

Overview and examples from

Finite Mathematics
Using Microsoft Excel[®]

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An electronic supplement to *Finite Mathematics and Its Applications*, 6th Ed. , by Goldstein, Schneider, and Siegel, Prentice Hall, 1997

Introduction

In any introductory mathematics course designed for non-mathematics majors, it is important for the student to understand and apply mathematical ideas in a variety of contexts. With the increased use of advanced software in all fields, it is also important for the student to effectively interact with the new technology. Our goal is to integrate these two objectives in a supplement for the text *Finite Mathematics and Its Applications*, by Goldstein, Schneider, and Siegel.

The package consists of interactive tutorials and projects in an Excel workbook format. The software platform used is the Microsoft Excel 5.0 spreadsheet. It was chosen for the following reasons:

- suited to applications encountered in a finite math course
- widespread use outside of academia
- ease of creating reports with a professional look

Use of Excel 5.0 was put into effect in the author's sections of the Finite Mathematics II course in the Spring 1996 semester. It was expanded to cover the Finite Mathematics I course for the Fall semester of 1996. Using a combination of specially designed projects and tutorials, students are able to analyze data, draw conclusions, and present their analysis in a professional format. The mathematical and computer skills learned with such an approach is an asset that they can carry with them to other courses as well as to their future places of employment.

Scope of supplement

The package is divided into three portions - introduction to the software platform, interactive tutorials to reinforce ideas, and projects of more complexity.

Introduction to the software

Worksheets which contain just enough essentials about Excel to get the students started quickly have been written specifically for this course. The interactive nature of the worksheets lends itself to a quick learning curve so that the student can spend his or her time learning *mathematics* on Excel.

Tutorial worksheets

These worksheets illustrate a particular topic studied in finite mathematics using the capabilities of Excel. These tutorials can be used as in-class activities in the course and can also be used as homework assignments. In addition to original problems in the tutorials, suitable problems from the text are also suggested. Instructors may find these tutorials helpful in designing lectures which incorporate computer presentations.

Projects

The project worksheets are more complex in scope and require a synthesis of the various topics covered in the course. Students are encouraged to work in groups and are required to turn in well formatted printouts using Excel and perhaps a word processor such as MS Word.

Integrating the materials in class

The topics chosen for the package were ones that would take full advantage of the capabilities of the spreadsheet software. The following objectives are stressed:

- algebraic, graphical, and tabular representation of equations and data
- exploratory experiments with data
- synthesis of mathematical ideas
- applications in a variety of contexts
- clear communication of results

In the author's classes, the course software *Explorations in Finite Mathematics*, by David Schneider, was used in a complementary fashion to the Excel package. Illustrating a procedure such as Gauss-Jordan reduction, graphical linear programming, or working with Venn diagrams is much simpler using the *Explorations* software. On the other hand, the spreadsheet is much easier when used to integrate diverse components of a complex problem. The integration of mathematics, text, and graphics makes the spreadsheet highly suitable for problems which illustrate a particular concept rather than procedure. It is with this idea that the tutorials and projects in this package were created.

Consequently, the students in our classes used the *Explorations* package to practice on the procedures themselves and used the Excel projects and tutorials to understand a general concept and apply it in various contexts.

Prior knowledge of Excel is not required for use of this package. The introductory workbook discusses general features of Excel that students will need to master. All one has to do is to start up the software and open the *intro.xls* file. Other, more specific features are discussed as the need arises. It is advisable for the instructor to go through the tutorials and projects before making specific assignments for the students.

Students are encouraged to ask questions in class about their computer assignments. The questions related to the mathematical aspects of the projects are often discussed. Any particular technical issue involving the software is usually discussed with the student(s) outside of lecture.

Lectures involving computer and overhead presentations can benefit from many of the tutorials in the package. The content of the presentation should serve as a complement to the lecture. Examples of such presentations are simulations of

random processes and graphical analysis of data. In our experience, short, to-the-point presentations tend to be more effective than those in which the presenter is working through multiple menu options, dialog boxes etc. Since the tutorials are available to the students, the presentation itself can be gone over by the student in his or her own time, thus reinforcing and expanding the ideas in the lecture.

A detailed summary of the tutorials and projects is given at the end of this introduction to aid in planning a course syllabus integrating this package.

Description of materials

All materials are in the form of Excel workbooks in MS Windows format. They should run on Excel 5.0 and later versions under Windows 3.X or Windows 95. Each tutorial and project is in a separate worksheet within the corresponding workbook.

Introductory workbook

In this workbook, basic concepts of Excel are introduced. An interactive tutorial is used to introduce concepts of formulas and graphs.

Filename: [intro.xls](#)

The descriptions of the tutorials and projects are listed in a table format in the following pages.

Summary of Tutorials in *Finite Mathematics Using Excel*

Chapter and corresponding section(s)	Tutorial Number	Summary	Comments
1. Linear Equations and Straight Lines Sec. 1.3,1.4 Sec. 1.3 Sec. 1.3 Sec. 1.5	1	Linear equations for a depreciation model - graphics and tables	<i>File: chap1.xls</i>
	2	Linear equations and Excel's Goal Seek	Introduces "Goal Seek", a built-in tool for analysis
	3	More applications using Goal Seek	
	4	Least Squares using Excel's built-in functions	Intrinsic Excel function and graphics are introduced for least squares
2. Matrices Sec. 2.3 Sec. 2.3 Sec. 2.3 Sec. 2.4 Sec. 2.4,2.6	1	Entering and adding Matrices	<i>File: chap2.xls</i> This tutorial is necessary for entering and working with arrays
	2	Multiplying Matrices	Array formulas are somewhat inelegant to enter in Excel. These tutorials help students practice this.
	3	Applications of Matrix Multiplication	
	4	Computing Matrix Inverses	
	5	Solving Linear systems	
4. Simplex Method Sec. 4.2,4.3 Sec. 4.2-4.4 Sec. 4.2-4.4	1	Linear Programming Using Excel Solver	<i>File: chap4.xls</i> Necessary for all subsequent work with Solver
	2	Solver's Answer Report	Useful for students to connect the examples in text with the setup in Solver
	3	More Solver Practice	
	4	Understanding Duality Using Excel Solver	

Summary of Tutorials in *Finite Mathematics Using Excel* - cont'd

Chapter and corresponding section(s)	Tutorial Number	Summary	Comments
6. Probability Sec. 6.4,6.5 Sec. 6.4,6.5 Sec. 6.8 Sec. 6.8	1	Data and probabilities : a graphical approach	<i>File: chap6.xls</i> Probabilities and conditional probabilities are explored through pie-chart representation Probabilities and conditional probabilities are explored through tabular representation The objective in both these tutorials is to help students visualize and gain a better intuition for probabilistic notions Necessary for all further simulation activities using Excel Continuation of Tut. #3; introduces graphics
	2	Data and probabilities : a tabular approach	
	3	Simulation of Events - I	
	4	Simulation of Events - II	
7. Probability and Statistics Sec. 7.2 Sec. 7.2,7.5 Sec. 7.2 Sec. 7.3,7.4 Sec. 7.5 Sec. 7.6	1	Measuring Central Tendencies	<i>File: chap7.xls</i> Explores differences between mean, median, and mode Built-in Excel functions are introduced for calculating binomial and normal probabilities Data Analysis Tool is used for simulation of binomial trials Uses Excel's built-in functions for mean etc. The Data Analysis Tool in Excel is used to simulate experiments with normally distributed data
	2	Calculating Binomial and Normal Probabilities	
	3	Simulation of Binomial Distributions	
	4	Using Statistical Functions in Excel	
	5	Simulation of Normal Distribution	
	6	Binomial Distribution and the Normal Curve	

Summary of Tutorials in *Finite Mathematics Using Excel* - cont'd

Chapter and corresponding section(s)	Tutorial Number	Summary	Comments
8. Markov Processes Sec. 8.1	1	The Transition Matrix	<i>File: chap8.xls</i> All the tutorials in this chapter use array formulas - see Chapter 2 tutorials
Sec. 8.2	2	Stable distributions and stochastic matrices	
Sec. 8.3	3	Absorbing Stochastic matrices	
9. The Theory of Games Sec. 9.2	1	Expected Value of Strategies	<i>File: chap9.xls</i> Uses array formulas - see Chapter 2 tutorials
Sec. 9.2	2	Optimal Strategies Using Solver	
10. Mathematics of Finance Sec. 10.1	1	Calculation of Interest	<i>File: chap10.xls</i> Generate tables to calculate interest - provide intuition for the process
Sec. 10.1	2	Using Excel Functions for Finance	
Sec. 10.2	3	Annuities	
Sec. 10.3	4	Amortization of loans	
11. Difference Equations Sec. 11.1	1	Difference Equations - Tables	<i>File: chap11.xls</i> Tables are generated to motivate work with difference equations
Sec. 11.1	2	Difference Equations - Charts	
Sec. 11.2	3	Difference Equations and Mathematical Models	

Chapter and corresponding section(s)	Tutorial Number	Summary	Comments
Sec. 11.3	4	Exploring graphs of Difference Equations	Further exploration of graphs of difference equations
Sec. 11.5	5	Growth/Decay Models Using Difference Equations	Studies radioactive decay models using difference equations

Summary of Projects in *Finite Mathematics Using Excel*

Chapter and corresponding section(s)	Project Number	Summary	Comments
1. Linear Equations and Straight Lines Sec. 1.3,1.4 Sec. 1.3 Sec. 1.5	1 2 3	Cost, revenue and breaking even Analyzing supply and demand equations Least squares analysis of data	<i>File: chap1.xls</i>
2. Matrices Sec. 2.4 Sec. 2.6	1 2	Application of linear systems of equations An open Leontief model	<i>File: chap2.xls</i>
4. Simplex Method Sec. 4.2,4.3 Sec. 4.2,4.3 Sec. 4.2,4.3	1 2 3	Allocation of Assets Using Excel Solver Risk Management Using Excel Solver Exercise plan analysis	<i>File: chap4.xls</i>
6. Probability	1 2 3	Analyzing means of transit to work Analyzing travel time to work Simulating reservoir capacity	<i>File: chap6.xls</i>

Summary of Projects in *Finite Mathematics Using Excel* (cont'd)

Chapter and corresponding section(s)	Project Number	Summary	Comments
7. Probability and Statistics Sec. 7.3,7.4 Sec. 7.3-7.5 Sec. 7.3-7.5	1	Statistical analysis of mutual fund data	<i>File: chap7.xls</i> Needs Data Analysis Tool installed
	2	Analysis of housing data	
	3	Data Simulations	
8. Markov Processes Sec. 9.1-9.2 Sec. 9.1-9.2	1	Application of stochastic matrices	<i>File: chap8.xls</i>
	2	Car breakdowns and stochastic matrices	
9. Theory of Games Sec. 9.2-9.3 Sec. 9.2-9.3	1	Advertising strategies	<i>File: chap9.xls</i>
	2	Investing strategies	
10. Mathematics of Finance Sec. 10.1 Sec. 10.2,10.3	1	Interest rates and yields	<i>File: chap10.xls</i>
	2	Mortgages: principal and interest	
11. Difference Equations Sec.11.1 Sec. 11.3,11.4 Sec. 11.3,11.5	1	Comparison of Interest Rates	<i>File: chap11.xls</i>
	2	How much can you borrow?	
	3	Modeling bacterial growth with difference equations	

In this tutorial, we will learn to use some basic features of Excel Solver in order to solve linear programming problems. Note that this solver can handle much more number of variables than the course software used in class.

Example: This example is an extension of the furniture manufacturing problem discussed in Chapters 3 and 4 of your text. For this example, in addition to chairs and sofas, the product line will also include loveseats. Each product will need to spend time in the carpentry, finishing and upholstery divisions. The table below summarizes the amount of time each product will need in each division.

Process	Chair	Sofa	Loveseat
Carpentry	6	3	2
Finishing	1	1	1
Upholstery	2	6	4

Each chair makes a profit of \$80; each sofa makes a profit of \$70; and each loveseat makes a profit of \$66. How many chairs, sofas, and loveseats must be manufactured if there are 96 hours for carpentry, 18 hours for finishing and 72 hours for upholstery?

Solution:

Your setup : Before calling on Excel power solver, set up the linear programming problem yourself. That is, write down the objective function, variables, and constraints.

In order to compute with Solver, we summarize the problem in the following table.

			Chair	Sofa	Loveseat
Number to Build->			0	0	0
Process	Hrs. Available	Hrs. Used			
<i>Carpentry</i>	96	0	6	3	2
<i>Finishing</i>	18	0	1	1	1
<i>Upholstery</i>	72	0	2	6	4

Profits

Per unit	\$80.00	\$70.00	\$66.00
Subtotal	\$0.00	\$0.00	\$0.00
TOTAL	\$0.00		

Solving the problem with Solver:

(1) First take some time to see how the problem has been set up in the table format. The mauve colored cells are the answers you are after - the optimal product mix and the total profit.

(2) To “play” with the problem, try changing the number of sofas, chairs, and loveseats by entering some numbers. What happens to the column d43:d45? Does your “play mix” satisfy the constraints?

(3) Note that the objective is to maximize the profit, the expression for which is in cell E50. Go to that cell and see how the formula is entered. Also go to other cells with data and see how they are entered.

NOTE: Sometimes you will see \$F\$9 for a cell reference instead of F9. \$F\$9 is called an ABSOLUTE REFERENCE. No matter where you copy a formula using \$F\$9, F9 will always be its location. See the Online Help topic on Formulas for more information.

(4) To see the Excel solution for this problem, click on the **Tools** in the menu bar. Pick **Solver** option. It will give you a dialog box. PAUSE ... look at the constraints and the objective.

(5) The Excel Solver accepts the constraints in a way which is compact and follows the structure of the spreadsheet. This is summarized as follows:

Problem Specifications

Target Cell	E50	Goal is to maximize profit
Variables	E41:G41	Units of each product to build
Constraints	D43:D45 <= C43:C45	Number of hours used must be less than hours available
	E41:G41 >= 0	Number to build value must be greater than or equal to zero

(6) How do these constraints follow from the setup you did earlier?

(7) Click on the SOLVE button in the dialog box. Also, click on the button for ANSWER - this will generate an answer report.

(8) What answer does Solver give you?

Chapter 4: Project 1

Allocation of Assets using Excel Solver

You are faced with investing in three different stocks, a municipal bond, and a CD (certificate of deposit). The annual return and risk on these various investments is summarized as follows:

<u>Name</u>	<u>Annual yield</u>	<u>Risk level</u>
<i>Stock A</i>	11%	2.5
<i>Stock B</i>	8%	1.5
<i>Stock C</i>	10%	1.3
<i>Muni. Bond</i>	7%	0.8
<i>CD</i>	4%	0

There are some constraints, however. Since you want to be a bit safe, you want to invest at least 10% of your principal in CD's. The total risk level you can tolerate is 1.7. The total risk is weighted by the portion in each type of investment. That is, if you had 60% of your principal in Stock A and 40% in municipal bonds, then your total risk is $.6 * 2.5 + .4 * .8 = 1.82$. Also note that your total allocation must add to 100%.

(1) How would you allocate your principal, by percentage, so as to maximize your return? Use Excel Solver. You will need to construct an extension to the given table above so that you can summarize all the information required for the Solver. Refer to **ch4tu1** for suggestions. Generate an answer report. ALSO, WRITE YOUR SETUP .

(2) Summarize the results you get and explain why it makes sense.

(3) What are some simplifying assumptions that we have made when formulating this problem? (Analyzing more sophisticated models is the subject of much current research in investment theory.)

Calculating Binomial Probabilities

These types of calculations are easy using Excel's built-in statistical functions.

Example: Let's look at Example 2 from Sec. 7.2: 58% of all married women in the US are in the work force. Five married women are selected at random. Find the probability that at least one of them is in the work force.

Solution: Note that $\Pr(X \geq 1) = 1 - \Pr(X = 0)$. That is, the probability that at least one woman works is $1 - \Pr(\text{none of the five women works})$.

Here, $p = 0.58$ and $n = 5$. We need to calculate the probability that none of the women work. This is accomplished by calling the BINOMDIST function in Excel:

Pr(X=0)	0.013069
Pr(X>=1)	0.986931

Click on the respective cells to see how the formulas are entered.

The BINOMDIST function is called as follows:

`=binomdist(num_of_successes,num_of_trials,prob_of_success,cumulative?)`

In this example, the parameters are as follows:

num_of_successes	0
num_of_trials	5
prob_of_success	0.58
cumulative?	FALSE

the last parameter asks if you want the $\Pr(X \leq \text{num})$.
in this case that is FALSE.

U Try It Change the probability 0.4 in the above example. Recalculate $\Pr(X \geq 1)$. Compare with the original answer and comment on the difference.

Problem: For the problem in the original example, calculate the probability that at most 2 women are in the work force using the `binomdist` function. Compare your answer with work by hand.

(Note: in this case, you set the cumulative option to TRUE.)

Problems: Try problems 1-13, 21-24 in Sec. 7.2 using the BINOMDIST function.

Calculating Normal Probabilities

As in the previous discussion, calculating probabilities arising from the normal distribution is also simple.

Example: Suppose that a set of test scores are normally distributed with mean 75 and standard deviation 8. What percentage of the scores are less than 83?

Solution: To answer this, invoke the NORMDIST function:

Pr(X <=83): 0.841345 84% scored below 83.

Click on the cells to see how the formula is entered.

In this example, the parameters are as follows:

value of the number - x	83
mean	75
standard deviation	8
cumulative?	TRUE

the last parameter asks if you want the Pr(X <= num).
In this case that is TRUE. If this value is set to FALSE, the value of the "bell curve" at x is returned.

Question: From your knowledge of the mean and standard deviation, how can you check the answer above? (Do not use tables!)

Problem: For the example above, calculate the percentage of scores above 80.

Graphs Graphs of the normal curve can be easily generated:

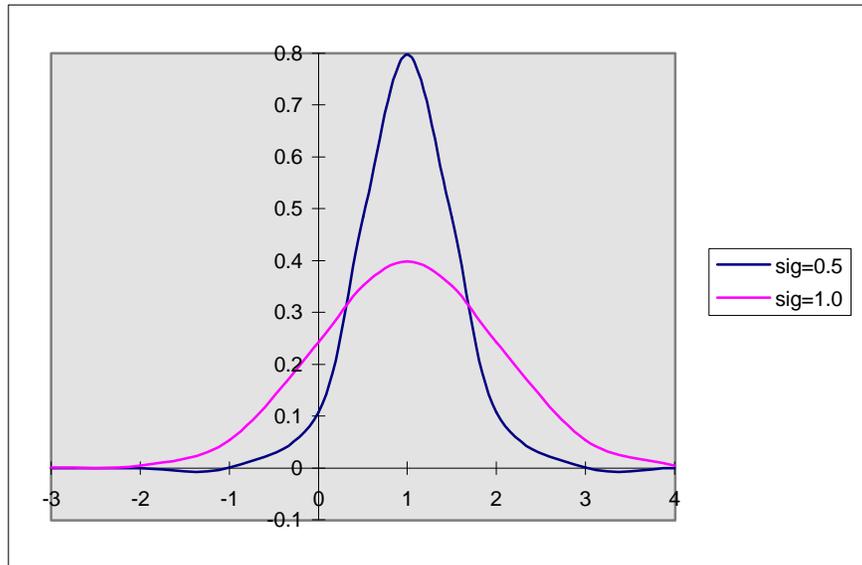
Example : Compare the graph of the normal curve with $\mu=1$ and $\sigma = 0.5$ with that of the normal curve with $\mu =1$ and $\sigma = 1.0$.

x	sig=0.5	sig=1.0
-3	1.01E-14	0.000134
-2	1.22E-08	0.004432
-1	0.000268	0.053991
0	0.107982	0.241971
0.5	0.483941	0.352065
1	0.797885	0.398942
1.5	0.483941	0.352065
2	0.107982	0.241971
3	0.000268	0.053991
4	1.22E-08	0.004432

This table was generated with the NORMDIST function. Click on the individual cells to see how the formula is entered.

The cumulative option is set to FALSE (why?)

Call on ChartWizard to draw the graph - the X-Y Scatter option with graph option #6 was used to create this. Do NOT use the LINE option!



Note that the graph with the larger sigma has a greater spread.

Problem: Try #37-39 in Section 7.2.

Chapter 7: Project 3

Data Simulations

Note: You will need the Data Analysis Tool installed for this project. Also you should be familiar with the material in Ch.7, Tutorial 5.

You want to simulate the lifetimes for a certain type of light bulb. You have been told that the lifetimes are normally distributed with $\mu=1200$ hours and $\sigma = 160$. (cf. Problem 30, Sec. 7.5).

A sample of 30 randomly selected light bulb is given to you.

- (1) Simulate the lifetime for each bulb using the Data Analysis Random Number Generation Tool. (Note: Using the Rand() function will NOT work since it creates only a uniform distribution.)

(Insert as many rows as necessary)

- (2) From the *sample* of thirty bulb lifetimes you generated in part(1), calculate the sample mean and sample standard deviation. Compare with the parameters μ and σ . Are they close? Why is there a difference between the two? State which Excel functions you used.

- (3) Create a frequency table for the data in part(1) using suitable range values. Make a column graph from your frequency table. Use descriptive headings. Does your column graph look bell shaped?

- (4) Repeat parts(1-3), but simulate the lifetimes of 100 light bulbs.

(Insert as many rows as necessary)

- (5) Compare the sample mean and standard deviation in part(3) with that in part(2). Which is closer to the parameters μ and σ ? What do you think will happen to the sample mean and standard deviation as the sample size gets larger and larger?