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Audit Sampling with JASP for Audit

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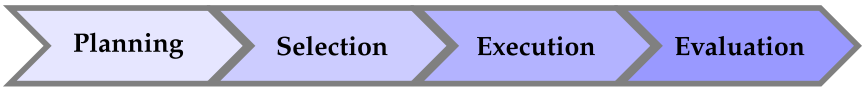
Contents

Statement of Need

Figure 1: JASP is a free cross-platform statistical software program with a state-of-the-art graphical user interface. JASP can be downloaded at `www.jasp-stats.org`.

Statistical theory lies at the core of many auditing guidelines and procedures. Auditors therefore need easy-to-use software that implements the required statistical analyses as well as sufficient knowledge to interpret the results of these analyses. `JASP` is an open-source, free-of-charge, cross-platform statistical software program that facilitates statistical auditing through the `Audit` module, a downloadable add-on module that is built to support the statistical aspects of an audit.

With the `Audit` module you, as the auditor, are able to plan, perform and interpret most statistical audit sampling procedures using the correct statistical methods and without being at risk of making any programming errors. The module is designed with the auditor in mind. This means that the interface is user-friendly and directly relates to audit processes and International Standards on Auditing. In order to create the easiest experience for auditors, the `Audit` module separates the standard audit sampling workflow into four stages: *planning*, *selection*, *execution* and *evaluation*. In the module's main feature, the `Sampling Workflow` analysis, you are guided through these four stages in terms of statistical techniques and the interpretation of their results.



Next to the frequentist methods that are standard in the audit practice, the `Audit` module incorporates Bayesian counterparts of these methods that can improve the transparency and efficiency of your audit. These Bayesian methods allow you to utilize the advantages of knowledge updating by incorporating your existing information.

In sum, the `Audit` module performs all the required statistical heavy lifting and enables you to plan, evaluate and interpret your statistical analysis in terms of auditing standards and using state-of-the-art classical and Bayesian techniques. The `Audit` module can be loaded in `JASP` by clicking the module icon shown in Figure 2.

Figure 2: JASP for Audit (JfA) is a freely downloadable add-on module for JASP. This icon represents the module in `JASP`

The Audit Sampling Workflow

The goal of every statistical audit sampling procedure is to perform statistical inference about a characteristic of a population based on a subset of the that population. This is understandably difficult to do properly, while still being able to understand the results. The `Audit` module breaks down your audit sampling procedure into a four-stage workflow in which you are able to plan the size of your required sample, select the required observations, perform the audit, and make a statistical statement about your population. The four stages in the audit sampling workflow are *planning*, *selection*, *execution* and *evaluation*. More information about the individual stages is provided below.

Stage 1: Planning

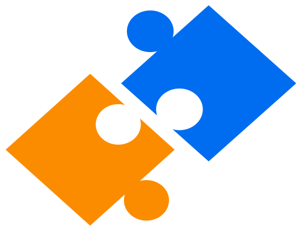


Figure 3: The icon for the `Planning` stage in the `Audit` module.

Audit sampling starts with finding out the appropriate sample size in the planning stage. Here, you use the available information that is gathered during earlier portions of the audit to determine the appropriate sample size to, for example, support the assertion that the misstatement in the population is lower than the set performance materiality. These expectations can be shaped through the outcomes of last years' audit, or other sources of information. Furthermore, this existing information is often present in the form of information about the organization's field of operations *(inherent risk)* and quality of the organization's internal control mechanisms *(control risk)*, which can be used to adjust the amount of evidence that is needed to approve the financial statements. On top of that, there is often an expectation of the amount or percentage of errors that are expected (or allowed) in the sample. All these factors affect how many observations you need to investigate to retain the required statistical confidence in your statistical statement.

Stage 2: Selection

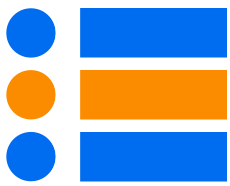


Figure 4: The icon for the `Selection` stage in the `Audit` module.

The calculated sample size from the planning stage is used as an input for the selection stage, where the goal is to select a statistically representative sample from the population. In statistical selection all possible sampling units receive an inclusion probability. Units are then selected from the population with a probability equal to the inclusion probability until the required sample size has been reached. The nature of the sampling units is dependent on the sampling method. The most commonly used sampling method for substantive tests is monetary unit sampling. In monetary unit sampling, probabilities are assigned on the level of individual monetary units. For example, a monetary unit sampling procedure may consider each individual dollar in the population as a sampling unit. In monetary unit sampling, when a monetary unit is selected for the subset, the observation that corresponds to that unique monetary unit is selected. As such, a transaction of €5,000 is five times more likely to be selected than a transaction of €1,000. In record sampling, probabilities are assigned on the observation level, resulting in equal inclusion probabilities for all transactions.

Stage 3: Execution

In the execution stage you will assess the fairness of the selected transactions by looking at their degree of correctness. You can choose to do this in one of two ways. The most straightforward method considers the transactions to be either correct or incorrect. This method does not consider the fact that observations can be partially over- or understated, and therefore results in a more conservative estimate of the total misstatement in the population.

A more common method considers the true value (audit value) of the transactions. In this method, information about the size of the misstatement proportional to the size of the transaction is retained. Annotating the sample with the latter technique often has preference over the former, as estimation of the total misstatement with audit values is more accurate and less conservative. If you wish to make a statement on the amount of misstatement, it is common practice to annotate the sample with their audit values.

However, if you do not have access to book values, the preferred annotation method is the correct/incorrect method. You exit this stage with an annotated sample of the population. The choice of probability distribution, sampling units, and sampling method, are leading in your choice of a statistical evaluation method for inferring misstatement in the population.

Figure 5: The icon for the `Evaluation` stage in the `Audit` module.

Stage 4: Evaluation

The evaluation stage is the final stage of the sampling workflow. Here you use the annotated sample from the execution stage to make a statistical inference about the total misstatement in your population. To this aim you use statistical techniques to calculate a projected maximum misstatement and approve the population when this projected maximum misstatement is below your limit of the performance materiality.

The Audit Risk Model

Considering the size of audit populations, it would be enormously expensive to make any audit assertion with absolute certainty. Since the auditor cannot evaluate the total population of financial statements, but wants to make a statement about this population with a certain amount of confidence, statistical inference is a prerequisite. Recognizing this, the auditor defines a probability that he or she will provide an incorrect opinion on the population of financial statements, the **audit risk**. To correctly quantify the audit risk in terms of probability, the International Standards on Auditing consider the Audit Risk Model, which provides a mathematical association between the specified audit risk and the assessed risks of material misstatement.

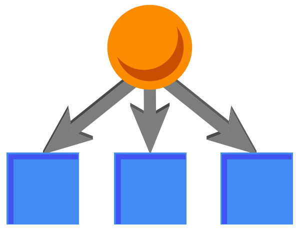


Figure 6: The Audit Risk Model partitions audit risk into inherent risk, control risk, and detection risk.

According to the Audit Risk Model, the audit risk as a whole 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 defined as 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 and are commonly assessed by the auditor on a 3-point scale consisting of the categories low, medium, and high. **Detection risk** is the probability that an auditor will fail to find material misstatements that exist in an organization's financial statements.

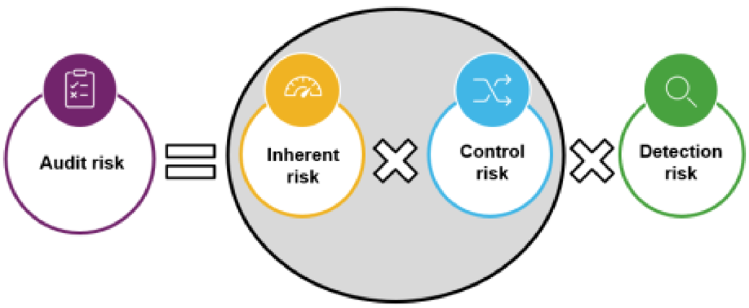


Figure 7: For a given level of audit risk, the tolerable level of detection risk bears an inverse relationship to the other two risks of material misstatement.

For a given level of audit risk, the tolerable level of detection risk bears an inverse relationship to the other two assessed risks, see Figure 7. Intuitively, a greater risk of material misstatement should require a lower tolerable detection risk and, accordingly, requires more persuasive audit evidence [1].

The Audit Risk Model is practically useful because it provides a framework to the auditor for increasing or decreasing the amount of evidence required from the sample based on existing information. For example, having found that the control risk of an organization is medium (60%) the auditor can increase the detection risk from 5% to 8.33%.

Using the Audit Risk Model the auditor is able to determine the required detection risk to maintain a specified audit risk, given their assessments of the inherent and control risk. The detection risk must be statistically substantiated by the auditor. Therefore, the auditor must audit a subset of the organization's financial statements large enough that, when a certain number of expected errors are found, the auditor can conclude with the specified statistical certainty that he or she did not fail to find material misstatements in the total population.

The auditor generally assesses inherent risk and internal control risk on a 3-point scale to determine the appropriate detection risk. Using the Audit Risk Model and zero expected errors the sample size depends on the risk factor R, which is a function of the detection risk.

$$R = -\ln(\text{Detection risk})$$

Table presents values of R as a function of the detection risk, provided that there are zero errors found in the sample [2].

Detection risk (%)	**1**	**4**	**5**	**10**	**14**
R	4.6	3.2	3	2.3	2

The risk factor R can be adjusted using the assessments of the inherent risk and the internal control risk. By default, the standard method of setting the probabilities of the inherent risk and the control risk is by following Table below for a detection risk of 5%.

	High	**Medium**	**Low**
R	3	2	1

These values of R are used to select default percentages for the inherent risk and the control risk. The `Audit` module uses the following default values for inherent risk and control risk:

- **High:** 100%
- **Medium:** 60%
- **Low:** 36%

When both inherent— and control risk are set to high (100%), the detection risk is not adjusted and equals the audit risk. For a conservative analysis, the auditor can therefore ignore the Audit Risk Model in its totality.

[1] IFAC. *International Standard on Auditing 200: Overall Objectives of the Independent Auditor and the Conduct of an Audit in Accordance with International Standards on Auditing.* 2018

[2] Paul Touw and Lucas Hoogduin. *Statistiek voor audit en controlling.* Sdu Uitgevers bv, Den Haag, 2011

The risk assessments facilitate a statistical procedure in which this information is incorporated through the `Sampling Workflow`, an experimental design that allows the auditor to do statistical inference on audit samples. The `Audit` module aims to follow this design as closely as possible, but it has a special focus on incorporating existing information through the Audit Risk Model (a classical analysis) or a prior probability distribution (a Bayesian analysis).

JASP for Audit: The Basics

The Audit module in JASP offers two ways of moving through the audit sampling workflow. First, the `Sampling Workflow` analysis will guide you through all four stages of the sampling workflow. Second, you can step into the audit sampling workflow at any time using the individual `Planning`, `Selection`, and `Evaluation` analyses. This manual will use the `Sampling Workflow` analysis to explain the core functionality of the `Audit` module.

The `Sampling Workflow` analysis can be found in JASP by clicking the `Audit` module icon and selecting **Sampling Workflow**. The `Sampling Workflow` aims to stay true to the sampling workflow as discussed in the previous chapter as much as possible. The graphical user interface is interactive and reflects both JASP's and JfA's philosophies, as advanced statistical components are hidden from the auditor under the `Advanced Options` section and information is disclosed progressively by moving through the workflow.

In the workflow's interactive layouts, the auditor can select the corresponding data and options to plan their audit. Upon completion of a stage, the auditor can request a report of the output by clicking **Download Report**. Every stage can produce output in the form of tables and plots that clarify the statistical results.

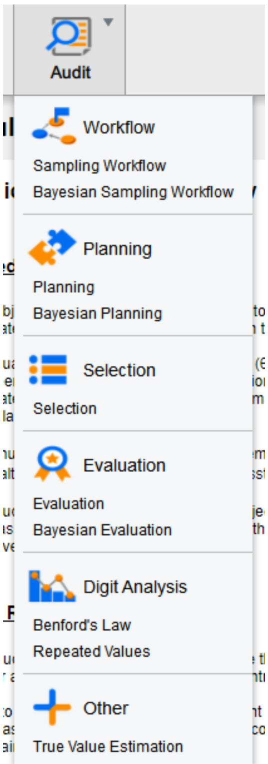


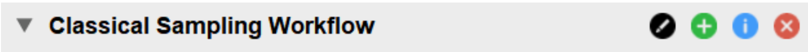
Figure 8: The analyses in the `Audit` module.

Validation of Statistical Results

The statistical results provided by the `Audit` module are extracted from the `R` package `jfa`. For a complete documentation of this package and its benchmarks, see the visit the package website at `https://koenderks.github.io/jfa/`.

Help Files

After opening an analysis, a help file describing the functionality of that analysis can be opened by clicking the ℹ icon next to the title of the analysis.



For some options, such as the sampling units and the sampling algorithms, additional help files are available. In these cases, an ℹ will be displayed next to the option.

Sampling Objectives

In order for the `Audit` module to know what audit question is currently being investigated, you will first be asked to formulate your sampling objectives.

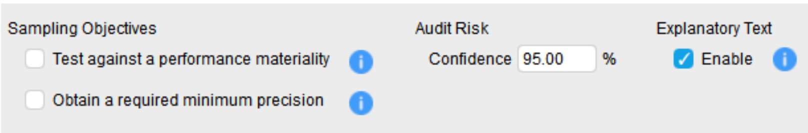


Figure 9: The interface to choose your sampling objectives at the start of the `Sampling Workflow` analysis.

☐ `Test against a performance materiality`
Enable this objective if you want to test whether the total misstatement in the population exceeds a certain limit (i.e., the performance materiality) based on a sample. 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. In the evaluation you will be able to quantify the evidence that your sample contains for or against the statement that the population misstatement does not exceed the performance materiality.

☐ `Obtain a required minimum precision`
Enable this objective if you want to obtain a required minimum precision when estimating the total misstatement in the population based on a sample. This approach allows you to plan a sample such that, when the sample meets expectations, the accuracy of your estimate is below a tolerable percentage. In the evaluation you will be able to quantify the accuracy of your estimate of the population misstatement.

At the end of the workflow you will be notified whether you have achieved your sampling objectives, or if more samples will be required.

Stage 1: Planning

The purpose of the `Planning` stage is to find a sample size so that, given a certain number of expected (or tolerable) errors, the sample provides sufficient information to achieve the specified sampling objectives.

Interface

Figure 10 shows the graphical user interface for the `Planning` stage.

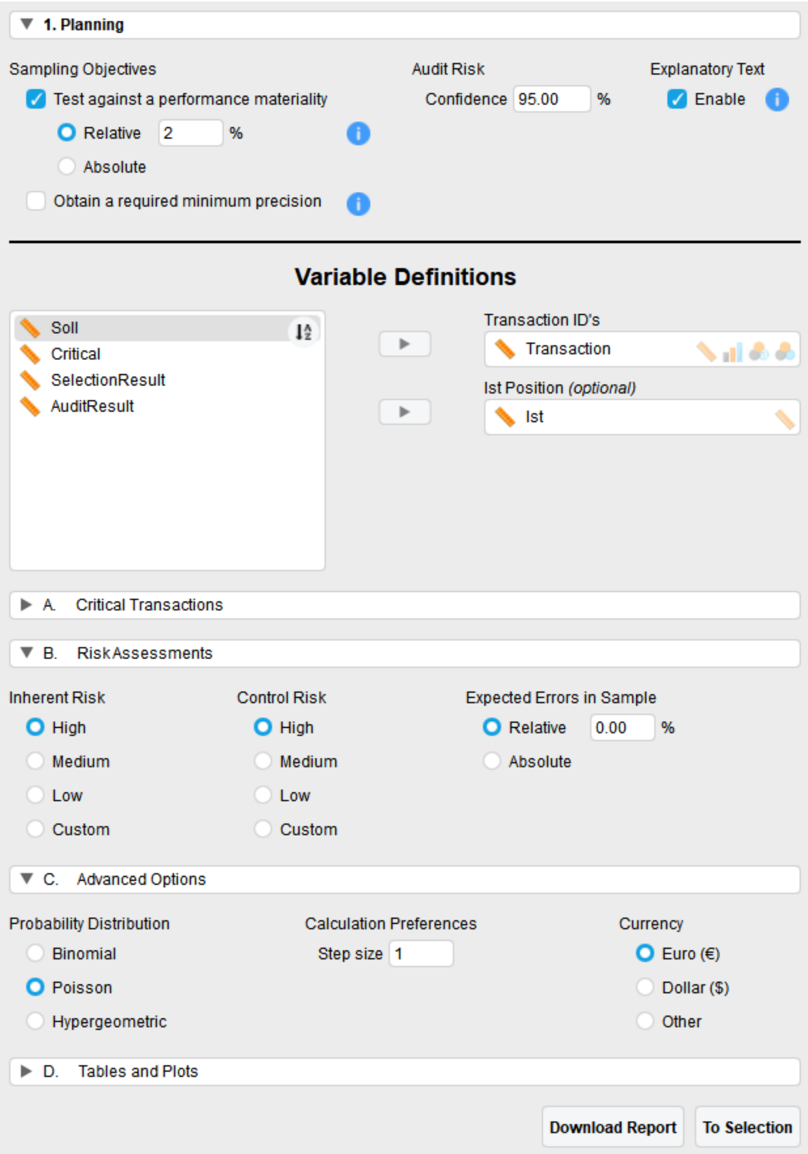


Figure 10: The start of the `Planning` stage in the `Sampling Workflow` analysis.

Options

The following options are associated with the `Planning` stage. Please note that not all options may be featured in the separate analysis.

Section	**Option Name**	**Input Type**	**Output Type**
Efficiency Techniques	Separate known and unknown misstatement*	Checkbox	Calculation
Risk Assessments	Inherent Risk	Radio button	Calculation
	Control Risk	Radio button	Calculation
	Expected errors in Sample	Numeric	Calculation
Prior Information	Prior information*	Drop-down	Calculation
	Expected errors in Sample*	Numeric	Calculation
Advanced Options	Probability Distribution	Radio button	Calculation
	Step size	Numeric	Calculation
	Currency	Radio button	Cosmetic
Tables and Plots	Descriptive statistics for Ist values	Checkbox	Table
	Implicit sample induced by prior distribution*	Checkbox	Table
	Description of prior and expected posterior distribution*	Checkbox	Table
	Expected posterior odds*	Checkbox	Table
	Expected Bayes factor*	Checkbox	Table
	Distribution of Ist values	Checkbox	Plot
	Compare required sample sizes	Checkbox	Plot
	Implied distribution of errors	Checkbox	Plot
	Implied prior distribution*	Checkbox	Table

** Only available in the Bayesian sampling workflow.*

Default Output

The table below highlights the default output from the `Planning` stage, that is, a table containing information about the sampling objectives and the required sample size for those objectives.

Performance materiality	Inherent risk	Control risk	Detection risk	Expected errors	Required sample size
1%	100%	100%	5%	0.000	300

Note. The required sample size is based on the Poisson distribution (λ = 3).

Stage 2: Selection

The purpose of the `Selection` stage is to statistically select a number of sampling units from the population such that their inclusion probabilities are known. Sampling units can be individual transactions (records) or individual monetary units. The sampling units are assigned an individual inclusion probability according to the selection method.

Interface

Figure 11 shows the graphical user interface for the `Selection` stage.

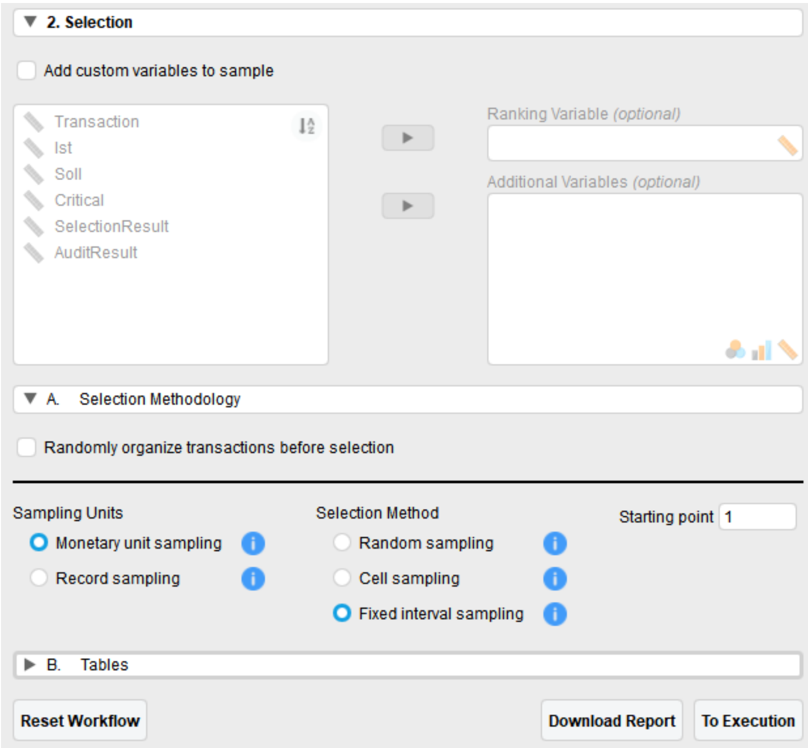


Figure 11: The interface of the `Selection` stage in the `Sampling Workflow` analysis.

Options

The following options are associated with the `Selection` stage. Please note that not all options may be featured in the separate analysis.

Section	**Option Name**	**Input Type**	**Output Type**
Selection Methodology	Randomly organize transactions	Checkbox	Calculation
	Sampling Units	Radio button	Calculation
	Selection Method	Radio button	Calculation
	Starting point / seed	Numeric	Calculation
Table	Display selected transactions	Checkbox	Table
	Descriptive statistics of selected transactions	Checkbox	Table

Default Output

The table below highlights the default output from the `Selection` stage, that is, a table containing information about the selection method used and the resulting sample size.

Selected sampling units	Selected transactions	Selection value	% of population value	Interval
300	178	€549883.17	91.45%	€2004.31

Note. Sampling unit 1 is selected from each interval.

Stage 3: Execution

In the `Execution` stage you will be asked in what way you would like to annotate your sample. Upon providing column names for the selection output and the (to be filled) audit results, the `Execution` stage shows a window in which you can annotate your sample with its audited values.

Interface

Figure 12 shows the graphical user interface for the `Execution` stage. Please note that, due to the manual nature of this part of the workflow, it is not featured in a separate analysis.

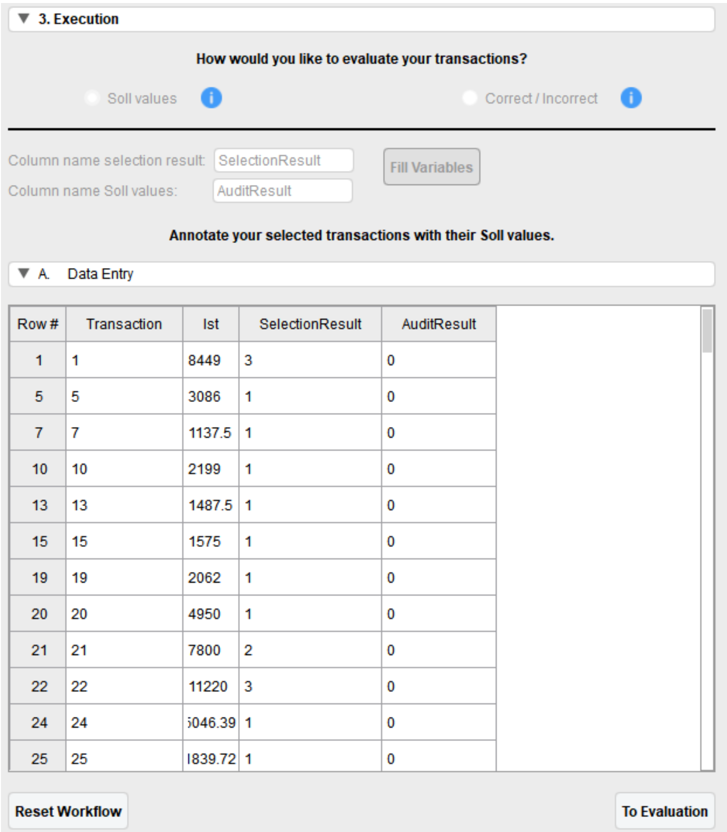


Figure 12: The interface of the `Execution` stage in the `Sampling Workflow` analysis.

Options

The following options are associated with the `Execution` stage.

Section	Option Name	Input Type	Output Type
	How would you like to annotate your observations?	Radio button	Annotation
	Column name selection result	String	Annotation
	Column name Soll values	String	Annotation
Data Entry	—	Numeric	Annotation

Stage 4: Evaluation

The purpose of the `Evaluation` stage is to infer the total misstatement in the population on the basis of the audited sample.

Interface

Figure 13 shows the graphical user interface for the `Evaluation` stage.

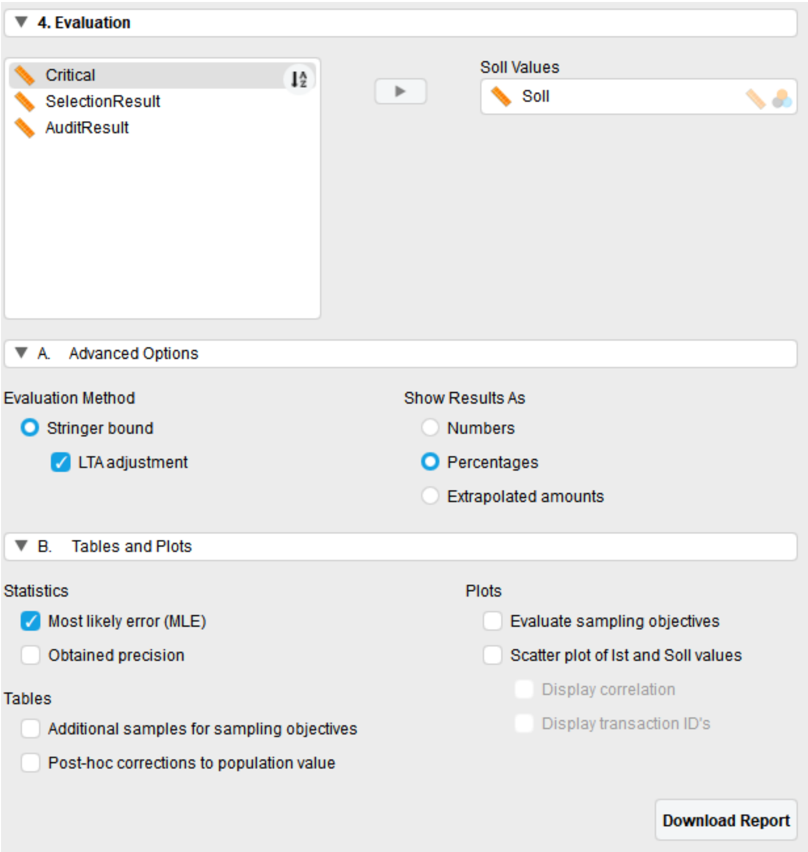


Figure 13: The interface of the `Evaluation` stage in the `Sampling Workflow` analysis.

Options

Section	**Option Name**	**Input Type**	**Output Type**
Advanced Options	Evaluation Method	Radio button	Calculation
	Show Results As	Radio button	Cosmetic
Tables and Plots	Most likely error (MLE)	Checkbox	Table
	Obtained precision	Checkbox	Table
	Additional samples for sampling objectives	Checkbox	Table
	Post-hoc corrections to population value	Checkbox	Table
	Evaluate sampling objectives	Checkbox	Plot
	Scatter plot of Ist and Soll values	Checkbox	Plot

Default Output

The table below highlights the default output from the `Evaluation` stage, that is, a table containing information about the provided sample and the inferences from that sample to the population.

Performance materiality	Sample size	Errors	Total tainting	Most likely error	95% Upper bound
€50000	60	0	€0	€0	€48702.91

Note. The upper bound is calculated according to the Stringer method.

The Sampling Workflow: An Illustrated Example

This example aims to show how the `Audit` module facilitates auditors in their standard audit sampling workflow (hereafter "audit workflow"). In this example of a Classical audit workflow[3], we will consider the case of BuildIt. BuildIt is a fictional construction company in the United States that is being audited by Laura, an external auditor for a fictional audit firm.

[3] For an example of a Bayesian version of this scenario, see the `jfa` vignette at `https://koenderks.github.io/jfa/articles/v1auditWorkflow.html`.

Throughout the year, BuildIt has recorded every transaction they have made in their financial statements[4]. Laura's job as an auditor is to make a judgment about the fairness of these financial statements. In other words, Laura needs to either approve or not approve BuildIt's financial statements. To not approve the financial statements would mean that, as a whole, the financial statements contain errors that are considered material. This means that the errors in the financial statements are large enough that they might influence the decision of someone relying on the financial statements. Since BuildIt is a small company, their financial statements only consist of 3500 transactions that each have a corresponding recorded book value. Before assessing the details in the financial statements, Laura already tested BuildIt's computer systems that processed these transactions and found that they were quite reliable.

[4] The data set is available in JASP via `Open` → `Data Library` → `7. Audit` → `Testing for Overstatements`.

In order to draw a conclusion about the fairness of BuildIt's recorded transactions, Laura separates her audit workflow into four stages. First, she will plan the size of the sample she needs to inspect from the financial statements to make a well-substantiated inference about them as a whole. Second, she will select the required sample from the financial statements. Third, she will inspect the selected sample and determines the audit value (true value) of the transactions it contains. Fourth, she will use the information from her audited sample to make an inference about the financial statements as a whole. To start off this workflow, Laura first loads BuildIt's financial statements into JASP.

Setting up the Audit

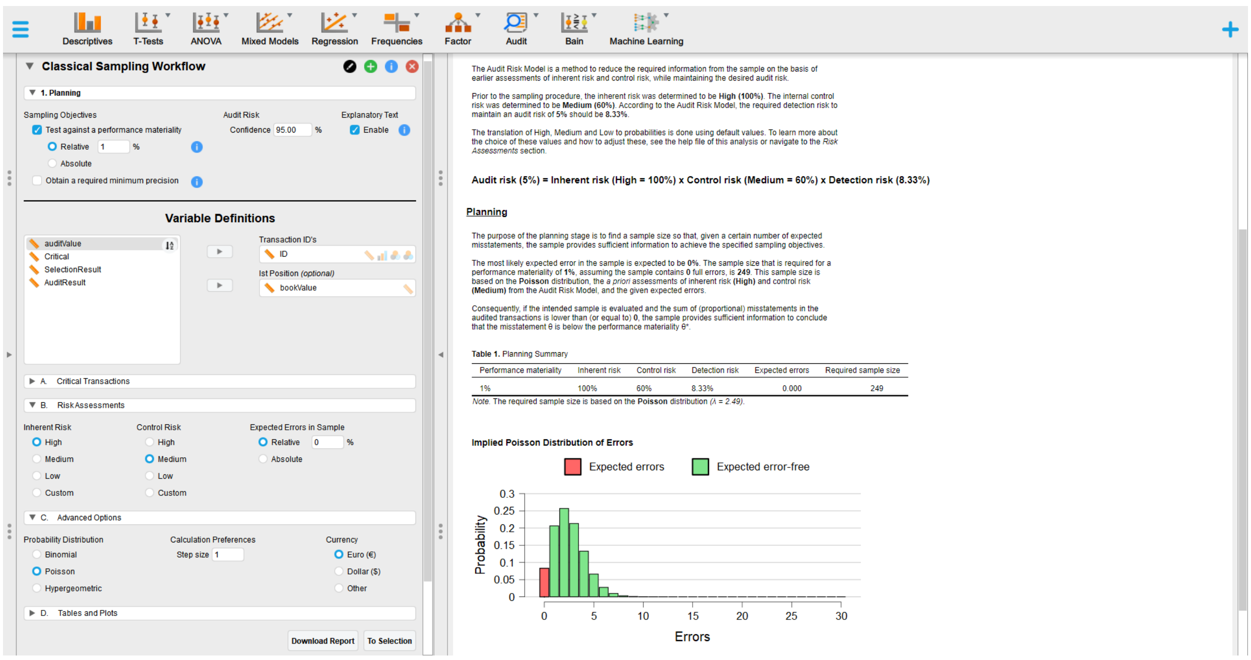
In statistical terms, Laura wants to make a statement that, with 95% confidence, the maximum misstatement in the financial statements is lower than what is considered material. She therefore determines the performance materiality, the maximum tolerable error in the financial statements, to be 1%. Based on last year's audit at BuildIt, where the maximum error turned out to be zero, she expects zero errors in the sample that she will audit. Laura can therefore reformulate her statistical statement as that she wants to conclude that, when zero errors are found in her sample, she can conclude with 95% confidence, that the misstatement in the population is lower than the materiality of 1%.

Usually the auditor judges inherent risk and control risk on a three-point scale consisting of low, medium, and high. Different audit firms handle different standard percentages for these categories. Laura's firm defines the probabilities of low, medium, and high respectively as 50%, 60%, and 100%. Because Laura performed testing of BuildIt's computer systems, she assesses the control risk as medium (60%).

Stage 1: Planning

Laura enters the `Sampling Workflow` in the `Planning` stage, where she first enters the performance materiality of 1% and leaves her confidence level at 95%. She makes sure to enable the ☐ **Explanatory text** so that an annotated report is created by the `Sampling Workflow` analysis. Next, she drags the variables **ID** and **bookValues** to the corresponding fields in the interface. She adjusts the assessment of control risk from ○ **High** to ○ **Medium** .

The default output shows that, provided Laura will encounter zero errors in her sample, she needs to audit 249 transactions from the population of 3500 transactions to reduce the audit risk sufficiently enough to conclude that the population does not contain misstatements larger than 1%.

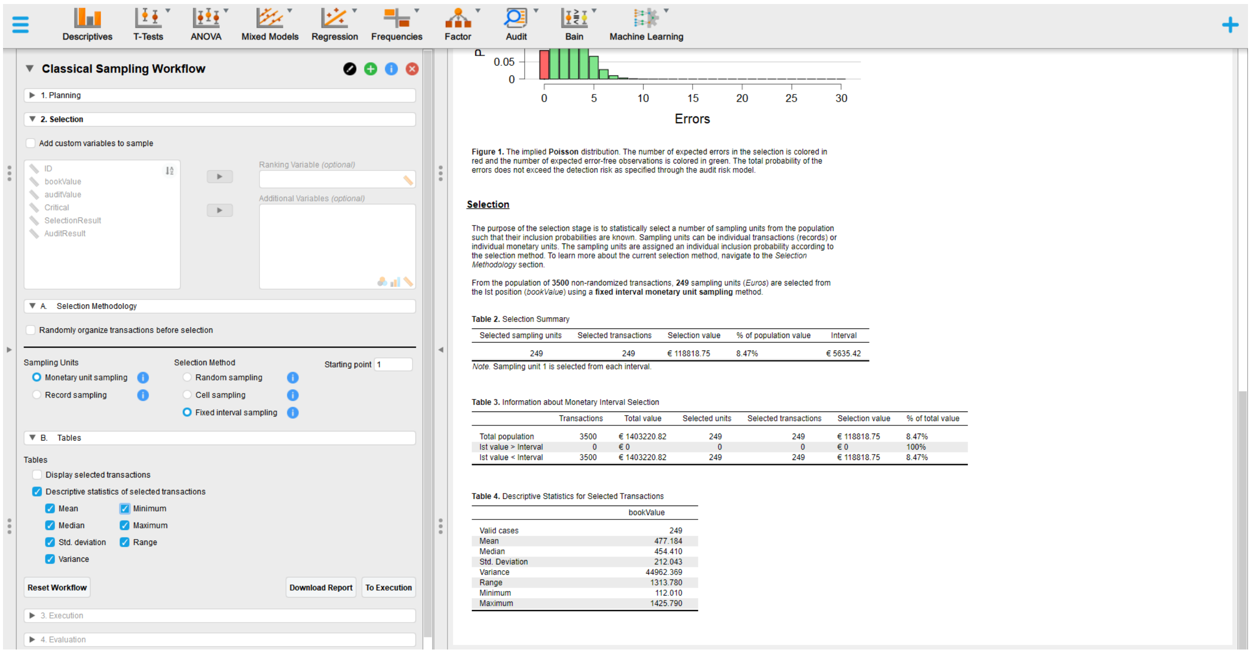


Laura continues to the `Selection` stage by clicking the **To Selection** button in the bottom-right corner of the interface.

Stage 2: Selection

Because Laura has entered a variable in the **Ist Position** field, in the `Selection` stage, the option ○ **monetary unit sampling** is automatically selected for her under **Sampling Units**. The default selection method is a ○ **Fixed interval sampling** method, but this can be changed in the corresponding section.

After looking at the default output, Laura finds that she does not need to adjust any options in this stage.

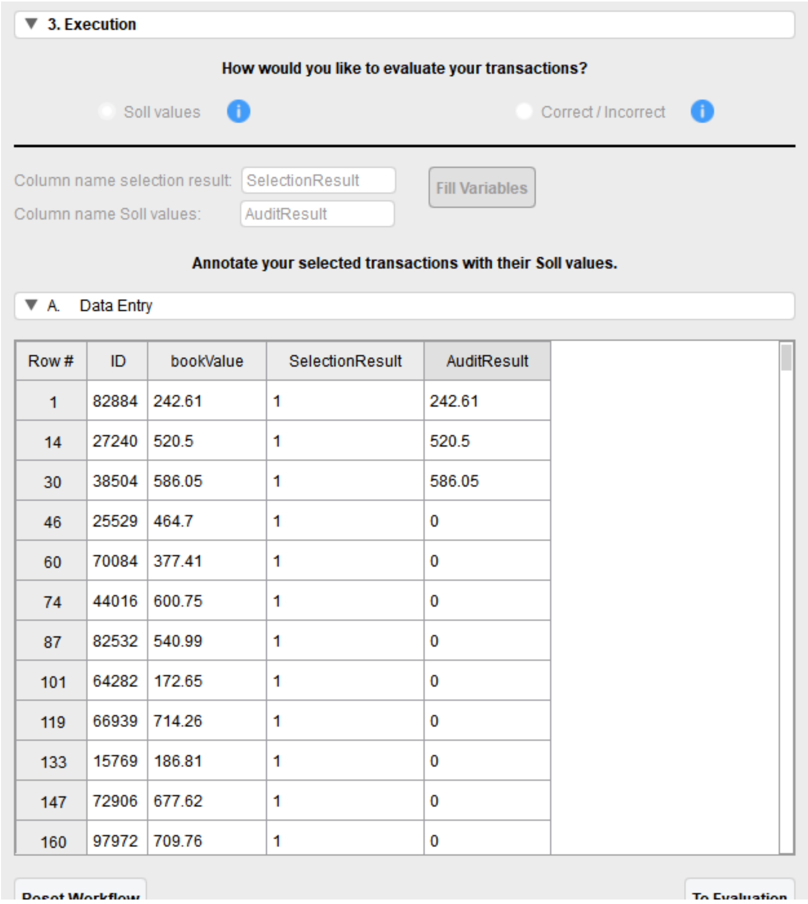


Laura continues to the `Execution` stage by clicking the **To Execution** button in the bottom-right corner of the interface.

Stage 3: Execution

In the execution phase Laura will be asked to enter two column names. The first column (**Selection result**) stores how often a euro of a transaction is selected for the sample. In the second column (**Soll values**) you can enter the audited amounts of the transactions yourself. The names of these columns are automatically filled in, but you can change them according to your own preference. Click on **Fill Variables** to enter the values of these variables for your data set[5]. After this, the **Data Entry** section opens. Here Laura can enter the audit values of the sample.

[5] Are you using an example file in which the Soll values are already known? Then you can proceed directly to the evaluation step without entering the audited amounts.



Laura continues to the `Evaluation` stage by clicking the **To Evaluation** button in the bottom-right corner of the interface.

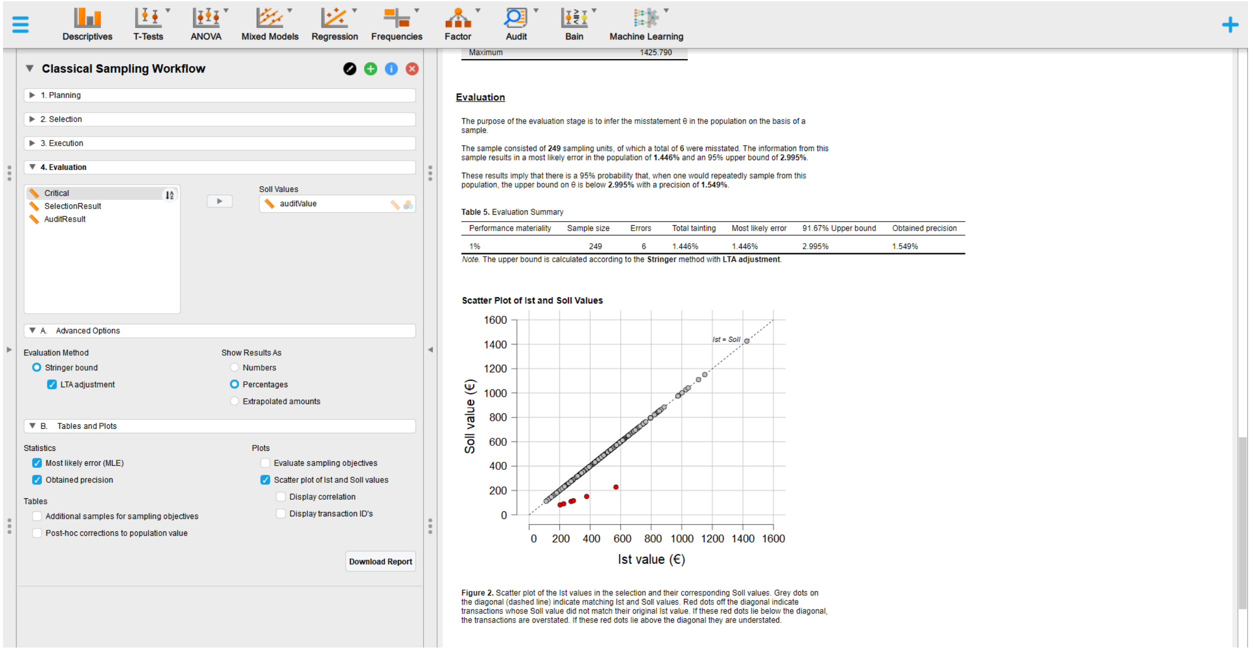
Stage 4: Evaluation

In the `Evaluation` stage, you can drag the column you created and filled in with the audit values to the **Soll Values** field in the interface. The inference will be automatically performed according to the options selected in the previous stages.

Under the **Advanced Options** section, Laura can adjust the method of evaluation (if possible) and the numerical form of the results. Furthermore, tables and plots that clarify the statistical results can be requested under the **Tables and Plots** section.

From the default output, Laura finds out that in her sample of 249 transactions, 6 transactions contained an partial error. This information gives her a most likely error of 1.446% with an 91.67% upper bound of 2.995%, and a precision of 1.549%.

Since the 91.67% upper bound on the misstatement in BuildIt's financial statements is higher than the performance materiality of 1%, Laura cannot conclude that the population as a whole does not contain misstatements lower than 1%. Therefore, she cannot approve BuildIt's financial statements.



Laura finishes the workflow by clicking the **Download Report** button in the bottom-right corner of the interface.

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