DIMPLE 3.0 Demonstration Guide

This demonstration aims to give you an overview of many of the main features of DIMPLE 3.0, as well as an introduction to some of the applications which DIMPLE can be used for.

The LANDSAT images on the demo disk are supplied by the Australian Centre for Remote Sensing, Australian Surveying and Land Information Group.

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Getting started

You will need a copy of DIMPLE 3.0 (either a demonstration copy or licensed copy) and the sample images from the demo CD to follow this guide.

The sample images are found on the demo CD in the folder "DIMPLE Demo Images" (Macintosh) or the folder "DEMOIMG" (Windows), and take up about 15 MBytes of disk space. You may wish to copy this folder from the CD to your hard disk for better performance.

Mac OS: Make sure your system is set to "thousands" or "millions" of colours mode using the Monitors control panel. Launch DIMPLE by double clicking on the DIMPLE icon in the DIMPLE folder.

Windows 95, Windows NT 4: Make sure your monitor is set to "High color (16 bit)" or "True color (24 bit)" using the Display control panel. Launch DIMPLE by choosing the DIMPLE icon from Programs in the Start menu.

Windows NT 3.51: Make sure your monitor is set to "65536 Colors" or "16777216 Colors" using the Display control panel. Launch DIMPLE by double-clicking on the DIMPLE icon in the DIMPLE program group.

Windows 3.1: Set your monitor to 16 bit (high colour) or 24 bit (true colour) mode using the control panel or utility for your video card. Launch DIMPLE by double-clicking on the DIMPLE icon in the DIMPLE program group.

1. Smoothing filters

The first example illustrates one use of the *rank filter*. It aims to remove transmission noise from an image of the moon, transmitted from a space probe to Earth. The field of digital image processing originally grew out of this type of application during the 1960's; similar techniques have more recently been used to process images from the Hubble Space Telescope, Magellan Space Probe, and Voyager probes.

1. Choose **Open** from the **File** menu. Move into the folder containing the DIMPLE sample images. Open the image "Moon.DIM". Notice the transmission noise.
2. Choose **Rank Filter** from the **Enhance** menu. Use a 3x3 *median filter* - a 3x3 rank filter with rank 5. Click on **OK**. Compare the original and filtered images.
3. Click on the original Moon image to bring it to the front. Choose **Filter** from the **Enhance** menu and then **Specify** from the submenu. This dialog box allows you to specify a custom filter for use with DIMPLE. You can choose the size of the filter, from 3x3 to 9x9, the coefficients for the filter, and conditions under which the filter will be applied.

   Low-pass filtering
   Specify this filter:

   1 1 1
   1 1 1
   1 1 1
   / Denominator: 9

   Click on **Filter** to apply the filter to the image.

Conditional filtering
Again, choose **Filter** from the **Enhance** menu, and **Specify** from the submenu. The filter you specified above is displayed again.

Check the **Condition** box and experiment with different conditions in conjunction with the above low-pass filter - for example "pixel value inside 254" will filter out all the white spikes in the image, which have a value of 254.

4. Choose **Close all** from the **File** menu when finished.

2. Digital convolution filters

The next two examples illustrate the use of *digital convolution filters* to achieve different effects. Both of the filters used here aim to operate on edges - either for edge detection or edge enhancement.

1. Open the image "Jet.DIM" (using **Open** from the **File** menu).

Laplacian Edge Detection

2. Choose **Filter** from the **Enhance** menu, then **Specify** from the submenu.

   You can save filters which you use frequently; if you save your filters in the "Filters" folder located in the same folder as the DIMPLE application, these filters will be listed in the **Filters** submenu.

   Click on the **Load**button, and then select the filter "Laplace.FIL". This is a Laplacian filter which is used for edge detection.

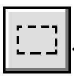
3. Click on the **Filter**button, and compar e the filtered image with the original image. You can specify other filters to detect edges running only in a certain direction - e.g. only horizontal edges.

Edge Enhancement

4. Click on the original Jet image to bring it to the front. Again choose **Filter** from the **Enhance** menu, and **Specify** from the submenu. Load the filter "Sharpen.FIL". Click on **Filter**.
5. Compare the filtered image to the original image. Notice particularly the increase in local contrast around the figures on the jet's tail, and around the edges of the jet.

Enhancing part of an image

You can use enhancement tools such as filters on part of an image. In this example, a high-pass filter is used to enhance the writing on the side of the jet.

6. Click on the original Jet image to bring it to the front. Click on the rectangular area selection tool . Select a rectangle around the writing "US AIR FORCE" on the side of the jet. Again choose **Filter** from the **Enhance** menu, and **Specify** from the submenu. The sharpening filter which you used in the previous step will still be displayed. Click on **Filter**.

7. A filtered image containing only the selected area is produced. Choose **Replace in "Jet"** from the **Edit** menu to replace the filtered writing in the original image. Bring the original Jet image to the front, and notice the change. You can undo the change by bringing the original image to the front and choosing **Undo Replace** from the **Edit** menu.

8. Choose **Close all** from the **File** menu when finished.

3. Contrast enhancement

The next few examples illustrate the use of the Histogram tool to perform histogram modifications to increase contrast in an image.

1. Open the image "Girl.DIM". Notice the low contrast in the image.

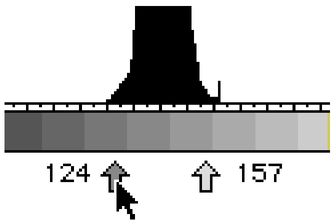
2. Choose **Histogram** from the **Analyse** menu, then **Pixel Values** from the submenu to obtain an image histogram. Compare the cumulative and frequency representations by clicking on the buttons marked "**f**" and "∑". Note that the minimum and maximum pixel values in the image are displayed above the **Apply** button.

Linear Stretch

3. Note that by default a linear stretch across the range of pixel values 0 to 255 is chosen. Click on the **Apply** button. Notice the increase in contrast. Click on **Revert**.

Saturation

4. Click on the lower saturation arrow, and drag it to the right to a saturation limit, as shown below.



   Similarly, click on the upper saturation arrow, and drag it to the left. (Saturation limits should be around 124 and 157.)

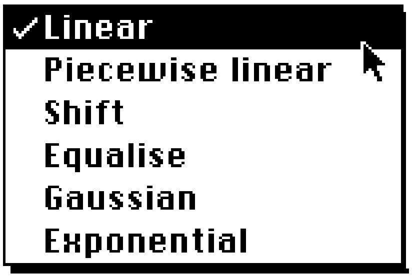
5. Click on **Apply** and notice the effects of a *saturated linear stretch.*

6. When finished, click on **Revert**, drag the lower saturation arrow back to 0, and the upper saturation arrow back to 255.

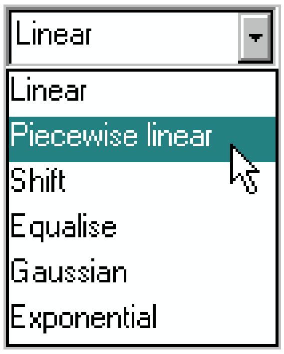
   You can also specify saturation limits as a number of standard deviations around the mean, or as a percentage range, using the "±n std devs" and "Percentage" radio buttons.

Equalisation

7. Choose **Equalise** from the transform method pop-up list.



Mac OS



Windows

8. Click on **Apply**. Notice the effect on the image. Click on **Revert** when finished.

Gaussian stretch

9. Choose the **Gaussian** method using the transform method pop-up list, then click on **Apply**. Notice the effect on the image. Experiment with different numbers of standard deviations by typing values into the **Std deviations** box: type "1" then click on **Apply**; then type "6" and click on **Apply.** Notice the effects of different standard deviations. Click on **Revert** when finished.

Exponential stretch

10. Choose the **Exponential** method using the transform method pop-up list, then click on **Apply**. Notice the effect on the image. Change the value of the **Exponent** by typing different values: type "2" then click on **Apply**; then type "0.5" and click on **Apply**. Experiment with lower and higher values of the **Exponent** and observe the result. Click on **Revert** when finished.

Histogram shift

11. Choose **Shift** using the transform method pop-up list. Click on the histogram and drag right or left; this has the effect of adding or subtracting a constant from each pixel in the image, brightening or darkening the image. Click on **Revert** when finished.

Piecewise Linear Stretch

12. Choose **Piecewise Linear** using the transform method pop-up list. A line showing mapping of pixel values to transformed values is shown. You can add breakpoints to this line by clicking, and move them by dragging. To see the results of the transform, click on **Apply**. Experiment with different breakpoints. Piecewise linear stretch is useful when an image has two distinct areas, each of which is to have a different stretch applied to it. Click on **Revert** when finished.

13. Choose **Close all** from the **File** menu when finished.

You can also use the histogram to manipulate the colour channels of a colour image in 8, 16, or 24 bits. An example of this is described later in this guide.

4. 3D Plotting

This example illustrates the use of 3D plotting on digital terrain data. The values in all images used up to now have represented light intensity; the values in one of the images in this example represent altitude. The 3D plot indicates the landform in the image.

1. Open the image "Jervis Bay.DIM" (Macintosh) or "JB.DIM" (Windows). This is a Landsat Thematic Mapper (TM) image of Jervis Bay, in New South Wales, Australia.

Multibands

2. Note that this is a *multiband image* consisting of several *numbered* and *auxiliary channels*. The numbered channels listed in the top pane of the window are statistically important for multiband operations such as classification (demonstrated later in this guide). Auxiliary channels contain additional information about the image which you do not want to use in such operations. The numbered channels in this multiband are the Landsat TM bands. Select the auxiliary channel "Elevation" by double-clicking in the multiband window to the left of the channel name. Type **return** or **enter** to bring the window to the front. This channel contains digital terrain data representing altitude.

Working with images from disk

3. If you do not have enough system memory to work with large images or multibands with many channels, DIMPLE allows you to leave the raster data for images on disk and still operate on them. The **in memory** icon: at the bottom of the image window indicates the image is currently in system memory. Click on the **in memory** icon to free up the system memory being used by the image. The icon changes to an **on disk** icon: . If you bring another window to the front and then bring "Jervis Bay:Elevation" to the front again you will notice it takes longer to update the image (the difference is small for such a small image). This is because the data is being read from disk. You can still operate on disk based images; however operations will be slower than if the image was memory based.

   Using an image on disk from a slow medium such as a CD-ROM is not recommended.

4. For channel images you can also click on the **in memory/on disk** icon displayed for each channel in the multiband window; or move all channels or all numbered channels only into memory or onto disk in one step. Click on the multiband window to bring it to the front. Move the numbered channels of the multiband onto disk by holding down the **shift** key and clicking on the **on disk** icon at the bottom of the multiband window. Hide the numbered channels of the multiband by holding down the shift key and choosing **Hide all channels** from the **Image** menu. Bring the channel image "Jervis Bay:Vegetation" to the front. Click in the close box of the window. Note that clicking the close box of a channel image hides the channel; hidden channels are still part of the multiband and available for processing.
   Click on the **in memory** icon at the bottom of the multiband window to move all channels back into memory.

RGB Colour Composite

5. In this step we produce an *RGB colour composite* image with different colours representing the different features in three of the channels. An RGB colour composite often helps provide better definition of features.

Choose **RGB** from the **Transform** menu. Use the pop-up lists to assign the channels to colours as follows:

"Jervis Bay:TM5 mid IR 1.55 - 1.75µm" to red;
"Jervis Bay:TM4 near IR 0.76 - 0.90µm" to green;
and "Jervis Bay:TM3 red 0.63 - 0.69µm" to blue.

You can also specify a stretch to be used for each channel in the colour composite, using the Stretch pop-up lists. Leave these at "Current".

You can produce a colour composite in 8-, 16-, or 24-bit colour. 24-bit images usually give the best colour definition. 16-bit images potentially have lower definition, but take less memory.

Click on **OK**. An RGB colour composite image is produced. Because we didn't use a stretch on the channels above, the colour composite has low contrast. You will now use the colour components histogram to change the contrast of the image.

6. Choose **Histogram** from the **Analyse** menu, then **Colour Components** from the submenu. The colour components histogram is displayed.

   Click on the "**R**" button to see the histogram for the Red channel. Choose a Linear stretch with a Percentage range of 1-99% by clicking on the **Percentage** radio button. Click on the **Apply** button, and the Red channel of the image is transformed.

   Repeat this for the Green and Blue channels. You will have produced a colour composite image with much better colour definition. You can also manipulate the colours of the image in Hue-Saturation-Intensity space or Cyan-Magenta-Yellow space using the Method radio buttons above the histogram.

To close the histogram, click on the Close box (Macintosh, Windows 95, and Windows NT 4) or double click on the system menu at the top left of the window (Windows NT 3.51, Windows 3.1).

3D plotting

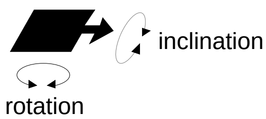
7. Bring the multiband window to the front, and then double click on the "Elevation" channel to select it. This image represents elevation. You can improve the contrast in the image using a pixel values histogram.

   Choose **3D Plot** from the **Transform** menu. Click on the **Composite** button. Choose "Jervis Bay:Vegetation" from the **Colour** pop-up list.

   Specify 50 intervals by typing "50" into the box labelled **Intervals**. This specifies the resolution of the 3D plot.

   With the pixel values only ranging from 0 to 17 a somewhat "flat" 3D plot will be produced. You can exaggerate the "bumpiness" of the plot by specifying a scale factor of 5 for the z-axis by typing "5" into the box labelled **Z-Scale**. Click on **OK**.

8. Note that the colours from the channel image "Jervis Bay:Vegetation" are draped over the plot. Once the plot has been produced, it can be re-oriented. Click on the plot window, and hold the mouse button down. A small plane like this:



will appear at the top left of the window. Drag the mouse up and down to change the inclination of the plot and left and right to change the rotation of the plot; the angles of inclination and rotation are displayed at the top left of the plot window; the small arrow on the plane represents the top of the original image. Release the mouse button to replot the image with the new orientation.

9. You can change the parameters used for the 3D plot by bringing the 3D plot window to the front, and again choosing 3D plot from the Transform menu.

   Try:

   - Exaggerating the scale of the 3D plot by choosing a Z scale of 10 or 15
   - Draping the RGB image you produced in the previous step by choosing it from the Colour pop-up list.
   - Changing the resolution of the plot by choosing a different number of intervals.

10. When finished, close the 3D plot window.

5. Using Vector Data

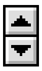
DIMPLE can import vector data in .DXF format. You can overlay vector images onto raster images to verify location of features, and you can use a vector image as the “master image” when performing image-to-image registration.

1. Open the images “Rivers.DVE” and “Roads.DVE”. These are vector images which have been imported into DIMPLE from .DXF files, and saved as DIMPLE vector files.

   Add these images to the Jervis Bay multiband using Add to Multiband from the Image menu, and name them Rivers and Roads.

   Bring the Jervis Bay RGB image to the front. Choose **Image overlay** from the **Annotation** menu. Choose “Rivers” from the Add vector pop-up list, then click on **Apply**. The river vector image is drawn over the RGB image.

Changing vector colours & order

2. Click on the colour box, labelled “None” next to “Rivers” in the Image overlay dialog box. Choose a colour like light blue from the dialog box which appears. Click on **Apply**. The river layer is now redrawn in the selected colour.
3. Overlay the vector image “Roads” in the same way and choose a colour for it.
4. Click on the name for the vector layer “Roads” in the overlay vectors dialog box. Use the arrow control  to move the vector layer up, then click on **Apply**. The roads layer is moved up, and is now drawn closer to the front.
5. Choose **Close all** from the **File** menu when finished.

6. Image Operation Language

The Image Operation Language (IOL) is a specialised programming language for implementing new image operations. The following examples illustrate some of the capabilities of IOL.

Image Complement

The first example aims to change the jet image on which we earlier performed an edge detection so that the edges are displayed in black and the background in white.

1. Open the image "Jet-Edges.DIM" (Macintosh) or "JETEDGE.DIM" (Windows). This is the Jet image with an edge detection filter applied, as demonstrated earlier in this guide.
2. Choose **Open IOL** from the **Transform** menu. Open the file "Negative.IOL". Look at the IOL program to see how this operation will work.
3. Choose **Run** from the **Transform** menu. A dialog box will ask which image you want the operation to act on; since there is only one image, just click on **OK**.
4. Compare the new image with the original image. Choose **Close all** from the **File** menu when finished.

   ❖ *Note:* if you have a "IOL" folder in the same folder as your DIMPLE application, any IOLs in this folder will appear in the **IOL** submenu on the **Transform** menu (this is to allow you quick access to frequently used IOL programs).

Unsharp Mask

IOL can be used to combine filters and other operations. A well-known sharpening technique relies on the observation that subtracting a smoothed version of an image from the image will leave only edges. By adding this difference back onto the original image, the edges are enhanced.

We will apply this technique to the Jet image, introduced at the beginning of this guide.

1. Open the image "Jet.DIM".
2. Choose **Open IOL** from the **Transform** menu, and open the IOL program "Unsharp Mask.IOL" (Mac OS) or "UNSHMASK.IOL" (Windows). Note how the program specifies a low-pass filter, and then adds the difference between this and the original image back to the original image.
3. Choose **Run** from the **Transform** menu.
   Note the sharpened version of the image.

Choose **Close All** from the **File** menu when finished.

Vegetation Detection

The next example aims to detect vegetation from two satellite images, one showing the amount of reflected red light, and the other the amount of reflected infra-red. The image is of Wollongong, New South Wales, Australia.

1. Open the multiband image "Wollongong.DIM" (Mac OS) or "WGONG.DIM" (Windows).
2. Choose **Open IOL** from the **Transform** menu. Open the file "Vegetation.iol" (Mac OS) or "Vegetate.IOL" (Windows). This IOL program operates on two images, and produces two output

images - a Normalised Difference Vegetation Index (NDVI), and a Transformed Vegetation Index (TVI). Examine the program to see its structure.

3. Choose **Run** from the **Transform** menu. Use the pop-up lists to associate “Wollongong:Red” with **Red** and “Wollongong:near IR” with **Infra-red**.

   For the **Output data type**, choose 32 bit real. DIMPLE can operate on a variety of data types, including 8, 16, and 32 bit integer, and 32 bit real. This operation will produce a vegetation indices in the range -1 to 1.

   For the **Stretch for display**, choose “Linear 1-99%”.

   Click on **OK.**

4. Notice the production of the two images - the vegetation index, and the transformed vegetation index. These are real images, so as you move the mouse over the image, the actual value of the vegetation index is displayed in the Info window. Different types of vegetation are shown as different shades of grey.

In the next section, we will use *density slicing* to analyse the vegetation index images just produced.

7. Density Slicing

Density slicing involves partioning an image into contiguous pixel ranges, and assigning a colour to each pixel range. This example uses the NDVI image.

1. Bring the image “NDVI” to the front.

2. Choose **Density Slice** from the **Analyse** menu. The Density Slice window appears, showing a histogram for the image. Underneath the histogram is the slice area, used for choosing slice boundaries; and the colour area, used for choosing colours for each slice.

3. Click on the slice area to add new slices. You can move a slice boundary by clicking on it and dragging it, or delete a slice by extending an adjacent slice over it. As you create slices, a default colour is assigned to each slice (a shade of grey), and the image window updated.

   You can also specify slice intervals by typing them in the slice values box. When you make changes here, buttons marked with a tick and a cross appear; click on the tick to accept your changes.

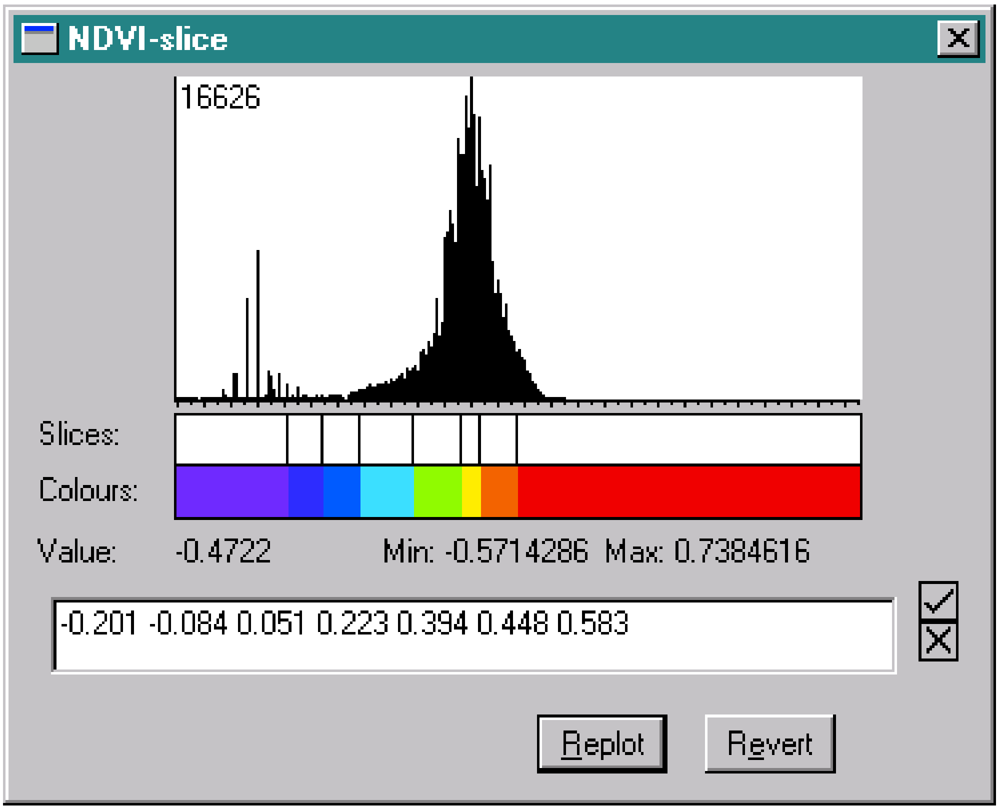
4. You can change the default colour scheme by choosing a different CLUT. Choose **CLUTs** from the **Enhance** menu, then **Colour scale** from the submenu. The colours used for the slices will range between violet (low values) and red (high values)

5. You can specify a colour for a slice. Click on the colour area below the slice, and choose a colour from the dialog box.

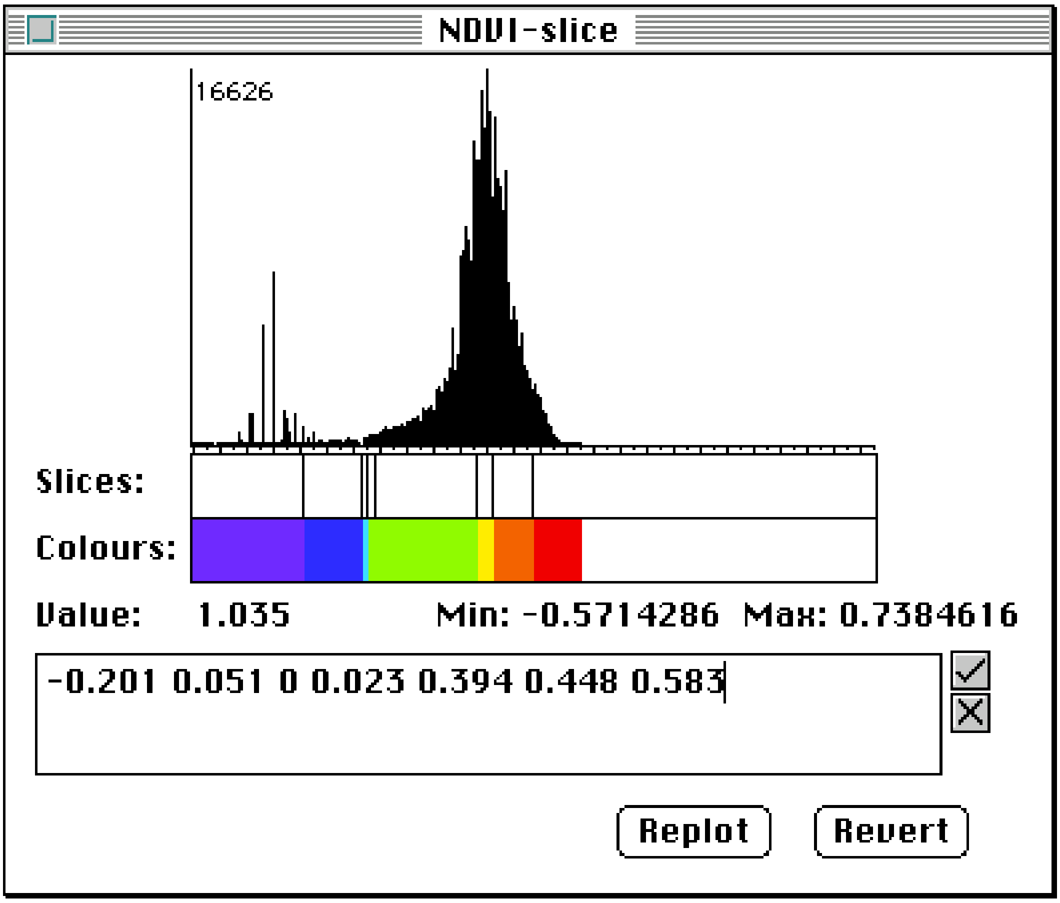
6. Experiment with different slice intervals by clicking and dragging on slices in the slice area. The example on the next page gives good results for the NDVI image.

7. You can add a density slice key to the image, showing the colours for each range of values. To do this, bring the NDVI image to the front, and choose **Add annotation** from the **Annotation** menu, and then **Density slice key** from the submenu. You can specify the format of the density slice key - the number of columns, size, and location.

8. You can create a classified image from the density sliced image. To do this, click on **Replot**. A new image window is created with contiguous pixel values. You can use the post-classification



Density Slicing - Windows



Density Slicing - Mac OS

editor to edit labels for each slice, and use the Class Key command to attach a class key to the sliced image. If you add the new image to the Wollongong multiband (using **Add to Multiband** from the **Image** menu), you can use any of the post-classification analysis tools described in the previous section to analyse the image.

9. Choose **Close all** from the **File** menu when finished.

8. Supervised classification

This example demonstrates the facilities provided for performing a supervised classification of an image.

1. Open the multiband image "Cairns.DIM". This image shows Landsat MSS data of Cairns in Northern Queensland, Australia.

Principal components

Producing an RGB colour composite can help to distinguish features in the image when producing training areas. In this example, we will produce a colour composite of the first three principal components of the Cairns image.

2. Choose **Principal Components** from the **Transform** menu. We want the first 3 principal components, so specify "3". For the **Output data type**, we will use "Same as input" - i.e. 8-bit integer. Specify a "Linear 1-99%" **Stretch for display**. Click on **Generate principal components**.

   Examine the three principal components images to see what features are best shown in which principal components.

3. Choose **RGB** from the **Transform** menu. For the channels, use:
   "Cairns PC-2" for Red;
   "Cairns PC-1" for Green;
   and "Cairns PC-3" for Blue.

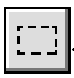
   Choose a **24 bit** RGB, and click on **OK**.

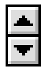
   Note that the various features of the image are easier to distinguish than in any of the component channels.

4. Choose **Add to Multiband** from the **Image** menu, and add the RGB image to the Cairns multiband. Close the principal components images, since they are not needed any more.

Training areas

Important: if you haven't already copied the demo images from the CD to your hard disk, you will need to copy the folder "Cairns Training Sets" (Mac OS) or "CAIRNSTS" (Windows) from the demo images folder to your hard disk in order to follow this section.

5. Click on the rectangular area selection tool: . Select an area of water from the RGB composite image. Notice that as the mouse moves over the image, a *pixel vector graph* is displayed in the info window at the left of the screen, indicating the pixel values in each of the four component numbered channels.

6. Choose **Collect Statistics** from the **Analyse** menu. A statistics window appears showing a histogram and statistics for the area selected. Click on the arrows:  to see the statistics for each numbered channel.

7. Choose **Apply Statistics** from the **Analyse** menu. Click on **New** to create a new training set. Give it the name "Water training set". Click on the box next to "With theme" and specify a colour for the new training set (e.g. blue). Move into the folder "Cairns training sets" (Mac OS) or "CAIRNSTS" (Windows), and click on **Save**.

8. Choose **Edit training sets** from the **Analyse** menu. A dialog box will be displayed asking you to move into the folder containing the training sets; move into the folder "Cairns training sets" (Mac OS) or "CAIRNSTS" (Windows), and click on **OK**. The Training Set Editor window will appear listing all the training sets in this folder; click on the training set that you created in step 5. Examine the statistics for the various channels by using the **Channel** pop-up list to select a channel.

   Click on the box next to **Theme**, and choose a colour for the class from the colour picker dialog box. To modify the training set name, type the new name in the text box labelled **Name**. To save changes you have made to your training set to disk, click on **Save Changes**. Click on the close box to close the Training Set Editor window.

Training set cross plot

9. A training set cross plot will allow you to graphically observe the separation between training sets. Choose **Cross Plot** from the **Analyse** menu then **Training Sets** from the submenu.

10. Move into the training sets folder, and click on **OK**.

11. Click on **Select All** to select all training sets. Choose **2 Std Dev** from the **Plot Type** pop-up list. Click on OK.

12. Move the mouse over the training set means. Notice that the name of the training set under the mouse is shown in the info window at the left of the screen.

13. Click on the close box to close the Training Set Cross Plot window.

Performing the classification

14. Click on one of the channels of the multiband to bring it to the front. Choose **Supervised classification** from the **Analyse** menu.

15. Move into the training set folder named "Cairns Training Sets" (Macintosh) or "CAIRNSTS" (Windows), and click on **Select current**.
    Select **Euclidean** as the method of supervised classification.

    Click on **Select All** to select all the training sets. Scroll down to the training set "Water training set", which you created earlier, and click on it to deselect it.

    Click on **Classify**. The classification may take some time to complete, depending upon the speed of your computer.

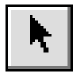
Post-classification analysis

16. The next few steps demonstrate the tools available in DIMPLE for analysing a classification. These tools may be applied to any classified image in DIMPLE - for example unsupervised classifications.

    Move the mouse over the classified image. Notice that the name of the class under the mouse is shown in the info window at the left of the screen, as is the pixel vector graph.

Classified image class key

17. To add a class key choose **Add annotation** from the **Annotation** menu, and then **Class key** from the submenu. You can specify the format of the class key - the number of columns, size, and position relative to the image. Click on **OK**.

    To change the font of the class key, ensure that the pointer tool  is selected, and click on the class key. Choose **Text style** from the **Annotation** menu, and choose an appropriate font.

Post-classification report

18. Make sure the classified image is the current window and choose **Report** from the **File** menu then **Post-classification** from the submenu to produce a post-classification report. There will be a wait of a minute or so while statistics from the classification are calculated. Scroll through the report to see details of the classification that was just performed.

Class cross plot

19. Bring the classified image to the front and then choose **Cross Plot** from the **Analyse** menu, then **Image Classes** from the submenu.
20. Click on **Select All** to select all classes. Choose "Band 4" for **Channel X**, "Band 5" for **Channel Y** and **Pixel Value** from the **Plot Type** pop-up list. Click on **OK**. to produce the cross plot
21. Move the mouse over the image. Notice that the name of the class under the mouse is shown in the info window at the left of the screen.
22. Click on the close box to close the Image Class Cross Plot window.

Class canonical variates cross plot

23. A class cross plot shows the class separation in the two channels selected for the plot. A cross plot of canonical variates can show the class separation among *all* channels.
    Bring the classified image to the front and then choose **Cross Plot** from the **Analyse** menu, then **Image Classes CV** from the submenu.
24. Before the cross plot can be produced a canonical analysis is used to obtain statistics on class separation. Click on **Select All** to select all classes for the canonical analysis. If you want to see a report detailing the statistics for the canonical analysis, check the **Produce report** and **Include statistics** boxes. Click on **OK**.
25. Once the canonical analysis is complete, you select the classes which are to appear in the cross plot. Click on **Select All** to select all classes, and then click on **OK**.

Each of the points shown on the canonical variate cross plot represents a class; its distance from other points represents the distance in multispectral space from the other classes.

26. When finished with the image class canonical variates cross plot, click on the close box to close the Cross Plot window.

Class editing

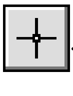
27. The DIMPLE class editor allows you to, among other things, interactively view the results of a classification, and change such features as class names and theme colours. To use the class editor, first bring the classified image to the front and then choose **Edit image classes** from the **Analyse** menu.
28. The Post-Classification Editor window will appear. Note the list of classes along with theme colours. You can view the statistics for a class by clicking on it; use the **Channel** pop-up list to look at different channels.
29. To change the name or theme colour for a class, first click on it - for example, click on "Suburban". Click on the colour box labelled **Theme**, and choose a different colour for the "Suburban" class. You can also change the name by typing a new one in the text box labelled **Name** - e.g. "City". To apply your class changes permanently to the classified image, click on **Apply Changes**.
30. Choose **Close all** from the **File** menu when finished.

9. Image Rectification and Registration

This example demonstrates the facilities provided for rectification of an image and for registering an image to a map coordinate system. The image used in this example is the RGB composite we produced earlier from the Jervis Bay image.

1. Open the image "Jervis Bay RGB.DIM" (Mac OS) or "JBRGB.DIM" (Windows).

Setting up the GCP model

2. Choose **New GCP model** from the **Image** menu.
3. Choose the coordinate system for the image. Click on the **Coord system** button.
DIMPLE supports projected, geographic, and user-defined coordinate systems. Jervis Bay is in New South Wales, Australia, and will use the Australian Map Grid (AMG) system, based on Australian Geodetic Datum 1966 (AGD66). Click on **Projected**, and then choose "AGD66/AMG" from the **System** pop-up list. Choose "56" from the **Zone** pop-up list. Click on **OK**.
4. Click on the point selection tool: . Click on the image to bring it to the front.
5. Click on the image to select a point then choose **Add GCP** from the **Image** menu. The selected point is assigned a number and is listed in the Ground Control Points dialog. Repeat step 4 to add an additional three points to the GCP model.
6. Click on the Ground Control Points window to bring it to the front.
You can now specify the map coordinates that each GCP is to be mapped to. Click on a GCP in the list. Note that the image and actual coordinates of the current GCP are also displayed in the boxes below the GCP list under the **Image** and **Actual** columns. For the x and y image coordinates

of the GCP, specify the actual AMG coordinates (in metres) by typing the values in the boxes under the **E** and **N** columns (any values will do for the example). Repeat step 6 for all GCPs.

A GCP model is supplied on the demo CD for the Jervis Bay image. Choose **Open** from the **File** menu, and then select the file "Jervis Bay GCPs.DGC" (Macintosh) or "JBGCP.DGC" (Windows). The GCP model will be displayed in the GCP window.

7. Click on the **Linear** button to select a first order polynomial to be used in the mapping.
8. Click on **Model**. A mapping polynomial is determined using the image and actual coordinates of the GCPs. This polynomial is then applied to the image coordinates of the GCPs and the results listed under the **Estimated** columns. The residual, or difference between the values estimated by the polynomial and the actual values you specified, are listed under the **Residuals** columns (if these columns are not visible use the scroll bar at the bottom of the GCP list). The mean of the residuals is displayed at the bottom of the window. From this information you can determine how good the model is.

Detecting outliers

9. You can look for outlier GCPs by excluding them from the model temporarily. Click on the space to the left of the GCP number of the GCP you wish to exclude. A "✕" appears indicating the GCP is to be excluded. Click on **Model**. Notice the difference in the estimated map coordinates and residuals. To include the GCP in the model again, click on the "✕" so that it disappears. To delete the current GCP from the model altogether choose **Clear** from the **Edit** menu.

❖ *Note:* the GCP window is also used for image to image registration. In this case you have a master image, which is already registered. You collect a GCP on the image to be registered as in steps 4 and 5. Then instead of typing its map coordinates for the **Actuals** in the GCP dialog, you select a point (Relative Control Point or RCP) on the master image that corresponds to this GCP, and choose **Set RCP** from the **Image** menu. The coordinates of the Relative Control Point (RCP) on the master image are then placed into the **Actuals** for the slave image GCP.

DIMPLE can also automatically locate RCPs - click on a GCP in the GCP window, then select a small area on the master image using the rectangular area selection tool, and choose **Auto locate RCP** from the **Analyse** menu. DIMPLE will find the most likely RCP in the master image corresponding to the selected GCP in the slave image.

GCP model report

10. Choose **Report** from the **File** menu then **Ground Control Points** from the submenu to produce a GCP model report. Scroll through the report to see details of the GCP model. Note that the mapping polynomial is displayed for both the image-to-map and map-to-image transformations.

Resampling the image

11. Click on the image to bring it to the front. Choose **Resample** from the **Image** menu.
12. Click on the **Rectification model** pop-up list. As well as GCP-based registration, DIMPLE provides several mathematical rectification models. Choose **Current GCP model**.

Note that the **Coordinates** system for the output image reflects that of the GCP model. The bounds of the input image are mapped to their estimated map coordinates using the GCP model and appear in the boxes labelled **Output image bounds**.

13. Specify that the output image is to have a pixel size of 50 by 50 (AMG metres).
14. Choose a resampling method. Nearest neighbour is suitable for images which are to be used for further analysis. For photographic images, Bilinear and Cubic will produce visually smoother images, but these methods are slower than nearest neighbour.
15. Click on **Resample**. There will be a wait of a minute or so while the resampling takes place.
16. Observe the output registered image. Move the cursor over the image and note that both image coordinates and map coordinates are displayed in the info window at the left of the screen and that the image origin is in the bottom left of the registered image.
17. Choose **Image Details** from the **Image** menu to see the details of the registered image. Click on **OK**.
18. Choose **Close all** from the **File** menu when finished.

10. Gridding & Interpolation

This example demonstrates importing point file data, and performing gridding and interpolation of this data to produce images for analysis. An example of part of a point file containing geochemical data is:

```
E,N,Zn,Pb,Cu,Fe,Mn
338325,8089966,12.6,19,17.4,2.9,39.9
337494,8089988,27.2,14.4,39.3,7,187.7
```

Each line represents one drill hole sample. The first two numbers are the map grid coordinates of the grid hole, and the remaining numbers represent the chemical analysis of that sample. The first line in the file is a header describing the layout of the data in the rest of the file.

DIMPLE can import a file like this and produce a raster image, with values interpolated to fill the gaps between samples. It can also produce a vector image to show the location of the samples.

1. Choose **Open** from the **File** menu, and select the file "Geochem.dat". This file contains some simulated geochemical data.
2. From the Image File Format dialog box, choose "Custom point file" as the file format. Click on **Open**.

   The first dialog box which appears asks you to specify the format of the data in the file.

   At the top of the dialog box, a line of data from the file is displayed. Click on the arrows: to see the next or the previous line. Click on the return button: to return to the first line in the file.

   This file uses commas to separate fields, so choose "Single comma" from the **Field separator** pop-up list.

   The first line of the file is a header, so specify **Skip first** [1] **line**. Because this line contains the names of the channels, check the "Read channel names from line 1" box.

Next, we specify in what columns in the file the fields of data are located. The **X** and **Y** coordinates are located in columns 1 and 2. The **Values** for Zn, Pb, Cu, Fe, Mn are located in columns 3 to 7, so type "3 4 5 6 7" to indicate that we want to produce images for all of these.

The data file uses the value -1E30 for Null - i.e. to indicate that a sample is not available. The specify this, choose "Single special value" from the **Nulls** pop-up list, and then type "-1E30" in the box next to it.

When you have specified all these parameters, Click on **OK**.

3. The next dialog box allows you to specify parameters for the gridding and interpolation process.

   First, the **Coordinate system** for this example will be Projected, AGD84/AMG, Zone 49.
   The origin for this coordinate system is the bottom left of the image.

   An appropriate **Pixel size** for this example will be 100 x 100 metres.

   Multiple samples indicates how DIMPLE will handle the situation in which there are multiple samples of data for the same point. Choose "Weighted Average".

   For the **Output data type**, choose "32 bit real" - the output images will contain values corresponding to the chemical analyses of the data. An 8 bit integer image would represent the analyses as values between 0 and 255, and although the colours would be meaningful, the original values would be lost. Other integer types would be suitable if the data being sampled was integer data.

   For **Stretch for display**, choose "Gaussian 3sd".

   Interpolation determines how pixels between samples will be filled in. The **Search radius** specifies how far from each "empty" pixel in the output image DIMPLE will search for neighbouring pixels. An appropriate value for this example is 6.

   The Smooth iterations and Smooth radius determine how filtering is applied to the interpolated pixels to produce a smooth output image. For this example, choose 3 **Smooth iterations** and a **Smooth radius** of 3.

   Click on **OK**.

4. Look at the individual channels to see how the gridding and interpolation process has produced raster images. As you move the pointer over the image, the analysis values are displayed in the Info window, as is the pixel graph of the values in each channel.

5. We will now produce an RGB colour composite of three channels. Choose **RGB** from the Transform menu, and choose a channel for each colour - e.g. Pb for Red, Cu for Green, and Zn for Blue. Choose a **24-bit** image. We will use the stretches currently applied to the images (i.e. Gaussian) to produce the colour composite, so leave the **Stretch** pop-up lists as "Current". Click on **OK**.

   The different colours in the image represent different combinations of the three elements.

6. A useful tool in analysing the colour composite images produced from gridded data is the Image cross plot. Choose **Cross plot** from the **Analyse** menu, and then **Images** from the submenu.

   For **Image X** and **Image Y**, choose two of the three channels which you used for the RGB colour composite - e.g. Cu and Zn. For **Colour**, choose the RGB image.

   The scatter plot shows the colours that represent various combinations of the two elements in the RGB image.

You can also produce vector images from point file data. In this example, we will produce a vector image which will show where the drill samples were taken.

7. Choose **Open** from the **File** menu, and again select the file "Geochem.dat".

8. From the Image File Format dialog box, choose "Custom point file" as the file format. This time, click on **Read as vector** to indicate that you want to produce a vector rather than a raster image. Click on **OK**.

9. The point file format dialog appears, with the settings above still shown. This time, we only want one image produced, so change the **Values** to one of the channels - e..g "3". Click on **OK**.

10. The next dialog box allows you to specify parameters for producing the vector image - the scale at which it will be displayed by default, and the symbol to be used for the points.

    Choose a "+" for the symbol **Through** the point, nothing for the symbol **Around** the point, and the medium size for **Size**. A preview of the point style is shown on the dialog box. Click on **OK.**

11. We will now overlay the vector image onto the RGB raster image we produced earlier. Bring the RGB image to the front, and choose **Image overlay** from the **Annotation** menu. From the **Add vector** pop-up list, choose the newly-created vector image. Click underneath **Colour** to specify a colour to draw the vectors in. You can also change the point style used to draw the points on the image.
    Click on **OK**, and the vector image is drawn on the RGB image. You can zoom in for a more accurate view of where the drill hole points are located.

Choose **Quit** from the **File** menu when finished.