Figures 3 to 6 were obtained using the screenshot functionality of VOSviewer.
 - **Copy to clipboard.** Choose this option to copy a screenshot of the main panel to the clipboard. The screenshot can for example be pasted into a Word document or a PowerPoint presentation.
- **Info.**
 - **VOSviewer Manual.** Use this button to open the VOSviewer manual.

- **About VOSviewer.** Use this button to view some general information about VOSviewer. The button brings up the **About VOSviewer** dialog box. This dialog box shows the version number of VOSviewer, a copyright notice, a license text, and the address of the VOSviewer web site.

2.4.2 Items tab

The **Items** tab provides a list of items in the currently active map. By default, a list of all items in the map is provided. However, a filter can be used to restrict the list to a subset of the items in the map. To do so, one enters a filter string in the **Filter** text box and one presses the **Filter** button. This yields a list of all items whose label contains the filter string.

The **Group items by cluster** check box determines the way in which items are listed. If the check box is unchecked, items are simply listed alphabetically. If the check box is checked, items are first grouped by cluster and then listed alphabetically within each cluster.

The **Show** button shows the currently selected item on the **Items** tab in the main panel. Instead of using the **Show** button, it is also possible to double-click on an item.

2.4.3 Map tab

The **Map** tab can be used to construct or transform a map. Maps are constructed using the VOS mapping technique and the VOS clustering technique.⁴ The **Map** tab can also be used to change the parameters of these techniques. The following parameters and controls are available on the **Map** tab:

- **Normalization parameters.**
 - **Method.** This parameter determines the method that is used to normalize the adjacency matrix of a network. There are three options:
 - **No normalization.** Using this option, no normalization is performed at all. In general, we strongly discourage this option.
 - **Normalization method 1.** This is the default normalization method. This method uses the so-called association strength measure (Van Eck & Waltman, 2009).

⁴ For more information about these techniques, we refer to Van Eck et al. (2010) and Waltman et al. (2010).

- **Normalization method 2.** This is an alternative normalization method. The difference between this method and the default method is rather technical, and we will therefore not discuss it here. Our recommendation is to try out both methods and to use the one that seems to yield more satisfactory results.
 - **Ignore self links.** This parameter determines whether self links in a network are ignored. In other words, the parameter determines whether the main diagonal of the adjacency matrix of a network is ignored. If self links are ignored, the elements on the main diagonal of the adjacency matrix are set equal to zero. In general, we strongly recommend ignoring self links.
- **Mapping parameters.**
 - **Convergence.** This parameter determines the convergence criterion used by the optimization algorithm of the VOS mapping technique. The parameter must have a value between 0 and 0.01. The closer the value of the parameter is to zero, the more accurate the mapping solution that will be obtained.
 - **Max. iterations.** This parameter determines the maximum number of iterations performed by the optimization algorithm of the VOS mapping technique. The larger the value of the parameter, the more accurate the mapping solution that will be obtained.
- **Clustering parameters.**
 - **Resolution.** This is a very important parameter that determines the level of detail provided by the VOS clustering technique. The parameter must have a non-negative value. The larger the value of the parameter, the larger the number of clusters that will be obtained. Our recommendation is to try out different values for the parameter and to use the value that yields the most appropriate level of detail.
 - **Random starts 1.** This parameter determines the number of times the optimization algorithm of the VOS clustering technique is run. Each time the optimization algorithm is run, a different randomly generated initial clustering solution is used. The larger the value of the parameter, the more accurate the final clustering solution that will be obtained. Performing only one or a few runs of the optimization algorithm can be sufficient to quickly obtain some preliminary clustering results. However, to obtain one's final clustering results, we strongly recommend to perform a significant number of runs (e.g., at least 100 runs) of the optimization algorithm. Especially in

the case of larger networks, a large number of runs of the optimization algorithm should be performed.

- **Random starts 2.** This parameter determines the number of times the so-called cluster split algorithm of the VOS clustering technique is run. This is a technical parameter that we will not discuss in more detail here. The larger the value of the parameter, the more accurate the clustering solution that will be obtained.
- **Run mapping/clustering.** The **Run** split button is available only if a network file has been loaded. The button can be used to run the VOS mapping technique and/or the VOS clustering technique. The **Random seed** parameter is used to randomly generate initial solutions for the optimization algorithms of the VOS mapping technique and the VOS clustering technique. A given random seed always yields the same initial solutions. The only exception is random seed 0. This random seed yields different initial solutions each time the VOS mapping technique and/or the VOS clustering technique are run.
- **Rotate/flip.**
 - **Rotate.** Use this button to rotate the currently active map. The **Degrees to rotate** parameter determines the number of degrees by which the map will be rotated.
 - **Flip Horizontally.** Use this button to flip the map horizontally.
 - **Flip Vertically.** Use this button to flip the map vertically.

2.4.4 Options tab

The **Options** tab can be used to change various settings of VOSviewer. The following settings can be changed:

- **Labels.**
 - **Size effect.** The higher the weight of an item, the larger the font size that is used to display the item's label in the main panel. The **Size effect** slider determines the strength of this effect.
 - **Max. length.** This text box determines the maximum length of a label displayed in the main panel. If the length of a label exceeds the maximum length, the last part of the label is not displayed.
 - **No overlap.** This check box determines whether labels are allowed to overlap each other in the main panel. If overlapping labels are not allowed, it depends on items' weights which labels are displayed and which are not.

- **Blurred background.** This check box determines whether a so-called blurred background is used in the main panel. Using a blurred background, labels that are not displayed in the ordinary way (due to overlap with other labels) are displayed in a blurred way. The **Blurred background** check box has an effect only if the **No overlap** check box is checked.
- **Gradual appearance.** This check box determines whether in the main panel labels appear gradually or instantaneously when one zooms in. The **Gradual appearance** check box has an effect only if the **No overlap** check box is checked.
- **Optimized screenshots.** This check box determines whether the number of labels visible in a screenshot of the main panel is optimized. Optimization of the number of labels visible in a screenshot means that some labels not visible in the main panel itself may be visible in a screenshot of the main panel. The **Optimized screenshots** check box has an effect only if the **No overlap** check box is checked.
- **Lines.**
 - **Number of lines.** If a network file has been loaded, lines can be displayed in the main panel (i.e., in the label view and the scatter view). Lines can be displayed between any pair of items with a non-zero link strength. The **Number of lines** text box determines the maximum number of lines to be displayed. If the number of links with a non-zero strength exceeds the maximum number of lines to be displayed, lines are displayed only for the strongest links.
 - **Use normalization.** This check box determines whether lines are displayed based on normalized or unnormalized link strengths. In most cases, the use of unnormalized link strengths yields more satisfactory results.
- **Visualization.**
 - **Label view.** Use this drop down list to choose the visualization used in the label view. There are three options that can be chosen. If the **Show labels only** option is chosen, items are indicated only by their label. If the **Show labels and circles** option is chosen, items are indicated both by their label and by a circle. If the **Show labels and frames** option is chosen, items are indicated by their label displayed within a frame.
 - **Density view kernel width.** This slider determines the value of the kernel width parameter of the density view and the cluster density view.

- **Density view transformation.** This slider determines the value of the color transformation parameter of the density view and the cluster density view.⁵
- **Density view color scheme.** Use this drop down list to choose the color scheme used in the density view.
- **White background in cluster density view.** This check box determines whether a black or a white background color is used in the cluster density view.
- **Change Cluster Colors.** This button is not available if colors have been specified for each item individually (using the *red*, *green*, and *blue* columns in a map file; see Subsection 3.1). The button brings up the **Change Cluster Colors** dialog box. This dialog box can be used to change the colors of clusters. If there are no clusters, the dialog box can be used to change the color of all items.

⁵ For more information about the kernel width parameter and the color transformation parameter, we refer to Van Eck and Waltman (2010).

3 File types

The two primary file types used by VOSviewer are the map file and the network file.⁶ Map files and network files are simple text files that can easily be viewed and edited using a text editor (e.g., Notepad) or a spreadsheet program (e.g., Excel). Map files and network files consist of multiple columns. That is, each line in a map file or a network file contains multiple pieces of information. Different pieces of information on the same line are separated from each other by a comma, a semicolon, or a tab. If a piece of information (e.g., the label of an item) itself contains a comma or a semicolon, the whole piece of information needs to be enclosed within double quotes.

An important way in which VOSviewer can be used is to construct maps based on data taken from the Web of Science bibliographic database. We emphasize that VOSviewer cannot directly process Web of Science output files. Some intermediate steps are necessary to convert Web of Science output files into map files and network files (or Pajek files) that can be processed by VOSviewer. These intermediate steps can be performed in many different ways. An extensive discussion of this issue is outside the scope of this manual. However, one possibility that we would like to suggest is to use the freely available SAINT toolkit.⁷

In Subsections 3.1 and 3.2, we discuss map files and network files in more detail. The example files to which we refer in these subsections are distributed together with VOSviewer. In Subsection 3.3, we discuss how a map can be made available on the internet in a convenient way.

3.1 Map file

A map file is a text file that contains information about the items in a map. Each line in a map file corresponds with an item. The only exception is the first line. This is a header line that indicates what is contained in each of the columns of a map

⁶ Until version 1.2.1 of VOSviewer, there were three primary file types, namely the items file, the co-occurrences file, and the coordinates file. As of version 1.3.0 of VOSviewer, these file types are no longer supported. The map file has replaced the items file and the coordinates file, and the network file has replaced the co-occurrences file. We further note that VOSviewer also has the ability to import Pajek files (as discussed in the beginning of Section 2).

⁷ This toolkit is available at www.rathenau.nl/themas/project/bibliometrische-softwaretools/saint.html.

file. Below, we list the columns that can be used in a map file. For each column, we provide the column header and we specify what the column contains.

<i>id</i>	The ID of an item. Items need to have an ID only if a map file is used in combination with a network file.
<i>label</i>	The label of an item.
<i>sublabel</i>	The sublabel of an item. In the main panel, the sublabel of an item is displayed below the item's ordinary label. Sublabels are displayed in a small font.
<i>description</i>	The description of an item. The description of an item is used to provide information about the item in the information panel. (HTML formatting can be used in this column.)
<i>x</i>	The horizontal coordinate of an item.
<i>y</i>	The vertical coordinate of an item.
<i>weight</i>	The weight of an item. (Only non-negative numbers are allowed in this column.)
<i>cluster</i>	The cluster to which an item belongs. (Only integers between 1 and 1000 are allowed in this column.)
<i>red</i>	The red component of the color of an item. (Only integers between 0 and 255 are allowed in this column.)
<i>green</i>	The green component of the color of an item. (Only integers between 0 and 255 are allowed in this column.)
<i>blue</i>	The blue component of the color of an item. (Only integers between 0 and 255 are allowed in this column.)

In a map file, one always uses only a subset of the above columns. The order in which the columns are used is not important.

There are a number of restrictions on the columns that are used in a map file. These are the most important restrictions:

- There must be an *id* column or a *label* column. (If there is no *label* column, the ID of an item is used as the item's label.)
- If there is a *sublabel* column, there must be a *label* column as well.
- The *x* and *y* columns must be used together.

- If there is a *cluster* column, there must be no *red*, *green*, and *blue* columns. (If there is a *cluster* column, the color of an item is determined by the cluster to which the item belongs.)
- The *red*, *green*, and *blue* columns must be used together. (These columns together determine the color of an item.)

For an example of a map file, see the file `journal_map.txt`.

3.2 Network file

A network file is a text file that contains the adjacency matrix of a network. The adjacency matrix of a network is a square matrix that indicates for each pair of items in the network the strength of the link between the items. The strength of a link is given by a non-negative number. If there is no link between two items, the strength of the link between the items equals zero. VOSviewer works with symmetric adjacency matrices. If a network file contains an asymmetric adjacency matrix, VOSviewer will make the matrix symmetric by averaging corresponding elements on both sides of the main diagonal.

A network file has either a full format or a sparse format:

- *Full format*. The entire adjacency matrix, including elements that are equal to zero, is stored in the network file. The file consists of n lines and $n + 1$ columns, where n denotes the number of items in the network. The element in the i th row and the j th column of the adjacency matrix is stored on the i th line and in the $(j + 1)$ th column of the network file. The first column of the network file contains IDs of items. This column indicates for each row and column of the adjacency matrix the ID of the corresponding item. For an example of a network file in full format, see the file `journal_network_full.txt`.
- *Sparse format*. Only the non-zero elements of the adjacency matrix are stored in the network file. The file consists of two or three columns. The first two columns contain IDs of items. The third column contains the non-zero elements of the adjacency matrix. This column indicates the strength of the link between the items referred to in the first two columns. If there is no third column, the strength of the link between the items referred to in the first two columns always equals one. In the case of a symmetric adjacency matrix, it is sufficient to store only half of the non-zero off-diagonal elements of the matrix in the network file. For an example of a network file in sparse format, see the file `journal_network_sparse.txt`.

A network file is usually used in combination with a map file. For each item ID in the network file, there must then be a corresponding item ID in the map file.

3.3 Making a map available on the internet

Suppose one wants to make a map available on the internet. One way to do this is simply by making the map file and/or network file available on the internet. To open the map, one then needs to take two steps. In the first step, the map file and/or network file are downloaded from the internet. In the second step, VOSviewer is started and the downloaded map file and/or network file are used to open the map.

The above two-step approach is not very convenient, and therefore an alternative approach is available as well. In this alternative approach, a map can be opened in VOSviewer directly from a web page. The alternative approach works as follows. The map file and/or network file need to be made available on the internet. Suppose one has both a map file and a network file, and suppose these files are located at, respectively,

`http://www.example.com/map.txt`

and

`http://www.example.com/network.txt.`

The map can then be made available on a web page by creating a hyperlink that points to

`http://www.vosviewer.com/vosviewer.php?map=http://www.example.com/map.txt&network=http://www.example.com/network.txt.`

Using this hyperlink, the map can be opened directly in VOSviewer.

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