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USE OF COMPUTERS IN A LABORATORY ENVIRONMENT

An Introduction to MS-DOS and Lotus 123

J. Brunt

INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

Content

1. Introduction

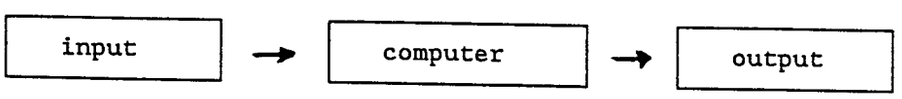
A computer is an electronic device that is able to execute very fast simple tasks.

Calculation devices were invented long ago; a brief overview (which does not pretend to be complete) is given below.

1100 BC	Abacus
1728	Kind of punchcard controlled weaving machine
1833	Mechanical calculation machine (Charles Babbage)
1880	Invention of the punchcard (Herman Hollerith)
1941	First digital computer (calculator, no programming) working with relais
1944	First programmable calculation machine. An electro-mechanical gadget. Numbers limited up to 24 digits.
1946	1st electronic computer, the "ENIAC" (First generation)
1948	Invention of the transistor
1958	1st computer with transistors (Second generation)
1960	Invention of the I.C. (Integrated Circuit), the "chip"
1965	1st computer with chips (Third Generation)
1970	1st microcomputer (Fourth Generation)
1979	First PC (Personal Computer)
????	Fifth generation??

A computer is called a microcomputer when its (micro)processor consists of only one chip which is responsible for controlling all processes. The PC is such a microcomputer.

Some Important Computer Devices



Input devices are keyboard, scanner, mouse, barcode reader, modem etc.
Output devices are printer, monitor, plotter, modem etc.

The keyboard consists of:

26 lowercase letters (a...z)
26 uppercase letters (A...Z)
10 digits (0...9)
32 punctuation marks (, .; ")
10 or more function keys
26 other keys (ESC, SPACEBAR)

Together at least 130 keys.

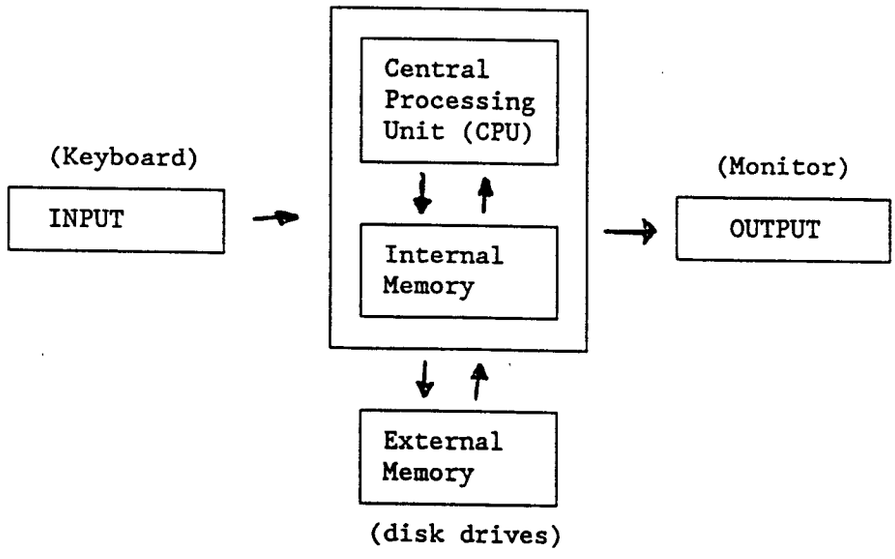
Printers

* Matrix printer or Dotmatrix printer
  Relatively cheap. The principle of a matrix printer is the same as a typewriter. It works with an ribbon, paper and printhead. The printhead does not contain letters, but needles. The quantity of needles in the printhead determines the quality of the output. Speed varies from 50 to 500 characters per minute.
* Daisy wheel printer, the printhead consists of a wheel with letters and punctuation. The print quality is better than that of the matrix printer. The printers are slow (10 to 100 characters per minute) and the printhead should be changed when one decides to change the lettertype.
* Inkjet printer, the printhead consists of needles filled with ink. The advantages are: less noisy and a higher letter quality. The disadvantage is the sensitivity for dust.
* Laserprinter, the principle is comparable with that of a photocopy machine. The whole image of a page is copied from the computer to an electrostatic device which is afterwards copied on a piece of paper. The letter quality is compatible with professional printing equipment. The speed of a laser-printer is expressed in pages per minute and varies from several to over one hundred pages per minute.

Monitors

The most often used (and usually indispensable) output device is the monitor. The quality of the monitor is determined by the quantity of pixels. More pixels give a higher resolution which results in sharper characters and figures on the monitor (not on the printer!).

Computer Configuration



The Central Processing Unit (CPU) or microprocessor is the heart of the computer. The power and speed of a microcomputer depends greatly on the type of processor. Different types of processors are (increasing speed and therefore price) 8088, 80286, 80386 and 80486.

One of the features of a computer is its capability to memorize tasks. The memory of a computer is divided in two parts: Internal Memory and External Memory.

The function of the internal memory of a computer is to store programmes and data on a temporary base in order to perform desired tasks (e.g. calculations, sorting, printing etc.). The internal memory is only temporarily active. When the computer is switched off, or an electricity breakdown occurs, all data and programmes present in this memory are erased and lost. The function of the external memory of the computer is mass storage of data and programmes. Before the CPU uses programmes in order to manipulate data, the programmes should be transferred from the External Memory to the Internal Memory. This process is called "Loading a Programme".
External memory is sometimes fixed in the computer (fixed disks or hard disks) and sometimes removable (floppy disks) or magnetic tape.

For all types of external memory applies that data and programmes are not lost when the electricity is switched off.

The floppy disk, floppy or diskette was developed by IBM in 1971. In order to load the programme from a floppy (external memory) into the computer's internal memory a disk drive is necessary. The first floppy had a size of 8 inch and was used in another type of computer. Nowadays the 5¼ inch is most popular for PC's. However, it is expected that this size will eventually be substituted by the newer 3½ inch diskette which, although smaller, can contain more data and is better protected against mishaps.

What NOT to do with a floppy disk:

- expose to extreme heat/cold
- expose to direct sunlight
- expose to magnetic fields (avoid placing them on a television, avoid metal detectors at airports)
- attach paperclips, ballpoints etc.
- bend or fold them
- touch them at the uncovered area

What ALWAYS to do with a floppy disk:

- Stick a label on it which tells you what is stored.
- Place it back in the cover after use.

SS = Single Sided, only one side of the floppy can be used
DS = Double Sided, two sides of the floppy can be used
SS = Single Density
DS = Double Density
HD = Hard Density (four double density)
Hard Sectored = floppy can be used immediately
Soft Sectored = floppy has to be prepared before use (formatting)

Nowadays mass storage of data and programmes is done on a hard disk, an external memory device. A hard disk is made of aluminium mixed with magnetic material. It consists of several plates packed in a sealed box which contains helium gas. The storage capacity of a hard disk is 50 to several hundred times larger than a floppy. The price of a hard disk depends mainly on two features:

1. The storage capacity
2. The access time

2. The Disk Operating System MS-DOS.

A computer can not work without the Disk Operating System (DOS). The American firm MicroSoft (MS) developed the Disk Operating System which is therefore named MS-DOS.

The Disk Operating System is a computer programme (software) which instructs the computer amongst others how to recognize the computer's configuration and how to deal with Input Output management.

This complex computer programme MS-DOS is regularly revised, improved and updated. Therefore one finds several "versions" of MS-DOS which will all run on an IBM PC.

Basically all versions are equal, one should be an experienced user to be able to make use of the more advanced features in updated versions.

When the computer is switched on, ("booting" the system) it will:

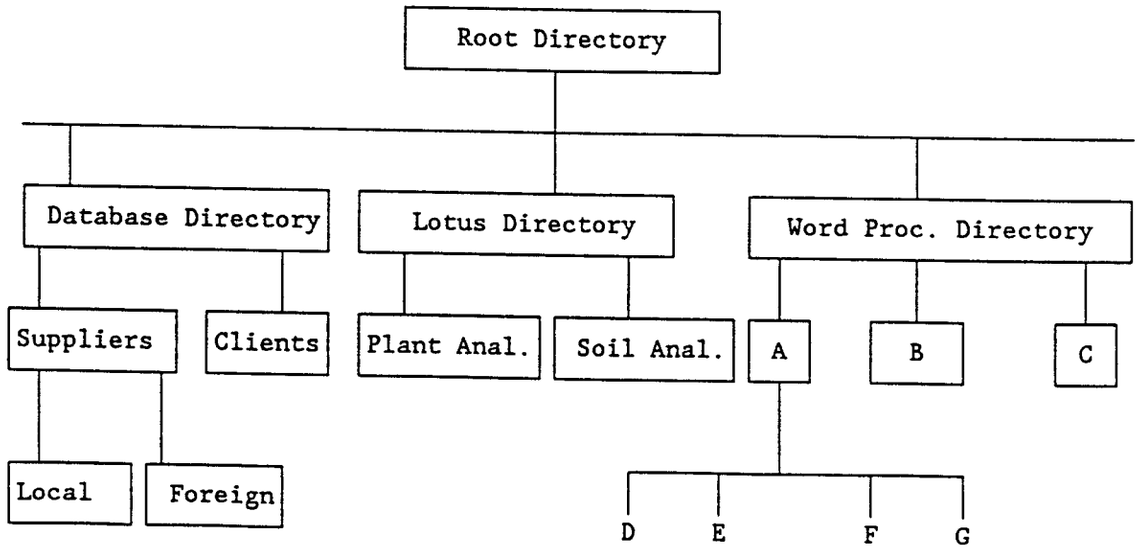
a. check its own memory and
b. search where it can find the Disk Operating System Programme, residing on a disk under the filename COMMAND.COM.

The computer is instructed to do so as this is pre-programmed in a fixed chip (hardware) which is activated when the electricity power is switched on.

As soon as the COMMAND.COM file is loaded i.e. copied from the disk (= external memory) to the internal memory, the computer is ready for use and waiting for your commands.

The hard disk is divided in directories which you can create and delete.

Example of a Directory Structure



Directories contain files and programmes.

MD (Make Directory)
CD (Change Directory)
RD (Remove a Directory)

There are seven MSDOS "survival" commands. These are the very basic commands every DOS user has to know.

List files on disk	**DIR**
Copy a file	**COPY**
Remove a file	**ERASE**
Prepare a floppy disk	**FORMAT A:**
Change the current disk drive	C: (drive letter followed by a colon)
Copy a diskette	**DISKCOPY**
Run DOS Programs	Type the programme name and press <ENTER>

MSDOS commands are executed when you press ENTER after typing the command.

The **DIR** command.

Type **DIR** followed by <ENTER>. You will see all files present in the current directory together with there sizes and date/time of creation. You also see the amount of free space on the disk. The maximum amount of files in a directory on a hard disk is 512 files and 112 on a floppy . When there are many files in the directory, the screen will scroll and there is no time to look at the files. In order to see the files page by page the switches /p or /w should be used (p for pause/page and w for wide). For more speed and ease "wildcard" characters may be used. The two wildcard characters are:

? Matches any one character in the filename
* Matches any number of characters in a file name

The **COPY** command.

The copy command copies files. **Copy LETTER.TXT b:** copies the file LETTER.TXT to the floppy in drive B. Just like the **DIR** command, also wildcard characters can be used. **Copy *.* b:** copies all files to the floppy in drive B.

The **ERASE** command.

The **erase** command erases files. The syntax is just like the **COPY** and **DIR** command; erase *.* erases all files in the current directory. Instead of erase the command **DEL** may be used (from delete).

The **A:** or **B:** or **C:** or **D:** or **E:** or **F:** command.

To change from the current diskdrive to another one, simple type the name of the drive followed by a colun and <ENTER>. MSDOS can handle up to six drives.

The **FORMAT** command.

This is the MOST DANGEROUS command. It may delete your entire harddisk during the late night hours! When you receive a new floppy, it is not always quit ready to receive information. It should be formatted first. The syntax is FORMAT a: DO NOT FORGET TO TYPE A:

The switch option /s (format a:/s) formats the floppy and copies amongst others the COMMAND.COM file on it. The floppy is then "bootable".

The **DISKCOPY** command.

The diskcopy command is used when entire 5¼ or 3½ inch diskettes have to be copied. The diskcopy command does not apply for copying the harddisk.
The syntax is: DISKCOPY a: b: The command copies the entire floppy situated in drive A to the floppy situated in drive B. When the computer has only one diskdrive you have to swap the source and target diskette in drive A.
Diskcopy is a dangerous command as it destroys all original information on the target diskette. (Use first the DIR command to check your target diskette)

The last two commands are not "build in" MSDOS commands like DIR, COPY etc. In fact they are small utility programmes supplied with the Disk Operating System diskette. Therefore the programmes DISKCOPY and FORMAT should be loaded first into the computer's memory.

To run MSDOS programmes basically the following two steps have to be taken:

1. Change from the root directory to the directory which contains your programme.

2. Type the programme name and hit <ENTER>

Finally, there are three MSDOS "panic buttons".

1. Ctrl-Break or Ctrl-C, stops a running command (emergency break)
2. Ctrl-Alt-Del, resets the computer and restarts DOS
3. The power switch which should be turned off if all other steps fail.

EXERCISES

1. Format a floppy disk (1) and reset the computer

2. Format a bootable floppy disk (2) and reset the computer

3. Copy the command.com file of floppy (2) to floppy (1), reset the computer

4. Copy the entire floppy (2) on floppy (1) and reset the computer

5. Make a directory, go to that directory and:
   a. list the files in that directory
   b. copy the command com file into that directory and list the files
   c. make a subdirectory and list the files
   d. go to that sub directory and list the files
   e. remove the directories

Some other build in MS-DOS commands (internal commands) are:

Date	DATE
Time	TIME
Show name of disk	VOL
Clear the screen	CLS
Rename a file	RENAME <FILENAME> <FILENAME>
Customize the DOS system prompt	PROMPT
Type a file on the screen	TYPE <FILENAME>

Some other MS-DOS utility commands (external commands) are:

Check the disk	CHKDSK
Display all directories	TREE
Display one screenful information	MORE <FILENAME>

(The commands TREE and MORE are often used in combination: TREE|MORE)

Print a file	PRINT <FILENAME>
Name Floppy or hard disk	LABEL

3. LOTUS 123

3.1 Introduction.

A spreadsheet is an electronic calculation sheet and consists of columns and rows. Lotus 123 has 256 columns and 8192 rows. Together they form more than two million cells in which information can be stored. In a laboratory, Lotus 123 is an excellent programme for data handling, especially when dealing with standard calculations. Calculations can be easily programmed, modified and used over and over again.

It is not the intention of this manual to cover all aspects of spreadsheet manipulations, for this purpose the literature list will be referred to. This manual may give the reader an idea of how the daily routines of a laboratory can be facilitated by means of the use of a spreadsheet with emphasis on the time consuming calculations and some aspects of quality control. The manual is a mixture of primary, intermediate and advanced spreadsheet features.

Lotus has also database facilities, however, the database can not handle more than 2000 records. Whether this is sufficient or not, depends on user's requirements and not on the yearly number of samples analyzed.

A laboratory which analyzes 1500 samples a year and decides to store sample data on a yearly bases may use LOTUS database facilities. A laboratory which analyzes 500 samples a year will eventually experience the limits of the LOTUS database possibilities when sample data are stored on a yearly consecutive way.

However, it should be emphasized that the development of software goes very fast and today's limitations are tomorrow's possibilities.

3.2. The Very Beginning

As soon as the Programme LOTUS is loaded (e.g. copied from the disk to the internal memory of the computer) one sees the columns A though H and rows 1 to 20. Those columns and rows form together 8 times 20 = 160 cells on the screen of the monitor.

Each cell is defined by coordinates (column letter and row number) like a chessboard.

The cursor is positioned in cell A1, which is also displayed in the upper left corner of the screen, and highlighted.

Cursor control and screen display

There are 6 different ways to control the cursor:

1. The cursor key (= 'arrow key') moves the cursor one place up, down, left or right.

2. Page Up and Page Down scrolls the screen one page up or down.

3. Ctrl Left or Ctrl Right cursor key scrolls the screen display left or right.

4. The combination End cursor key moves the cursor to the end or beginning of a range.

5. The HOME key moves the cursor to the most upper left part of the spreadsheet (in most cases cell A1)

6. The GOTO key (Function key F5) is used when coordinates are known.

At the right upper corner of the screen the INDICATOR shows the status of the spreadsheet. Important indicators are:

READY	LOTUS 123 is ready for inputs
VALUE	You are busy to input a value (a number, formula or function)
LABEL	You are busy to input a label (letters, words, etc)
EDIT	You are in the EDIT mode (Press Function key F2)
WAIT	LOTUS 123 is executing a command (busy to do calculations)
MENU	You are in the MENU mode (Press the SLASH key " / ")
ERROR	An ERROR has occurred, press the ESC (escape) key to continue The ERROR indicator is always followed by a beep sound (e.g. division by zero)

The ESC key is used when "things go wrong". It should be pressed as many times as necessary to return to the sheet's work environment (You are back in the sheet's work environment when you can move the cursor in the spreadsheet).

3.3 Lotus Data Input and Main Menu

A cell can contain labels, numbers, formulas or functions.

Labels are letters, characters or words (but also ZIP codes and telephone numbers) and typed straightforward into a cell; also numbers are entered straightforward into a cell.

A FORMULA should always start with either:

1. the plus sign +

2. the left bracket sign (

3. the string sign $

4. the "monkeytail" sign @

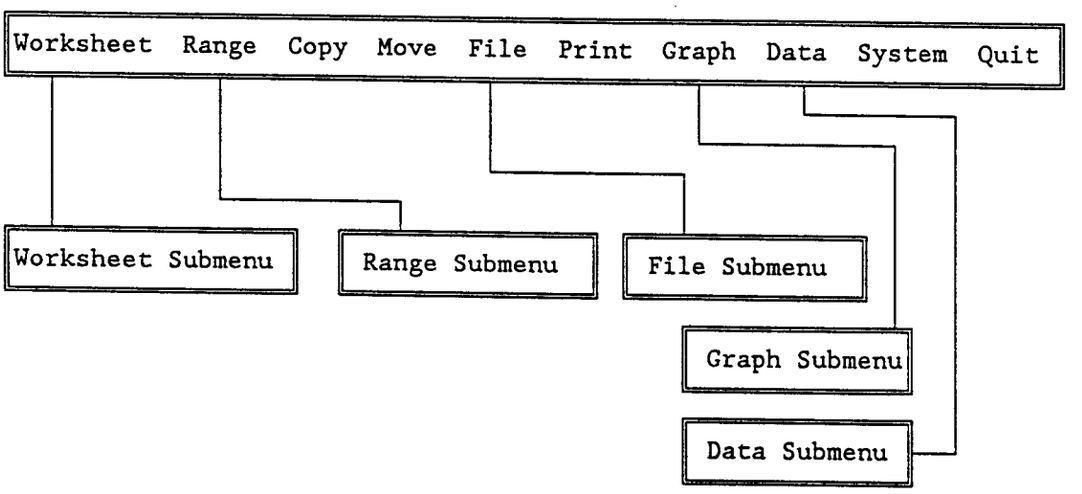
5. a numerical value and an operator (e.g. 5+ or 100*)

The monkeytail sign (@) is necessary when the LOTUS user utilizes the already build in LOTUS functions which will be dealt with later. (LOTUS distinguishes formulas from functions)

If a formula is not preceded by one of the four above mentioned options, LOTUS considers the formula as a label (words) and can not perform calculations.

The SLASH key " / " displays the main menu on top of the screen. The main menu consists of several submenus.

MAIN MENU LOTUS 123



IMPORTANT: Worksheet subcommands are effective for the WHOLE worksheet, while range subcommands are effective for part of the worksheet.

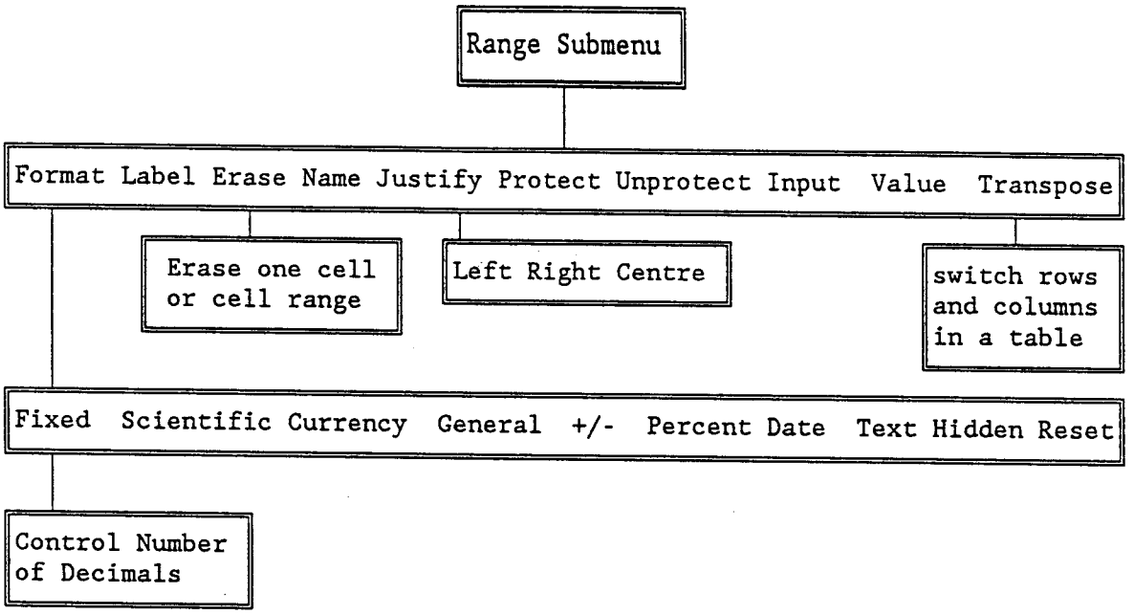
Often used menu combinations are: Range/erase (erases a defined part of the worksheet) and worksheet/erase/yes (erases the entire worksheet).

CASE 1 Getting used to the main menu (/)

Enter some numbers and words in the spreadsheet and use the copy, move, range format and range erase commands to practice with.

IMPORTANT: When one of the options of the Range Submenu is chosen, LOTUS will always ask to identify the range to be manipulated (format, erase, justify, transpose, etc).

A range is made by ANCHORING the cursor and highlighting the range to be manipulated. The cursor is anchored by pressing the dot key.

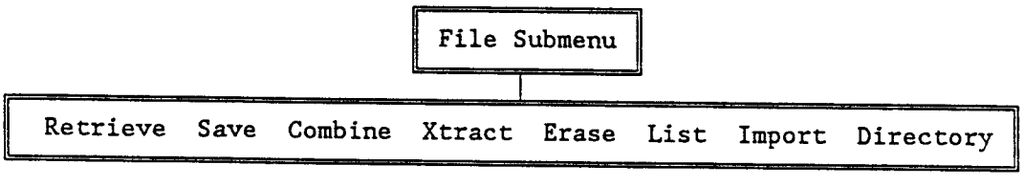


CASE 2 Getting used to save and retrieve the worksheet.

Save the worksheet, using the option File in the main menu.

Retrieve your work (/ File Retrieve) and save again. Observe the OVERWRITE warning.

If you do NOT want to overwrite your previous work, you have to choose another file name.



3.4 Relative and Absolute Cell Addressing

With formulas, you can either use relative or absolute cell addressing. The difference between relative and absolute cell addressing is best explained with two examples.

A. Referring to relative cell addresses:

In order to calculate the moisture content in a series of ten soil samples, the following observations (expressed in grams) were made:

Table 1 Weight of dish and soil before and after drying
(LOTUS 123 File: MOISTURE)

	A	B	C	D	E	F
1	weight	weight dish	weight dish	percentage		
2	empty	+ sample	+ sample	moisture		
3	dish	before drying	after drying			
5	12.129	19.073	18.993	100*((B5-A5)-(C5-A5))/(B5-A5)		
6	11.971	20.421	18.993			
7	14.316	22.547	22.304			
8	14.074	18.431	18.302			
9	13.716	21.274	21.201			
10	13.791	20.034	19.766			
11	12.041	19.561	18.986			
12	13.451	20.687	19.952			
13	12.312	19.331	18.562			
14	12.735	21.561	20.129			
16						
17						
18						
19						
20						

In cell D5 the mathematical formula is "programmed", referring to certain cell addresses. Cell D5 should be copied into the cells D6 up to D14 and the moisture content in all other samples is immediately calculated.

CASE 3 Calculate the moisture content of the ten samples and save the file

In cell D5 the cell addresses are used in a relative way. This can be visualized when the cursor is moved to cell D7. All row numbers in the formula are adjusted accordingly what can be seen in the upper left corner of the screen.

What is really stored in cell D5 is not ... B5-A5 ..., but a formula that says: "Subtract the value three cells left from the value two cells left" This is why the formula could be copied to other cells and still works correctly. Relative cell addresses store references to other cells by their position relative to the active cell.

B. Referring to absolute cell addresses:

Absolute cell addresses are often used when dealing with constant factors in a formula, e.g. normality of a solution, quantity of millilitres used for the blank. A cell is made "absolute" when the "string sign" is used before the column letter and before the row number. The string sign is the US $ sign.

In order to calculate the organic matter content in a series of ten soil samples, the following observations were made:

Table 2 Sample Weight, Molarity FeSulphate, Blank Consumption and Quantity of ml Titrated to Assess Organic Carbon Content (LOTUS 123 File: ORCARBON)

	A	B	C	D	E
1	Molarity	FeSulphate	0.9762	ml used for blank	9.95
2					
3	weight	gauge	gauge	quantity	organic
4	soil	level	level	ml	carbon
5	sample	start	end	titrated	content
6					
7	0.8576	0.01	4.88	+c9-b9	1.3*c1*(e1-d7)/a7
8	0.9682	0.03	6.35		
9	0.9658	0.06	9.56		
10	0.9396	9.56	13.67		
11	0.9100	0.10	8.56		
12	0.8956	8.56	9.99		
13	0.9901	0.00	5.90		
14	0.9698	0.01	5.21		
15	0.8925	5.21	9.31		
16	0.9006	9.31	9.61		
17					
18					
19					
20					

CASE 4 Calculate the organic carbon content of the ten samples and save the file

3.5 Lotus Functions

LOTUS 123 has many build in "ready made" functions. An overview of these functions can be found when the HELP key <F1> is pressed and

1. place the highlight above HELP INDEX (left lower part of the screen).
2. press <ENTER>
3. place the highlight above @Functions (left middle part of the screen).
4. press <ENTER>
5. place highlight above the function category of your choice
6. press <ENTER>

In order to return to the spreadsheet work environment press ESC

Functions always start with the :"monkeytail" sign @.

If a function is not preceded by the "monkeytail" sign, LOTUS considers the function as a label (word) and can not execute the command.

Often used functions are @SUM(range), @AVG(range), @STD(range), @IF

CASE 5 Retrieve the file of CASE 4"

Calculate the average weight of the soil sample
Calculate the standard deviation of the weight.
Calculate the coefficient of variation of the weight.
(coefficient of variation = standard deviation divided by the average)

CASE 6 Retrieve the file "PARTICLE" (see Table 3, page 16)

1. Format the data
2. Calculate the average clay content
3. Calculate the standard deviation of the sand data

Quality control can be obtained by using the sum of the fractions and the @IF function.

The @IF function is build up as follows:

@IF(<condition>,<then statement>,<else statement>)

In combination with the operator #OR# the Quality Control "Warning" can be limited to one column only. Another operator is #AND#

Note that the "else statement" may also consist of a second @IF function.

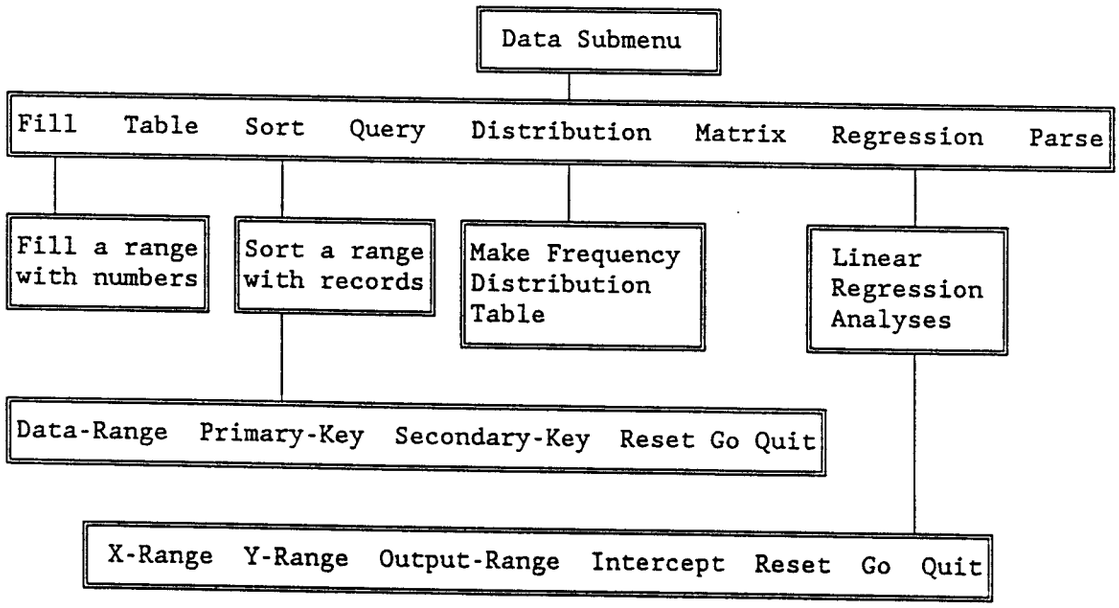
The advantage of a more complicated @IF function is the fact that different "markings" can be used for values lower and higher than the two defined limits.

The disadvantage (?) of a more complicated @IF function might be the larger use of internal memory of the computer. (Brackets in formulas are consuming relative large parts of the memory).

Table 3 Particle Size Distribution in a Series of Soil Samples
(LOTUS 123 File: PARTICLE)

	A	B	C	D	E	F	G	H
1	sample	%	%	%	sum of	Quality		
2	number	clay	silt	sand	fractions	Control		
3	---	---	---	---	---	---	---	---
4	1	28.5	1	70.5	+B4+C4+D4	@IF(E4<...#or#E4>...,"*","")		
5	2	16	1.5	82.5				
6	3	15.7	1	83.2	option:	@IF(E4<..,"-",(@IF(E4>..,"+","")))		
7	4	16	2	82				
8	5	15.4	2.8	81.8				
9	6	16	1.5	82				
10	7	13	2.41	81.67				
11	8	14.1	2.5	83.7				
12	9	17	0.89	82.4				
13	10	30	3	67				
14	.	.	.	.				
15	.	.	.	.				
16	.	.	.	.				

3.6 The Data Submenu



The data submenu has some powerful options when dealing with large amounts of data. Table 4 shows part of the results of a sample exchange round when the same soil sample was analyzed on CEC and exchangeable bases by different laboratories. The LOTUS file is named CEC.

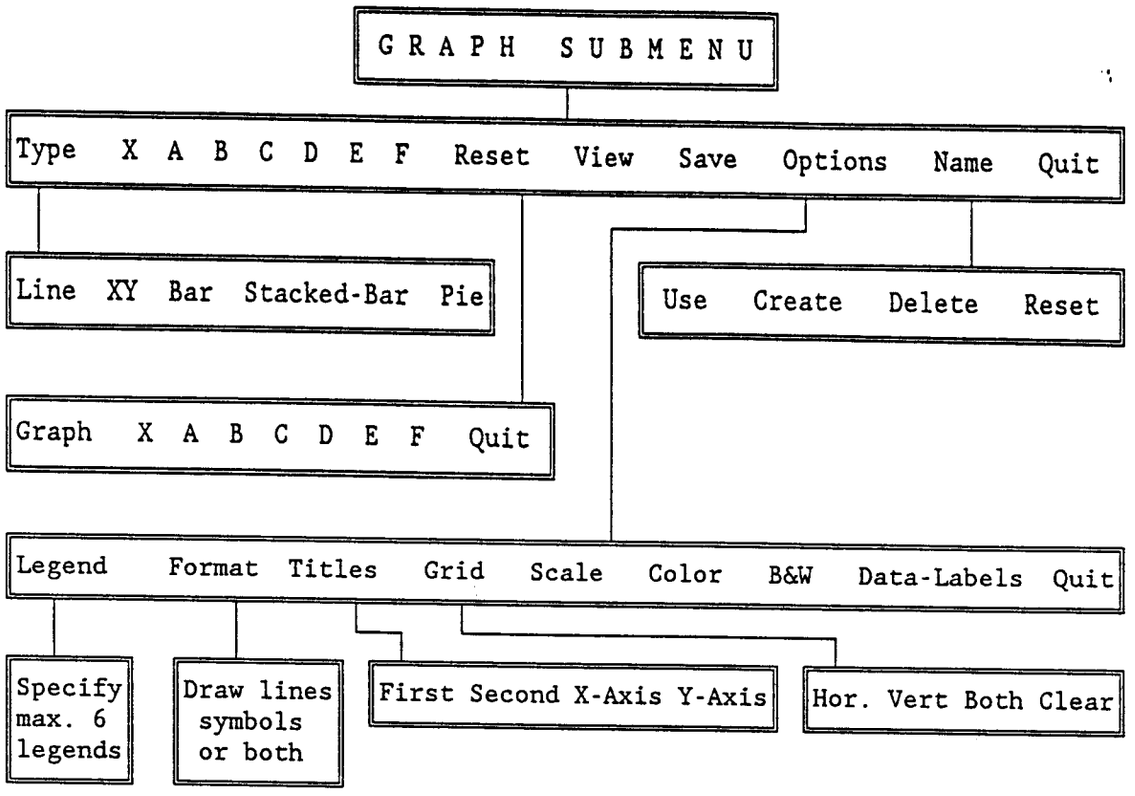
Table 4 CEC and exchangeable bases in a Series of Soil Samples (LOTUS 123 File: CEC)

	A	B	C	D	E	F	G	H
1	CEC	ex-K	ex-Na	ex-Ca	ex-Mg	ex.		
2	me/	me/	me/	me/	me/	bases		
3	100g	100g	100g	100g	100g	(%)		
4								
5	1.9	0.1	0.1	0.9	0.5			
6	4.75	0.1	0.01	0.24	0.24			
7	2.15	0.1	0	0.1	0.3			
8	2.52	0.12	0.19	0.32	1.79			
9	3.5	0.1	0	1.73	0.25			
10	3.14	0.09	0.01	0.1	0.15			
11	2.2	0.04	0.11	0.9	0.2			
12	3.92	0.11	0.03	0.96	0.73			
13								
14								
15								
16								

CASE 7 Retrieve the file "CEC"

1. Format the data
2. Calculate the base saturation (sum of bases divided by CEC times 100%)
3. Calculate the standard deviations for CEC and exchangeable sodium
4. Calculate coefficients of variation for CEC and exchangeable sodium (coefficient of variation = 100 times standard deviation / mean)
5. Check and mark for base saturations >100% (use the @if function)
6. Check and mark for CEC values larger or smaller then twice the standard deviation (use the @if function and use an absolute cell address in the @std function)
7. Give sample numbers (use Data Submenu FILL)
8. Make frequency distribution table for CEC values (use Data Submenu DISTRIBUTION)
9. Sort on base saturation (use Data Submenu SORT)
10. Save the file.

3.7 The Graph Submenu



CASE 8 Graphical presentations

A laboratory equipped to analyze soil, plant and water samples analyzed in 1989 the following quantities:

Type of samples	1st quarter	2nd quarter	3rd quarter	4th quarter
soil	125	135	150	175
plant	150	150	170	110
water	175	200	230	220

1. Make a line and bar graph of the soil analyses in 1989 and name the graph.
2. Make a line and bar graph of the plant analyses in 1989 and name the graph.
3. Make a line and bar graph of the water analyses in 1989 and name the graph.
4. Make a total graphical presentation for the year 1989 regarding the quantities of different sample materials and total analyses per quarter (use bar and stacked bar graphs) and print this graph by:

a. Name and Save the graph
b. Save the spreadsheet
c. Quit the Lotus 123 Programme
d. Start the Print Graph Programme; use options Image Select and Go.

IMPORTANT

The two options NAME and SAVE in the graph submenu are often confusing but are used for the following purposes:

NAME is used to attach the graph to the spreadsheet (under a name which not necessarily needs to meet the requirements of an MSDOS file name). It is possible to edit the graph if the spreadsheet is saved.

SAVE is used when you want to print your graph. The graph name should meet the requirements of an MSDOS filename and is no more attached to the spreadsheet. Apart from the graph size it is not possible to edit the graph.

It is advised to NAME a graph BEFORE SAVING.

CASE 10 Graphical presentations (continued)

1. Retrieve the file "CEC"
2. Make a bar graph of the CEC frequency distribution and name the graph
3. Make a pie chart of the CEC frequency distribution and name the graph
4. Save and print both graphs

3.8 Macro's

A macro is a series of commands that perform a desired task.

Macros are mostly used for the following two purposes:

- When simple keystrokes are often repeated

- When a complex series of keystrokes must be performed by an inexperienced operator.

The latter may eventually lead to the creation of interactive macros with branching and decision control commands which goes beyond the scope of the course.

A macro is defined by:

a. A range name consisting of only one letter, in this case the letter should be preceded with the backslash (\) or, once the macro is initiated, it can be chained to other macros with

b. A range name consisting of a series of letters, in this case it is advised to use a word which indicates the purpose of the macro.

How to create a macro?

Simply enter the necessary keystrokes to perform the desired task into a worksheet cell and use the "range name" command to assign a name to that cell.

How to activate a macro?

Press both the ALT key and the corresponding range name letter (only one letter macros can be initiated from the keyboard).

Calling the Lotus Main Menu is often the first task of a macro. In this case the "backslash" should be preceded with a label ('). All macros are in fact labels. Therefore if a macro starts with a number or formula it should be preceded with a label. The TILDE (~) is used to activate the <ENTER> key.

You may enter up to 256 keystrokes in one single cell. However, from a practical point of view it is advised to keep the quantity of keystrokes limited to 30 or 40 strokes in one cell. When LOTUS performs a macro it will jump to the next row when all commands in the first row are executed and stops when an empty cell is encountered. Therefore macros are build up columnwise and are easily modified, tested and debugged when the quantity of strokes in a single cell is not too large.

Examples of keystroke macro's:

When creating huge worksheets with a lot of data, it is wise to save the sheet regularly. This procedure is done automatically by simply entering the following six keystrokes in a cell: '/fs~y

To set the columnwidth: '/wcs

To format a cell for date format: '/rfd~~

to enter today's date in a cell: '/wcs10~/rfd~~@now~

changing a number into a label: {edit}{home}'~{down}

The last example is a simple form of a non-keystroke macro and can be used to change a column of "telephonnumbers" into "telephonlabels".

LOTUS 123 has a special build in command language which enables you to create menu-driven applications which leads the user automatically through a series of tasks.
The available macro commands in LOTUS 123 can be found using the HELP function (press the F1 key, move down to Help Index <ENTER>, Macros <ENTER>, Continued <ENTER>, Macrokeywords <ENTER>). A complete list of available macro commands is also given below.

BEEP	FOR	MENUBRANCH	RECALC
BLANK	FORBREAK	MENUCALL	RECALCCOL
BRANCH	GET	ONERROR	RESTART
BREAKOFF	GETLABEL	OPEN	RETURN
BREAKON	GETNUMBER	PANELOFF	SETPOS
CLOSE	GETPOS	PANELON	WAIT
CONTENTS	IF	PUT	WINDOWSOFF
DEFINE	INDICATE	QUIT	WINDOWSON
DISPATCH	LET	READ	WRITE
FILESIZE	LOOK	READLN	WRITELN

We will develop a small user interactive macro which may form the base of a larger and more complex system used in a laboratory. We will combine the files MOISTURE and PARTICLE using a simple menu driven application.

1. Make a new worksheet (/ worksheet erase yes)
2. Create a menu using macro command {MENUBRANCH}. (Name the macro \a)

```
Example:    type in cell b1 {menubranch e1}
            type in cell e1 moisture content
            type in cell e2 calculation of
            type in cell e3 '/frmoisture~

            type in cell f1 particle size distribution
            type in cell f2 calculation of
            type in cell f3 '/frparticle~
```

3. Save the file

4. Test and possibly debug your macro. When the macro works correct, name the macro \0 and save again. The \0 macro is an autoexecute macro; it will be activated immediately after you load the worksheet.

5. Load the file moisture. In this worksheet we have to instruct the user to enter all his data and then activate a macro. For this purpose we insert some empty rows on top of the worksheet (menu, worksheet, insert, row) and display the message:
   PLEASE ENTER YOUR DATA and PRESS <ALT> S TO START CALCULATIONS.

6. In an empty place of the worksheet we create the macro "\s" (menu, range, name, create, \s, <ENTER>.

7. The macro "\s" must do the following steps:
   a. go to the first calculated moisture content in column D
   b. copy this formula down to the last data input
   c. jump into a menu which gives the user a.o. a choice to continue data input or exit the moisture content file

```
ad a. Example {HOME}{GOTO}d7~
ad b. Example '/c~{DOWN}.{LEFT}{END}{DOWN}{RIGHT}~
ad c. Example {MENUBRANCH K1}
```

In cell K1 we start to design the menu:

```
Example:
Enter in K1 Data
      in K2 Input more
      in K3 {goto}a7~{end}{down}{down}

Enter in L1 Main Menu
      in L2 Back to
      in L3 '/fr (retrieve the file with the autoexecute macro which you saved
      under 3).
```

Examples of more complex macros can be found in the files TRIANGLE.WK1 and LINREG.WK1.

The file TRIANGLE.WK1 will graphically plot clay, silt and sand percentages in the texture triangle while LINREG.WK1 will calculate and plot a linear regression line using concentrations and extinctions of a standard series. The measured extinctions in the samples are converted to concentrations.

3.9 Literature

Lotus 1-2-3 Release 2.2 Reference Manual	Lotus Dev. Cooperation
Advanced Business Models with 1-2-3™	Stanley R. Trost
The ABC'S of 1-2-3™	C. Gilbert & L. Williams
The Hidden Power of Lotus 1-2-3: Using Macros	R.W. Ridington