

Table of Contents

Overview	vii
-----------------------	-----

Course Schedule	xiii
------------------------------	------

SECTION 1

Part 1. Online Session: Math Review and Math Preparation for Course

Preview Part 1	1
Introduction	3
Reading and Practice Problem Assignment	5
Math Review Exam	9
Review Part 1	15

Part 2. Online Session: Introduction to the Analysis ToolPak and Excel Data Analysis Demonstration

Preview Part 2	17
Introduction	19
Activating the Analysis ToolPak in Excel 2010	19
Running a Regression in Excel	23
Review Part 2	37

SECTION 2

Part 3. Introduction: Why Should Real Estate Appraisers Care about Statistics?

Preview Part 3	39
Course Introduction	41
Online Session: Multiple Regression Model	41
Developing an Opinion of Value	46
How Could the Information We Developed in the Online Session Augment the Valuation Process?	49
How and Why Might Clients Value Statistical Analyses by Appraisers?	49
Why Should Real Estate Appraisers Care about Statistics?	51
Review Part 3	53

Part 4. Basic Measures: Central Tendency, Dispersion, and Symmetry

Preview Part 4..... 55
Central Tendency 59
Three Basic Measures of Central Tendency (Three Kinds of Averages) 59
Simple Mean v. Weighted Mean..... 67
Samples and Populations..... 69
The Standard Deviation..... 70
The Coefficient of Variation (COV) 75
Range and Interquartile Range 76
Box and Whisker Plots (One Reason We Care about Quartiles)..... 80
Analyzing Shape 87
Review Part 4..... 91

SECTION 3

Part 5. Data Distributions

Preview Part 5..... 93
Probability..... 95
Conditional Probability 96
Subjective Probability..... 98
Probability Density Functions 102
The Uniform Probability Density Function 103
The Normal Probability Density Function 105
Assessing Normality 109
The Central Limit Theorem 117
Nonparametric Statistics..... 121
Review Part 5..... 123

Part 6. Research Design

Preview Part 6..... 125
The Statistical Research Design Process 127
Construct a Research Hypothesis and Related Pair of Statistical Hypotheses . 130
Research Validity..... 133
Reliability..... 135
Credibility 136
Probability (Scientific) and Nonprobability Samples..... 140
Probability Sampling Methods 141
Controlling Sampling Error..... 144
Review Part 6..... 145
PRACTICE TEST SECTIONS 2 AND 3..... 147

SECTION 4

Part 7. Charting Basics: Trendlines and Charts

Preview Part 7	155
Ordered Arrays, Frequency Distributions, and Histograms	159
Converting a Frequency Distribution Table into a Percentage Distribution Table and Creating a Percentage Histogram	168
Using Polygons to Compare Multiple Percentage Distributions.....	169
Summary Tables, Contingency Summary Tables, Bar Charts, and Pie Charts ...	173
Charting Time Series Data	176
Using Scatter Plots to Illustrate Correlation and to Plot a Trendline.....	183
Charting Ideals and Ethical Issues in Charting.....	187
Review Part 7.....	191

SECTION 5

Part 8. Simple Linear Regression

Preview Part 8.....	193
Simple Linear Equations	197
How Does a Regression Model “Think”?	199
Assumptions Underlying Simple Linear Regression and How They Relate to Inference.....	210
Interpreting Regression Model t Statistics	216
Sample Size Issue Related to Simple Linear Regression	220
Predicting with a Simple Linear Regression Model and Development of Confidence Intervals	220
Regression Error Patterns Indicating Violations of the Assumptions Underlying a Linear Regression Model	227
Review Part 8.....	235
PRACTICE TEST SECTIONS 4 AND 5.....	237

SECTION 6

Part 9. Trends and Forecasts

Preview Part 9.....	243
Time Series Data	245
Approaches to Modeling Time Series Data	245
Simple Linear Time Series Model	246
Curvilinear Time Series	252
Distance (Proximity) Effects.....	263
Causal Time Series	266
Review Part 9.....	271

SECTION 7

Part 10. Multiple Linear Regression: Part I

Preview Part 10.....	273
Multiple Linear Equations.....	275
Underlying Assumptions and Tests of Significance	277
Curves in Multiple Linear Regression	281
Some Model Building Issues	287
Overfitting and Omitted Variables.....	302
Review Part 10.....	305
PRACTICE TEST SECTIONS 6 and 7.....	307

SECTION 8

Part 11. Multiple Linear Regression: Part II

Preview Part 11.....	313
Indicator Variables.....	315
Interaction Variables.....	325
Using Dummy Variables to Account for Market Conditions in Panel Data	335
Review Part 11.....	345

SECTION 9

Part 12. Multiple Linear Regression Case Study

PRACTICE TEST SECTION 8	347
Preview Part 12.....	351
Multiple Linear Regression Case Study	353
Review Part 12.....	365

Part 13. Exam Content Review

Basic Information for the Exam.....	367
Guidance on Studying for the Final Exam.....	367
Guidance on Taking the Final Exam.....	367
Test-Taking Strategies	367
Content Review: Course Objectives and Terms and Concepts to Remember	368
Review Quiz	379

APPENDIX

Commercial Green and Energy-Efficient Addendum
Residential Green and Energy-Efficient Addendum

Overview

Course Description

Quantitative Analysis limits its focus to the practical application of quantitative tools for analyzing data, drawing appropriate conclusions from datasets, and presenting both the analysis and conclusions in ways that enhance communication with appraisal clients. It reviews and furthers the application of some of the basic statistical measures (mean, median, mode, standard deviation, etc.) and spends a good deal of time on linear regression analysis for use in producing and understanding various types of analyses. Central goals of the course are showing participants how to understand the reliability and validity of all data used to draw conclusions and providing the knowledge needed to check the validity of the conclusions others may draw from the same or similar datasets. Each presentation and activity demonstrates real-world appraisal applications and is aimed at furthering an appraiser's ability to provide credible analysis of issues related to real property. The goals for the course are to help participants

- Properly apply and explain statistical methods, such as simple and multiple linear regression analysis, using market information
- Understand and critique statistical applications
- Understand how to incorporate statistical analysis in valuation reports
- Understand how to evaluate the reliability of various types of data used in valuation
- Build competence in using the language of quantitative analysis
- Use graphs to present data and analysis
- Understand research design issues such as hypothesis construction, data reliability and validity, and sampling

This course is one of a series of courses that are part of the Appraisal Institute Analytics for Valuation and Real Estate Analyst Professional Development Programs. For more information about the programs, see Professional Development Programs on the Appraisal Institute website at www.appraisalinstitute.org.

Important Notes

- **Diagnostic Test Prerequisite.** To successfully complete courses in the advanced education curriculum, it is important that participants have basic spreadsheet skills. Therefore, before enrolling in an advanced education course, participants are required to take a diagnostic test in which the participant demonstrates his or her skill level in creating and working with spreadsheets. Participants may register

for an advanced education course if they do not pass the diagnostic test, but it is not recommended.

- **Blended Learning.** Each course in the advanced curriculum incorporates both online and live classroom learning. A two-hour online session begins the course. While the content for each course is different, these online sessions all incorporate discussion and examples, and require participants to complete various tasks. By completing the online session, participants will have a better understanding of what to expect in the live classroom sessions that will follow. If the tasks are difficult, participants will have time to review and prepare before the live portion of the course begins. Tasks will not be graded; however, they must be completed to successfully pass the course. The online session, which goes live 28 days before the classroom session begins, must be completed **BEFORE** the classroom session begins.
- **Excel Datasets.** This course incorporates a variety of interactive learning activities, including Excel datasets. Participants are required to download the necessary Excel files while completing the online session so that they have them when they begin the classroom portion of the course.
- The Excel datasets for *Quantitative Analysis* may be used during the course as an aid in problem solving but also have real-world applications outside the course. Many have embedded calculations; these are for simplicity but should not be used as a crutch. It is essential that participants understand the logical and mechanical operations associated with the Excel files and not just obtain the right answer.

Learning Enhancements

The course has been designed with a variety of elements to enhance your learning experience.

- **Preview.** To give you a taste of what is to come, each part begins with a preview page that includes a brief overview of the content, learning objectives to consider as you move through the content, and learning tips that will assist you in understanding the information you're about to cover.
- **Learning Objectives.** Each learning objective covers essential information for understanding the concepts in the course. Look them over before the part begins so that you have a frame of reference as you move through the material. At the end of each part, reread the objectives. Are you able to do what is stated? If not, this is the time to ask your instructor for help or review the concepts that you do not understand.
- **Examples and Problems.** To supplement the discussions, we've included examples and exercises to help you visualize and practice what you are learning.

- **Review.** Each part concludes with a review, which includes the learning objectives and key terms and concepts that have been covered. Also, we've provided recommended readings and additional practice problems from the course textbook, *An Introduction to Statistics for Appraisers*, which will reinforce what you have learned in class.
- **Practice Tests.** Practice tests are included throughout the course. The questions are similar to the types of questions you might find on the exam. By answering these questions, you will find out whether you can apply the concepts covered.

Class Policies

- 100% attendance is required. No exceptions.
- Limit use of computers and wireless devices to classroom projects.
- Communicate with business associates during break time instead of class time.
- During class, do not read materials that are not used in class, such as news, email, and social media.
- Silence cell phones and other communication devices.
- Use recording devices only if prior permission has been granted.
- If attending a classroom offering, refrain from ongoing conversations with those seated near you and other distracting behavior.

General Information

- **Calculators.** A financial calculator is required. The accepted model used in the course is the HP-12C.
- **Laptop computers.** A laptop computer is required.
- **Spreadsheet program. Excel 2010** is required.
- **Breaks.** There will be two 10-minute breaks during the morning session and two 10-minute breaks during the afternoon session unless noted otherwise by the course sponsor. The lunch break is one hour.

- **Attendance sheets** will be distributed during class to verify your attendance during the morning and afternoon sessions.
- **Certificates of completion** may be downloaded after completion of the course, and attendance during the entire course is required.

Required Text

- Wolverton, Marvin L., Ph.D., MAI. *An Introduction to Statistics for Appraisers*. Chicago: Appraisal Institute, 2009. (See errata list on the following page.)

Recommended Text

- *The Dictionary of Real Estate Appraisal*, 7th ed., Chicago: Appraisal Institute, 2015.

Prerequisites

Required

- *Advanced Education Diagnostic Test*: Participants are required to take a diagnostic test in which the participant demonstrates his or her skill level in creating and working with spreadsheets. Participants may register for an advanced education course if they do not pass the diagnostic test, but it is not recommended.

Recommended

- *Real Estate Finance, Statistics, and Valuation Modeling*
- *Using Spreadsheet Programs in Real Estate Appraisals—The Basics* or similar course/seminar

Exam

- 40 multiple-choice questions
- **Calculators.** A financial calculator is required for the exam. The accepted model used in the course is the HP-12C.
- **Important note.** All laptops, cellular phones, tablets, iPads, wearable technology (smart watch, Apple Watch, Google Glass, etc.), and other devices that can store data or connect to the internet are **NOT** permitted during the exam. In addition, all watches, wallets, bags, and purses must be removed and stored out of reach prior to taking the exam.

Errata: An introduction to Statistics for Appraisers

Page 80. The second sentence in the first paragraph in the **Variance and Standard Deviation** section states

The population standard deviation is the mean of the deviations of all elements of the population.

CORRECTION:

The population variance is the mean of the squared deviations of all elements of the population.

Page 162. The second string of equations has a misplaced decimal point in the denominator. It says “0.44²” and it should say “0.044².” The corrected string of equations is

$$n = \frac{Z^2 p(p-1)}{e^2} = \frac{1.96^2 \cdot 0.50(1-0.50)}{0.044^2} = 496$$

Page 179. The first line of the first sentence in the **Using the t Statistic to Test Hypotheses about the Mean** section includes a typographical error. The word “vancy” should be “vacancy.”

Page 271. The equations for mean square prediction error and mean absolute prediction error are written incorrectly. They should be written as follows:

$$\text{Mean Square Prediction Error} = \frac{\sum_{i=1}^{n'} (y_i - \hat{y}_i)^2}{n'}$$

$$\text{Mean Absolute Prediction Error} = \frac{\sum_{i=1}^{n'} |y_i - \hat{y}_i|}{n'}$$

Page 296. The first string of equations on this page is missing a 1. It should read as follows:

$$R^2 = 1 - \frac{SSE}{SST} = 1 - \frac{3.81E10}{2.33E11} = 1 - \frac{3.81}{23.3} = 1 - 0.164 = 0.836$$

Page 349. The answer to Question 10 in Problems 2.1 is written as “-xyzt.” The correct answer is “-yzt².”

Page 370: The term “covariance” should be “coefficient of variation.” Formula is correct.