FINITE MATHEMATICS ON THE HP 95LX

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This workshop concerned the use of spreadsheets to enhance the teaching of courses designed for non-science majors such as a finite mathematics course. A typical finite mathematics course deals with a wide variety of mathematical models applicable to business, social and life sciences. Spreadsheets provide an excellent tool for the construction and analysis of these models; in fact, that's why electronic spreadsheets were created ([1]). Spreadsheets provide an electronic medium, which serves as both a blackboard and a notebook, that allows the interactive use of text, graphs, formulas and numerical data.

Spreadsheets can be integrated into a course either as laboratory assignments that reinforce classroom discussions and explore relationships or as part of classroom discussions. Since spreadsheet are widely used in business, industry and other disciplines the problem solving skills students develop with this software are immediately transferable to the mathematical environment they encounter in workplaces.

The HP 95LX makes the classroom use of spreedsheets practical. It is a handheld computer which provides access to the power of a spreadsheet anywhere from a classroom to a park bench. It removes the need to carry tables for looking up values such as the z-scores for normal probability distributions and various financial multipliers. An additional advantage of the HP 95LX is the ability to use the clipboard to exchange values between its Lotus spreadsheet and the HP calculator.

In this workshop, using the HP 95LX, some of the modeling capabilities of Lotus 1-2-3 appropriate for a finite mathematics course were illustrated. The first two topics considered were algebraic formulas and graphs. The remaining topics depend in one way or another on these basic ideas. Applications to finding extrema and zeros were illustrated. Three additional topics were presented after the basics: matrix applications, financial models and regression. The matrix inverse and multiplication operations were used to explore the meaning of "inverse" and to solve systems of equations with nonsingular coefficient matrices. Lotus 1-2-3 can be used to model problems involving compound interest, annuities, present value, and amortization. In Appendix A a sample assignment dealing with the future value of an annuity is provided.

The last topic presented in the workshop concerned linear and multilinear regression. Regression provides an introduction to curve fitting, an extremely important topic whose inclusion in elementary courses only became practical with the availability of computers. By the introduction of appropriate transformations other curves such as powers, exponential, and logistic can be fit to data. This provides an excellent opportunity to reinforce properties of logarithms and exponentials. Tools such as regression allow students to connect data with

mathematical functions, i.e., to see the relationships between mathematics and the world around them. A sample regression assignment is provided in Appendix B.

Other topics from finite mathematics could have been chosen for illustration. The list could include frequency distributions and descriptive statistical measures, propositional logic, probability, and simulation using random number generation and table lookup functions.

Reference

[1] Steven Levy, A spreadsheet way of knowledge: how the computer is reshaping American business-for better and for worse. Harper's, 269, Nov. 1984, pp 58-64.

Appendix A FINANCIAL MODELING

This assignment deals with the (future) value of an **ordinary annuity.** A typical problem is as follows:

> Fred Jones plans to deposit $100 at the end of **each** quarter into an account that pays 8% annually, compounded quarterly. What will be the value of the account at the end of the 4th quarter (payment)?
> (If Fred made his deposits at the beginning of each quarter instead of at the end, this would be an Annuity Due problem.)

1. Start with a clean worksheet and enter the following text, numbers and formulas. Additional information will be filled in below. Note that each of a series of deposits are called "payments".

	A	B	C	D	E	F
1	Annuity problem			period	end-balance	
2	payments	100		1	+B2	
3	rate/yr	0.08		2	+E2+E2*$B$7+$B$2	
4	period/yr	4		3		
5	'#periods	4		4		
6						
7	rate/period	+B3/B4				
8	total amt					

2. Cell E2 contains the deposit at the end of Quarter #1; the formula in E3 adds the interest to the value in cell E2 together with another payment. Copy the formula in E3 to cells E4..E5 in order to see the balance at the end of the 4th quarter.

3. We want to compute the Total amount in cell E5 directly. In cell E7 enter the formula for the Future Value of an ordinary Annuity found in the text using cell B2 for R, cell B7 for i, and cell B5 for n. The result should be the same as given in cell E5. Because the formula is messy, Lotus provides a built-in function that does the computation; enter the formula **@FV(B2,B7,B5)** in cell B8 and check that it gives the same value found in cell E5.

Now you are ready to become a financial consultant! Assume all annuities below are ordinary annuities.

4. a. Peter, who is 35 years old, intends to make monthly contributions of $300 into a fixed account until he retires at age 65 -- that's 360 months. The account earns interest at an 8% annual rate, compounded monthly. What will be the future value (ordinary annuity) of Peter's account when he retires?

b. Peter's friend Paul hears about Peter's good deal; He starts to contribute $300 a month into the same plan, but Paul starts one month later than Peter. How much less will Paul earn just because he only contributed for 359 months?

c. Patty started contributing to the retirement account at age 25 and plans to contribute $150 monthly for 40 years (480 months). What is the future value of her account and how does it stack up with Peter and Paul?

5. a. When Dick is 25 years old he starts making a $200 a month contribution into an IRA for 10 years. He then discontinues the contributions and allows the account to accumulate interest for the next 30 years. Find the total amount that Dick accumulates assuming that the annuity and the account both earn interest at 7% compounded monthly.

b. Jane also makes monthly contributions of $200 into an IRA, but begins at age 35 and contributes for 30 years. Find the future value of Jane's account assuming that it also earns interest at a 7% annual rate compounded monthly.

c. Write a short paragraph that contrasts the investment strategies of Dick and Jane. For example, compare the differences in contributions with the differences in total accumulation. Which strategy would you recommend?

Appendix B REGRESSION

In this assignment you construct a **scatter diagram** for a set of data, find the "best fitting" **regression line**, and use the linear equation to predict values of the dependent variable.

We start with the following situation. A company has the following production costs:

Units produced (in 1000s)	2	3	5	7	8	10
Costs (in $1000)	12	21	34	52	54	63

Place the labels "No.Units" in cell A1 and "Costs" in cell B1. Then place the data in the respective columns.

a. **Scatter Diagram.** Construct an Xy-graph using the settings:
X-range: A2..A7 (for the independent variable) and
A-range: B2..B7 (for the dependant variable).

A scatter diagram is an Xy-graph using **only symbols**, without the lines. To arrange this, from the **Graph menu**, select
Options Format A Symbols Quit Quit.
After Viewing the graph return to the worksheet.

b. **Regression analysis.** We plan to use the number of Units as the independent variable, the Cost as the dependent variable, and place the output information in columns D to G. Press **/DR** to bring up the Regression menu and enter the following settings:
X-range: A2..A7
Y-range: B2..B7
Output range: D1 (the upper left corner of output range)
To run the regression select **Go**.

Look at the Regression Output in cells D1..G9. What is the **Constant**? What is the **X Coefficient**? In cell D12 write the linear equation that is the "best fit" to the Cost from the No. of Units. How good is the fit?

c. **Estimating the dependent variable.** We want to predict the cost for different values of the independent variable and compare with the scatter diagram. First you need to use the linear equation you found above to estimate Costs for the No. of Units you know. In cell C2 enter the formula **$F$8*A2+$G$2**. Copy the formula in cell C2 to C3..C7.

To estimate the cost of producing say 6500 units place the value 6.5 in cell A9 and copy the regression formula from C2 to C9.

To superimpose the regression line on the scatter diagram, go to the Graph-menu, select the **B** range and enter the setting:
B-range: C2..C7

Additional Practice

1. The Consumer Price Index (CPI) for years 1969-1991 is given below. The data is in the file CPI.wk1. The values are for the index at the end of the year and are based on prices in 1969. Note: the value of this index will differ from that reported in local newspapers. Because of the sensitive political nature of these numbers, the reference period has been changed twice since 1969 (in 1978 and 1988) and in 1978 the index was split into two populations. The CPI-Urban is used since it covers 80% of the population.

Year	Period	CPI	Year	Period	CPI
1969	0	100.0	1981	12	249.2
1970	1	105.2	1982	13	259.9
1971	2	108.9	1983	14	267.0
1972	3	113.3	1984	15	276.0
1973	4	123.5	1985	16	286.0
1974	5	137.1	1986	17	291.4
1975	6	146.9	1987	18	301.9
1976	7	155.4	1988	19	309.3
1977	8	165.8	1989	20	323.6
1978	9	181.4	1990	21	344.2
1979	10	205.5	1991	22	354.9
1980	11	229.3			

a. Use linear regression to find the "best" linear equation that expresses the CPI as a function of time.

b. Predict the value of the Consumer Price Index (CPI) at the end of 1992. By what percent would you predict prices to raise during 1992?

2. To prescribe the appropriate amount of certain drugs it is important for doctors to estimate a patient's % body fat. This is equivalent to finding the Lean Body weight (LBWt), i.e., weight not counting body fat. Your task is to develop a linear formula that estimates the LBWt of a man from his actual weight and waist size.

A study of 10 men gives the measurements below. The data is in the file FAT.wk1.

Wt (lbs)	130	186	164	148	152	165	180	152	170	168
Waist (in)	32	38	36	34	36	38	42	40	39	36
LBWt (lbs)	108	142	128	118	116	120	130	100	125	130

a. Determine a linear equation

LBwt = (Coef.1)*Wt + (Coef.2)*Waist + Constant

that best fits the lean body weight of a man. (Remember to use <u>both</u> Wt and Waist as independent variables.) Are both independent variables significant?

b. Predict the lean body weight of a man weighing 160 lbs. with a 34 inch waist.