JASP for Audit User Manual

Statistical Auditing Group

"The best things in life are free."

Contents

Preface

The **JASP for Audit User Manual** provides detailed instructions and best practices for working with the Audit module in the free and open-source software JASP. It covers various aspects, including data import and export, analysis techniques, and interpretation of results.

The Statistical Auditing Group at Nyenrode Business University, which develops and maintains JASP for Audit, curates the manual to ensure users have accurate and up-to-date information.

Getting Started

Statistical theory is fundamental to many auditing procedures. To perform these procedures effectively, auditors need user-friendly software for statistical analyses and the knowledge to interpret the results. JASP (JASP Team, 2025) is an open-source, free-of-charge, cross-platform statistical software program that supports statistical auditing through its Audit module (Derks et al., 2021, 2023).

The Audit module (i.e., JASP for Audit) allows auditors to plan, execute, and interpret a wide range of statistical auditing procedures using state-of-the-art statistical methods, thereby reducing programming errors and simplifying the process. Tailored for auditors, the module features an intuitive interface that aligns with audit processes and international standards on auditing. In addition to standard frequentist methods, the Audit module incorporates Bayesian methods to enhance audit transparency and efficiency by utilizing existing information.

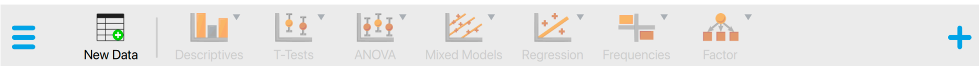
In summary, the Audit module takes care of the complex statistical work, allowing you to concentrate on interpreting the results of your analysis. The remaining paragraphs in this chapter discuss how to get started using JASP for Audit.

Downloading JASP

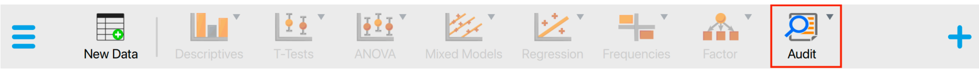
JASP for Audit is part of JASP, which can be freely downloaded from www.jasp-stats.org. Click the ‘Download JASP’ button on the homepage to access the download page and choose your preferred installation. JASP is available for Windows, MacOS, Linux, and Chrome OS.

Enabling the Audit module

After opening JASP, you will see the following main menu bar at the top of the screen.



To find the Audit module, click the '+' icon on the right of this menu bar. A different menu will appear on the right side which shows all available modules. Check the box next to 'Audit' to make the module visible in the main menu bar. You can now access the Audit module and its analyses by clicking its module icon in the menu bar (see image below).

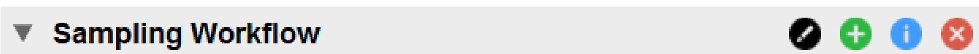


Accessibility

The Audit module is a robust tool for statistical auditing. The following paragraphs detail its accessibility features, including where to locate help files and how to the reliability of the statistical results is ensured.

Help files

Once you open an analysis in the Audit module, you can click the blue 'i' icon next to the analysis title to access a help file that explains its functionality. Additional help files for certain settings can be accessed by clicking the blue 'i' icon next to those settings.



Validation of statistical results

The statistical results generated by the Audit module are based on the R package jfa (Derks, 2025). For comprehensive documentation and information on the benchmarks used for validation, please visit the package website at https://koenderks.github.io/jfa/.

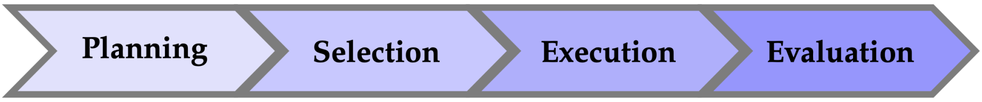
Part I

Audit Sampling

Chapter 1

Sampling Workflow

The goal of statistical audit sampling is to infer the misstatement in a population based on a representative sample. This can be challenging, but the Audit module simplifies the process into four stages: planning, selection, execution, and evaluation.



More detailed information about the individual stages in the audit sampling workflow is provided below.

1.1 The four stages of the sampling workflow

In the planning stage, you determine the sample size needed to support the assertion that the population's misstatement is below the performance materiality. This involves using prior audit outcomes and information about inherent risk and control risk. Expectations about error rates also influence the sample size required to maintain statistical confidence.

Using the sample size from the planning stage, you select a statistically representative sample. Each sampling unit receives an inclusion probability, and units are selected based on these probabilities. Monetary unit sampling assigns probabilities to individual monetary units, making higher-value items more likely to be selected. Record sampling assigns equal probabilities to all items.

In the execution stage, you assess the correctness of selected items. The simplest method categorizes items as correct or incorrect, while a more accurate method considers the true value (audit value) of items. Annotating samples with audit values provides a more precise estimate of misstatement. If book values are unavailable, use the correct/incorrect method.

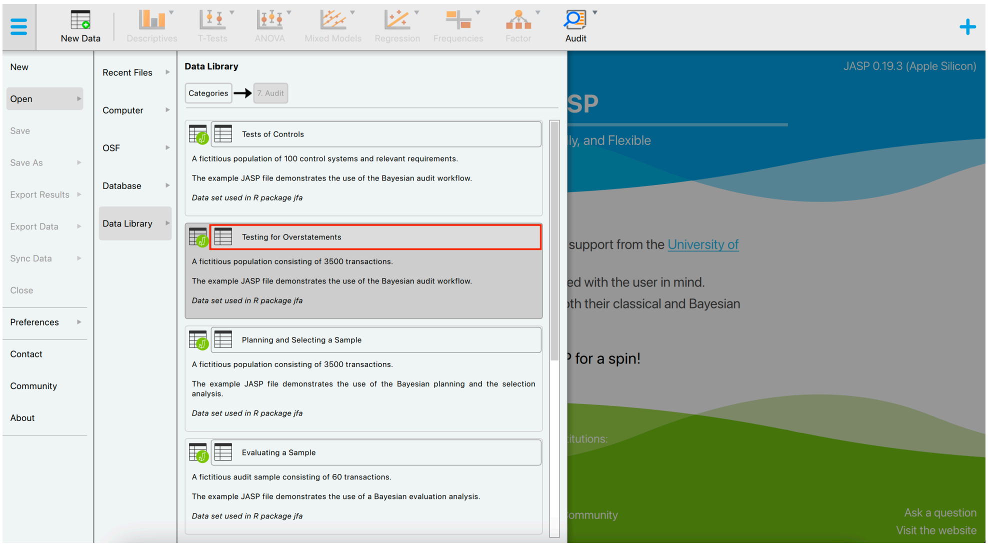
In the evaluation stage, you use the annotated sample to infer the total misstatement in the population. Statistical techniques calculate a projected maximum misstatement, and the population is approved if this is below the performance materiality.

This manual emphasizes the practical application of the audit sampling workflow in JASP. For a deeper understanding of the statistical theory behind the four stages of the audit sampling workflow, read the free online book Statistical Audit Sampling with R.

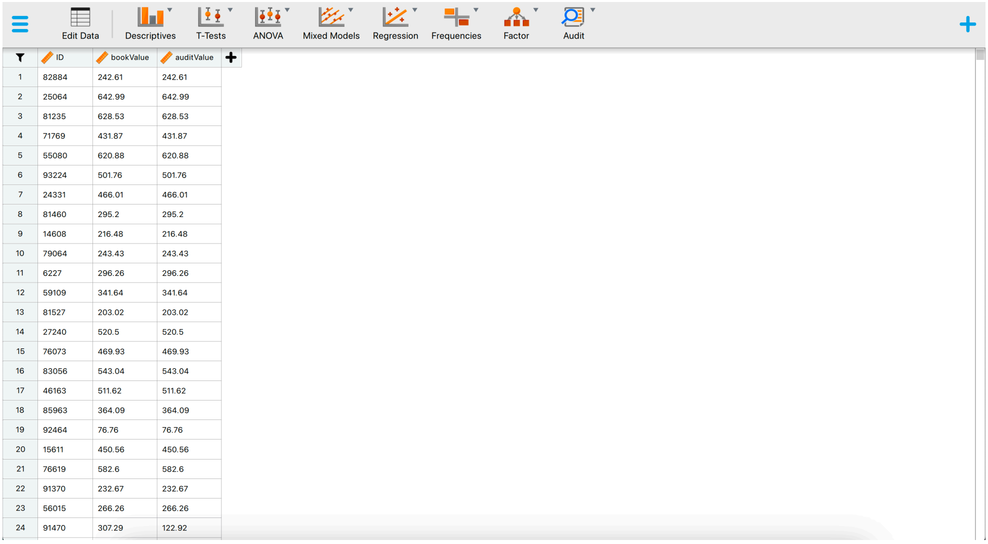
1.2 Practical example

The Audit module in JASP offers two ways to navigate the audit sampling workflow: the Sampling Workflow analysis, which guides you through all four stages, and individual analyses for Planning, Selection, and Evaluation. This chapter uses the classical sampling workflow analysis to explain the Audit module's core functionality. Note that a Bayesian variant of the sampling workflow is also available.

Let's explore an example of the audit sampling workflow. To follow along, open the 'Testing for Overstatements' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Testing for Overstatements' (not the green JASP-icon button).

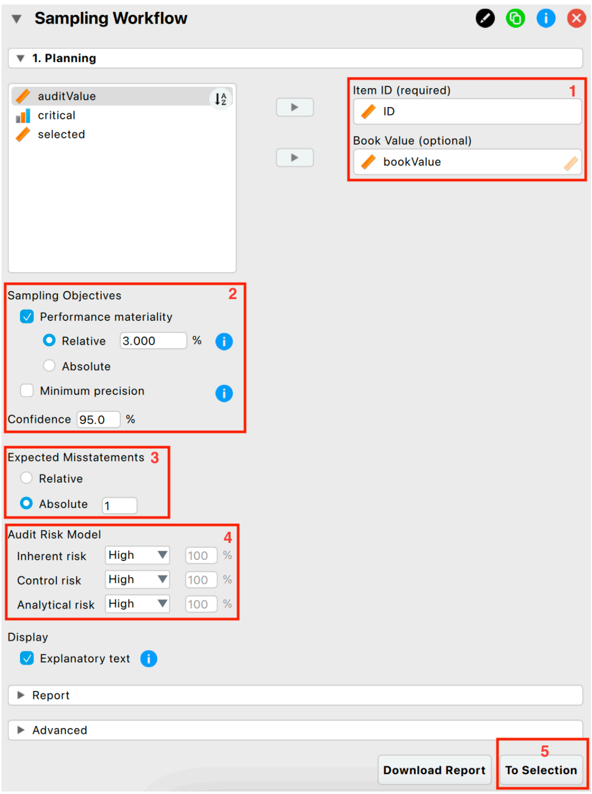


This will open a dataset with 3500 rows and three columns: 'ID', 'bookValue', and 'auditValue'. The 'ID' column represents the identification number of the items in the population. The 'bookValue' column shows the recorded values of the items, while the 'auditValue' column displays the true values. The 'auditValue' column is included for illustrative purposes, as auditors typically know the true values only for the audited sample, not for all items in the population.



1.2.1 Stage 1: Planning

To start the sampling workflow, click on the Audit module icon and select 'Sampling Workflow'. This will open the following interface, where you need to specify the settings for the statistical analysis.



The following five settings are required:

1. **Indicate the variables:** First, enter the variable indicating the identification numbers of the items in the corresponding box. Optionally, if you have access to the book values of the items, you can enter this variable as well.

2. **Sampling objectives:** Next, formulate your sampling objectives. Enable the 'Performance materiality' objective if you want to test whether the total misstatement in the population exceeds a certain limit (i.e., the performance materiality). This approach allows you to plan a sample such that, when the sample meets your expectations, the maximum error is said to be below performance materiality. Enable the 'Minimum precision' objective if you want to obtain a required minimum precision when estimating the total misstatement in the population. This approach allows you to plan a sample such that, when the sample meets expectations, the uncertainty of your estimate is within a tolerable percentage. In the example, we choose a performance materiality of 3.5%.

3. **Expected misstatement:** Then, indicate how many misstatements are tolerable in the sample. In the example, we choose to tolerate one full misstatement in the sample.

4. **Prior information:** Additionally, indicate the risks of material misstatement via the audit risk model. According to the Audit Risk Model, audit risk can be divided into three constituents: inherent risk, control risk, and detection risk. Inherent risk is the risk posed by an error in a financial statement due to a factor other than a failure of internal controls. Control risk is the probability that a material misstatement is not prevented or detected by the internal control systems of the company (e.g., computer-managed databases). Both these risks are commonly assessed by the auditor on a 3-point scale consisting of low, medium, and high. Detection risk is the probability that an auditor will fail to find material misstatements in an organization's financial statements. For a given level of audit risk, the tolerable level of detection risk bears an inverse relationship to the other two assessed risks. Intuitively, a greater risk of material misstatement should require a lower tolerable detection risk and, accordingly, more persuasive audit evidence. In this example, we choose to set all risks to 'High' and solely rely on evidence from substantive testing.

The primary output from the planning stage, shown below, indicates that a minimum sample size of 134 sampling units is required to achieve 95% assurance that the misstatement in the population is below 3.5%, while allowing for one misstatement in the sample.

Table 1. *Planning Summary*

	Value
Performance materiality	0.035
Inherent risk	1.000
Control risk	1.000
Analytical risk	1.000
Detection risk	0.050
Tolerable misstatements	1.000
Minimum sample size [a]	134

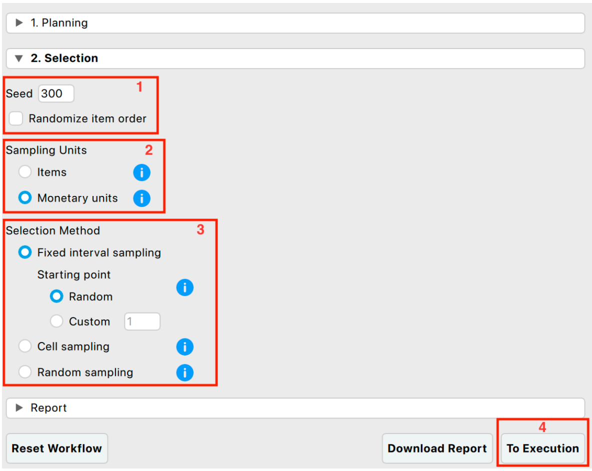
Note. The minimum sample size is based on the binomial distribution (p = 0.035)
[a] Based on this sample size, the selection interval spans 10471.8 units.

5. **Next stage:** Finally, progress to the selection stage by clicking the 'To Selection' button.

For a more detailed explanation of the settings and output in the planning stage, see Chapter 2.

1.2.2 Stage 2: Selection

In the selection stage, you must select the 134 sampling units from the population. Once the 'To Selection' button is pressed, the interface from the selection stage opens.



The following four settings are required:

1. **Randomness:** Begin by selecting the settings related to randomness in the selection procedure. The seed setting is important as it ensures that random procedures are reproducible, allowing for consistent results across multiple runs. A random number will be chosen each time you start the analysis. Additionally, the 'Randomize item order' setting is available to randomly shuffle the rows in the dataset, which can help mitigate any biases that might arise from the original order of the data.

2. **Sampling units:** Next, specify the sampling units for the selection process. These units can either be items or monetary units. If no book value variable

is provided, the sampling units default to 'Items', enabling attribute sampling. Conversely, if a book value variable was indicated during the planning stage, the sampling units default to 'Monetary units', facilitating monetary unit sampling (MUS). MUS is particularly useful for auditing financial data as it considers the monetary value of each unit.

3. **Sampling method:** Then, choose the selection method to be used in the sampling process. The available algorithms include:

- **Fixed interval sampling:** This method selects units at regular intervals from the dataset, ensuring a systematic sampling approach.
- **Cell sampling:** This technique involves dividing the dataset into cells and randomly selecting units from each cell, promoting a systematic sampling approach with a bit of randomness.
- **Random sampling:** This approach randomly selects units from the entire dataset, providing a simple yet effective method for ensuring randomness.

The primary output from the selection stage, as shown in the first table below, reveals that 134 sampling units were selected from 134 items. The sample's total value amounts to €67,821.22, representing 4.8% of the total population value. The second table provides details specific to interval selection using monetary unit sampling. It indicates the number of items selected in the 'Top stratum', which includes all items larger than a single interval (for fixed interval selection). In this instance, there were 0 items in the top stratum.

Table 3. *Selection Summary* ▼

No. units	No. items	Selection value	% of population value
134	134	€67,821.22	4.8%

Note. From each of the intervals of size 10471.8, unit 9584 is selected using seed 300.

Table 4. *Information about Monetary Interval Selection*

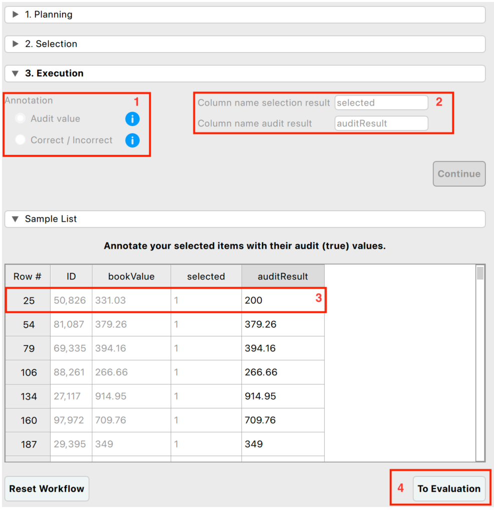
	Items	Value	Selected items	Selected units	Selection value	% of total value
Total	3,500	€1,403,220.82	134	134	€67,821.22	4.8%
Top stratum	0	€0	0	0	€0	0%
Bottom stratum	3,500	€1,403,220.82	134	134	€67,821.22	4.8%

Note. The top stratum consists of all items with a book value larger than a single interval.

4. **Next stage:** Finally, progress to the execution stage by clicking the 'To Execution' button.

1.2.3 Stage 3: Execution

In the execution stage, you must judge the fairness of the 134 sampled items. Once the 'To Execution' button is pressed, the interface from the execution stage opens.



The following four settings are required:

1. **Annotation method:** First, decide how to annotate the selected items. You have two choices:

    - Audit value: Annotate the items with their audit (true) values. This method is recommended (and automatically selected) when the items have a monetary value.
    - Correct / Incorrect: Annotate the items as correct (0) or incorrect (1). This method is recommended (and automatically selected) when the items do not have a monetary value.

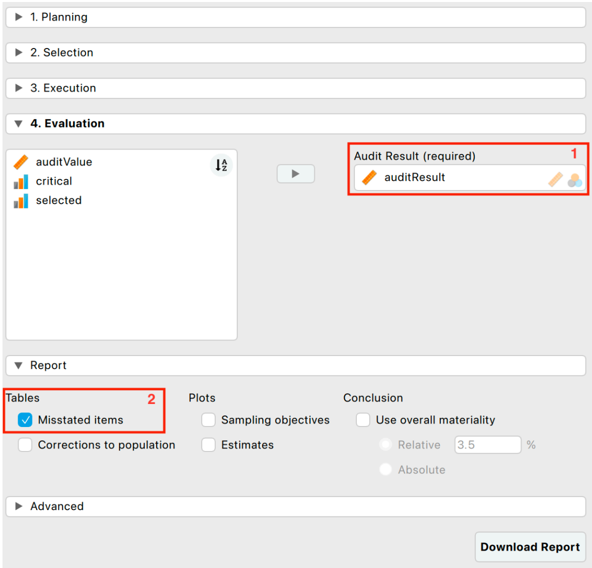
2. **Column names:** Next, specify the names of the two columns that will be added to the dataset. The first column name will indicate the result of the selection, while the second column name will contain the annotation of the items. Click the 'Continue' button to confirm the settings and open the data viewer.

3. **Annotating items:** Then, use the data viewer to annotate the selected items with their book value. For example, in this case, item 50826 (row 25, highlighted in red) had a book value of €333.03 but a true value of €200. The remaining items have correctly reported book values.

4. **Next stage:** Finally, progress to the evaluation stage by clicking the 'To Evaluation' button.

1.2.4 Stage 4: Evaluation

In the evaluation stage, you assess the misstatement in the sample and extrapolate it to the entire population. Once you press the 'To Evaluation' button, the interface for the evaluation stage will open.



The following setting is required:

1. **Annotation variable:** Specify the variable that contains the annotation of the items in the corresponding box.

The following setting is optional:

2. **Additional tables:** It is recommended to request the 'Misstated items' table from the 'Report' section. This table displays the items in the sample where the book value did not match the true value. Additional tables and figures to clarify the output, which will be discussed in Chapter 4, can be requested here as well.

The primary output from the evaluation stage, as shown in the first table below, indicates that the most likely misstatement in the population is estimated to be 0.003, or 0.3%. The 95% upper bound for this estimate is 0.027, or 2.7%. This upper bound is lower than the performance materiality of 3.5%, meaning the auditor has achieved at least 95% assurance that the population misstatement is below the performance materiality.

Table 4. *Evaluation Summary*

	Value
Performance materiality	0.035
Sample size	134
Misstatements	1
Taint	0.396
Most likely misstatement	0.003
95% Upper bound	0.027
Precision	0.025
p-value	0.019

Note. The results are computed using the binomial distribution.

Table 5. *Misstated Items*

ID	Book value	Audit value	Difference	Taint	Counted
50,826	€331.03	€200	€131.03	0.396	x1
Total			€131.03	0.396	

Based on the results of this statistical analysis, the auditor concludes that the population is free of material misstatement.

Chapter 2

Planning

This chapter is about the ‘Planning’ analysis in the ‘Audit Sampling’ section of the module.

2.1 Purpose of the analysis

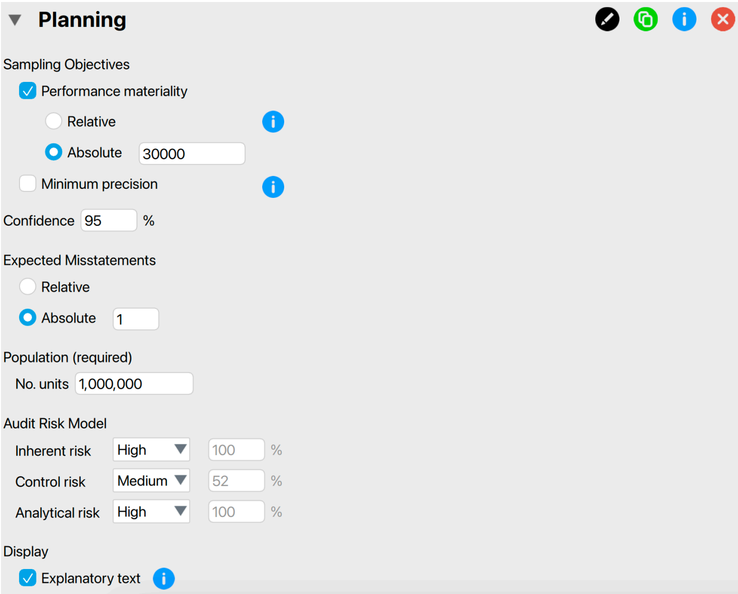
The goal of the planning analysis is to determine the minimum sample size needed to meet the audit’s objectives. For example, a common audit objective is to obtain a specific level of confidence that the misstatement in the population is below the tolerable misstatement rate. This rate can be expressed as a monetary amount, known as performance materiality.

2.2 Practical example

Let’s consider an example of a planning analysis. Imagine we are auditing a population of 1,000 items with a total value of €1,000,000. In this scenario, we aim to determine the minimum sample size required to conclude, with 95% confidence, that the population does not contain misstatements exceeding the performance materiality of €30,000, which is 3% of the total value. Furthermore, we aim to incorporate a buffer and approve the population if a single misstatement is identified in the sample.

2.2.1 Main settings

To plan the minimum sample size for this audit objective, we open the ‘Planning’ analysis within the Audit module. The interface for the planning analysis is displayed below.



These are the main settings for the analysis:

- **Sampling objectives: Performance materiality:** In this section, we can input the performance materiality either as a percentage (relative) or as a monetary amount (absolute). If we choose to enter it as a monetary amount, we must also specify the number of units in the population. Here, we enter €30,000 as the absolute performance materiality.

- **Sampling objectives: Minimum precision:** We can choose this setting if we want to identify the misstatement in the population with a specified minimum uncertainty (i.e., the difference between the most likely misstatement and the upper limit for the misstatement). However, since this is not relevant to our audit objective, we leave this box unchecked.

- **Confidence:** Specify the confidence level for your analysis. This level, which complements the significance level, dictates when to reject the null hypothesis and, consequently, the amount of work needed to approve the population. A higher confidence level necessitates more audit evidence to conclude that the population is free of material misstatement. In this example, we use a confidence level of 95%.

- **Expected misstatements:** Specify the number of misstatements tolerated in the sample. This means that if you find the specified number of misstatements in the sample, you can still approve the population. In this example, we tolerate a single misstatement, so we specify this setting to an absolute value of 1.

- **Population: No. units:** Specify the number of sampling units in the population. If you intend to select monetary units, this represents the total value of the population. If you plan to select items, this refers to the number of items in the population. In this case, we intend to use monetary unit sampling and hence we fill in the total population value of €1,000,000 here.

- **Audit risk model:** Indicate the risks of material misstatement using the audit risk model. This model helps reduce the required confidence level for the audit sampling procedure (1 - detection risk) by assessing inherent risk, control risk, and analytical risk. This results in less persuasive audit evidence being required. The model is expressed as:

$$\text{Audit risk} = \text{Inherent risk} \times \text{Control risk} \times \text{Analytical risk} \times \text{Detection risk}$$

. Inherent risk, control risk, and analytical risk are typically evaluated on a 3-point scale: high, medium, and low. These assessments are mapped onto percentages based on professional judgment. The standard percentages used by JASP for Audit are based on those used by the Dutch independent government auditor and are provided in the output table below.

Table 1. *Default Settings Audit Risk Model*

	Inherent risk	Control risk	Analytical risk
High	100 %✓	100 %	100 %✓
Medium	63 %	52 %✓	50 %
Low	40 %	34 %	25 %

✓ = Selected

In this example, let's assume we have conducted internal control testing, allowing us to set the internal control risk to 'Medium', which corresponds to 52%. Consequently, the detection risk can be calculated as $\frac{0.05}{1 \times 0.52 \times 1} = 9.6\%$.

- **Display: Explanatory text:** Finally, select whether to show explanatory text in the output.

2.2.2 Main output

The main table in the output below displays the performance materiality as a proportion, along with the probabilities for the audit risk model. In this scenario, the detection risk is 9.6%. The second-to-last row indicates the tolerable misstatements as a number, showing that no misstatements are allowed in the sample. The final row presents the minimum sample size required to meet the sampling objectives, which is 130 units in this case. The note below the table clarifies that this sample size is determined using the binomial distribution (check out the 'Advanced' section for alternative methods).

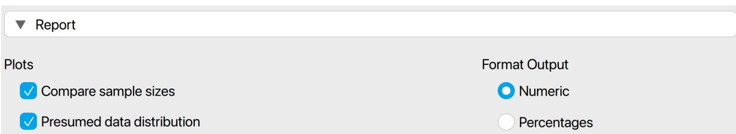
Table 2. Planning Summary ▼

	Value
Performance materiality	0.030
Inherent risk	1.000
Control risk	0.520
Analytical risk	1.000
Detection risk	0.096
Tolerable misstatements	1.000
Minimum sample size [a]	130

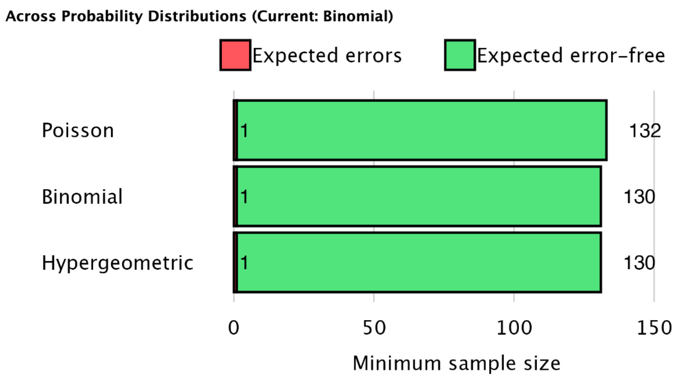
Note. The minimum sample size is based on the binomial distribution (p = 0.03)
[a] Based on this sample size, the selection interval spans 7692.31 units.

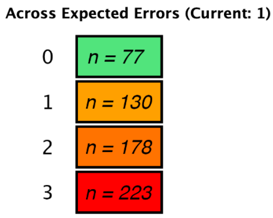
2.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.

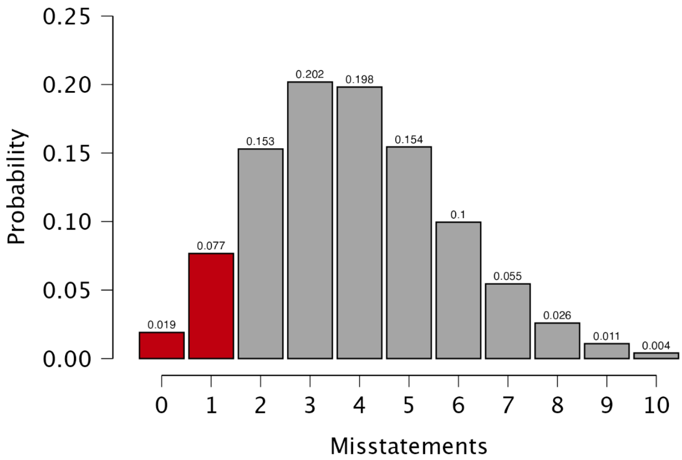


- **Plots: Compare sample sizes:** This setting generates two figures. The first figure illustrates the minimum sample size under three statistical distributions commonly used in statistical auditing: the Poisson distribution, the binomial distribution, and the hypergeometric distribution. The second figure displays the minimum sample size for various tolerable misstatements.





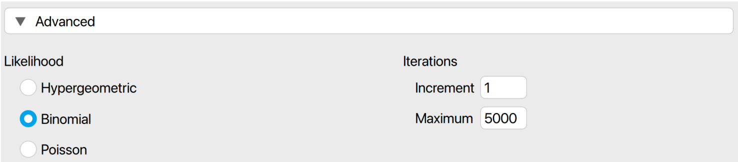
- **Plots: Presumed data distribution:** This figure illustrates the presumed distribution of misstatements in the sample under the hypothesis of material misstatement in the population. The red bar highlights the tolerable misstatements, which together have a probability lower than the detection risk. In this scenario, the figure visualizes that if the population contains material misstatement, there is a 1.9% + 7.7% = 9.6% probability of observing zero or one misstatements in the sample of 130 units. This probability is sufficiently low to reject the hypothesis of tolerable misstatement.



- **Format output:** This setting lets you choose whether certain numbers in the tables are displayed as proportions or percentages.

2.2.4 Advanced

The following advanced settings allow you to customize the statistical computations according to your preferences.



- **Likelihood:** The likelihood is the distribution used to calculate the probabilities of observing a certain number of misstatements. The hypergeometric likelihood (available only if ‘No. units’ is filled in) assumes a finite population and results in smaller sample sizes for small populations. The binomial and Poisson distributions yield similar sample sizes when the population is large.
- **Iterations: Increment:** Select the step size for the sample sizes to be considered. For example, a value of 5 will include sample sizes of 5, 10, 15, etc., while a value of 20 will include sample sizes of 20, 40, 60. The default value for this setting is 1, which considers all possible sample sizes.
- **Iterations: Maximum:** Choose the maximum sample size to be considered. The analysis will stop if the sample size exceeds this value. The default value is 5000.

Chapter 3

Selection

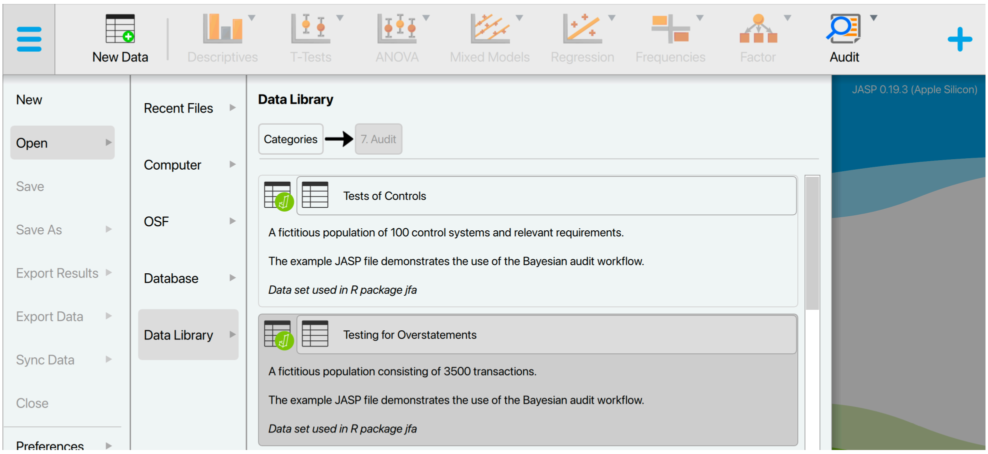
This chapter is about the 'Selection' analysis in the 'Audit Sampling' section of the module.

3.1 Purpose of the analysis

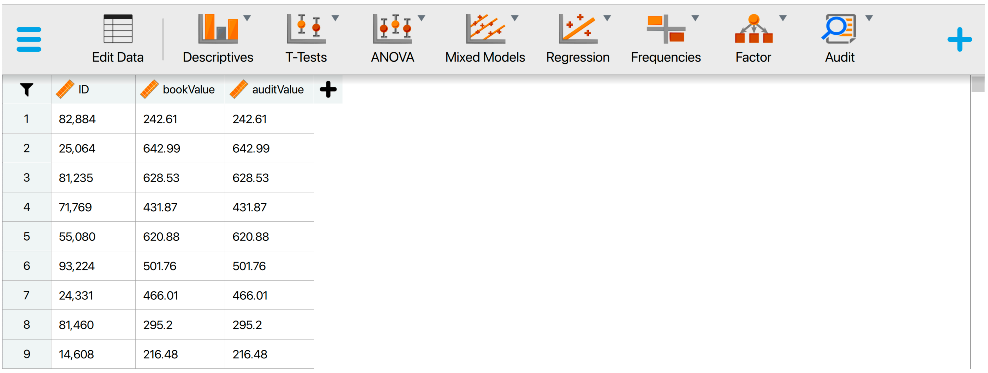
The main goal of the selection analysis is to draw a representative sample of items from the population. These items can then be marked in the population file so they can be easily identified and tested. Particularly in an audit context, special sampling methods, such as monetary unit sampling, are used to ensure the sample has specific characteristics or meets certain criteria, such as always including items with a high book value.

3.2 Practical example

Let's explore an example of a selection analysis. To follow along, open the 'Testing for Overstatements' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Testing for Overstatements' (not the green JASP-icon button).

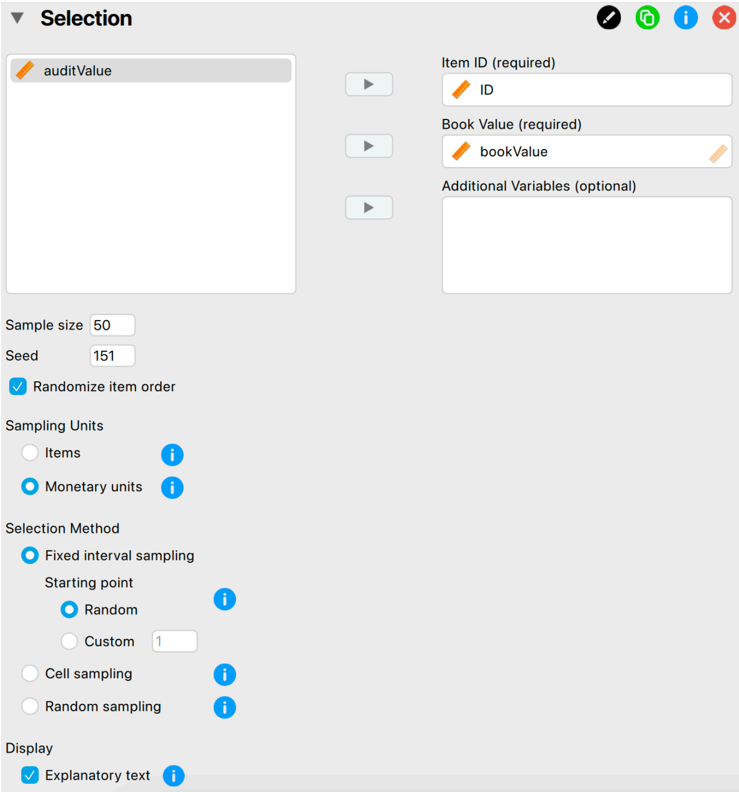


This will open a dataset with 3500 rows and three columns: 'ID', 'bookValue', and 'auditValue'. The 'ID' column represents the identification number of the items in the population. The 'bookValue' column shows the recorded values of the items, while the 'auditValue' column displays the true values. The 'auditValue' column is included for illustrative purposes, as auditors typically know the true values only for the audited sample, not for all items in the population.



3.2.1 Main settings

In this example, we aim to select a sample of 50 monetary units from the population using monetary unit sampling with a fixed interval. To draw this sample, we open the 'Selection' analysis within the Audit module. The interface for the selection analysis is displayed below.



These are the main settings for the analysis:

- **Variables:** Start by entering the variable that holds the identification numbers for the items into the 'Item ID' field. Additionally, since we are performing monetary unit sampling, enter the variable 'bookValue' into the 'Book Value' field. Any variables you enter into the 'Additional Variables' field will be displayed along with the selected items in any output tables.
- **Sample size:** Specify the number of sampling units you want to select from the population. In this example, we aim to test a sample of 100 monetary units, so we enter the value 50 in this field.
- **Seed:** A seed in computing is a starting point for generating random numbers. By setting a seed, you ensure that the results of the selection procedure can be reproduced across computers, which is useful for sharing your analysis.
- **Randomize item order:** Choose whether to randomly shuffle the items in the population before starting the selection process. This can help eliminate any patterns that may exist in the dataset. It's generally a good idea to use this setting, so we enable it in this example.
- **Sampling units:** Choose the type of sampling units you want to select. Selecting 'Items' will perform attribute sampling, while 'Monetary units' will perform monetary unit sampling. Since we have access to book values in this example, we select 'Monetary units'.
- **Selection method:** Choose the selection algorithm. Since we want to sample monetary units using a fixed interval, we select 'Fixed interval sampling'.

  - **Fixed interval sampling: Starting point:** This setting determines the starting point in the first interval. To enhance randomness, we set it to 'Random'. Alternatively, we could choose a specific starting point by selecting the 'Custom' option.
- **Display: Explanatory text:** Finally, select whether to show explanatory text in the output.

3.2.2 Main output

The first main table in the output, shown below, displays the number of selected units and the number of items from which these units were chosen. In this example, 50 sampling units have been selected across 50 items. Additionally, the table shows the total value of the items in the sample and the percentage of the population value that these sample items represent. The 50 items have a total value of €27,998.55, which is 2% of the total population value of €1,403,220.82, as calculated by 27,998.55 / 1,403,220.82 = 0.01995. The note under the table shows that the length of a single interval is €28,064.42.

Table 1. *Selection Summary*

No. units	No. items	Selection value	% of population value
50	50	€27,998.55	2 %

Note. From each of the intervals of size 28064.42, unit 13456 is selected using seed 151.

The second main table in the output provides details specific to interval selection methods. It divides the population into two strata: the top stratum, which includes all items with a book value greater than a single interval of €28,064.42 (the top stratum limit would be two interval lenghts for cell sampling), and the bottom stratum, which contains items with a book value smaller than €28,064.42. In this example, there are no items with a book value exceeding €28,064.42, so the top stratum is empty.

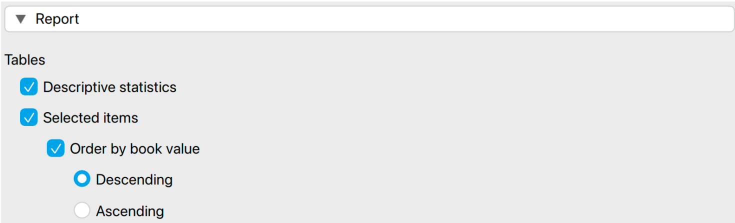
Table 2. *Information about Monetary Interval Selection* ▼

	Items	Value	Selected items	Selected units	Selection value	% of total value
Total	3,500	€1,403,220.82	50	50	€27,998.55	2 %
Top stratum	0	€0	0	0	€0	0 %
Bottom stratum	3,500	€1,403,220.82	50	50	€27,998.55	2 %

Note. The top stratum consists of all items with a book value larger than a single interval.

3.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.



- **Tables: Descriptive statistics:** Checking this box generates a table of descriptive statistics (e.g., mean, median, standard deviation) for the variable in the 'Book Value' field and all variables in the 'Additional Variables' field. This can be used to gain insights into the distribution and characteristics of the sample.

Table 3. *Descriptive Statistics for Sample*

	Items	bookValue
Valid cases	50	50
Mean		559.971
Median		533.135
Std. deviation		274.372
Variance		75,280.232
Range		1,321.310
Minimum		104.480
Maximum		1,425.790

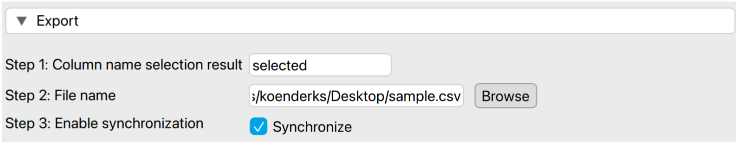
- **Tables: Selected items:** Checking this box generates a table that lists all the selected items in the sample along with their corresponding book values, if this variable is provided.
  - **Order by book value:** This setting allows you to sort the items in the table based on their book value, with the option to arrange them in either ascending or descending order. In this example, we sorted the book values in descending order.

Table 4. *Selected Items* ▼

Row	Selected	ID	bookValue
386	1	7,650	€1,425.79
2,311	1	85,014	€1,189.66
1,371	1	68,134	€1,109.19
306	1	11,569	€1,025.03
705	1	21,900	€919
2,178	1	81,326	€839.21
579	1	5,712	€833.33
85	1	4,437	€758.71
1,009	1	97,578	€754.48
1,171	1	39,619	€747.26
224	1	10,375	€746.81
1,282	1	53,993	€744.55
2,521	1	20,853	€734.19

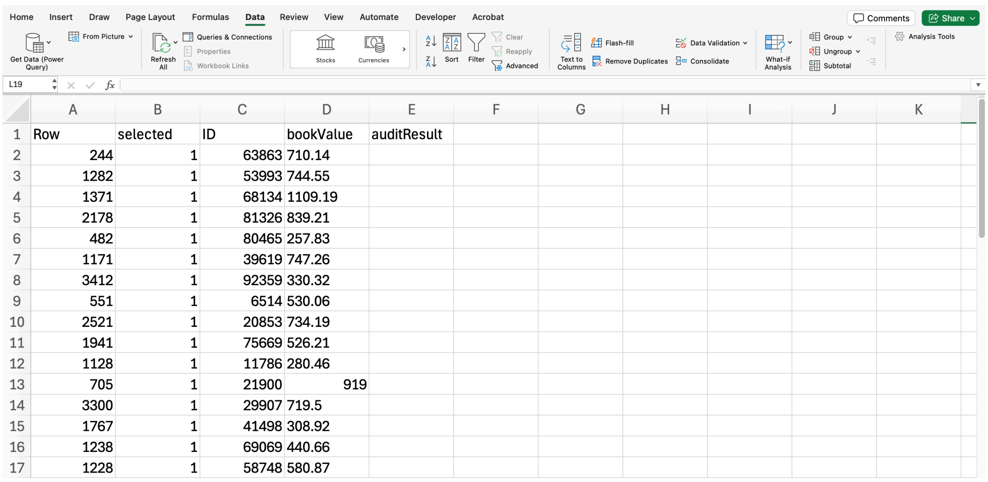
3.2.4 Export

The following settings enable you to isolate and export the selected items to a .csv file.



- **Column name selection result:** Enter the name of the column that will be added to the population file. This column will contain the results of the selection procedure, indicating whether the item is selected for the sample and how many times it is included.
- **File name:** Click 'Browse' to choose a location on your computer where you want to save the sample list.
- **Enable synchronization:** Finally, click on this setting to create the .csv file on your computer. When this setting is enabled, any changes you make to the sample by adjusting settings in the interface will be immediately reflected in the .csv file. If you prefer not to have this automatic update, uncheck this box after enabling it initially.

After applying these settings, you should find the resulting .csv file saved on your computer.



	A	B	C	D	E
1	Row	selected	ID	bookValue	auditResult
2	244	1	63863	710.14	
3	1282	1	53993	744.55	
4	1371	1	68134	1109.19	
5	2178	1	81326	839.21	
6	482	1	80465	257.83	
7	1171	1	39619	747.26	
8	3412	1	92359	330.32	
9	551	1	6514	530.06	
10	2521	1	20853	734.19	
11	1941	1	75669	526.21	
12	1128	1	11786	280.46	
13	705	1	21900	919	
14	3300	1	29907	719.5	
15	1767	1	41498	308.92	
16	1238	1	69069	440.66	
17	1228	1	58748	580.87	

Chapter 4

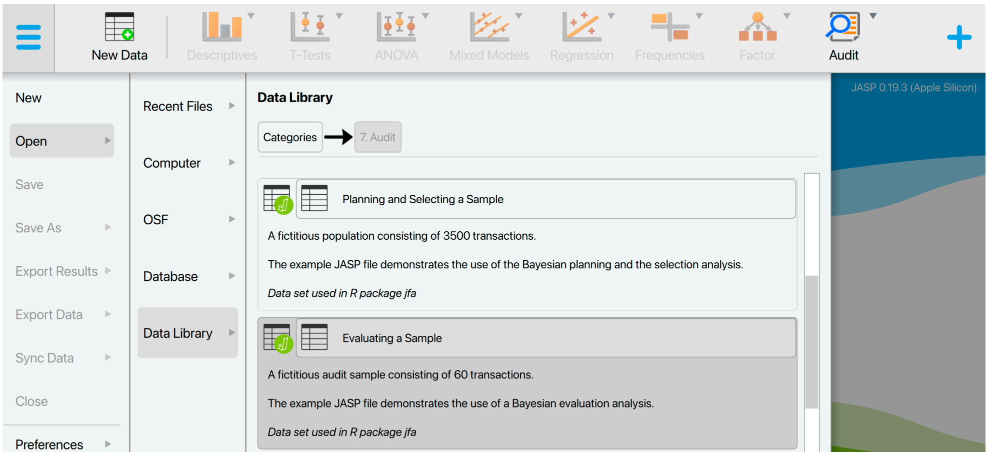
Evaluation

This chapter is about the 'Evaluation' analysis in the 'Audit Sampling' section of the module.

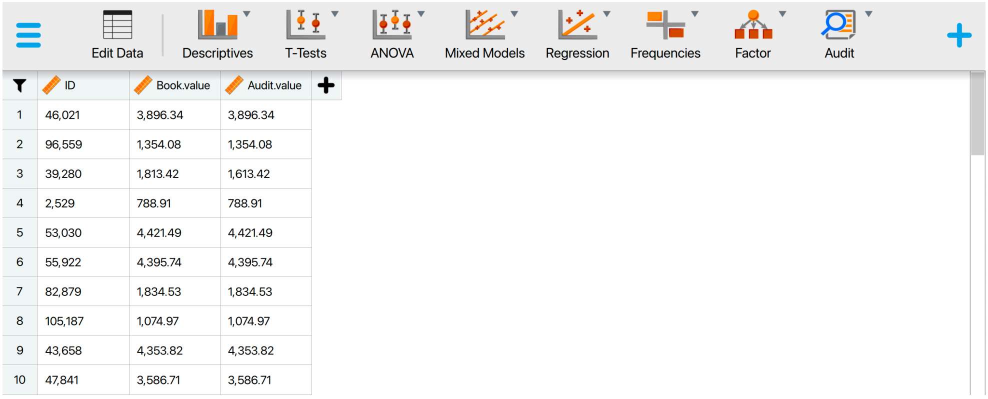
4.1 Purpose of the analysis

4.2 Practical example

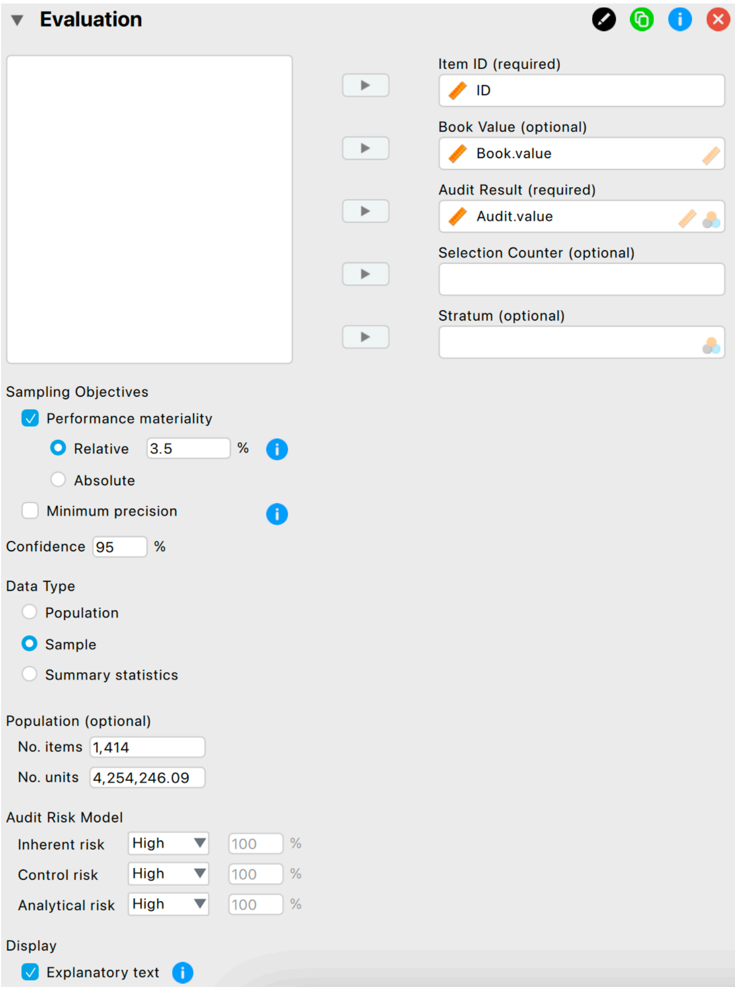
Let's explore an example of an evaluation analysis. To follow along, open the 'Evaluating a Sample' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Evaluating a Sample' (not the green JASP-icon button).



This will open a dataset with 90 rows and three columns: 'ID', 'Book.value', 'Audit.value'. The 'ID' column represents the identification number of the items in the population. The 'Book.value' and 'Audit.value' columns show the recorded and true values of the items, respectively.



4.2.1 Main settings



These are the main settings for the analysis:

- **Sampling objectives: Performance materiality:** ...
- **Sampling objectives: Minimum precision:** ...
- **Confidence:** ...
- **Data type:** ...
- **Population: No. items:** ...
- **Population: No. units:** ...
- **Audit risk model:** ...
- **Display: Explanatory text:** ...

4.2.2 Main output

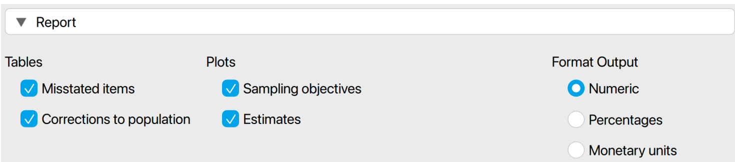
Table 1. *Evaluation Summary*

	Value
Performance materiality	0.035
Sample size	90
Misstatements	1
Taint	0.110
Most likely misstatement	0.001
95% Upper bound	0.035
Precision	0.034

Note. The results are computed using the Stringer method.

4.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.



- **Tables: Misstated items:** ...

Table 2. *Misstated Items*

ID	Book value	Audit value	Difference	Taint	Counted
39,280	€1,813.42	€1,613.42	€200	0.110	x1
Total			€200	0.110	

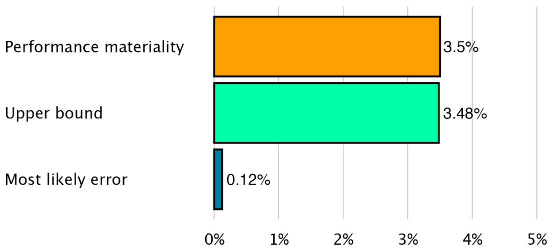
- **Tables: Corrections to population:** ...

Table 4. *Corrections to Population*

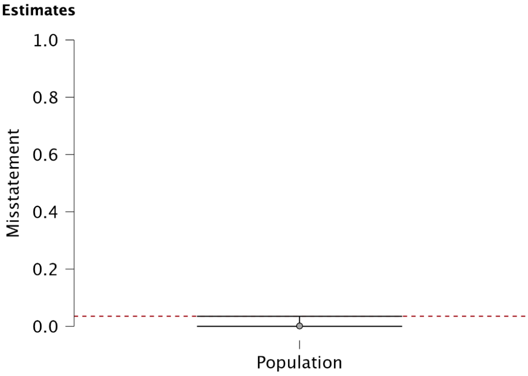
	Correction
No misstatements with 95% confidence	0.035

Note. The correction to achieve no misstatements is the upper bound.

- **Plots: Sampling objectives:** ...

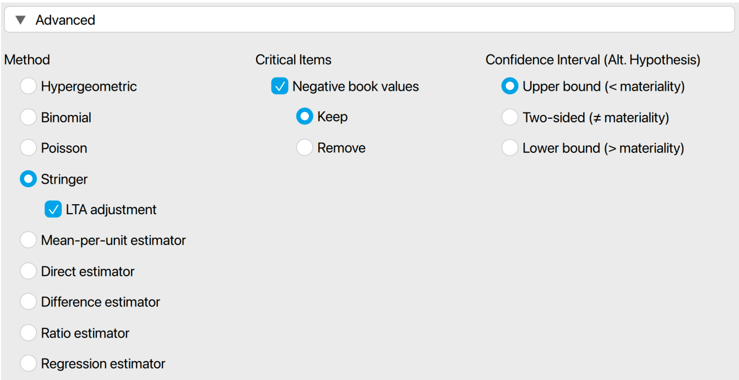


- **Plots: Estimates:** ...



4.2.4 Advanced

The following advanced settings allow you to customize the statistical computations according to your preferences.



- **Method:** ...
- **Critical items:** ...
- **Confidence interval (Alt. hypothesis):** ...

Chapter 5

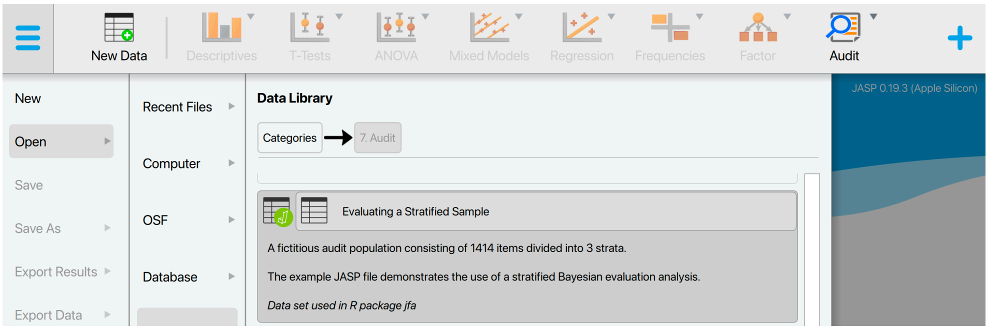
True Value Estimation

This chapter is about the 'True Value Estimation' analysis in the 'Audit Sampling' section of the module.

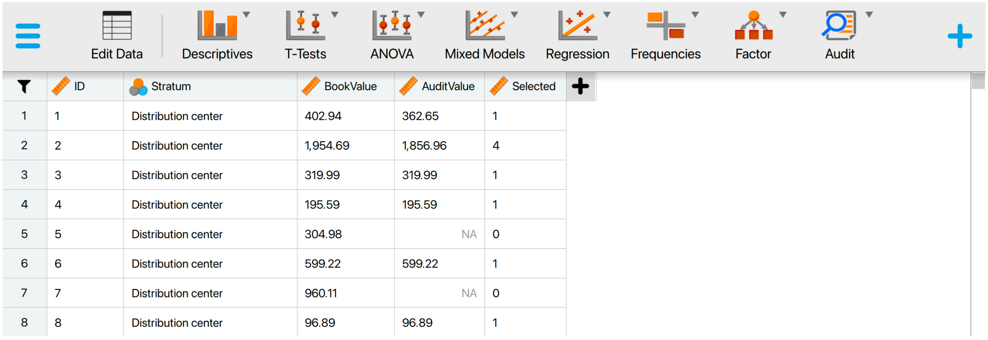
5.1 Purpose of the analysis

5.2 Practical example

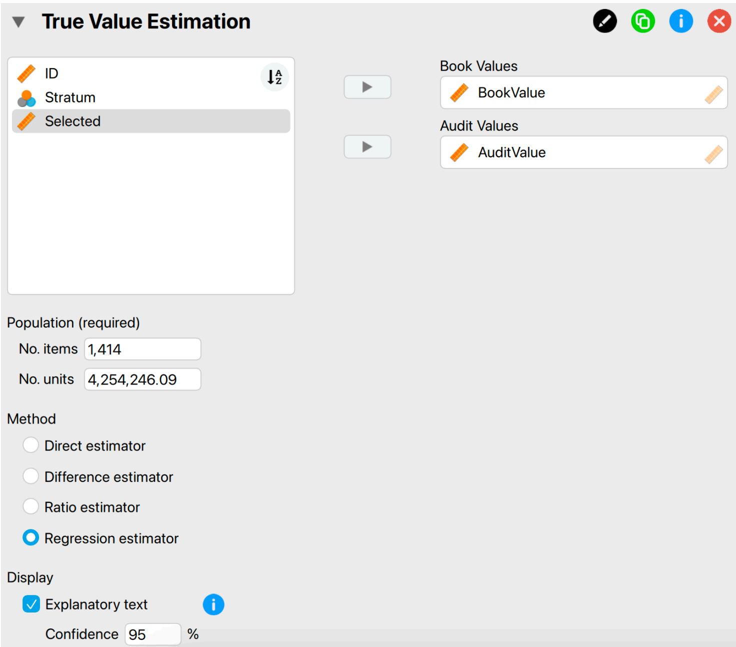
Let's explore an example analysis of a true value estimation analysis. To follow along, open the 'Evaluating a Stratified Sample' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Evaluating a Stratified Sample' (not the green JASP-icon button).



This will open a dataset with 1414 rows and five columns: 'ID', 'Stratum', 'BookValue', 'AuditValue', and 'Selected'. The 'ID' column represents the identification number of the items in the population. The 'Stratum' column shows the location from which the item was retrieved. The 'BookValue' and 'AuditValue' columns show the recorded and true values of the items, respectively. Finally, the 'Selected' column shows which items were selected to be included in the sample.



5.2.1 Main settings



These are the main settings for the analysis:

- **Population: No. items:** ...
- **Population: No. units:** ...
- **Method:** ...
- **Display: Explanatory text:** ...
- **Display: Confidence:** ...

5.2.2 Main output

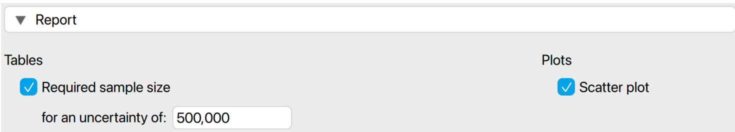
Regression estimator

		95% Confidence interval	
Estimate $\hat{W}$	Uncertainty	Lower	Upper
€2,512,392.17	€551,398.32	€1,960,993.85	€3,063,790.49

Note. Displayed numbers may differ from exact outcomes due to rounding in the calculations.

5.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.

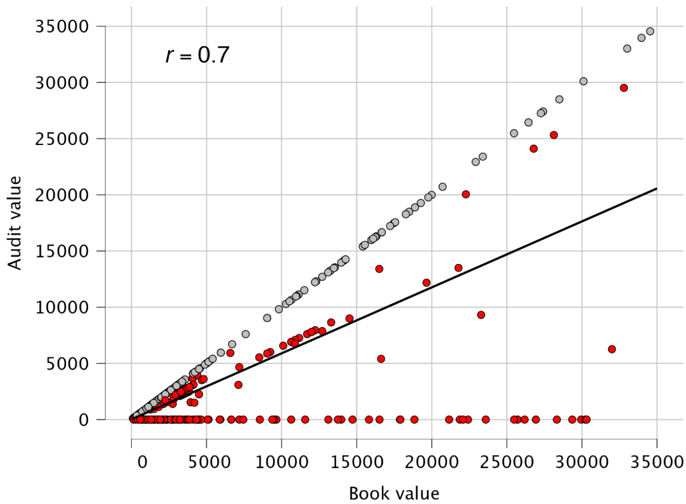


- **Tables: Required sample size:** ...

Required Sample Size

Estimator	Uncertainty	Required *n*	Additional *n*
Regression	€500,000	459	59

- **Plots: Scatter plot:** ...



Part II

Data Auditing

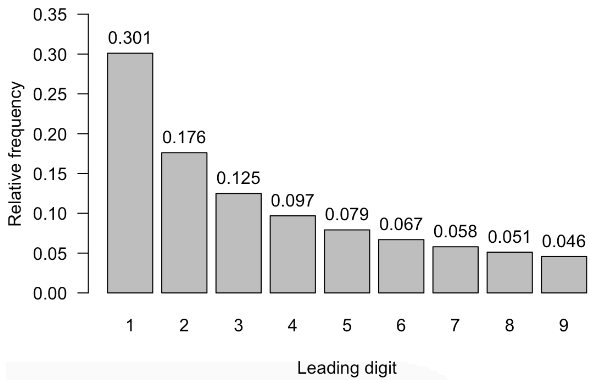
Chapter 6

Benford's Law

This chapter is about the 'Benford's Law' analysis in the 'Data Auditing' section of the module.

6.1 Purpose of the analysis

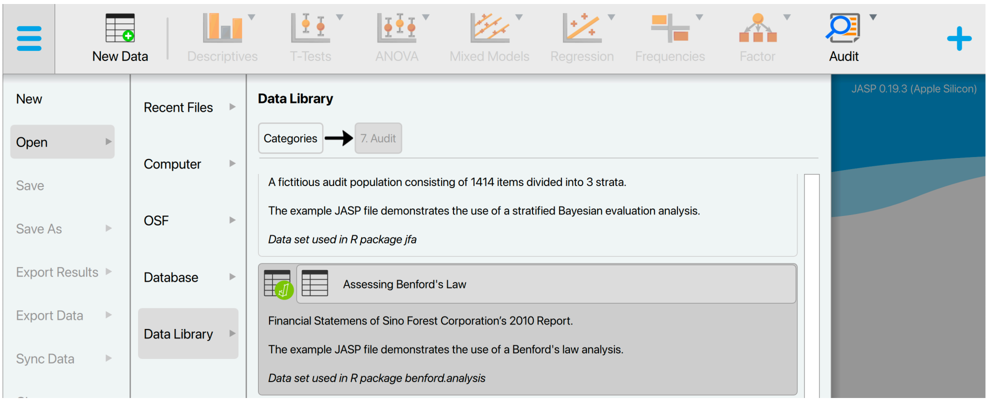
Benford's law states that the distribution of leading digits in a population naturally follows a certain distribution. Specifically, the frequencies of each digit d_i are defined by $p(\mathrm{d}_i) = \log_{10}(1 + \frac{1}{d})$, see the figure below. For instance, the probablity of observing a 1 as a leading digit is 0.301, or 30.1%. This can be tested in a statistical manner. That is, the null hypothesis, H_0, states that the distribution of first digits follows Benford's law, while the alternative hypothesis, H_1, states that it does not.



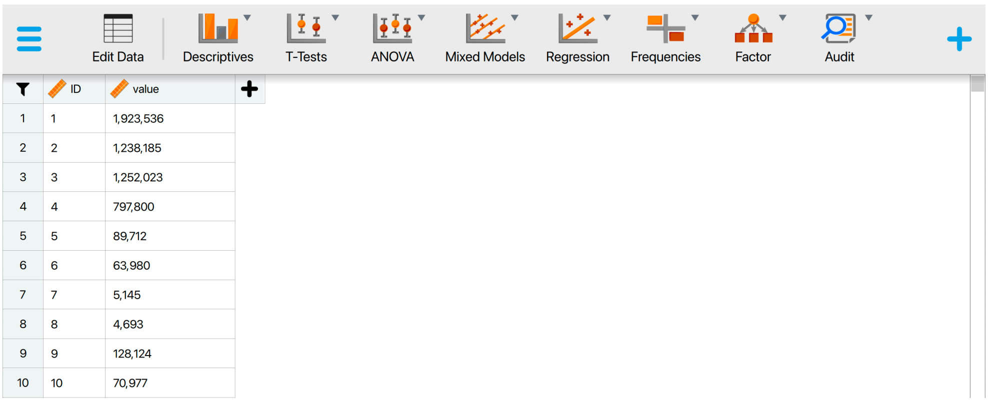
The purpose of the analysis in JASP is to investigate whether the distribution of first, second, or last digits in a set of numbers follows Benford's law. In auditing, this may provide evidence that certain items or transactions in a population might warrant further investigation.

6.2 Practical example

Let's explore an example analysis of Benford's law. To follow along, open the 'Assessing Benford's Law' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Assessing Benford's Law' (not the green JASP-icon button).



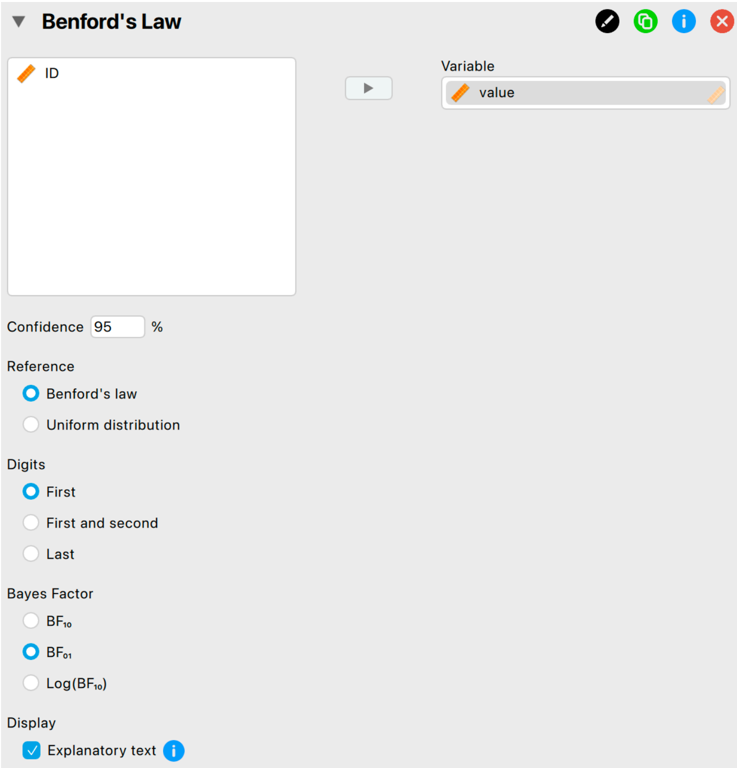
This will open a dataset with 772 rows and two columns: 'ID' and 'value'. The 'ID' column represents the identification number of the items in the population. The 'value' column shows the recorded values of the items.



	ID	value
1	1	1,923,536
2	2	1,238,185
3	3	1,252,023
4	4	797,800
5	5	89,712
6	6	63,980
7	7	5,145
8	8	4,693
9	9	128,124
10	10	70,977

6.2.1 Main settings

In this example, we will investigate whether the distribution of first digits in the variable 'value', which represents the recorded values of transactions in a financial population, adheres to Benford's law. That is, the null hypothesis, H_0, states that the distribution of first digits follows Benford's law, while the alternative hypothesis, H_1, states that it does not. To test this, we open the 'Benford's Law' analysis from the Audit module. The interface of the Benford's law analysis is shown below.



These are the main settings for the analysis:

- **Variable:** Begin by entering the variable whose digit distribution you wish to test in the designated box. In the example, this is the variable 'value', so we drag this variable to the field on the right.
- **Confidence:** Indicate the confidence level for your analysis. This level, which complements the significance level, determines when to reject the null hypothesis. In the example, we use a confidence level of 95%.
- **Reference:** Select a reference distribution to compare the chosen digits against. By default, this is set to 'Benford's law,' but you can also opt for a uniform distribution. In the example, we select 'Benford's law'.
- **Digits:** Choose which digits to compare against the reference distribution. You can select the first digits (default), the first two digits, or the last digits. Benford's law typically applies to the first or first two digits, while the uniform distribution is usually applied to the last digits. In the example, we choose to test the first digits against Benford's law.
- **Bayes factor:** Select which Bayes factor is displayed in the main output table. 'BF_{10}' represents the Bayes factor in favor of the alternative hypothesis over the null hypothesis, 'BF_{01}' represents the Bayes factor in favor of the null hypothesis over the alternative hypothesis, and '$\text{Log}(BF_{10})$' represents the logarithm of BF_{10}.
- **Display: Explanatory text:** Finally, select whether to show explanatory text in the output.

6.2.2 Main output

The main table in the output, shown below, shows the sample size (n), the mean absolute deviation (MAD), the chi-square value (X^2) and its degrees of freedom (df). The table shows a p-value of 0.478, indicating that H_0 should not be rejected at a significance level of 5%. Furthermore, the table presents the Bayes factor in favor of the null hypothesis, BF_{01}, which is $6.9 \text{x} 10^6$. This suggests that the data provide very strong evidence supporting H_0 over H_1.

Table 1. *Omnibus Test – Benford's Law* ▼

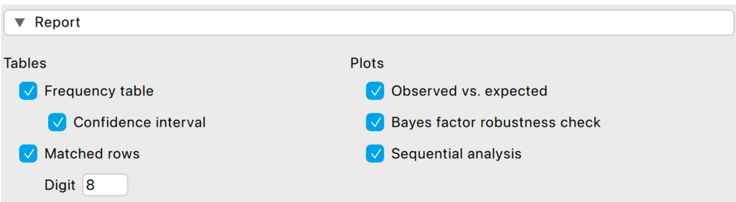
	n	MAD	X^2	df	p	BF_{01} [a]
value	772	0.007	7.652	8	0.468	$6.900 \times 10^{+6}$

Note. The null hypothesis specifies that the first digits (1 – 9) in the data set are distributed according to Benford's law.
[a] The Bayes factor is computed using a Dirichlet(α_1,...,α_9) prior with α = 1.

Note that non-conformity to Benford's law does not necessarily indicate fraud. A Benford's law analysis should therefore only be used to acquire insight into whether a population might need further investigation.

6.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.



- **Tables: Frequency table:** Check this box to display a table of the observed and expected frequencies of the digits. Clicking the 'Confidence interval' option shows confidence intervals for the observed relative frequencies in the table.

  The frequency table displays the observed count for each leading digit in the second column. Adjacent to this, it shows the expected relative frequency under Benford's law alongside the observed relative frequency in the data. Additionally, p-values and Bayes factors are provided to test whether the observed relative frequencies differ from the expected ones. In this case, only the digit 8 has a p-value smaller than 0.05, indicating a significant deviation from the expected relative frequency under Benford's law.

Table 2. *Frequency Table*

Leading digit	Count	Benford's law	Relative frequency	95% Confidence Interval Lower	95% Confidence Interval Upper	p[a]	BF_{01}[b]
1	231	0.301	0.299	0.267	0.333	0.937	24.083
2	124	0.176	0.161	0.135	0.188	0.277	15.737
3	97	0.125	0.126	0.103	0.151	0.957	33.397
4	70	0.097	0.091	0.071	0.113	0.626	32.411
5	64	0.079	0.083	0.064	0.105	0.689	37.398
6	54	0.067	0.070	0.053	0.090	0.719	41.126
7	40	0.058	0.052	0.037	0.070	0.537	37.795
8	54	0.051	0.070	0.053	0.090	0.022	3.449
9	38	0.046	0.049	0.035	0.067	0.606	46.150

Note. The null hypothesis specifies that the relative frequency of a digit is equal to its expected relative frequency under Benford's law.
[a] Confidence intervals and *p*-values are based on independent binomial distributions.
[b] Bayes factors are computed using a beta(1, 1) prior.

- **Tables: Matched rows:** Check this box to display a table showing the rows that have a certain number as their leading/last digit(s).

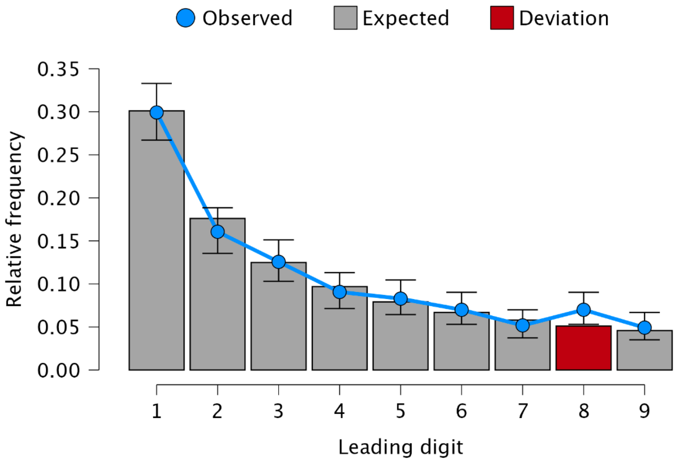
In the example, we request a table of rows that match the digit 8. The first column displays the row number where the digit is found, and the second column shows the matched value. Using this table, you can identify the transactions that may warrant further investigation.

Table 3. *Rows Matched to Leading Digit 8* ▼

Row	Value
5	89,712.000
21	8,179.000
33	8,498.000
34	8,756.000
59	87,670.000
84	8,179.000
103	826.000
125	8,555.000
138	82,447.000
192	845.000
199	8,000.000
210	837.000
215	8,000.000
218	8,340.000
225	826.000

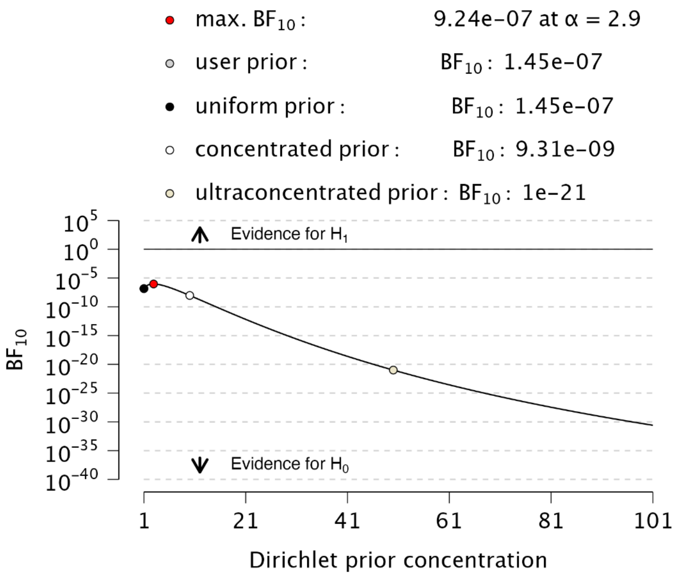
- **Plots: Observed vs. expected:** Check this box to display a figure that illustrates the observed frequencies compared to the expected frequencies.

The figure in the output visualizes the observed relative frequencies compared to the expected ones, with the digit 8 highlighted in red. From this figure, it is immediately clear that the transactions starting with the digit 8 may warrant further inspection.



- **Plots: Bayes factor robustness check:** Check this box to display a figure that shows the Bayes factor under different specifications of the prior concentration parameter.

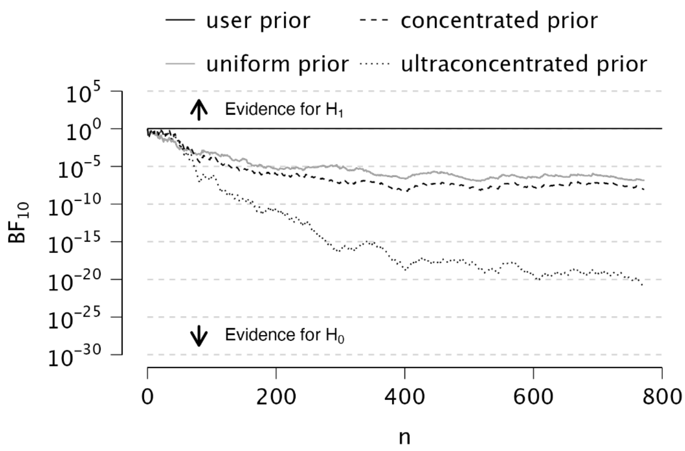
  The figure below is referred to as a robustness check. If the Bayes factor supports a particular hypothesis across all reasonable values of the prior concentration parameter, the result is considered robust regarding the choice of prior distribution. In this instance, the figure demonstrates that the Bayes factor consistently provides evidence in favor of the null hypothesis, regardless of the prior concentration parameter values.



- **Plots: Sequential analysis:** Select this box to display a figure illustrating the Bayes factor as a function of sample size, across various prior specifications.

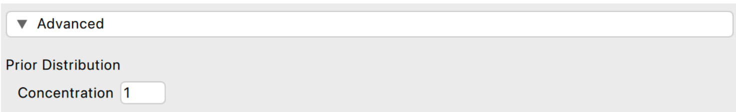
  In the example analysis, the sequential analysis plot demonstrates that the

Bayes factor provides increasing evidence in favor of H_0 as the sample size grows. Additionally, this evidence is more pronounced when using a more concentrated prior distribution.



6.2.4 Advanced

The following advanced settings allow you to customize the statistical computations according to your preferences.



- **Prior distribution: Concentration:** Specify the concentration parameter for the Dirichlet prior distribution. Adjusting this value will alter the Bayes factor in the main output table. A larger concentration parameter indicates a more concentrated prior distribution, suggesting that the population proportions are more similar. When testing against the uniform distribution, this implies a stronger belief in H_0. Conversely, when testing against Benford's law, it indicates a stronger belief in H_1.

Chapter 7

Repeated Values

This chapter is about the 'Repeated Values' analysis in the 'Data Auditing' section of the module.

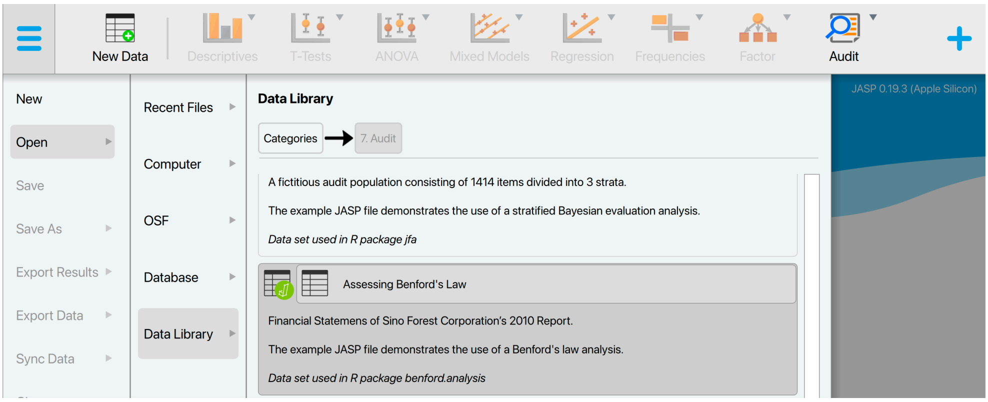
7.1 Purpose of the analysis

The repeated values analysis analyzes the frequency with which values get repeated within a dataset (called "number-bunching") to statistically identify whether the data were likely tampered with. Unlike Benford's law this approach examines the entire number at once, not only the first or last digit (Simohnsohn, 2019).

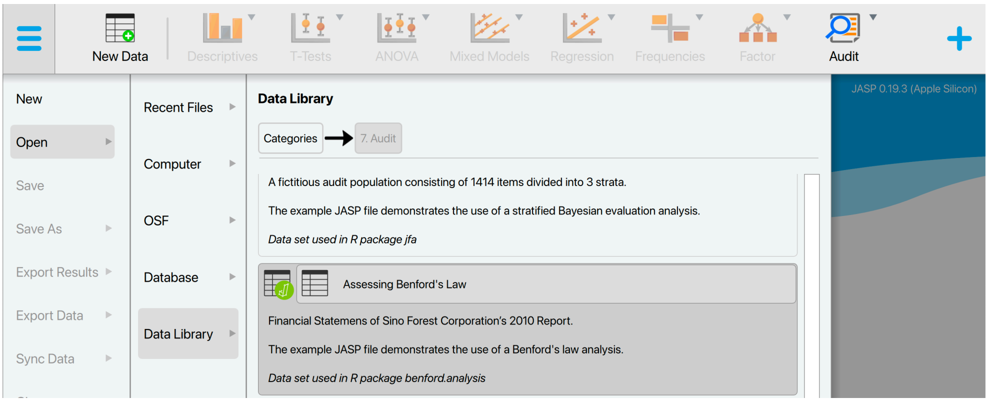
To determine whether the data show an excessive amount of bunching, the null hypothesis that the data do not contain an unexpected amount of repeated values is tested. To quantify what is expected, this test requires the assumption that the integer portions of the numbers are not associated with their decimal portions.

7.2 Practical example

Let's explore an example analysis of repeated values. To follow along, open the 'Assessing Benford's Law' dataset from the Data Library. Navigate to the top-left menu, click 'Open', then 'Data Library', select '7. Audit', and finally click on the text 'Assessing Benford's Law' (not the green JASP-icon button).

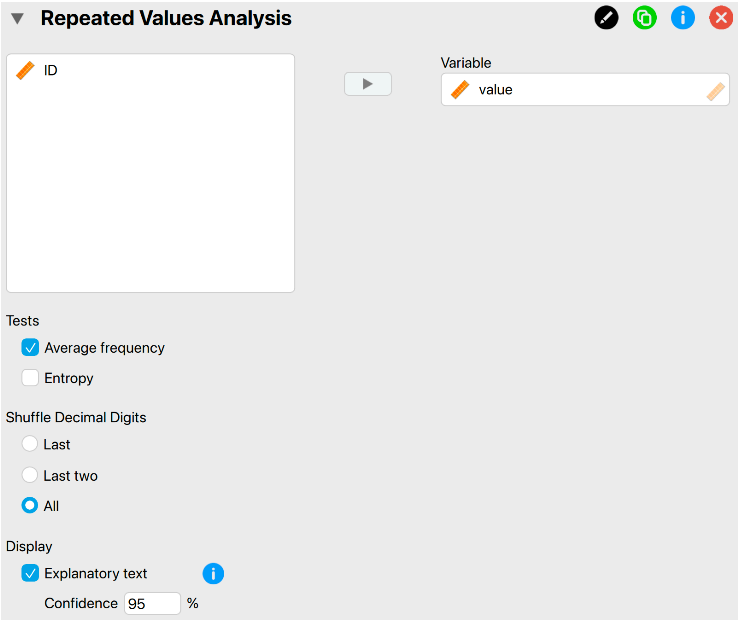


This will open a dataset with 772 rows and two columns: 'ID' and 'value'. The 'ID' column represents the identification number of the items in the population. The 'value' column shows the recorded values of the items.



7.2.1 Main settings

The interface ...



These are the main settings for the analysis:

- **Variable:** ...
- **Tests: Average frequency** ...
- **Tests: Entropy** ...
- **Shuffle decimal digits:** ...
- **Display: Explanatory text:** ...
- **Display: Confidence:** ...

7.2.2 Main output

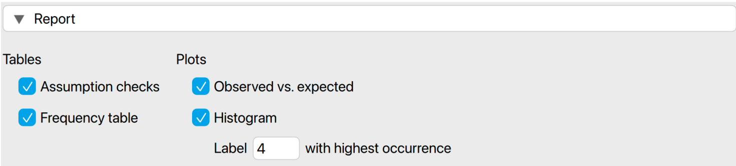
Table 1. *Repeated Values Test*

		Frequency	
	n	Average	p
value	772	1.324	0.024

Note. The displayed *p*-value is one-sided and is computed on the basis of 500 samples.

7.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.



- **Tables: Assumption checks:** ...

Table 2. *Assumption Checks*

			n	r	t	df	p
Integer values	-	Decimal values	772	−0.027	−0.738	770	0.461

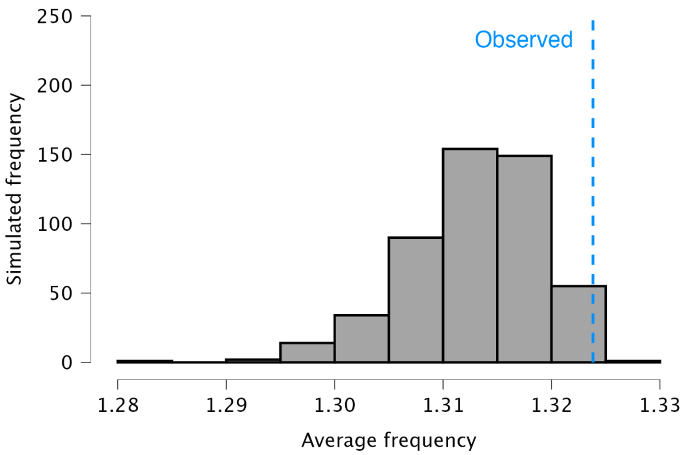
Note. The displayed p-value is for a two-sided test against H_0: $r = 0$.

- **Tables: Frequency table:** ...

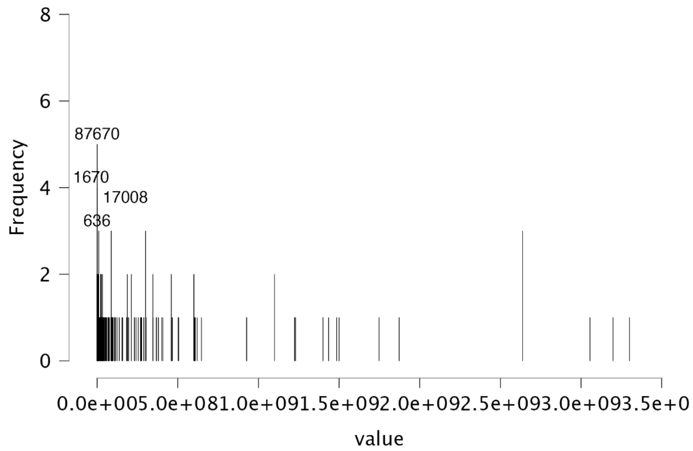
Table 3. *Frequency Table* ▼

Value	Count	Percentage
87,670	5	0.6 %
1,670	4	0.5 %
17,008	4	0.5 %
636	3	0.4 %
1,403	3	0.4 %
8,756	3	0.4 %
50,000	3	0.4 %
150,000	3	0.4 %
1,473,353	3	0.4 %

- **Plots: Observed vs. expected:** ...

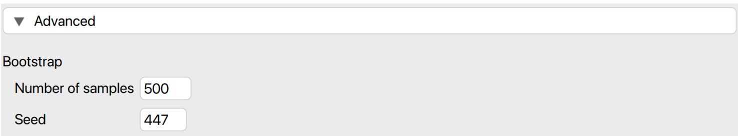


- **Plots: Histogram:** ...



7.2.4 Advanced

The following advanced settings allow you to customize the statistical computations according to your preferences.



- **Bootstrap: Number of samples:** ...
- **Bootstrap: Seed:** ...

Part III

Algorithm Auditing

Chapter 8

Fairness Workflow

The goal of fairness is ...

8.1 The X stages in the fairness workflow

8.2 Practical example

Chapter 9

Evaluation

This chapter is about the 'Evaluation' analysis in the 'Algorithm Auditing' section of the module.

9.1 Purpose of the analysis

9.2 Practical example

9.2.1 Main settings

9.2.2 Main output

9.2.3 Report

The following settings enable you to expand the report with additional output, such as tables and figures.

9.2.4 Advanced

The following advanced settings allow you to customize the statistical computations according to your preferences.

This is the user manual for **JASP for Audit**, a module within the free and open-source statistical software program **JASP (https://jasp-stats.org)** built to support the statistical aspects of an audit. The module offers a user-friendly graphical interface, simplifying complex statistical auditing procedures to make them as effortless as possible.

Next to the classical frequentist statistical techniques that are standard in audit practice, the module offers state-of-the-art Bayesian techniques that enable auditors to work more efficiently and transparently. Furthermore, JASP for Audit helps the auditor in interpreting, explaining, and reporting the analyses and leaves a transparent audit trail.