

2021 EngineRoom Validation Kit

Welcome!

MoreSteam is dedicated to providing high-quality software and excellent customer service to users of our products, including users of EngineRoom® software.

We recognize that your company may operate in a regulated environment and, as such, may need to validate and document your intended use of our software. To that end, we have prepared this software validation kit. Among other things, this kit provides documentation that our software has been rigorously tested against independent, reliable, and documented sources that are unaffiliated with MoreSteam to ensure accuracy and reliability of EngineRoom's statistical analyses and output. The instructions and datasets in this documentation can be used as baseline data and results to compare with EngineRoom during the validation process.

In addition, this EngineRoom Validation Kit provides various related reference material. These information resources include documentation of our application development lifecycle practices and the practices we use when validating EngineRoom prior to release. As reflected by the Table of Contents, these materials comprise the following:

- EngineRoom Software Development Life Cycle
- EngineRoom Software Testing Protocol
- EngineRoom Technical Specifications
- EngineRoom Security Document
- EngineRoom Output validated against National Institute of Standards and Technology (NIST) Datasets

At MoreSteam, we are committed to continuous improvement and strive to keep raising the bar in the field of quality improvement. If you have any questions regarding our validation policies and processes, please contact our EngineRoom Support Team by sending an email to <u>erteam@moresteam.com</u> or by visiting the EngineRoom website at https://www.moresteam.com/engineroom/support.cfm.

Sincerely,

Peg Pennington, President MoreSteam.com LLC 9961 Brewster Lane Powell, OH 43065

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Instructions

Overview:

These instructions will guide the user through the software validation procedure, i.e., a standard procedure of generating analytic outputs using the EngineRoom software application, and matching the generated outputs with validated outputs. Notably, for those unfamiliar with EngineRoom, EngineRoom will generate the outputs using sets of data pre-populated in the application, which will reduce the time needed to generate the required outputs and the time otherwise required for the assessor to learn how to navigate EngineRoom's user interface.

As detailed below, it is necessary to have an active MoreSteam account provisioned with an active subscription to EngineRoom application. If you do not have such access, we provide instructions and assistance in providing an account and license. Also, we provide a link that will add an EngineRoom Validation project to the assessor's account, thus providing access to prepopulated datasets and analyses. These in-application outputs can be refreshed and/or revisited for just-in-time validation assessments. We also provide files of numerically and visually accurate outputs/results for the tests provided by in the prepopulated project file. These reference outputs are intended for comparison with the results generated using the EngineRoom application. The validated results can be found within this Validation Kit by referring to the Table of Contents and locating the section titled "EngineRoom Validation Test Output".

Procedure:

- First, assure you have access to EngineRoom software via an active account and subscription by logging into EngineRoom software at <u>engineroom.moresteam.com</u>. If you do not have an active account or EngineRoom subscription, you can either obtain a trial subscription <u>here</u> or by contacting MoreSteam at <u>support@moresteam.com</u>.
- 2. Next, access the <u>EngineRoom Validation</u> project housed within your EngineRoom subscription. Clicking the EngineRoom Validation project link will open the EngineRoom application and the EngineRoom Validation project will appear on EngineRoom's Welcome screen. Select the "Launch Project" button and access the project. In the event the EngineRoom Validation project does not appear in your account, or you have any difficulty accessing either the EngineRoom application or the EngineRoom Validation project, please contact MoreSteam.
- 3. The EngineRoom Validation project includes multiple data sources (data sets) appearing on the left side of the workspace, and multiple completed studies (including graphical and numerical outputs) on the right side of the workspace. When selected, the completed studies are automatically refreshed and generate outputs based on the data sources relating to the studies.

Notes:

Acceptable differences between the generated results and the validated references may be found because of:

- differences in browsers or browser settings (e.g.: colors on graphs)

- minor differences in the formatting of output in EngineRoom (e.g., line thickness, font appearance, etc.)

Other than acceptable differences, the multiple Validated EngineRoom outputs should match the outputs generated by the EngineRoom Validation project studies.

Compliance with CFR Title 21 – Part 11

- For purposes of U.S. Food and Drug Administration (FDA) validation, EngineRoom should be considered a tool. EngineRoom customers who are FDA-regulated might be expected to validate systems built using the EngineRoom application. Because EngineRoom is a tool, the user must demonstrate to the FDA that EngineRoom is being used correctly. See "Complying with United States Code of Federal Regulations, Title 21 Part 11" in Appendix 1: "FDA-related issues" in "The Quality Imperative" for more information.
- Customers can re-create analyses by saving and running/refreshing the provided EngineRoom Validation Project, which contains the aforementioned multiple data sources and studies with output. The study outputs represent the correct outputs for various data configurations and study settings and are included in a PDF file which can be used to check the results from the analyses.

EngineRoom Statistical Software provides password protection for viewing, opening, saving, and modifying project files. This protection serves as validation for the ongoing use and storage of project files and data. For complete control, password protection should be combined with a file or source control system to verify dates, times, and approved access.

EngineRoom Software Verification and Validation

Versions of third-party software used: R 3.5.0 and .NET Framework 4.6.2 with C# 7.0

Automated R Tests (Regression Tests)

- These test each of our R Scripts and make sure that the results are what we expect.
 - Utilize pre-existing JSON files in the repository containing the exact results of a given combination of inputs and options into a study.
 - For each noted combination of inputs and options, we run the script and check that its results match that of the JSON file.
- Tests are run before and after any changes to the R scripts are submitted to Code Review.
- Changes to formula calculations in a script trigger corresponding changes to the testing JSON files associated with the script, to account for the new calculations.
- Test data inputs are sourced from MoreSteam's courses (where data sets are validated using multiple commercial software packages and hand calculations) as well as textbooks and online data libraries (such as NIST, Kaggle and Github).
- If cases with specific inputs/options need to be accounted for that are not covered in the test battery, we add them to the tests.

Automated C# Tests (Unit Tests)

- For the tools coded in C#, unit tests are used to verify:
 - Studies run correctly
 - Studies contain expected results objects
 - Key calculations yield accurate values

Automated Test Info (Both C# and R)

• The builds for development and production proceed on the local development server. If any automated test fails, the build fails and does not push its artifacts to the development/production sites.

QA Testing (Manual Tests)

- While a code edit is undergoing Code Review, the reviewers test multiple situations relating to the code in order to stress test the edited code.
- Any unexpected behavior is noted and fixed immediately, while pre-existing bugs or aberrations are noted for resolution in a later sprint.
- Code Review is complete once all tests pass the evaluation criteria.

Smoke Testing (Manual Regression Tests)

- Before a major release, multiple team members implement a script to test specific parts of the application for incorrect behavior.
- Multiple browsers are tested to ensure cross-browser compatibility.

- If incorrect behavior is found that does not exist on the production server, it is patched and re-tested before release.
- If incorrect behavior is found that does exist on the production server, it is prioritized for resolution on the next sprint cycle.

EngineRoom Technical Specifications

System Requirements

Browser

- Chrome (Version 79+)
- Edge (Version 91+)
- Firefox (Version 78+)
- Safari (Version 13+)

Screen Resolution

- 1024 x 768 (minimum)
- 1920 x 1080 (recommended)

Operating Systems

- Microsoft Windows (7 and higher)
- Apple Mac OS X

Dataset Requirements

Supported Formats: Microsoft Open XML format for spreadsheets (.XLSX and .CSV)

Note: If you do not have Microsoft Excel, your spreadsheet program may be capable of exporting to this format.

Maximum File Size

- Data files: 500kB (approximately 30,000 cells)
- Supporting files (images, PDF, etc.): 10 MB

Maximum Column Size

• 10,000 cells

Maximum Storage

• Data and supporting files: 500 MB

EngineRoom Security Document

With nearly 20 years of experience building and running software for thousands of the world's largest corporations, EngineRoom has adopted advanced security technologies and practices.

We make continuous efforts to assure that the infrastructure remains robust, available, and resilient to intrusion. These safeguards assure on-going user access to EngineRoom and keep your data safe.



Comparison against NIST Statistical Standards using NIST Data Sets and Validated Output

The National Institute of Standards and Technology (NIST) provides a suite of Statistical Reference Data Sets (StRD) to assist in the evaluation of the numerical accuracy of statistical software. More information about these data sets is available at www.itl.nist.gov/div898/strd/.

The StRD data sets are the subject of this paper. The following sections report the results of tests that were run in EngineRoom. All tests used the same date: March 22, 2021. The tests were run for 64-bit systems on the latest versions of the following browsers (Note, IE is no longer supported in EngineRoom):

- Windows versions: Edge, Chrome
- macOS versions: Safari, Chrome

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- I. Univariate Summary Statistics
- II. ANOVA
- III. Linear Regression

I. Univariate Summary Statistics

URL: <u>https://www.itl.nist.gov/div898/strd/univ/homepage.html</u> Selected 3 Data sets from the list: PiDigits, NumAcc2 and NumAcc4

| Dataset Name | Level of Difficulty | Number of Observations | Source |
|------------------------|------------------------|---------------------------|-----------|
| <u>PiDigits</u> | Lower | 5000 | Observed |
| <u>Lottery</u> | Lower | 218 | Observed |
| Lew | Lower | 200 | Observed |
| <u>Mavro</u> | Lower | 50 | Observed |
| Michelso | Lower | 100 | Observed |
| NumAcc1 | Lower | 3 | Generated |
| NumAcc2 | Average | 1001 | Generated |
| NumAcc3 | Average | 1001 | Generated |
| NumAcc4 | Higher | 1001 | Generated |

Univariate Summary Statistics Results Table:

| Data Set | Size | Statistic | NIST Value | ER Value |
|----------|------|------------------------------------|----------------------|------------|
| PiDigits | 5000 | Mean | 4.5348000000000 | 4.535 |
| | | Standard Deviation | 2.86733906028871 | 2.867 |
| | | First-order Autocorrelati on | -0.00355099287237872 | -0.004 |
| NumAcc2 | 1001 | Mean | 1.2 | 1.2 |
| | | Standard Deviation | 0.1 | 0.1 |
| | | First-order Autocorrelati on | -0.999 | -1 |
| NumAcc4 | 1001 | Mean | 1000000.2 | 10,000,000 |
| | | Standard Deviation | 0.1 | 0.1 |
| | | First-order Autocorrelati on | -0.999 | -0.992 |

Full Results:

1. PiDigits:

NIST:

```
Certified Values
Sample Mean ybar: 4.5348000000000
Sample Standard Deviation (denom. = n-1) s: 2.86733906028871
Sample Autocorrelation Coefficient (lag 1) r(1): -0.00355099287237972
```

Number of Observations:

5000

| Statistics | | |
|---------------------------------|--------|-----------------|
| | Υ | |
| Count | 5,000 | |
| Min | 0 | |
| Max | 9 | |
| Mean | 4.535 | |
| Median | 5 | |
| Standard Deviation | 2.867 | |
| Variance | 8.222 | |
| Anderson-Darling Test Statistic | 85.68 | |
| Anderson-Darling p-value | 0 | |
| Skewness | -0.008 | Correlation |
| Kurtosis | -1.22 | R -0.004 |

2. NumAcc2:

| Ν | 1IS | <u>ST</u> : | |
|---|-----|-------------|--|
| _ | | | |

| <u></u> . | | | Certifi | ed Values |
|------------------|--|-------|---------|-----------|
| Sample Sample | Mean Standard Deviation (denom - n-1) | ybar: | 1.2 | (exact) |
| Sample | Autocorrelation Coefficient (lag 1) | r(1): | -0.999 | (exact) |
| Number | of Observations: | | 1001 | |

| Statistics | | |
|---------------------------------|--------|-------------|
| | Υ | |
| Count | 1,001 | |
| Min | 1.1 | |
| Max | 1.3 | |
| Mean | 1.2 | |
| Median | 1.2 | |
| Standard Deviation | 0.1 | |
| Variance | 0.01 | |
| Anderson-Darling Test Statistic | 179.2 | |
| Anderson-Darling p-value | 0 | |
| Skewness | 0 | Correlation |
| Kurtosis | -2.003 | R -1 |

3. NumAcc4:

NIST:

| | | | Certified Va | lues |
|------------------|--|-------------|-------------------|---------|
| Sample Sample | Mean Standard Deviation (denom = n-1) | ybar: s: | 10000000.2 0 1 | (exact) |
| Sample | Autocorrelation Coefficient (lag 1) | r(1): | -0.999 | (exact) |
| Number | of Observations: | | 1001 | |

| Statistics | | |
|---------------------------------|------------|-----------------|
| | Υ | |
| Count | 1,001 | |
| Min | 10,000,000 | |
| Max | 10,000,000 | |
| Mean | 10,000,000 | |
| Median | 10,000,000 | |
| Standard Deviation | 0.1 | |
| Variance | 0.01 | |
| Anderson-Darling Test Statistic | 179.2 | |
| Anderson-Darling p-value | 0 | |
| Skewness | 0 | Correlation |
| Kurtosis | -2.003 | R -0.992 |

II. <u>ANOVA</u>

URL: https://www.itl.nist.gov/div898/strd/anova/anova.html

Selected 3 Datasets from the list: SiRstv, SmLs04 and SmLs08 Design: One-Way Balanced Model: $y_{ij} = \mu + \tau_i + \epsilon_{ij}$

| Dataset Name | Level of Difficulty | Constant Leading Digits | Replicates per Cell | Number of Treatments | Source |
|----------------|------------------------|-------------------------------|------------------------|-------------------------|-----------|
| <u>SiRstv</u> | Lower | 3 | 5 | 5 | Observed |
| <u>SmLs01</u> | Lower | 1 | 21 | 9 | Generated |
| SmLs02 | Lower | 1 | 201 | 9 | Generated |
| SmLs03 | Lower | 1 | 2001 | 9 | Generated |
| <u>AtmWtAg</u> | Average | 7 | 24 | 2 | Observed |
| SmLs04 | Average | 7 | 21 | 9 | Generated |
| <u>SmLs05</u> | Average | 7 | 201 | 9 | Generated |
| <u>SmLs06</u> | Average | 7 | 2001 | 9 | Generated |
| <u>SmLs07</u> | Higher | 13 | 21 | 9 | Generated |
| <u>SmLs08</u> | Higher | 13 | 201 | 9 | Generated |
| <u>SmLs09</u> | Higher | 13 | 2001 | 9 | Generated |

One-way ANOVA Results Table:

| Data Set | Replicates | Statistic | NIST Value | ER Value |
|----------|------------|---------------|----------------------|----------|
| SiRstv | 5 | Between SS | 5.11462616000000 E-2 | 0.0511 |
| | | Within SS | 2.16636560000000 E-1 | 0.2166 |
| | | Between MS | 1.27865654000000 E-2 | 0.0128 |
| | | Within MS | 1.083180000000 E-2 | 0.0108 |
| | | F Statistic | 1.18046237440255 | 1.18 |
| SmLs04 | 21 | Between SS | 1.6800000000000 | 1.68 |
| | | Within SS | 1.8000000000000 | 1.8 |
| | | Between | 2.1000000000000 E-1 | 0.21 |

| | | MS | | |
|--------|-----|---------------|-----------------------|-------|
| | | Within MS | 1.000000000000000 E-2 | 0.01 |
| | | F Statistic | 2.1000000000000 E+1 | 21 |
| SmLs08 | 201 | Between SS | 1.60800000000000 E+1 | 16.08 |
| | | Within SS | 1.80000000000000 E+1 | 18.04 |
| | | Between MS | 2.0100000000000 | 2.01 |
| | | Within MS | 1.000000000000000 E-2 | 0.01 |
| | | F Statistic | 2.0100000000000 E+2 | 200.6 |

1. SiRstv:

NIST:

Certified Values:

| Source of Variation | df | Sums of Squares | Mean Squares | F Statistic |
|------------------------|----|----------------------|----------------------|----------------------|
| Between Instrument | 4 | 5.11462616000000E-02 | 1.27865654000000E-02 | 1.18046237440255E+00 |
| Within Instrument | 20 | 2.16636560000000E-01 | 1.08318280000000E-02 | |

EngineRoom:

ANOVA Table

| | DF | Sum Sq | MeanSq | FValue |
|------------|----|--------|--------|--------|
| Instrument | 4 | 0.0511 | 0.0128 | 1.18 |
| Residuals | 20 | 0.2166 | 0.0108 | NA |

2. SmLs04:

NIST:

Certified Values:

| Source of Variation | df | Sums of Squares | Mean Squares | F Statistic |
|------------------------|-----|---------------------|---------------------|---------------------|
| Between Treatment | 8 | 1.6800000000000E+00 | 2.1000000000000E-01 | 2.1000000000000E+01 |
| Within Treatment | 180 | 1.800000000000E+00 | 1.0000000000000E-02 | |

EngineRoom:

| ANOVA Table | | | | | | |
|-------------|-----|--------|--------|--------|---------|--|
| | DF | Sum Sq | MeanSq | FValue | p-value | |
| Treatment | 8 | 1.68 | 0.21 | 21 | 0 | |
| Residuals | 180 | 1.8 | 0.01 | NA | NA | |

3. SmLs08:

NIST:

Certified Values:

| Source of Variation | df | Sums of Squares | Mean Squares | F Statistic |
|------------------------|------|---------------------|---------------------|--------------------|
| Between Treatment | 8 | 1.6080000000000E+01 | 2.0100000000000E+00 | 2.010000000000E+02 |
| Within Treatment | 1800 | 1.8000000000000E+01 | 1.0000000000000E-02 | |

EngineRoom:

ANOVA Table

| | DF | Sum Sq | MeanSq | FValue |
|-----------|-------|--------|--------|--------|
| Treatment | 8 | 16.08 | 2.01 | 200.6 |
| Residuals | 1,800 | 18.04 | 0.01 | NA |

III. Linear Regression

URL: https://www.itl.nist.gov/div898/strd/lls/lls.shtml

Data set: Norris

Linear Regression Results Table:

| Data Set | Sample size | Statistic | NIST Value | ER Value |
|----------|----------------|---------------------|------------------------|---|
| Norris | 36 | Par1 Coefficient | -0.262323073774029 | -0.262 |
| | | Par1 SE | 0.232818234301152 | 0.2328 |
| | | Par2 Coefficient | 1.00211681802045 | 1.002 |
| | | Par2 SE | 0.429796848199937 E-03 | 0.0004 |
| | | Residual S | 0.884796396144373 | SQRT(MSE) = SQRT(0.7829) = 0.8848 |
| | | R-sq | 0.999993745883712 | 1 |
| | | Regression SS | 4255954.13232369 | 4,255,954 |
| | | Regression MS | 4255954.13232369 | 4,255,954 |
| | | Residual SS | 26.6173985294224 | 26.62 |
| | | Residual MS | 0.782864662630069 | 0.7829 |
| | | F Statistic | 5436385.54079785 | 5,436,386 |

Norris:

NIST:

Certified Regression Statistics

| Parameter | Estimate | Standard Deviation of Estimate |
|-----------|--------------------|-----------------------------------|
| BØ | -0.262323073774029 | 0.232818234301152 |
| B1 | 1.00211681802045 | 0.429796848199937E-03 |
| | | |

Residual Standard Deviation 0.884796396144373

R-Squared 0.999993745883712

Certified Analysis of Variance Table

| Source of | Degrees o | f Sums of | Mean | F Statistic |
|------------|-----------|------------------|-------------------|------------------|
| Variation | Freedom | Squares | Squares | |
| Regression | 1 | 4255954.13232369 | 4255954.13232369 | 5436385.54079785 |
| Residual | 34 | 26.6173985294224 | 0.782864662630069 | |

y = -0.2623 + (1.002) * (x)

Regression Statistics

| Correlation | 1 |
|--------------------|----|
| Coefficient, R | |
| R Squared | 1 |
| Adjusted R Squared | 1 |
| Count | 36 |

Coefficient Table

| | Estimate | Std. Error | t value | p- value | 95% Cl (lower) | 95% Cl (upper) |
|-------------|----------|---------------|------------|-------------|-------------------|-------------------|
| (intercept) | -0.262 | 0.2328 | -1.1 | 0.2677 | -0.719 | 0.194 |
| х | 1.002 | 0.0004 | 2,300 | 0 | 1.001 | 1.003 |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|------------|----|-----------|-----------|-----------|---------|
| Regression | 1 | 4,255,954 | 4,255,954 | 5,436,386 | 0 |
| Residuals | 34 | 26.62 | 0.7829 | NA | NA |
| Total | 35 | 4,255,981 | NA | NA | NA |

EngineRoom Validation Test Output

- I. Dataset: Basic Graphs
- II. Dataset: Measurement System Analysis
- III. Dataset: Statistical Process Control
- IV. Dataset: ParametricHypTests
- V. Dataset: NonParametricHypTests
- VI. Dataset: Regression
- VII. Dataset: DOE_Full
- VIII. Dataset: DOE_Fractional
- IX. Dataset: DOE_General

I. Dataset: BasicGraphs





2. Bar Chart - Frequencies



3. Box Plot - Vendors



4. Box Plot: Contract Amount x Vendors



5. Histogram: Vendors



6. Histogram: Contract Amount x Vendors

| | created 2 minutes ago / modified | 2 minutes | sago | | | | | | | زم، graph |
|---------------|---|-----------|-------|--------|--------|-------------|-----------|----------|--------|-----------|
| tract ount | tatistics | | 0 | | Charts | of Contract | Amoun | t | | |
|)2 | addition of the second s | 1 | 2 | 3 | Charts | or contract | . / inoun | ° E | | Λ |
| | Count | 29 | 43 | 20 | | | | | ф, с Ш | 00 |
| | Min | 56 | 56 | 50 | | | | 1 | | |
| | Max | 115 | 140 | 128 | ° C | | | | | |
| 1 | Mean | 82.55 | 80.42 | 75.4 | enb | | | | | |
| 1 | Median | 82 | 76 | 76 | E_2 | | | | | |
| 9 | Standard Deviation | 13.59 | 18.92 | 17.42 | 0 | 60 | 80 | 100 1 | 120 | 140 |
| ` | Variance | 184.8 | 357.8 | 303.6 | | | | | | |
| , | Anderson-Darling Test Statistic | 0.403 | 2.313 | 0.6286 | 15- | | | 2 | | |
| | Anderson-Darling p-value | 0.3352 | 0 | 0.087 | 10- | | | | | |
| 9 | Skewness | 0.5567 | 1.347 | 1.355 | nba 5 | | | | Highe | st range |
| | Kurtosis | 0.2043 | 1.374 | 3.346 | Ĕ 0 | | | | | |
| | | | | | | 60 | 80 | 2 | 120 | 140 |
| | | | | | | | | 2 | | |
| | | | | | ₹ 6 | | | 5 | | |
| | | | | | uen 4 | | | | | |
| | | | | | be 2- | | | | | |
| | | | | | LL 0 | 60 | 80 | 100 | 120 | 140 |

7. Pie Chart: Defects



8. Scatter Plot: Test 1 x Test 2



9. Scatter Plot: Test 1 x Test 2 x Test 3





10. Trend Chart: Frequencies_1 x Frequencies_2

11. Pareto Analysis: Defects

| 3 | | | | | | ို export ြ copy i∃0notes ြာ0files |
|-------------------------------------|---------------|------------------|----------------------|------------|----------------|---|
| Frequency Parete Variable Analys | Pareto | Analysis | : Defects | | | ද်္ပာ} study setup |
| Defects | created 2 m | iinutes ago / mo | odified a minute ago | | | |
| | Results | | | | | Chart of Defects |
| 78 | | Frequency | Cumulative Frequency | Percentage | Cum Percentage | $ \textcircled{a} \vdash \bigoplus \bigcirc \bigcirc$ |
| | Late delivery | 26 | 26 | 33.33 | 33.33 | Pareto |
| | Cold pizza | 18 | 44 | 23.08 | 56.41 | 100 |
| | Missing item | 11 | 55 | 14.1 | 70.51 | |
| | Tastes bad | 8 | 63 | 10.26 | 80.77 | |
| | Other | 7 | 70 | 8.97 | 89.74 | 60 80 |
| | Rude driver | 5 | 75 | 6.41 | 96.15 | |
| | Wrong price | 3 | 78 | 3.85 | 100 | 60 e |
| | | | | | | anti ati |
| | | | | | | قــــــــــــــــــــــــــــــــــــ |
| | | | | | | |
| | | | | | | 20 |
| | | | | | | 20 |
| | | | | | | |
| | | | | | | Cold. Missi Task Othe Rude Wron |
| | | | | | | delivery "Pizza" "Ing item |
| | | | | | | Defects |

II. Dataset: Measurement System Analysis

1. Gauge R&R: Measurement

Gauge R&R: Measurement

created a day ago / modified 2 hours ago

ANOVA Table - Crossed, with Interaction

| | Df | Sum Sq | Mean Sq | F value | p-value |
|-----------------|----|--------|---------|---------|---------|
| Part # | 4 | 368.3 | 92.08 | 61,086 | 0 |
| Operator | 2 | 0 | 0 | 0.0023 | 0.9977 |
| Operator*Part # | 8 | 0.0121 | 0.0015 | 0.6615 | 0.7205 |
| Repeatability | 30 | 0.0684 | 0.0023 | | |
| Total | 44 | 368.4 | | | |

ANOVA Table - Crossed, without Interaction

| | Df | Sum Sq | Mean Sq | F value | p-value |
|---------------|----|--------|---------|---------|---------|
| Part # | 4 | 368.3 | 92.08 | 43,508 | 0 |
| Operator | 2 | 0 | 0 | 0.0016 | 0.9984 |
| Repeatability | 38 | 0.0804 | 0.0021 | | |
| Total | 44 | 368.4 | | | |

Gauge R&R - Variance Components (ANOVA) Method

| | VarComp | % Total Variance |
|-----------------|---------|------------------|
| Total Gauge R&R | 0.0021 | 0.02 |
| Repeatability | 0.0021 | 0.02 |
| Reproducibility | 0 | 0 |
| -Operator | 0 | 0 |
| Part-to-Part | 10.23 | 99.98 |
| Total Variance | 10.23 | 100 |

Gauge R&R - AIAG Method

| | Std Dev | StudyVar | % Study Var |
|-----------------|---------|----------|-------------|
| Total Gauge R&R | 0.046 | 0.276 | 1.44 |
| Repeatability | 0.046 | 0.276 | 1.44 |
| Reproducibility | 0 | 0 | 0 |
| -Operator | 0 | 0 | 0 |
| Part-to-Part | 3.199 | 19.19 | 99.99 |
| Total Variance | 3.199 | 19.19 | 100 |
| | | | |

Number of Distinct Categories 98

Charts of Measurement



2. Attribute Agreement Analysis: Binary

| ent | |
|-----|--|
| is | |
| | |

Attribute Agreement Analysis: Binary

created a day ago / modified 4 hours ago

Within Appraiser Agreement

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% CI (upper) |
|-------|--------------|-------------|-------------|----------------|----------------|
| Janet | 20 | 20 | 100 | 86.09 | 100 |
| Chris | 18 | 20 | 90 | 68.3 | 98.77 |
| Sam | 19 | 20 | 95 | 75.13 | 99.87 |

Within Appraiser Fleiss Kappa Statistic

| | Response | Карра | SE Kappa | Z | p-value |
|-------|----------|-------|----------|-------|---------|
| Janet | F | 1 | 0.2236 | 4.472 | 0 |
| | Р | 1 | 0.2236 | 4.472 | 0 |
| Chris | F | 0.798 | 0.2236 | 3.569 | 0.0002 |
| | Р | 0.798 | 0.2236 | 3.569 | 0.0002 |
| Sam | F | 0.886 | 0.2236 | 3.962 | 0 |
| | Р | 0.886 | 0.2236 | 3.962 | 0 |

Each Appraiser Vs Standard

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% CI (upper) |
|-------|--------------|-------------|-------------|----------------|----------------|
| Janet | 16 | 20 | 80 | 56.34 | 94.27 |
| Chris | 18 | 20 | 90 | 68.3 | 98.77 |
| Sam | 15 | 20 | 75 | 50.9 | 91.34 |

Each Appraiser Fleiss Kappa Statistic

| | Response | Карра | SE Kappa | Z | p-value |
|-------|----------|--------|----------|-------|---------|
| Janet | F | 0.5604 | 0.1581 | 3.545 | 0.0002 |
| | Р | 0.5604 | 0.1581 | 3.545 | 0.0002 |
| Chris | F | 0.8987 | 0.1581 | 5.684 | 0 |
| | Р | 0.8987 | 0.1581 | 5.684 | 0 |
| Sam | F | 0.5422 | 0.1581 | 3.429 | 0.0003 |
| | Р | 0.5422 | 0.1581 | 3.429 | 0.0003 |

Between Appraiser Agreement

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% CI (upper) | | |
|--|--------------|-------------|-------------|----------------|----------------|--|--|
| All | 10 | 20 | 50 | 27.2 | 72.8 | | |
| Between Appraiser Fleiss Kappa Statistic | | | | | | | |

| | Response | карра | SE карра | Ζ | p-value |
|-----|----------|--------|----------|-----|---------|
| All | F | 0.4965 | 0.0577 | 8.6 | 0 |
| | Р | 0.4965 | 0.0577 | 8.6 | 0 |

All Appraisers Vs Standard

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% CI (upper) |
|-----|--------------|-------------|-------------|----------------|----------------|
| All | 10 | 20 | 50 | 27.2 | 72.8 |



3. Attribute Agreement Analysis: Ordinal data

Attribute Agreement Analysis: Ordinal data

created a day ago / modified 4 hours ago

Within Appraiser Agreement

ient sis

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% Cl (upper) |
|---|--------------|-------------|-------------|----------------|----------------|
| 1 | 4 | 10 | 40 | 12.16 | 73.76 |
| 2 | 6 | 10 | 60 | 26.24 | 87.84 |

Within Appraiser Fleiss Kappa Statistic

| | Response | Карра | SE Kappa | Z | p-value |
|---|----------|--------|----------|--------|---------|
| 1 | 1 | 0.7115 | 0.1826 | 3.897 | 0 |
| | 2 | 0.375 | 0.1826 | 2.054 | 0.02 |
| | 3 | 0.4886 | 0.1826 | 2.676 | 0.0037 |
| | 4 | 0.28 | 0.1826 | 1.534 | 0.0626 |
| | 5 | 0.1346 | 0.1826 | 0.7373 | 0.2305 |
| | 6 | 1 | 0.1826 | 5.477 | 0 |
| | Overall | 0.4687 | 0.0849 | 5.521 | 0 |
| 2 | 1 | 1 | 0.1826 | 5.477 | 0 |
| | 2 | 1 | 0.1826 | 5.477 | 0 |
| | 3 | 0.3182 | 0.1826 | 1.743 | 0.0407 |
| | 4 | 0.8137 | 0.1826 | 4.457 | 0 |
| | 5 | 1 | 0.1826 | 5.477 | 0 |
| | 6 | -0.111 | 0.1826 | -0.609 | 0.7286 |
| | Overall | 0.6685 | 0.0874 | 7.645 | 0 |

Within Kendall Coefficient of Concordance

Kendall Chi-Sq DF p-value

| 1 | 0.9224 | 24.91 | 9 | 0.0031 | |
|---|--------|-------|---|--------|--|
| 2 | 0.7605 | 20.53 | 9 | 0.0149 | |

Each Appraiser Vs Standard

| | # Agreements | # Inspected | % Agreement | 95% CI (lower) | 95% CI (upper) |
|---|--------------|-------------|-------------|----------------|----------------|
| 1 | 4 | 10 | 40 | 12.16 | 73.76 |
| 2 | 6 | 10 | 60 | 26.24 | 87.84 |

Each Appraiser Fleiss Kappa Statistic

| | Response | Карра | SE Kappa | Z | p-value |
|---|----------|--------|----------|--------|---------|
| 1 | 1 | 0.8693 | 0.1826 | 4.761 | 0 |
| | 2 | 0.5721 | 0.1826 | 3.133 | 0.0009 |
| | 3 | 0.7524 | 0.1826 | 4.121 | 0 |
| | 4 | 0.4526 | 0.1826 | 2.479 | 0.0066 |
| | 5 | 0.1285 | 0.1826 | 0.704 | 0.2407 |
| | 6 | 1 | 0.1826 | 5.477 | 0 |
| | Overall | 0.6268 | 0.0868 | 7.219 | 0 |
| 2 | 1 | 1 | 0.1826 | 5.477 | 0 |
| | 2 | 1 | 0.1826 | 5.477 | 0 |
| | 3 | 0.5937 | 0.1826 | 3.252 | 0.0006 |
| | 4 | 0.9111 | 0.1826 | 4.99 | 0 |
| | 5 | 1 | 0.1826 | 5.477 | 0 |
| | 6 | 0.148 | 0.1826 | 0.8108 | 0.2087 |
| | Overall | 0.7908 | 0.0884 | 8.951 | 0 |

Between Appraiser Agreement

| | # Agreements | # Inspecte | 9 d A | % Agreement | 95% Cl (lower) | 9 (L | 5% Cl upper) | | |
|-----|-----------------|---------------|----------|----------------|-------------------|---------|-----------------|-------|--|
| All | 2 | 2 | 10 | 20 |) | 2.521 | | 55.61 | |

Between Appraiser Fleiss Kappa Statistic

| | Response | Карра | SE Kappa | Z | p-value |
|-----|----------|--------|----------|-------|---------|
| All | 1 | 0.8383 | 0.0816 | 10.27 | 0 |
| | 2 | 0.625 | 0.0816 | 7.655 | 0 |
| | 3 | 0.4205 | 0.0816 | 5.149 | 0 |
| | 4 | 0.4583 | 0.0816 | 5.613 | 0 |
| | 5 | 0.3208 | 0.0816 | 3.928 | 0 |
| | 6 | 0.3333 | 0.0816 | 4.082 | 0 |
| | Overall | 0.499 | 0.0384 | 13 | 0 |

Between Kendall Coefficient of Concordance

| | Kendall | Chi-Sq | DF | p-value |
|-----|---------|--------|----|---------|
| All | 0.7655 | 41.34 | 9 | 0 |

All Appraisers Vs Standard

| | # | # | % | 95% Cl | 95% CI | |
|-----|------------|-----------|-----------|---------|---------|-------|
| | Agreements | Inspected | Agreement | (lower) | (upper) | |
| All | 2 | 10 | 20 | | 2.521 | 55.61 |

| All | All Applaisers Fleiss Rappa Statistic | | | | | | | |
|-----|---------------------------------------|--------|----------|-------|---------|--|--|--|
| | Response | Карра | SE Kappa | Z | p-value | | | |
| All | 1 | 0.9346 | 0.1291 | 7.24 | 0 | | | |
| | 2 | 0.786 | 0.1291 | 6.089 | 0 | | | |
| | 3 | 0.673 | 0.1291 | 5.213 | 0 | | | |
| | 4 | 0.6819 | 0.1291 | 5.282 | 0 | | | |
| | 5 | 0.5643 | 0.1291 | 4.371 | 0 | | | |
| | 6 | 0.574 | 0.1291 | 4.446 | 0 | | | |

All Appraisers Fleiss Kappa Statistic



4. Process Capability Analysis: Width (Isl=0.8, target=0.85, usl=0.9)

Specifications

| Lower Specification Limit: | 0.8 |
|---------------------------------|------|
| Target: | 0.85 |
| Upper Specification Limit: | 0.9 |
| Specification Range (Tolerance) | 0.1 |

Normality Test

| Anderson-Darling Test Statistic | 0.2326 |
|---------------------------------|--------|
| Anderson-Darling p-value | 0.794 |

Process Capability Statistics (Within)

| Ср | 0.8751 |
|---------|--------|
| Cpk | 0.8131 |
| % Yield | 99.02 |
| Sigma | 2.333 |

Process Capability Statistics (Overall)

| Рр | 0.8617 |
|---------|--------|
| Ppk | 0.8007 |
| Cpm | 0.8475 |
| % Yield | 98.9 |
| Sigma | 2.291 |

Process Performance (% Defective)

| | Observed | Expected (Within) | Expected (Overall) |
|-------------|----------|-------------------|--------------------|
| % Below LSL | 1 | 0.7356 | 0.8151 |
| % Above USL | 1 | 0.2468 | 0.2819 |
| Total | 2 | 0.9824 | 1.097 |

Process Characteristics

| Sample Size | 100 |
|------------------------------|--------|
| Subgroup Size | 5 |
| Number of Subgroups | 20 |
| Sample Mean | 0.8465 |
| Standard Deviation (Within) | 0.019 |
| Standard Deviation (Between) | 0.0193 |



III. Dataset: Statistical Process Control

1. X and Moving Range Chart - Yield



X Chart Statistics

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|---------|------------|------------|------------|------------|
| UCL | 17.08 | 14.95 | 16.09 | 15.91 |
| Average | 12.82 | 12.68 | 13.03 | 13.51 |
| LCL | 8.559 | 10.41 | 9.965 | 11.12 |

Moving Range Chart Statistics

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|---------|------------|------------|------------|------------|
| UCL | 5.232 | 2.791 | 3.763 | 2.946 |
| Average | 1.601 | 0.8543 | 1.152 | 0.9018 |
| LCL | 0 | 0 | 0 | 0 |



2. X bar and R/S Chart - Yield



X Chart Statistics

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|---------|------------|------------|------------|------------|
| UCL | 14.32 | 13.6 | 14.24 | 14.59 |
| Average | 12.82 | 12.68 | 13.03 | 13.51 |
| LCL | 11.32 | 11.75 | 11.81 | 12.43 |

R Chart Statistics

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|---------|------------|------------|------------|------------|
| UCL | 6.217 | 3.838 | 5.042 | 4.476 |
| Average | 3.103 | 1.915 | 2.516 | 2.233 |
| LCL | 0 | 0 | 0 | 0 |


3. np Chart: Defectives (n=50)



4. p Chart: Defectives



5. c Chart: Defects



6. u Chart: Defects



7. g Chart: Doses b/w medication errors



8. g Chart: Date of infection



9. CUSUM Chart: Distance



10. EWMA Chart: Distance



IV. Dataset: ParametricHypTests

1. 1 Proportion Test: Pass

| 1 Propo | ortion Test | : Pass | | | | | | | | A assur | nptions | {၀ိ} test s |
|---------------------|---------------------------------|-----------------|-------------------------|---------------------------------------|---------------------------|--------------------------------|------------------------|----------------------------|--------|-------------|------------|------------------------|
| created 2 day | s ago / modified a | minute a | go | | | | | | | | | ~~~ |
| С | onclusion | At the event | e 5% lev : '1' in 'F | vel, reject the r Pass' is greater | ull hypo than '0. | othesis. Th .5'. | ere is suf | ficient | eviden | ce that the | e propo | rtion of th |
| Null Alternative | Hypothesis Hypothesis | The p The p | roporti roporti | on of the event ion of the even | '1' in 'Pa t '1' in 'F | ass' is less t Pass' is gre | han or eo ater than | qual to 1 '0.5'. | '0.5'. | | | |
| Hypothesis T | est Results | | | | | Charts o | f Pass | | | | | |
| Lower Cut-off | < Upper Cut-off | < Test S | tatistic | -Inf < 1.645 < | 3.801 | | | | | 6 | + ↔ | QÂ |
| p-value < alpha | 1 | | | 1e-04 < | < 0.05 | | | | | | | |
| 95% Confidence | e Interval | | | (0.629) | 3, Inf) | p-value | p-value | | | Τe | est Stati | Stic Test Statistic |
| Sample Sumr | mary | | | | | L 6 | | | | -00 | _ | |
| Sample Sample | e Size (n) Succ | ess Cou | int Pro | portion | | Rejeo | t Do Not R | eject | | Do N | lot Reject | Reject |
| Pass | 80 | 1 | 57 | 0.7125 | | 0 | 0.2 | 0.4 | 0.6 | | 0 | 5 |
| | | | | | | Confid | dence Inte | erval | | 1 Pi | roportio | ons |
| | | | | | | Proportion | 3 | | S | Succe | esses | |
| | | | | | | | | | rtion | | | |
| | | | | | | | | | odo | 0.5 | | Failures |
| | | | | | | | | | Ā | | | |
| | | | | | | 0.5 | 0.6 0.7 | 0.8 | 0.9 | 0 | Pass | |
| | | | | | | | | | | | vdridDi | 25 |

2. 2 Proportions Test: Line1 x Line2



3. Multiple Proportions Test: Locations

| Multiple P | roportic | ons Test: | Locations | | 4 | ∖ assumpti | ons ζόζ te | st set |
|----------------------|----------------|----------------------------|---|---|--------------------------------|--------------------|--------------|--------|
| created 2 days ag | o / modified a | minute ago | | | | | ~~~ | |
| Cond | lusion | At the 5% l the claim t | evel, do not rejec hat the proportio | t the null hypothesis. ons of 1 are equal acro | There is insu ss all groups | ufficient ev 5. | idence to re | ejec |
| Null Hyp | othesis | The propor | tions of 1 are eq | ual across all groups. | | | | |
| Alternative Hy | oothesis | The propor | tions of 1 are NO | l equal across all group | ps. | | | |
| Hypothesis Test | Results | | | Charts of 4 v | variables | | | |
| Test Statistic < Cri | tical Chi-Squ | are Cut-off | 2.741 < 7.815 | | | 0 [+ | | Г L |
| p-value > alpha | | | 0.4333 > 0.05 | | | | | |
| Degrees of freedo | m | | 3 | p-val | ue p-yalue | Test Test S | t Statistic | |
| Pairwise Compa | risons | | | | | -00 | | |
| PairlJ | pi - pj | Critical Val | ue Significant? | RejectDo N | Not Reject | Do No | RejectReject | |
| (Location1,Location | n2) 0.01 | 0.09 | 74 FALSE | 0 0. | 2 0.4 0.6 | 0 | 10 | |
| (Location1,Location | n3) 0.05 | 0.11 | 55 FALSE | | tions | | | |
| (Location1,Location | n4) 0.01 | 0.10 | 41 FALSE | S | | | | |
| (Location2,Location | n3) 0.06 | 0.11 | 25 FALSE | .01 0.5 | | | | |
| (Location2,Location | n4) 0.02 | 0.10 | 08 FALSE | rope | | | | |
| (Location3,Location | n4) 0.04 | 0.11 | 83 FALSE | Ê | | | | |
| Sample Summa | ry | | | Location, | Location3 | 24 | | |
| | ~: | | Count Dropo | Var | iables | | | |

| Sample | Sample Size (n) | Success | Count | Proportion |
|-------------------|-----------------|---------|-------|------------|
| Location1 | 100 | 1 | 7 | 0.07 |
| Location2 | 100 | 1 | 6 | 0.06 |
| Location3 | 100 | 1 | 12 | 0.12 |
| Location4 | 100 | 1 | 8 | 0.08 |
| Pooled Proportion | 400 | 1 | 33 | 0.0825 |

4. 1 Mean t-Test: Values

| T Weart Crest | : Values | | 📈 assumptions နီဝိ} test |
|---------------------------|----------------------------|--|--|
| created 2 days ago / mo | dified a day ago | | |
| Conclus | ion At the 10% is less tha | ն level, reject the null hyp n '5'. | pothesis. There is sufficient evidence that the mean of 'Valu |
| Null Hypoth | esis The mean | of 'Values' is greater than | or equal to '5'. |
| Alternative Hypoth | esis The mean | of 'Values' is less than '5 | N. C. |
| Hypothesis Test Resu | ilts | | Charts of Values |
| Test Statistic < Lower Cu | it-off < Upper Cut- | off -2.562 < -1.397 < Inf | |
| p-value < alpha | | 0.0168 < 0.1 | |
| 90% Confidence Interva | I | (-Inf, 4.904) | p-value Test Statistic |
| Degrees of freedom | | 8 | |
| Sample Summary | | | |
| | Values | | 0 0.2 0.4 0.6 -2 0 |
| Count | 9 | | Confidence Interval |
| Min | 4.4 | | Hypothesized |
| Max | 5.1 | | e e e e e e e e e e e e e e e e e e e |
| Mean | 4.789 | | Values |
| Median | 4.7 | | A state of the |
| Standard Deviation | 0.2472 | | |
| Variance | 0.0611 | | 4.7 4.8 4.9 5 4.4 4.6 4.8 5 |

5. 2 Means t-Test: BTU



| Standard Deviation | 3.02 | 2.767 |
|----------------------------|--------|--------|
| Variance | 9.12 | 7.656 |
| Anderson-Darling Statistic | 0.4745 | 0.1896 |
| Anderson-Darling p-value | 0.2283 | 0.8951 |
| Skewness | 0.7075 | -0.099 |
| Kurtosis | 0.784 | -0.272 |

6. 2 Means t-Test (Paired Samples): Methods

| R. | | | $ \bigcirc $ export $ \bigcirc $ copy $ \ge = 0 $ notes | s 🗁 0 files ⑦ help [] max ⑧ clos |
|---|---------------------------------------|--|--|--|
| reans t- t (Paired 2 Means t-Test (P | aired Sample | es): Methods | | A assumptions |
| created 2 days ago / modified a | i day ago | | | |
| Conclusion | At the 5% level, difference ('Me | , reject the null hyp thod1' - 'Method2') | othesis. There is sufficient e is less than '0'. | vidence that the mean of the |
| Null Hypothesis Alternative Hypothesis | The mean of the The mean of th | e difference ('Metho e difference ('Metho | d1' - 'Method2') is greater th od1' - 'Method2') is less thai | an or equal to '0'. n '0'. |
| Hypothesis Test Results | | | Charts of 2 variables | |
| Test Statistic < Lower Cut-off | < Upper Cut-off -4 | 4.023 < -2.132 < Inf | | |
| p-value < alpha | | 0.0079 < 0.05 | | |
| 95% Confidence Interval | | (-Inf, -6.431) | p-value | Test Statistic |
| Degrees of freedom | | 4 | | |
| Sample Summary | | | Reject Do Not Reject | Reject Do Not Reject |
| М | ethod1 - Method2 | | 0 0.2 0.4 0. | 6 -4 -2 0 2 |
| Count | 5 | | Confidence Interval | Summary |
| Min | -25.2 | | Hypothe Differe | sized of the second sec |
| Max | -5.7 | | les | |
| Mean | -13.68 | | Method - | Method2 |
| Median | -12.9 | | > | |
| Standard Deviation | 7.603 | | -20 -15 -10 -5 0 | -25 -20 -15 -10 -5 |
| Variance | 57.81 | | | Data |

Sample Summary

| | Method1 - Method2 |
|----------------------------|-------------------|
| Count | 5 |
| Min | -25.2 |
| Max | -5.7 |
| Mean | -13.68 |
| Median | -12.9 |
| Standard Deviation | 7.603 |
| Variance | 57.81 |
| Anderson-Darling Statistic | NA |
| Anderson-Darling p-value | NA |
| Skewness | -0.843 |
| Kurtosis | 0.4109 |

7. One-way ANOVA: Routes

| ां श् One- | way | | | | | | | | û export ा⊂ copy ፤Ξ 0 notes 🗁 0 files ⑦ help [] max ⊗ clo |
|-----------------|-------------------|-------|---------------|-----------------------|--------------------------------|---------------------------|-----------------------|---------------------|---|
| ANC | MA One | -wa | y ANO | VA: Ro | outes | | | | A assumptions {} test setup |
| | created | 2 day | s ago / moc | dified 5 min | utes ago |) | | | |
| | | Со | nclusi | on At | the 20 ⁰ eans of | % level, do the levels | not reje of 'Route | ct the r es' are | null hypothesis. There is insufficient evidence to reject the claim that the all equal. |
| oute2 | N | ull F | lypothe | e <mark>sis</mark> Th | e mear | ns of the le | vels of 'F | outes' | are all equal. |
| 21 dl | Alternat | ive ł | Hypothe | esis Th | e mear | ns of the lev | els of 'Re | outes' a | are NOT all equal. |
| Routes | Hypothes | is Te | est Resu | ilts | | | | | Charts of 3 variables |
| 21 | Test Statis | tic < | F-Critical | 1.009 < 1 | 1.653 | | | | |
| Data riables | p-value > a | alpha | | 0.3706 | > 0.2 | | | | |
| | ANOVA T | able | | | | | | | p-value Test Statistic p-value Test Statistic |
| | | DF S | Sum Sq 🛛 | MeanSq | FValue | p-value F | -Critical | | _00 00 |
| | Routes | 2 | 188.2 | 94.11 | 1.009 | 0.3706 | 1.653 | | Reject Do Not Reject Do Not Reject Reject |
| | Residuals | 60 | 5,594 | 93.24 | NA | NA | NA | | 0 0.2 0.4 0.6 0 1 2 |
| | Total | 62 | 5,783 | NA | NA | NA | NA | | Tukey Confidence Intervals Summary |
| | All Pairwi | se C | omparis | sons | | | | | Route3-Route2 60 |
| | | | Lower 8 Cl | ^{30%} M | ean U C | pper 80% I | Signif | icant? | |
| | Route2– Route1 | | | -6.747 -1 | .571 | 3.60 | 5 | FALSE | Route2-Route1 |
| | Route3- | | | -2 557 2 | 619 | 7 79 | 5 | EAL SE | Variables |

All Pairwise Comparisons

| | Lower 80% Cl | Mean | Upper 80% Cl | Significant? |
|-------------------|-----------------|--------|-----------------|--------------|
| Route2– Route1 | -6.747 | -1.571 | 3.605 | FALSE |
| Route3– Route1 | -2.557 | 2.619 | 7.795 | FALSE |
| Route3– Route2 | -0.986 | 4.19 | 9.366 | FALSE |

Sample Summary

| | Route1 | Route2 | Route3 |
|---------------------------------|--------|--------|--------|
| Count | 21 | 21 | 21 |
| Min | 20 | 10 | 20 |
| Max | 48 | 44 | 65 |
| Mean | 33.29 | 31.71 | 35.9 |
| Median | 33 | 33 | 34 |
| Standard Deviation | 8.861 | 8.451 | 11.39 |
| Variance | 78.51 | 71.41 | 129.8 |
| Anderson-Darling Test Statistic | 0.3627 | 0.2358 | 0.5409 |
| Anderson-Darling p-value | 0.4088 | 0.7595 | 0.1454 |
| Skewness | 0.0985 | -0.588 | 1.048 |
| Kurtosis | -1.272 | 0.687 | 1.181 |

8. Blocked One-way ANOVA: Routes x Make

| NOVA Block | ked 2 days | One-v ago / mod | Vay Al lified 3 mir | NOVA nutes ago | : Route | es x Ma | ake | 🛆 assumptions 🖧 te |
|-------------|----------------------|--------------------|------------------------|----------------------|---------------------------|------------------------|----------------------|---|
| | Со | nclusio | on _{cl} | t the 109 aim tha | % level, do t the mean | not rejeo is of the | t the nu evels of | ull hypothesis. There is insufficient evidence to reject f 'Routes' are all equal across the levels of 'Make'. |
| N | ull H | ypothe | sis Tl | ne mear | ns of the le | vels of 'R | outes' a | are all equal across the levels of 'Make'. |
| Alternat | ive H | lypothe | sis Th | ne mean | is of the lev | els of 'Ro | utes' ar | e NOT all equal across the levels of 'Make'. |
| Hypothes | is Te | st Resu | lts | | | | | Charts of 4 variables |
| Test Statis | tic < F | -Critical | 1.087 < | 2.396 | | | | © F ↔ Q ⋒ |
| p-value > a | lpha | | 0.3439 | > 0.1 | | | | |
| ANOVA Ta | able | | | | | | | p-value Test Statistic p-value Test Statistic |
| | DF S | um Sq N | ∕leanSq | FValue | p-value F- | -Critical | | -00 |
| Routes | 2 | 188.2 | 94.11 | 1.087 | 0.3439 | 2.396 | | RejecDo Not Reject Do Not Rejecteject |
| Make | 2 | 574.6 | 287.3 | 3.32 | 0.0432 | NA | | 0 0.2 0.4 0.6 0 2 4 |
| Residuals | 58 | 5,020 | 86.55 | NA | NA | NA | | Tukey Confidence Interval: Summary |
| Total | 62 | 5,783 | NA | NA | NA | NA | | Route3-Route2 60 |
| All Pairwis | se Co | mparis | ons | | | | | |
| | | Lower 9 Cl | 0% N | lean Ul CI | pper 90% | Signifi | cant? | |
| Pouto2 | | | | | | | | Route2-Route1 |

All Pairwise Comparisons

| | Lower 90% Cl | Mean | Upper 90% Cl | Significant? |
|-------------------|-----------------|--------|-----------------|--------------|
| Route2– Route1 | -5.467 | 1.571 | 8.61 | FALSE |
| Route3– Route1 | -9.66 | -2.619 | 4.419 | FALSE |
| Route3– Route2 | -11.23 | -4.19 | 2.848 | FALSE |

Sample Summary

| | Route1 | Route2 | Route3 |
|---------------------------------|--------|--------|--------|
| Count | 21 | 21 | 21 |
| Min | 20 | 10 | 20 |
| Max | 48 | 44 | 65 |
| Mean | 33.29 | 31.71 | 35.9 |
| Median | 33 | 33 | 34 |
| Standard Deviation | 8.861 | 8.451 | 11.39 |
| Variance | 78.51 | 71.41 | 129.8 |
| Anderson-Darling Test Statistic | 0.3627 | 0.2358 | 0.5409 |
| Anderson-Darling p-value | 0.4088 | 0.7595 | 0.1454 |
| Skewness | 0.0985 | -0.588 | 1.048 |
| Kurtosis | -1.272 | 0.687 | 1.181 |

9. 1 Variance Chi-Square Test: AtoBDist



Sample Summary

| | AtoBDist |
|----------------------------|----------|
| Count | 125 |
| Min | -7.303 |
| Max | 8.023 |
| Mean | 0.4417 |
| Median | 0.13 |
| Standard Deviation | 3.491 |
| Variance | 12.19 |
| Anderson-Darling Statistic | 0.8911 |
| Anderson-Darling p-value | 0.0222 |
| Skewness | 0.1245 |
| Kurtosis | -0.823 |

10. 2 Variances Test: BTU



11. 2 Variances Test: Summary data

| | 3 | | | | \triangle export \square copy $= 0$ note | s 🗁 0 files ⑦ help 📋 max 🛞 close |
|---------------------------|-------------------------------|----------------------------|---|--|--|----------------------------------|
| Group 2 Var Variable T | ances 2 Variances | s Test: | Summary o | data | | 🛆 assumptions 👌 test setup |
| Data | created 2 days ago | / modified a | day ago | | | |
| Variables | Concl | usion | At the 5% leve claim that the | l, do not reject the n variance of 'A' is equ | ficient evidence to reject the | |
| | Null Hypo Alternative Hypo | o thesis othesis | The variance o The variance o | of 'A' is equal to the v f 'A' is NOT equal to tl | ariance of 'B'. he variance of 'B'. | |
| | Hypothesis Test F | Results | | | | |
| | Lower Cut-off < Tes | t Statistic | < Upper Cut-off | 0.3066 < 2 < 2.814 | | |
| | p-value > alpha | | | 0.185 > 0.05 | p-value | Test Statistic |
| | 95% Confidence Int | erval | | (0.7108, 6.522) | p-value | Test Statistic |
| | Degrees of freedom | ı | | (11, 18) | | -00 000 00 |
| | Sample Summary | / | | | Reject Do Not Reject 0 0.2 0.4 0.6 | RejectDo Not Reject |
| | | A B | | | Confidence Internal | |
| | Count | 12 19 | 1 | | Hypothesized | |
| | Standard Deviation | 2 1.414 | | | Ratio | |
| | Variance | 4 2 | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | 2 4 6 | |
| | | | | | | |

12. Multiple Variances Test: Routes

| श | | | | | e | export 🕞 copy 📃 🛛 notes 🗁 🛛 files 🕐 help 🖕 'max 🛞 🖉 | clos |
|---------------------|---------------------------------------|--------------------|--------------------------|----------------------------------|--|---|------|
| Mult Varia Te | Multiple Vari | ances Te | est: Rou | utes | | assumptions of test set | up |
| Route1 | created 2 days ago / m | odified a minut | e ago | | | | |
| 11 21 | Conclus | ion At ti clair | he 20% lev n that the | vel, do not rej variances are | ect the null h e equal acros | hypothesis. There is insufficient evidence to reject the oss all groups. | |
| ite2 | Null Hypoth | esis The | variances | are equal ac | oss all group | ıps. | |
| Route3 | Alternative Hypotr | iesis The | variances | are NOT equa | l across all gr | groups. | |
| | Hypothesis Test Res | ults | | | | Charts of 3 variables | |
| 21 | Lower Cut-off < Test St | atistic < Upp | er Cut- | 0.1055 | < 0.5676 < | | 1 |
| es | | off | | 0 | 2.393 | The second | |
| | p-value > alpha Degrees of freedom | | (2, 60) | | p-value lest Statistic p-value Test Statistic | | |
| | Sample Summary | | | | | -00 00000000000000000000000000000000000 | |
| | Sample Sammary | Route1 | Route2 | Route3 | | RejectDo Not Reject Reject 0 0.5 1 0 2 4 6 | |
| | Count | 21 | 21 | 21 | | <u>Current and</u> | |
| | Min | 20 | 10 | 20 | | | |
| | Max | 48 | 44 | 65 | | | |
| | Mean | 33.29 | 31.71 | 35.9 | | | |
| | Median | 33 | 33 | 34 | | | |
| | Standard Deviation | 8.861 | 8.451 | 11.39 | | | |
| | variance | /8.51 | /1.41 | 129.8 | | Data | |
| erson | -Darling Statistic | 0.3627 | 0.235 | 8 0.5409 |) | | |
| lerson | -Darling p-value | 0.4088 | 0.759 | 5 0.1454 | ŀ | | |
| wness | 5 | 0.0985 | -0.58 | 8 1.048 | 3 | | |
| tosis | | -1.272 | 0.68 | 7 1.181 | | | |

V. Dataset: NonParametricHypTests

1. 1 Sample Sign Test: Fillwt

| থ | | | | <u></u> | export 🕞 copy | i≡0notes 🗁 | 0 files ⑦ help | []max ⊗ clo | se |
|-------------------|--|----------------------------------|-------------------------|-----------------|--------------------------|---------------------|----------------------------------|-----------------|----|
| 1 Samp Sign Te | 1 Sample Sign Te | est: Fillwt | | | | A | assumptions | Cost test setup | |
| d | created 2 days ago / modified | a day ago | | | | | 2 6 | ~~~ ····· | |
| 38 | Conclusior | At the 15% le is less than '1 | vel, reject the n '. | ull hypothesis | . There is suffic | cient evidence | that the medi | an of 'Fillwt' | |
| | Null Hypothesis | s The median o | f 'Fillwt' is greate | er than or equa | al to '1'. | | | | |
| | Alternative Hypothesis | s The median of | of 'Fillwt' is less t | than '1'. | | | | | |
| | Hypothesis Test Results | | | Charts of F | illwt | | | | |
| | Test Statistic < Lower Cut-of off | f < Upper Cut- | 15 < 16 < Inf | | | | 0 🕂 🕂 | | |
| | p-value < alpha | | 0.1279 < 0.15 | p- p-va | value | Tes | Test Statistic Test Statistic | | |
| | 87.21% Confidence Interval | | (-Inf, 0.9448) | | | _00 | | ~ | |
| | Sample Size for Test (exclude Sample Median | ing ties) | 38 | Reject 0 | Do Not Reject 0.2 0.4 | | Reject Do Not | Reject 7 18 | |
| | | | 0.95 | Confide | nce Interval | | Summary | , | |
| | sample summary | illwt | | | Hyp | othesized Median | | | |
| | Count | 38 | | | | bles | | | |
| | Min |).5539 | | | | | | | |
| | Max | 1.57 | | | | - | | | |
| | Median | 1.002 | | 0.85 | 0.9 0.95 | 1 0.5 | 1 Data | 1.5 | |
| | Wedian | 0.95 | | | | | Data | | |
| Median | 1 | 0.93 | | | | | | | |
| Standa | rd Deviation | 0.2651 | | | | | | | |
| Variand | e | 0.0703 | | | | | | | |
| Anders | on-Darling Statistic | 1.061 | | | | | | | |
| Anders | on-Darling p-value | 0.0077 | | | | | | | |
| Skewne | ess | 0.5664 | | | | | | | |
| Kurtosi | s | -0.329 | | | | | | | |
| | | | | | | | | | |

2. 1 Sample Wilcoxon Signed Ranks Test: Fillwt

| थ | | | | ∐ export 🕞 copy 📃 0 | notes 🗁 0 files (?) help 📜 max (🗵 close | | |
|-------------------------|--|---------------------------------------|---|--|--|--|--|
| 1 Sam Wilcox Test | 1 Sample Wilcox created 2 days ago / modifie | kon Signed R d a day ago | anks Test: F | illwt | assumptions $\{ \widehat{0} \}$ test setup | | |
| 38 | Conclusior | At the 15% lev claim that the | he null hypothesis. There is insu ' is greater than or equal to '1'. | e null hypothesis. There is insufficient evidence to reject the is greater than or equal to '1'. | | | |
| | Null Hypothesis Alternative Hypothesis | The median of The median of | f ' Fillwt' is greate r 'Fillwt' is less thar | than or equal to '1'. o '1'. | | | |
| | Hypothesis Test Results | | | Charts of Fillwt | | | |
| | Lower Cut-off < Test Statist | ic < Upper Cut-off | 296 < 362 < Inf | | | | |
| | p-value > alpha | | 0.4538 > 0.15 | | | | |
| | 85% Confidence Interval Significance Level Sample Size for Test (excluding ties) Estimated Median | | (-Inf, 1.03) | p-value p-value | Test Statistic Test Statistic | | |
| | | | 38 | | -∞ ∞ | | |
| | | | 0.9959 | Reject Do Not Reject | Reject Do Not Reject .6 200 300 400 | | |
| | Sample Summary | | | Confidence Interval | Summarv | | |
| | | Fillwt | | Hypothesized Median | , , , , , , , , , , , , , , , , , , , | | |
| | Count | 38 | | | | | |
| | Max | 1.57 | | | Aarii | | |
| | Mean | 1.002 | | | | | |
| | Median | 0.93 | | 0.98 1 1.02 | 0.5 1 1.5 Data | | |
| Standa | rd Deviation | 0.2651 | | | | | |
| Variand | e | 0.0703 | | | | | |
| Anders | on-Darling Statistic | 1.061 | | | | | |
| Anders | on-Darling p-value | 0.0077 | | | | | |
| Skewne | ess | 0.5664 | | | | | |
| Kurtosi | s | -0.329 | | | | | |
| | | | | | | | |

- -

3. Paired Samples Sign Test: Drug A, B

| থ | | | | 🖞 export 🕞 copy 📃 0 notes 🗁 0 files ⑦ help [] max 🛞 close | | | | |
|-------------------------|--|--|------------------|---|--|--|--|--|
| Paire Samp Sign T | ed less est Paired Samples S created 2 days ago / modified | Sign Test: D a day ago | rug A, B | À assumptions ᡬ₀} test setup | | | | |
| Drug A | Conclusion | Conclusion At the 10% level, do not reject the null hypothesis. There is insufficient evidence to claim that the median of the differences ('Drug A' - 'Drug B') is equal to '0'. | | | | | | |
| Drug B | Null Hypothesis Alternative Hypothesis | The median o The median of | f the difference | es ('Drug A' - 'Drug B') is equal to '0'. s ('Drug A' - 'Drug B') is NOT equal to '0'. | | | | |
| | Hypothesis Test Results | | | Charts of 2 variables | | | | |
| | Test Statistic < Lower Cut-off | < Upper Cut-off | 2 < 3 < 6 | | | | | |
| | p-value > alpha | | 0.1797 > 0.1 | n value Test Statistic | | | | |
| | Sample Size for Test (excludi | ng ties) | (-5, 1) | p-value Test Statistic | | | | |
| | Median of Differences | | -1 | -00 000 | | | | |
| | Sample Summary | | | Reject Do Not Reject RegetNot Reject 0 0.2 0.4 0.6 0 5 10 | | | | |
| | 1 | orug A - Drug B | | Confidence Interval Summary | | | | |
| | Count | 10 | | Difference | | | | |
| | Max | 6 | | U B B C B C C C C C C C C C C C C C C C | | | | |
| | Mean | 1.1 | | - ar | | | | |
| | Median | 1 | | | | | | |
| | Standard Deviation | 2.378 | | Data | | | | |
| Variance | : | | 5.656 | | | | | |
| Anderso | n-Darling Statistic | | 0.4277 | | | | | |
| Anderso | n-Darling p-value | | 0.2479 | | | | | |
| Skewnes | S | | 0.4721 | | | | | |
| Kurtosis | | | 1.759 | | | | | |

4. Paired Samples Wilcoxon Signed Ranks Test: Drug A, B

| হ | | · | | ∴ export 🕞 copy := 0 notes 🗁 0 files ⑦ help [] max ⊗ close | | | | |
|-------------------------------|--|--|---|--|--|--|--|--|
| Pairo Samp Wilco Tes | Paired Samples Wilcoxon Signed Ranks Test: Drug A, B | | | | | | | |
| Drug A | Conclusio | n At the 10% level of the At the 10% level of the At the A | At the 10% level, do not reject the null hypothesis. There is insufficient evidence to reject the claim that the median of the differences ('Drug A' - 'Drug B') is equal to '0'. | | | | | |
| Drug B | Null Hypothes Alternative Hypothes | is The median o | f the differences ('I f the differences ('D | (' Drug A' - 'Drug B') is equal to '0'. Drug A' - 'Drug B') is NOT equal to '0'. | | | | |
| | Hypothesis Test Result | S | | Charts of 2 variables | | | | |
| | Lower Cut-off < Test Statis | stic < Upper Cut- | 10 < 10.5 < 43 | @ ⊡ ↔ Q @ [] | | | | |
| | p-value > alpha | | 0.1651 > 0.1 | p-value Test Statistic | | | | |
| | 90% Confidence Interval Significance Level | | (-2.5, 5.116e-05) 0.1 | -00 00 | | | | |
| | Sample Size for Test (excl | uding ties) | 9 | Reject Do Not Reject Reject Do Not Reject | | | | |
| | Median of Differences | | -1 | Confidence Interval | | | | |
| | Sample Summary | | | Hypothesized Difference | | | | |
| | Count | Drug A - Drug B | | | | | | |
| | Min | -6 | | | | | | |
| | Max | 3 | | | | | | |
| | Mean | -1.1 | | -2 -1 0 -5 Data | | | | |
| Median | | | -1 | | | | | |
| Standard | Deviation | 2.3 | 378 | | | | | |
| Variance | | 5.6 | 56 | | | | | |
| Anderson | -Darling Statistic | 0.42 | 77 | | | | | |
| Anderson | Darling n value | 0.24 | 170 | | | | | |
| Skowpeer | -bailing p-value | 0.24 | | | | | | |
| Skewness | • | -0.4 | 1/2 | | | | | |
| Kurtosis | | 1.7 | 59 | | | | | |

5. Mann Whitney Wilcoxon Test: BTU (normal approximation)

| er er | | • | | ① export ⊡ copy :Ξ 0 notes ▷ 0 files ⑦ help □ max ⊗ clos |
|------------------------------|--|---|---|---|
| Mar Whitu Wilco Tes | Mann Whitney st created 2 days ago / modif | Wilcoxon Te ied a day ago | est: BTU (r | (normal approximation) $($ assumptions $($ test setup |
| 40 | Conclusio | n At the 15% long that the claim that the | evel, do not rej ne median of 'E | reject the null hypothesis. There is insufficient evidence to reject the f 'BTU.In_1' is greater than or equal to the median of 'BTU.In_2'. |
| J.In_2 50 | Null Hypothes Alternative Hypothes | is The median | of 'BTU.In_1' is | ' is greater than or equal to the median of 'BTU.In_2'. ' is less than the median of 'BTU.In_2'. |
| | Hypothesis Test Result | S | | Charts of 2 variables |
| | Lower Cut-off < Test Statistic < Upper Cut-off p-value > alpha 85% Confidence Interval Significance Level Sample Size for Test (excluding ties) Median of Differences | | ff 871 < 908 < 0.2287 > 0. (-Inf, C 0. | 3 < Inf > 0.15 f, 0.2) 0.15 40 NA Reject Do Not Reject P.Value P.V |
| | Sample Summary | | | Confidence Interval |
| | Count Min Max Mean Median | BTU.In_1 BTU.I 40 4 2 18.26 16 9.908 10 9.59 10 | n_2 50 .97 .06 .14 .29 | BTU.In_2 BTU |
| tandard | Deviation | 3.02 | 2.767 | 7 |
| ariance/ | | 9.12 | 7.656 | 5 |
| ndersor | n-Darling Statistic | 0.4745 | 0.1896 | 5 |
| ndersor | n-Darling p-value | 0.2283 | 0.8951 | 1 |
| kewnes | 5 | 0.7075 | -0.099 | 9 |
| urtosis | | 0.784 | -0.272 | 2 |

6. Mann Whitney Wilcoxon Test: Task 1, 2 (Exact test)

| গ্র | | | · · · · | û export 🕞 copy 🗄 0 n | otes 🗁 0 files ⑦ help []max ⊗ clos |
|-----------------------------------|---|---|--|--|--|
| Mann Whitne Wilcoxe Test | Mann Whi | tney Wilcoxon T | est: Task 1, 2 (| Exact test) | 🔬 assumptions နတ္ခ်ို test setup |
| | Con | clusion At the 159 'Task1' is g | % level, reject the null greater than the med | hypothesis. There is sufficio ian of 'Task2'. | ent evidence that the median of |
| ask2 | Null Hy Alternative Hy | pothesis The media pothesis The media | an of 'Task1' is less tha an of 'Task1' is greate | n or equal to the median of ' r than the median of 'Task2 | Task2'. '. |
| | Hypothesis Test | Results | | Charts of 2 variables | |
| | Lower Cut-off < Up p-value < alpha 85% Confidence In Significance Level Sample Size for Tes Median of Differen | per Cut-off < Test Statis terval st (excluding ties) ices | stic -Inf < 137 < 138 0.1497 < 0.15 (4.42e-05, Inf) 0.15 15 5.5 | P-value p-value Reject Do Not Reject | Image: Contract of the state of the st |
| | Sample Summar | у | | Confidence Interval | Summary |
| | Count Min Max Mean Median | Task1 Task2 15 15 31 29 85 73 49.2 44.6 48 44 | | Hypothesized Difference | |
| andard De | eviation | 14.14 12.68 | | | |
| ariance | | 200 160.7 | | | |
| nderson-D | arling Statistic | 0.4849 0.6214 | | | |
| nderson-D | arling p-value | 0.1927 0.0856 | | | |
| ewness | | 1.209 1.119 | | | |
| urtosis | | 1.677 1.105 | | | |

7. Kruskal Wallis Test: Drug

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|---------------------------------------|---|--|--|----------------------------|
| Wallis Test Kruskal Wallis Test | est: Drug | | | A assumptions S test setup |
| created 2 days ago / modifie | d 2 minutes ago | | | |
| Conclusio | n At the 20% lev medians of th | vel, reject the nu ne levels of 'Drug | ll hypothesis. There is sufficio ' are NOT equal. | ent evidence that the |
| Null Hypothes Alternative Hypothes | is The medians of is The medians | of the levels of 'D of the levels of 'I | rug' are equal. Drug' are NOT equal. | |
| Hypothesis Test Results | | | Charts of 4 variables | |
| Cut-off < Test Statistic 4.64 | 2 < 9.36 | | | |
| 10 Degrees of freedom | 3 | | p-value | Test Statistic |
| s Kruskal Wallis Ranks Tal | ole | | | -00 00 |
| Sample Sample Size (n) Sa | mple Median Ave | rage Rank | Reject Do Not Reject | Do Not Reject Reject |
| Drug A 10 | 11 | 14.45 | 0 0.2 0.4 0.6 | 5 -5 0 5 10 |
| Drug B 10 | 12 | 17.55 | Summary | |
| Drug C 10 | 15.5 | 29.5 | Drug D | |
| Drug D 10 | 12.5 | 20.5 | | |
| Pairwise Comparisons | | | | |
| Comparison Zij Z* | Significant? | | | |
| Drug B,Drug A 0.5929 2.12 | 8 FALSE | | | |
| Drug C,Drug A 2.879 2.12 | 8 TRUE | | Data | |
| airwise Comparisons | | | | |

P

| Comparison | Zij | Z* | Significant? |
|---------------|--------|-------|--------------|
| Drug B,Drug A | 0.5929 | 2.128 | FALSE |
| Drug C,Drug A | 2.879 | 2.128 | TRUE |
| Drug D,Drug A | 1.157 | 2.128 | FALSE |
| Drug C,Drug B | 2.286 | 2.128 | TRUE |
| Drug D,Drug B | 0.5643 | 2.128 | FALSE |
| Drug D,Drug C | 1.721 | 2.128 | FALSE |

| Sample Summary | | | | | | |
|----------------------------|--------|--------|--------|--------|--|--|
| | Drug A | Drug B | Drug C | Drug D | | |
| Count | 10 | 10 | 10 | 10 | | |
| Min | 7 | 10 | 10 | 8 | | |
| Max | 14 | 18 | 19 | 19 | | |
| Mean | 11 | 12.1 | 15.3 | 12.9 | | |
| Median | 11 | 12 | 15.5 | 12.5 | | |
| Standard Deviation | 2.108 | 2.378 | 2.869 | 4.122 | | |
| Variance | 4.444 | 5.656 | 8.233 | 16.99 | | |
| Anderson-Darling Statistic | 0.564 | 0.7885 | 0.2172 | 0.2897 | | |
| Anderson-Darling p-value | 0.1072 | 0.0264 | 0.7817 | 0.5371 | | |
| Skewness | -0.8 | 1.835 | -0.376 | 0.3627 | | |
| Kurtosis | 0.4781 | 4.346 | -0.348 | -1.117 | | |

8. Friedman Test: Drug x Subject



Pairwise Comparisons

| Comparison | Zij | Z* | Significant? |
|---------------|--------|-------|--------------|
| Drug B,Drug A | 1.386 | 2.394 | FALSE |
| Drug C,Drug A | 3.551 | 2.394 | TRUE |
| Drug D,Drug A | 1.299 | 2.394 | FALSE |
| Drug C,Drug B | 2.165 | 2.394 | FALSE |
| Drug D,Drug B | 0.0866 | 2.394 | FALSE |
| Drug D,Drug C | 2.252 | 2.394 | FALSE |

Sample Summary

| | Drug A | Drug B | Drug C | Drug D |
|----------------------------|--------|--------|--------|--------|
| Count | 10 | 10 | 10 | 10 |
| Min | 7 | 10 | 10 | 8 |
| Max | 14 | 18 | 19 | 19 |
| Mean | 11 | 12.1 | 15.3 | 12.9 |
| Median | 11 | 12 | 15.5 | 12.5 |
| Standard Deviation | 2.108 | 2.378 | 2.869 | 4.122 |
| Variance | 4.444 | 5.656 | 8.233 | 16.99 |
| Anderson-Darling Statistic | 0.564 | 0.7885 | 0.2172 | 0.2897 |
| Anderson-Darling p-value | 0.1072 | 0.0264 | 0.7817 | 0.5371 |
| Skewness | -0.8 | 1.835 | -0.376 | 0.3627 |
| Kurtosis | 0.4781 | 4.346 | -0.348 | -1.117 |

VI. Dataset: Regression

1. Simple Regression: Score1 x Score2



Regression Model

Score2 = 1.118 + (0.2177) * (Score1)

Regression Statistics

| Correlation Coefficient, R | 0.9784 |
|-------------------------------|--------|
| R Squared | 0.9572 |
| Adjusted R Squared | 0.9511 |
| Count | 9 |

Coefficient Table

| | Estimate | Std. Error | t value | p- value | NALowerCI95 | NAUpperCl95 |
|-------------|----------|---------------|------------|-------------|-------------|-------------|
| (intercept) | 1.118 | 0.1093 | 10 | 0 | NA | NA |
| Score1 | 0.2177 | 0.0174 | 13 | 0 | NA | NA |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|------------|----|--------|---------|---------|---------|
| Regression | 1 | 2.542 | 2.542 | 156.6 | 0 |
| Residuals | 7 | 0.1136 | 0.0162 | NA | NA |
| Total | 8 | 2.656 | NA | NA | NA |



2. Multiple Regression: HeatFlux



Coefficient Table

| | Estimate | Std. Error | t value | p- value | 95% Cl (lower) | 95% Cl (upper) |
|-------------|----------|---------------|------------|-------------|-------------------|-------------------|
| (intercept) | 389.2 | 66.09 | 5.9 | 0 | 259.6 | 518.7 |
| East | 2.125 | 1.214 | 1.7 | 0.0925 | -0.256 | 4.505 |
| South | 5.318 | 0.9629 | 5.5 | 0 | 3.431 | 7.206 |
| North | -24.13 | 1.869 | -13 | 0 | -27.79 | -20.47 |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|------------|----|--------|---------|---------|---------|
| Regression | 3 | 12,834 | 4,278 | 57.87 | 0 |
| Residuals | 25 | 1,848 | 73.92 | NA | NA |
| Total | 28 | 14,682 | NA | NA | NA |

Variation Inflation Factors

| | VIF Value |
|-------|-----------|
| East | 1.122 |
| South | 1.206 |
| North | 1.091 |

Variables Not in Model



3. Logistic Regression: RestingPulse



Estimated Response Model

| | Coefficients | S.E. | Z | p-value | Lower 90% CI | Upper 90% Cl |
|-------------|--------------|--------|--------|---------|--------------|--------------|
| (intercept) | -1.987 | 1.679 | -1.183 | 0.2367 | | |
| Smokes | -1.193 | 0.553 | -2.157 | 0.031 | -2.103 | -0.283 |
| Weight | 0.025 | 0.0123 | 2.042 | 0.0412 | 0.0049 | 0.0452 |

| | Odds Ratio | Lower 90% CI | Upper 90% Cl |
|--------|------------|--------------|--------------|
| Smokes | 0.3033 | 0.1221 | 0.7532 |
| Weight | 1.025 | 1.005 | 1.046 |

Test of Model Fit

| | Chi-Square | DF | p-value |
|--------------------|------------|----|---------|
| Model Significance | 7.574 | 2 | 0.0227 |
| Pearson | 88.63 | 89 | 0.4911 |
| Deviance | 93.64 | 89 | 0.3477 |
| Hosmer-Lemeshow | 5.037 | 8 | 0.7536 |

Test of Multicollinearity

Variable VIF Smokes 1.042 Weight 1.042



VII. Dataset: DOE_Full

1. FullDOE_DesignWizard

| Your design summary: | | | | |
|-------------------------|------|--|--|--|
| Factors | 3 | | | |
| Levels per factor | 2 | | | |
| Center points per block | 0 | | | |
| Replicates | 1 | | | |
| Number of blocks | 1 | | | |
| Total runs: | | | | |
| Corner points | 8 | | | |
| Center points | 0 | | | |
| Total runs | 8 | | | |
| Resolution | Full | | | |
| Resolution | Full | | | |

2. FullDOE_Analyzer



Half Normal Effects

| Term | Effect Size |
|---------|-------------|
| B-Temp | 20.5 |
| C-Power | 17 |
| BC | 21.5 |

Factorial Plots

Model Equations

| Coded Model | Response = 66.5 + -10.75*BC + -10.25*B + -8.5*C |
|---------------|---|
| Uncoded Model | Response = -199 + -0.86*BC + -10.25*B + -0.68*C |

Effects Coefficient

| | Effect Size | Coefficients | Standard Error | 80% CI (lower) | 80% CI (upper) |
|----------|-------------|--------------|----------------|----------------|----------------|
| Constant | NA | 66.5 | 1.759 | 63.8 | 69.2 |
| BC | -21.5 | -10.75 | 1.759 | -13.45 | -8.053 |
| B-Temp | -20.5 | -10.25 | 1.759 | -12.95 | -7.553 |
| C-Power | -17 | -8.5 | 1.759 | -11.2 | -5.803 |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|-----------|----|--------|---------|---------|---------|
| Model | 3 | 2,343 | 781 | 31.56 | 0.003 |
| BC | 1 | 924.5 | 924.5 | 37.35 | 0.0036 |
| B-Temp | 1 | 840.5 | 840.5 | 33.96 | 0.0043 |
| C-Power | 1 | 578 | 578 | 23.35 | 0.0084 |
| Residuals | 4 | 99 | 24.75 | NA | NA |
| Total | 7 | 2,442 | NA | NA | NA |

Model Statistics

| Standard Error | 4.975 |
|--------------------|--------|
| R Squared | 0.9595 |
| Adjusted R Squared | 0.9291 |





VIII. Dataset: DOE_Fractional

| Guide Me 💙 2 Levels | A Factors | V: 8 runs | Setup | Replicates | Summary |
|--|-----------------------|----------------|-------------|------------------|-------------------------------------|
| our design summary: | / | / | | / | |
| Factors | 4 | | | | |
| evels per factor | 2 | | | | |
| Center points per block | 0 | | | | |
| Replicates | 2 | | | | |
| Number of blocks | 2 | | | | |
| Fotal runs: | | | | | |
| Corner points | 16 | | | | |
| Center points | 0 | | | | |
| Total runs | 16 | | | | |
| Resolution | IV | | | | |
| 'his design will be able to other two-factor interacti Create Design | o estimate ma ons. | in effects, bu | t some two- | factor interacti | ons will be aliased (confounded) wi |

1. FractionalDOE_DesignWizard
2. FractionalDOE_Analyzer

dD ∴ export 🕞 copy := 0 notes 🗁 0 files ? help []max ⊗ close DOE Analyz FractionalDOE_Analyzer restore default 👸 study setup created 2 days ago / modified 5 minutes ago Model Output Factorial Plots **Design Summary** Number of Runs 16 Half normal effects plot Number of Factors 4 Number of center points per block 0 * Not In Model Percentage In Model Number of blocks 2 • In Model 0.5 Number of replicates 2 Not In Model Runs per replicate 8 Significance (α) Level 0 0.05 20 15 10 Number of Responses |Std Effect| Pareto effects plot 1 Factor Information Factor Name Coded Levels Uncoded Levels A Factor 1 -1, 1 -1, 1 B Factor 2 -1, 1 -1, 1 C Factor 3 -1, 1 -1, 1 D Factor 4 -1, 1 -1, 1 0 10 15 20 Std Effect

Half Normal Effects

| Term | Effect Size |
|------------|-------------|
| A-Factor 1 | 6.375 |
| B-Factor 2 | 15.38 |
| C-Factor 3 | 1.875 |
| D-Factor 4 | 20.88 |
| AC | 7.625 |
| BC | 10.12 |

Model Output

Model Equations

| Coded Model | Response = 70.06 + 10.44*D + -7.69*B + 5.06*BC + -3.81*AC + 3.19*A + -0.94*C |
|-------------|---|
| Uncoded | Response = 70.06 + 10.44*D + -7.69*B + 5.06*BC + -3.81*AC + 3.19*A + |
| Model | -0.94*C |

Factorial Plots

Effects Coefficient

| | Effect Size | Coefficients | Standard Error | 95% CI (lower) | 95% CI (upper) |
|------------|-------------|--------------|----------------|----------------|----------------|
| Constant | NA | 70.06 | 4.16 | 60.47 | 79.66 |
| D-Factor 4 | 20.87 | 10.44 | 4.16 | 0.8437 | 20.03 |
| B-Factor 2 | -15.37 | -7.687 | 4.16 | -17.28 | 1.906 |
| BC | 10.12 | 5.062 | 4.16 | -4.531 | 14.66 |
| AC | -7.625 | -3.812 | 4.16 | -13.41 | 5.781 |
| A-Factor 1 | 6.375 | 3.187 | 4.16 | -6.406 | 12.78 |
| C-Factor 3 | -1.875 | -0.938 | 4.16 | -10.53 | 8.656 |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|------------|----|--------|---------|---------|---------|
| Block | 1 | 7.563 | 7.563 | 0.0273 | 0.8728 |
| Model | 6 | 3,508 | 584.6 | 2.111 | 0.1618 |
| D-Factor 4 | 1 | 1,743 | 1,743 | 6.294 | 0.0364 |
| B-Factor 2 | 1 | 945.6 | 945.6 | 3.414 | 0.1018 |
| BC | 1 | 410.1 | 410.1 | 1.481 | 0.2583 |
| AC | 1 | 232.6 | 232.6 | 0.8398 | 0.3863 |
| A-Factor 1 | 1 | 162.6 | 162.6 | 0.587 | 0.4656 |
| C-Factor 3 | 1 | 14.06 | 14.06 | 0.0508 | 0.8274 |
| Residuals | 8 | 2,216 | 276.9 | NA | NA |
| Total | 15 | 5,731 | NA | NA | NA |

Model Statistics

| Standard Error | 16.64 |
|--------------------|--------|
| R Squared | 0.6134 |
| Adjusted R Squared | 0.2752 |





IX. Dataset: DOE_General

1. GeneralDOE_DesignWizard

| A | | | 🖞 export 🦷 | E] copy ⋮⊟ | 0 notes 🗁 | ofiles ? | help []max | 🛛 🛞 close |
|------------------|-------------------------------|----------------|------------|------------|------------------|----------|------------|-----------|
| Design Wizard | GeneralD created a day ago | OE_Design | Wizard | | | | | |
| | Guide Me 🔰 3 | + Levels > 3 | Factors | Setup | > Pov | ver | Summary | ^ |
| Y | our design sum | mar y : | | | | | | |
| F | Factors | 3 | | | | | | |
| 1 | Levels | 3,2,2 | | | | | | |
| F | Replicates | 2 | | | | | | |
| 1 | Total runs: | | | | | | | |
| | Runs | 12 | | | | | | |
| | Replicates | 2 | | | | | | |
| | Total runs | 24 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | Create Decian | | | | | | | |
| | Create Design | | | | | | | - |
| 4 | • | | | | | | | • |
| | | | | | | | | |

2. GeneralDOE_Analyzer

| | Ľ | j export 📭 | copy :=0 | notes 🗁 0 fil | es (?) help [_] max (X) |
|------------------------|-----------------------|-----------------|--------------|----------------------|---------------------------------|
| ^{lyzer} Gener | alDOE And | alyzer | | \rightarrow | and a facult () at which a set |
| created a d | ay ago / modified | 2 minutes ago | 0 | | re default (0 3 study set |
| | Sum | mary M | odel Output | Factorial Plot | |
| Docign Sum | many | | | | |
| Number of P | ina 24 | | | | |
| Number of E | artors 3 | | | | |
| Number of bl | ocks 2 | | | | |
| Number of re | ours 2 | | | | |
| Runs per rep | icate 12 | | | | |
| Significance (| | | | | |
| Number of R | esponses 1 | | | | |
| Number of K | | | | | |
| Factor Infor | mation | | | | |
| Factor Nam | e | Coded Levels | Unco Leve | oded Is | |
| A | Percen Carbonatior | t 1 | , 2, 3 | 10, 12, 14 | |
| В | Pressure | 2 | 1, 2 | 25, 30 | |
| C | Line Speed | 1 | 12 | 200 250 | |

ANOVA

| | DF | Sum Sq | Mean Sq | F value | p-value |
|-----------------------|----|--------|---------|---------|---------|
| Block | 1 | 1.042 | 1.042 | 1.639 | 0.2187 |
| Model | 6 | 325.4 | 54.24 | 85.36 | 0 |
| A-Percent Carbonation | 2 | 252.7 | 126.4 | 198.9 | 0 |
| B-Pressure | 1 | 45.38 | 45.38 | 71.41 | 0 |
| C-Line Speed | 1 | 22.04 | 22.04 | 34.69 | 0 |
| AB | 2 | 5.25 | 2.625 | 4.131 | 0.0358 |
| Residuals | 16 | 10.17 | 0.6354 | NA | NA |
| Total | 23 | 336.6 | NA | NA | NA |

Model Statistics

| Standard Error | 0.7971 |
|--------------------|--------|
| R Squared | 0.9698 |
| Adjusted R Squared | 0.9566 |





main effect plots 🔤 interaction plots

