ROCKIT 1.1B2

Beta Version

WINDOWS™ Operating System
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Contents

System requirements & notes

This version of ROCKIT should run on all PC models running Microsoft Windows operating systems from Windows95™ to later versions (e.g., Windows 2000™ or XP™). (Please see special notes 5 and 6 and troubleshooting points 1 and 2 if you have a different Operating System.) Note that this software is experimental and should be used carefully. We do not assume any responsibility for any damages incurred because of the use of this software. However, the software was tested and we provide free support for it (roc@bsd.uchicago.edu).
Matrix input is not recommended because it is not working properly.

System requirements

- A PC equipped with an 80286 or later processor.
- Windows95™ or later version of WINDOWS™ operating system.

Request for feedback

- ROCKIT 1.1B2 is a Beta Version of this software. Although we have tested this software extensively and fixed all of the "bugs" discovered by our expert program crasher, there is no guarantee that we have squashed every "bug." If you discover any possible errors or anomalies in the user interface, please contact us immediately so that we may fix the problem. Our address appears also in the *Acknowledgments* section below (page 7).

- Feedback is especially important because we hope to release a new version of ROCKIT in the near future.

An overview of ROCKIT

ROCKIT combines previous University of Chicago software for ROC analysis into a single, integrated package and includes additional features, such as the ability to analyze partially-paired datasets. ROCKIT is designed to fit conventional binormal ROC curves to both continuously-distributed and ordinal category (e.g., "confidence-rating") diagnostic test results. It should handle up to 10,000 positive and 10,000 negative cases if data are entered on a case by case basis or ratings in up to 20 categories if data is entered in matrix form.

Purposes of ROCKIT

(1) To calculate maximum-likelihood estimates of the parameters "a" and "b" of a conventional "binormal" model for the input data (see reference 1, on page 48, and comments at item 10, on page 37, for a description of the conventional "binormal" model;)

(2) to calculate maximum-likelihood estimates of the parameters of a "bivariate binormal" model for data from two potentially correlated diagnostic tests and, thus, to estimate the binormal ROC curves implied by those data and their correlation (see reference 9, on page 48;)

and

(3) to calculate the statistical significance of the difference between two ROC curve estimates according to any one of three distinct statistical tests (see reference, 8 on page 48:)

(i) The **Bivariate Test:** A bivariate Chi-square test of the simultaneous differences between the "a" parameters and between the "b" parameters of the two ROC curves. (*Null hypothesis*: the datasets arose from the same binormal ROC curve.)

(ii) The **Area Test:** A univariate z-score test of the difference between the areas under the two ROC curves. (*Null hypothesis*: the datasets arose from binormal ROC curves with equal areas beneath them.)

(iii) The **TFP Test:** A univariate z-score test of the difference between the true-positive fractions (TPFs) on the two ROC curves at a selected false-positive fraction (FPF). (*Null hypothesis*: the datasets arose from binormal ROC curves having the same TPF at the selected FPF.)

Accepted types of input data for testing differences

Three types of input data are allowed when testing the statistical significance of the differences between ROC curve estimates:

(1) Unpaired (uncorrelated) test results. The two "conditions" are applied to independent case samples — for example, from two different diagnostic tests performed on different patients, from two different radiologists who make probability judgments concerning the presence of a specified disease in different images, etc.;

(2) Fully paired (correlated) test results, in which data from both of two conditions are available for each case in a single case sample. The two "conditions" in each test-

result pair could correspond, for example, to two different diagnostic tests performed on the same patients, to two different radiologists who make probability judgments concerning the presence of a specified disease in the same images, etc.; and

(3) Partially-paired (correlated) test results — for example, two different diagnostic tests performed on the same patient sample and on some additional patients who received only one or another of the diagnostic tests.

Warnings and notes about the ROCKIT algorithm

Note:

The input data must not include more than one test result from each case for each condition. If multiple test results from a single case-condition combination are pooled in the input, the program will overestimate the statistical significance of any apparent difference between the ROC curves, thereby invalidating the statistical test. When multiple test-result pairs are available from each case (for example, from replication in each condition), the datasets should be run separately (for example, for each replication) or our LABMRMC software should be used instead.

ROCKIT assumes that the population ROC curve for each condition plots as a straight line on "normal-deviate" axes, or equivalently, that the input data follow normal distributions after some unknown monotonic transformation (see reference 1, on page 48). ROC curves measured in a broad variety of fields demonstrate this "binormal" form (references 2-4, on page 48). This assumption is often acceptable even when the raw data have multimodal and/or skewed distributions, because it is equivalent to assuming that some variable functionally related to the one measured in the experiment is normal for both distributions.

In a preliminary step, ROCKIT automatically categorizes continuously-distributed input data for each "condition" (see note 3, on page 46) in an attempt to produce a useful spread of operating points on each ROC curve (reference 5, on page 48). The categorical datasets created in this way for each condition are then analyzed independently by a modified Dorfman program (references 6 and 7, on page 48) to obtain maximum-likelihood (or quasi-maximum-likelihood) estimates of the conventional binormal "intercept," "slope," and "category-boundary" parameters separately for each ROC curve.

If the data are either paired or partially paired, the product-moment correlation coefficients are calculated directly from the bivariate categorical-data matrices for actually-negative and actually-positive cases and are then used as initial estimates by ROCKIT to compute (by the method of scoring, described in reference, 6, on page 48) maximum-likelihood estimates of the parameters of the bivariate-binormal model that is assumed to underlie the correlated test results. The bivariate-binormal model and the statistical tests that ROCKIT performs are described in references 8 and 9, on page 48.

Acknowledgments

The algorithms employed by ROCKIT were designed by Charles E. Metz, Benjamin A. Herman, Jong-Her Shen, Helen B. Kronman, and Pu-Lan Wang. The ROCKIT program was written by Benjamin A. Herman with contributions from Jong-Her Shen, Helen B. Kronman, and Pu-Lan Wang. Cheryl Roe contributed substantially to the tasks of debugging ROCKIT and revising an earlier version of this user's guide. The current version of this user's guide was revised substantially by Lorenzo Pesce.

Development of this software was supported by the U.S. Department of Energy under contracts DE-AC02-80EV10359 and DE-AC02-82ER60033 and under grant DE-FG02-86ER60418. The subroutines "estm1" and "doralf" and the subroutines that they call were taken (with some modification) from the program "RSCORE II" by Donald D. Dorfman, Department of Psychology and Radiology, The University of Iowa.

Disclaimer & licensing agreement

Inquiries or comments concerning this program should be directed to:

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To run ROCKIT…

To start

⇒ Open the "ROCKIT" application by double-clicking on its icon (Be sure to have open the folder in which the icon is located. Standard installations have the icon on the Desktop.)

Notes:

- ROCKIT uses a prompt-driven interface not unlike the old DOS interfaces. However, a partial Graphical User Interface (GUI) has been added for "Menus" and "Dialog Boxes," in an effort to make the program more user-friendly.
- You can control ROCKIT by using:
    - the **prompt driven interface**, to control the operations specific to ROCKIT; and
    - the **menu bar**, for standard operations common to most WINDOWS applications

When you initiate execution of the program, in the prompt driven interface you will see the question:

"Do you want to use data from a previously created input file for the next run?
(y/n or q to quit)".

At this stage you can either use the menu bar or begin typing in the prompt driven interface.

How to use the prompt driven interface

Type an appropriate response for each prompt and hit the "↵ Enter" ("Return") key.

Use of the prompt driven interface is described in detail in the chapter entitled "Input and output options".

⇒ *After any prompt, you can quit ROCKIT by selecting "Quit" from the file menu of the menu bar.*

How to use the menu bar

Here we describe the options available through the menu bar on top of the ROCKIT window.

Figure 1. ROCKIT File Menu

The **File** Menu has 5 options.

Save:

Saves the contents of the output window [including scrolled text] to a file named "ROCKIT output."

⇒ *Note*: This is not the same as creating an output file. (See "

⇒ Output options" and "Description of output" below.)

Save As...:

Brings up a standard "Save As…" dialog box so that you can name the file. Otherwise, this is the same as the Save command. (See "*Note*" immediately above.)

Print...:

If no selection has been made in the window, then the entire contents of the output window [including scrolled text] are sent to the default printer. If a selection has been made, then only the selected text is sent to the printer.

About:

Displays information about the program/ compiler.

Exit:

Quits the program.

The standard **Edit** Menu has 5 options, 4 of which may be used in ROCKIT

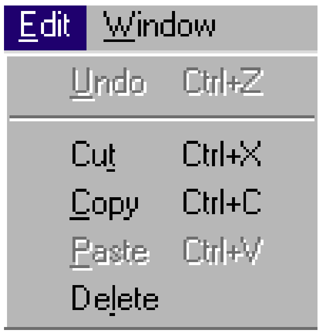

Figure 2. ROCKIT Edit Menu

Undo: **Unused**

Cut:
Cuts the selection and puts it onto the clipboard.

Copy:
Copies the selected text to the clipboard.

Paste:
Pastes the text on the clipboard into the output window at the current insertion point. This item will remain grayed if the insertion point is not at the end of the output text.

Delete:
Delete the selected text.

Notes:

⇒ Because of the way FORTRAN reads in data, only one line of input may be pasted in at a time.

⇒ The clipboard is limited to the ROCKIT window

⇒ Edit selections will remain grayed if no text has been selected or saved on the clipboard.

The standard **Window** Menu

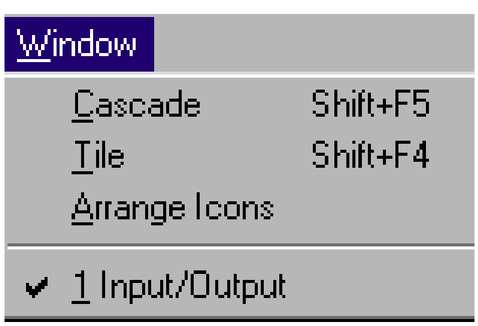

Figure 3. ROCKIT Window Menu

This menu allows you to arrange all of your open program windows in either Cascade or Tile format.

Input and output options

Input options

When ROCKIT starts, the following should appear in the prompt driven interface or dialog window (although there might be slight differences depending upon the version you are using):

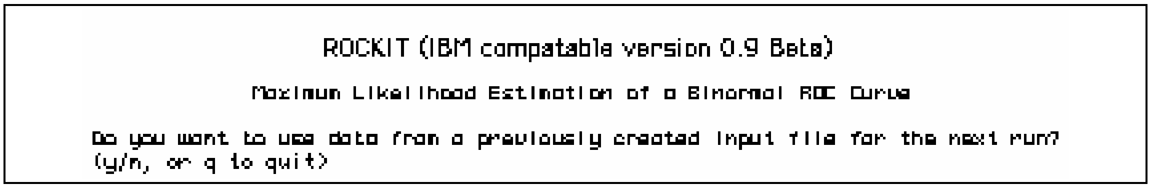

Figure 4. ROCKIT startup screen

As the question suggests, you can input data in either of two ways:

(a) From a previously created input data file *(recommended method)*;

or

(b) From the keyboard in response to screen prompts. With this option, the program allows you to save the input data in a file that can be reused or modified.

To input data from a previously created file

- Respond "yes" to the prompt in the previous picture; then hit the "↵Enter" ("Return") key.
- When a standard dialog box for locating and opening files appears:

— navigate to the folder in which the input file you want to run is located; and

— open the file by double-clicking on its name, or clicking on the "Open" button.

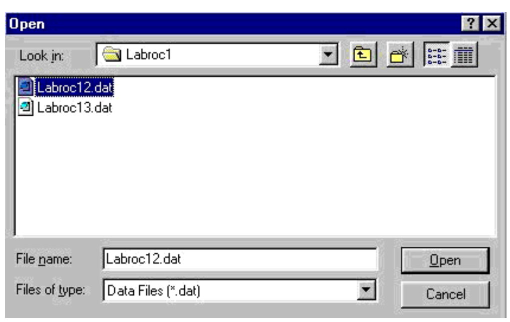

Figure 5. Dialog box for locating and opening files

⇒ *Clicking "Cancel" in the dialog box causes ROCKIT to repeat the previous screen prompt so you can change (or repeat) your answer.*

To input data from the keyboard

- Respond "no" (and hit the "↵Enter" ("Return") key) after the prompt that asks if you want to use data from a previously created input file (see first figure of this section above).
- Respond appropriately to the screen prompts that will to appear (please see section "Keyboard input description".)
- The program checks automatically for a number of possible inconsistencies in the entered data. Screen messages will inform you of any such inconsistencies.
- Remember that entering data by typing the input directly in response to prompts is prone to errors, so this input method is not recommended. Moreover, a mistake made during keyboard input often requires that **the entire input sequence must be redone**. Keyboard input has been allowed for completeness and simplicity, but its use is strongly discouraged.

```
                    ROCKIT (IBM compatable version 0.9 Beta)

              Maximum Likelihood Estimation of a Binormal ROC Curve

Do you want to use data from a previously created input file for the next run?
(y/n, or q to quit)
n
Do you want to create a file to store the data you will input?
(y/n, or r to restart)
n
 Do you want a (F)ull, (C)oncise or (N)o OUTPUT file?
n
 Do you want (F)ull or (C)oncise Screen output?
f
1 { Enter data description (up to 60 characters including blanks):
This is an Example of Keyboard Input


2 {  With Rating-Data Matrices, at most 2 datasets can be entered.
 Otherwise, up to 5 datasets may be input

 How many data sets do you wish to enter (1-5)?
2
                                                    |------------|
3 {  Enter Description for Condition 1: (12 chars max) Test 1 Exmpl
 Enter Description for Condition 2: (12 chars max) Test 2 Exmpl

           You are entering 2 datasets

4 {       1              2
 est 1 Exmpl  Test 2 Exmpl
 ou may analyze up to 2 of the 2 datasets

 ou may compute ROC estimates
     for a single dataset,
     for 1 pair of datasets, or
     for all possible pairs of the 2 datasets.

 t the following prompt:
  For either a single dataset or a pair of datasets,
    enter the number of the first dataset to be analyzed.
  To analyze all possible dataset pairs enter all.

    irst dataset to analyze is # (1-2; all): 1

5 {  To analyze a single dataset (1): enter 0 for the next question.
 To analyze a pair of datasets:
    enter the number of the second dataset to be analyzed

    Second dataset to analyze is # (0; 1-2 ): 2

 ----------------------
     CONDITION  1
 ----------------------
6 {  Are the data for condition 1 collected on a
(D)iscrete rating or (C)ontinuous interval scale (D or C)?:
D
7 {  Is category (1) or (N) indicative of Actually-Positive cases (1 or N)?:
N
8 {  Data from BOTH tests must be entered in the SAME format.
 Will you be entering the data in (M)atrix or (L)ist form?
L

 ----------------------
     CONDITION  2
 ----------------------
 Are the data for condition 2 collected on a
(D)iscrete rating or (C)ontinuous interval scale (D or C)?:
C
 Are (L)arge or (S)mall values indicative of Actually-Positive cases (L or S)?:
L


9 {  n one line for each actually-negative case, enter the test result
 for the first-condition, one or more blanks, and then the test result
 or the next-condition, etc.
 se a "#" to represent any missing data.

 after the last actually-negative test-result has been entered,
 input an asterisk (*) in response to the next prompt.)
    Actually-negative case #    1:
1        .25         ;;patient 001
    Actually-negative case #    2:
        75E-2        ;;patient 002
    Actually-negative case #    3:
        1.25         ;;patient 003
    Actually-negative case #    4:

     end of actually-negative cases ****
```

Figure 6. Example of keyboard input. The numbers to the left refer to section numbers in the “Keyboard input description” subsection of the “Required input” chapter. The meaning of each number is described there.

To create a file that will save keyboard input

- Respond “yes” /”y” to the screen prompt that asks whether you want this option.

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                         ROCKIT (IBM compatable version 0.9 Beta)

                  Maximum Likelihood Estimation of a Binormal ROC Curve

Do you want to use data from a previously created input file for the next run?
(y/n, or q to quit)
n
Do you want to create a file to store the data you will input?
(y/n, or r to restart)
y
```

Figure 7. Prompt for saving Keyboard input

- When the standard “Save As…” dialog box appears:
  - — navigate to the folder in which you want the input file saved (in our example “Labroc1”);
  - — type a name for the new input file; and
  - — click on the “Save” button or hit the “↵Enter” (“Return”) key to save the file.

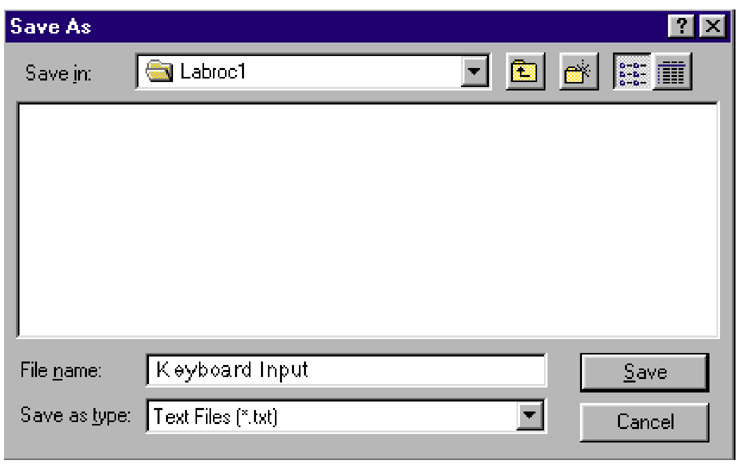

Figure 8. "Save As" for keyboard input as input file

⇒ Alternatively, you can create an input file with any program that allows you to save the necessary information (see “Required input” below) as a “MS-DOS Text with Layout” or “TEXT(MS-DOS)” document (e.g., Microsoft Word and Excel, respectively). Remember that ROCKIT is an MS-DOS program at its core, and often needs old MS DOS settings. The information that the input file must contain on each line is described under “Required input,” below. Each input-file document must be *closed* by your editing program before it can be opened by ROCKIT. (See “Using other programs to create input files,” below.)

Output options

You can generate output in any (or all) of the following ways:

(a) by creating an output file *(recommended method)*;

(b) by sending the text in the output window or a selection of text from the output window to a printer;

or

(c) by sending the text in the output window or a selection of text from the output window to a file.

⇒ Two types of output are available from ROCKIT: Full and Concise. Full output contains some additional information, such as the variance-covariance and correlation matrices. (See chapter "Description of output" below for complete details.) Concise output contains only a subset of the full output. Either type of output can be selected for screen output and the output file.

⇒ Some of ROCKIT's output may not be displayed in the output window (see note in "To send contents of the output window to a printer or a file" section below). However, if you create a Full output file, (*a*) above, it will contain all of ROCKIT's output. (See "Description of output" below for more details.)

⇒ Only some of ROCKIT's **input** will be saved in the output *file*. The output *window* will contain all of ROCKIT's prompts and all of the text input through the keyboard, and therefore can be useful as a complete record of the information entered into the program. Printing the output window is similar to "Echo Printing" in DOS, where everything that appears on the screen is sent to the printer. Note, however, that this echo information is not sent directly to a *created* output file. Created output files contain only the information that is listed in the "Description of output" section below.

To create an output file

- Decide which type of output you require (for most purposes it will be concise) and respond “Full” or “Concise” to the screen prompt that asks which type of output file you would like.

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                    ROCKIT  (IBM compatable version 0.9 Beta)

              Maximum Likelihood Estimation of a Binormal ROC Curve

Do you want to use data from a previously created input file for the next run?
(y/n, or q to quit)
n
Do you want to create a file to store the data you will input?
(y/n, or r to restart)
n
 Do you want a (F)ull, (C)oncise or (N)o OUTPUT file?
F
```

Figure 9. Prompt for Output file

- When a standard “Save As…” dialog box appears:

— navigate to the folder in which you want the output file saved;

— type a name for the new output file; and

— click on the “Save” button or hit the “↵Enter” (“Return”) key to save the file.

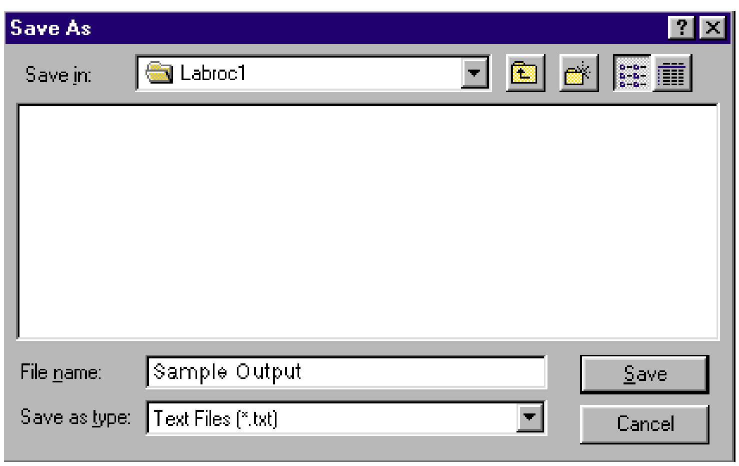


Figure 10. Example of “Save as” dialog box for output files. The example here specifically refers to an example where an output file named “Sample Output” was saved in the folder “Labroc1”. See text above for explanation.

To send contents of the output window to a printer or a file

- Respond “Full” or “Concise” to the screen prompt that asks which type of screen output you would like (as shown in the last line of the following figure).

```
                   ROCKIT (IBM compatable version 0.9 Beta)

             Maximum Likelihood Estimation of a Binormal ROC Curve

Do you want to use data from a previously created input file for the next run?
(y/n, or q to quit)
n
Do you want to create a file to store the data you will input?
(y/n, or r to restart)
n
 Do you want a (F)ull, (C)oncise or (N)o OUTPUT file?
F
 Do you want (F)ull or (C)oncise Screen output?
C
```

Figure 11. Prompt for full or concise screen output

- Perform the ROC analysis as usual. Output will be stored in the output window.
- To send all of the information in the output window to the printer:
  - — select “Print” from the File Menu of the menu bar;
  - — in the “Print” dialog box that will pop up select “All” in the “Page Range” menu box
  - — fill out the rest of the standard “Print” dialog Box; and
  - — click on the “Print” button or hit the “↵Enter” (“Return”) key to print the output.

<***CONTINUEDON NEXT PAGE***>

- To save all of the information in the output window to a file:
  — select "Save as…" from the File Menu;
  — navigate to the folder in which you want the output saved;
  — type a name for the new file; and
  — click on the "Save" button or hit the "↵Enter" ("Return") key to save the file.

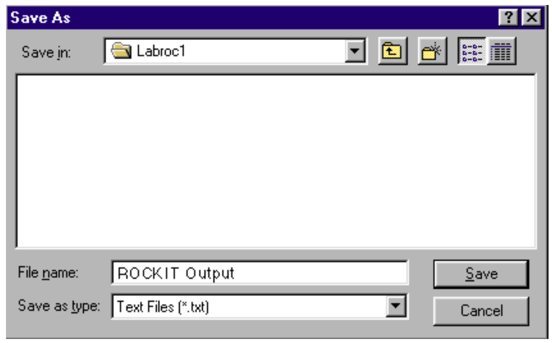


Figure 12. "Save as" for Output window content

- To print a selection from the output window (NOTE: this may not work on all systems):
  — select the text you wish to print from the dialog window; then
  — choose "Print" from the File Menu in the menu bar;
  — choose "Selection" in the "Page Range" menu box;
  — fill out the remaining part of "Print" dialog Box; and
  — click on the "Print" button or hit the "↵Enter" ("Return") key to print the selection.

  ⇒ *If you want to run another dataset after you print a selection, then you must click after the last line in the output window. Otherwise, the computer will generate an error indicating that you cannot edit the text in the output window.*

⇒ ***Please note**: ROCKIT uses toolbox routines which allow only 32K of data to be saved in the "scroll back buffer." This means that you can only scroll back to approximately the last 900 lines of text displayed in the output window. Unfortunately, with some datasets, and especially with keyboard input of large datasets, this may be only a fraction of the full output. Therefore, if you wish to print the entire output of a session it is highly recommended that you create an output file and then use your favorite word processor to inspect the file.*

Editing input and output files

The input and output files that ROCKIT creates are standard "MS-DOS TEXT" files, which you can inspect and/or edit with virtually any **word-processor** (e.g., "Word" or "Word Perfect").

- To inspect and/or edit an input or output file:
  - — open your word-processor; and then
  - — open the input or output file from the word-processor menu.

  ⇒ At least with Microsoft Word, the style (e.g., line spacing, margin settings, font, and font size) in which the input or output file is displayed can be modified by defining an appropriate "Normal" style within Word's "Define Styles…" or "Styles..." dialog box under the "Format" menu.

- If you edit an input file for subsequent use by ROCKIT or edit an output file for subsequent use by curve-plotting or statistical-analysis software, make sure that you save it in an appropriate format. The most appropriate format for ROCKIT and many other applications is "MS-DOS TEXT", "MS-DOS TEXT with Layout", "TEXT-ONLY" or similar formats depending upon your word processor and the version of windows that you are using. (Some trial and error may be required to find the correct format for your system). Microsoft Word sets its default "Save As…" format to the appropriate kind if the input file was in that format when it was opened.

- When it is necessary to edit a ROCKIT file and then return to ROCKIT:
  - — open your editing application (for most purposes this would be a word processor);
  - — open the desired ROCKIT input or output file by selecting the "Open" command under your editing program's "File" menu;
  - — *close* the file after inspecting and/or editing it (ROCKIT will not be able to open an input file unless it was closed by your editing application); and
  - — then switch to ROCKIT either by selecting the ROCKIT window or by opening it, if you closed it.

Required input

Keyboard input description

Keyboard input is a cumbersome, error-prone method for entering data. While we have attempted to provide comprehensive integrity checking, it is impossible for the program to test for all possible types of errors. In particular, user errors such as transposition of numbers, mixed up columnar entry, and simple blunders in typing are virtually impossible for the program to detect. In an effort to reduce these errors, ROCKIT's keyboard input routines use extensive prompting to tell you which case you are currently entering. However, please note that ROCKIT may not be able to determine whether there has been a data-entry error until **all** of the cases have been entered. When this happens, **all** of the cases must be re-entered. It is usually much easier to use a word-processor or a spreadsheet program to create an input file, which you can then check before you "give" it to the program. (See "Input file description" later in this section.)

(See page 13 for an example of keyboard input.)

This section describes how to respond to the particular prompts that follow the more general prompts described in the chapter "To run ROCKIT…." (Please see the example at page 13 to locate these input lines).

This section is divided into three subsections:
First the input that is required to describe the datasets: "Dataset description"

And then two sections that describe two alternative paths, depending upon how the data will be entered:

"List data entry"

or

"Matrix data entry"

Dataset description

The numbers below represent input lines or groups of input lines and correspond to the numbers in the example on page 13.

1. A free-text description of the data you will input.
   - This description can include up to 60 characters, including any leading blanks.
   - This description allows you to easily identify the type of data you are entering. Moreover, if you have asked ROCKIT to create a file to save the data that you input, then this description will allow you to determine easily what data are in the file.

2. The number of datasets you wish to enter.
   - ROCKIT currently supports a maximum of 5 datasets entered in **list** format
   - ROCKIT currently supports a maximum of 2 datasets entered in **matrix** format

3. A brief description of each dataset.
   - Each description can include up to 12 characters.
   - A convenient 12-character ruler ("|----------|") is included in the screen prompts to ease keyboard entry.

4. An opportunity to indicate which datasets you wish to analyze or the number of the particular dataset you want to start with.
   - The number of each dataset will be displayed with the previously-entered description immediately below the prompt.
   - ROCKIT can compute ROC estimates for a single dataset, for a single pair of datasets, or for all possible pairs of datasets.
   - Entering "all" will automatically analyze all dataset pairs that can be generated with the datasets that you entered and will supersede item 5 below[1].

5. (Normally not asked) The number of the second dataset you wish to analyze
   - If "all" was entered above, this question will **not** be asked and the corresponding input will not be required.
   - Entering either 0 or the same value as entered in step 4 above will cause ROCKIT to analyze only the single dataset whose number was entered at step 4.
   - Entering a different number from step 4 will result in the analysis (see reference 9, on page 48) of these 2 datasets.

[1]Users may sometimes consider entering the number of the first dataset they wish to analyze here. Since this is keyboard driven input, it does not make much sense to enter multiple datasets and then analyze only 1 or 2. However, this feature is meaningful when using an input file where one has multiple datasets in the file but wants to analyze only 1 or 2 of those datasets. Thus, the most common answer for this prompt is "all" when you input your data directly from the keyboard.

6. Enter "D" or "C" to indicate whether discrete or continuous data are to be entered for this condition. (Only discrete data can be entered for matrix data entry format, so the answer you give here is not relevant if you choose matrix data entry format in step 8 below)

7. An indication of which types of values most likely represent actually-positive cases
   - For continuous data, enter either "L" or "S" to indicate that larger or smaller values represent positivity (e.g., higher probability of presence of disease).
   - For discrete data, enter the category number (either "1" or "N") that represents positivity (e.g., "certain or almost certain presence of the disease").

8. Enter the alphabetic code word "L" or "M" to indicate whether the data you enter will be in list or matrix format.
   - If more than 2 datasets are to be entered or if continuous data are being entered (item 6 above), then this question will not be asked and the data must be entered in List data entry format
   - ROCKIT can accept either Matrix or List input but cannot accept a mix of the 2 types of input across conditions. Therefore, this question will be asked only for the first condition, and all other conditions must follow the same format.

⇒ ***Note**: Items 6 and 7 above will be repeated for each condition, whereas item 8 will be requested only for the first condition and only if there are 1 or 2 conditions*

.

As already stated, we are now going to split the description of the prompts which follow. This is done because the prompts are different if one chooses list or matrix data entry input formats. Please follow the path more appropriate for your datasets.

In general, list data entry format is more powerful and often more convenient.

To use list data entry with categorical data (which is necessary with more than 2 datasets and/or more than 20 categories), all the cases belonging to the same category are entered as tied values in a list data entry format (for example, each case with a response in category 5 will be input independently with the value "5." Each category will be treated equivalently, matching categories with numbers: i.e., all cases rated in category 1 will get a 1; all cases rated in category 2 will get a 2, and so forth. Please see "*List data entry*" if this data input method is not clear to you.)

List data entry

The numbers below represent input lines or groups of input lines and correspond to the numbers in the example on page 13 for points 1-8, and to the example on page 24 for points 9 and 10). Bullets below represent the description of those input lines.

1-8. See Above

9. A sequence of test-result values for actually-negative (e.g., "actually normal") cases.

   - On a line for each actually-negative case, enter the test result for condition 1, one or more blank spaces, the test result for condition 2, etc. Data from up to 5 conditions can be entered. If no test result is available for a given condition enter a "#" instead. *Optionally*, these test results can be followed by one or more blank spaces and then a brief free-text description of the case. (See Figure 13 on page 24 for an example)
   - Each continuous test-result value can include up to 6 digits to the left of the decimal point (in addition to a "+" or "-" sign) and up to 6 digits to the right.
   - Each categorical (discrete rating) test-result value can range from 1 to 20. Numbers larger than 20 can be entered if the data have been collected on a scale with more than 20 categories. However, in that situation ROCKIT will treat the data as if they were continuous data with many tied values and therefore will reduce the number of categories automatically to 10 or 20, depending upon the number of cases entered (see item 3, on page 46.)
   - Up to 5000 actually-negative cases can be entered for each condition.
   - Input of actually-negative cases must be terminated by a final line containing an asterisk (*) as its first character.

10. A sequence of test-result values for actually-positive (e.g., "actually diseased or abnormal") cases.

    - The input format is the same as that for actually-negative cases.
    - Up to 5000 actually-positive cases can be entered for each condition.
    - Again, the input sequence must be terminated by a final line of free text containing an asterisk (*) as its first character.

11. The desired statistical test (see page 5) if two or more datasets have been entered. (This point is not included in the figure in the following page.)

⇒ It is crucially important to note that this program is **not** appropriate for pooled test-result values (see note on page 6).

9

```
(on one line for each actually-negative case, enter the
test result for the first-condition, one or more blanks,
and then the test result for the next-condition, etc.
 Use a "#" to represent any missing data.

After the last actually-negative test-result has been
entered, input an asterisk (*) in response to the next
prompt.)

    Actually-negative case #    1:
1.0  .25    ;; patient 001
    Actually-negative case #    2:
#    75E-2  ;; patient 002
    Actually-negative case #    3:
6.0  1.25   ;; patient 003
    Actually-negative case #    4:
*
**** end of actually-negative cases ****
```

10

```
(on one line for each actually-positive case, enter the
test result for the first-condition, one or more blanks,
and then the test result for the next-condition, etc.
Use a "#" to represent any missing data.

After the last actually-positive test-result has been
entered, input an asterisk (*) in response to the next
prompt.)

    Actually-positive case #    1:
#    .50    ;; patient 004
    Actually-positive case #    2:
1.4  .35    ;; patient 005
    Actually-positive case #    3:
3.0  1.50   ;; patient 006
    Actually-positive case #    4:
*

  *** end of actually-positive cases ***
```

Figure 13. Example of keyboard list data entry. The numbers to the left refer to section numbers of the "List Data Entry" section. Check there for a more extensive description of their meaning. Point 11 of the description is not included.

Matrix data entry

1-8. See Above. For the other points, please see the figure at the bottom of this page

12. The total number of categories in the rating scale (3 to 20)

13. The total number of actually-negative (e.g., “actually normal”) cases.

14. The number of responses in each category for actually-negative cases.
    - On one line enter, the number of responses in each category (*integers only*).
    - Category numbers are printed for convenience.

15. The total number of actually-positive (e.g., “actually diseased”) cases.

16. The number of responses in each category for actually-negative cases.
    - On one line enter the number of responses in each category (*integers only*).
    - Category numbers are printed for convenience.

17. Desired statistical test (see page 5) if two datasets have been entered (Not shown)

⇒ ***Note**: Items 9 through 13 above will be repeated for each condition.*

⇒ *This program is **not** appropriate for pooled test-result values (see note on page 6).*

```
      ----------------------
          CONDITION  1
      ----------------------
6  {  Are the data for condition 1 collected on a
   { (D)iscrete rating or (C)ontinuous interval scale (D or C)?:
     d
7  {  Is category (1) or (N) indicative of Actually-Positive cases (1 or N)?:
     n
8  {  Data from BOTH tests must be entered in the SAME format.
   {  Will you be entering the data in (M)atrix or (L)ist form?
     m
9  {  How many categories does the discrete rating scale contain?: (3-20)
     13

      ----------------------
          CONDITION  2
      ----------------------
      MATRIX entry selected, so
       Data from ALL CONDITIONS are assumed to be collected on a Discrete Rating Scale.

7  {  Is category (1) or (N) indicative of Actually-Positive cases (1 or N)?:
     N
9  {  How many categories does the discrete rating scale contain?: (3-20)
     7

      For Condition   1: test 1
10 { Enter the Total Number of Actually-Negative Cases (an integer):
     7
      Beginning with category 1 and separated by blanks,
      Enter (on one line, integers only) the number of responses to Actually-
     Negative cases in each category:
11 {     1   2   3   4   5   6   7   8   9  10  11  12  13
         1   0   1   0   1   0   1   0   1   0   1   0   1

      For Condition   1: test 1
12 { Enter the Total Number of Actually-Positive Cases (an integer):
     12
      Beginning with category 1 and separated by blanks,
      Enter (on one line, integers only) the number of responses to Actually-
     Positive cases in each category:
13 {     1   2   3   4   5   6   7   8   9  10  11  12  13
         0   1   0   1   0   1   0   2   0   3   0   4   0
```

Figure 14. Example of matrix data entry format

Input file description

(Please see examples on pages 31 and 32 for input files created using Microsoft Word, or example on page 34 for input files created using Microsoft Excel)

Numbers represent input lines or groups of input lines, whereas Bullets represent the description of those input lines. See notes at the bottom of page 20 for a description of the structure of this section.

Dataset description

1. A free-text description of the input file (up to 60 characters, including any leading blanks).

   I. This description allows you to identify easily the type of data stored in the file. For example, if the current file contains information on a study of 4 different mammography CAD techniques, then this line might be:

      I. CAD comparison in mammo, 4 conditions

2. The code word KIT to identify the file as an ROCKIT file.

3. On one line, enter the names of all of the conditions, beginning with the first condition

   I. Each condition name must be enclosed in quotes (“”) and be less than 12 characters long.

   II. Spaces or tabs must separate each condition. (See sample input files on page 30.)

   III. A maximum of 5 conditions may be entered.

4. On one line enter an alphanumeric codeword for each condition, separated by one or more blank spaces, to indicate the parameters of the dataset (see the examples at the end of this point, next page, for clarity).

   I. The first character in each codeword is “C” for continuous data or “D” for discrete data

   II. The second character:

      I. For continuous data it is “S” if smaller values have highest likelihood to belong to actually-positive cases or “L” if larger values have highest likelihood to belong to actually-positive cases.

      II. For discrete data, it is “1” if smaller-numbered categories are associated with actually-positive cases or “N” if the higher-numbered categories are associated with actually-positive cases.

III. The third character in each codeword is “L” for list data or “M” for matrix data. If “L” is selected then no further values are required.

IV. Only if Matrix data entry format is used. The final characters are a 2-digit number indicating the total number of categories. This number can range from “01” to “20”.

Examples of alphanumeric codewords

1. Continuous data with larger values representing positivity must be entered as a list and would have the code word: CLL
2. Discrete data with higher-numbered category representing positivity and entered as a list would have the code word: DNL
3. Seven-category discrete data with category 1 representing positivity, entered as a matrix, would have the code word: D1M07

As already stated, we are now going to split the description of the prompts which follow. This is done because the prompts are different if one chooses list or matrix data entry input formats. Please follow the path more appropriate for your datasets.

In general, list data entry format is more powerful and often more convenient.

To use list data entry with categorical data (which is necessary with more than 2 datasets and/or more than 20 categories), all the cases belonging to the same category are entered as tied values in a list data entry format (for example, each case with a response in category 5 will be input independently with the value “5.” Each category will be treated equivalently, matching categories with numbers: i.e., all cases rated in category 1 will get a 1; all cases rated in category 2 will get a 2, and so forth. Please see “*List data entry****” if this data input method is not clear to you.)***

List data input file

5. A sequence of test-result values for actually-negative (e.g., ”actually disease-free” or “actually normal”) cases.

    - On a line for each actually-negative case, enter the test result for condition 1, one or more blank spaces, the test result for condition 2, etc. Data from up to 5 categories can be entered if no test-result is available for a given condition, then enter a “#” instead. *Optionally*, these test results can be followed by one or more blank spaces and then a brief free-text description of the case.
    - Each continuous test-result value can include up to 6 digits to the left of the decimal point (in addition to a “+” or “-” sign) and up to 6 digits to the right.
    - Each categorical (rating) test-result value can range from 1 to 20. If the data have been collected on a scale with more than 20 categories, please enter the data as if they were collected on a continuous scale.
    - Up to 5000 actually-negative cases can be entered for each condition.
    - Input of actually-negative cases must be terminated by a final line containing an asterisk (*) as its first character.

6. A sequence of test-result values for actually-positive (e.g., “actually diseased” or “abnormal”) cases.

    - The input format is the same as that for actually-negative cases.
    - Up to 5000 actually-positive cases can be entered for each condition.
    - Again, the input sequence must be terminated by a final line of free text containing an asterisk (*) as its first character and a return as its last character.

⇒ *It is crucially important to note that this program is* ***not*** *appropriate for pooled test-result values (see note on page 6).*

Matrix data input file

For the first (or only) condition:

5. The total number of actually-negative (e.g., "actually disease-free" or "actually normal") cases.

6. The number of responses in each category for actually-negative cases.

   - On one line enter, in the order of the category numbers, the number of responses in each category (*integers only*).

7. The total number of actually-positive (e.g., "actually diseased" or "abnormal") cases.

8. The number of responses in each category for actually-negative cases.

   - On one line enter, in the order of the category numbers, the number of responses in each category (*integers only*).

If you are entering independent data for 2 conditions, then repeat items 5 through 8 for the second condition (remember that no more than 2 conditions can be entered using matrix format)

> ⇒ *It is crucially important to note that this program is* ***not*** *appropriate for pooled test-result values (see note on page 6).*

Using other programs to create input files

Many programs can be used to create the input files as described above. However, it is essential that these programs save the input file in a text-only (word processor) or formatted-text (spreadsheet) format, and of a type compatible with MS-DOS. Although we shall mention only Microsoft Word and Excel in the examples below, most other such programs work in a similar fashion.

To create an input file using Microsoft Word

- Open Microsoft Word.
- Open a new document by selecting “New...” from the “File” Menu.
- Enter your data into the file according to the “Input file description” section on page 26 above.
- Save the file:
  - — select “Save As...” from the “File” Menu;
  - — In the “Save File as Type” pop-up menu choose “MS-DOS TEXT with Layout” or “Text Only” (the names will vary depending on the version of Windows and Word that you are using; in the worst case keep trying until one works);
  - — type the name you want to save the file as; and
  - — click on the “Save” button or hit the “↵Enter” (“Return”) key to save the file.

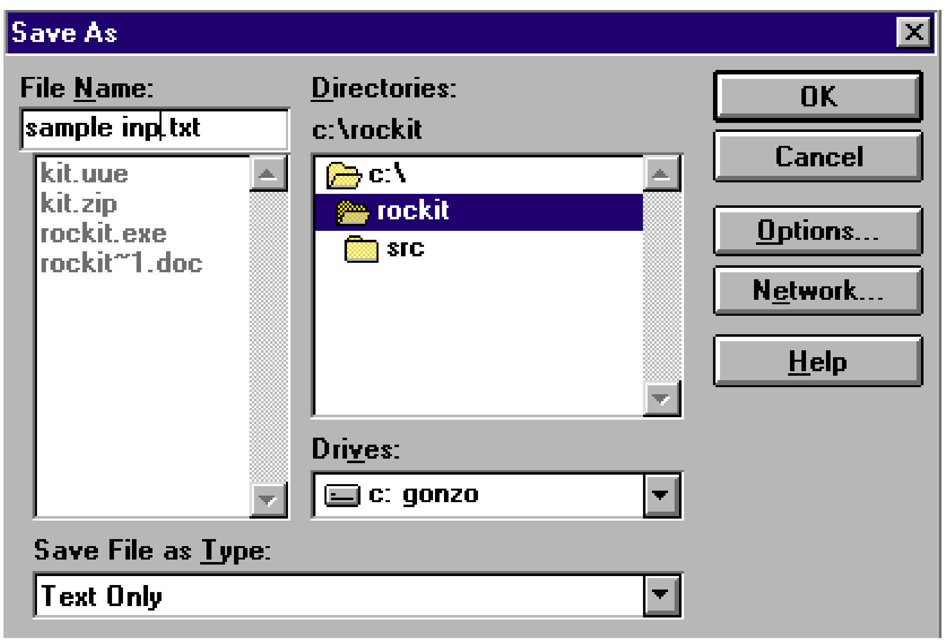
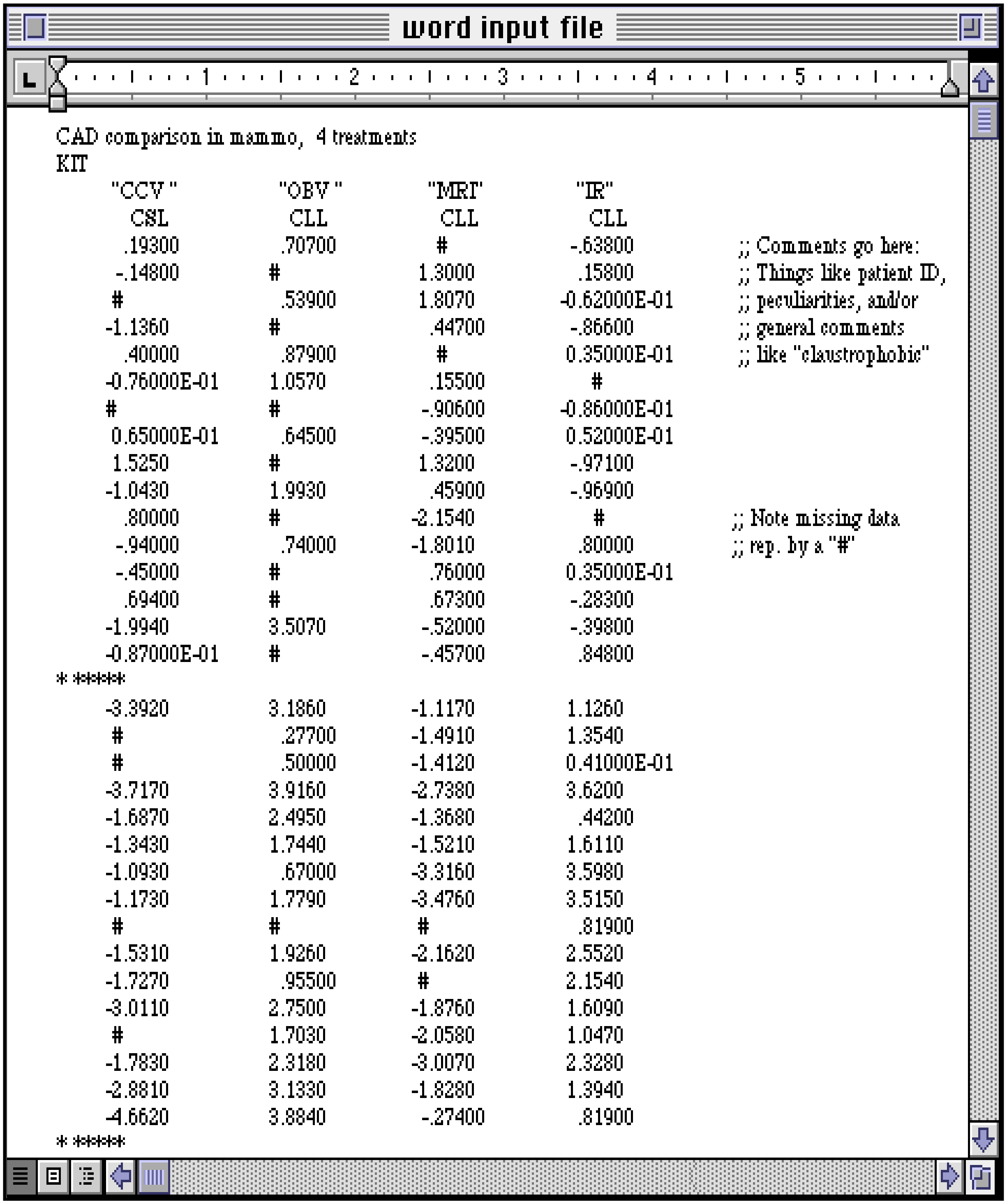


Figure 15. Save for input file created with Microsoft Windows



word input file

```
CAD comparison in mammo,  4 treatments
KIT
      "CCV"         "OBV"        "MRI"        "IR"
       CSL           CLL          CLL          CLL
      .19300        .70700         #         -.63800       ;; Comments go here:
      -.14800         #          1.3000       .15800       ;; Things like patient ID,
        #           .53900       1.8070     -0.62000E-01   ;; peculiarities, and/or
     -1.1360          #           .44700     -.86600       ;; general comments
      .40000        .87900         #         0.35000E-01   ;; like "claustrophobic"
    -0.76000E-01    1.0570        .15500        #
        #             #          -.90600    -0.86000E-01
     0.65000E-01    .64500       -.39500     0.52000E-01
      1.5250          #          1.3200      -.97100
     -1.0430        1.9930        .45900     -.96900
      .80000          #         -2.1540         #          ;; Note missing data
      -.94000       .74000      -1.8010       .80000       ;; rep. by a "#"
      -.45000         #           .76000     0.35000E-01
      .69400          #           .67300     -.28300
     -1.9940        3.5070       -.52000     -.39800
    -0.87000E-01      #          -.45700      .84800
* *****
     -3.3920        3.1860      -1.1170      1.1260
        #           .27700      -1.4910      1.3540
        #           .50000      -1.4120      0.41000E-01
     -3.7170        3.9160      -2.7380      3.6200
     -1.6870        2.4950      -1.3680       .44200
     -1.3430        1.7440      -1.5210      1.6110
     -1.0930        .67000      -3.3160      3.5980
     -1.1730        1.7790      -3.4760      3.5150
        #             #            #          .81900
     -1.5310        1.9260      -2.1620      2.5520
     -1.7270        .95500         #         2.1540
     -3.0110        2.7500      -1.8760      1.6090
        #           1.7030      -2.0580      1.0470
     -1.7830        2.3180      -3.0070      2.3280
     -2.8810        3.1330      -1.8280      1.3940
     -4.6620        3.8840       -.27400      .81900
* *****
```

Figure 16. Example of Microsoft Word list data entry input file

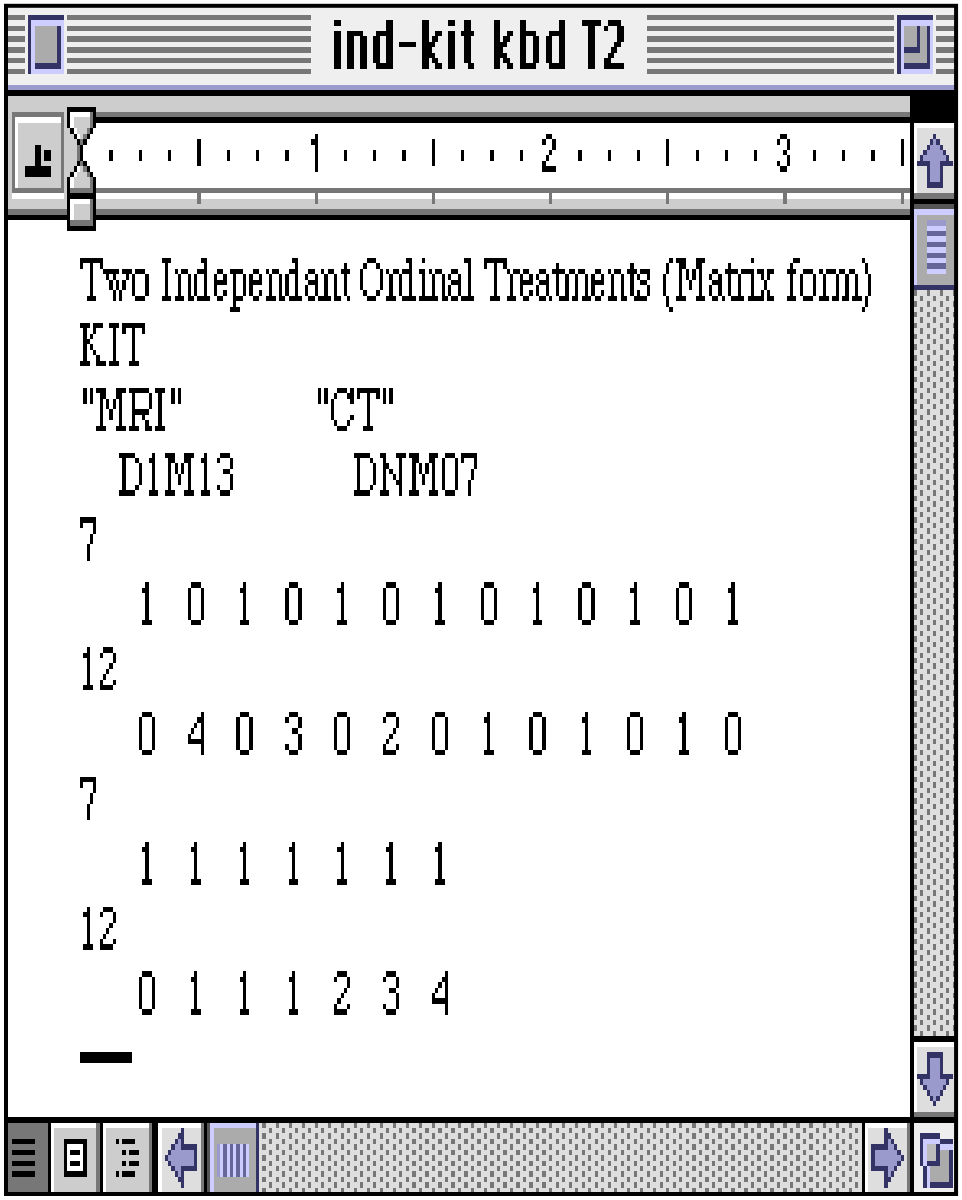


Figure 17. Example of Microsoft Word matrix data entry input file

To create an input file using Microsoft Excel

- Open Microsoft Excel.
- Open a new document by selecting "New..." from the "File" Menu.
- Enter your data into the file according to the "Input file description" section on page 26 above:
  - — Enter each condition in its own column.

    ⇒ Note: Excel does not automatically enclose text in quotes. Therefore you must enclose the condition descriptions in quotes and always save as "formatted text" or "TEXT(MS-DOS)" or some similar name, depending upon the version of Windows and Excel that you are using.
  - — Enter each case in its own row.

- Save the file:
  - — select "Save As..." from the "File" Menu;
  - — choose **"Formatted Text"** or "**TEXT(MS-DOS)**" in the "Save File as Type" pop-up menu (see comment at the previous point);
  - — type the name you want to save the file as; and
  - — click on the "Save" button or hit the "↵Enter" ("Return") key to save the file.

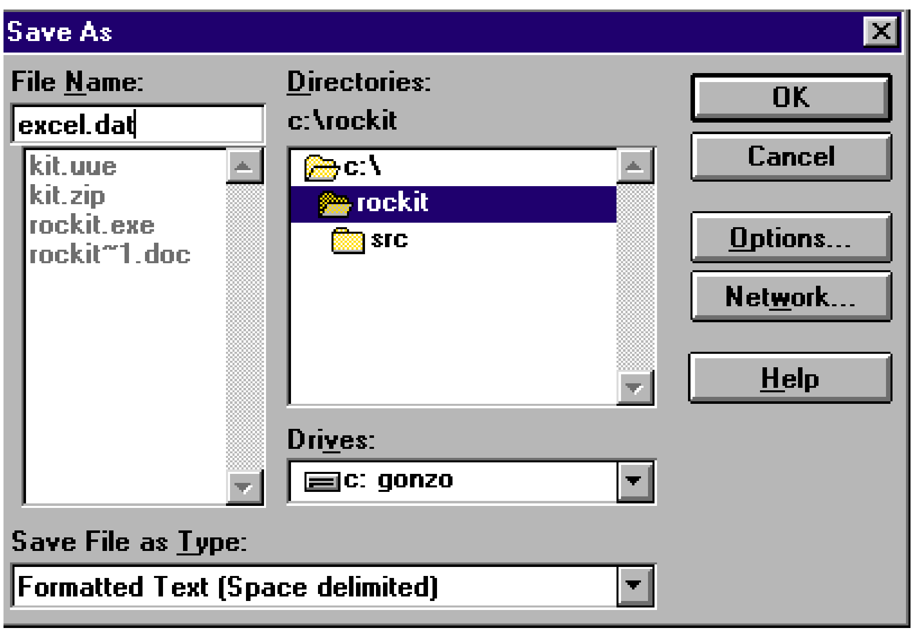


Figure 18. Save for input file created with Microsoft Excel

Excel input file

	A	B	C	D	E	F
1	CAD comparison in mammo, 4 treatments					
2	KIT					
3		"CCV"	"OBV"	"MRI"	"IR"	
4		CSL	CLL	CLL	CLL	
5		0.193	0.707	#	-0.638	;; Comments go here:
6		-0.148	#	1.300	0.158	;; Things like patient ID,
7		#	0.539	1.807	-0.062	;; peculiarities, and/or
8		-1.136	#	0.447	-0.866	;; general comments
9		0.400	0.879	#	0.035	;; like "claustrophobic"
10		-0.076	1.057	0.155		
11		#	#	-0.906	-0.086	
12		0.065	0.645	-0.395	0.052	
13		1.525	#	1.320	-0.971	
14		-1.043	1.993	0.459	-0.969	
15		0.800	#	-2.154	#	;; Note missing data
16		-0.940	0.740	-1.801	0.800	;; rep. by a "#"
17		-0.450	#	0.760	0.035	
18		0.694	#	0.673	-0.283	
19		-1.994	3.507	-0.520	-0.398	
20		-0.087	#	-0.457	0.848	
21	******					
22		-3.392	3.186	-1.117	1.126	
23		#	0.277	-1.491	1.354	
24		#	0.500	-1.412	0.041	
25		-3.717	3.916	-2.738	3.620	
26		-1.687	2.495	-1.368	0.442	
27		-1.343	1.744	-1.521	1.611	
28		-1.093	0.670	-3.316	3.598	
29		-1.173	1.779	-3.476	3.515	
30		#	#	#	0.819	
31		-1.531	1.926	-2.162	2.552	
32		-1.727	0.955	#	2.154	
33		-3.011	2.750	-1.876	1.609	
34		#	1.703	-2.058	1.047	
35		-1.783	2.318	-3.007	2.328	
36		-2.881	3.133	-1.828	1.394	
37		-4.662	3.884	-0.274	0.819	
38	******					

Excel input file

Figure 19. Microsoft Excel list data entry input file. Note the format of the comments on the rightmost column and the presence of the quotation marks, also note that the correct quotation marks are the same on the left and of the right of names (i.e., no “smart quotes”).

Description of output

```
1
  Continuous      Discrete
 Analyzing file comparing datasets 1 & 2
2*
                                                          Date - 16-Jan-98
                                                          Time - 13:48:29

                    ROCKIT (IBM compatable version 0.9 BETA)
              Maximum Likelihood Estimation of a Binormal ROC Curve
3*

                   From CONTINUOUSLY-Distributed Test Results

  for condition 1 :  Continuous

        -------------------------------------------------------
          Original input of   53 Actually-NEGATIVE cases
        -------------------------------------------------------

    .193        -.148       1.900       -1.136         .400
   -.076        1.294        .065        1.525       -1.043
    .800        -.940      -1.743        -.938         .417

        -------------------------------------------------------
          Original input of   49 Actually-POSITIVE cases
        -------------------------------------------------------

  -3.392        -.639       -.300       -3.717       -1.687
  -1.343        -.945      -1.003       -1.335       -4.730
  -1.093       -1.173        .382       -1.531       -1.727

                              from RATING Data

  for condition 2 : Discrete

     Original Categorical Response Data:

       With category runs collapsed.
      Category                    1     2     3     4     5
      Actually-Negative Cases    22    19     6     4     2
      Actually-Positive Cases     4     6     3     7    29
```

Figure 20. Description of output: run and dataset data

Run and dataset data

1. Description of the datasets analyzed, followed by a comment indicating which dataset numbers correspond to those descriptions.

2*. The date and time of the run, followed by a standard banner indicating which version of the program was executed.

3*. Heading indicating whether "Continuously distributed" or "Rating" data were entered, then the "condition number" (1 or 2) and the description of the dataset. Finally, the input data are displayed.

If continuous data were entered, then the banner will indicate the number of actually negative cases entered followed by the case values in the order in which they were entered.

If discrete rating data were entered, then a banner indicating "Original Categorical Response Data" is displayed followed by the actual input matrix (with category runs collapsed if any empty categories exist).

*Displayed only in the full output.

```
                                                      Date - 16-Jan-98
                                                      Time - 18:26:01

4   ROCKIT (IBM compatable version 0.9 Beta)
        Mixed Input File (e.g., Fully Paired Discrete and Continuous)

           Maximum Likelihood Estimation of the Parameters
           of the Bivariate Binormal Model for PAIRED Data
                                 and
            Calculation of the Statistical Significance of
         the Difference between Binormal ROC Curve Estimates.
------------------------------------------------------------------------
5†  Statistical Test to be Employed:
        Area (Az) test
------------------------------------------------------------------------
6   Name of Input File being used: Mixed Kit Input File
------------------------------------------------------------------------
    Condition 1: Continuous

    Data collected on a nominally continuous scale.
    Smaller values of the test result represent stronger evidence that the
    case is actually-positive (e.g., that the patient is actually abnormal)

7   Condition 2: Discrete

    Data effectively collected in  5 categories.
    Category  5 represents the strongest evidence of positivity.
    (e.g., that the disease is present)

    Total number of correlated actually-negative cases =   53.
    Total number of correlated actually-positive cases =   49.
------------------------------------------------------------------------
```

Figure 21. Description of output: statistical test and dataset data

Statistical test and dataset data

4. The date and time of the run, followed by a heading that gives the description of the data file and the type of analysis being done:

   For the bivariate binormal model:
   i. a fully paired data analysis,
   ii. an unpaired data analysis, or
   iii. a partially-paired data analysis;

   or for the conventional binormal model:
   iv. the binormal parameters of a single curve

5†. The name of the statistical test to be employed

6. The name of the input file (if any) that was used or created.

7. For each condition, the condition number and description followed by a statement indicating how the data were collected (on either a continuous scale or an N-category scale) and which values represent positivity (e.g., larger or smaller values for continuous data, or the actual category number for discrete data). Finally, the total numbers of actually-negative and actually-positive cases are displayed. *(If the data are partially-paired, then ROCKIT will display both the numbers of paired and the numbers of unpaired cases.)*

---

†Displayed only when two conditions are compared

Input data after categorization

8*

Input Matrix for Actually-Negative cases:

Condition 2 Ratings	Condition 1 Categ. 20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
4	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	4
3	2	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
2	9	5	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	19
1	8	5	0	2	0	1	0	0	0	2	0	0	0	1	0	1	0	1	1	0	22
sum 1	20	11	0	4	0	4	0	1	0	3	0	1	0	1	0	2	2	2	2	0	53

Input Matrix for Actually-Positive cases:

Condition 2 Ratings	Condition 1 Categ. 20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
5	0	0	3	0	1	0	1	0	0	0	0	0	2	0	5	3	0	2	4	8	29
4	1	0	0	0	0	0	0	0	2	0	1	0	0	0	1	0	1	0	0	1	7
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	3
2	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	1	0	0	1	6
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	4
sum 1	1	0	4	0	1	0	2	0	2	0	2	0	3	0	8	4	3	2	4	13	49

Figure 22. Description of output: Input data after categorization

8*. Matrices that summarize the input for the actually-negative cases and the actually-positive cases. These matrices not only display the data in the form that ROCKIT uses for its computations, but also indicate the categorization ("Categ.") performed on a continuous data set.

The example matrices above represent the type of output expected when "Condition 1" contains continuously distributed data that has been categorized by the LABROC5 scheme (reference 6, on page 48) and "Condition 2" contains ratings from a discrete ordinal scale. The type of data is indicated in these matrices by the key words: "Categ." for LABROC5 categorized data and "Ratings" for the discrete ordinal ratings.

```
9
 Operating Points Corresponding to the Input Data Categorized by the LABROC5 Scheme:

For Condition 1:
 FPF:  .000  .000  .038  .075  .113  .151  .151  .170  .170  .189  .189
 TPF:  .000  .265  .347  .388  .449  .531  .694  .694  .755  .755  .796

 FPF:  .245  .245  .264  .264  .340  .340  .415  .415  .623 1.000
 TPF:  .796  .837  .837  .878  .878  .898  .898  .980  .980 1.000


 Operating Points Corresponding to the Input Data:

For Condition 2:
 FPF:  .000  .038  .113  .226  .585 1.000
 TPF:  .000  .592  .735  .796  .918 1.000

10
          ----------------------------------------------------
           Initial Estimates of the Binormal ROC Parameters:
          ----------------------------------------------------

For Condition 1:  Continuous

               a =  1.7935
               b =  1.0892

   z(k) =   .299  -.118  -.311  -.439  -.481  -.608  -.685  -.716  -.789  -.885
          -.955  -.987 -1.088 -1.122 -1.381 -1.589 -1.782 -1.961 -2.274

          ----------------------------------------------------
           Initial Estimates of the Binormal ROC Parameters:
          ----------------------------------------------------

For Condition 2: Discrete

               a =  1.2753
               b =   .5735

   z(k) =   .213  -.758 -1.185 -1.798

11
            Procedure Converges after   3 Iterations
```

Figure 23. Description of output: operating points, initial estimates, and number of iterations

Operating points, initial estimates, and number of iterations

9. ROC operating points corresponding to the input data. Operating points for continuous data are computed from the data after they have been categorized by the LABROC5 scheme (6, on page 48).

10. Initial estimates of the binormal ROC parameters for each condition.

    - The parameter "a" represents the vertical intercept and "b" represents the slope of the fitted ROC curve when it is plotted as a straight line on "normal-deviate" axis. The quantities z(k) represent the estimated category boundaries on the latent normal scale.

    - The initial estimates are computed as a "first guess" or starting point for the MLE algorithm. With a single condition, this first guess is equivalent to a least-squares fit of the data. However, with multiple conditions, this initial estimate is the final estimate obtained by fitting a binormal ROC curve individually to the data from each condition.

11. The number of iterations that were needed by ROCKIT to converge to a solution.

12
```
=====================================================
  Final Estimates of the Binormal ROC Parameters
 and the Inter-Condition Correlation Coefficients:
=====================================================


          Condition 1:                  Condition 2:
           Continuous                    Discrete
```
13
```
Binormal Parameters and Area Under the Estimated ROC :
       a          =       1.7539                      1.2715
       b          =       1.2259                       .5683
       Area (Az)   =        .8662                       .8655
       Area (Wilc) =        .8641                     *******
 *** Wilcoxon area estimates are computed for continuous data only.
```
14
```
    1: z(k) =  -.317   .140   .285   .415   .448   .578   .643   .675   .736   .828
                .890   .921  1.012  1.041  1.271  1.441  1.596  1.736  1.991
    2: z(k) =  -.217   .756  1.176  1.820
```
15
```
Estimated Standard Errors and Correlation of these Values:
       Std. Err. (a)  =      .3329                       .2460
       Std. Err. (b)  =      .2653                       .1579
       Corr(a,b)      =      .6325                       .5866
       Std. Err. (Az) =      .0352                       .0391
       Std. Err.(Wilc)=      .0374                     *******
 *** Wilcoxon area estimates are computed for continuous data only.
```
16
```
Symmetric 95% Confidence Intervals
       For a :        ( 1.1015, 2.4063)           (  .7894, 1.7537)
       For b :        (  .7059, 1.7459)           (  .2588,  .8778)

Asymmetric 95% Confidence Interval
       For Az:        (  .7848,  .9235)           (  .7739,  .9277)
```
17†
```
Inter-Condition Decision Variable Correlation Estimates:
     Effective Correlation of the Test Results Between Conditions:
       For Actually-Negative Cases (Rn) =  -.1042
       For Actually-Positive Cases (Rs) =  -.0811

     Estimated Standard Errors of the Inter-Condition
     Correlation Coefficients:
       Std. Error of Rn (for Actually-Negative Cases)=   .1588
       Std. Error of Rs (for Actually-Positive Cases)=   .1714


     Correlation of Area(1) and Area(2) =    .0575
```
18
```
Statistical Significance of the Difference between the Two
*CORRELATED* ROC Curve Estimates According to the Selected Test:
*************************************************************


The computed *CORRELATED* Area test statistic
has a value of =    .0132

with corresponding two-tailed p-value =   .9894
and corresponding one-tailed p-value  =   .4947.

Approximate 95% Confidence Interval for the Difference:
      ( -.0995,  .1008)
```

Figure 24. Description of output: final estimates with standard errors

Final estimates with standard errors

12. A banner indicating that the final estimates are to be displayed, followed by one column for each condition with the dataset description displayed under its condition heading.

13. The binormal parameter and area estimates for each condition and, for continuous data, Wilcoxon area estimates. (If 2 paired conditions were analyzed and both were entered as discrete data, then the Wilcoxon area will not be displayed.)

14. The final estimates of the category boundaries (on the latent normal scale) corresponding to the binormal distributions.

15. The estimated standard errors and correlations of the final parameter and area values. (If all of the conditions contain discrete data, then the standard error of the Wilcoxon area will not be displayed.)

16. The symmetric 95% confidence intervals for the binormal parameter estimates and the asymmetric 95% confidence interval for the binormal area estimate.

17†. If two paired conditions were analyzed, then the inter-condition correlation estimates are displayed along with their corresponding standard errors.

18†. If two conditions were analyzed, then the results of the selected statistical test will be displayed along with the 95% confidence interval on the result.

Variance-Covariance and Correlation Matrices

19*. Variance-Covariance Matrix (This is a symmetric matrix. Only the lower half is shown):

	ax	bx	ay	by	rs	rn	zx(1)	zx(2)	zx(3)	zx(4)	zx(5)	zx(6)	zx(7)	zx(8)	zx(9)	zx(10)	zx(11)	zx(12)	zx(13)	zx(14)	zx(15)	zx(16)	zx(17)	zx(18)	zx(19)	zy(1)	zy(2)	zy(3)	zy(4)
ax	.1108																												
bx	.0559	.0704																											
ay	.0032	.0001	.0605																										
by	.0001	.0001	.0228	.0249																									
rs	-.0016	-.0011	-.0013	-.0007	.0294																								
rn	.0001	.0014	.0001	.0007	0.0000	.0252																							
zx(1)	.0278	.0112	.0011	0.0000	0.0000	.0005	.0303																						
zx(2)	.0314	.0089	.0011	0.0000	0.0000	0.0000	.0214	.0283																					
zx(3)	.0316	.0070	.0011	0.0000	0.0000	-.0002	.0196	.0258	.0282																				
zx(4)	.0315	.0048	.0011	0.0000	0.0000	-.0004	.0181	.0239	.0261	.0284																			
zx(5)	.0314	.0041	.0011	0.0000	0.0000	-.0004	.0178	.0235	.0257	.0279	.0284																		
zx(6)	.0307	.0012	.0011	0.0000	0.0000	-.0006	.0165	.0220	.0241	.0261	.0267	.0291																	
zx(7)	.0301	-.0005	.0011	0.0000	0.0000	-.0006	.0159	.0213	.0233	.0254	.0260	.0283	.0295																
zx(8)	.0298	-.0013	.0011	0.0000	0.0000	-.0007	.0157	.0210	.0230	.0251	.0256	.0279	.0292	.0298															
zx(9)	.0292	-.0031	.0011	0.0000	0.0000	-.0007	.0151	.0204	.0224	.0245	.0250	.0273	.0285	.0292	.0304														
zx(10)	.0280	-.0060	.0011	0.0000	0.0000	-.0008	.0144	.0195	.0216	.0236	.0242	.0265	.0277	.0284	.0296	.0316													
zx(11)	.0270	-.0081	.0011	-.0001	0.0000	-.0009	.0138	.0190	.0211	.0231	.0237	.0260	.0273	.0279	.0292	.0312	.0326												
zx(12)	.0265	-.0091	.0011	-.0001	0.0000	-.0009	.0136	.0187	.0208	.0229	.0234	.0258	.0271	.0277	.0290	.0310	.0325	.0332											
zx(13)	.0248	-.0125	.0011	-.0001	0.0000	-.0011	.0129	.0180	.0201	.0222	.0228	.0252	.0265	.0272	.0285	.0306	.0321	.0328	.0352										
zx(14)	.0242	-.0136	.0011	-.0001	0.0000	-.0011	.0126	.0178	.0199	.0220	.0226	.0251	.0264	.0270	.0283	.0305	.0320	.0327	.0351	.0359									
zx(15)	.0189	-.0232	.0011	-.0001	0.0000	-.0013	.0108	.0161	.0183	.0207	.0213	.0240	.0255	.0262	.0277	.0300	.0317	.0325	.0352	.0361	.0437								
zx(16)	.0142	-.0309	.0011	-.0001	0.0000	-.0015	.0095	.0149	.0173	.0198	.0205	.0235	.0250	.0258	.0274	.0300	.0319	.0328	.0357	.0367	.0450	.0520							
zx(17)	.0094	-.0384	.0011	-.0001	0.0000	-.0017	.0082	.0138	.0164	.0191	.0199	.0231	.0248	.0257	.0274	.0302	.0323	.0333	.0364	.0375	.0465	.0541	.0617						
zx(18)	.0048	-.0455	.0011	-.0001	0.0000	-.0019	.0071	.0128	.0156	.0185	.0193	.0228	.0246	.0256	.0275	.0306	.0327	.0339	.0373	.0384	.0482	.0563	.0644	.0724					
zx(19)	-.0042	-.0588	.0011	-.0001	0.0000	-.0022	.0049	.0111	.0142	.0175	.0184	.0223	.0245	.0256	.0278	.0313	.0339	.0352	.0391	.0405	.0517	.0609	.0700	.0790	.0974				
zy(1)	.0024	0.0000	.0147	.0059	0.0000	.0004	.0020	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0299			
zy(2)	.0024	-.0001	.0129	-.0017	0.0000	-.0007	.0019	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0021	.0021	.0021	.0021	.0159	.0333		
zy(3)	.0024	-.0001	.0105	-.0085	0.0000	-.0012	.0019	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0022	.0022	.0124	.0291	.0440	
zy(4)	.0024	-.0002	.0025	-.0262	0.0000	-.0020	.0019	.0020	.0020	.0020	.0020	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0022	.0022	.0022	.0023	.0023	.0073	.0272	.0446	.0911
	ax	bx	ay	by	rs	rn	zx(1)	zx(2)	zx(3)	zx(4)	zx(5)	zx(6)	zx(7)	zx(8)	zx(9)	zx(10)	zx(11)	zx(12)	zx(13)	zx(14)	zx(15)	zx(16)	zx(17)	zx(18)	zx(19)	zy(1)	zy(2)	zy(3)	zy(4)

Figure 25. Description of output: Variance-Covariance Matrix

20*. Correlation Matrix (This is a symmetric matrix. Only the lower half is shown):

	ax	bx	ay	by	rs	rn	zx(1)	zx(2)	zx(3)	zx(4)	zx(5)	zx(6)	zx(7)	zx(8)	zx(9)	zx(10)	zx(11)	zx(12)	zx(13)	zx(14)	zx(15)	zx(16)	zx(17)	zx(18)	zx(19)	zy(1)	zy(2)	zy(3)	zy(4)
ax	1.0000																												
bx	.6325	1.0000																											
ay	.0386	.0016	1.0000																										
by	.0014	.0029	.5866	1.0000																									
rs	-.0272	-.0244	-.0301	-.0256	1.0000																								
rn	.0026	.0334	.0018	.0264	0.0000	1.0000																							
zx(1)	.4797	.2416	.0259	.0008	0.0000	.0171	1.0000																						
zx(2)	.5603	.1999	.0268	-.0002	0.0000	-.0018	.7330	1.0000																					
zx(3)	.5666	.1579	.0269	-.0005	0.0000	-.0081	.6704	.9138	1.0000																				
zx(4)	.5620	.1071	.0268	-.0008	0.0000	-.0137	.6187	.8451	.9252	1.0000																			
zx(5)	.5591	.0925	.0267	-.0009	-.0001	-.0151	.6062	.8289	.9077	.9814	1.0000																		
zx(6)	.5407	.0265	.0264	-.0012	-.0001	-.0205	.5571	.7665	.8411	.9110	.9287	1.0000																	
zx(7)	.5270	-.0103	.0262	-.0013	-.0001	-.0230	.5330	.7366	.8097	.8783	.8956	.9656	1.0000																
zx(8)	.5194	-.0290	.0261	-.0014	-.0001	-.0242	.5214	.7223	.7947	.8628	.8800	.9495	.9837	1.0000															
zx(9)	.5024	-.0668	.0258	-.0015	-.0001	-.0265	.4986	.6946	.7659	.8331	.8501	.9189	.9528	.9690	1.0000														
zx(10)	.4722	-.1266	.0253	-.0017	-.0001	-.0298	.4640	.6532	.7231	.7893	.8061	.8744	.9080	.9241	.9550	1.0000													
zx(11)	.4489	-.1682	.0249	-.0018	-.0001	-.0318	.4405	.6253	.6944	.7602	.7769	.8450	.8787	.8948	.9258	.9709	1.0000												
zx(12)	.4365	-.1891	.0247	-.0018	-.0001	-.0327	.4288	.6115	.6803	.7458	.7626	.8307	.8644	.8805	.9116	.9569	.9860	1.0000											
zx(13)	.3974	-.2505	.0240	-.0020	-.0001	-.0353	.3943	.5709	.6388	.7040	.7207	.7890	.8229	.8392	.8706	.9165	.9461	.9603	1.0000										
zx(14)	.3838	-.2706	.0238	-.0020	-.0001	-.0361	.3830	.5576	.6252	.6904	.7071	.7755	.8095	.8258	.8574	.9035	.9333	.9476	.9875	1.0000									
zx(15)	.2717	-.4176	.0215	-.0022	0.0000	-.0406	.2974	.4573	.5230	.5876	.6045	.6739	.7089	.7259	.7587	.8071	.8387	.8538	.8964	.9097	1.0000								
zx(16)	.1870	-.5117	.0197	-.0023	0.0000	-.0427	.2384	.3878	.4521	.5164	.5333	.6035	.6392	.6566	.6904	.7406	.7735	.7894	.8341	.8481	.9433	1.0000							
zx(17)	.1142	-.5833	.0181	-.0024	.0001	-.0437	.1900	.3304	.3933	.4571	.4740	.5447	.5809	.5986	.6332	.6848	.7188	.7352	.7818	.7964	.8960	.9548	1.0000						
zx(18)	.0537	-.6369	.0167	-.0024	.0001	-.0441	.1509	.2836	.3452	.4085	.4253	.4962	.5328	.5507	.5858	.6384	.6732	.6901	.7381	.7532	.8565	.9173	.9631	1.0000					
zx(19)	-.0408	-.7101	.0144	-.0024	.0001	-.0439	.0911	.2113	.2706	.3325	.3491	.4198	.4567	.4748	.5105	.5645	.6004	.6179	.6678	.6836	.7924	.8564	.9037	.9402	1.0000				
zy(1)	.0416	.0007	.3456	.2168	-.0001	.0131	.0652	.0671	.0671	.0667	.0666	.0658	.0652	.0649	.0642	.0628	.0618	.0612	.0594	.0588	.0532	.0486	.0445	.0410	.0352	1.0000			
zy(2)	.0394	-.0019	.2873	-.0605	.0002	-.0254	.0607	.0640	.0644	.0645	.0645	.0641	.0638	.0636	.0631	.0621	.0612	.0608	.0592	.0587	.0537	.0495	.0457	.0424	.0369	.5040	1.0000		
zy(3)	.0342	-.0027	.2037	-.2552	.0001	-.0373	.0523	.0557	.0563	.0566	.0566	.0564	.0562	.0560	.0557	.0549	.0542	.0539	.0526	.0521	.0479	.0444	.0411	.0382	.0334	.3418	.7605	1.0000	
zy(4)	.0237	-.0029	.0331	-.5500	-.0002	-.0417	.0359	.0388	.0394	.0398	.0398	.0399	.0398	.0398	.0396	.0391	.0387	.0385	.0377	.0374	.0346	.0322	.0300	.0280	.0247	.1390	.4940	.7042	1.0000
	ax	bx	ay	by	rs	rn	zx(1)	zx(2)	zx(3)	zx(4)	zx(5)	zx(6)	zx(7)	zx(8)	zx(9)	zx(10)	zx(11)	zx(12)	zx(13)	zx(14)	zx(15)	zx(16)	zx(17)	zx(18)	zx(19)	zy(1)	zy(2)	zy(3)	zy(4)

Figure 26. Description of output: Correlation Matrix

TPF as a function of FPF, with Standard errors

21

```
For condition 1 :  Continuous

     Estimated Binormal ROC curve, with Lower and Upper
     Bounds of the Asymmetric Point-wise 95% Confidence
     Interval for True-Positive Fraction at a Variety
     of False-Positive Fractions:

         FPF       TPF        (Lower Bound, Upper Bound)

         .005      .0801       (    .0069  ,    .3637   )
         .010      .1360       (    .0206  ,    .4386   )
         .020      .2223       (    .0557  ,    .5253   )
         .030      .2904       (    .0950  ,    .5817   )
         .040      .3472       (    .1352  ,    .6243   )
         .050      .3963       (    .1749  ,    .6587   )
         .060      .4394       (    .2134  ,    .6878   )
         .070      .4778       (    .2504  ,    .7129   )
         .080      .5124       (    .2857  ,    .7351   )
         .090      .5438       (    .3192  ,    .7549   )
         .100      .5724       (    .3509  ,    .7728   )
         .110      .5987       (    .3809  ,    .7891   )
         .120      .6230       (    .4092  ,    .8041   )
         .130      .6454       (    .4360  ,    .8178   )
         .140      .6662       (    .4612  ,    .8306   )
         .150      .6856       (    .4850  ,    .8424   )
         .200      .7650       (    .5857  ,    .8903   )
         .250      .8231       (    .6621  ,    .9246   )
         .300      .8668       (    .7214  ,    .9491   )
         .400      .9256       (    .8066  ,    .9784   )
         .500      .9603       (    .8647  ,    .9919   )
         .600      .9805       (    .9068  ,    .9975   )
         .700      .9917       (    .9388  ,    .9994   )
         .800      .9973       (    .9638  ,    .9999   )
         .900      .9996       (    .9836  ,   1.0000   )
         .950      .9999       (    .9919  ,   1.0000   )
```

Figure 27. Description of output: TPF as a function of FPF, with Standard errors

21. TPF values on the fitted binormal ROC curve for the named condition at selected FPF values, together with upper and lower bounds of the asymmetric “point-wise” 95% confidence interval for TPF (reference 11, on page 48).

22a †

```
Estimated Relationship between the Critical Test-Result Value
(which separates 'positive' results form 'negative' results)
and the Corresponding Operating Point on the Fitted Binormal
ROC Curve:

*************************************************************************

     Critical Test            (  FPF ,    TPF  )
     Result Value


          -2.5755             (   .041,    .354)
          -2.0260             (   .055,    .420)
          -1.7920             (   .075,    .495)
          -1.6005             (   .102,    .578)
          -1.4125             (   .149,    .683)
          -1.1545             (   .156,    .696)
          -1.1265             (   .179,    .734)
          -1.0435             (   .187,    .746)
          -1.0230             (   .204,    .770)
           -.9425             (   .231,    .803)
           -.8630             (   .250,    .823)
           -.7575             (   .260,    .833)
           -.6830             (   .282,    .852)
           -.5965             (   .327,    .886)
           -.4560             (   .339,    .893)
           -.4525             (   .388,    .920)
           -.3075             (   .444,    .943)
           -.1915             (   .625,    .984)
            .3330             (   .500,    .960)
```

22b †

```
Estimates of Expected Operating Points on fitted ROC
curve, with lower and upper bounds of asymmetric 95%
confidence interval along the curve for those points:

Expected operating point        Lower bound          Upper bound
  (  FPF ,    TPF  )          (  FPF ,    TPF  )    (  FPF ,    TPF  )

  ( .1198,   .7268)           ( .0660,   .6612)     ( .1988,   .7855)
  ( .2249,   .8001)           ( .1391,   .7438)     ( .3348,   .8483)
  ( .5858,   .9184)           ( .4551,   .8864)     ( .7075,   .9432)
  ( .5000,   .8982)           ( .3665,   .8594)     ( .6335,   .9286)
```

Figure 28. Description of output: Critical test results value and operating points

Critical test result values and operating points

22a[†]. For each condition from which continuous data were obtained, an estimate of the relationship between various critical test-result values and the corresponding points on the fitted binormal ROC curve.

22b[†]. For each condition from which discrete data were obtained, an estimate of the expected operating points on the fitted ROC curve and upper and lower bounds of the corresponding asymmetric "point-wise" 95% confidence interval for TPF (reference 11, on page 48).

23 †

```
     'Plots' of the Fitted Binormal ROC Curves:
***********************************************************

        FPF        TPF for         TPF for
                 Condition 1     Condition 2
       -----    -------------   -------------

        .005        .0801           .4237
        .010        .1360           .4798
        .020        .2223           .5415
        .030        .2904           .5802
        .040        .3472           .6089
        .050        .3963           .6318
        .060        .4394           .6509
        .070        .4778           .6674
        .080        .5124           .6819
        .090        .5438           .6948
        .100        .5724           .7065
        .110        .5987           .7172
        .120        .6230           .7270
        .130        .6454           .7361
        .140        .6662           .7446
        .150        .6856           .7526
        .200        .7650           .7862
        .250        .8231           .8128
        .300        .8668           .8349
        .400        .9256           .8703
        .500        .9603           .8982
        .600        .9805           .9215
        .700        .9917           .9417
        .800        .9973           .9599
        .900        .9996           .9772
        .950        .9999           .9863
```

Figure 29. Description of output: TPF as a function of FPF for plotting purposes

TPF as a function of FPF for plotting purposes

23†. FPF and TPF points suitable for plotting the pair of estimated ROC curves.

Special notes & troubleshooting

Special notes

Historical and legacy issues

1. ROCKIT **combines** previous University of Chicago software for ROC analysis into a single, integrated package and **includes additional** features, such as the ability to analyze partially-paired datasets. ROCKIT supersedes completely ROCFIT, LABROC1, INDROC, CORROC2, and CLABROC, which are **no longer maintained or supported.**
2. ROCKIT will accept input files created for our previous ROC programs (ROCFIT, LABROC, INDROC, CLABROC and CORROC2). When one of these old file formats is encountered, ROCKIT will ask if you wish to save the old format file as a new file. This new file will be saved in the new "ROCKIT" format. See the end of this section for how to do so
3. ROCKIT currently supports a maximum of 5 datasets entered in **list** format (the same format used by the now-obsolete LABROC, CLABROC, and CORROC2.)
4. ROCKIT currently supports a maximum of 2 datasets entered in **matrix** format (the same format used by the now-obsolete ROCFIT and INDROC).

Operating system issues

5. Versions of ROCKIT for the Apple Macintosh™ OS operating system are available as well.
6. This Windows version of ROCKIT will execute on computers running the Microsoft Windows 3.1™ operating system if Microsoft's Win32s DLLs are installed. ROCKIT is a 32 bit application which will not directly execute on a 16 bit Windows 3.1 system. However, Microsoft has created a set of DLLs, called Win32s, which will allow ROCKIT to run on a Windows 3.1 system. If your operating system is Windows 3.1, please download the win32s DLLs and install them according to the instructions provided by Microsoft.

Hardware issues

7. We recommend running ROCKIT only on computers with a '486 or later processor.
8. ROCKIT requires 2.1 MB of RAM to execute. Therefore, your system must have at least **4 MB of RAM.** Moreover, it requires 2 MB of free disk space.
9. If your computer uses a processor older than a '486 and does not have a math coprocessor, ROCKIT may still work on your computer if you have a software math coprocessor emulation extension, such as SoftwareFPU™. However, because

emulators must translate every math instruction for the processor, program performance is severely degraded with an emulator.

Troubleshooting

Operating system issues

1. ROCKIT **will not** run under the DOS operating system. Microsoft WINDOWS™ must be installed on your machine.

2. Menu bar items and their functionality, as well as file formats and types, may vary among different versions of Windows and among different supporting applications (such as word-processors). Perhaps the best strategy for dealing with such issues is trial and error while using the hints that we provide throughout the user's guide (the most important of which is: employ plain text or a MS-DOS kind of text format whenever possible). If the program does not work properly despite your best efforts to diagnose the problem, please contact us at roc@bsd.uchicago.edu.

Input/output issues

1. *It is crucially important to note that this program is **not** appropriate for pooled test-result values (see note on page 6).*
2. Limitations on ROCKIT data handling:
   - Up to 10,000 negative cases and 10,000 positive cases
   - Up to 5 conditions (e.g., "treatments" or "diagnostic tests")
   - If data are input in Matrix format, up to 20 categories and no more than 2 conditions
3. If you ask ROCKIT to create a new input file, it will create a flawed input file if any error is encountered during data input. If an error is encountered and you would like to run the program from the input file, then you must manually edit the input file with your word processor and correct any erroneous data.
4. ROCKIT checks data from each condition for degeneracy (reference 10, on page 48). With paired or partially-paired data ROCKIT checks the marginal datasets, whereas with unpaired datasets ROCKIT checks the independent datasets. If a dataset is degenerate, ROCKIT will output a message describing the kind of degeneracy found and the corresponding exact-fit ROC, and it will then abort execution of that dataset. In general, degeneracy should be found only in very small datasets and/or in those with many tied values.

Calculation/Algorithm related issues

1. When fully- or partially-paired conditions are compared, some datasets can cause underflow during the maximum-likelihood calculations. To circumvent this problem, ROCKIT may merge two or more of the initially-established categories in one or both conditions before proceeding, thereby reducing the number of estimated operating points. In our experience, category merging rarely occurs unless the two conditions are highly correlated.

2. The ROC curve that ROCKIT estimates for each condition from paired test-result data may be slightly different from the curve that ROCKIT estimates for each condition alone. More generally, the ROC curve that ROCKIT estimates for a given condition can depend to some degree upon the data with which the condition is paired. For example, if triplets of test results are obtained from three conditions (X, Y, and Z), then the ROC that ROCKIT estimates for condition X may depend on whether the test results from condition X are paired with those from condition Y or those from condition Z. In our experience, these effects usually are small and can be ignored. In situations where differences among multiple estimates of a particular ROC are substantial, we recommend that an overall estimate of the ROC be obtained by averaging the individual estimates of the "a" parameter and the individual estimates of the "b" parameter of the curve. The overall ROC is then given by the expressions FPF = $\Phi(v)$ and TPF = Φ (a + bv), where "v" takes on values from -3 to +3 and $\Phi(z)$ represents the cumulative standard-normal distribution function.

3. Before maximum-likelihood estimation of an ROC curve is attempted, continuously-distributed input data are rank-ordered and then collapsed into truth-state runs as per the LABROC4 algorithm (reference 5, on page 48). These runs are then reduced to "K" categories in an *ad hoc* but empirically useful way by means of our "LABROC5" categorization procedure (reference 5, on page 48). If both the number of actually-negative cases and the number of actually-positive cases in the input are greater than or equal to 40, then K=20; otherwise, K=10.

   - If the input data were collected on a discrete categorical scale, and/or if a substantial proportion of the data from actually-negative and/or actually-positive cases involves tied test-result values, and/or if the actually-negative and actually-positive distributions are "well separated" (high curves), then ROCKIT may not be able to achieve the target number of categories; in that situation, it produces as many categories as possible.

Legacy issues

1. Because the algorithms used by ROCKIT are somewhat different from those used by our previous software (e.g., LABROC1,) the estimates may differ slightly (e.g., by <~0.001). These differences are to be expected and should lie well within the 95% confidence interval of the estimates previously calculated.

2. To create a new "ROCKIT" format input file from an old input file:

   - Respond "yes" to the screen prompt that asks whether you want this option; then hit "↵Enter" ("Return").

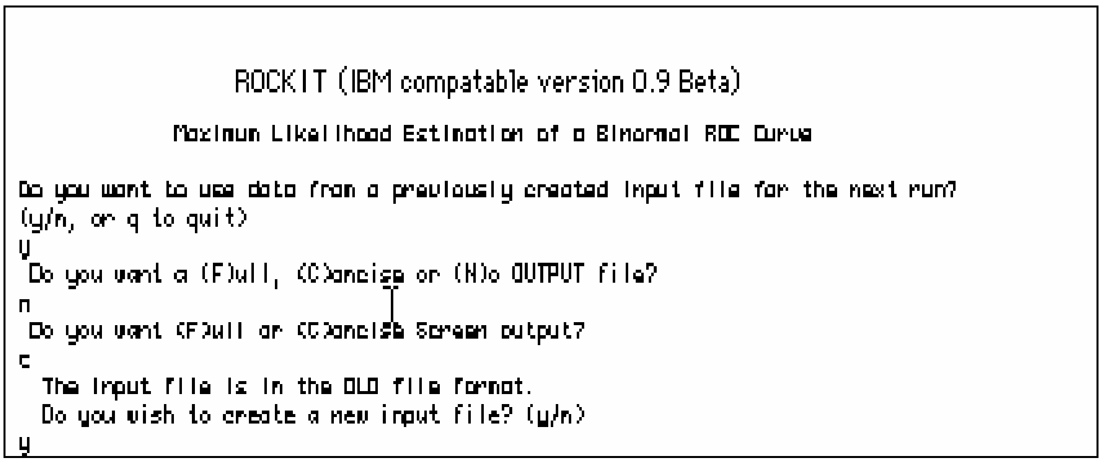


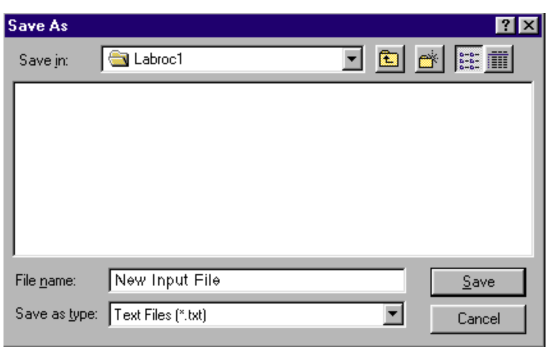
Figure 30. Prompt for converting old formats into ROCKIT format

   - When the standard "Save As…" dialog box appears:

— navigate to the folder in which you want the new input file saved;

— type a name for the new input file; and

— click on the "Save" button or hit the "↵Enter" ("Return") key to save the file.



Note: ROCKIT will expand ROCFIT datasets so that they are in list format unless they involve more than 5000 cases of a single type (actually-positive or actually-negative).

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9. Metz CE, Herman BA, Roe CA. Statistical comparison of two ROC curve estimates obtained from partially-paired datasets. Med Decis Making **18:** 110-121, 1998.
10. Metz CE. Some practical issues of experimental design and data analysis in radiological ROC studies. Invest Radiol **24**: 234-245, 1989.
11. Ma G, Hall WJ. Confidence bands for receiver operating characteristic curves. Med Decis Making **13**: 191-197, 1993.

Table of figures/ROCKIT screen shots

NOTE: Figures will appear differently for different versions of the program and for different versions of Windows (these screenshots have been taken on Windows 95). The features relevant to the use of ROCKIT, that is what we wanted to exemplify here, can be easily identified across different program and operating system versions. Some screen shots have been edited for clarity (changing fonts or alignment). Not all the figures are from the same version of the program, differences are non important for the use of the code.

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