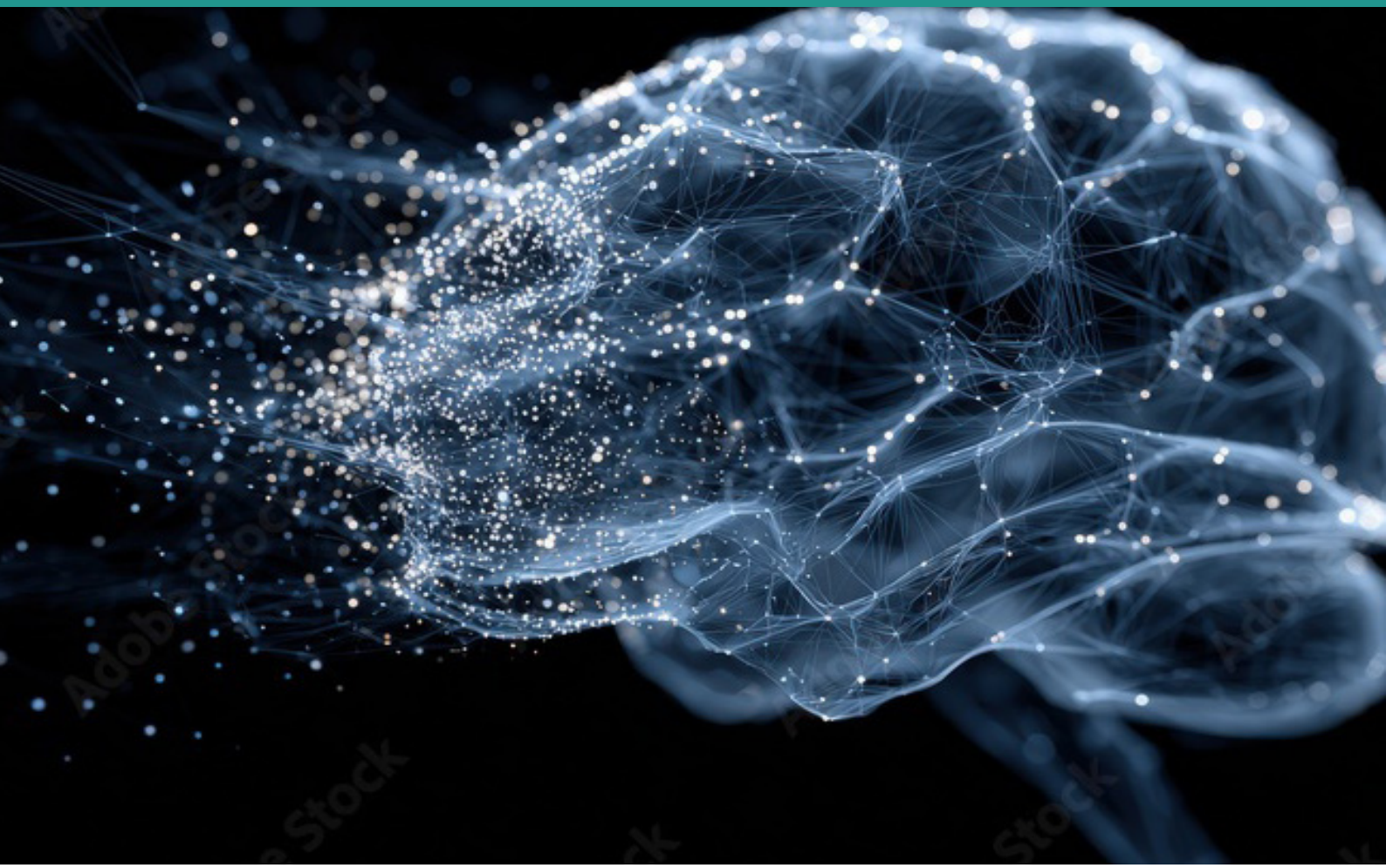
Use of artificial intelligence on audit of the EU Funds (AI4Audit)

Project Summary

Technical Support Instrument

Supporting reforms in 27 Member States



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Outline

- Introduction
- Conceptual Framework
- The Use of AI
- Project Estimation Phases
- Sampling Design
- Predictive Risk
- Main Outcomes
- Recommendations for AAs

Context

AI4Audit revolutionizes the auditing of EU funds by **integrating advanced AI** methodologies, **reducing the burden on human resources and costs** while **improving reliability of conclusions**.

Introduction | Context

Audit of EU Funds

- In Portugal (and EU in general) thousands of **audit activities/procedures operations** are performed annually, which require significant time, human resources and costs.

- The audit work aims to understand the error amount over the expenditure declared to the European Commission (EC).

- The Audit Authority selects and audits a sample of operations and uses that information to project the errors into the expenditure of the whole population.

Introduction | Context

Audit of EU Funds

- The **estimated errors at the programme level have diverse implications** which can involve financial corrections (including corrections of extrapolated errors), the application of flat-rate corrections and/or the need to develop improvement plans.

- It is, therefore, of the utmost importance:
  - **To increase the reliability of the produced estimates, simultaneously simplifying the effort.**

Problems

Traditional audits are time-consuming, costly, and **often inconclusive**, **necessitating** a **shift** to more efficient, **AI-driven methodologies**.

Introduction | Problems

Audit of EU Funds' Problems

- Highly **time** consuming.
- Requires significant specialized **human resources**.
- Generates high **costs** and **burdens** over beneficiaries.
- The **deadlines** for reporting are very demanding.
- **Results** of the currently used sampling-based audit methodologies can be **inconclusive***, leading to the need of **additional audit work** nearing regulatory deadlines.

* Inconclusive results indicate the lack of adequate certainty of whether the population contains substantial amount of error.

Idea

By leveraging artificial intelligence, **AI4Audit seeks to enhance the reliability and efficiency of audits**, ensuring **more accurate detection of errors**.

Introduction | Idea

Idea

- Develop new methodologies based on data science, including artificial intelligence to **estimate/predict the occurrence and amount of errors and their impacts** in **operational programmes** supported by European Funds in Portugal.

- Use these **innovative methodologies to:**
  - **Substitute or complement traditional audit of operations** exclusively based on sampling.
  - **Reduce significantly the human effort in audit, simultaneously increasing the reliability** of the conclusions.
  - **Increase the assurance of the audit work** and contribute to improving the overall management and control systems in Portugal.

Introduction | Ambition Summary

General Objectives

- ✓ **Increase** the **efficiency, effectiveness** and **proportionality** EU Funds **auditing**.
- ✓ Ensure the **preparedness of IGF – Audit Authority**, while reducing its workload and beneficiaries' burden.

Addressing the Objectives

- ✓ Development of novel methodologies using **data science** and **artificial intelligence** to **detect irregularities**, **risks**, cases of **suspicion of fraud**, ultimately supporting the final audit opinion.

Further Ambition

- ✓ Support the design of a **new data governance, audit framework and management strategy**, considering the adopted AI model's techniques.
- ✓ Guarantee the produced **estimates' reliability and** the **audit opinion**, while **simplifying the efforts** required to produce such results.

Specific Objectives

Innovative **AI** methodologies will **replace traditional sampling, ensuring reliable estimates with reduced human effort and costs.**

Introduction | Specific Objectives

SO1

✓ Develop innovative methodologies to replace or complement the traditional sampling-based auditing of operations.

✓ Ensure the reliability of the estimates produced, simplifying the effort in terms of human resources and costs spent to produce them.

SO2

SO3

✓ Avoid the occurrence of inconclusive audit results, which lead to the need of additional audit work.

✓ Increase the proportionality of audits, reducing the burden on beneficiaries generated by partially substituting audits by analytical activities with minor impact on the beneficiaries.

SO4

Introduction | Specific Objectives

SO5

✓ Ensure the application of methodologies supported by computational power that can eliminate or significantly reduce the effort currently made by human resources.

✓ Induce a better use of data already available in the public administration and promote the adaptation of a new audit framework and management strategy, following the developed methodologies.

SO6

SO7

✓ Disseminate the results through scientific communication, dissemination actions, and workshops to national entities and the European Commission.

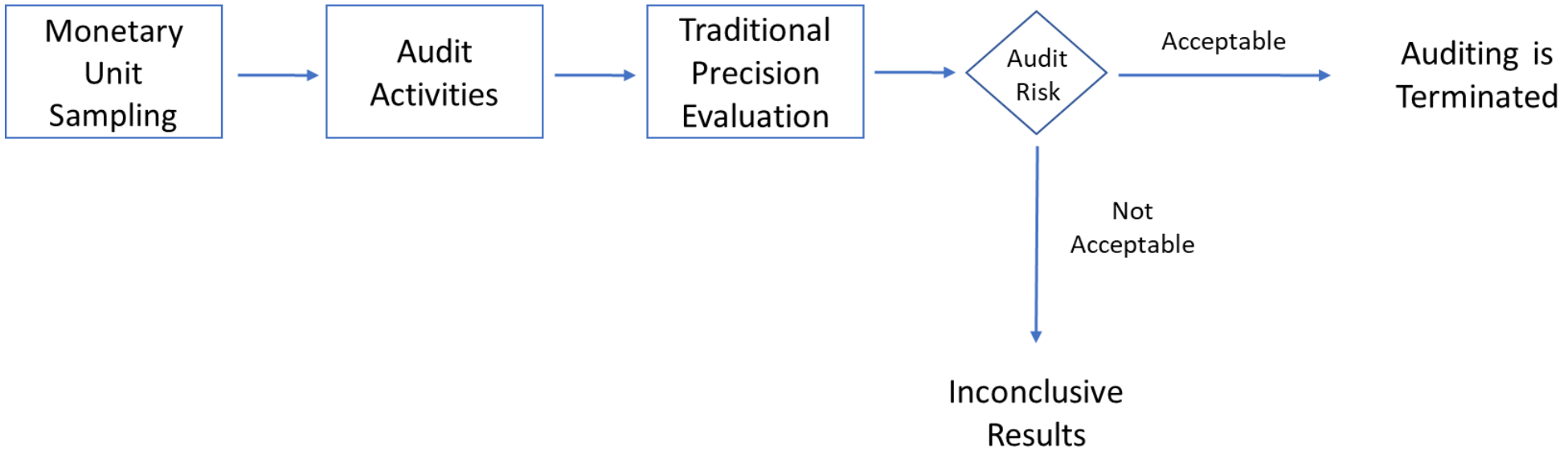
✓ Ensure training and knowledge transfer actions, allowing relevant entities (involved in errors' evaluation and detection of fraud suspicion) to benefit from the results achieved and further implement the recommendations that come from the project.

SO8

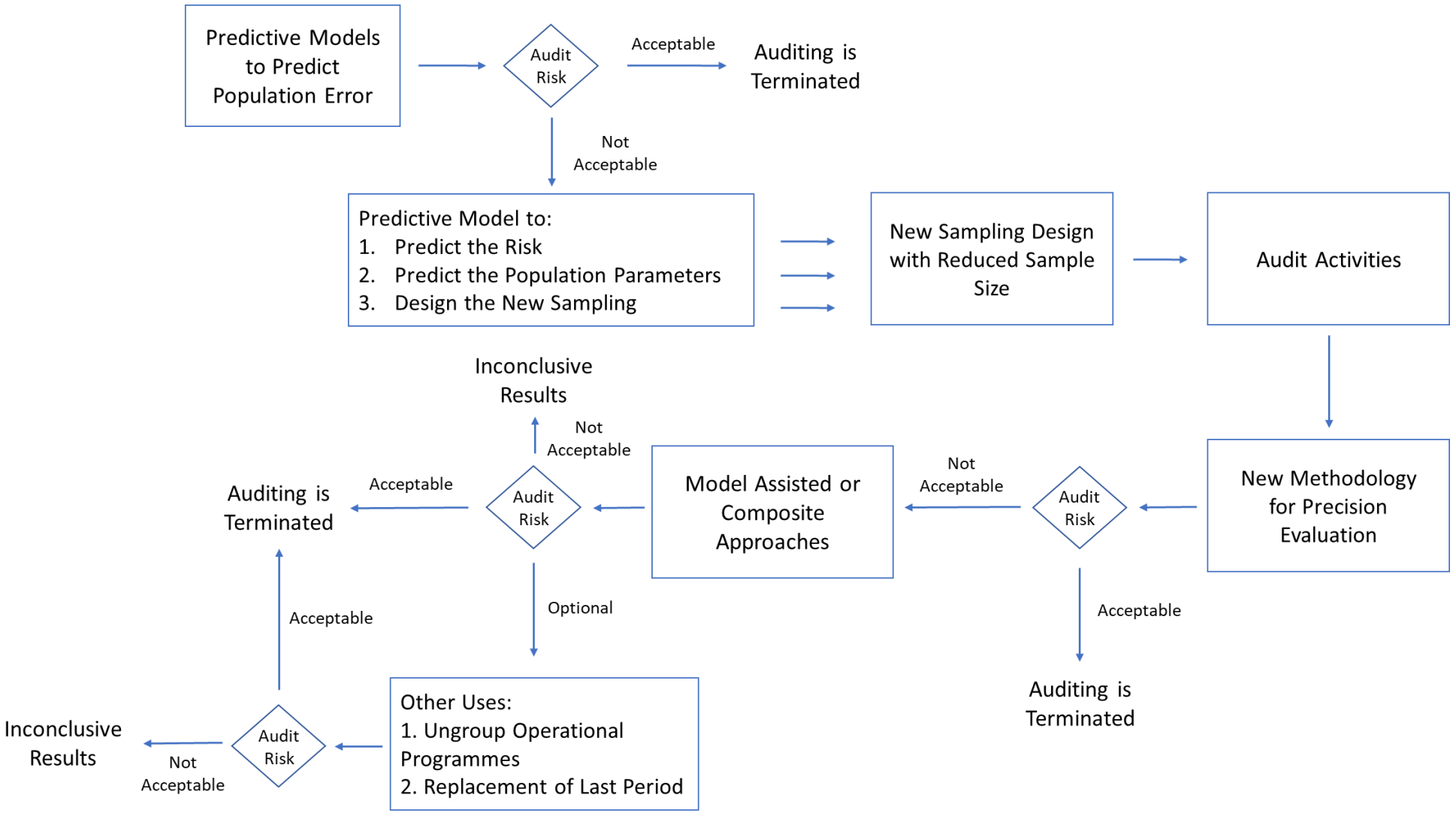
Conceptual Framework

The new AI-based framework offers a **more robust, efficient**, and **reliable approach** to auditing EU funds.

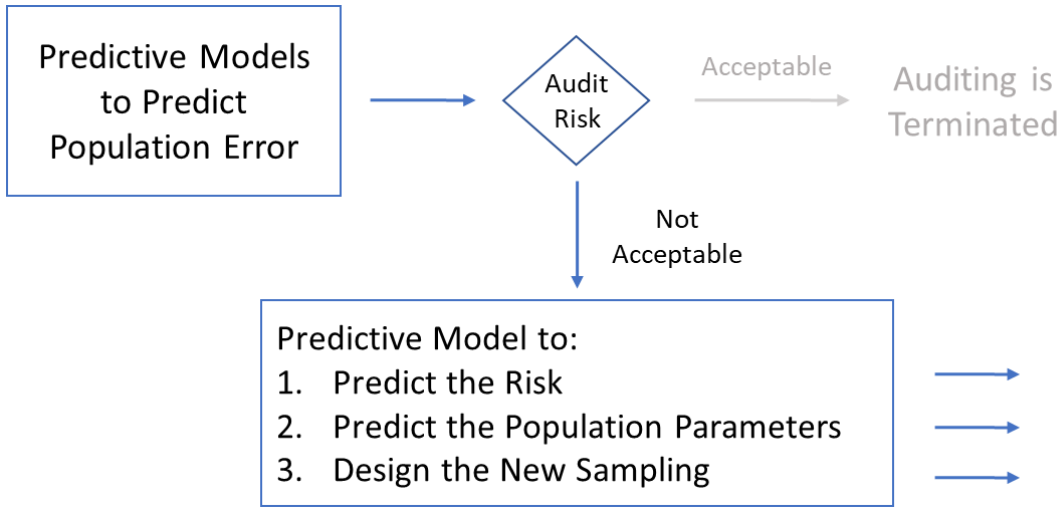
Current Conceptual Framework



Conceptual Framework | Proposed



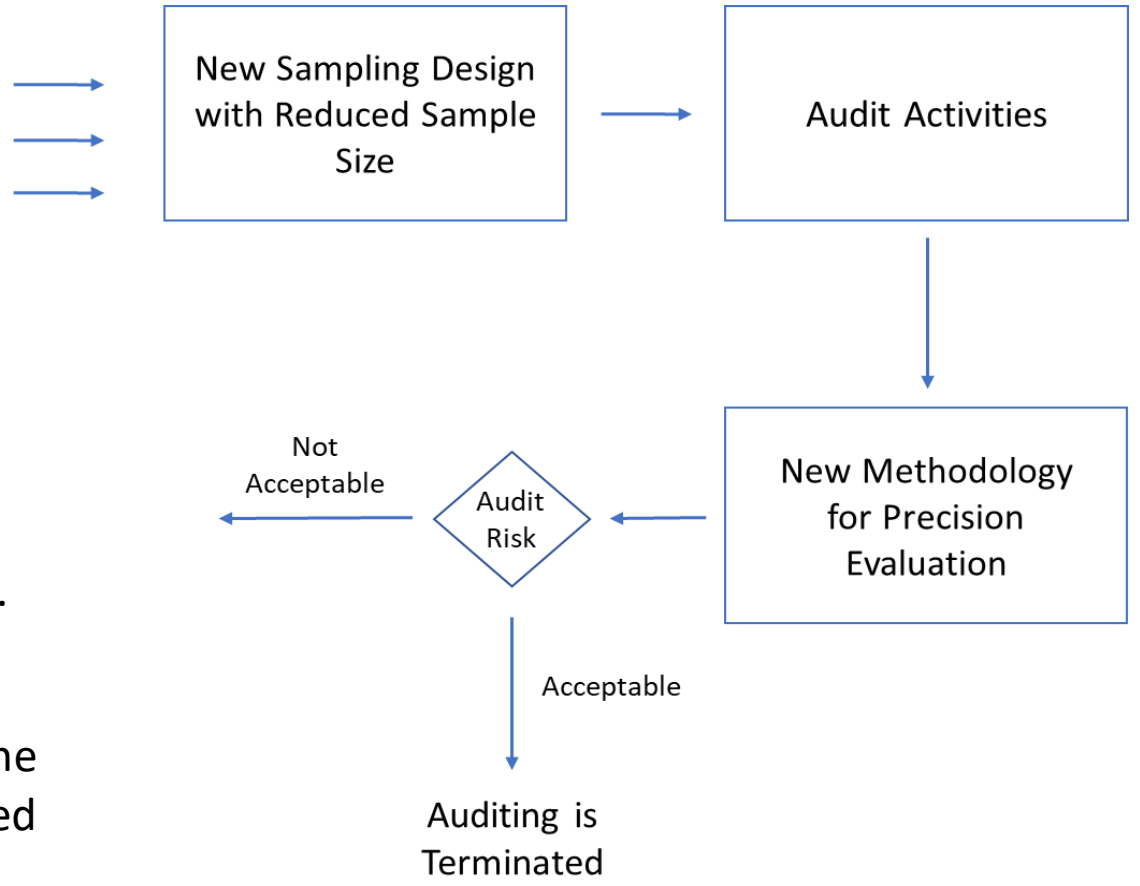
Conceptual Framework | Proposed



Using previously audited operations, predictive models are trained to:

1. **Predict the error rate** of the operations → Used for the population error rate estimation
2. **Measure the risk** of an operation → Used for a new more efficient sampling design

Conceptual Framework | Proposed



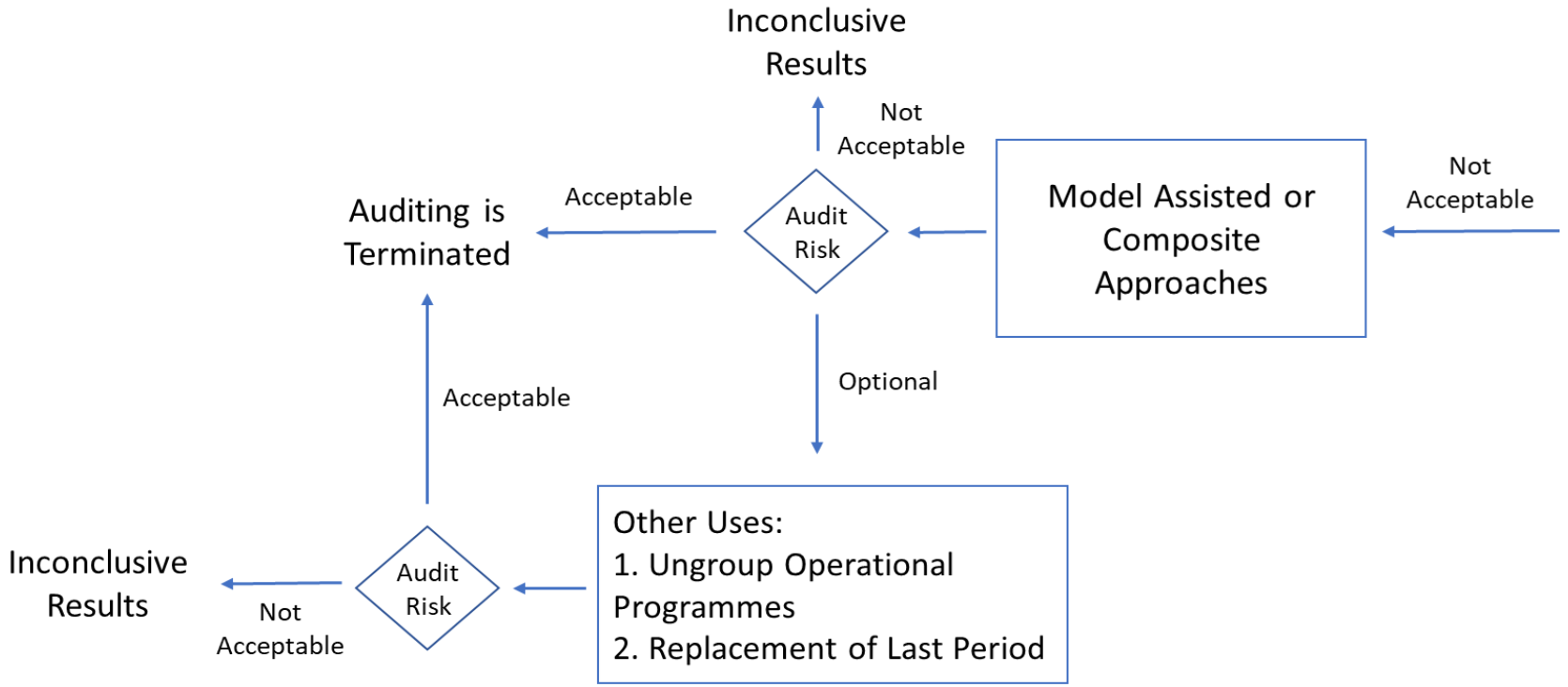
- Sampling design chooses operations based both on risk and monetary value.
- Then, audit activities proceed as normal.
- To evaluate the precision of the estimates, a new method was proposed to allow for samples below 30 units.

Conceptual Framework | Proposed

Combination of traditional estimates with AI-derived predictions to find the Population Error, with improved precision.

Optional paths the AA may take include:

- Obtain **error rate estimates for subgroups of operational programmes**
- **Fully Replace the last period of audit** by predictions given by the predictive model

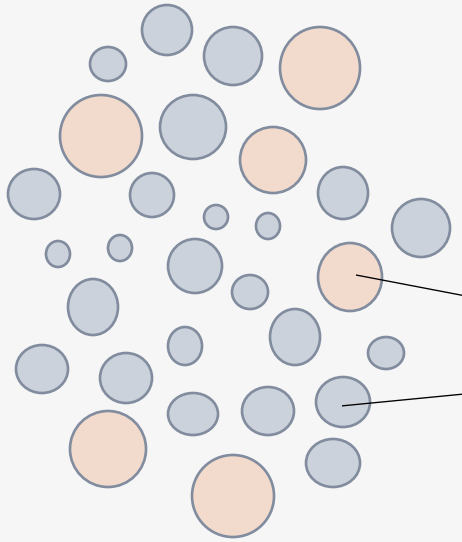


The use of AI

Two distinct predictive models are used in the proposed methodologies.

Training data

Population
(all operations)



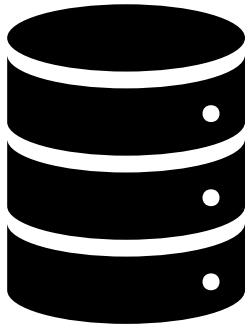
- Operations that were selected to be **audited**
- **Known** (available) **error rate** score
- This set of operations are known as **sampled operations**

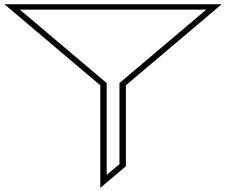
- Operations that were **not** selected to be **audited**
- **Unknown error rate** score

Goal: Use **predictive models** to derive the **error rate** and the **risk of error of each operation of the population.**

Training data

90+ initial features





Feature Selection

Predictive **models** were developed and tested to derive the **error rate** and the **risk of error of each operation of the population.**

Risk Model

Training Process

- Uses previously audited (or sample) **operations,** for which the **error occurrence is available,** to train the predictive model.
- The error occurrence indicates if the operation contains error or not.

Application

New population operations **include** the **same variables of the sample**

Operations
Op 1
Op 2
…
Op n

Fed into → **Predictive algorithm** → To Predict →

Error Risk score for each operation

Error Risk
23%
76%
…
5%

The risk model provides the probability of each operation having error rate different than zero.

Error rate estimates

Training Process

- Uses previously audited (or sample) **operations,** for which the **error rate is available,** to train the predictive model.
- The error rate indicates the amount of error an operation has.

Application

New population operations **include** the **same** explanatory **variables**

Operations
Op 1
Op 2
…
Op n

Fed into → **Predictive model** → To Predict →

Error Rate score for each operation

Error Rate
0.8%
25%
…
0%

Transformed into →

Global error rate considering all operations

Population Error Estimate

E.g. 1.2%

Composite Approach

Improving the precision of total error estimation

IGF AA

Population's Error Rate

Combined with

Error Rate predictiveModels

Population's Error Rate Estimation

=

New Population Error Estimates

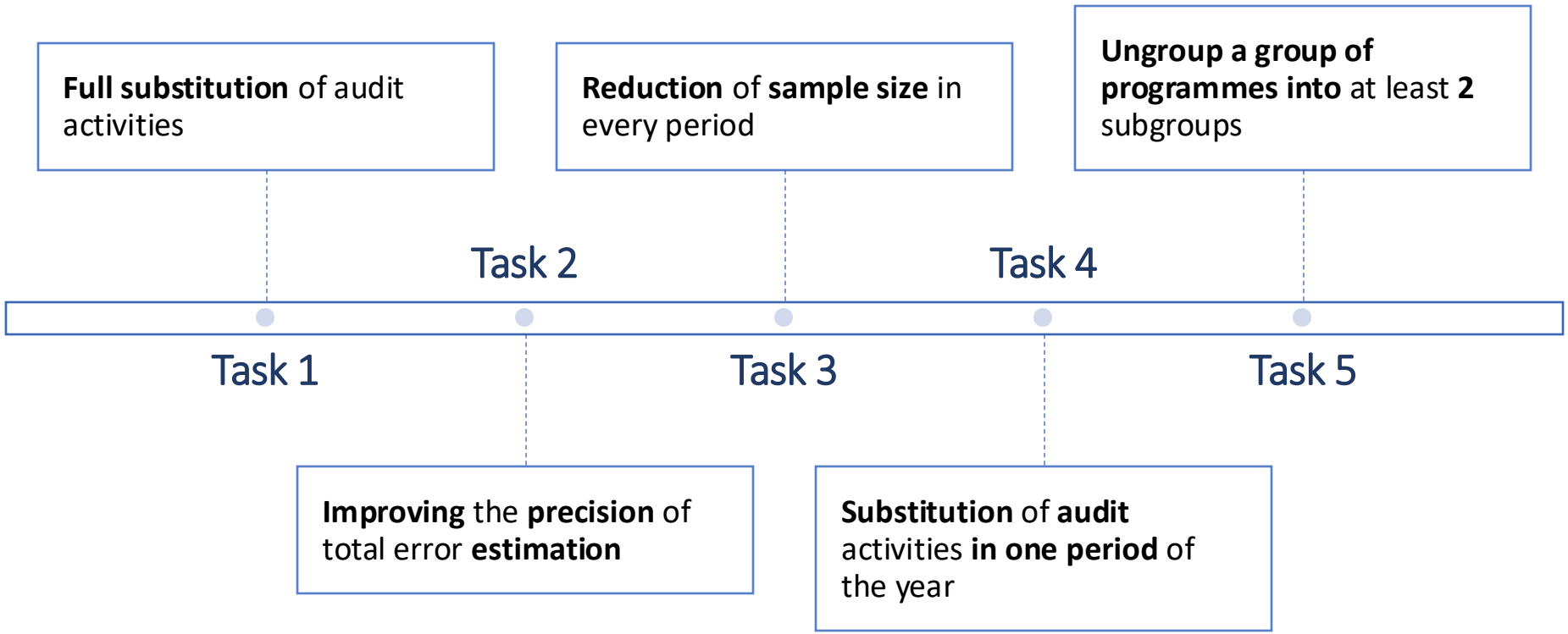
by combining two independent projections

Combining both approaches can improve **the quality of the population's error projection**.

Project Estimation Phases

AI4Audit's phased approach aims to optimize audit processes at every step.

Project's Estimation Phases

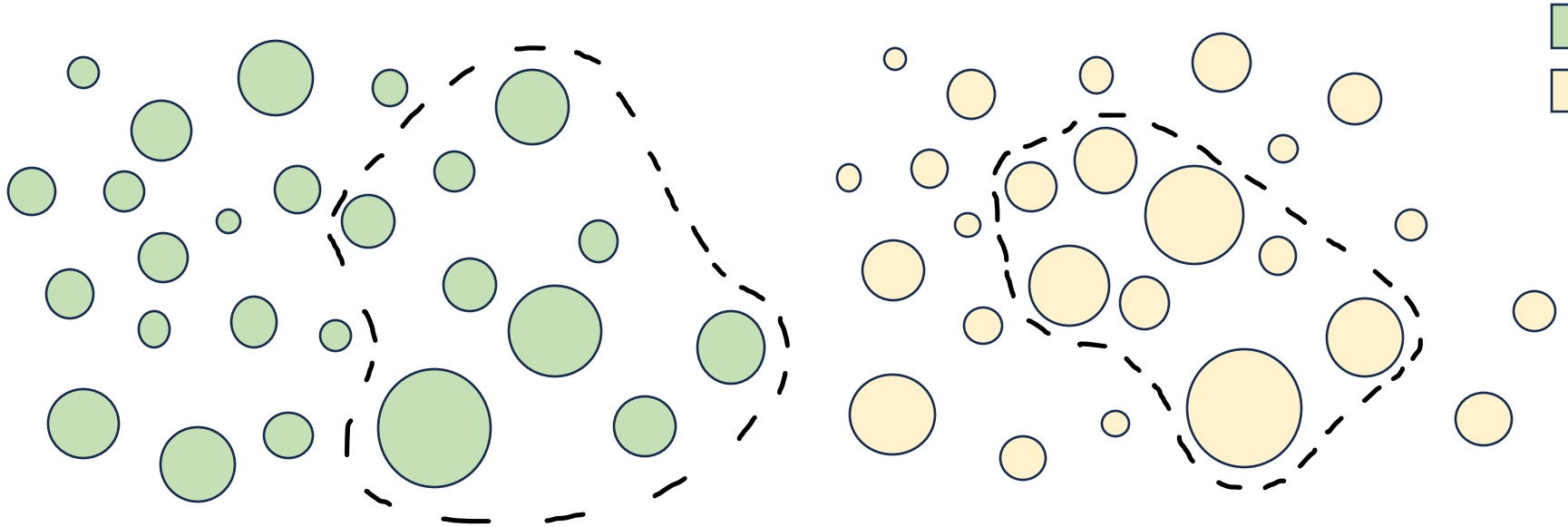


Sampling Methodology

Monetary Risk Sampling (MRS) introduces a novel approach, **combining monetary value and risk to enhance precision and reduce sample sizes**.

Sampling Design

Monetary Unit Sampling (MUS)	Monetary Risk Sampling (MRS)
Probability of selection is given by the **book value** of the **operation**	Probability of selection is given by the **book value** and **error risk** of the **operation**

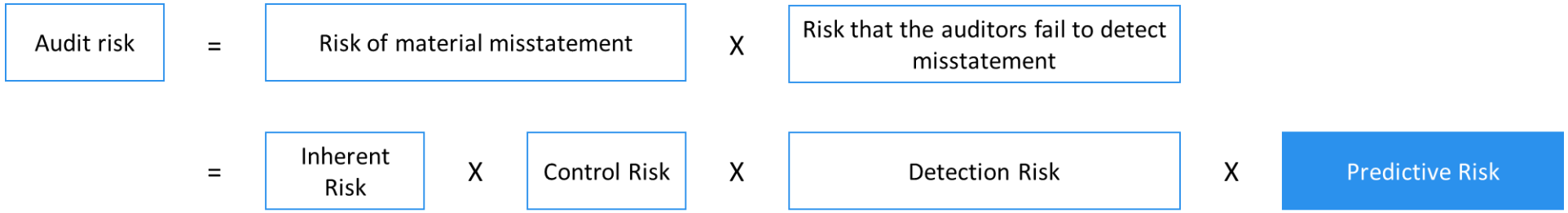


Predictive Risk

The introduction of the **predictive risk into the audit risk model** allows the **reduction of the audit effort**.

Predictive Risk

Context

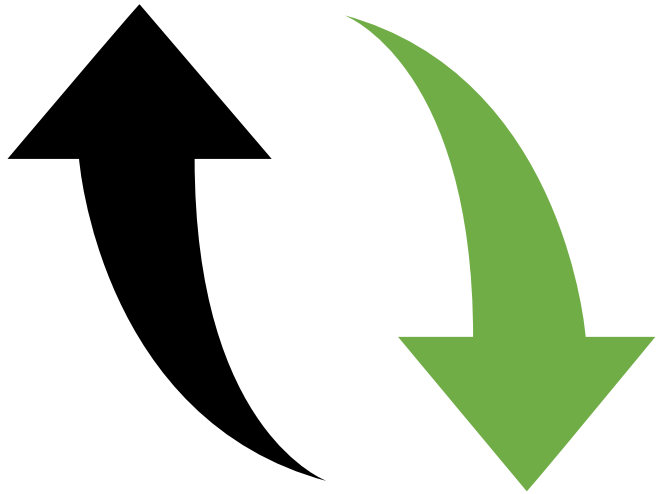


- The **audit risk** is the **risk** that the **population contains** relevant **errors** (material misstatement), and they are **not detected**. The objective is to have no more than 5% audit risk.
- The **detection risk** is the **risk auditors do not identify** material **errors** in the population. If we want to decrease this risk, the number of operations audited need to increase.
- The **predictive risk** is the **risk of the error not being detected by the predictive model**. It makes it possible to reduce the auditing effort by increasing the detection risk, while assuring the same audit risk.

Predictive Risk

How much is it possible to **loosen the detection risk**, given the **introduction of the predictive risk**?

Given a **Predictive Risk** of	The **Detection Risk** can be	Resulting in a **reduction of the number of audited operations** by
100%	**30%**	**Baseline**
70%	**43%**	**42%**
40%	**75%**	**91%**
≤30%	**100%**	**100%**



For both funds, a predictive risk below 30% was achieved

Outcomes

This proof of concept suggests the possibility of significant **improvements in the precision** of results, as well as **reduction of audit effort,** by using AI capabilities at several steps.

Main Outcomes

1. Model predictions are compatible with traditional estimates

- ✓ Models' predictions are compatible with traditional estimates, as they are contained in the historical confidence intervals.
- ✓ Model precision competes with the current precision based on substantive testing.
  - ✓ Tests showed an improvement in precision for all years and funds using the predictive models.

Main Outcomes

2. Precision and sample size gains

- ✓ New composite approaches for error estimation allow to improve precision by around 35% both for ERDF/CF and ESF, for the same audit effort.
- ✓ Allow to fully eliminate situations of inconclusive results for ERDF/CF and ESF.
- ✓ Plausible to reduce the sample size by up to 60%, without precision deterioration.
- ✓ Possible to fully eliminate audit activities in the last period of the year, substituting them for the model prediction, while maintaining a similar (or even improved) precision.

Main Outcomes

3. Possibility to ungroup operational programmes

- ✓ Achieved conclusive results for two separate groups of operational programmes (OPs), avoiding results' contamination due to OPs with high errors.
- ✓ It is possible to project the errors with adequate precision, without increasing the sample size.

Main Outcomes

4. Monetary Risk Sampling (MRS) design offers an alternative to MUS

- ✓ Introduced a new sampling method that considers the monetary value and risk of the operation (instead of only considering the monetary value) in the process of sample selection.
- ✓ MRS offers significant precision gains or, alternatively, sample size reductions (compared to MUS). Gains in precision are between 21% and 28% and sample reduction between 38% and 52%.
- ✓ The method avoids that only large expenditure operations are selected to the sample and tends to select operations with high monetary risk.

Main Outcomes

5. A new complete framework was achieved

- ✓ The probability of reaching inconclusive results is lower with the new audit framework (than with the current audit framework).
- ✓ The final complete framework allows to perform the audit work with sample sizes as low as 20 items.
- ✓ Although such a small sample size may result in a departure from normal distribution, a new bootstrap estimation method was created, which can be applied in the context of any type of distribution and sample size.

Impact

At the current accounting year, 2023/2024, **IGF will start using the proposed methodologies** as part of its audit plan.

This proof of concept establishes the **base to replicate the new audit methodologies** to other audit authorities.

The proposed framework shows the **potential for expansion to other Member States**, provided the necessary pre-processing and model development tasks are performed.

The EC Joint Audit Directorate for Cohesion **(DAC) approved the expansion of this proof of concept** to a new group of Audit Authorities. A significant number of AAs from different **Member States have shown interest in integrating this follow-up**.

Recommendations for AAs

Given the work developed, some recommendations can be made in the following areas:

- Information Systems
- Models Application
- Evaluation and Implementation

Recommendations for AAs

Information Systems

R01

✓ Establishment of an integrated information system and the creation of a comprehensive data warehouse comprising all the auxiliary data essential for the predictive models.

✓ Integrate the sample extraction process within the same IS

R02

R03

✓ Avoid the need to import and export data between different platforms

Recommendations for AAs

Model's Application

R04

- ✓ Focus should shift towards leveraging predictive models for sample selection, resorting to composite estimation when other methods yield inconclusive results, and exploring the option of population disaggregation when necessary.

- ✓ Consider selective audits for certain periods of the year, substituting the auditing activities by the model's predictions, could optimize efficiency.

R05

R06

- ✓ Use predictive approaches as tool to reduce the audit effort (reducing sample sizes) and increase assurance, instead of fully eliminating audit activities, in a first stage of application.

Recommendations for AAs

Evaluation and Implementation

R07

- ✓ Auditors should understand how the methodologies work. This includes the grasp on machine learning models, the data specifications needed for the successful implementation, and how all the mentioned steps are combined. Hence, fostering workshops and training sessions will ensure all stakeholders are well-versed in the project's methods, conclusions, and its potential impact.

- ✓ Set a guideline to periodically update predictive models, including exceptional updates whenever there is information about events with potential structural impact.

R08

R09

- ✓ Ongoing validation of model prediction, including predicted risks is necessary to ensure that the predictive strategy maintains coherent with reality.

Thank you

This project is funded by the European Union via the Technical Support Instrument (TSI) and implemented by Nova IMS, in cooperation with the European Commission Directorate-General for Structural Reform Support (DG REFORM)

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