

Learning Path 1: Foundations of Data Analysis

Descriptive Statistics and Graphical Analysis

- **Types of Data**
 - Basic Concepts
 - Types of Data
 - Quiz: Types of Data
- **Using Graphs to Analyze Data**
 - Basic Concepts
 - Bar Charts and Pareto Charts
 - Pie Charts
 - Heatmaps
 - Histograms
 - Dotplots
 - Individual Value Plots
- Boxplots
- Time Series Plots
- Primer: Importance of Time Order
- Quiz: Using Graphs to Analyze Data
- Minitab Tools: Bar Chart
- Minitab Tools: Pie Chart
- Minitab Tools: Heatmap
- Minitab Tools: Histogram
- Minitab Tools: Dotplot
- Minitab Tools: Individual Value Plot
- Minitab Tools: Boxplot
- Minitab Tools: Time Series Plot
- Exercise: Graphical Analysis
- **Using Statistics to Analyze Data**
 - Basic Concepts
 - Mean and Median
 - Range, Variance and Standard Deviation
 - Quiz: Using Statistics to Analyze Data
 - Minitab Tools: Display Descriptive Statistics
 - Exercise: Descriptive Statistics

Statistical Inference

- **Fundamentals of Statistical Inference**
 - Basic Concepts
 - Random Samples
 - Quiz: Fundamentals of Statistical Inference
 - Minitab Tools: Random Sampling
- **Sampling Distributions**
 - Basic Concepts
 - Sampling Distribution of the Mean
 - Quiz: Sampling Distributions
- **Normal Distribution**
 - Basic Concepts
 - Probabilities Associated with a Normal Distribution
- Probabilities Associated with the Sample Mean
- Quiz: Normal Distribution
- Minitab Tools: Cumulative Probabilities with a Normal Distribution
- Exercise: Probabilities and Normal Distributions

Hypothesis Tests and Confidence Intervals

- **Tests and Confidence Intervals**
 - Primer: Confidence Intervals for Population Parameters
 - Confidence Intervals
 - Hypothesis Testing
 - Using Hypothesis Tests to Make Decisions
 - Type 1 and Type II Errors and Power
 - Quiz: Tests and Confidence Intervals
- **1-Sample t-Test**
 - Basic Concepts
 - Individual Value Plots
 - 1-Sample t-Test Results
 - Assumptions
 - Quiz: 1-Sample t-Test
 - Minitab Tools: 1-Sample t-Test
 - Exercise: 1-Sample t-Test
- **2 Variances Test**
 - Basic Concepts
 - Boxplots
 - 2 Variances Test Results
 - Assumptions
- Quiz: 2 Variances Test
- Minitab Tools: 2 Variances Test
- Exercise: 2 Variances Test
- **2-Sample t-Test**
 - Basic Concepts
 - Individual Value Plots
 - 2-Sample t-Test Results
 - Assumptions
 - Quiz: 2-Sample t-Test
 - Minitab Tools: 2-Sample t-Test
 - Exercise: 2-Sample t-Test
- **Paired t-Test**
 - Basic Concepts
 - Individual Value Plots
 - Paired t-Test Results
 - Assumptions
 - Quiz: Paired t-Test
 - Minitab Tools: Paired t-Test
 - Exercise: Paired t-Test
- **1 Proportion Test**
 - Basic Concepts
 - 1 Proportion Test Results
 - Assumptions
 - Quiz: 1 Proportion Test
 - Minitab Tools: 1 Proportion Test
 - Exercise: 1 Proportion Test
- **2 Proportions Test**
 - Basic Concepts
 - 2 Proportions Test Results
 - Assumptions
 - Quiz: 2 Proportions Test
 - Minitab Tools: 2 Proportions Test
 - Exercise: 2 Proportions Test
- **Chi-Square Test**
 - Basic Concepts
 - Chi-Square Test Results
 - Assumptions
 - Quiz: Chi-Square Test
 - Minitab Tools: Chi-Square Test
 - Exercise: Chi-Square Test

Analysis of Variance (ANOVA)

• Fundamentals of ANOVA

- Basic Concepts
- Graphs and Summary Statistics
- Quiz: Fundamentals of ANOVA

• One-Way ANOVA

- Hypothesis Tests
- F-Statistics and P-Values

- Multiple Comparisons
- Assumptions and Residual Plots
- Quiz: One-Way ANOVA
- Minitab Tools: One-Way ANOVA
- Exercise: One-Way ANOVA
- Primer: Blocking in One-Way ANOVA

• Two-Way ANOVA

- Basic Concepts
- Graphs
- Hypothesis Tests
- F-Statistics and P-Values
- Assumptions and Residual Plots
- Quiz: Two-Way ANOVA
- Minitab Tools: Two-Way ANOVA
- Exercise: Two-Way ANOVA

Correlation and Regression

• Relationship Between Two Quantitative Variables

- Basic Concepts
- Scatterplot
- Correlation
- Quiz: Relationship Between Two Quantitative Variables

- Minitab Tools: Scatterplot
- Minitab Tools: Correlation
- Exercise: Scatterplots and Correlation

• Simple Regression

- Basic Concepts
- Regression

- Hypothesis Tests and R^2
- Assumptions and Residual Plots
- Quiz: Simple Regression
- Minitab Tools: Simple Linear Regression
- Exercise: Simple Regression
- Primer: Trend Analysis in Time Series

Learning Path 2: Statistical Quality Analysis

Control Charts

• Statistical Process Control

- Primer: Phase 1 and 2 Control Charts
- Basic Concepts
- Patterns in Control Charts
- Quiz: Statistical Process Control

- Quiz: Control Charts for Variables Data in Subgroups
- Minitab Tools: $\bar{X}$ -R Chart
- Exercise: $\bar{X}$ -R Chart
- Case Study: $\bar{X}$ -R Chart

- Quiz: Control Charts for Individual Observations
- Minitab Tools: I-MR Chart
- Exercise: I-MR Chart

• Control Charts for Variables Data in Subgroups

- Basic Concepts
- R Charts
- S Charts
- $\bar{X}$ Charts

• Control Charts for Individual Observations

- Basic Concepts
- Moving Range Charts
- Individuals Charts

• Control Charts for Attributes Data

- Basic Concepts
- NP and P Charts
- C and U Charts
- Quiz: Control Charts for Attributes Data
- Minitab Tools: P Chart
- Exercise: P Chart

Process Capability

• Process Capability for Normal Data

- Basic Concepts
- Assumptions
- Testing for Normality
- Quiz: Process Capability for Normal Data
- Minitab Tools: Normality Test
- Exercise: Assumptions for Process Capability

• Process Capability for Nonnormal Data

- Transformations and Alternate Distributions
- Box-Cox Transformation
- Johnson Transformation
- Alternate Distributions
- Quiz: Process Capability for Nonnormal Data
- Minitab Tools: Box Cox Transformation
- Minitab Tools: Johnson Transformation
- Minitab Tools: Capability Analysis with Johnson Transformation
- Minitab Tools: Alternate Distributions
- Minitab Tools: Capability Analysis with Alternate Distributions

- Exercise: Process Capability with Data Transformations
- Exercise: Process Capability with Alternate Distributions

• Capability Indices

- Potential Capability: Cp and Cpk
- Process Performance: Pp and Ppk
- Sigma Level
- Quiz: Capability Indices
- Minitab Tools: Cp and Pp
- Minitab Tools: Sigma Level
- Exercise: Process Capability for Normal Data

• Tolerance Intervals

- Basic Concepts
- Normal Tolerance Intervals
- Nonnormal Tolerance Intervals
- Quiz: Tolerance Intervals
- Minitab Tools: Normal Tolerance Intervals
- Minitab Tools: Nonnormal Tolerance Intervals
- Exercise: Tolerance Interval

Measurement Systems Analysis

• Fundamentals of Measurement Systems Analysis

- Basic Concepts
- Accuracy
- Precision
- Comparing Accuracy to Precision
- Quiz: Fundamentals of Measurement Systems Analysis

• Repeatability and Reproducibility

- Basic Concepts
- Gage R&R Studies
- Quiz: Repeatability and Reproducibility

• Graphical Analysis of a Gage R&R Study

- Basic Concepts
- Components of Variation
- $\bar{X}$ and R Charts
- Interaction Between Operator and Part
- Comparative Plots
- Gage Run Charts

- Quiz: Graphical Analysis of a Gage R&R Study
- Minitab Tools: Crossed Gage R&R Study
- Minitab Tools: Gage Run Chart
- Exercise: Graphical Analysis of a Gage R&R Study

• Variation

- Standard Deviation and Study Variation
- Tolerance
- Quiz: Variation
- Exercise: Numerical Analysis of a Gage R&R Study

• ANOVA with a Gage R&R Study

- Variance Components
- Analysis of Variance Tables
- Quiz: ANOVA with a Gage R&R Study
- Exercise: ANOVA Output for a Gage R&R Study

• Gage Linearity and Bias Study

- Basic Concepts
- Gage Linearity
- Gage Bias
- Quiz: Gage Linearity and Bias Study
- Minitab Tools: Gage Linearity and Bias Study
- Exercise: Gage Linearity and Bias Study

• Attribute Agreement Analysis

- Basic Concepts
- Binary Data
- Nominal Data
- Ordinal Data
- Quiz: Attribute Agreement Analysis
- Minitab Tools: Attribute Agreement Analysis with Binary Data
- Minitab Tools: Attribute Agreement Analysis with Nominal Data
- Minitab Tools: Attribute Agreement Analysis with Ordinal Data
- Exercise: Attribute Agreement Analysis

Learning Path 3: Design of Experiments

Analysis of Variance (ANOVA)

• Fundamentals of ANOVA

- Basic Concepts
- Graphs and Summary Statistics
- Quiz: Fundamentals of ANOVA

• One-Way ANOVA

- Hypothesis Tests
- F-Statistics and P-Values
- Multiple Comparisons
- Assumptions and Residual Plots
- Quiz: One-Way ANOVA
- Minitab Tools: One-Way ANOVA
- Exercise: One-Way ANOVA
- Primer: Blocking in One-Way ANOVA

• Two-Way ANOVA

- Basic Concepts
- Graphs
- Hypothesis Tests
- F-Statistics and P-Values
- Assumptions and Residual Plots
- Quiz: Two-Way ANOVA
- Minitab Tools: Two-Way ANOVA
- Exercise: Two-Way ANOVA

Design of Experiments

• Factorial Designs

- Primer: T Tests for Effects in DOE
- Basic Concepts
- Creating Full Factorial Designs
- Analyzing Full Factorial Designs
- Quiz: Factorial Designs
- Minitab Tools: Create a Full Factorial Design
- Minitab Tools: Analyze a Full Factorial Design
- Exercise: Create a Full Factorial Design
- Exercise: Analyze a Full Factorial Design
- Case Study: Full Factorial Design

• Blocking and Incorporating Center Points

- Blocking
- Center Points
- Analyzing Designs with Blocks and Center Points
- Quiz: Blocking and Incorporating Center Points
- Minitab Tools: Create a Factorial Design with Blocks and Center Points
- Minitab Tools: Analyze a Factorial Design with Blocks and Center Points
- Exercise: Create a Factorial Design with Blocks and Center Points
- Exercise: Analyze a Factorial Design with Blocks and Center Points

• Fractional Factorial Designs

- Basic Concepts
- Create Fractional Factorial Designs
- Analyze Fractional Factorial Designs
- Quiz: Fractional Factorial Designs
- Minitab Tools: Create a Fractional Factorial Design
- Minitab Tools: Analyze a Fractional Factorial Design

• Response Optimization

- Primer: Response Optimization Using Desirability
- Response Optimization
- Quiz: Response Optimization
- Minitab Tools: Response Optimization
- Exercise: Response Optimization

Learning Path 4: Predictive Analytics

Correlation and Regression

- **Relationship Between Two Quantitative Variables**
 - Basic Concepts
 - Scatterplot
 - Correlation
 - Quiz: Relationship Between Two Quantitative Variables
- Minitab Tools: Scatterplot
- Minitab Tools: Correlation
- Exercise: Scatterplots and Correlation
- **Simple Regression**
 - Basic Concepts
 - Regression
- Hypothesis Tests and R^2
- Assumptions and Residual Plots
- Quiz: Simple Regression
- Minitab Tools: Simple Linear Regression
- Exercise: Simple Regression
- Primer: Trend Analysis in Time Series

Multiple Regression

- **Relationships Between Multiple Quantitative Variables**
 - Primer: Missing Data
 - Basic Concepts
 - Matrix Plot and Correlation
 - Quiz: Relationships Between Variables
 - Minitab Tools: Matrix Plot
 - Minitab Tools: Multiple Correlation
- **Multiple Regression**
 - Basic Concepts
 - Multiple Regression Models
 - Assumptions and Residual Plots
 - Prediction
 - Quiz: Multiple Regression
 - Minitab Tools: Fit Regression
 - Exercise: Multiple Regression
- **Polynomial and Interacting Terms**
 - Polynomial Terms
 - Interaction Terms
 - Quiz: Polynomial and Interaction Terms
 - Minitab Tools: Fit Regression Model with Polynomial
 - Minitab Tools: Fit Regression Model with Interaction
 - Exercise: Polynomial and Interaction Terms
- **Model Selection**
 - Stepwise Regression
 - Best Subsets Regression
 - Quiz: Model Selection
- Minitab Tools: Fit Regression Model with Stepwise
- Minitab Tools: Best Subsets Regression
- Exercise: Model Selection
- **Binary Logistic Regression**
 - Basic Concepts
 - Model Fitting and Diagnostics
 - Model Visualization and Prediction
 - Quiz: Binary Logistic Regression
 - Minitab Tools: Fit Binary Logistic Regression Model
 - Exercise: Binary Logistic Model

Predictive Analytics

- **Predictive Analytics**
 - Basic Concepts
 - Machine Learning
 - Quiz: Overview of Predictive Analytics
- **Model Validation**
 - Basic Concepts
 - Validation Techniques
 - Quiz: Validation Techniques
 - Minitab Tools: Fit Regression Model with Validation
- **Tree Based Methods**
 - Basic Concepts
 - Using Decision Trees
 - Quiz: Tree-Based Methods
- **CART Classification Trees**
 - Primer: CART Classification Splitting
 - Fitting a CART Classification Tree
 - Model Summary Statistics
 - Using the CART Classification Tree Results
 - Prediction with CART Classification Trees
- Quiz: CART Classification Trees
- Minitab Tools: CART Classification
- Exercise: CART Classification
- **CART Regression Trees**
 - Primer: CART Regression Splitting
 - Fitting a CART Regression Tree
 - Using the CART Regression Tree Results
 - Prediction with CART Regression Trees
 - Quiz: CART Regression Trees
 - Minitab Tools: CART Regression and Prediction
 - Exercise: CART Regression
- **MARS Regression**
 - Basic Concepts
 - Knots
 - Basis Functions Using Knots
 - Fitting a MARS Model
 - Using MARS Model Results
 - Prediction with a MARS Model
 - Quiz: MARS Regression
 - Minitab Tools: MARS Regression
 - Exercise: MARS Regression
- **Random Forests Classification**
 - Primer: Random Forests Classification
 - Bootstrap Sampling
 - Basic Concepts
 - Out-of-Bag Validation
 - Fitting a Random Forests Model
 - Using Random Forests Model Results
 - Prediction with a Random Forests Model
 - Quiz: Random Forests Classification
 - Minitab Tools: Random Forests Classification
 - Exercise: Random Forests Classification
- **TreeNet Regression**
 - Primer: TreeNet Regression
 - Basic Concepts
 - Fitting a TreeNet Regression Model
 - Using TreeNet Model Results
 - Prediction with a TreeNet Regression Model
 - Quiz: TreeNet Regression
 - Minitab Tools: TreeNet Regression
 - Exercise: TreeNet Regression