

Chapter Five

IFASTATS: USING A MICROCOMPUTER FOR STATISTICAL ANALYSIS IN LANGUAGE STUDIES*

OVERVIEW OF THE IFASTATS PROGRAMS

IFASTATS is a set of programs for statistical analysis which run on a Commodore 64 (C-64) microcomputer equipped with either a disk drive or a datasette (cassette drive). Because of their price range, the Commodore 64 and Sinclair Spectrum microcomputers are the most common home personal computers in this country. The IBM PC-compatible standard applies in business applications to be sure, but PC compatibles are generally priced too high in Poland for individuals. Appropriate software for statistical analysis that works with either the Commodore or Sinclair micros is difficult to find. The IFASTATS programs are intended to help fill the resulting gap. At present, there are five programs in the series.

IFADATA is a program which allows the user to type in raw (unanalyzed) data at the computer keyboard. The data may then be arranged (as a list or table), examined, altered, sorted, and stored on disk for later use. Thus, once the user creates a data file with IFADATA, it may be used - and reused - with any of the IFASTATS programs at any later time.

IFAMEANS can read in the user's data file and perform any of several simple operations relating to arithmetic means (averages). It can calculate the mean (and standard deviation) for each row

* Douglas W. Coleman, University of Łódź.

or column of a data table. It can help users judge whether differences observed between two means are statistically significant, using a t-test or the z statistic. It can also help identify significant differences among several means using a one-way ANOVA test (the F statistic).

IFACURVE (a) reads in a list of student scores; (b) calculates the mean and standard deviation; and (c) determines cutoff scores for grades of 2, 3, 3+, 4, 4+, and 5 based on the distance of each score from the group mean, this distance being measured in terms of standard deviations. For example, a score of 80% on one examination and an 80% on another rarely mean the same thing. The group average and standard deviation for the two exams will probably be different: one exam may be more difficult than the other, and the questions on one exam may discriminate more clearly between weak and strong students (resulting in a larger standard deviation). IFACURVE takes these factors into account and helps the examiner interpret the real meaning of the scores more accurately.

IFACORR can read in a data table and then analyze the data with any of the following measures of correlation: Chi-square, Spearman's rho, gamma, and Pearson's r.

IFACODE is a program for recoding the values in a data table or reorganizing the format of the table. For example, using a cutoff point selected by the user, IFACODE will convert a data table from raw scores (e.g. percentages) to 1's and 0's, substituting a one for every score at or above the cutoff, a zero for every score below the cutoff. The resulting new data table can then be stored on disk or cassette with a new name. (This particular function of IFACODE sets up a data table for analysis via implicational scaling, a planned extension of IFASTATS in a program to be called IFASCALE).

IFADATA: SETTING UP A DATA TABLE

In order for the computer to use data, the data must first be put into the computer's memory. IFADATA allows the user not only to enter data into the C-64's memory directly (by typing it in

at the keyboard), but also to save the data on disk or cassette tape. When the computer is turned off, it 'forgets' whatever data is stored in its memory. Saving the data on disk or tape makes it possible to reanalyze the same data at any time later without retyping it; the data which has been saved on disk or tape can simply be copied back into the computer's memory.

Computer programs, like IFADATA, must also be in the computer's memory in order to be used. To get IFADATA (or any of the IFASTATS programs) into memory, it must be loaded from a copy on disk or tape. To load IFADATA, first turn on the computer system (the video monitor, the disk drive or datasette, and the C-64). You will see a message like the following on the video display:

```
COMMODE 64 BASIC V2
64K RAM SYSTEM 38911 BASIC BYTES FREE
READY.
```

Below the word 'READY' you will see a flashing square called a cursor.

To load IFADATA from disk, open the disk drive door, insert the disk label-side up with the label end toward you and close the door. If this is not clear, see the disk drive user manual or ask someone who knows how to insert a disk. (Note: disks require careful handling; they can be damaged easily. If you are not familiar with their use, see your disk drive user manual).

Type this:

```
LOAD "IFADATA", 8
```

and press the RETURN key. The computer will respond with this:

```
SEARCHING FOR IFADATA
- LOADING
READY.
```

If you are using a C-64 with a datasette instead of a disk drive, start by inserting the cassette into the datasette. Rewind the cassette. When the cassette is completely rewound, release the rewind button by pressing the stop button on the datasette (as with an ordinary cassette recorder). Then type this:

```
LOAD "IFADATA"
```

(without the comma and the number 8) and press RETURN. The message

PRESS PLAY ON TAPE

will appear, and you should then press the play button on the front of the datasette. The video display will go blank while the computer searches the tape for the program. When IFADATA has been loaded, you will see the 'READY.' message and the flashing cursor.

Whether you are using disk or tape, when you see the 'READY.' message and the flashing cursor, type this:

RUN

and press the RETURN key. At this point you will see the IFADATA title page. Follow the instruction at the bottom of the title page and press the RETURN key. You will see an address to write to for information about IFASTATS; again, follow the instruction and press the RETURN key.

PRESS A NUMBER KEY TO CHOOSE

1. DEFINE A NEW DATA TABLE
2. LOAD A DATA TABLE FROM DISK
3. SAVE THE DATA TABLE ON DISK
4. EXAMINE/ALTER THE TABLE
5. SORT THE TABLE BY ROWS
6. SORT THE TABLE BY COLUMNS
7. OUTPUT TABLE
8. QUIT

Fig. 1. IFADATA main menu

Now you will see the main 'menu' for IFADATA, shown in Figure 1. Like menus in other computer programs, this one presents a list of choices available to you. To make a selection press the number key corresponding to your choice. For example, if you press the key for the number 1, you will be able to give the computer a new data table by typing it in at the keyboard. Options 2 and 3 are 'LOAD A DATA TABLE FROM DISK' and 'SAVE THE DATA TABLE ON DISK'. (If you loaded IFASTATS from cassette tape, then you will see these same options displayed as '... FROM TAPE' and '... TO TAPE' respectively). Pressing the key for the number 4

selects the option 'EXAMINE/ALTER THE TABLE', used to check the data table for errors and, if necessary, to make corrections. Options 5 and 6 permit you to sort the table in different ways. Option 7 is used primarily to show the data table as a whole on the video display or on a printer, but also allows you to switch back and forth between the use of disk and tape if your system has both a disk drive and a datasette. Choosing option 8, 'QUIT' lets you leave IFADATA to load and run another program.

TYPING IN DATA

All data for the IFASTATS programs must be put in the form of a list (1 row by some number of columns or 1 column by some number of rows) or a table (of 2 or more rows by 2 or more columns). For the sake of convenience, all discussions of IFASTATS programs refer to either as a 'data table'. All the data in a data table must be coded as numbers. This means that for nominal data, categories must be assigned arbitrary numbers (e.g., for the variable 'sex', the category 'male' could be coded as 1, 'female' as 2, or vice versa; for the variable 'native language' 'Polish' could be coded as 1, Swedish as 2, 'German' as 3, and so on). A sample data table is shown in Figure 2.

10	10	10	-	1	13	When you select option 1 - 'DEFINE
15	12	13		20	16	A NEW DATA TABLE' - IFADATA asks how
16	8	13		13	12	big the table will be, so that the
17	11	9		20	13	program can tell if the computer has
13	12	-	1	13	12	enough memory to hold it. IFADATA first
12	9	9		13	9	asks the number of rows, then the
16	12	-	1	15	10	number of columns. You must type the
14	9	-	1	18	10	appropriate numbers (pressing RETURN
14	8	11		18	13	after each), depending on the size of
15	9	10		21	16	your data table. See Figure 3. If the
14	6	-	1	12	13	C-64's memory can hold your table,
5	-	1	-	1	9	then IFADATA will tell you how much
8	11	11	-	1	10	memory it will use, measured in bytes.
12	10	9	-	1	10	(If your table will not fit, IFADATA
13	7	7		10	10	will display the message 'TABLE TOO
9	7	4		11	9	BIG ERROR'. See the Appendix in the
12	12	12		19	13	
4	6	3		9	6	
8	8	8		11	9	
12	10	12	-	1	7	
4	4	4	-	1	5	
6	6	6		13	9	

Fig. 2. Sample data table

IFASTATS User Guide for a complete list of IFASTATS error messages.) Next, follow the instructions by either pressing the RETURN key to start typing in your data, or pressing the key for the letter 'a' to abort (to instead go back to the main IFADATA menu). If you press RETURN, the program will prompt you with the row and column number for each item in the table, as shown in Figure 3. Compare the numbers being typed in to those in Figure 2 and you will see that the data table shown in Figure 2 is the one in the process of being created here.

When you have typed the last data item, IFADATA will display the message 'PRESS RETURN TO CONTINUE.' Pressing the RETURN key will then take you back to the IFADATA main menu.

```

SIZE OF TABLE:
HOW MANY ROWS?
22
HOW MANY COLUMNS?
5
YOUR TABLE OF 22 ROWS
AND 5 COLUMNS
USES 559 BYTES OF MEMORY.
PRESS RETURN TO BEGIN DATA ENTRY.
PRESS 'a' TO ABORT ENTRY.
ROW 1 :
COLUMN 1 : ? 10
COLUMN 2 : ? 10
COLUMN 3 : ? 10
COLUMN 4 : ? -1
COLUMN 5 : ? 13
ROW 2 :
COLUMN 1 : ? 15

```

Fig. 3. Defining a new data table

OTHER OPTIONS

Option 4 ('EXAMINE/ALTER THE TABLE') is intended mainly to allow you to check the data table for errors and to make changes or corrections. When you select option 4, you get another menu, as shown in Figure 4. You may examine a whole row (option 1) or a whole column (option 2). You may, alternatively, examine a single data item in the table (option 3). When you are shown each data item (whether using option 1, 2, or 3), you may alter it by typing a new value and then pressing RETURN. Instead, if you only press the RETURN key, the value you are shown will be kept. Option 4 takes you back to the main IFADATA menu.

PRESS A NUMBER KEY TO CHOOSE

- 1. VIEW/ALTER A ROW**
- 2. VIEW/ALTER A COLUMN**
- 3. VIEW/ALTER CELL(S) IN TABLE**
- 4. RETURN TO MAIN MENU**

Fig. 4. EXAMINE/ALTER menu

To save a data table on disk or tape (as a data file), select option 3 from the main menu. If you are using a disk drive, make sure ahead of time that you have either (a) enough space on your IFASTATS disk or (b) another blank, already-formatted disk (see your disk drive user's manual for instructions on formatting disks). Otherwise, make sure you have a cassette with plenty of blank space on it. IFADATA will ask you what name you would like to give to the disk/tape file which will contain your data table. Type a name and press RETURN.

If you are using a disk drive, IFADATA will record your data on the disk and will tell you when it is finished by displaying the message 'PRESS RETURN TO CONTINUE'. Press the RETURN key to go back to the main menu.

If the computer detects an error during the process of recording the data on the disk, IFADATA will report the error and stop. If this happens, you may try again to save your data on disk by typing GOTO 1000 (and pressing RETURN) - this will return you to the IFADATA main menu. Before trying to save the data table a second time, refer to your disk drive manual to see what went wrong the first time.

If you are using a datasette, IFADATA will tell you what to do next by displaying the message 'PRESS PLAY AND RECORD ON TAPE'. Press the play and record buttons on the datasette at the same time. The video display will go blank while IFADATA is recording the file on the cassette. When all the data has been recorded, the program displays the message 'PRESS RETURN TO CONTINUE'. Press the RETURN key to go back to the main menu.

Unless your data table is very small (and would therefore be

very easy to type in again), it is wisest to save it twice, on two different disks or cassettes. This will protect it against possible damage to the cassette or disk on which it is stored. Simply repeat the procedure, choosing option 3 from the IFADATA main menu. In any case, also keep your original paper copy (handwritten or typed) in a safe place.

Option 2, 'LOAD A DATA TABLE FROM DISK' (or '...TAPE'), copies a data table from disk (or cassette) into the computer's memory. Select option 2; you will see a message like this:

LOAD A DATA TABLE FROM DISK:

NAME OF FILE?

There will be a flashing cursor after the question mark. Type the name of the data table you want to load and press RETURN.

If you are using a disk drive, make sure the disk containing the data table is already in the disk drive (with the drive door properly closed) before you press RETURN. IFADATA will tell you if it has a problem loading the file. (If there is a problem the program will stop and you will see the 'READY.' message).

If you are using a datasette, make sure the cassette containing the data table is already in the machine (with the tape positioned near the beginning of the data) before you press RETURN. The program will display the message 'PRESS PLAY ON TAPE'; press the play button on the datasette. As with loading a program, the video display will go blank while IFADATA searches for the data table and loads it.

When the data table has been loaded, IFADATA displays the 'PRESS RETURN TO CONTINUE.' message. Pressing the RETURN key will take you back to the main menu.

Options 5 and 6 in the IFADATA main menu allow you to sort the table, either by rows (5) or by columns (6). If you choose option 6 - 'SORT THE TABLE BY COLUMNS' - another menu (Figure 5) will appear with three options: to sort the columns according to their averages, to sort them according to the value in a particular row, or to return to the main menu. The columns will be sorted in descending order. In other words, if you select a sort by column averages, the column with the highest average will become column 1, the column with the second highest average will become column 2, and so on. If you choose to have IFADATA sort

process of being displayed on the video monitor. 'OUTPUT TABLE' always assumes there are no decimal points already in the data; it is not asking where the decimal points are, but rather, where you would like them to appear in the output. In this way, suppose the data in Figure 7 represents percentages (ignore, for the moment, the -1 value you see in the table). You could display the same data as proportions (e.g. .10, .10, .10, -.01, etc.) by specifying two significant digits and two digits (rather than zero) to the right of the decimal point.

Option 3 in the 'OUTPUT TABLE' menu is 'SWITCH FILE I/O DEVICE'. Choosing this option changes the input/output device for filing data tables from disk to datasette or from datasette to disk. This option can only be used if your C-64 system has both a disk drive and a datasette. The main use of this option is to transfer data from tape to disk or vice versa: load the data file from one of these two devices; use the 'OUTPUT TABLE' option to switch the file I/O device; then save the data file on the other device.

SOME SIMPLE STATISTICS WITH IFAMEANS

IFAMEANS can perform several simple statistical analyzes relating to arithmetic means (averages). Thus, it assumes your data is at least of the equal interval level. IFAMEANS can handle data tables up to roughly 29,000 bytes in size (this is large enough for a data table of approximately 100 x 50).

If you are using a disk drive, you can load IFAMEANS by typing

```
LOAD "IFAMEANS", 8
```

after the 'READY.' message and pressing RETURN. Note that the procedure is the same as with IFADATA, but the program name 'IFAMEANS' is substituted. If you are using a datasette, the procedure is also the same as for loading IFADATA, but - again - substitute the program name 'IFAMEANS'. After the program is loaded, the computer will again display the 'READY.' message.

Type

```
RUN
```

and press the RETURN key. You will see the IFAMEANS title page.

Press the RETURN key twice to see the IFAMEANS main menu (Figure 8). Option 1 - 'LOAD A DATA TABLE FROM DISK (or'TAPE') - works exactly as in IFADATA. Options 2 and 4 display row and column averages, respectively. Selecting either option 3 or 5 takes you to another menu from which you can choose a t-test (or z statistic) of either of two types, or a one-way ANOVA test. By selecting option 6 on the main menu, you can identify missing data in your table (if there is any) so that IFAMEANS can take this missing data into account when it performs its calculations (see below).

PRESS A NUMBER KEY TO CHOOSE

1. LOAD A DATA TABLE FROM DISK
2. DISPLAY ROW AVERAGES
3. COMPARE ROW AVERAGES
4. DISPLAY COLUMN AVERAGES
5. COMPARE COLUMN AVERAGES
6. DECLARE A NODATA VALUE
7. QUIT

Fig. 8. IFAMEANS main menu

```

OUTPUT TO PRINTER (Y/N)?
COLUMN 1 AVERAGE: 11.3181818
          STANDARD DEVIATION: 4.00459692
COLUMN 2 AVERAGE: 8.90476191
          STANDARD DEVIATION: 2.34317652
COLUMN 3 AVERAGE: 8.88235295
          STANDARD DEVIATION: 3.1599516
COLUMN 4 AVERAGE: 14.4117647
          STANDARD DEVIATION: 4.89357458
COLUMN 5 AVERAGE: 10.3636364
          STANDARD DEVIATION: 3.27392956
  
```

PRESS RETURN TO CONTINUE

Fig. 9. Column averages

Figure 9 shows the video display after option 4 from the IFAMEANS main menu has been selected. (Of course, a data table was

first loaded via option 1 - in this case, the data table shown in Figure 2, above.) IFAMEANS first asks whether you want the table to be displayed on a printer. If your C-64 system has a printer, you may press the Y key (for 'yes'); then you will get the results on paper. This is particularly useful when the results will not all fit on the video display at the same time. If you do not have a printer, and the results will not all fit on the video screen at one time, you may slow down the rate at which results are displayed by holding down the CONTROL key (labelled CTRL on older C-64's). You may also stop the display at any point by pressing the RUN STOP key at the lower left of the C-64 keyboard. You will see the 'READY.' message and the flashing cursor. To restart the display, type

CONTINUE

and press the RETURN key. Figure 10 shows the video display that you get if you press the N key (for 'no'). For each column, IFAMEANS displays the average and standard deviation. The program reports the results exactly as calculated, without trying to eliminate spurious digits; it is up to you to round off the figures appropriately.

PRESS A NUMBER KEY TO CHOOSE

1. COMPARE A COLUMN AVERAGE TO THE OVERALL AVERAGE
2. COMPARE TWO COLUMN AVERAGES
3. COMPARE THREE OR MORE COLUMN AVERAGES
4. RETURN TO MAIN MENU

Fig. 10. COMPARE COLUMN AVERAGES menu

Option 2 - 'DISPLAY ROW AVERAGES' - works in the same way.

Options 3 and 5 are also very similar to one another. However option 3, like 2, calculates averages by summing across rows. Option 5, like 4, calculates averages by summing down columns. Because of the great similarity, only option 5 need be discussed.

Choosing option 6 - 'COMPARE COLUMN AVERAGES' - takes you to another menu, shown in Figure 10. (The menu from option 3 is

identical, but with the word 'COLUMN' replaced by 'ROW'.) Option 1 in the 'COMPARE COLUMN AVERAGES' menu calculates the value of the t or z statistic for a comparison of any one column to the overall average for the table. The result is reported as t if the column contains fewer than 30 data items, as the z statistic if it contains 30 or more items (the computation for t and z in this case is the same). The interpretation of the two statistics is different, requiring the use of a separate statistical table for each. However, since t can be used with larger numbers of data items (i.e., 30 or more) as well, the value for degrees of freedom (used in the interpretation of t) is reported even when IFAMEANS labels the result ' z '; thus, when the result is reported as z , you may interpret it as z or t .

A somewhat different version of the t or z statistic is calculated when you select option 2 of the 'COMPARE COLUMN AVERAGES' menu. An example is shown in Figure 11. First, IFAMEANS asks which columns you want to compare. After you have typed the two numbers identifying the columns, the program will calculate the averages and standard deviations for each of the two columns, the standard error of difference for the means of the two columns, the value for t or z , and the degrees of freedom. IFAMEANS will then report these results on the video display, as shown in Figure 11. As with option 1 of the 'COMPARE COLUMN AVERAGES' menu, the main result is reported as t if there are fewer than 30 data items in either of the two columns, as z if both columns have more than 30. The value for degrees of freedom is reported in either case, however, so that the result here may also be interpreted as t even with larger groups.

```

COLUMN 1:
AVERAGE: 11.3181818
STANDARD DEVIATION: 4.88459692
COLUMN 3:
AVERAGE: 8.98235295
STANDARD DEVIATION: 3.1599516
STANDARD ERROR OF DIFFERENCES BETWEEN
COLUMN 1 AND COLUMN 3: 1.14738795
THE VALUE OF T: 2.12308201
DEGREES OF FREEDOM (FOR T): 37
PRESS RETURN TO CONTINUE

```

Fig. 11. Calculation of t

```

DEGREES OF FREEDOM IN NUMERATOR
(BETWEEN GROUPS): 4
DEGREES OF FREEDOM IN DENOMINATOR
(WITHIN GROUPS): 34
F RATIO: 7.88529011
WITHIN-GROUP VARIANCE (MSW): 11.697399

```

PRESS **RETURN** TO CONTINUE

Fig. 12. Calculation of F-ratio

Selecting option 3 from the 'COMPARE COLUMN AVERAGES' menu causes IFAMEANS to perform a one-way ANOVA test. The program first asks how many columns you wish to compare; you may type the number of columns or the word 'ALL', followed by the RETURN key. (If you give a specific number of columns, the program will then ask you to identify the column numbers, one at a time). Figure 12 shows the screen display reporting the results of a one-way ANOVA test. To interpret the F-ratio, you must look at a table of critical values of F (to be found in any number of statistical texts). The values for two different types of degrees of freedom (between groups and within groups) tell you where to look in the table. The value for within-group variance (MSW) is included so that you may do the hand calculation for a Scheffe test to identify the exact source(s) of significant differences among the means (see, for example, Hatch and Farhady, 1982: 143-146).

Option 6 on the 'COMPARE COLUMN AVERAGES' menu takes you back to the IFAMEANS main menu. There, option 6 is 'DECLARE A NODATA VALUE'. You sometimes will have missing data in your table. For example, suppose you are doing a study, let's say, one testing the same group of subjects in several aspects of language acquisition. In this case, each row in the table might represent one subject (e.g., one foreign language student). Each column could represent one aspect. But, suppose the different aspects cannot be measured all at one sitting. If a student is absent on the day of one of the test components, then there will be no score for that student on that day. It would not be reasonable to enter a score of zero because this does not represent an accurate

measurement of the state of the subject's foreign language acquisition. (In an experiment, the purpose of a test is not to assign a grade for course credit, but to take as unbiased a measurement as possible). Suppose the raw scores are to be recorded on a scale of 0 to 20 (with zero meaning no correct answers and twenty being the number of items on the test, and therefore, the maximum possible number correct). In cases where a student is absent, the score for that student on that day might be entered, for example, as -1, a value which is not possible as a raw score. Then IFAMEANS can be told to ignore all -1's found in the data table when performing its calculations. This is done with the 'DECLARE A NODATA VALUE' option. Any value which cannot occur as a raw score may be used (e.g., 21 might have been used instead in this case). The table shown in Figure 3 (above) includes -1 as a 'NODATA' value. (Note that the use of a negative number as the 'NODATA' value can make the missing data easier to identify in the printed data table).

Obtaining IFASTATS and the IFASTATS User Guide

The IFASTATS programs are available in two forms: on cassette and on 5 1/4 inch floppy disk. (As explained above, there is only one set of programs; they will work with either device.) The IFASTATS User Guide is available both in 'hardcopy' form (on paper) and as a data file (on the IFASTATS disk). The IFASTATS User Guide provides detailed information on the use of all programs currently in the IFASTATS package, including those only mentioned above. Further information about IFASTATS and the User Guide may be obtained by writing to the current director of the microcomputer lab at the Institute of English Studies in Lodz.