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
  - 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
  - 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
  - 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
  - Trend Analysis in Time Series

Learning Path 2: Statistical Quality Analysis

Control Charts

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

- Control Charts for Variables Data in Subgroups
  - Basic Concepts
  - R Charts
  - S Charts
  - $\overline{X}$ Charts

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

- Control Charts for Individual Observations
  - Basic Concepts
  - Moving Range Charts
  - Individuals Charts
  - Quiz: Control Charts for Individual Observations

  - Minitab Tools: I-MR Chart
  - Exercise: I-MR Chart

- 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

- 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

- 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

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
  - $\overline{X}$ 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
  - 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
  - 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

- 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
  - 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
  - Trend Analysis in Time Series

Multiple Regression

- Relationships Between Multiple Quantitative Variables
  - 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
  - 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
  - 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
  - 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
  - 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