THE PIT OPERATIONAL MANUAL

Introduction to PIT

This part of the appendix is essentially a step-by-step training manual, or "cookbook", intended to aid the user (you) in learning how to operate PIT, the Photo Interpretation Tool. For more details on its use consult the Help menu when PIT is installed, as instructed below, or the forthcoming Training Manual now under preparation at Code 935 (check the Internet version of the Remote Sensing Tutorial under the What's new Button [first page of the Overview] for annnouncement of the Manual's release and instructions on its acquisition).

PIT is originally written in Unix but the program has been modified to run under Windows. The version you will download from the CD-ROM or from the Internet is designed to operate only in Microsoft Windows (95/98 or NT), i.e., is oriented towards PC systems. PIT currently can handle standard Band Sequential format which, for Landsat, expresses each image point in a DN range from 0-255 (single byte; 8 bits). Both Landsat MSS and TM are accepted, as is properly formatted AVHRR and GOES data.

The data sets you will create presently cannot be saved under certain circumstances (exceptions will be noted). Thus, PIT is essentially a training tool for learning by doing the basics of image processing. It is not yet designed to yield permanent images that can be ported from the program to external directories for other uses (but watch for a .gif capability to be added). PIT can display a raw image, or a specially stretched single image representing some given band. It does not routinely allow for simultaneous display of multiple images, so that visual comparison must be carried out by creating or calling for one image at a time. PIT also permits color composites, using three input images assigned arbitrarily to the red, green, and blue monitor guns. These can be natural color (TM band 1,2,3), standard false color (2,3,4), or other color-band combinations (e.g, 7R, 5G, 1B). PIT is also capable of producing single ratio images in black and white, or colored ratio composites. It is likewise able to conduct Principal Components Analysis (PCA) generating as many Principal Components Images (PCI) as input bands. These also can be combined in groups of three to generate color composites.

PIT's primary use is in image classification. Both unsupervised and supervised programs are included. The three supervised methods are Maximum Likelihood (ML), Probablistic Neural Network (PNN), and Polynomial Discriminate Method (PDM). Outputs are color-coded images with a legend of classes (no upper limit on number chosen but best confined to less than 20) exhibiting color assignments shown either on the top or the left of the classified image. Training sites for each class are selected by filling in some number of cells that appear as a grid over the image being interpreted; the cell size can be varied. Statistics on the class distribution are available.

Once chosen, the class DN values can be displayed as histograms or spectral signatures. Histograms for each input band can also be shown. A portion of a band histogram can be selected and then all pixels in the image having the DN values within that segment may be highlighted in color for those pixels within the image falling within this DN range. Scatter diagrams plotting the distribution of DN values for any two bands are producible.

Installing PIT from the Internet

There are several files that you will need to download -

(a) PIT.zip - this zipped file contains all of the files required to run PIT except for those listed below.

(b) tcl804.exe - this will install Tcl/Tk 8.0 on your computer and is necessary for the proper operation of the PIT interface.

(c) israel.zip, morrobay.zip, nb.zip, rocks.zip, avhrr.zip, goes.zip - these are image files to be used during the walkthrough of PIT later on in this Appendix.

These files can be found on the Remote Sensing Tutorial website at the following URL - http://rst.gsfc.nasa.gov/Appendix/nicktutor_A-6.html.

Once you have downloaded these files you will need to follow these instructions -

1. Create a new folder called PIT on your hard drive.
2. Create a new folder called PIT Images on your hard drive at the same level as PIT.
3. Unzip PIT.zip into the PIT folder.
4. Double-click on tcl80P2.exe to install Tcl/Tk 8.0.*
5. Unzip the image files into the PIT Images folder.
6. To execute PIT, double click on the file named "pit.bat" in your PIT folder. Depending on the file manager you use, the ".bat" extension may not be shown and the file type may be listed as an MS-DOS file.
7. For convenience, you will likely wish to tie the execution file to a screen icon.

* You will first be asked to enter a location for the distribution. The default should be fine but you may specify a different location if you choose. It is recommended that you not specify your PIT folder (or a folder within your PIT folder) which may complicate future updates to your PIT distribution. The Tcl/Tk 8.0 installation process may ask additional questions depending on how your system is configured. If you already have Tcl/Tk 8.0 (or after installing it), the file "tcl80p2.exe" can be deleted.

Installing PIT from the CD-ROM

The files that you will need are on the CD-ROM in the following directory - /Appendix/PIT.

(a) PIT.zip - this zipped file contains all of the files required to run PIT except for those listed below.

(b) tcl804.exe - this will install Tcl/Tk 8.0 on your computer and is necessary for the proper operation of the PIT interface.

(c) israel.zip, morrobay.zip, nb.zip, rocks.zip, avhrr.zip, goes.zip - these are image files to be used during the walkthrough of PIT later on in this Appendix.

Once you have located these files on your CD-ROM you will need to follow these instructions -

1. Create a new folder called PIT on your hard drive.
2. Create a new folder called PIT Images on your hard drive at the same level as PIT.
3. Unzip PIT.zip into the PIT folder.
4. Double-click on tcl80P2.exe to install Tcl/Tk 8.0.*
5. Unzip the image files into the PIT Images folder.
6. To execute PIT, double click on the file named "pit.bat" in your PIT folder. Depending on the file manager you use, the ".bat" extension may not be shown and the file type may be listed as an MS-DOS file.
7. For convenience, you will likely wish to tie the execution file to a screen icon.

* You will first be asked to enter a location for the distribution. The default should be fine but you may specify a different location if you choose. It is recommended that you not specify your PIT folder (or a folder within your PIT folder) which may complicate future updates to your PIT distribution. The Tcl/Tk 8.0 installation process may ask additional questions depending on how your system is configured. If you already have Tcl/Tk 8.0 (or after installing it), the file "tcl80p2.exe" can be deleted.

General Overview of PIT

Before opening PIT, you will probably need to change your screen display to at least 1024 x 768 pixels (PIT was designed for a minimum of this size and anything smaller will cause imagery and bottom menus to be "chopped off"). A screen resolution of 1280 x 1024 is the best choice and should be used if possible. To make this modification in PC Windows, go to "My Computer", select "Control Panel", then click on "Display", and choose "MGA Settings". There are two movable buttons (left-right) marked "Display" and "Desktop". If need be, drag each button until the 1024 x 768 (or 1280 x 1024) option is shown. You will be instructed now to "reboot" (start again) the computer, using the indicated button. Your new screen setting will result (all initial icons will appear smaller). Again, you have a choice of switching back and forth between these instructions in the

Tutorial and PIT once loaded, using the minimal button [-], or, preferably, you will work from a print-out version of this Appendix (pp. 6-24) to read the appropriate instructions.

(1.) As always, you start by loading the program, using either the icon or "pit.bat".

(2.) On the right of your screen, a black rectangular window will appear and superimposed on it will be a large black window. The window underneath, labelled "dirlist", is normally not used and must be removed by minimalizing it. But, first, drag it by its top title bar further right and look at its buttons, only several of which are activated.

(3.) The bigger window, with "No Image" in its center, and labelled Pit on its title (top) bar, also contains the main menus accessed through 6 buttons on the left and a Help button on the right.

(4.) First, click on Help and then on Display Help in its window. There is a large quantity of information that is often helpful when a particular function or command needs further explanation. But, it is generally inconvenient to access this by scrolling and hunting, so, if you so desire, print it all out (25 pages) for reference.

(5.) Next, simply click on each of the left six buttons to familiarize yourself with the various command options. Some are in black, and ready to use, others in gray will only be later activated (into black) when a particular program or stage in processing is running.

(6.) The large "no image" black window is called the "Thumbnail" window (a throwback term to earlier versions of PIT in which it, and several others, were notably smaller). You will use this window to display individual gray scale images or color composites.

Displaying Images

At the present time, the following imagery, all TM, is stored in a Directory called "PITimages". This contains the following scenes: 1) Morrobay, the same image as used in Section 1 of the Tutorial; 2) Rocks, the same Waterpocket Fold scene used in Section 2; 3) Israel; and 4) NB, an image (location uncertain) in the Colorado Plateau of the U.S., illustrating a plateau type topography. Each image is 512 by 512 pixels (about 16 km or 10 miles on a side). For this training session, we will use the Israel scene, which is dominated by agriculture, with several types of crops and fields free of growing produce, along with towns, sand, and water. The scene is along the southern Israeli coast, with the town of Ashdod on the coastline. The image was acquired in August of 1985. To begin, follow these next steps to learn ways to call images into the Thumbnail window. Then, work through the subsequent instructions.

(1.) Click on Images, then Open, and the window labeled "Image path, sources, and size" comes up. Note that on the right are seven "Browse" buttons each associated with a rectangular box labeled Band 1, Band 2,….Band 7. Click on the first Browse button.

(2.) A window labeled "Select band 1 path " appears. Now click on the Parent Directory button. In the right subwindow are a list of general directories. Drag the button to the directory named "PITimages" and left click (hereafter, whenever the left button on the mouse is to be used, the word "click" alone will be used; if the right button is to be applied, the words "right click" will be chosen) on that directory name.

(3.) In the subwindow will appear a listing of all image files supplied with this PIT program. First listings are the 7 TM bands, labeled by ISRAEL and covering an area including the town of Ashdod, about 20 miles south of Tel Aviv, a nearby military airport, and crop fields. Drag Highlight (in blue) ISRAEL.1 and click on Enter. Note that the rectangular box labeled band 1 is now filled with ./../PITimages.ISRAEL.1.

(4.) Move to the second browse button and repeat the step 8 procedure. Do the same now - browse button-highlight name-enter - for those other bands as you wish to enter - in this case, all 7 TM bands for ISRAEL, which will be the image we will work on exclusively in Appendix 1. Be especially watchful in this sequence and make sure that the band number you want goes into its corresponding box; for TM you will confuse things if you put, say, TM 3 into Band 1 - it's good practice to have TM and band numbers the same; if you make a mistake and put the wrong band into a box, simply hit Browse and choose the correct one - this will overwrite the erroneous one.

(5.) Go now to the Source Box and press the Browse button. A listing of Landsat sensor systems,NOAA/AVHRR, and GOES sensors will be shown. Highlight Landsat TM; then enter via the Select button. Move to the next box, Size, through Browse and pick the only choice, 512 x 512 and hit its Browse button.

(6.) Now, click on Enter at the bottom. If you have not placed entries in all 7 available boxes, a window will replace the band entry window telling you that certain bands were not specified, and you will be asked to acknowledge this omission. After hitting Acknowledge, a large gray tone image will appear. This is the initial Thumbnail for the scene, a view of TM Band 1. Take a quick look; locate the following reference features: Mediterranean sea; docks; town of Ashdod; sand dunes; roadways; airport; active crops (darker rectangles, etc.); fallow fields (medium gray patterns).

(7.) The Image routine serves just to get the different bands online. Only one image, by default the first band, is automatically displayed. To see the other bands, and do some image adjustments, you must click on the View button. The menu window that drops down has two choices. Current confirms that the Thumbnail image is B1, which you set as Band 1. To see the other bands, you click on Display Image Control Window.

(8.) To see the other bands, and do some image adjustments, you must click on the View button. The menu window that drops down has two choices. Current confirms that the Thumbnail image is B1, which you set as Band 1. To see the other bands, you click on Display Image Control Window.

(9.) The first thing that appears is a small window labeled: PIT - Thumbnail Image Controls. It will have three rectangular boxes, the first labeled Expression, in which B1 is entered, and the second and third, each with a sliding button, labeled Contrast and Brightness. At the bottom are four larger buttons, two of which, Apply and RGB, are of interest at this time.

(10.) Our first task is to examine each of the 7 bands. Band 1 is currently shown as indicated by the B1 in the Expression box. For the moment, ignore Contrast and Brightness. To see B2, you can proceed either by placing your cursor in the Expression box next to the 1 and delete that character with the left keyboard arrow, then type in 2 and click on Apply OR clicking on the black inverted triangle button to the right, which will drop down a list from B1 to B7, then clicking on B2 and Apply. Any other band is called up in the same way. Familiarize yourself with the appearance of each band; Band 6 is the thermal band and is rather washed out in this unstretched rendition. Look at it.

(11.) The appearance of some - maybe all - of the bands can be improved. The standard way is through some type of contrast stretch. In Section 1 on Morro Bay some of the mathematic stretches were defined and explained. PIT, as now developed, does not have these capabilities and flexibilities. It simply permits two manipulations but these lead to meaningful and esthetic results.

(12.) To learn the effective use of these sliding buttons, go back to any of the bands you wish. Let us choose Band 4 (B4). Get it displayed. Now move (holding the left mouse button down, displace the sliding button by dragging the mouse on its pad) the sliding button for Contrast all the way to the right. In the small window next to the button, a number "*8.00" should appear and the image becomes bright white after clicking Apply. Then, drag the button all the way to the left and look for "/8.00"; the image is dark (black) after clicking Apply. Once again, bring the button back to its center position. Now slide it slowly to the right. At some short distance, the number "*1.10 will suddenly appear. So, keep dragging it rightward and note that the numbers increase by units of 0.1 (leftward, the same result). Same holds for slow leftward movement. Trying the same approach using the sliding Brightness button produces a right range up to +400 and a left range to -400. Slow movement from center starts right or left increments in units of +10 and -10.

(13.) Let us do a sample stretch. Set the Contrast button at *1.50 and Brightness at +100 and then click on Apply. You will note an overall change in image gray tones, with a somewhat different range of gray levels and an overall increase in brightness. The resulting image may strike you as improved from the start - this is a rather subjective judgment. Now set the C and B limits at *250 and +200. No doubt you will react negatively to the result. Try C and B limits at /150 and - 200. This also will not be a pleasing result. For a given image, there tends to be a narrow range of C and B in combination with changed values that give satisfying improvements. You, as the analyst must pass judgment on a set of B and C values that seems to you to improve image quality - but this is obviously subjective. Note: if you move the buttons left or right only slight amounts (before any numbers appear) and then hit Apply to see any changes, nothing does change and the buttons revert to center; this means that real changes can

occur only when numbers start appearing. Generally, most images improve when the C numbers fall in ranges less than *2 and /2 and B not greater than + or - 150 but some processing operations yield new images that require more extensive stretches or overall tone increase/decrease, so that the larger values apply. While you are at it, try to find the best stretch that optimizes band 6 gray levels.

(14.) Images in color are the next set of products sought through image processing. PIT makes these in a straightforward way. To start, again click on View and then Display Image Control Window. As before, the Thumbnail Image Control window will come up, as it does for individual band stretches. But, now click on the RGB button, and a new larger window comes up with three internal rectangular boxes, the top outlined in red, the middle in green, and the bottom in blue. Each one also has a pair of C and B sliding buttons. Note that, by default, B1 is inserted in each of the three Expression boxes. Also, there are Gray and Palette buttons to the right. Do not use the Palette button at this time. If you want to see any individual band image, press on Gray which will bring up any individual band you enter in the usual way. A stretch may be needed.

(15.) To see an image in color, choose what band you wish to render in the particular color you select, either by accepting or editing the band number in the Expression box or clicking on the black triangle and selecting the Bn desired. As an example, put B4 in the red Expression box, B3 in green, and B2 in blue. Then press Apply. A standard false color composite, with vegetation in red, should replace the band 3 image. Next, either delete/type the number or use the triangle, put B3, B2, and B1 in the red, green and blue outlined boxes. This will give a good natural color view.

(16.) But, better renditions are possible, even likely. Move experimentally the sliding buttons for each of the three bands to new positions, followed by Apply. Keep doing this until you reach a color display that seems close to nature or is at least esthetic. One natural view that is pleasing is B3: *1.10, +30; B2 *1.80, +30; B1 *1.10, +10. In effect, you are enhancing the image by selective, band by band, contrast stretching.

(17.) For the fun and knowledge of it, try other combinations, as you choose. For example, R = B7, G = B2, B = B4. Various subtle new information may emerge from some particular combination. Also, vary C and B. Remember to enter through Apply.

(18.) PIT has a systematic size changing program, or Zoom, that enlarges or diminishes an image. To bring about a change, follow this sequence (which also previews a major operation which we will do under the Classification tutorial): From the PIT Thumbnail window (hereafter, alternately just referred to as the PIT window), click on the rightmost button, Windows, then through these choices in the step windows that will appear to the right = Open - Interpretation - Scheme (top or left). After the left mouse button is released at the last step, a large window will appear with a black rectangle on the left (or top; depending on choice) and an image will appear in a window to its right. That image is the current one that is active. If you prefer to display another band, press on View, click on Display Image Control Window, then change band number in the Expression box (or click on RGC and fill in all three to get a color composite), and hit Apply. Note that the

image that you settle on will have a square grid superposed on it (this grid is used in the classification procedure). To remove this grid for now, go to View, then click on Show and note that four options are listed. One is labeled Grid and has a check mark in front. Click on the check mark, which removes it, and then displays the image without the grid. You are now ready to Zoom.

(19.) The procedure to change size is simple. First, click on View, then on Zoom in its dropdown menu. This will display numbers like 2x, 4x, 8x…. Whichever has the check in front denotes the size increment that will take place one step at a time. Most instances, an increase by 2x is adequate, but the higher numbers enlarge or diminish the image by greater amounts. For now, choose 2x. Then, click on Mode, and in its window menu will be two options: Zoom In (enlarges) and Zoom Out (diminishes). Assuming you have a full scene in display, choose the Zoom In command. Nothing apparently happens but move your mouse to bring the cursor into the image. You should see that the cursor has changed to a small bright square outline with a dot in its middle. Place that square somewhere in the image where you seek enlargement and click once (left). A new scene shows up in the image window, which you should recognize as a part of the image surrounding the square at its center. If you want to see a different area enlarged, repeat the procedure with the cursor placed within it. Or, given the first enlargement, center the square and click again. Once more, the expansion is by a factor of 2x; the image now begins to show individual pixels (as squares) but recognizable features may still retain identifying patterns. Repeating this once more (now 2x three times, or 8x) makes the pixels so large that the patterns begin to break down. To reverse the size increase, go to Mode, then Zoom Out, by clicking. The cursor, when it is placed somewhere on the (enlarged) image, has a different shape: it is a cross (+) with the tips ending in tiny arrowheads. Depending on the degree of enlargement, one or more clicks will in effect decrease the pixel size while restoring the image scene to larger areas that are displayed. From 8x, three clicks will restore the original full scene, if that was the starting point. Enlargements by zooming in provide smaller subsections of a scene that may be all you will wish to classify or otherwise manipulate. Note:you can start with a higher zoom factor, e.g., 4x or 8x, cutting out incremental steps.

(20.) PIT presently is not designed to routinely display more than one image band at a time but there is a way to put most of the areas of two bands on the screen simultaneously. To do this, first put up the PIT Thumbnail image and if other than the default image is to be displayed, get it in the usual manner through View - Display Image Control Window and select the band (delete/place number or black triangle) wanted + Apply. After it is then displayed, you next want to bring up the second band. To do this, at the top click and drag on Windows - Open - Classification - Supervised - Image - Top Scheme, and click the mouse button on that last command. Either a blank pair of windows will come up or the bottom window will have the image of one of the bands (check Current). To get the band you want in this right window, go to View - Display Image Control Window - band number - Apply. You should now see both band images but a small part of one and/or the other may not be visible. You can move either or both around the screen by placing the cursor on the top banner, holding the mouse button down and dragging. Keep in mind, also, that there are other situations in using

PIT where windows might overlap; in some instances these can be repositioned by dragging one or more, again by placing the cursor on the blue title bar (top). Note: Using top schemes and 1280 x 1024 screen resolution will allow the windows to be viewed side-by-side with no overlap.

Histograms and Scatter Plots

The purpose and value of histogram data plots have been discussed in Section 1. Here we will learn how to produce and display these and scatter plots as aids to understanding the statistical distribution of DN values in individual and paired bands.

(1.) For the moment we will work with the default image in the PIT window. Click on Windows, then drag over Open, then (in the small window to its right) click on Histogram, and then on Small View. Releasing the mouse button brings a small window up on the left called PIT - Histogram. Click on the Plot button, which drops a gray window with Source (highlight). Drag the mouse to the right into a window which has Thumbnail highlighted, then right again to a list of the bands that are active. Choose band 1 and release the mouse button. A histogram appears. Note the maximum and minimum DN values (the spread), the values where the first significant frequencies occur, and the peak values of the mono- or polymodal distribution; also the degree to which the distribution is gaussian or normal. This information is especially important when used by image processing programs that have several modes of contrast stretching.

(2.) PIT Histogram has an interesting feature. You can select a portion of the displayed histogram, which blocks out all the DN values in this range, and then display in the image that is up all the pixels that fall within that value range. This demarcates visually the spatial distribution of all such pixels.

(3.) To do this, take the histogram display window (assuming it is being shown), and placing the mouse cursor on its Title banner, drag the window away from the Thumbnail image to the open screen space to the right. Now, place the cursor somewhere within the actual histogram at whatever left DN point you wish to start the DN range. Drag the cursor rightward; as you do, that portion will fill in with color; continue until the area of the histogram containing the range you are going to display on the image has been highlighted (you can change color by clicking on Ranges, then checking the color desired). Raise (de-iconify) the Interpretation window (or open it if it had been closed). When that window is displayed, click on the button called Matching, then on Draw Boxes, followed by From Histogram. Watch as the color in the histogram starts to fill in image pixels falling in the chosen range, with this proceeding downward until the entire image is thus colored. All pixels within the range are now identified in their spatial positions. (Note, drag the PIT - Interpretation leftward until the image is near the left screen margin - this will allow you to see both image and histogram window fully. Even better - use 1280 x 1024 screen resolution and top schemes.)

(4.) To see pixel distributions for the other bands, first, remove the colored area on the histogram now open by clicking on the Delete button in color-bordered box in PIT - Histogram. Then, click and slide on Plot - Source - Interpret - Thumbnail - Band Listing (make choice). The histogram for the chosen band is displayed. But, the image in the PIT window is the default Thumbnail. You need to display the new band. From the PIT Window, choose View, then Display Image Control Window, and then from the dropdown window labeled Thumbnail Image Control, select (replace number or hit black triangle) the band desired. Once it is displayed, go through the histogram coloring and Match procedures as before.

(5.) Next, let us explore Scatter Diagrams. From the PIT window, click and drag through Windows - Open - Scatter - Small View, click and release. The PIT Scatter window drops into place. Click on Source, drag through Thumbnail to the right, and keep dragging rightward. You will see a window with a listing of Band 1 vs… through Band 7 vs… and by dragging further right a listing of the bands. To set up the scatter pairing do this: move cursor to first band of interest in the vs window; it will highlight in a whiter tone; then move cursor to last window on right and to the other band which will also highlight. Click on that and the Scatter Diagram will appear. Note that it consists of some geometric pattern in several shades of gray (the lighter the tone, the greater the number of pixels in the distribution). If the pattern is a narrow ellipse, with about a 45° angle, the two bands are strongly correlated; if the angle is less or greater than the same pixel point has two somewhat different DN values but there is still some correlation. If other than an ellipse occurs, this usually denotes a bimodal or polymodal distribution. Examination of the corresponding histograms helps in the interpretation of the type of pattern that emerges. To see Scatter Diagrams for other band pairs, simply repeat the process starting with Plot and ending with the desired pairing. To remove the diagram, click on Plot - Clear Plot.

Ratioing and Principal Components

Ratio images, both as single band pairs and color composited multiple band pairs, are rather easy to make with PIT but the resulting images need fine tuning as to Contrast and Brightness. Furthermore, even the best renditions often need careful interpretation and may contain only a limited amount of new information. Principal Components Images (PCI) are also formed through a fairly simple routine that involves Principal Component Analysis (PCA) but again meaningful images depend on the C and B values applied. For each, follow these steps.

(1.) For ratios, let us first try the pair: B4 and B2. To see the ratio image, start with View, then place the cursor on Display Image Control Window and click, which brings up the Thumbnail Image Control window. Some band is entered in the Expression box. You cannot use the black triangle efficiently to enter the ratio, so delete with the cursor the band present (unless it happens to be B4) and in the blank type in B4/B2 (remember, ratioing is division of one band pixel DNs by those of another band, and / is the division operator). Press Apply. The result is a black image. Your first thought is to adjust C and

B. Move C to its rightmost position (*8.00) and B to +100. A faint image appears but is hard to work with. Conclusion: not enough range for C. For ratio images, this range needs expansion. Go to the Settings button and move the cursor onto Contrast Range, which becomes highlighted and causes a window to appear to its right. There are a number of different values; the default one is *8.00. Change this to *256.0. This will cause the image control window to automatically close. Reopen it as described above. Now, redo the ratio process, with these new settings. Move the C button to *70 and set the B button to + 50, and Apply. A much improved image is the result. Now, try the ration B4/B1 and adjust the C and B buttons until you like what you see. *100 and + 40 is OK; you might find better values. Try different ratios and strive to optimize the gray tone expressions. How well can you render B6/B1? Rather weird, eh! But with some meaning. Note the relative "warmth" of the sea versus the sand dunes; the vegetation versus the town.

(2.) Making color composites just requires hitting the RGB button on the Thumbnail Image Control button. The new window has the red, green, and blue subwindows as is customary. But the last single ratio value you looked at fills all three Expression boxes. You will need to type in the specific ratios you seek into each box. Then, press Apply. The resulting color image may be garish or gorgeous, depending largely on the C and B values set at entry. Try different values for each ratio pair, each time hitting Apply. Generally, you will find some narrow sets of values that give a pleasing result. Some combos will reveal more than others. Certain end results will probably call attention to particular image features whereas others won't. Experiment. Try different ratios or inverting the bands in a given ratio; also switch ratios and colors. As an example, put B4/B2 in the red box; B7/B5 in the green box, and B1/B3 in the blue. Check with the Ratio discussion in Section 1 for hints as to interpretation.

(3.) Making PCI images is easy. Assuming all bands are entered and active, and you are in PIT (Thumbnail), press on the Image button and then click on the PCA option in the window that drops down. A new window appears that has Create PCI as a command. When you click on it, a large window like the one that appeared as you entered the 7 TM bands, except B1 through B7 is replaced by PC1 through PC7, is displayed. Move your mouse cursor to the Box PC1 and click on Browse. A window that has many directories listed on the right probably doesn't include "PITimages". Click on Parent Directory button and scroll down the listing until PITimages appears. When you click on it, in the box near the bottom labeled Directory, this will appear "/…/PITimages". Below it is a blank box marked File. Type in a file name with extension ".pc1". Here, we will choose "Israel1.pc1". Pressing Enter returns you to the 7 PC boxes. Place the cursor in PC1, hit Browse, and repeat the process, this time entering "Israel2.pc2" in the File Box. Do this again for as many Principal Components as you wish, in this case we will proceed through "Israel6.pc6. Then, at the bottom of the 7 list, hit Enter. At the lower left you will see a rapidly moving PC statement giving the percentage of processing at the moment. When this is done, you have formed the PCIs.

(4.) To see the various PCI images, from the PIT window, click on View and then on Display Image Control Window, which raises the Thumbnail Image Control window.

Click on the black triangle button. A list showing the 7 Bands appears, but also there is a list below with PC1 through PC6. Click on any one and it will be entered into the Expression box, and displayed by clicking on Apply. Change C and B as you please, to get a well-balanced set of gray tones. To see any other PCI, simply hit the triangle and choose the new PCI image. For our Israel case, PC1 is most like the band images, and is closest to Band 3 but initially darker (can adjust with C and B), PC2 emphasizes vegetation (bright), PC3 is largely medium to bright gray (note the interesting ellipse around the airport - probably a road associated with a fence if this is a military field), PC4 and PC6 contain little contrast and are probably low on information, whereas PC5 does have meaningful tonal patterns that seek interpretation.

(5.) PCI color composites can present images that have additional information over the single PCI image. While in the Thumbnail ImageControl window, click on the RGB button, and the familiar three color outline boxes appear. Using the black triangle by each box, enter the particular PCI image to associate with that color. To display, press Apply. Start with R = PC1, G = PC2, and B = PC3, display through Apply. If the color balance is not satisfactory, repeat, moving the C and B buttons (intuitively) to new values. Keep trying until you find a proper balance (not too much of one color). To acquaint you with the possibilities, try various combinations of PC1, 2, 3, and 5, discarding PC4 and PC6 (or try them if you are curious.)

(6.) As mentioned in Section 1, interpreting PCA products is almost an art. You may learn little more than from natural or false color displays. But, at times certain features that have been missed in those displays may be revealed. Principal Components images have the advantage over band images in that the process of calculating the PCs leads to decorrelation between bands. Recall that the first PC contains most of the spectral information inherent to the scene; proceeding through higher numbered PCs produces images representing progressively less such information. Note that PCI images can be substituted for spectral band images in the classification of imagery.

Classification

In many instances the most useful image processing output is a classified scene. This is because you are entering a partnership with the processing program to add information from the real world into the image you are viewing, in a systematic way, in which you try to associate names of real features or objects with the spectral/spatial patterns evident in inidividual bands, color composites, or PCI images. PIT is capable of producing both unsupervised and supervised classifications (review the relevant parts in Section 1 if you need a refresher on principles). In the next pages we will walk you through the steps in developing each type of classification.

Unsupervised Classifications

Here the strategy is to determine statistically separable distributions of DN values in multispectral space. Rules establish where a given pixel is located in this space. PIT

utilizes two such classifiers, labeled UC1 and UC2. (We will examine only UC1 here because UC2, which can be a better discriminator, takes a very long [hour +] time to run). The default number of spectral classes is set at 27. Many of these contain less than 2% of the pixels (as distributed spatially over the image) and are commonly hard to see in the final result. There are two ways, both described below, to eliminate or adjust for these minor classes. The steps involved in PIT unsupervised classification are:

(1.) With all spectral bands loaded, go through the sequence of clicking/dragging by starting at Windows,then Open - Classification - Unsupervised - Image - Left Scheme, clicking on the last one. A new window appears with the Thumbnail image (default) or any other you have chosen using the View routine. At the left side is a series of rectangles in a column, the first labeled Class 1, the second Class 2, and so on, and each outlined by some color (with 27 total, many of these colors will prove hard to distinguish from one or more others). The first 15 Class boxes are visible; those to Class 27 can be accessed with the vertical scroll bar.

(2.) On this window in the upper right is a Classifier button. Click on it and select UC1... from the drop-down menu that appears. A dialog box will be displayed in which the parameters for using the UC1 classifier may be selected. For now we'll simply use the defaults. Press run, and sit back while the classification proceeds through these steps, shown dynamically at bottom left: Running Classifier (%); Determining Classifier Boxes (quick, unmarked); and Drawing Classified Boxes. As this last step begins, look at the image - you will start to see various colors superimpose on the image, gradually working from top to bottom. After a few minutes, the entire image is fully colored, often with a truly esthetic (modern art-like) pattern. Note that each class box on the left has a small box with a checkmark and at its right, a percentage that indicates the percent of the total number of pixels that belongs to this class as well as the actual number of pixels within the grand total of the 262,144 pixels in the full scene. Of the 27 classes, 16 will be greater than about 1.5%. At the end, the gray lettering in this legend turns black (i.e., completed).

(3.) For the Israel scene, about 9 colors associate with enough area to be distinguishable at first glance or after a brief, but careful look. In order of decreasing percentage, the most common color in the part of the image in the fields (east from the town) is green followed by yellow, blue, orange, peach, purple, red (red is so conspicuous, it seems to have a larger area of display than actual) and brown. The ocean is a wine purple and the sand dunes are a darker yellow. What all this means is that there are probably about 10 classes common enough to be specified during the supervised classification we will next conduct. This is a prime use for unsupervised classification, to identify those classes that are spatially significant, and to display where they are located,so as to assist you in defining classes to include in the supervised classification. Most of the 8 colors found in the agricultural part of the scene are likely crops of different kinds or stages of growth, possible tree groves, and fallow fields.

(4.) You can also determine the spatial distribution of any given class by clicking on the checkmark in its left square. After it disappears, the lettering in the legend class boxes

goes gray, and a time elapses while the class removed disappears from the scene. This is often very hard to see for classes less than about 5 to 10%. Try it on the red. Eventually, the underlying gray tone of the image will appear in the areas of the scene where the class occurs. Then click in the square to restore the checkmark, and then the red will start filling in top to bottom until all the lettering again becomes black.

(5.) Now, let's see what reducing the number of classes leads to. Go through the same procedure as before up into the window containing the Run button. Go through the same procedure as before, but change the number of classes to 12 before clicking Run. Wait until the full unsupervised classification is finished. There clearly are less colors, less of a hodgepodge. Note that the color assignments have changed: the red of the 27 classification has been replaced by blue in the same pattern; the red itself is now the largest single class and is widespread. You can try other class totals if you wish, to see if simplification results, but remember to restore the "12" to "27" when finished.

(6.) It is suggested that, if you plan to now (or soon) do a supervised classification, that you retain the unsupervised one as a reference. Hit the Minimize button [-] in the upper right and in Windows fashion it will appear at the bottom button bar. Be warned that when you wish to put it back on screen, and click on that bottom button, its frame outline will appear but the image itself will take a few minutes to be restored to the full screen.

Supervised Classifications

The climax of our learning experience with PIT is now upon us - producing a supervised classification of the Israel scene. In this, you will assume some interpretive knowledge, based on your experience and common sense in identifying various categories to establish the classes to be mapped onto the image. In the Israel scene, several are obvious: the Mediterranean Sea; the sand dunes; the towns, active growing vegetation, and fallow fields. This is well-displayed in the standard false color composite, which we will adopt as the image to use in specifying training sites. We will select the cell block method of picking samples within classes that is the easiest to use in the PIT program.

We will start by specifying only 8 classes; later you may elect to rerun the classification using a larger number that depends on your confidence in visually picking out the sites where new classes seem best displayed. Our first attempt will work with the full scene to choose the cells. That has problems which will become obvious as you proceed. After you get your first classified image, you will be encouraged to redo the process using movable enlarged portions of the scene, which in effect makes the sites for cell blockage larger. Also, we will start with the Maximum Likelihood Classifier; the PNN and PDM classifiers will be explained later. So, onward.

(1.) As you did before, bring up a band 4, 3, 2 (R,G,B) color image of the Israel scene, going through the View, Display Image Control Window, RGB button routine. After the scene is up, drag the RGB window off the image and place to the right. Make any C and B adjustments you think make class distinctions easier.

(2.) Inspection of the Israel image yields these obviously different classes, whose shapes and colors lead to separability: (Sea)water; Town; Sand Dunes; Active Crops (strong red tone). Four others show well enough to warrant designation as classes but their identities are more nebulous: Other Crops (dark red); Dark Fields (darkish grayish); Fallow Fields (grayish brown); Natural Surfaces (yellow brown). Other classes are seemingly present but their areas are too small to be sampled by the cell size we will choose. This is true, for example, for linear features like roads and the airport runways. So, we will stick with only 8 classes at this juncture.

(3.) At this point, go to the PIT Window and click on Scheme. One option is in gray; (not activated), the others in black (active). Click on "Add Class". A window will drop down, labeled "Enter a Class Name and Color" In the first Name Box, type "Water". Go to the Browse Color button and click. A long list (requiring a scrolling button) will appear. Click on "Blue" when it appears: part of the window will take on this color. Press Enter and the color name will appear in the Color Box. Press Add and both boxes will be cleared. Next, type in Town, go to the Color Menu, scroll down to Brown, and repeat the rest of the procedure. For the rest of the classes we set up in this first try, the names/colors are: Sand Dunes = Yellow; Mature Crops = Dark Green; Other Crops = Pale Green; Dark Fields = Gray; Fallow Fields = Light Pink, and Natural Surface = Medium Purple. The selection being done, press Done. (Note: if you already know a color name [after familiarity with the list], you can elect to type it directly into the Color box rather than scroll the list itself.)

(4.) Raise (de-iconify) the Interpretation window (if it had been minimized). The classes created will now appear as a list of color outlined rectanlges at the left (or top). The scene may be the gray image or the color view, depending on what was saved or minimized earlier. If the gray image, then convert it to the false color version in the usual way (Display Image Control; RGB). You will observe that a black grid, with widely spaced squares, is superimposed. Each square encloses 64 x 64 pixels. For this scene, the square box contains too many different classes - many in their visual expression are much smaller than the box (hearafter called a Cell). It is necessary to either reduce the Cell size (increase the total number) or, as we will do later, greatly enlarge part of the scene (Zoom). To reduce the cell dimensions, go to View, then down to Cell, and click. The small window to the right contains two options. Clicking on Size produces a window with a series of n x n sizes, with the 64 x 64 size checked. Change to 16 x 16 by moving the cursor to that position and clicking, which will check it. If you wish to change the color of the grid, then click on Grid, the other option, to a new color. Here, we will stay with black. Also, if you wish to remove the entire grid (perhaps temporarily), click on View, then Show, and click off the checkmark in the right window next to Grid; to restore, re-enter and click it on.

(5.) You are now ready to start filling in the grid cells with local samples of the class you interpret to be in each. Try to find the most "pure" examples but a fraction of a cell containing one or more other classes (visual differences) can be tolerated. Lets start with water in the upper left. Go to the legend box labeled Water and click on the small circle at its left. A black dot (bullet) will fill it. The mouse cursor will change shape to a

larger white dot. In the image find the sea (upper left), place that cursor in a cell enclosing water and click. The cell fills with blue. Do this for a few more cells adjacent or near by. Note that in the legend box, each time you add a cell, the total (16 by 16 or 256) increases the score shown. You should try to have at least 1500 and perhaps 2500 or more cells thus picked for each class.

(6.) Next, activate the black dot in the next box, Town, outlined in brown. Find what you interpret to be examples in the image and click on enough cells (brown) to meet quota. On to obvious sand dunes below the town. Activating its circle, pick at least 8 boxes (filled with yellow). Do likewise to the remaining five classes. The Mature Crops are those in bright red. You will be able to select perhaps 2-3 cells at any one area of the image,so you must go to several areas to activate at least 8 cells. For Other Crops (darker red), these being smaller in size, you probably have to go to 6 to 9 different locations. Training sites for Dark Fields are apparently sparse, at least in areas large enough to fill a cell. Look at the right center margin for one such site; also in the lower left. You may not find even 6 "good" cells; accept a smaller number. Fallow Fields, present in the color composite as shades of gray-brown, are even smaller, so you have to hunt for cells one at a time that meet the conditions. The last class, Natural Surface, may be "artificial". But the terrain north of Ashdod looks a bit different from sand dunes and may be a barren surface with sand and soil. It has a more subdued yellow-brown color and some texture. Enter several cells there and again at a small similar area in the lower left corner.

(7.) You have now selected samples of all classes, associated with certain cells in the grid. There is no Save or Close Button, but the class selection information is saved as long as you are actively working in PIT. However, you need to remove this display while you are engaged in the next classification step. There are two options: 1) you can just close the window by hitting the minimize button [-] at the upper right; this will place a PIT - Interpretation button at the bottom of your MS-Windows screen; or 2) you can seemingly close the classes window by pressing [X] at the upper right; to recover this window, just go to the main PIT window (which may be minimized also; click to activate), then to Windows, and then Open - Interpretation - Left Scheme, and the image with the class cells on it will come up; but, if you had saved through [X] as a Zoom enlargement, this will not appear but instead you will see the full scene with all colored cells located (if you wish to revert to an enlargement, use the Zoom routine).

(8.) Also, you may have made a mistake or two in coloring a cell with what you decide is the wrong class; to correct that, select the proper class (from the class scheme) and click with the mouse cursor in the cell being corrected. And, you may decide to omit a class. If so, go to Scheme and select Delete a Class; a menu will appear to the right with all classes listed; delete by clicking on the desired class. There is also a Delete All Classes option, if you wish to start over. Or, you can retain the classes and desire only to choose a new set of cells; this involves Scheme - Clear Interpretations, with a list of classes in the right window that appears; click on the class whose cells you want to remove, and then on the Clear Button that appears; or you can remove the entire group with the Clear All Interpretations button.

(9.) At this stage, it should prove informative to look at the spectral signatures of each class to judge how much real separability there is between any pair of classes or all the classes together. You can do this now because you have taken samples of each class so that appropriate statistics can be calculated. Go back to the PIT window: click and drag on Windows - Open - Signature - Small View (click). A new window labeled PIT - Signature shows up at the upper left. Click/drag on Plot - Source - Interpretation - Spectral - Image (click). Wait about 10 seconds. Then in the black window you should see spectral curves (as straight line segments) for all 8 classes you set up, each with the color assigned to it. The abscissa is simply the number of spectral bands, plotted at equal intervals; the ordinate is the DN range from 0 - 255. There is a scroll button: by dragging it down you will see each class spectral curve by itself, with its name labeled. Some comments about what you can conclude from the plots: all classes seem separable, i.e., even if several are close in DN value for one band, there always are one or more bands that show significant differences; Town and Fallow Field are most closely alike; there are peaks at bands 3 and 5 (count from the origin to the third and fifth dots on the curves) suggesting that overall, those bands are brighter; all band 2 values are lower, implying that this band may be darker overall owing to either sensor or calibration conditions.There are strong peaks for band 6 and all the curves converge to a narrow range; this indicates that the DN values are similar and radiances were not much different for the classes involved; this is borne out by the image when displayed - it is tonally flat with little variation. In general, if that is the case, it is wise to omit band 6 from the classification; use band 6 only if there tends to be bright and dark patterns that indicate hot spots and cool areas. For the classification we will now do, include band 6, but if you redo this at some oher time, you can elect to drop band 6.

(10.) We are now at the climax - ready to do the final classification. Make sure the PIT - Interpretation window is minimized. Bring the PIT window up and click on Windows. Then, follow the usual click/drag sequence: Windows - Open - Classification - Supervised - Image - Left Scheme. This will bring forth the large window with the image (Band 1, in this case) and the 8 class legend (color outlined) to its left. Click on the Classifier button (on the menu bar) and select ML... from the drop-down menu that appears. A dialog box will be displayed in which the parameters for using the ML classifier may be selected. We'll use the defaults so just click the Run button. The progress will be shown at the lower-left: Creating temporary PIT file - Creating temporary training set - Running classifier - Determining classifier boxes - Drawing classifier boxes. When that last statement arrives, you will begin to see colors at the top of the gray image that will progress downward until the entire image is filled. This is the Maximum Likelihood classification you sought.

(11.) In general, the result should look believable (yours will vary from mine because you almost certainly chose different cell sites for the classes; but there should be strong similarities). The ocean water should just be in blue in the upper left; there is a small lake near the scene center which may or may not be in blue. Probably, the color assigned to Town shows up more widespread than you expect. It should be nearly solid and continuous near the wharves and dominant but mixed with other classes just

inland; this color shows up also in local concentrations within the vast agricultural part of the image, and denotes small settlements, the airport, and the village of Lob. Both green patterns look realistic as indicators of active crop growth. Fallow fields, in pink, probably are the most prevalent class in the scene - you may judge that there is perhaps too much of this class, depending on how you selected your cells. The natural surface (purple) seems meaningful.Look at the percentage of each class in the Legend.

(12.) One class, Dark Fields, will likely be around 5%. It does not stand out - the gray color given to it doesn't contrast enough. It is easy to change. Click on Scheme, look in the window that drops for Modify Class, and a new window with the eight classes list will appear to the right. Click on Dark Fields and a small version of the window you used to select Class Name and Color appears. Keep the name and browse through the color list. Check any new one you wish, but we suggest Grey 30. After a few moments, that dark color will replace the light gray. Consider this to be the final version - in effect a land use map of the Ashdod coast and inland agriculture. You can now elect to do one of three things: 1) keep it active, but minimized; 2) save it, or 3) delete it. For now, minimize it. Note that both the label at the top of the classified scene and the minimize button call this Classification/1.

(13.) So, now we ask you to pause a moment and think through this question: What could you have done to have made this classification easier to do? PAUSE. Well, the biggest problem you no doubt had was to find single cells that were relatively "pure".Other Crops, and particularly, Fallow Fields and Dark Fields, were usually hard to find as the predominant class in many/most cells. They are often just too small and must share the cell with at least a second - sometimes third - class. How can you get around this problem. Make the cells smaller - not practical under the circumstance - OR make the image larger, that is, zoom it up. Lets try the latter. To do this, restore the PIT interpretation window from its minimized button. Click on Scheme and then Clear All Interpretations. This eliminates your previous cell selection. Note that PIT Interpretation has a Mode Button. Click on it and note that its window has a Zoom In option. Click on this. A square cursor appears that can be placed anywhere in the full scene image. Put it somewhere near the middle of the upper left quadrant. Click, and an enlarged (by 2 x 2, the default) scene replaces the full one. But, the cell size in the grid remains the same. However, each individual cell (which encompasses 8 x 8 or 64 cells) in the grid "straddles smaller parts of the scene, so that there is a higher likelihood of finding "pure" classes within some given cell. Note, too, that there are both horizontal and vertical scroll bars. When you move right or down or both, you will traverse through the entire scene (fully down and right moves the image to its lower right corner in the full scene). Thus, you can still choose cell classes over the entire image - each cell filled in just samples smaller areas.

(14.) Do this, that is, choose new class cells, minimize this Interpretation, and proceed thru the PIT- Classification as you did before. We suspect you will find it easier to select good examples of dominantly Dark or Fallow Fields, and you can block out the town better than before. After your classification is displayed (as Classification/2), see if you have obtained a reduction in the percent of Fallow Fields and greater percentage of Dark

Fields. The Town may also be more "compact" and realistic. As a general rule of thumb, we have concluded that, if you know a fair amount about the categories present in any scene you plan to classify and if there is a high proportion of small areas that nevertheless appear to be valid classes, you will achieve better results if you select your class training cells from at least one level up in Zoom (zooming in too much tends to present a scene with a patchwork of blocky pixels). Close this classification by minimizing it.

(15.) What might you do next. We suggest that you repeat the classification, in the steps outlined above, but with one change. Choose PNN instead of ML. Try this now. But, heed these warnings first: The PNN (neural network) classifier is much slower than ML (maximum likelihood) - it took about 15 minutes on a 200 MHz machine to complete "Running Classifier". Part way into an ultimately successful run, the ScreenSaver pattern came on. The processing continued but the image and legend disappeared only to restore towards the end, after repeated pushing on random keys in the usual way to restore the screen. Suggest you hit a key periodically in a time interval less than drives the Screen Saver. In any event, the final PNN classification appeared and subjectively was judged the better of the two (PNN vs ML). The Town was sharply delineated. The amount of Other Crops seemed a better representation in the PNN version. But, reserve judgment for yourself after you succeed with this PNN classification.

(16.) As an option, run the PDM (Polynomial Discriminate Method) classifier. Do exactly the same as before, except select the PDM option. It will take about the same time as PNN. Results are similar to PNN but there is a real difference from ML. In the dual run we made, ML distribution for classes Dark Fields and Fallow Fields was 8.5% and 40% and with PDM was 22% and 23% respectively. This could depend much on the choice of specific cells but in this comparison the same cells were used. The distribution of percentages is thus sensitive to the particular areas in which the training site cells are located and on the classifier used. Which classification is best can only be determined by comparing with actual ground truth, but intuition helps.

(17.) While we're at it, lets run a revealing experiment. Let us peform a standard ML classification but on only bands 2, 3, and 4. This will in effect simulate a Landsat MSS image. Lets see how well this reduced number of bands can achieve a suitable distribution of classes. Request a ML classification as before but before clicking Run specify that only bands 2, 3, and 4 should be used. Do this by clicking on the buttons labeled 1, 5, 6, and 7 in the "Spectral Bands:" area of the dialog box. This will cause them to change to a light gray (rather than black) indicating that they will not be used. Now click Run to start the classification. After the classification is displayed, look at it and, if you retained any other classification, compare the two. Your conclusion will likely be: the "MSS" classification did almost as well as those based on 6 or 7 TM bands. Why? Largely, because this Israel scene is dominated by vegetation, so MSS 6 and 7 pretty much match TM 4. If the scene had contained considerable rock materials, and certain other classes, these differentiate better when TM bands 5 and 7 are available to distinguish their special characteristics. When (if) you decide to classify the several other scenes in this PIT Appendix, those that contain rock materials (e.g., the

Waterpocket Fold scene) should benefit from utilizing TM bands 5 and 7, and probably 6 also.

(18.) As an aside, the writer (NMS) experimented with a maximum likelihood classification using TM bands 1 through 4 and selecting 6 of the 8 original classes, eliminating Dark Fields and Natural Surfaces. The result was to make Towns appear more realistic - Ashdod was more widespread - and to replace Dark Fields and Natural Surfaces with Fallow Fields. The overall effect was a "cleaner" (sharper) classification but at the cost of omitting two classes that are discrete and probably real and worth mapping.

(19.) PIT also facilitates classification using PCIs rather than spectral bands. If you are curious about the nature and appearance of such a classification, make some number of PCIs, as described before, and run a ML classification, specifying PCIs instead of spectral bands in the dialog box. Interesting, eh!

(20.) You may have noticed a button labeled Training Set that appears on both the PIT - Interpretation and the PIT - Classification title bars. Since we won't be using this function, ignore it. But, its purpose is to establish training sites for use with a classifier (e.g., Miminum Distance) not a part of PIT but one that can be used in some other processing software package or with a classifier that can be imported to PIT. Also, under the Image button is an option called Palette. We will not use this either, but it refers to the use of a color palette image control. There are several other functions and procedures on PIT that, again, will not be integral to this training exercise. You can learn something about most of these by scanning through the Help explanation.

(21.) The last thing you will want to add to your PIT skills is the ability to save your work. From the PIT window menu bar, click on the PIT button and select "Save As..." from the drop-down menu. A dialog box will appear. Navigate the the PITimages folder (most likely by clicking "Parent Directory" and then double-clicking on PITimage in the new list of files displayed). In the "File:" field type in the name of a file with a ".pit" extension and then click Save. This will save your current PIT session to that file (called a PIT file). A PIT file contains the image you were working on, the image controls selected, classes created, and all of your interpretations. Now, to see it, let's suppose you want to check out the PIT - Interpretation group of training cells you diligently selected earlier. And let's assume you had exited the entire PIT program (after saving the PIT file!). Get back into PIT from scratch. Hit the PIT button on the left end of the title bar. Then on Open. A Select a PIT File window appears. Enter the PITimages directory in the Dir. Box and then insert the file name you chose (can access it through Parent Directory, and it will show up on a list [click on the file desired and it enters automatically; if you remember its name, just type it in) and press Enter. It is now in active memory. To see the training site display image, from the PIT bar, click on Window - Open - Interpretation - Left Scheme, as you've done before, and yesterday's work reappears. You can also save the results of a classification as a GIF file. To do so click the View button on the menu bar of the Classification window and select "Save As - GIF..." from the drop-down menu. You will be prompted for the name of the GIF file to save.

Conclusion

SO, WE'VE COME TO THE END OF THIS TRAINING SESSION. And, almost to the end of the Tutorial. But there is more that you can do. A complete 7 TM band set for Morro Bay, California, that you encountered in Section 1 as an introduction to Landsat imagery and to image processing is included in the PIT package; so is the set covering the Waterpocket Fold in Utah. Review Sections 1 and 2 to remind yourself of the image content and the classes established for each scene. Then, treat them as unknowns and do your own classification (use the same classes or define new ones). See how well the different PIT classifiers perform compared to the Idrisi classifiers. Be adventuresome and run unsupervised as well as supervised versions. There is still another TM image set, the NB series, in the PITimage collection, which pictures a plateau-like terrain in some part of the Colorado Plateau in Utah. It is quite bland and not very interesting but you may want to play with it. Finally, there may be in the collection an AVHRR and a GOES image if they become available before the CD-ROM you are using is produced. Use your imagination in processing these if they are part of the collection. (Keep in mind that the number of theirbands is not the same as the TM sets, and image size is different [PIT automatically reads the columns and rows as indicated by a number array other than 512 x 512.])

HAVE FUN!!