Introduction

The **CCmI Diagram Editor** allows you to explore, create, edit and share visual diagrams. The tool supports general nodes-and-edges diagrams: nodes are graphic objects drawn as a shape (squares, circles, triangles etc.) with some text content in it and edges are just lines connecting the nodes to each other. Examples of such diagrams are: **UML diagrams**, **ER diagrams**, **tube maps**, **mind maps**, **flow chart diagrams** and more. This document details how to use the tool. The rest of this paragraph gives an overview of the main concepts behind its design. On page 2 and 3 a description of the components of the tool is given. On page 4, 5 and 6 the commands to operate the tool are listed, followed by a brief explanation of how to use it to collaborate with other people, through a computer network.

The unique feature of this tool is that it can be accessed using different interaction modalities, each of which relates to a different human sense: sight, hearing, and haptic. This means a user can access a diagram by looking at it, hearing how it sounds and touching it. Eventually, the modalities can be used in combination with each other, in order to improve the user's performance. This makes the Editor a very suitable tool for visually impaired people, whose interaction can benefit from the combination of audio and haptics. The tool also incorporates a network system in which visual impaired people can collaborate, via the Diagram Editor, with sighted people, whilst editing a common diagram they are working on together (as it may happen, for instance, among colleagues during a meeting in a workplace).

Let's now look at **Nodes** and **Edges** more thoroughly. As said already, nodes are shapes on a graph. There can be different **Types** of nodes in a diagram and the nodes of a given type will all have the same shape. All nodes are labelled with a **Name**, that cannot be an empty string and is (automatically) drawn somewhere within their shape. Besides the name, a node can hold other data (of any kind) called **Properties.** Properties will appear either inside or next to the shape, according to the type of the node. Properties of the same node are, in turn, organized in types. Let's consider, for instance, a simple diagram of the **London Tube Map**; nodes might then represent tube stations, their name being the name of the station. A **Property Type**, instead, might be *Station Exits*, every property entry of that type being the name of a road, via which it's possible to get in and out of the station. Finally each property entry can have one or more **Modifiers** associated with it. Modifiers are the attributes of a given property type, that can be associated with each property entry. An example of a modifier for *Station Exits* entries could be "*has Buses"*; an indication of whether the specific exit of the station has public bus stops.

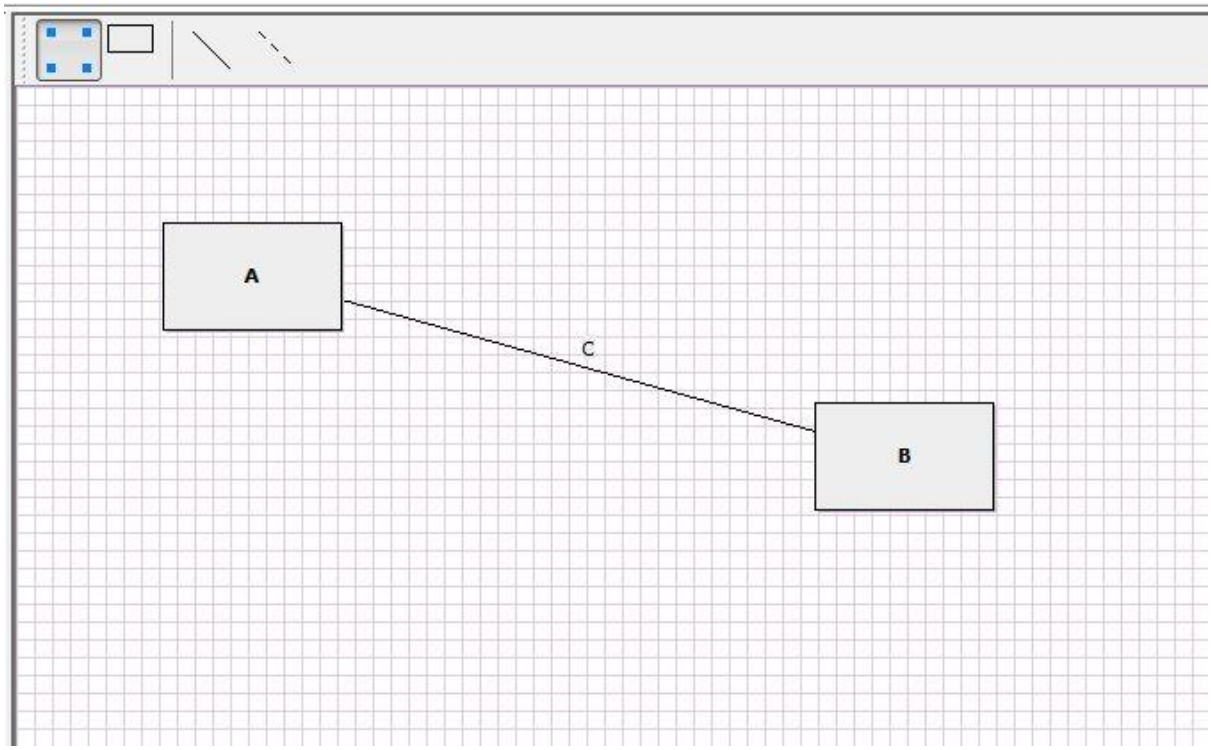
Edges are drawn in a graph as straight, dotted or dashed lines, connecting from two up to four nodes. Edges have a non-empty **Name** too, drawn at the centre of the line and can also be given an **End Label**: a text string which appears at the end of the edge line, where it joins the node it's connected to. Furthermore, edges can have some kind of **Arrow Head** at any end, to express a direction in the connection between nodes. In the tube map example, edges would be the train lines connecting one station to another.

Exploring the Diagram: The Views

As said above, the user can interact with the tool using different interaction modalities. In this document, we refer to the three interfaces that enable these modalities, as **Views**. The use of one View does not exclude the use of another. This applies especially for the haptic and audio view, whose cross-modal use is encouraged by providing cross-view commands (see the commands section).

Visual View

The visual view works much like many common diagram editors. Nodes and edges are created using the mouse in a *Drag&Drop* fashion. Unless the user needs to enter text, no keyboard command can be used to edit/explore the diagram within this view.



Audio View

The audio view is based on a **Tree**, a hierarchical multilevel structure similar to the file systems used to organize files in modern operating systems. The building elements of this hierarchy are labelled items holding some information about the diagram; for example the name or the type of a node, or the edges a node is connected to. There is a root item at the top of the hierarchy and every item can have one or more children. The **level** of an item is the number of ancestors that the item has. So the root is at level 0, the root's children are at level 1, a root's child's children at level 2 and so on up to 4, which is the maximum depth that you can go in the tree.

The content of the visual diagram is deployed in the tree structure to make it accessible via audio to the user. The arrow keys of the keyboard move a cursor through the hierarchy; in both directions from one level to another (*left* and *right* arrow keys) and along the sibling items descending from the same parent (*up* and *down* arrow keys). When the cursor encounters an item in the hierarchy, the item label is uttered by a Text-to-Speech synthesizer and, in some cases, a non-speech sound is played too. Editing the diagram via the tree (see commands section at page 4) is also accompanied

by sound feedback. For instance a short sound will be played to indicate success or failure in accomplishing an action, and a continuous sound will be played while a dialog window is open to prompt the user for some input.

Let's now look at the tree structure more thoroughly: At **level 0** you have just the **root item**, which, for every diagram is labelled as "*Diagram*". At **level 1** (children of the root) you have all the **types** of either nodes or edges of this diagram. So for example in the tube map, you would find an item called "*stations*" for nodes, which are all of one type; and an item for each line of the tube ("*Central line*", "*Northern line*", "*District line*" etc.) for edges. At **level 2** you have all the nodes and edges of the diagram, grouped by type. So the children of the "*Central line"* item are, quite intuitively, just the edges of type "*Central line*" in the diagram. As for **level 3 and 4**: if you look at the children of each Node item, you'll find the **property types** of the nodes' properties and the **edge types** of the edges connected to that node. The children (at **level 4**) of these type items inside a node are respectively: the property entries and the names of the connected edges, again grouped by their type. So, inside the node "*Tottenham Court Road*" you would have "*Central Line*", "*Northern line*" as edge types and "*Station Exits*" as the (only) property type of the node. Inside "*Central Line*" you would then have the name of the edges connecting "*Tottenham Court Road*" to its next stations on the central line. The same goes for "*Northern line*". Inside "*Station Exits*" instead, you would have "*Tottenham court Rd*", as this station takes the name from the road where it is located. Finally the children (at **level 3**) of each edge item (which, remember, are at **level 2**) are the names of the nodes that this edge is linking together.

All the tree items can be assigned one or more bookmarks and a note. Bookmarks can be used to quickly retrieve an item from anywhere in the tree. A note is a text the user can enter in the tool, to make a note of something related to that item.

Haptic View

The haptic view uses special haptic devices that allow you to figure out, purely through tactile feedback, how the diagram is laid out in the graph. The device has a robotic arm attached to a stylus (or a handle) that can be programed to simulate feeling 3D shapes textures and forces. In the CCmI Diagram Editor the diagram, which is a 2D object, lays on a vertical plane in the middle of the haptic 3D space. If you move the device towards nodes and edges the stylus gets pulled towards it. You can also move nodes and edges around in the graph using the buttons on the stylus. Since the haptic device is normally operated with one hand, the other hand can operate the keyboard, and so interact with the Audio View, providing the user with a fully cross-modal experience.

At present, the CCmI Diagram Editor supports two devices: the *PHANTOM Omni®* [1]and the *Novint Falcon®*[2]. Besides these, *Tablet/Mouse* device support is also provided if neither haptic device is available. When using this option, if you hover over the screen with a mouse or a graphic tablet, you'll receive audio feedback each time you come across an object in the diagram. The tool will automatically work with a haptic device when it's connected. On the contrary, the Tablet/Mouse option must be expressly enabled from the "*Preference/Show Haptic Window"* menu item.

[1] See http://www.sensable.com/haptic-phantom-omni.htm

[2] See http://www.novint.com/index.php/novintfalcon

Commands for Exploring and Editing the Diagram

Getting Started

All the features of the Diagram Editor can be accessed through the top menu. To use this menu with the keyboard press *Alt* and then use the arrow keys to flick through all the items available. The menu is itself accessible for visual impaired users and has speech feedback, when operated with the arrow keys.

To start editing the first diagram, select one of the available diagrams in the "*File/New Diagram"* menu. Alternatively, if you only use a keyboard, press *Alt+f* followed by the *right* arrow key. Then flick through the available diagrams using the *up* and *down* arrow key and press <*Enter*> to open the one you selected.

It is possible to open several diagrams at the same time, each of which will live in a different tab of the editor. Once a diagram is open, it is placed in a new tab that automatically gains the keyboard focus. When the focus is on the tab you can't edit the diagram using the keyboard but you can switch between the different tabs using the *right* and *left* arrow keys. By pressing the *tab key,* you can switch between the tab where a diagram is and its tree view. Once the focus is on the tree view, you will be able to enter key commands to explore and edit the diagram. Note that the tree will not respond to mouse clicks, as it's meant to be operated exclusively via the keyboard.

Visual View Commands

Add Node: left click a Node button on the toolbar and then click on the graph where you want to position the node.
Select Nodes for Move or Delete: just hold the *Ctrl* key and left click on all the nodes you want to select.
Rename Node: right click on the Node and select <*Set Name*> from the pop up menu.
Delete Node(s): right click on the Node and select <*Delete*> from the pop up menu. Any other selected node or edge, besides the clicked node, will also be affected by the command.
Move Node(s): just drag the node somewhere within the graph. If the *Ctrl* key is held, any other selected node, besides the clicked one, will also be affected by the command.
Edit Properties: right click on the node and select <*Set Properties*> from the pop up menu. A property editor dialog will appear for you to add, change and delete properties.
Edit Modifiers: click the <*Edit Modifiers*> button when selecting a not empty row in the property editor dialog. A modifier dialog will appear for you to check/uncheck modifiers.
Add Edge: select two or more nodes (holding *ctrl* key) and click on an Edge button on the toolbar.
Rename Edge: right click on the Edge and select <*Set Name*> from the pop up menu.
Delete Edge: right click on the Edge and select <*Delete*> from the pop up menu. Any other selected node or edge, besides the clicked edge, will also be affected by the command.
Move Edge: select all the nodes the Edge is connected to and move them. If the Edge is bent, then you need to select the Edge as well.
Bend Edge: just drag the Edge, with the mouse, somewhere within the graph.
Set End Label: right click in the proximity of the Edge End and select <*Set Label*> from the pop up menu.
Set Arrow Head: right click in the proximity of the Edge End and select <Set Arrow Head> from the pop up menu.

Audio View Commands

Switch Diagram: press <*tab*> to switch the focus between the diagram tree and the tab containing the diagram. When focusing the tab, you can use <*left arrow*> and <*right arrow*> to switch between the diagrams that are currently open in the editor.
Move the cursor through the tree: use <*left arrow*> and <*right arrow*> to go up and down in the tree level. When you press <*right arrow*>, you will hear an expanding sound, indicating you are expanding the current item to look at its children. On the contrary, when you press <*left arrow*>, you will hear a collapsing sound. Use <*up arrow*> and <*down arrow*> to go through the siblings tree items. When going through Nodes and Edges, the audio feedback will include a sound, distinctive of their type. When you reach the end of the siblings list (in either direction) you will loop back to the other end and you will hear a double sound, indicating that you are going through the same list again.
Get the name of Tree Item: press <*space bar*>.
Get Info on a Tree Item: press <*Ctrl+space bar*>.
Jump to a Tree Item: press <*Ctrl+j*> and select the item where to jump from the displayed dialog. You can jump to different items in the tree, depending on the item you jump from. A teleport sound will inform you that the jump was successful.
Add Node: position the cursor to the Type of the Node you want to add and press <*Ctrl+ Enter*>. A new Node will be created with the default name "*new T n*" where *T* is the Type of the Node and *n* is a unique integer identifier. You can then cursor right into the list of nodes of type *T*, find the new node and rename it.
Rename Node: position the cursor on the Node and press <*Ctrl+r*> .
Delete Node: position the cursor on the Node and press <*Ctrl+Del*>.
Add Property: position the cursor on the Property Type of the Property you want to add and press <*Crtl+Enter*>.
Rename Property: position the cursor on the Property and press <*Ctrl+r*>.
Delete Property: position the cursor on the Property and press <*Ctrl+Del*>.
Edit Modifiers: position the cursor on the property you want to edit the modifiers of and press <*Ctrl+Enter*>. A modifier dialog will be displayed for you to check/uncheck modifiers.
Select Node for Edge creation: position the cursor on the Node and press <*shift*> .
Add Edge: position the cursor to the Type of the Edge you want to add and press <*Ctrl+ Enter*>. A new Edge will be created with the default name "*new T n*" where *T* is the Type of the Edge and *n* is a unique integer identifier. You can then cursor right into the list of edges of type *T*, find the new Edge and rename it. You first need to select the nodes you want to connect with this Edge.
Rename Edge: position the cursor on the Edge and press <*Ctrl+r*> .
Delete Edge: position the cursor on the Edge and press <*Ctrl+Del*>.
Set End Label: position the cursor on the Edge End you want to edit the label of and press <*Ctrl+Enter*>. Select <*Set Label*> from the selection dialog displayed and then select the label.
Set Arrow Head: position the cursor on the Edge End you want to edit the label of and press <*Ctrl+Enter*>. Select <*Set Arrow Head*> from the selection dialog displayed and then select the arrow head.
Set Notes: position the cursor on the tree item you want to add a Note to and Press <*Ctrl+n*>. A Note editor dialog will be displayed for you to enter the Note. Unlike any other text you can enter in the Editor, Notes are multiline and hitting <*Enter*> would create a new line rather than entering the Note in the system. In order to set the Note for the Tree Item, you need to press <*Ctrl+Enter*>.
Add Bookmark: position the cursor on the Tree Item you want to add a Bookmark to and press <*Ctrl+b*>. If prompted with a selection dialog, select the <*Add Bookmark*> option. Enter the name of the bookmark and press <*Enter*>. You can then quickly find the bookmarked item using the *Jump* command (<*Ctrl+j*>).
Remove Bookmark: position the cursor on the Tree Item you want to remove a Bookmark from and Press <*Ctrl+b*>. In the selection dialog displayed, select the <*Remove Bookmark*> option and press <*Enter*>.
Move the haptic device to a Node/Edge: position the cursor on the Node/Edge you want the haptic device to move to and press <*Ctrl+f*>

Haptic View Commands

Toggle loose/sticky mode: press *Button2*
Get Info about Node/Edge: press *Button 3* or, if the device has only two buttons, double click *Button 1.*
Move Node: point the haptic device to the Node you want to move and click *Button 1*, this will pick up the Node and you will hear a suction-cap-like sound. Then move the haptic device anywhere in the haptic space and click *Button 1* again. This will drop the Node you picked up and it will move it to this point. When moving the haptic device you will hear a chain-like sound, indicating you are dragging the object around; also you will feel a force in the haptic device towards the point where you picked up the object from. After dropping the object, you will hear a drop-like sound and the haptic force will cease.
Bend Edge: point the haptic device to the point along the Edge where you want to bend it from and click *Button 1;* this will pick up the Edge on that point. Move the haptic device anywhere in the haptic space and click *Button 1* again. The Edge will be bent up to this point, stretching it from the point where you picked it up. The feedback (audio and haptic) is the same as for moving a Node.
Position the tree cursor to a pointed Node/Edge: point a Node/Edge with the haptic device and press <*Ctrl+h*>

Sharing the Diagram

Diagrams can be shared via the Internet protocol with other people, who run their own instance of the tool on a computer in the same network. This means everybody will operate on the same diagram and changes made by one person will affect what the other people see in their display.

If you want to share a diagram, the first thing to do is to launch the server from "*Collaboration/Start Server*" in the menu. Once the server is running, a diagram can be shared by switching to the tab where it's open and clicking "*Collaboration/Share Diagram*" in the top menu. When a diagram is shared, the string "*@localhost*" is appended to its name. Other users will then have to connect to your server by clicking on "*Collaboration/Open share diagram*" in the top menu and then enter the **IP address** of the computer where the server is running. When you connect to a remote server, you'll get a list of all the diagrams available for sharing on that server. When you pick up a diagram from the list, it will be open in a new tab and the string "*@x.x.x.x*", where "*x.x.x.x*" is the IP address of the server, will be appended to its name.

In order to disconnect from a server instead, you just need to close the diagram from "File/Close" in the menu bar. Besides, when a server is shut down ("*Collaboration/Stop Server*" or exit the Editor) all the active connections will get closed automatically. For advanced use, the network **ports** where the Editor's local server will listen and where the Editor will connect, when used as a client, can be set from the "*Collaboration/Networking*" list in the main menu.