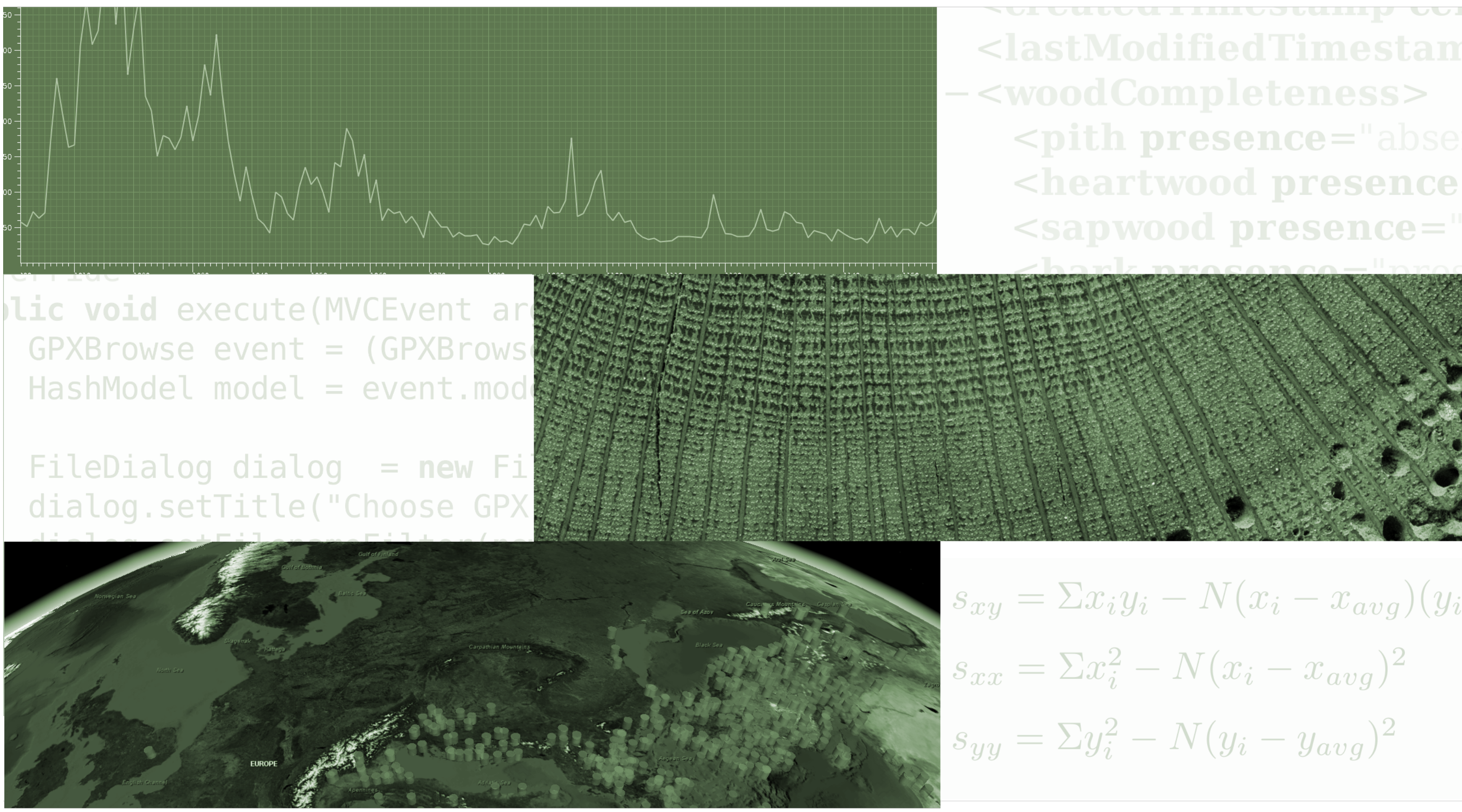
Corina

A guide for users and developers



By Peter W. Brewer and Ken Harris

For Corina server and desktop
version 2.12

GPL v3 Free Software — Free as in Freedom

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Preface

Corina is the tree ring measuring and analysis program developed at the Cornell Tree-Ring Laboratory. It is focused primarily on the measurement of tree ring widths and the organization and curation of the data, metadata and physical samples. It is cross-platform (running on all Java 6 enabled operating systems including Windows, MacOSX and Linux) and open-source. It includes support for Velmex, Lintab and Hensen measuring platforms.

Corina has been developed since 2000 as a desktop Java application, following an earlier DOS-based version which itself was derived from a collection of FORTRAN and C utilities. Earlier iterations of Corina (version 0.x and 1.x) were built around a standard file-based data management system. In 2007, work began on a major rewrite of the software whereby this file-based data management was replaced with an object-relational database management system (ORDBMS) and server/client webservice infrastructure. This series of releases (versions 2.x) are what are described in this manual.

This manual is divided into two main sections, the first for users, the second for developers. Corina is open source software (see the details of the license on pages 55–60) so you are welcome to inspect and edit the code. The second part of this manual will help you do that.

Over the years Corina has been developed by a number of people: Peter Brewer, Chris Dunham, Aaron Hamid, Ken Harris, Drew Kalina, Lucas Madar, Daniel Murphy, Robert 'Mecki' Pohl and Kit Sturgeon. We hope that you find Corina useful and look forward to hearing your feedback.

Part I

User Guide

Chapter 1

Installation

Corina is made up of two packages; the Corina desktop application and the Corina database server. Corina was designed primarily for laboratories with multiple users, each running the Corina desktop application on their own computer connecting to a single central server containing the lab's data. In this situation the Corina server would be run on a separate computer to those running the desktop client, but this need not necessarily be the case. It is perfectly possible to run both the server and the client on the same computer. This is likely to be the situation if you simply want to try out Corina, if you don't have a separate server, or if you do not work in a multi-user laboratory.

1.1 Desktop application

Installation packages for the Corina desktop application are available for Windows, MacOSX and Ubuntu Linux. Corina can also be run on other operating systems as long as they support Java 6.

To install Corina, download the installation file for your operating system from *http://dendro.cornell.edu/corina/download.php*. The website should provide you with a link to the installer for your current operating system:

- **Windows** – Run the setup.exe and follow the instructions. If you do not have Java installed the installer will direct you to the Java website where you can get the latest version. Once installed, Corina can be launched via the Start menu.
- **Mac OS X** – As mentioned above, Corina requires Java 6. Although MacOSX ships with Java installed, unfortunately Apple have been very slow to provide Java 6. Although it was released in 2006, it was not until August 2009 that Apple made Java 6 available as part of v10.6 (Snow Leopard). Corina can therefore only be run on Snow Leopard or later. To do so, download the dmg disk image file and mount it by double clicking on it. Drag the Corina.app into your applications folder and copy the manual and license files to somewhere convenient in your documents folder. For the more adventurous there is the possibility that you could run Corina using SoyLatte instead of the standard Java installation that comes with the operating system. This could be a possible method for running Corina even on earlier versions of MacOSX but is unsupported and largely untested.
- **Ubuntu Linux** – A deb file is available which was designed for use on Ubuntu distributions but should work on any Debian based system. Install using your favorite package management system e.g.

  ```
  sudo dpkg --install corina_2.xx-1_all.deb
  ```

  On Ubuntu and similar distributions, the package should add a Corina shortcut to your applications menu. Alternatively you can start Corina from the command line by typing corina.
- **Other operating systems** – Make sure you have Java 6 installed, then download the Corina jar file to your hard disk. You can run Corina from the command line by typing:

```
java -jar corina.jar
```

1.1.1 Mapping support

Corina includes 3D mapping for visualization of sampling locations. Although this is not necessary for most tasks, to make use of the mapping functions you will require a OpenGL 3D capable graphics card. To check whether your computer already supports 3D mapping, open Corina, go to Admin, then Site map. Corina will warn you if your graphics card is not supported.

All MacOSX computers should automatically support OpenGL. Most Windows and Linux computers made since 2006 should also support OpenGL, however, this does require proper drivers to be installed. In some cases Windows computers may include a compatible graphics card, but may only have the default Windows video drivers installed. If you are having trouble with the mapping in Corina make sure you have installed the most recent drivers for your graphics card. Linux users may be required to install proprietary graphics drivers.

The mapping component of Corina makes use of NASA's open source World Wind Java. NASA's website *http://worldwind.arc.nasa.gov/* contains further information and instructions that you may find helpful if you are having problems getting the mapping to work.

1.2 Server installation

For the Corina desktop application to be useful you will also require access to a Corina server. If you are running Corina in a lab where the Corina server has already been set up by your systems administrator, you can skip this section.

The Corina server is made up of a number of components, which unlike the desktop client, can not be easily combined together into cross-platform packages. Although all the constituent components are open-source and available for all major platforms, building and maintaining separate packages for each platform is too large a task for a small development team. To conserve resources, we therefore made the decision to utilize Virtual Machine technology to ensure that the Corina server could still be run on all major operating systems. This means that we can package the Corina server for a single operating system (Ubuntu Linux) and then distribute it as a Virtual Appliance that can be run as a program on your normal operating system.

The Corina server is therefore available via two main methods. The first is as a VirtualBox Virtual Appliance which can be run on any major operating system, the second is as an Ubuntu package for running natively on a Linux server. The source code for the server is also available so it is perfectly possible for more experienced users to set up the Corina server to run natively on other platforms. But to do this you will require a good knowledge of Apache 2, PHP and PostgreSQL.

1.2.1 Virtual Appliance - all operating systems

To run the Corina server Virtual Appliance, you will first need to download and install VirtualBox from *http://www.virtualbox.org*. Installation packages are available for Windows, MacOSX, OpenSolaris and many Linux distributions.

Once you have VirtualBox installed, you will then need to download the Corina server from the Cornell website *http://dendro.cornell.edu/corina*. This package contains a bare-bones Ubuntu Linux server with everything required to run the Corina server installed and ready to use. As VirtualBox, the entire Ubuntu operating system and Corina server components are all open source there are no license fees to pay.

Open VirtualBox and go to File, Import Appliance, then follow the wizard selecting the Corina server appliance file when prompted. Once installed you can run your server by highlighting it in the list and pressing start. The server will boot up in a window alongside your normal operating system and eventually reach a login prompt. To save on download size and disk space only the essential packages to make the server run have been installed. This means there is no graphical interface just a command line. Hopefully this should not be a problem as once set up, the only interaction needed with the Virtual Appliance will be through the normal

Corina desktop application. If you would prefer to use a graphical interface to the server this can be easily installed. See chapter 10 for further details.latex define environment

Before you can use your server you will need to know the IP address that the server has been assigned by your network. To do this login at the prompt with the default admin credentials: user – corina; password – w3l0v3tr33s. Once logged in, type `corina --test` and a basic configuration test will be performed. If all is well, all tests will be passed and it will tell you the URL of your new server. You will need to set your Corina client to point at this webservice to use your server.

1.2.2 Ubuntu native installation

If you are fortunate enough to be running Ubuntu then the native Ubuntu deb package is the best and easiest method for installing the Corina server, otherwise see section 1.2.1 to install the server as a Virtual Appliance.

To install the Corina server in Ubuntu simply download the deb package from the Cornell server *http://dendro.cornell.edu/corina* and install with your favourite package manager. For instance, to install from the command line simply type:

```
sudo dpkg --install corina-server.deb
```

The package will automatically run a configuration script to assist with creating a database user, building the Corina PostgreSQL database, setting database permissions and setting up the Apache webservice. The configuration ends with a test routine to check all services are set up correctly and if so, will provide you with the URL of the newly configured Corina webservice.

1.2.3 Advanced install on other operating systems

As mentioned previously, the limited resources available for Corina development means that we have been unable to produce native installers for platforms other that Ubuntu. If you are an experience systems administrator though, it should not be too difficult to set up the Corina server manually.

The Corina server is essentially a PostgreSQL database accessed via a PHP webservice running on Apache 2. The following dependencies are therefore required: postgresql-8.4; postgis; postgresql-contrib-8.4; postgresql-8.4-pljava; sun-java6-jre; apache2; php5; php5-pgsql; php5-curl; php5-mhash.

The basic procedure for installation is as follows:

- Install all dependencies
- Create PostgreSQL database from Corina template SQL file
- Set up a database user and provide access to the server in the pg_hba.conf file
- Give this user read and write permissions to the database
- Copy the webservice code into a web accessible folder
- Set up Apache to see this folder by creating an entry in the sites-enabled folder
- Restart PostgreSQL and Apache and check you can access the webservice from a web browser

Chapter 2

Measuring samples

Although it is possible to manually enter the ring widths of your samples into Corina, it is normal to automate this process using a measuring platform. Corina supports the most common measuring platforms including Velmex and Lintab.

2.1 Configuring measuring platforms

Measuring platforms typically use serial ports to communicate to computers. In recent years computer manufacturers have been phasing out serial ports so you may need to purchase a serial-USB converter. Modern MacOSX, Linux as well as Windows 7 should support most serial-USB adapters out of the box, otherwise you must install the relevant drivers before continuing. Recent Lintab USB platforms use internal serial-USB converters so are treated in exactly the same way by Corina.

To begin, shut down your computer, attach your platform, then reboot and launch Corina. Next, go to the preferences window and open the hardware tab and you should see an interface that looks like figure 2.1.

In the type pull down menu, select the type of measuring equipment you are using. Note that this refers to the equipment that the computer is attached to, and not necessarily the measuring platform itself. For instance, Velmex platforms are typically connected through a Metronics digital readout device. Included in this list is the EveIO device which is an open-source device designed for the Cornell Tree-Ring Laboratory. Circuit drawings for this device can be obtained from the Cornell lab to enable Hensen measuring platforms to be used with Corina (and other software).

> Standard Lintab platforms use a proprietary communications protocol. Rinntech–the manufacturers of Lintab platforms–claim intellectual property rights over this protocol. During discussions between the Corina development team and Rinntech an agreement was reached whereby the Corina developers agreed not to release details of the protocol. In turn Rinntech has agreed to produce an adapter that can be attached to Lintab platforms so that they communicate with an open ASCII protocol. Users wishing to use Lintab platforms with Corina (or any software not developed by Rinntech) must therefore contact Rinntech and purchase an adapter.

Next you must choose the port that your platform is connected to from the pull down menu. In Windows this will be a COM port, in Linux and Mac this will be a /dev/xxx port. Depending on the type of platform you choose, you may also need to set various communication parameters. If these boxes are enabled, please check the documentation that came with your measuring platform to ensure these values are set correctly.

To check whether your platform is working, click the 'Start measuring test' button and attempt to measure a few rings. Once you are satisfied, click OK on the preferences window and you will be returned to the Corina home screen.

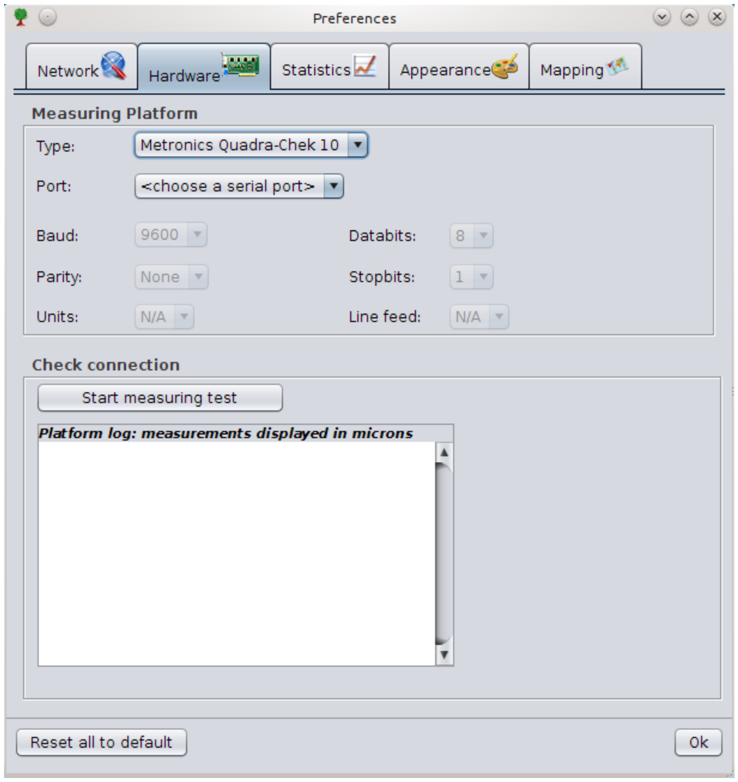


Figure 2.1: The hardware preferences dialog.

2.2 Differences in measuring hardware

Different measuring platforms have different capabilities. For instance, some include a physical switch for firing measurement events, others also include switches for resetting measurements to zero. Some platforms (e.g. Lintab) also continuously report the measurement values to the computer. So depending on the hardware you use, Corina will present the you with slightly different options.

Please note that the architecture of Corina is such that providing support for additional measuring platforms is a relatively simple task. If you have equipment that is not currently supported, please contact the developers to see if it can be included.

2.3 Measuring a sample

Once your measuring platform has been configured, measuring your first sample is simple. To start a new measurement go to *File* ➔ *New* or click the 'new' icon on the home screen. A dialog will appear where you can scan your sample's barcode, or press the button to enter metadata for your sample later. Barcodes minimize data entry errors and also speed up the process of measuring your samples. See section **??** for more information. Once you have scanned your barcode or pressed the button, you will then be presented with an empty Corina data screen (figure 2.2).

The next step is to fill out the metadata tab. If you have used a barcode, nearly all of this metadata will be filled in for you, otherwise you will need to fill this out yourself. Details about metadata can be found in chapter 3, page 13.

To begin measuring your sample you can now go to *Edit* ➔ *Start measuring* or you can press F5. While measuring you should be provided with audible feedback for each ring measured with a more pronounced sound made every 10th ring. If there is a problem communicating with your measuring hardware, check your settings

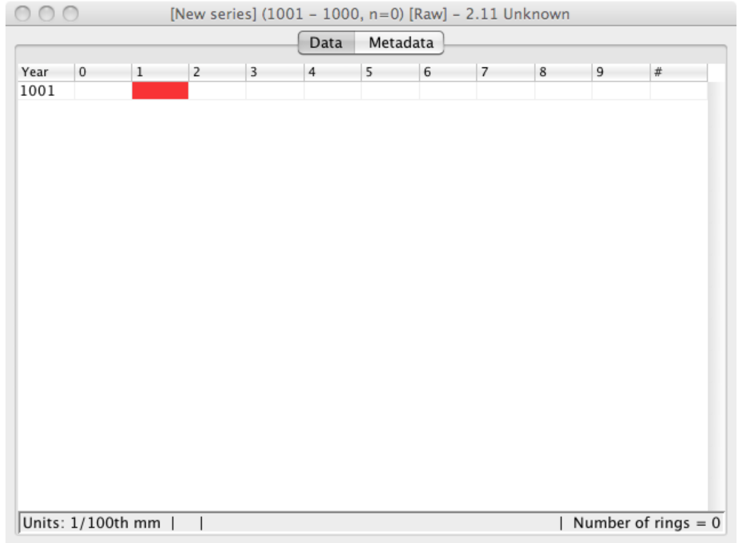


Figure 2.2: An empty data window ready to receive measurements. Note the status bar at the bottom includes buttons for changing the display units and cumulative statistics.

in the preferences dialog. If you still have problems contact the Corina developers by going to *Help* → *Report bug on last transaction*, making sure you include your email address and any further information.

While you measure your sample you can flag features in a ring by right clicking on any cell in the table and selecting one or more of the standard notes (see figure 2.3).

Corina supports all standard TRiDaS remarks including: fire damage; frost damage; crack; false ring(s); compression wood; tension wood; traumatic ducts; single pinned; double pinned; triple pinned and many others. Rings that include remarks are indicated by the relevant icon in the data screen. Depending on your method of work, this can be useful for keeping track of sample pin holes. For instance, if a missing or false ring is discovered after a sample has been pinholed, the offset in pinholes can be easily seen without resurfacing the sample. In the future Corina will also include support for user defined ring remarks.

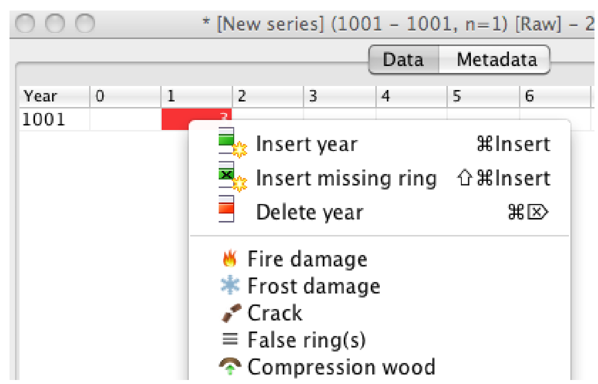


Figure 2.3: Right click context menu showing some of the options for adding remarks to rings.

The data screen also contains a status bar at the bottom. By click on the units section, you can switch between micron and 1/100th mm units. Corina understands the units being supplied by the measuring platform, therefore changes here are purely for display purposes only. If you have a platform that measures in microns, but prefer to see the values in 1/100th mm then you can use this feature. At the bottom ring of the status bar you can choose one of a variety of summary information about your series.

Once you have finished measuring your sample, you should then go to *File* → *Save* to save your series to the database.

2.4 Reconciling data

Corina has been developed not only for experience dendrochronologists, but as a tool for teaching students. It therefore includes a comprehensive 'reconciling' tool for supervisors to check the quality of measurements made by students. The reconcile dialog does a comparison of a measurement series made by a student with a references series of the same radius measured by the supervisor. The same dialog can also prove useful for comparing measurements from two experienced dendrochronologists when handling particularly difficult samples.

Chapter 3

Metadata

Metadata is 'data about data'. In Corina this means all the information associated with your physical samples and measurement series e.g. species, location, who measured it, dimensions, slope, soil type etc.

The metadata in Corina, and in fact the entire Corina data model, is based on the Tree Ring Data Standard (TRiDaS). Before you use Corina you may find it useful to read Jansma et al. (2010) so that you get a better understanding of the principles of TRiDaS, but a summary is also provided here.

3.1 Tree Ring Data Standard - TRiDaS

TRiDaS is an XML-based data standard for recording dendrochronological data and metadata. More than 80 dendrochronologists, computer scientists and specialists from research disciplines that rely on dendrochronology have so far contributed to its development, including dendroarchaeologists, art and architecture historians, ecologists, geologists and climatologists. The standard is therefore capable of recording the wide variety of metadata required by these different fields. TRiDaS builds upon other established standards, such as GML for the recording of locality information. The extensible nature of XML also means that TRiDaS can evolve to accommodate the changing needs of dendrochronologists over time.

TRiDaS includes a total of eight data entities: project; object; element; sample; radius; measurementSeries; derivedSeries; and value. Detailed descriptions of each of these entities are given below and their relationships are illustrated in figure 3.1.

A project is defined by a laboratory and encompasses dendrochronological research of a particular object or group of objects. Examples include: the dating of a building; the research of forest dynamics in a stand of living trees; the dating of all Rembrandt paintings in a museum. What is considered a "project" is up to the laboratory performing the research. It could be the dating of a group of objects, but the laboratory can also decide to define a separate project for each object. Therefore, a project can have one or more objects associated with it. Due to the way research is conducted at the Cornell Tree-Ring Lab, TRiDaS projects are not currently supported within Corina, although future plans include adding project support.

An object is the item to be investigated. Examples include: violin; excavation site; painting on a wooden panel; water well; church; carving; ship; forest. An object could also be more specific, for example: mast of a ship; roof of a church. Depending on the object type various descriptions are made possible. An object can have one or more elements and can also refer to another (sub) object. For instance a single file may contain three objects: an archaeological site object, within which there is a building object, within which there is a beam object. The list of possible object types is extensible and is thus flexible enough to incorporate the diversity of data required by the dendro community. Only information that is essential for dendrochronological research is recorded here. Other related data may be provided in the form of a link to an external database such as a museum catalogue.

An element is a piece of wood originating from a single tree. Examples include: one plank of a water well; a single wooden panel in a painting; the left-hand back plate of a violin; one beam in a roof; a tree trunk preserved in the soil; a living tree. The element is a specific part of exactly one object or sub object. An

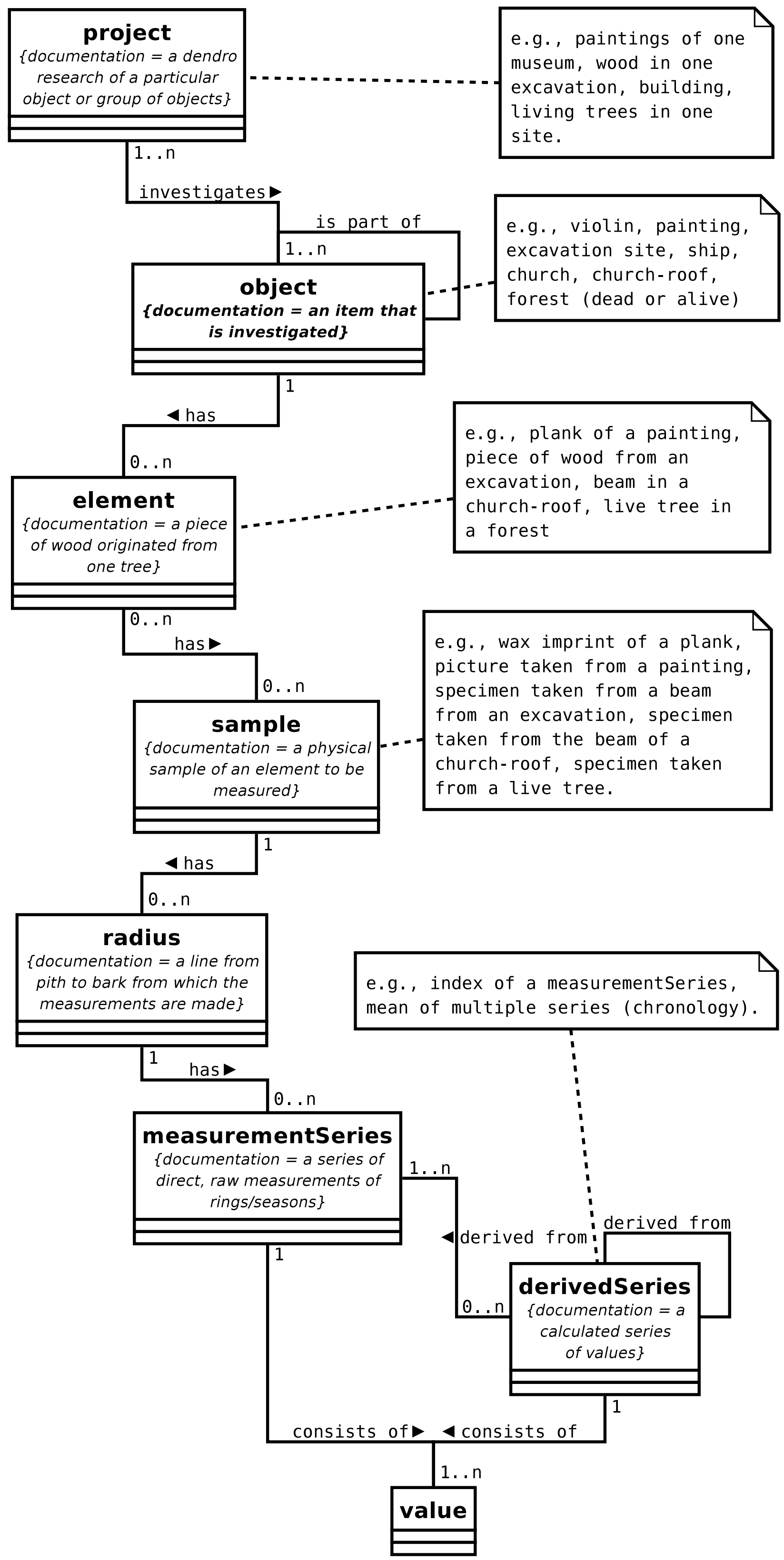


Figure 3.1: TRiDaS data model showing the relationships between data entities.

object will often consist of more than one element, e.g., when dealing with the staves (elements) of a barrel (object). One or more samples can be taken from an element and an element may be dated using one or more derivedSeries.

A sample is a physical specimen or non-physical representation of an element. Examples include: core from a living tree; core from a rafter in a church roof; piece of charcoal from an archaeological trench; slice from a pile used in a pile foundation; wax imprint of the outer end of a plank; photo of a back plate of a string instrument. Note that a sample always exists and that it can either be physical (e.g. a core) or representative (e.g. a picture). A sample is taken from exactly one element and can be represented by one or more radii.

A radius is a line from pith to bark along which the measurements are taken. A radius is derived from exactly one sample. It can be measured more than once resulting in multiple measurementSeries.

A measurementSeries is a series of direct, raw measurements along a radius. A single measurementSeries can be standardised or a collection of measurementSeries can be combined into a derivedSeries. The measurements themselves are stored separately as values.

A derivedSeries is a calculated series of values and is a minor modification of the "v-series" concept proposed by Brewer et al. (2010). Examples include: index; average of a collection of measurementSeries such as a chronology. A derivedSeries is derived from one or more measurementSeries and has multiple values associated with it.

A value is the result of a single ring measurement. Examples include: total ring width; earlywood width; latewood width. The values are related to a measurementSeries or a derivedSeries. In case of a measurementSeries the variable and its measurement unit (e.g. microns, 1/100th mm etc) are recorded as well.

Working top to bottom, the TRiDaS entities are nested within each other. For instance a project contains one or more objects, which in turn contains one or more elements, and so on. The benefit of this is that you record data once and once only. In standard file-based dendrochronological software, when creating measurement series you are typically required to type the name of the site, the species of tree etc over and over again. This is not only time consuming, but very error prone.

Keeping data consistent is also difficult. For instance, if it was determined that a tree species was identified incorrectly, in existing file-based software, the user would need to locate all data series from this tree and manally update the metdata. This is not the case in Corina. A tree is represented just once in Corina and samples of this tree, and the subsequent measurement series reference this one entry. If metadata for this tree needs to be changed, the tree record is updated in just this one place. Because the measurement series obtain this information by reference, then all associated series are automatically kept up to date.

3.2 Entering sample metadata

The metadata for a series is viewed and edited on the 'Metadata' tab of the main window such as that shown in figure 3.2. You can see the interface is organized according to the TRiDaS data model with separate screens for object, through to series.

When creating a new series, the metadata screens must be populated in order. This is necessary because of the nesting of entities described above. For instance, an element is associated with an object, so an object must be chosen because and element can be defined. Likewise, an element must be chosen before any samples of this element can be defined.

Much of the time the entities that you need will already be stored within the database. Instead of re-entering data, you simply need to select the existing entry from the database, saving a great deal of time. Depending on the situation buttons will appear at the top of the dialog to let you 'choose' an entry from the database, 'revert' to the previously chosen entry, 'change' the existing entry to a different one from the database, or create a 'new' record.

Please note that the content of these metadata screens is kept read-only by default. To edit the values, you must first click the padlock icon to unlock the fields. When you have finished making changes you need to press the save button to write the changes to the database before moving to another metadata screen.

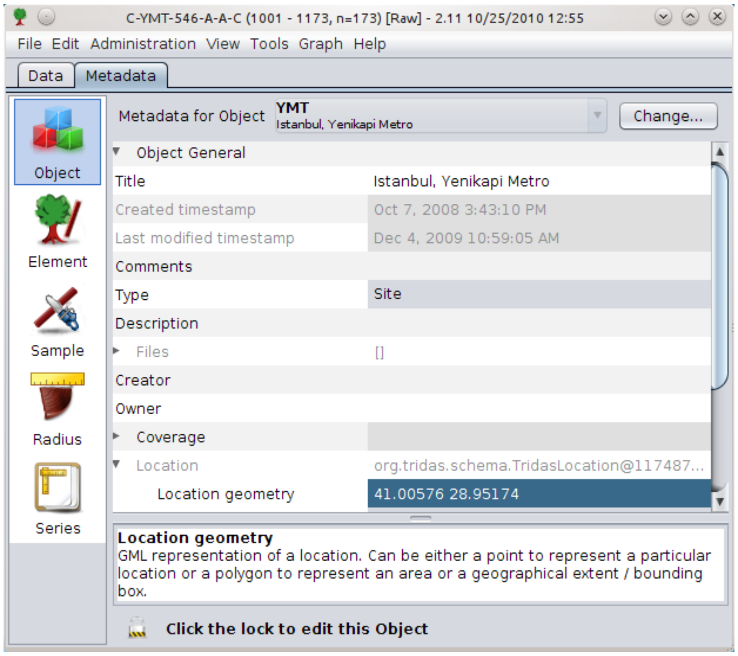


Figure 3.2: Example of the metadata dialog. The screen is showing the details of a TRiDaS object. Note that the location geometry field is highlighted and so a description of what is expected in this field is given below.

Very few of the metadata fields in the TRiDaS data model are mandatory, but a few are. In this case, these fields are highlighted with a red background. Note that whether a field is mandatory or not can depend on the other fields that have been filled in. For instance, the dimensions of an element are not required, but if dimensions are given then the units for these measurements must also be provided.

A number of the metadata fields are restricted with regards the values that you can enter. These are known as 'controlled vocabularies' in TRiDaS terms. Controlled vocabulary fields are represented by drop down menus. Similarly fields that expect numerical values (such as element dimensions) will only allow numbers. The final method data entry method is through custom dialogs. The only custom dialog currently implemented is for locations. This accepts coordinates in either decimal degrees or degrees minutes and seconds. Alternatively you can use data from a GPS handset by providing a GPS Exchange (GPX) format file containing the waypoints. The GPX format is the most common interchange format for GPS data. You can pick the relevant waypoint from the drop down menu. You can also preview the defined coordinates on a map using the 'view on map' button.

A popular open source GPS communication tool is GPS Babel. It is an easy to use application which can download data from the majority of GPS handsets. See *http://www.gpsbabel.org* for more information.

3.3 Entering bulk metadata

Entering metadata on a sample-by-sample basis works perfectly well, but does not necessarily fit best with the typical workflow of a laboratory. Samples do not typically arrive in a lab in ones and twos, rather in large quantities following a field excursion. In this case it is most efficient to enter all the metadata for the samples as they arrive. This is often best in terms of data accuracy as the metadata can be entered while the field notes are still fresh in the mind.

To enable the efficient entry of lots of metadata Corina includes the bulk data entry interface. This can be access from the file menu and is illustrated in figure 3.3. There are three pages, one each for objects, elements and samples.

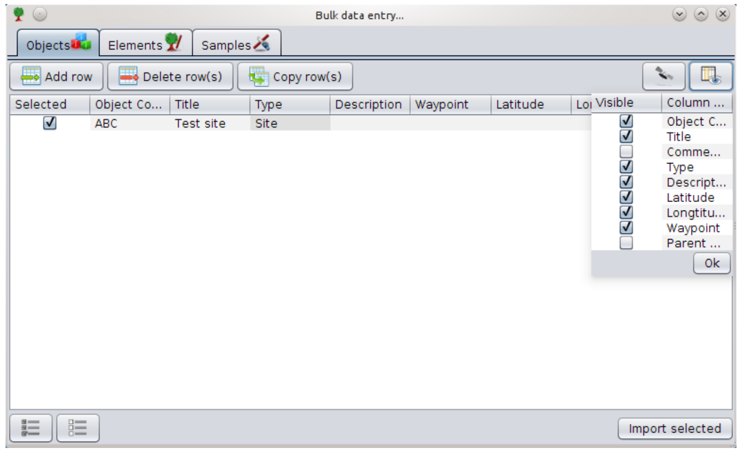


Figure 3.3: The bulk metadata entry screen. The 'show/hide columns' button has been pressed showing how the user can turn on and off particular columns.

The interface is designed like a spreadsheet so as to be as familiar to users as possible. Each row of the table represents a new entry in the Corina database. Which columns are shown to the user is determined by the 'show/hide columns' button on the top right of the screen.

The bulk entry interface also includes support for reading GPS units. By pressing the satellite button on the toolbar, the user can provide a GPS Exchange (GPX) format file containing the waypoint locations recorded in the field. Corina will add a waypoint column to the spreadsheet with a drop down menu which will automatically populate the latitude and longitude fields for the record.

It is common for many of the metadata fields to be same in a single field collection. For instance, when coring trees in a forest, they are often of the same species. Rather than requiring the user to repeatedly type the same data over and over, the 'copy row' button can be used to duplicate a record, and then the user can change the few fields that are different.

When you have entered all the data you want, you can press the 'Import selected' button to write the records to the database.

3.4 Metadata browser

The metadata browser interface provides a convenient way to view all the metadata within your Corina database. It can be accessed through the 'Administration' menu.

The metadata browser contains two parts: a hierarchical representation of all TRiDaS entities in your database on the left; and a metadata viewer for the selected entry on the right. This interface is also the best method for fixing mistakes in your database.

Although Corina's database architecture maintains integrity within your data, it does come at the price of being a little more complicated to fix mislabelled series. For instance, what if you were to measure a series 'B' and assign it to sample ABC-138-A only later to realize you misread the label and it was in fact ABC-188-A. In a traditional file-based system, you would probably just need to rename the file you'd just created. In Corina however, you need to redefine the relationship of the series within the database and reassign it to the create sample. This is best understood when looking at the hierarchical tree in the metadata browser. Hopefully you will see that you what you need to do is to move the series from its current position in the database to the correct one.

The reorganization of data in this way is achieved by right clicking on items in the hierarchical tree and choosing with 'merge' or 'reassign'.

Chapter 4

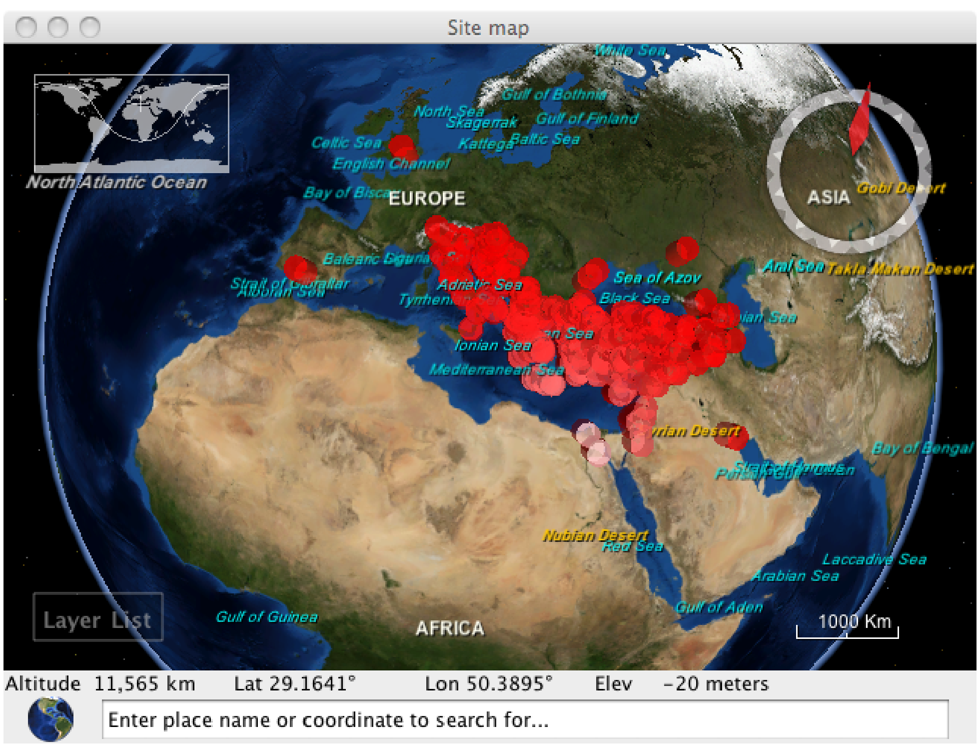
Mapping

Corina includes an integrated open source 3D mapping system (based on NASA's award winning World Wind Java SDK) similar to the program Google Earth which you're no doubt familiar with. As mentioned in the installation chapter, this mapping system requires an OpenGL 3D capable graphics card.

Before you can use the mapping in Corina, it must have something to map! See the chapter on Metadata (page 13) for information about adding coordinates to your system.

There are two ways to map data from your database. First of all, you can see a map of all the sites (i.e. TRiDaS objects) by going to Administration, then Site map. This will give you a screen like this:

Figure 4.1: Screenshot showing an example of a site map.



You can also see a map of your current series if you have latitude/longitude metadata by clicking on the map tab on the main data screen.

4.1 Navigation

You can navigate around your maps using both your mouse and keyboard.

4.1.1 Mouse with scroll wheel

Pan Left mouse button click and drag – all directions
Zoom Use the scroll wheel on the mouse or Left and Right mouse (both buttons) click and drag up and down
Tilt Right mouse button click and drag – up and down or use 'Page Up' and 'Page Down' on the keyboard.
Rotate Right mouse button click and drag – left and right Note: Crossing the top and bottom half of the screen while rotating will change direction.
Stop Spacebar
Reset Heading N
Reset all R

4.1.2 Single button mouse

Pan Left mouse button click and drag - all directions. L left mouse button click once to center view.
Zoom Hold 'Ctrl' on the keyboard and Left mouse button click and drag - up and down
Tilt Hold 'Shift' on the keyboard and Left mouse button click and drag - up and down or use "Page Up" and "Page Down" on the keyboard.
Rotate Hold 'Shift' on the keyboard and Left mouse button click and drag - left and right
Stop Spacebar
Reset Heading N
Reset all R

These controls enable you to explore your location information in 3D such as the example of Mount Vesuvius in figure 4.2.

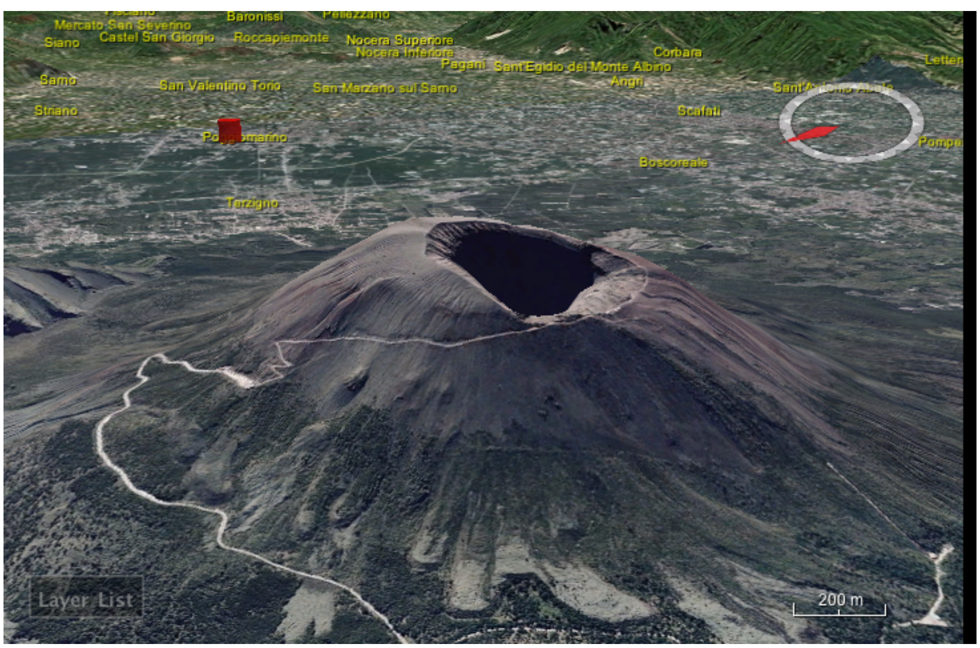


Figure 4.2: Example of 3D mapping in Corina.

Another method of navigating around the map is by using the built in gazetteer. You can enter and place name or coordinate information into the box at the bottom of the screen and you will fly to the requested location.

4.2 Interacting with data

Each marker on the map represents either a TRiDaS object or element in your Corina database. By clicking on these pins you can get more information from the database (see figure **??**).

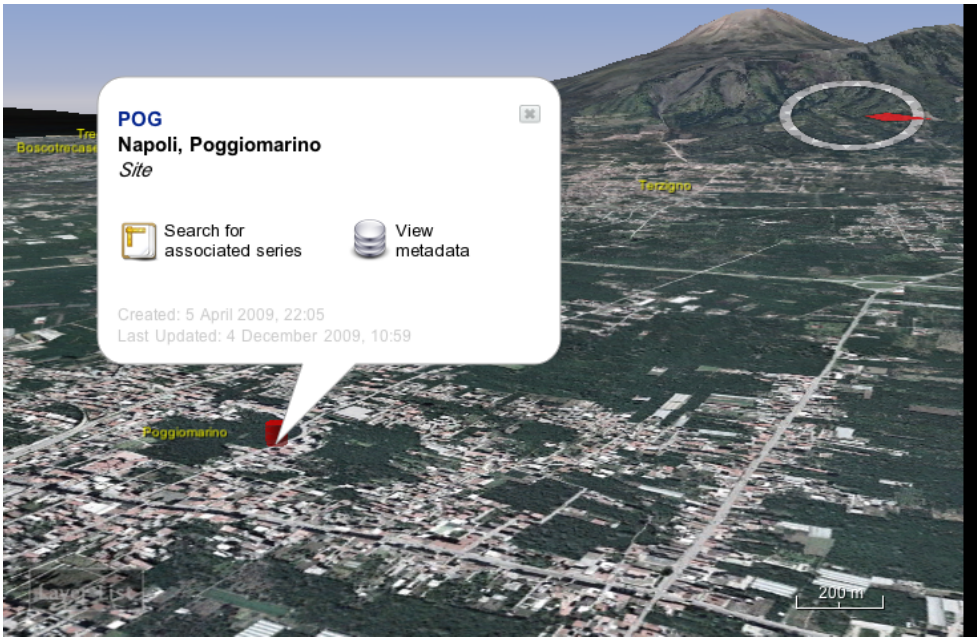


Figure 4.3: Screenshot of a map with information pin expanded

The example above shows the ring marker is of a site in Napoli called Poggiomarino (code name POG). You can see the option for searching for all series in the database associated with this site, and also the option for viewing all the metadata.

4.3 Background map layers

Corina comes ready configured with basic map layers, including high resolution satellite imagery and basic political features. You can turn background layers on and off by going to View ➔Layers.

Map layers are downloaded on-the-fly so there is likely to be a delay when you initially visit to a new region. However, up to 2Gb of map data can be cache locally to your hard disk, so on future visits, maps should load quickly.

The mapping system in Corina includes support for remote map servers that use the OGC Web Mapping Service (WMS) standard. If you go to View ➔Layers ➔Add remote layers, you will get a dialog with a tab for each WMS server configured for your system. By default this includes the NASA Earth Observation and Jet Propulsion Lab servers. By ticking layers in this list you can add data layers to your map.

You can add map data from other WMS servers by clicking the '+' tab and entering the URL of the server you would like to use. This will give an additional tab with all the available map layers. This server will only be available for the duration of your current session so will need to be added each time you start Corina. If you would like a particular WMS server to be made permanently available, your Corina administrator can do this (see 'Managing map services', on page 41 for further details). Additional WMS servers added in this way will be available to all users the next time they connect to your Corina server.

Your system administrator may host a map server specifically for your lab, for instance, containing high resolution plans of an archaeological site that you are working on, or environmental data for your study region. Figure **??** shows an example overlay of sea surfaces temperatures loaded dynamically from the NASA EO server.

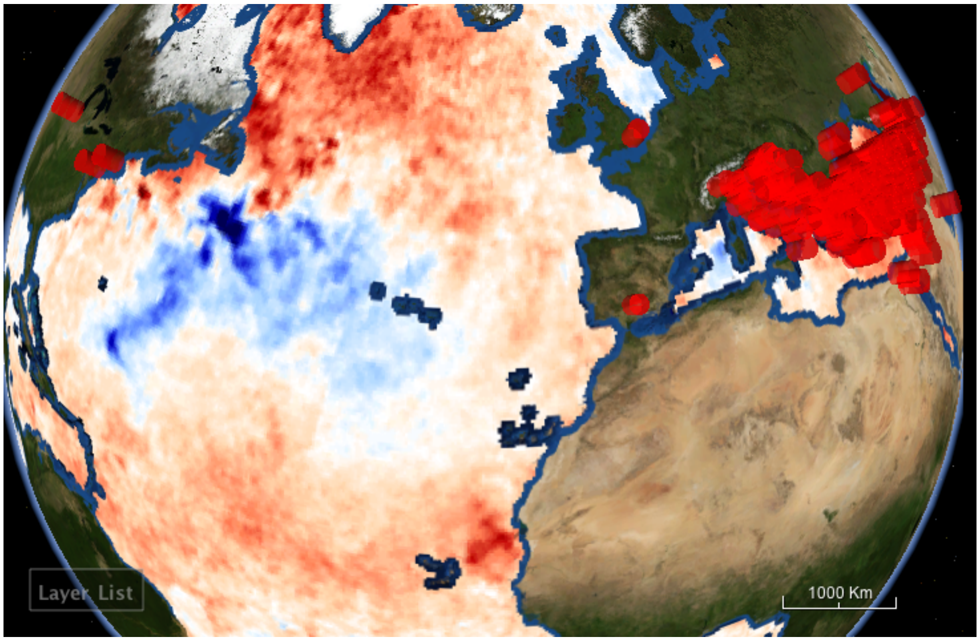


Figure 4.4: Map screenshot with a NASA sea surface temperature overlay dynamically loaded from the NASA WMS server.

4.4 Data map layers

Data map layers (i.e. site and sample locations) are controlled with the layer list in the bottom left of the screen. When viewing series, you will have the option of adding layers containing points for all the other series at the current site, and showing all the sites in the database.

4.5 Exporting maps

You can export maps by going to File ¿ Export map as image. For best results, maximize your map window first. You may also like to turn off various map widgets by going to the View menu. The exported image will include everything you can see on your map screen.

Chapter 5

Graphing

The graphing component is reused in many places throughout the Corina desktop application. The following description although based on the main graphing screen in Corina is largely applicable to all dialogs that include graphs (e.g. crossdating, indexing and reconciliation).

The main method for graphing your tree-ring data is by choosing an option from the Graph menu. Depending on the type of series you have open, the options available to you will be different. For raw measurement series, you will just have the option to 'Graph active series'. This will give you a simple graph of the current series that you have open. If you have a derived series open, then you may also choose 'Graph component series' which will plot all the series that go to create this series, or 'Graph all series' which graphs all the component series as well as the current series.

5.1 Controlling graphs

When newly created graphs are plotted according to the scale on the axes. A feature of Corina graphs though is that they can be manipulated directly on the screen. Both dendrochronology was computerized, dendrochronologists would plot rings manually on to graph paper. These paper graphs were then placed on lightboxes and moved around to enable comparisons. The graph function in Corina emulates this behaviour allowing users to click and drag graphs around to test for visual matches.

Figure 5.1 shows an example graph dialog. The mouse is hovering of the blue measurement series at relative year 1040 illustrating Corina's highlighting and guide line capabilities. A feature not shown in this screenshot is the illustration of sapwood rings. When sapwood rings are present the corresponding years on the chart are denoted via a heavier line.

The layout of graphs can be changed using both the toolbar buttons and menu options. The type of graph can be changed between a standard line graph, a semi-log graph and a toothed graph using the radio buttons. The remaining buttons are as follows:

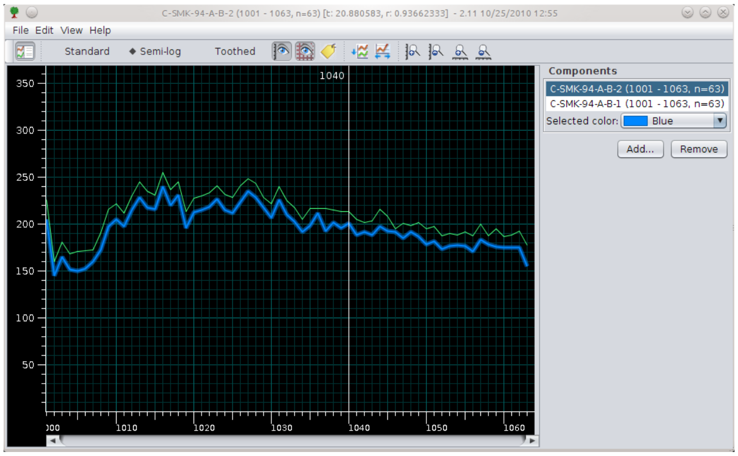


Figure 5.1: An example graph window containing two undated series of the same sample on a semi-log graph. Note the legend is visible with the options for adding or removing series.

- Zoom in on the horizontal axis
- Zoom out on the horizontal axis
- Zoom in on the vertical axis
- Zoom out on the vertical axis
- Toggle show/hide the grid lines
- Toggle show/hide the series labels
- Toggle show/hide the vertical axis
- Spread the series evening up the vertical axis
- Set the baselines of all the series to zero
- Resize graph to fit horizontally
- Toggle show/hide the legend

There are also a number of keyboard shortcuts that you might find useful:

Tab : Cycles through each graph component
Ctrl+W : Increase vertical scale
Ctrl+S : Decrease vertical scale
Ctrl+A : Increase horizontal scale
Ctrl+D : Decrease horizontal scale
Up arrow : Moves selected graph up by 10 units
Down arrow : Moves selected graph down by 10 units
+ : Moves selected graph up by 1 unit
- : Moves selected graph down by 1 unit
HOME : Scroll to first year of series
END : Scroll to last year of series
PAGE UP : Scroll left by one page width
PAGE DOWN : Scroll right by one page width
SPACE : Sets horizontal origin of all graphs to the same value

5.2 Exporting graphs

To export your graphs for use in reports you can go to File →Export plot as PDF file, or Export plot as PNG file. This presents you with a dialog for setting the colors, labels and size of the exported image. This functionality is due for an overhaul in the future to provide more flexible support for publication quality graphics.

Chapter 6

Importing and exporting

Importing and exporting of dendro data in Corina is provided through the TRiCYCLE libraries. TRiCYCLE is a universal dendro data conversion application for converting back and forth between over 20 supported data formats (Brewer et al., 2011). The open source libraries that provide the functionality to TRiCYCLE are incorporated directly into Corina providing support for all these formats.

Belfast Apple	Oxford
Belfast Archive	PAST4
Besancon (including SYLPHE variants)	Sheffield D-Format (Dendro for Windows)
CATRAS	Topham
Comma delimited text files (CSV)	TRiDaS
Corina Legacy	TRIMS
DendroDB	Tucson (RWL and CRN)
Heidelberg (TSAP-Win)	Tucson Compact
Microsoft Excel 97/2000/XP	VFormat
Microsoft Excel 2007	WinDENDRO
Nottingham	

Table 6.1: List of the twenty-one formats supported by Corina. See appendices **??** – **??** (pages **??** – **??**) for full descriptions.

6.1 Exporting data

Exporting data is initiated by the File ➔Export data menu. If this is called from the main Corina data window, it will export the current series. If it is called from the Corina home screen, then it will present you with the database browser and allow you to pick one or more series to export.

6.2 Exporting graphs

6.3 Exporting maps

6.4 Importing data

Chapter 7

Curation

7.1 Laboratory workflow

Corina includes a number of functions to assist you with the curation of your physical sample collection. To understand how these are designed to assist users, we must first consider the workflow within a laboratory.

In research laboratories, samples generally come to the lab in large batches following field collection. In this case the typical workflow may be as follows:

1. Collect samples and record field notes as accurately as possible
2. On returning to the lab enter field notes as soon as possible into the 'bulk data entry' interface
3. Print sample barcode labels
4. Prepare physical samples and label with barcodes
5. Assign samples to storage boxes
6. Measure samples, using barcodes to recall metadata from database
7. Crossdate samples / build chronologies
8. When all samples from a box are completed register box as archived and then store

For commercial labs offering dendrochronological dating as a service, samples more likely to arrive in smaller batches. In this case, the bulk data entry interface may not be the most efficient method for entering metadata. In this case the user may simply prefer to use the *File* ➔ *New* method for each sample.

Either way, the concept behind the curation of a collection in Corina revolves around the accurately recording as much metadata about a sample as possible, then labelling the physical sample with a label containing a barcode for Corina and sample code for the user. By entering a sample into the database as soon as it enters the lab, it can be traced throughout the workflow. When a chronology is built, it is easily to quickly and efficient locate all samples that have been used. By assigning samples to boxes, groups of similar samples (e.g. from the same site) can also be easily stored together and located quickly and efficiently.

7.2 Barcodes

Barcodes allow you to keep track of what samples you have and where they are stored. Although it is not essential to use the barcode functions, we strongly suggest you do because they save time and money, but most importantly they greatly reduce the scope for erroneous data entry. For instance, when measuring a sample a user simply scans its barcode and all the relevant metadata is retrieved from the database, rather than relying on them to enter data manually. Barcodes have been routinely used in the retail industry since the 1980s. They can be equally as useful in dendrochronology laboratories.

Corina creates and reads barcodes for samples, measurement series and boxes. Each barcode encodes the unique identification code stored in the Corina database for each of these entities. Due to Corina use of universally unique identifiers (UUIDs), these codes a garanteed to be unique opening the opportunity of labs to loan samples, much like libraries do with books. There are many styles (or 'symbologies') of barcodes in use today, but Corina uses one of the most common (Code 128) which is supported by the vast majority of barcode readers. For a detailed discussion on the specifications of the Corina barcode see section 13.4.

Basic barcode readers are now cheap and widely available, with basic devices retailing for a few tens of dollars. Most are characterised as 'keyboard interface devices' and work like an automated keyboard, typing in a string of characters when a label is scanned.

Within the Corina application, whenever the user is required to specify a box, sample or series, they have the option of typing the human readable lab code or scanning the barcode. By using the barcode, the user can be sure they are not entering typographic errors so we recommend using barcodes whenever possible.

The most important barcode is the label for the physical wood sample. These are easily generated through the *Administration* ➔ *Labels* ➔ *Sample labels* menu entry. Currently the layout of these labels is fixed, but in the future we aim to provide different styles.

7.2.1 Sample labels

Before labels can be generated, metadata entries the sample level must have been made in the database. This is typically done using the 'bulk data entry' interface (see page 16). If samples are already in the database, the user needs to select the object of interest in the label creation dialog to see all the available samples. It is then just a matter of selecting the samples of interest and moving them into the 'selected' column. Once the list is populated (samples from multiple objects can be included), then you can either click 'Preview' to see a PDF of the labels, or 'Print' to print directly.

The current label style is designed to fit on standard core mounts and most samples. There are no widely available die-cut labels that fulfill this need, so the labels are intended to be printed on archival grade full page sheet labels (e.g. Avery® layout 6575), and then manually guillotined.

7.2.2 Box labels

The procedure for printing box labels is the same as for samples. Samples must have already been assigned to boxes before the label is printed (see section 7.3 for details). To print (or preview) box labels go to *Administration* ➔ *Labels* ➔ *Box labels*. The label style is designed to be printed on $5'' \times 8\frac{1}{8}''$ labels, two per sheet such as the Avery® 6579 layout.

> Until dynamic label styles have been implemented, box labels will print one per page. To make use of the second label on the page, the same sheet should be fed through the printer a second time.

7.2.3 Series barcodes

Series barcodes are printed at the top of a standard series report. These are produced through the *File* ➔ *Print*, or *File* ➔ *Print preview*, menus.

7.3 Storage boxes

Corina uses the term 'box' to refer to the collection of samples you archive. Many labs (including Cornell) use cardboard bankers boxes to store samples once they are completed, but the same box concept could refer to draws or shelves in your collection.

7.3.1 Creating and editing boxes

Records for boxes in the system are created and edited through the *Administration* ➔ *Curation* ➔ *Box details* menu. To editing an existing box, you can scan the barcode label on the box, or select from the list. To create a new box, click the 'Create new box' button and enter its details. There is no restriction on what boxes should be called, but it is probably easiest if you use some sort of numerical sequence to assist with organizing the boxes in your store. At Cornell, we use a two part name for each, the first being the year of collection, the second being a sequential number (e.g. 2009-11).

The contents tab lists all the samples that have been assigned to this box. To add new samples, simply click the 'Add sample to box' button and scan the sample's barcode.

7.3.2 Inventory

An important feature of any collection management system is the ability to perform an inventory on the collection. Even with the most robust system, samples will always go astray so its important to be able to periodically check that the boxes contain what you expect.

The 'Contents' tab of the Box details dialog contains a feature to assist with this. Next to the list of samples that are recorded as present, there is a temporary checklist column. By checking the boxes for each sample actually stored in the box it is easy to see which samples have been mislaid. If the 'Mark unchecked as missing from box' button is then pressed, the date and time the discrepancy was noted is then recorded in the comments field for the box.

7.3.3 Checking boxes in and out

Corina includes function for checking boxes in and out of a store, much like when a book is borrowed from a library. The *Administration* ➔ *Curation* ➔ *Check out box from store* and *Administration* ➔ *Curation* ➔ *Return box to store* menus do just this. You can either scan the box barcode or select the box from the drop down menu. These options record when a box is checked out/in and by whom. These details can be seen by users in the box details dialog.

7.3.4 Locating samples

As you might expect, Corina also includes a function for locating your physical samples. This is available in the *Administration* ➔ *Curation* ➔ *Find a sample* menu. There are three methods for locating a sample: via barcode; via lab code; and manually by object/element/sample.

If you have the sample in your hand and you simply want to know which box it should be returned to you can scan the barcode. If you are looking for a sample and you know its lab code then you can enter this instead. Alternatively, you can use the drop down menus to search for one or more samples at once. For instance, you can locate all the samples for a particular object and element.

Chapter 8

Indexing

Trees tend to put on big rings when they're young, and smaller rings when they get older. Some trees put on very large rings, while others put on very small rings. These variations in growth can make it difficult to crossdate samples. Some dendrochronologists therefore prefer to index or normalize their ring width data before combining into chronologies.

Indexing is a manipulation you can perform on your data to make it easier to crossdate.

The procedure for indexing is as follows:

1. You open a series (raw data)
2. You ask Corina to index it
3. Corina shows you some possible curves
4. You pick a curve (based on its graph, statistical scores, and your expectation of how the tree is growing)
5. Corina converts each year's ring width to a ratio of actual growth to expected growth for that year
6. You save the series (indexed data)

Indexing changes the units of a dataset. A raw sample has units of hundredths of a millimeter (0.01 mm) or microns. An indexed sample has units of parts per thousand (0.1%, or ‰).

This doesn't cause a problem with crossdating. The t-score normalizes all samples as part of its test, and the trend only cares if the values are increasing or decreasing. For more information on crossdating and chronology building, see chapter 9. It does, however, cause a problem with 'summing' since summing needs to take the average (what's the average of 1mm and 75%?). Therefore, the samples in a sum must be either all raw, or all indexed.

8.1 Types of index

There are a total of six different indexing methods available in Corina:

8.1.1 Exponential Index

This is the most commonly used index as it matches the way trees typically grow. Quickly when young and then gradually slower. An exponential index is therefore by far the most common index you'll use as 9 times out of 10 this will be the best choice.

This index tries to fit an equation of the following form to your data, searching for the best values of a, b and p.

- $y = a + be - px$

This is sometimes called a negative exponential index, because the exponent is negative. Corina doesn't require that the exponent is negative, but if it's not, using this index probably isn't such a good idea; it means the tree is generally getting bigger, not smaller.

The least-squares algorithm used comes from Cormen et al. (2001); the matrix solving function comes from Van Loan (1999).

Sometimes the exponential index does a lousy job. If a tree is living in a crowded area and the trees around it get cut down, suddenly it has much better growing conditions, so it might grow faster as it gets older, instead of slower. If you tried to use an exponential curve on a tree like this, it would exaggerate this growth, and useful data would get flattened out.

The result is you're looking at the growing conditions of this one tree, so it's not going to crossdate as well.

Alternatively, imagine you are working on a tree with a fire scar that has a few very large rings. An exponential index wouldn't take much notice of this, because most of the sample is still shaped like an exponential curve, but when you applied it they would be grossly out of proportion. For these types of samples, there are other indexing algorithms available.

8.1.2 Polynomial Index

When you ask Corina to perform a Polynomical Index it tries to fit a polynomial curve to your data using the following equation:

- $y = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_2 x^2 + a_{1x} + a_0$

You decide what degree polynomial, n, to use and Corina automatically finds the best values of a_0, $a_1 \ldots a_n$, to fit your data.

8.1.3 Horizontal Line Index

This only changes the magnitude not shape of the curve and is used when you would link to combine raw and indexed data together. It is a special case of polynomial where the horizontal line is equal to the average value.

- $y = x_{avg}$

This index is not used for crossdataing because dividing each value by the same value doesn't change the shape of the curve, only its magnitude. A horizontal line index is, however, useful because every element in a sum must use the same units, either raw or indexed. Therefore if you want to include a raw sample with an indexed sample then a horizontal line index can be used to convert the raw sample without otherwise altering the shape of the curve.

8.1.4 Floating Index

This is a running average of the 11 surrounding years. The adaptive index is generally used as a "last resort" when both exponential and a high-degree polynomial have failed. It is simply the average of the eleven surrounding years:

- $ind_i = 1/11(data - i - 5 + data_{i-4} + \ldots + data_{i+4} + data_{i+5}$

This index was originally called floating average, probably in reference to the fact that the index curve "floats" around, not following any explicit $y = f(x)$-type formula. But people tended to call it floating, and then floating-point, which means something very different. You might still hear people calling this index by these other names.

8.1.5 High-Pass Filter Index

The high-pass index is a more general case of the adaptive index. Instead of simply taking the average of 11 values, it takes a weighted average. It's an example of a "high-pass" filter because high-frequency signals can pass through, but low-frequency signals are filtered out.

The default is "1-2-4-2-1", meaning:

- $ind_i = 1/10(data_{i-2} + 2{\cdot}data_{i-1} + 4{\cdot}data_i + 2{\cdot}data_{i+1} + data_{i+2})$

This comes from Cook and Peters (1981) who used it as a discrete filter before moving to a cubic spline. Note that almost half $(4/10)$ of the computed value is simply its old value. The high-pass index is nearly the same as the input, so the χ^2 values are usually the lowest, therefore do not choose this index solely on a low χ^2 value.

8.1.6 Cubic Spline Index

Cubic splines are a very specific type of high-pass filter. A cubic spline curve is created by combining a collection of cubic (3rd degree polynomial) functions.

There are many methods for constructing cubic splines through a dataset. The algorithm used by Corina has a parameter, s, which controls how tightly the spline fits the data. A lower value fits the data more tightly, a higher value fits the data more loosely. Therefore, s=0 fits the data exactly while s=1 is a simple line. A good starting point for dendro data seems to be around $s = 1x1016$.

Cubic splines were first used for dendro by Cook and Peters (1981) using an algorithm from Reinsch (1967).

You can change the s-value used for the subic spline in the preferences. You might use a cubic spline in the same cases you would use a high-pass filter e.g. when the sample doesn't generally follow an exponential or polynomial curve very well, perhaps due to a fire scar.

8.2 Indexing data

To index your data, first you need to open the series you would like to index. Next choose *Tools* ➔ *Index* to display the indexing dialog (figure 8.1).

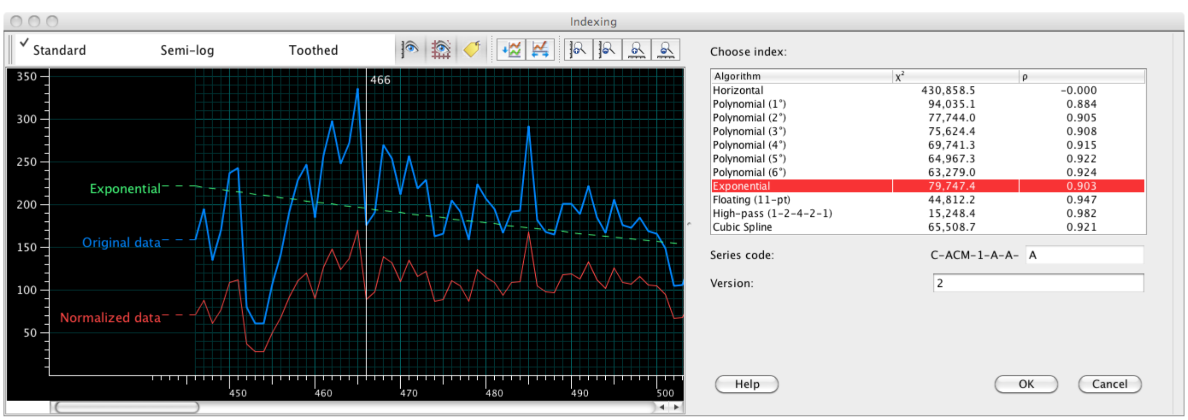


Figure 8.1: Indexing dialog showing the original data in blue, the exponential index of this data in green, and the normalized data in red.

From the indexing dialog you can then choose which type of index to apply to your data. The table on the right show the available options along with the χ^2 and p values to help you choose the correct index to use. The graph shows your original data, the index line and the result of applying the index to the data and changes dynamically as you pick between different indexing methods. Once you have decided which index you want to use, select it, and click OK ensuring that you have given your data series a new version number.

Chapter 9

Crossdating and chronology building

All algorithms work in pretty much the same way. There's a "fixed" sample, and there's a "moving" sample. Imagine you have printouts of their graphs on translucent paper. The fixed graph is taped to a table, and you can slide the moving sample left and right. This is actually how it was originally done, on graph paper, with one inch per decade. Start with the moving sample to the left of the fixed sample, overlapping it by 10 years. Look at how well the graphs match: this is the first score that's computed. Slide the moving sample to the right one year and so on until you reach the end.

You could do it all simply by moving graphs and eyeballing the crossdates like this but there are hundreds of sites and millennia of chronologies you'll want to crossdate your samples against, so that would take a while. Corina has a few algorithms to find likely crossdates almost instantaneously. They aren't perfect, though, and all crossdates should be inspected visually to ensure they are a good fit.

9.1 Algorithms

Corina includes a total of five different algorithms for crossdating:

9.1.1 T-Score

The t-score is the classic crossdate. Everybody quotes t-scores: if you want to brag about how good a cross is, you tell them your t-score. Unfortunately, every dendro program seems to have a slightly different implementation of tscore, so the numbers you get from Corina might not be exactly comparable to the numbers from other programs.

The version Corina uses is based on the algorithms given in Baillie and Pilcher (1973), though with some apparent bugs corrected. In the following equations, $x_0, x_1, x_2, \ldots$ are the data of the fixed sample in the overlap, $y_0, y_1, y_2, \ldots$ are the data of the moving sample in the overlap, and N is the length of the overlap.

The first step is to make each dataset bivariate normal by replacing each value with the mean of the values around it, and then taking its natural logarithm. The preparation for the T-Score is therefore done as follows and is done to both the fixed and moving series:

- $x_i \leftarrow \frac{x_{i-2}+x_i+x_{i+1}+x_{i+2}}{5}$
- $x_i \leftarrow ln(_{xi})$

The student's T computation is then done as follows:

- $s_{xy} = \Sigma x_i y_i - N(x_i - x_{avg})(y_i - y_{avg})$
- $s_{xx} = \Sigma x_i^2 - N(x_i - x_{avg})^2$
- $s_{yy} = \Sigma y_i^2 - N(y_i - y_{avg})^2$

- $r = \frac{s_{xy}}{\sqrt{(s_{xx}s_{yy})}}$
- $t = r\sqrt{\frac{N-2}{1-r^2}}$

The t-score is called a "parametric" algorithm, because it takes into account the magnitudes of the samples.

A t-score is considered statistically significant if it's greater than a certain value. Just what this value is varies with the length of the overlap between the samples: a 500 year overlap can have a t-score of 2.6 and pass, but an overlap of only 15 years would have to be higher, like 3.0. In reality most dendrochronologists require t-scores to be much higher than this, and would also insist on overlaps of many decades.

9.1.2 Trend

Trend is another popular crossdate statistic. It computes the percentage of years with the same trend (going-up- or going-down-ness). Scores greater than 60%-70% are good. Trend is also referred to as ufigkeitsko-Gleichläeffizient, Gleichläufigkeit and Eckstein's W.

The trend is the simplest crossdate. For each sample, it computes the trend of each 2-year interval (1001-1002, 1002-1003, and so on). The trend of a 2-year interval is simply whether the next ring is larger, smaller, or the same. The trend score is the percentage of intervals in the overlap which are the same. For example, a 75% trend (a very good score, by the way) means that for 75% of the intervals in the overlap, both samples went up in the same years and down in the same years.

If one sample stays the same, and the other increases or decreases, Corina considers that to be halfway between a same-trend and different-trend, and gives it half a point. Trend is a "non-parametric" algorithm, because it only takes into account if a given ring is bigger or smaller than the previous one, not by how much. To the trend, a drop of "100 1" looks exactly the same as a drop of "100 99". Two completely random samples will have a trend of 50%, on average. So you'd expect a trend must be greater than 50% to be significant.

According to Huber and Fletcher (1970), a trend is significant if:

1. $tr > 50\% + \frac{50}{\sqrt{N}}$ - For example a pair of samples with a 50-year overlap needs a $50 + 50\sqrt{50} = 57.1\%$ trend to be significant, but at a 400-year overlap need only a $50 + 50\sqrt{400} = 52.5\%$ trend. In practice, however, this doesn't tend to work terribly well. Using this scheme, there are typically about three times as many "significant" trend scores as t-scores, and users want this narrowed down a bit more. So take $\sigma = 3$ and use:
2. $tr > 50\% + \frac{50\sigma}{\sqrt{N}}$ - This gives about the same number of significant trend scores as t-scores.

Trends are also used in reconciliation. After they've been reconciled, both readings of a sample should have 100% trend.

9.1.3 Weiserjahre

The Weiserjahre algorithm is used for crossdating summed samples (chronologies) against single samples. All of the algorithms that have been mentioned so far only compare the ring widths. This works fine for raw samples, but when crossdating summed samples, there's a lot more information available, namely, the Weiserjahre data. Wouldn't it make sense to count a [20] 19×1 ring more heavily than a [1] $1 \div 0$ ring? 19 out of 20 samples think it's an increasing year, not just 1.

This is what the Weiserjahre cross does: for each possible overlap, it starts by counting the number of significant intervals of the master for that overlap. A significant interval is one with at least 3 samples, where at least 75% of them have the same trend. Then it computes the percent agreement (like the trend) between the master and the raw sample for only those significant years of the overlap. Of course, for the trend of the master, it doesn't use the trend of the master; it uses the trend of the majority of its elements. They're usually the same, but not necessarily.

Another way to think about the Weiserjahre crossdate is: it's like a trend, but ignoring years where the sum has only 1 or 2 samples, or where there isn't an overwhelming trend in the sum. Also like the trend, the results are given as a percentage.

9.1.4 R-Value

The R-value, or correlation coefficient, is a crossdate which you'll almost never use. It's not terribly useful to dendrochronologists, but statisticians might want to know its value, so Corina makes it available.

The R-value is used in the T-Score, the T-score being defined in terms of the r-value and the overlap, N. If you look at the equations for calculating a T-Score you will see on the penultimate line:

- $r = \frac{s_{xy}}{\sqrt{(s_{xx} s_{yy})}}$

An r-value can range from 0.0 (no correlation) to 1.0 (perfect correlation).

9.1.5 D-Score

The D-score (AXE), is a combination of the T-Score and Trend.

- $D = (tr - 50\%) \times t$

Corina considers 40 to be the threshold for significant AXE.

9.2 Crossdating series

9.3 Managing chronologies

Chapter 10

The Corina server

For basic day-to-day running of the Corina server, you simply need to make sure that the server is running. All other interaction and managment (creating users, granting permissions, accessing data) is done through the Corina desktop application. This section, however, outlines a number of aspects of the server that advanced users may find useful.

10.1 Extending the Virtual Appliance

For those of you that are unfamiliar with Linux, the basic command line prompt is not likely to be very comfortable. If you are interesting in looking at the server in more detail you may therefore prefer to install a full graphical interface. Unlike Windows, there are a number of different graphical interfaces (or desktops) to choose from in Linux, the most popular being Gnome and KDE. To install one of these you need to type one commands listed below. The first line installs Gnome and the second KDE. Windows users that are new to Linux may find KDE more familiar than Gnome.

```
sudo apt-get install ubuntu-desktop
```

```
sudo apt-get install kubuntu-desktop
```

10.2 Security

The basic installation of the Corina server includes the standard configuration for Apache, PHP and PostgreSQL. Although these products are considered secure by default, there are a number of measures that can be taken to make them more so. If your server is only accessible within your local intranet (e.g. behind a robust firewall) then you may not feel it necessary to modify the standard setup. Precautions may be deemed more important if you server is accessible from the internet. In this case it would be wise to contact your local network administrator for further information.

10.2.1 Usernames and passwords

There are a number of default usernames and passwords setup on your server. If your server is accessible for the internet we strongly advise you to change these defaults and anyone with knowledge of the Corina server could access and compromise your machine.

System user - these are the credentials you use to log in to the command prompt in your Corina Virtual Appliance. By default the user is 'corina' and the password is 'w3l0v3tr33s'. To change this log in to the command prompt and type `passwd` and follow the instructions.

Database user - these are the credentials used by the webservice to read and write to the database.

Corina admin user - these are the admin credentials that you use to log in with in your Corina desktop application. Be default the user is '???' and the password is '???'. To change these open the Corina desktop application, then go to Admin then Change password.

10.2.2 Authentication and encryption

Corina uses a relatively sophisticated method to ensure that unauthorised users cannot access the Corina database through the webservice. It is loosely based around http digest authentication and uses a challenge and response scheme. This makes use of cryptographic hashes (a relatively short digital fingerprint of some data but which cannot be decompiled to retrieve the original data) and nonces (a pseudo-random string used just once). All hashes used in the Corina webservice use the MD5 algorithm. This decision will be periodically reviewed to ensure that MD5 is the most appropriate and secure algorithm to use. Whilst an MD5 hash of a short phrase can be compromised, the length and randomness of the original data means with current cracking techniques this is essentially impossible. For a complete description of Corina's authentication procedure see section 13.1.

The default Corina server setup, however, uses standard HTTP protocol to communicate between the server and the desktop application. This is the same protocol used for the majority of web pages on the internet and a determined hacker could eavesdrop on this communication. Depending on how important and private you perceive your data you may choose to use Secure Socket Layer (SSL) to encrypt this communication. This is the same technology used by websites such as online banking. To make full use of this upgrade in security you will however also require a SSL certificate from an official licensing authority. These certificates typically cost several hundred dollars per year.

10.3 Directly accessing the database

Although the Corina database is designed to only be accessed by the Corina desktop application via the Corina server's webservice, you may decide that you'd like to directly access the database yourself. For instance, you may like to write complicated SQL queries to probe your database in ways not currently supported by the Corina desktop client.

> ⚠ *Any changes made to the database may have drastic consequences. We strongly recommend that you never write changes directly to the database as this can cause loss of data and corrupt future upgrades to Corina.*

10.3.1 PGAdminIII

One of the easiest ways to access the PostgreSQL database is through the application PGAdmin3. This is a cross-platform open source application for communicating with PostgreSQL databases. You can install PGAdmin3 on your desktop computer and access the remotely running database using your database user credentials. By default, PostgreSQL runs on port 5432.

10.3.2 ODBC

It is also possible to connect to your Corina database via an ODBC connection. This allows limited access to the database from a variety of database applications including programs like Microsoft Access for which further details are given here. To use ODBC you will need to install the PostgreSQL ODBC driver (*http://www.postgresql.org/ftp/odbc/*) on your desktop computer.

Once you've installed the driver you can then open a blank database in Access and go to Files, Get external data then Link tables. In the file dialog box change the file type to ODBC Databases(). Next, select the PostgreSQL Unicode driver, then fill out the server details. You should then be able to open the tables and views from the Corina server database directly from within Access as if they were local tables. Be warned though that Access and ODBC have many limitations compared to PostgreSQL, especially with regards data types. For this reason we *strongly* recommend using this for read only purposes. Using the ODBC connection to write changes to your PostgreSQL database is quite likely to cause serious issues.

10.3.3 PSQL

The final, and most advanced method is to use the psql client on your server. This is a command line client which can be used to interrogate the database. If you're not already familiar with psql it is unlikely that this is a good method for you to use!

10.4 Managing map services

Chapter 11

Help

Part II

Developers guide

Chapter 12

Development environment

Corina is open source software and we actively encourage collaboration and assistance from others in the community. There is always lots to do, even for people with little or no programming experience. Please get in touch with the development team as we'd love to hear from you.

12.1 Developing Corina Desktop

The IDE of choice of the main Corina developers is Eclipse (*http://www.eclipse.org*. There are many other IDEs around and there is no reason you can't use them instead. Either way, the following instructions will hopefully be of use.

We have successfully developed Corina on Mac, Windows and Linux computers over the years. The methods for setting up are almost identical.

The first step is to install eclipse, sun-java6-jdk and subversion. These are all readily available from their respective websites. On Ubuntu they can be install from the command line easily as follows:

```
sudo apt-get install eclipse subversion sun-java6-jdk
```

Once installed, you can then launch Eclipse. To access the Corina source code you will need to install the Subversive plugin to Eclipse. As of Eclipse v3.5 this can be done by going to *Help* ➔ *Install new software*. Select the main Update site in the 'Work with' box, then locate the 'Subversive SVN Team Provider' plugin under 'Collaboration'. If you are using an earlier version of Eclipse you may need to add a specific Subversive update site. See the Subversive website (*http://www.eclipse.org/subversive/*) for more details. Once installed you will need to restart Eclipse.

Next you need to get the Corina source code. Go to File *New* ➔ *Project*, then in the dialog select *SVN* ➔ *Project from SVN*. There are two methods of accessing the Corina repository: anonymously, in which case you will have read only access; or with a username provided by the Corina development team. Anonymous users will need to add a repository in the form: *http://dendro.cornell.edu/svn/corina/* and full users will need to use *svn+ssh://dendro.cornell.edu/home/svn/corina/*.

Once the project has downloaded to your workspace, you may need to set the compliance level. This can be done by going to *Project* ➔ *Properties* ➔ *Java compiler* and choosing compliance level of 6.0. Corina uses a handful of Java 6 specific functions, particularly with regards JAXB, so will not run successfully with Java 5.

To launch Corina, you will need to *Run* ➔ *Run Java application*. Create a new run configuration with the main class 'set to edu.cornell.dendro.corina.gui.Startup'.

12.2 Developing the webservice

The Corina webservice is written entirely in PHP. Eclipse is used for this development too so most of the setup steps are identical to setting up Eclipse for developing the Corina desktop client. You will, however, probably want to install the PHP development plugin so that you get syntax highlighting etc. See the Eclipse PDT website (*http://www.eclipse.org/pdt/*) for further information.

12.3 Dependencies

Apache commons lang Apache 2.0 TridasJLib Apache 2.0 Batik Apache 2.0 RXTXcomm LGPL JDOM Apache 2.0 Swing layout LGPL Log4J Apache 2.0 JNA LGPL Apache mime 4J Apache 2.0 Commons codec Apache 2.0 http Client LGPL Http core Apache 2.0 Http mime Apache 2.0 Jsyntaxpane Apache 2.0 L2prod-common-shared Apache 2.0 L2prod-common-sheet Apache 2.0 l2fprod common buttonbar Apache 2.0 itext GAPL PDFRenderer LGPL DendroFileio Apache 2.0 java simple mvc MIT JgoogleAnalyticsTracker MIT gluegen BSD jogl BSD+ nuclear clause worldwind NASA slf4j MIT jfontchooser LGPL miglayout BSD pljava BSD postgresql PostgreSQL License (BSD/MIT) forms BSD simplelog GPLv3 jxl LGPL wizard GPLv2 netbeans swing outline GPLv2

Chapter 13

Systems architecture

The centralised nature of the Cornell Tree-Ring Lab data required a server-client architecture of some type. In the original Corina v1 this was achieved simply by having users save their data in a network folder saved on a central server. Whilst this method was adequate, it has many data storage issues that can be largely solved by moving the data storage infrastructure to a relational database management system.

Although it would be possible (and arguably simpler) to refactor Corina to talk directly to one central database server it was decided to go a step further and implement a Web Services orientated server-client architecture for Corina v2.

A web services approach decouples the desktop client from the server so that the server can work on its

13.1 Authentication design

The authentication mechanism is loosely based around http digest authentication and uses a challenge and response scheme. This makes use of cryptographic hashes (a relatively short digital fingerprint of some data but which cannot be decompiled to retrieve the original data) and nonces (a pseudo-random string used just once). All hashes used in the Corina webservice use the MD5 algorithm. This decision will be periodically reviewed to ensure that MD5 is the most appropriate and secure algorithm to use. Whilst an MD5 hash of a short phrase can be compromised, the length and randomness of the original data means with current cracking techniques this is essentially impossible.

The first time a client attempts to retrieve data from the webservice (or when the client's credentials are incorrect or have expired) the following events occur:

- Server returns an message requesting authentication. This message includes a nonce (a hash of the current date and time to the nearest minute) which we will call 'server nonce'.
- The client creates a second nonce (client nonce) which is a random hash of it's choosing, and a response which is a hash of "username:hashofpassword:servernonce:clientnonc". It sends this response, along with the username and client nonce back to the server but does not send the original server nonce.
- The server computes the same "username:hashofpassword:servernonce:clientnonce" hash using the information it has stored in the database. As the server nonce is constant for a minute the two response should match. If not the server recomputes the server nonce for one minute ago and tries again. This ensures that the server nonce sent to the client is valid for between 1 and 2 minutes.
- Once the server authenticates the user a session cookie is sent to the client. On subsequent requests the server recognises the session id and doesn't request authentication again.

As the user's password is hashed at all points, even if the communication is hijacked the attacker will not be able to derive the users password. The user's password is also stored in hash form within the database. This also means that system administrators do not have access to the passwords either.

The use of the server nonce within the response means that it will only be valid for a maximum of two minutes. This removes the possibility of a replay attack.

13.2 Database permissions design

The database has a user and group based security scheme at three object levels: site, tree and measurement. A user can be a member of one or more groups, and groups can be members of zero or more other groups. The current implementation allows for one nested level of groups within groups however this could be extended if required. Security is set on a group-by-group basis rather than on a single user to ensure ease of management.

There are five types of permissions granted: create, read, update, delete and no permission. Each permission is independent of each other with the exception of 'no permission' which overrides all other permissions.

A group can be assigned one or more of the permissions types to any of the sites, trees or measurements in the database. Intermediate objects such as subsites, specimens and radii inherit permissions from their parent object. For instance if a group has permission to read a site then it will have permission to read all subsites from that site.

It is envisaged that most of the time, permissions will be set on a site-by-site basis. It will not be necessary to explicitly assign permissions to trees and measurements as all permissions will be inherited. So assuming that no permissions are set on a tree for a particular group, the permissions for the tree will be derived from the site from which the tree was found. If, however, permissions are assigned to the tree, then these will override those of the site. In this way it will be possible to allow a group to read the data from one particular tree from a site in which there otherwise do not have permission to access.

Privileges are cumulative. This means that if a user is a member of multiple groups then they will gain all the privileges assigned to those groups. If one of the groups that the user is a member of has 'no privileges' set on an object it will however override all other privileges. Therefore if a user is a member of groups A and B, and group A has read privilege and group B has 'no privilege' then the user will not be able to access the record.

A special 'admin group' has been created into which only the most trusted users are placed. Members of the admin group automatically gain full privileges on all data within the database. They also have permission to perform a number of administrative tasks that standard users are insulated from.

13.3 Universally Unique Identifiers

All entities in the Corina database have a primary key based on the Universally Unique Identifier (UUID) concept. This is a randomly created 128-bit number which due to the astronomically large number of possibilities (3×1038) means that it is guaranteed to be unique across all installations of Corina. This code is typically represented by 32 hexadecimal digits and 4 hyphens like this: 550e8400-e29b-41d4-a716-446655440000.

13.4 Barcode specifications

Barcodes in Corina are based on the UUID primary keys of database entities. Because they are used for different entities in Corina (boxes, samples and series) it was also necessary to incorporate a method for determining what type of entity a barcode represents. This is done by appending a single character and a colon to the beginning of the UUID: 'B:' for box; 'S:' for sample; 'Z:' for series.

The barcodes in Corina use the Code 128 scheme. This symbology was chosen as it allows the encoding of alphanumeric characters in a high-density label and can be read by all popular barcode scanners. While it would have been possible to create a barcode of plain UUIDs, the 36 (or even 32) characters would result in a barcode wider than many scanners could read. Most scanners on the market have a maximum scan width of at least 80mm, so this was used as the baseline to work to.

To make the barcodes less than 80mm, the UUID (with prepended entity type character code) are Base64 encoded. For example the series with UUID 3a8f4336-d17d-11df-abde-c75e325aebae would be encoded from Z:3a8f4336-d17d-11df-abde-c75e325aebae to become: Wjo6j0M20X0R36vex14yWuuu

Part III

Appendices

Appendix A

GNU General Public License

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