AIML4OSS – Synthetic data (WP13)

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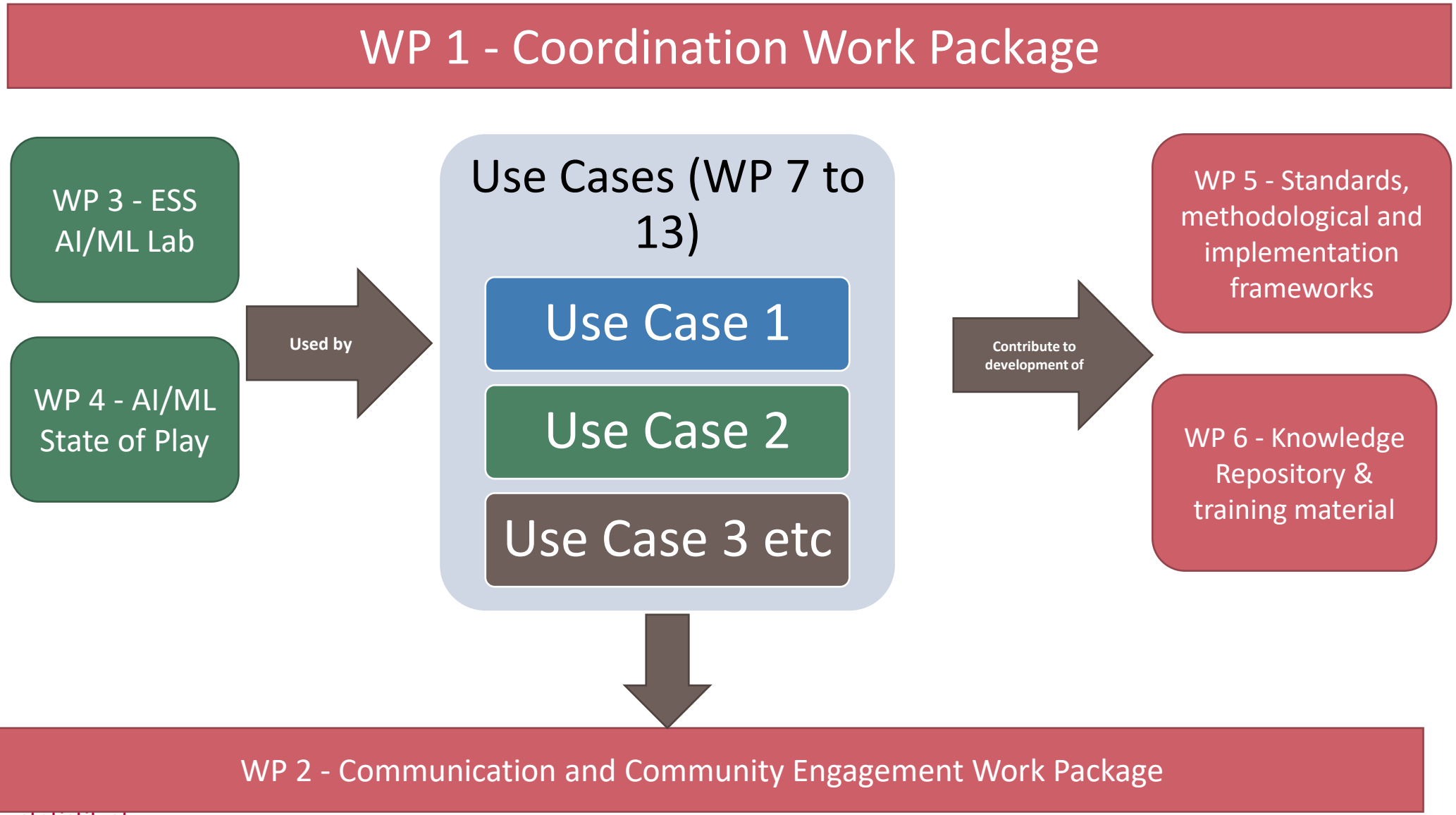
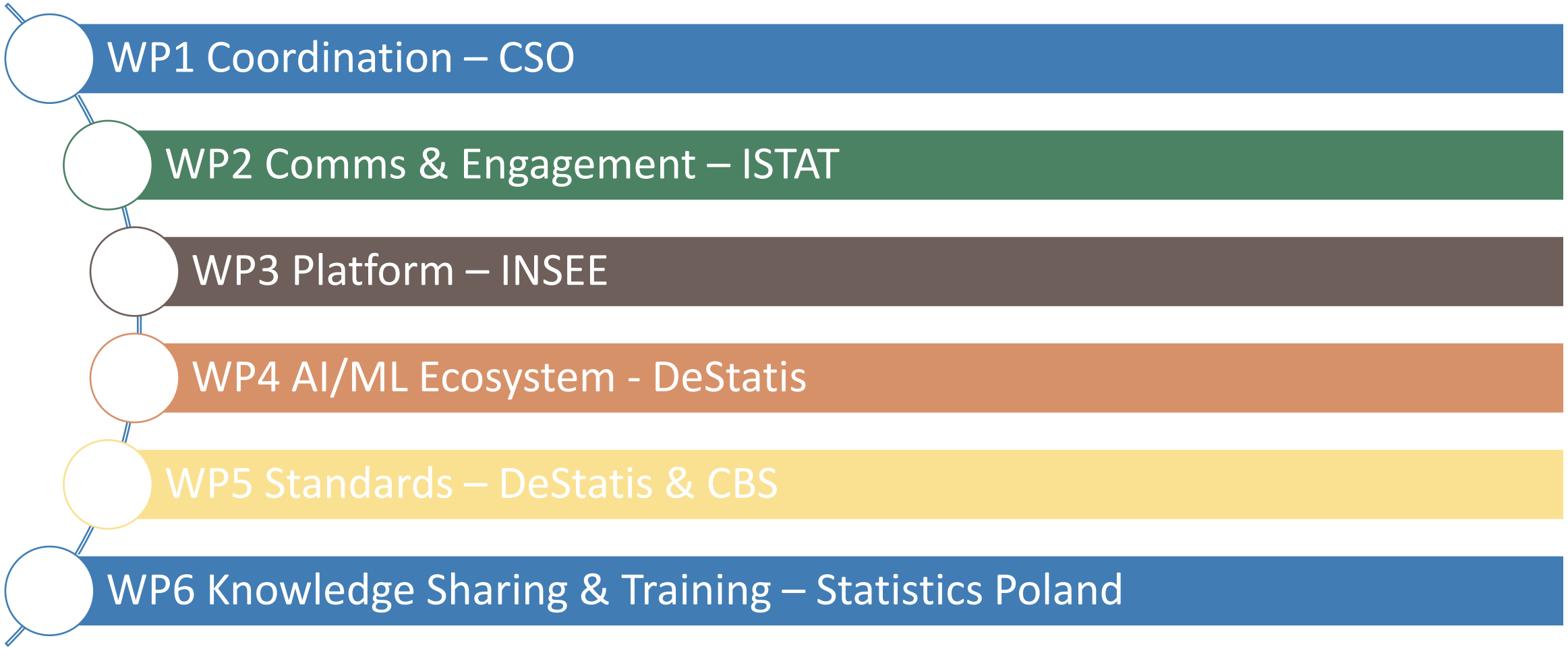
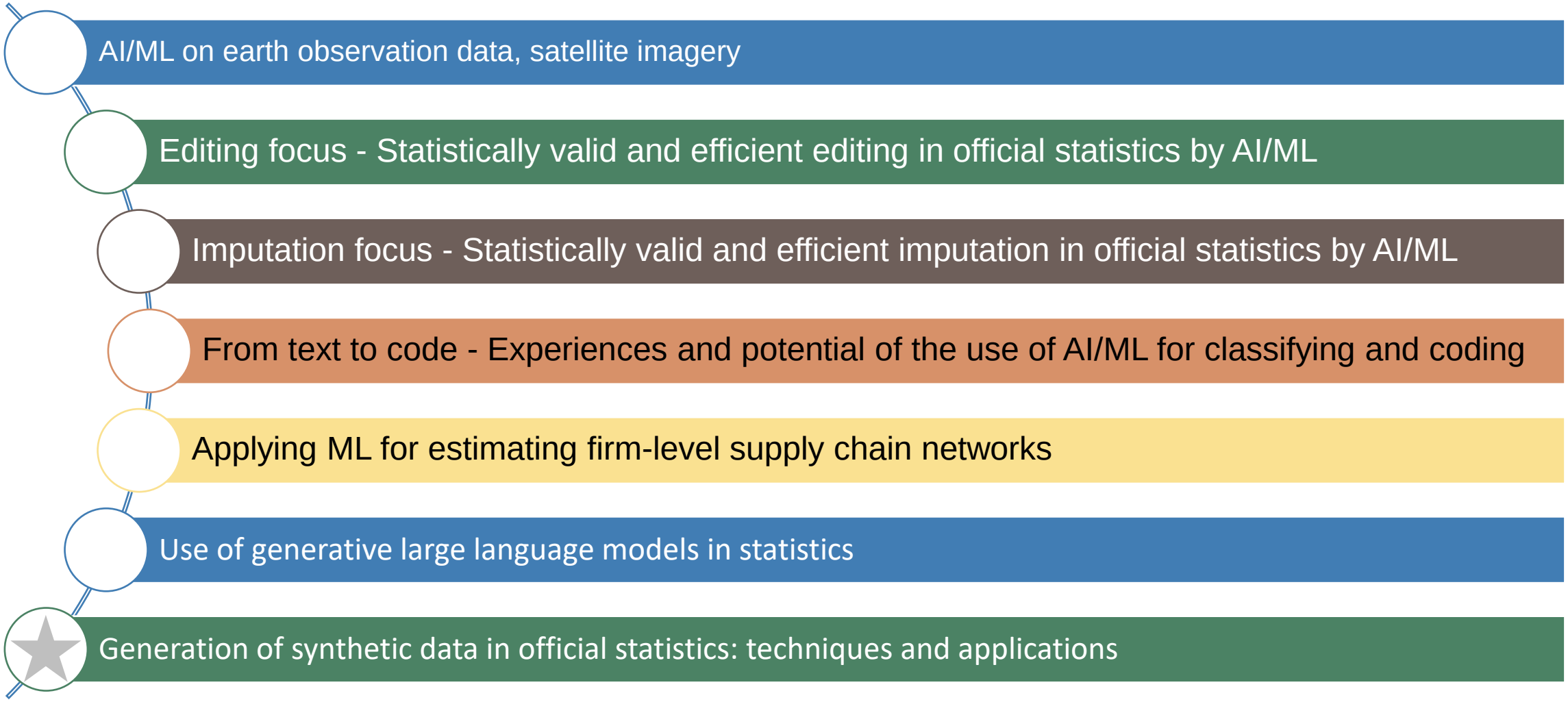
Project


WP 1 - Coordination Work Package
WP 3 - ESS AI/ML Lab
WP 4 - AI/ML State of Play
Used by
Use Cases (WP 7 to 13)
Use Case 1
Use Case 2
Use Case 3 etc
Contribute to development of
WP 5 - Standards, methodological and implementation frameworks
WP 6 - Knowledge Repository & training material
WP 2 - Communication and Community Engagement Work Package

Overarching Work Packages



Use Cases


AI/ML on earth observation data, satellite imagery
Editing focus - Statistically valid and efficient editing in official statistics by AI/ML
Imputation focus - Statistically valid and efficient imputation in official statistics by AI/ML
From text to code - Experiences and potential of the use of AI/ML for classifying and coding
Applying ML for estimating firm-level supply chain networks
Use of generative large language models in statistics
Generation of synthetic data in official statistics: techniques and applications

Who's Involved? In WP13

An Phríomh-Oifig Staidrimh Central Statistics Office

Istat Istituto Nazionale di Statistica

INSTITUTO NACIONAL DE ESTATÍSTICA STATISTICS PORTUGAL

DESTATIS wissen.nutzen.

INSEE

Statistics Poland

INE Instituto Nacional de Estadística

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Work

- Investigate different AI/ML algorithms to generate synthetic data in official statistics domains
- Balancing utility and privacy
- Quality assessment: comparisons of the statistical properties, distributions, and performance metrics

- We will use the Onyxia environment (in SSPcloud provided by INSEE)

- Currently, we are collecting methods for privacy and utility assessment and to generate synthetic data in different proof-of-concepts

Purpose of Synthetic Data – first draft structure

- **Structural data set** = Software Development/Testing data set
  - Preparatory file before access to secured use file
- **Public use file**, e.g. for educational pruposes – main statistical features
- **Scientifc use file** - to gain insights in a specific reseach area
  - Special purpose scientific use file -
- **A perfect "twin"** of the reality.
  - All possible statistical analysis can be covered.
  - ML model training

Utility metrics categories – proposal by Destatis (based on Drechsler et al. 2024)

- Fit-for-purpose utility
  - First impression of the quality of the synthetic output
    - E.g. Plausibility checks, graphical evaluation of the distributions
- Global utility
  - Compare original data with protected data (distribution similarity)
    - E.g. Propensity score (can a model distinguish between original and synthetic)
- Outcome-specific utility
  - Measure utility for specific analyses
    - E.g. Comparison of GLM coefficient for a specific model

„Synthetic does not mean the data is safe“ Privacy measure - discussion

- Can privacy be measured with „only“ the original and the synthetic data as input?
- If not what kind of information is needed on the model/methodology?

- **Attack model based methods**, e.g.,
  - Membership Inference Attacks
  - Attribute Inference Attacks
- **Attribution and Disclosure Risk Metrics**, e.g.,
  - Equivalence Class Attribution Probability
- **Privacy Risk Metrics for Fully Synthetic Data**
  - Replicated uniques
- **Privacy Risk Metrics for Partially Synthetic Data**
  - Expected Match Risk

Methods to generate synthetic

- Statistical and Rule-Based Methods
- Machine Learning and Deep Learning based Methods
- Privacy-Preserving Frameworks
  - E.g. DP-safe ML or synthpop

- Deep Learning: Transformer, Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs)

Next steps

- Utility and privacy measure will be assessed if they are easily availabe in R and Python, if not, selected ones will implemented.
- Define the use case each partner is running: statistical domain, methods for generation, risk/utility measures