Dr. Genius User's Manual

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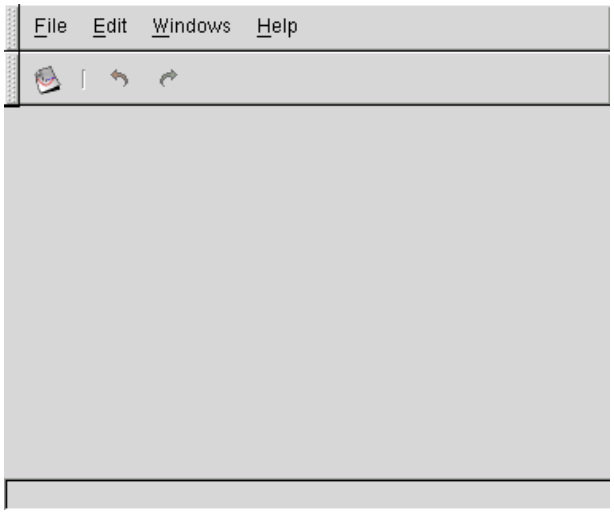
Chapter 1

Introduction

Dr. Genius is the interactive geometry package for the Gnome Desktop. It allows users to create geometric figures that can be manipulated with respect to geometric rules. The program is useable with students from the primary through secondary levels.

Figure 1.1: Dr. Geowelcome screen



To create a new empty geometric figure, the user clicks on the first (on the left) button in the toolbar. Alternatively, a new figure can be created using the menu item `File->New->Figure` from the menu bar. When a new figure is created, a new toolbar with a set of six icons appears. The last item (on the right) in the toolbar is an option menu; it is used to adjust the scale of the current geometric figure.

The six icons correspond to different types of functions. These functions are described in the next chapter.

With each figure, a pane is available. By default the pane is pushed to the extreme left so that only the representation of the figure is visible. At any moment, the user can push the pane to the right to make visible the figure description. A figure description is a tree list. The tree is composed of all the elements of the figure. The elements relative to other elements can be expanded by pressing the '+' sign,

Figure 1.2: An empty geometric figure

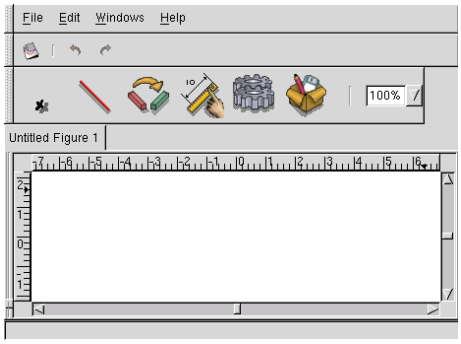
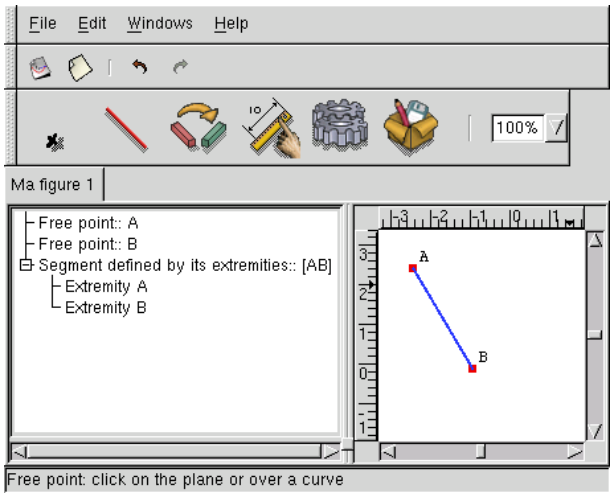


Figure 1.3: A Dr. Geofigure and its description



that way the user can visualize the parents of this element.

Chapter 2

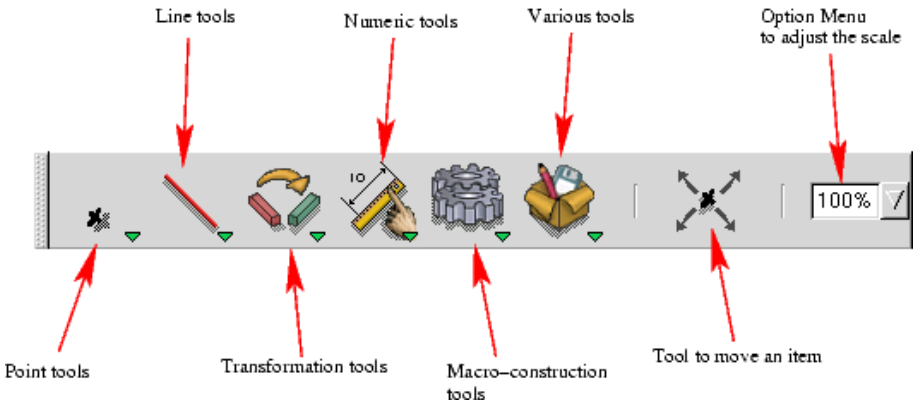
Basic Functions

This chapter describes the tools used to construct geometric figure. At the end of this chapter, customisation is presented.

2.1 Construction Tools

These tools are split into six groups available from the second toolbar of Dr. Geo.

Figure 2.1: Dr. Geo's tool categories and their descriptions



2.1.1 Point Tools

Free Point

Create a free point on an area or a free point on an uni-dimensional object. In the first case, the created point can be moved anywhere in the figure area. To build the point the user just clicks on the background. In the latter case, it is constrained to the uni-dimensional object (line); it is stuck to the object. To build this kind of point the user clicks over a line (i.e. straight line, ray, segment, circle, arc, etc.).

Midpoint

Create the middle of two points or the middle of a segment. In the first case, the user selects two points. In the latter case the user just selects a segment.

Intersection

Create the intersection point(s) of two line objects. The user needs to select two line objects.

Point by its Coordinates

Create a point defined by its coordinates. The user needs to select two numbers, the first selected number is the abscissa; the second one is the ordinate.

2.1.2 Line Tools

Straight Line

Create a straight line defined by two points. The user selects two points.

Ray

Create a ray (half-line) defined by two points. The user selects two points; the first point is the origin, the second one belongs to the ray.

Segment

Create a segment given by two points.

Vector

Create a vector given by two points. The user selects two points. The first point is the origin; the second one is the extremity.

Circle

Create a circle. The user can create a circle from different selections:

1. the centre and a point on the circle;
2. the centre and a number (the radius of the circle);
3. the centre and a segment which length is the radius of the circle.

Arc Circle

Create an arc defined by three points. The first selected point is the origin of the arc; the third one is the extremity and the second one is a point on the arc.

Locus

Create a locus defined by two points. The user selects two points, one is a free point on a line and the other one is a constrained point of the first one (i.e. when one moves, the other one does as well).

Polygon

Create a polygon defined by n points. The user selects n+1 points delimiting the polygon. The first and last selected points are the same; this tells Dr. GEOthat the selection is over. The polygon object is not an object like the other lines; it is not possible to place a point on it or to construct an intersection between a polygon and another line object.

2.1.3 Transformation Tools

Parallel Line

Create a line passing through a point and parallel to a "direction" (another line or line segment moving in a "direction"). The user selects a point and a direction (i.e. a straight line, a ray, a segment or a vector).

Perpendicular Line

Create a line perpendicular to a direction and passing through a point. The user selects a point and a direction (i.e. straight line, a ray, a segment or a vector).

Axial symmetry

Create the image of an object by an axial symmetry. The user selects an object to transform and the axis of symmetry (a straight line). When the user wants to construct the image of a straight line, s/he must first select it with the mouse; the first selected line is the line that which will be transformed.

Central Symmetry

Create the image of an object by a central symmetry. The user selects the object to transform and the centre of its symmetry (a point). When the user wants to construct the image of a point, s/he must first select it (with the mouse). The transformation will then be performed on this point.

Translation

Create the image of an object by translation. The user selects the object to transform and the vector of translation. When the user wants to construct the image of a vector, s/he must select it (with the mouse). The transformation will then be performed on this vector.

Rotation

Create the image of an object by a rotation. The user selects the point to transform, the centre and the angle of the rotation. When the user wants to create the image of a point, s/he must first select it (with the mouse). The transformation will then be performed on this selected point.

The angle can be selected from different type of value:

- **numeric value**: in this case the angle is expressed in radians. Examples of numeric values are: free value, distance between two points, a segment length, a coordinate, a value returned by a Dr. Genius Guile Script, etc.;

- **a geometric angle formed by three points**: in this case the angle is expressed in degrees. Be aware that in this case the angle can only fall within [0 ; 180];

- **an oriented angle formed by two vectors**: in this case the angle is expressed in degrees between [0 ; 360[.

Scale

Create the image of a an object by a scale transformation (homothetie). The user selects the point to transform, the centre and the factor (i.e. a number). When the user wants to create an image of a point, s/he must first select it; the transformation will be performed on this selected point.

2.1.4 Numeric Tools

Distance, Length & Number

Create a numeric value. The numeric value can be computed or user- edited depending on the user's selections:

1. two points: distance between these two points;
2. a segment: the length of this segment;
3. a vector: the vector's magnitude;
4. a circle: the length of the circle;
5. an arc circle: the length of the arc;
6. a straight line: the slope of the line;
7. a straight line and a point: the distance between the line and the point;
8. a click on the background permits the user to enter a new value (i.e. a free value).

Angle

Create an angle defined by three point or two vectors. In the first case, the resulting angle is non oriented (i.e. a geometric angle in the range [0 ; 180]. In the second case, the angle is oriented and it is within the range]-180 ; 180].

Coordinates

Create the coordinates of a point or a vector. This tool creates both the abscissa and the coordinate.

Dr. GeoGuile Script

Create a Dr. GeoGuile Script. The script receives input of n objects. It eventually returns a number, printed in the figure. A script can be used for its side effects or for its returned value. The Dr. GeoGuile Scripts are covered in details in the Chapter Advanced Features Chapter 3 and exactly at Section Script Section 3.2, page 23.

2.1.5 Macro-Construction Tools

Setting a Macro-Construction

Extract a construction sequence of a figure and turn it as a macro-construction.

Executing a Macro-Construction

Execute (i.e. "run" or "play") a pre-built macro-construction. The macro-construction can be either newly created or loaded from file.

(!) Macro-Constructions are exposed in Section Macro-ConstructionSection 3.1, page 19.

2.2 Other functions

2.2.1 Moving figure

Figure can be moved by pressing CONTROL key and button 1 of the mouse.

2.2.2 Moving object

An object can be moved by draggin it. The figure is then recomputed according to its properties. Almost every type of geometric object can be moved. When necessary, Dr. Geoperforms a reverse dragging. For example, this occurs when the user moves a line defined by two points, Dr. Geowill move the two points according to the desired line position.

2.2.3 Deleting Objects

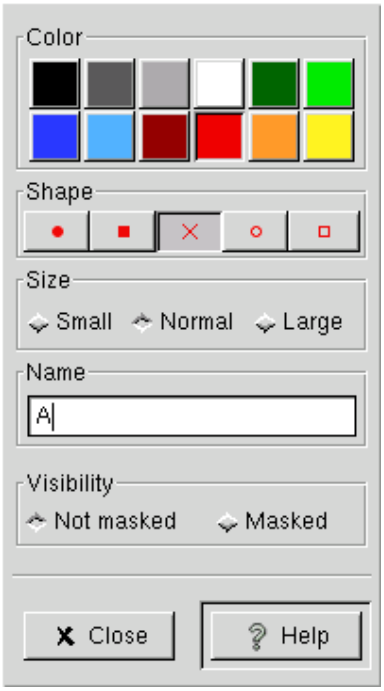
An object on the figure can be deleted when activating this menu. Eventually, the user can undelete using the undo function from the toolbar or application menu. By default the undo level is set to 10 but the user can adjust this value from the preference dialog.

2.2.4 Editing Object Styles

Each object owns such style attributes as colour, thickness, label, size or shape. Additionally, it is possible to hide an object temporarily without deleting it. For example, it can be useful to hide intermediate constructions without deleting them. All these attributes can be adjusted from a dialog activated when the user selects an object in the figure.

The point style dialog concerns any kind of point object. From it, it is possible to adjust its color, shape, size, name and visibility.

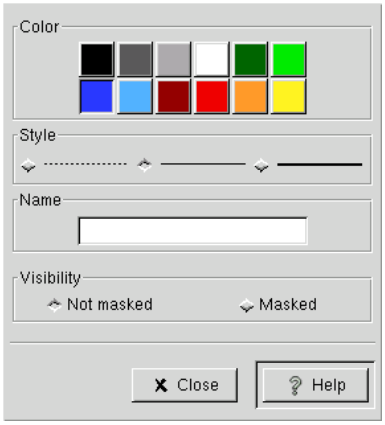
Figure 2.2: The style dialog for point object



The line style dialog concerns straight line, ray, segment, vector, circle, arc circle, locus. From it, it is possible to adjust the color, style, name and visibility.

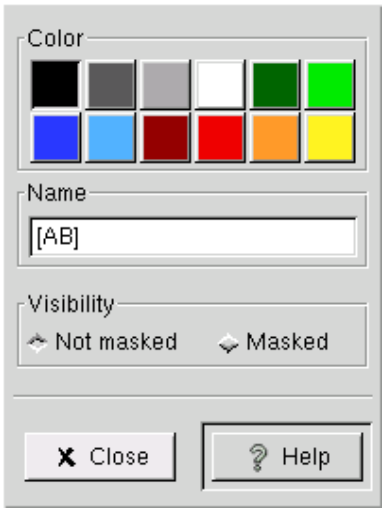
The numeric & polygon style dialog concerns all kind of values (user edited, computed by user's DR. GEOGUILE Script or representing geometric measure) and

Figure 2.3: The style dialog for line object



polygon shape.

Figure 2.4: The style dialog for numeric & polygon objects



2.2.5 Editing Object Properties

Some objects own properties adjustable by the user. When the user clicks on such objects, an appropriate dialog appears. Actually the following objects own user adjustable properties:

1. Free point on the area: abscissa and coordinate can be edited;

2. Free value: its value can be edited;

Figure 2.5: Edit free point coordinates

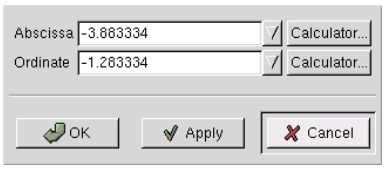
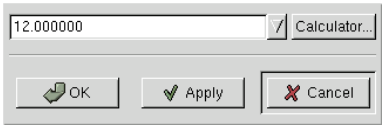
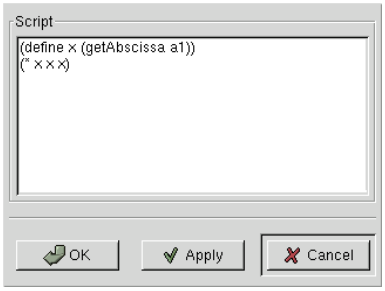


Figure 2.6: Edit free value



3. Script: its code can be edited.

Figure 2.7: Edit a script



2.3 User's Preferences

2.3.1 Default Behaviour

Dr. Geodefault behaviour can be customised in several ways. To adjust the preferences, the user goes to the menu item `Edit->Preferences...` to open the preferences dialog.

The dialog is composed of a notebook with two pages:

1. The first page concerns global preferences:
   Actually, the user can only adjust the default name of a session to be saved on disk.

2. The second page is about geometric figure preferences:
   From this page, a wide range of option can be adjusted:

   - The number of Undo/Redo level;

Figure 2.8: Global preferences

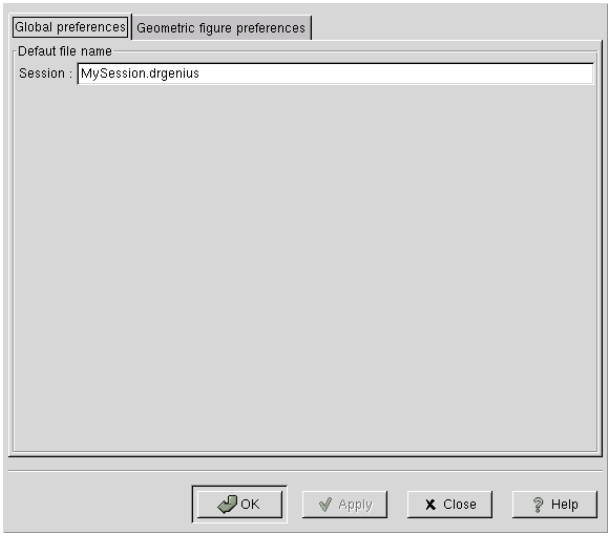
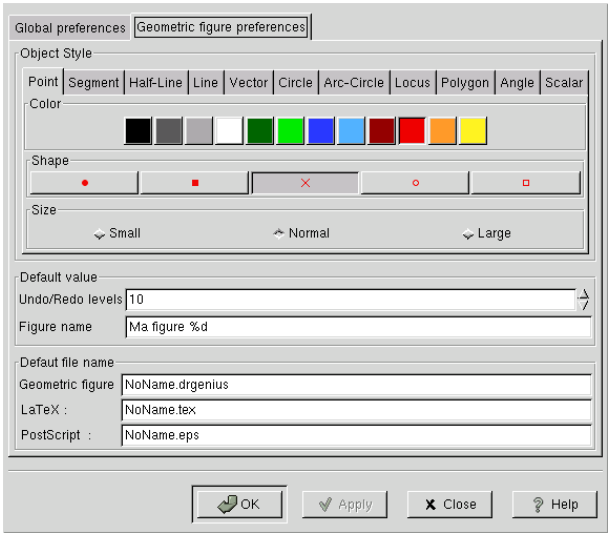


Figure 2.9: Geometric figure preferences

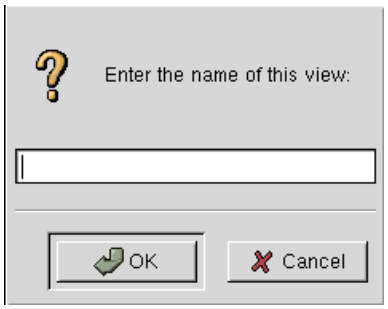


- The default figure name to be used when a new figure is created. The %d is replaced by an integer value handled by Dr. Geo, this value is incremented at each newly created figure;
- Several default name for single figure file and LaTeX/PostScript export;
- In the superior area of the page, another notebook allows the user to adjust the default object style of each figure item (geometric or numeric ones). The concerned styles are colour, shape, size and style.

2.3.2 Other Preferences

In addition to changing the default behaviour of Dr. Geo, the user can change the name of a figure from the menu item `Edit->Rename`.

Figure 2.10: Renaming a figure view



Chapter 3

Advanced Features

In this chapter we present features used to extend the cabilities of Dr. GEOin various ways.

The first is macro-construction; it allows the extraction of a construction logic in a record. Then, this record can be repeated or saved as a file.

The Dr. GEOGuile Script features are the other means for extending Dr. GEO. These scripts are really figure items like the other geometric items. They receive as input, user selected figure item references and they return values, plugged into figures.

Dr. GEOGuile Scripts can be useful for their returned values or their side effects; which really depends on what the user wants to achieve.

The last feature is user-interface customisability. The idea is to give the teacher the cability to prepare geometric figure files with tools taken from the Dr. Genius toolbar and contextual menu. This capability may help in achieving a desired "pedagogical effect"

3.1 Macro-Construction

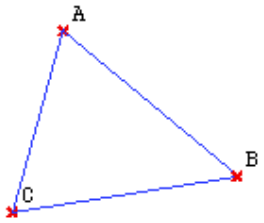
Macro-constructions are a bit like a procedure which receives as input figure items and then returns one or more figure items, constructed by the macro-construction. They are built on a model defined by the user. This means that the user has to build a construction sequence only once. Then she can tell Dr. GEOthat she wants this sequence to be recorded in a macro-construction. To record a construction sequence, Dr. GEOneeds to know which are the initial items of the sequence and the resulting items. Of course the resulting items must depend *only* on the initial items; otherwise Dr. Genius would not be able to deduce the resulting items from the initial ones.

Using its knowledge of the initial and resulting items, Dr. GEOdeduces the construction sequence and saves it in a macro-construction. The user can then execute this macro-construction simply by inputting (initial) items (they must match the type) in the figure. The macro-construction can then build the resulting items.

(!) Invisible intermediate figure items are also built by the macro-construction. These items are necessary to build the resulting items.

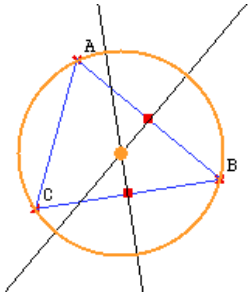
To illustrate the macro-construction feature, we will use an example in which the user wants to record the construction of a circle with a given center which passes through three points, also given.

Figure 3.1: Our initial figure



Before constructing the macro-construction, the user needs to construct the final figure; it is used as a pattern from which to build the macro-construction.

Figure 3.2: Our figure with the resulting construction



3.1.1 Constructing a Macro-Construction

At this point, the construction sequence is done. Now, the user needs to tell Dr. Genius that she wants to create a macro-construction from this sequence. She can call the `Construct a macro` function from the icon or from the contextual menu in the figure view.

From the wizard dialog, the user selects the input & output parameters, the name and description of the macro-construction.

The second page of the dialog is used to select the input parameters. In our example, these are the three initial points. The user just needs to go to this second page and she can select the three points in the figure. The selected items will blink.

From the 3rd page, she selects the output parameters. In our example, we want the circle and its centre as the result of the macro-construction. She proceeds as in the case of the input parameters to select them.

In the 4th page, the user enters the name and the description of the macro-construction. This information is displayed when the user executes a macro-

Figure 3.3: The 1st page of the wizard dialog to construct a macro-construction

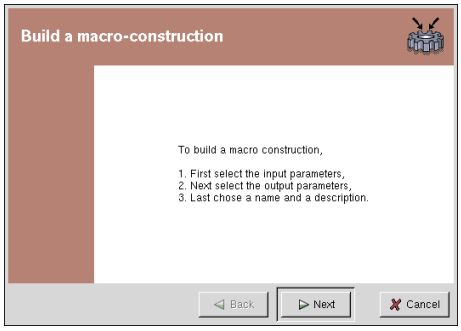


Figure 3.4: The 2nd page, the three points are already selected

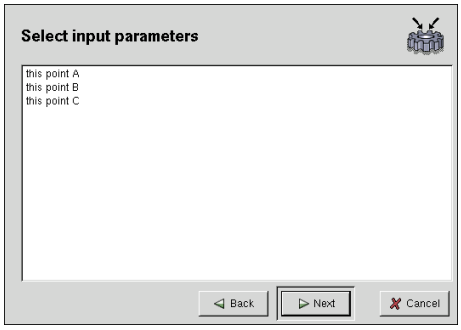
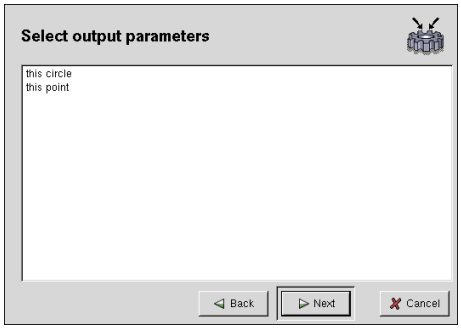


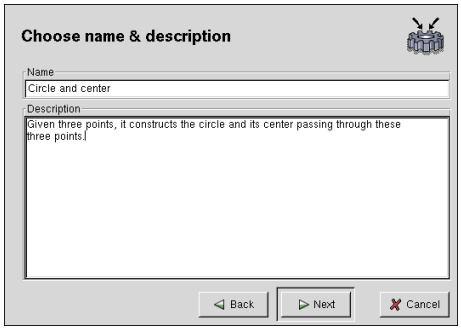
Figure 3.5: The 3rd page, the circle and its centre are already selected



construction, so it helps to distinguish macro-construction between them.

From the last page of the wizard dialog (the 5th one), the user can terminate the creation by pressing the `Finish` button. Alternatively, she can return to previous pages to adjust the macro-construction parameters.

Figure 3.6: The 4th page, the name and description of the macro-construction



(!) If the input & output parameters selections do not match (Dr. Geocannot extract the logic of the construction), the macro-construction cannot be built. In such a case, the user needs to reconsider the input and output parameters selection. She can go back to the 2nd and 3rd page of the wizard dialog to adjust her choices.

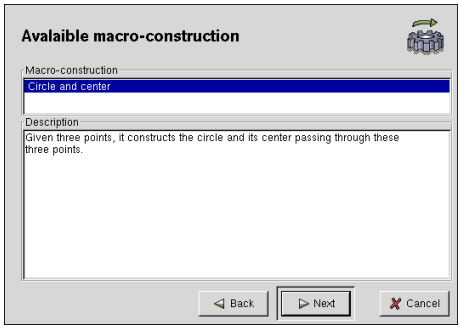
At this point the macro-construction is built and recorded in Dr. Geo. In the next section, we will see how to use this macro-construction.

3.1.2 Executing a Macro-Construction

To execute a macro-construction, the user calls the `Execute pre-build macro` function from the icon or from the contextual menu in the figure view.

From the wizard dialog, the user selects the macro-construction. In the 2nd page, she selects the macro-construction from the list in the top area of the dialog. Once a macro-construction is selected, she can directly click on the input parameters in the figure. As soon as all the necessary input parameters are selected, the macro-construction is executed and the final parameters appear.

Figure 3.7: The user selects the input parameters directly in the figure



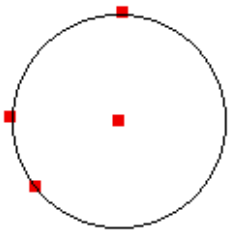
In our example, the macro-construction needs three input parameters (three

points) and it builds a point and a circle. To execute our macro-construction, we need a figure with a least three points.

Figure 3.8: A figure with three points

Once our macro-construction is applied to these three points, we get the desired circle and its centre.

Figure 3.9: The resulting figure with the circle and its centre



3.2 Dr. GeoGuile Script

Dr. Geois Guile aware. This means it is possible to execute Guile scripts within Dr. Geo. But what is Guile? From the Guile manual:

> *Guile is an interpreter for the Scheme programming language, packaged for use in a wide variety of environments.*

The following citation describes accurately how is used Guile within Dr. Geo:

> *Like a shell, Guile can run interactively, reading expressions from the user, evaluating them, and displaying the results, or as a script interpreter, reading and executing Scheme code from a file. However, Guile is also packaged as an object library, allowing other applications to easily incorporate a complete Scheme interpreter. An application can use Guile as an extension language, a clean and powerful configuration language, or as multi-purpose "glue", connecting primitives provided by the application.*

In Dr. Geo, an API is available from the Guile interpretor. This API is a set of hooks in the geometric engine. Therefore the user can write scripts to manipulate figure items (geometric and numeric). Also, as scripts are figure items like any other, they do not need to be saved as separate files. They are saved in the figure file. In the following, we will use the DGS acronym for Dr. GeoGuile Script.

3.2.1 Creating a DGS

3.2.2 More about DGS

3.3 User interface customisation

Chapter 4

Saving and Loading Constructions

Constructions can be saved in two ways. One construction per file or a construction set per file (i.e. a Dr. Genius session).

4.1 Saving one construction

From the menu `File->Save` or `File->Save As...`, a file can be saved containing the figure under the active view.

> (!) Dr. Genius can work with several figures at the same time. The user can switch from one figure to another one by clicking on the corresponding tabs.

With the second menu, the user can change the name of the saved document.

> (!) The default file name proposed to the user by Dr. Genius can be changed from the `Edit->Preferences...` menu. For more information see Section Defaut BehaviourSection 2.3.1, page 15.

4.2 Saving a Session

A session is a set of Dr. Genius data the user wants to save in one shot in a file. It allows teacher to organise a set of data (figure, macro-construction, note) in one file, so it is more convenient to re-open such data.

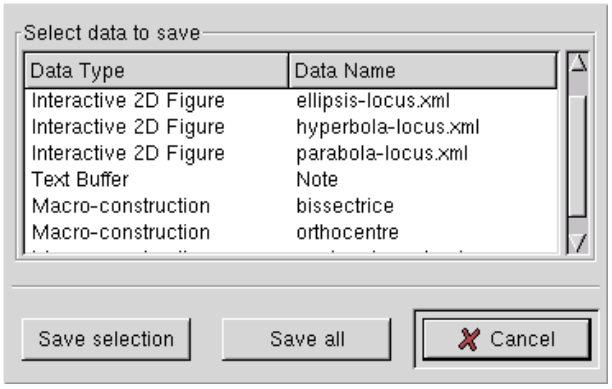
From the `File->Save Multiple` menu, the user can display the session dialog.

The list of all active data is saved in this file and presented in a table. The first colon represents the type of data contained in Dr. Genius. The second one represents the name of the data.

> (!) Actually, a session can contain three kinds of data: 2D interactive figure, macro-construction and text.

Then users can decide to select one by one the data to save from the list. Then she can press the `Save Session` button. Alternatively, she can save all the data by pressing the `Save All` button.

Figure 4.1: The Dr. Genius session dialog



(!) `File->Save Multiple` menu is the only way to save macro-constrcutions to a file.

4.3 Loading Constructions

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