



An AI-Driven Framework for Automated Statistical Analysis Plan Generation in Clinical Trials

From Unstructured Protocol to Traceable, Compliant Statistical Analysis Plans



Problem Definition

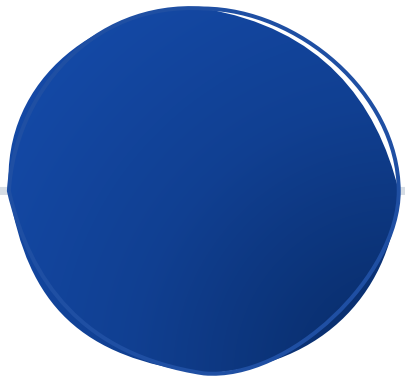
How SAPs Are Traditionally Created

Interpretation ⚠️

Key elements interpreted
and re-written

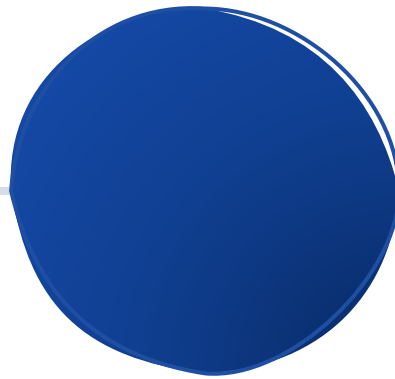
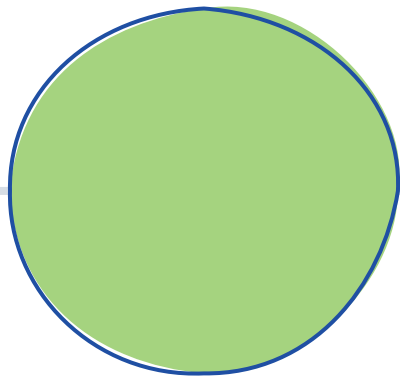
Draft ⚠️

SAP drafted as a
narrative document



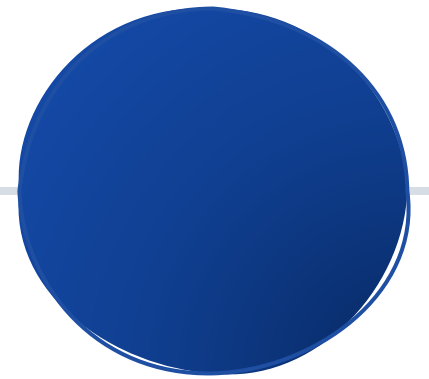
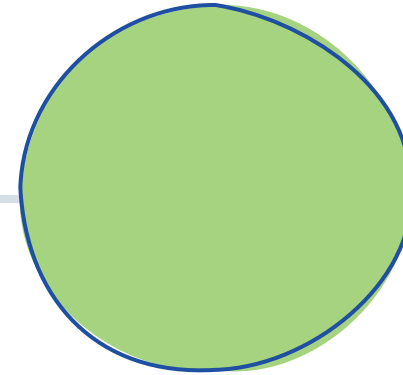
Protocol

Protocol reviewed
manually by
statisticians



Decision ⚠️

Methods selected
based on experience

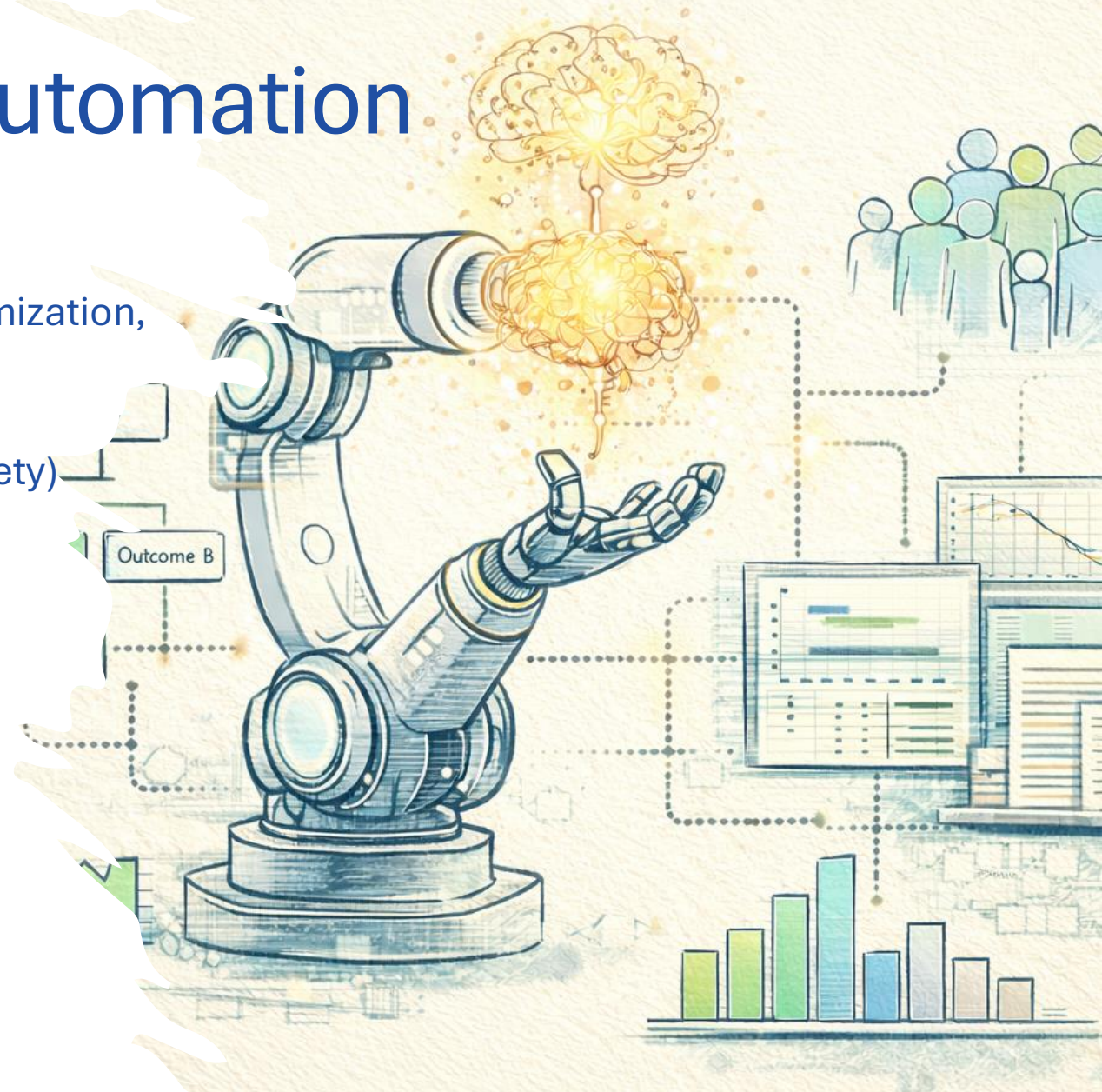


Review

Review feedback
applied iteratively

What Actually Needs Automation

- **Protocol Interpretation**
 - Study design normalization (phase, arms, randomization, visits)
 - Endpoint interpretation and standardization
 - Analysis population definitions (ITT, mITT, PP, Safety)
 - Timepoint and assessment mapping
- **SAP Ontology & Metadata**
 - Endpoint classification (type, estimand, scale)
 - Statistical method selection
 - Missing data strategy
- **SAP Structure & Content**
 - Standardized SAP section framework
 - Decision-driven narrative generation



Requirements and Success Measurements

Key Requirements

- ICH E9 / E9(R1) alignment
- Sponsor / corporate library reuse
- End-to-end traceability
- Deterministic and explainable logic

How We Measure Success

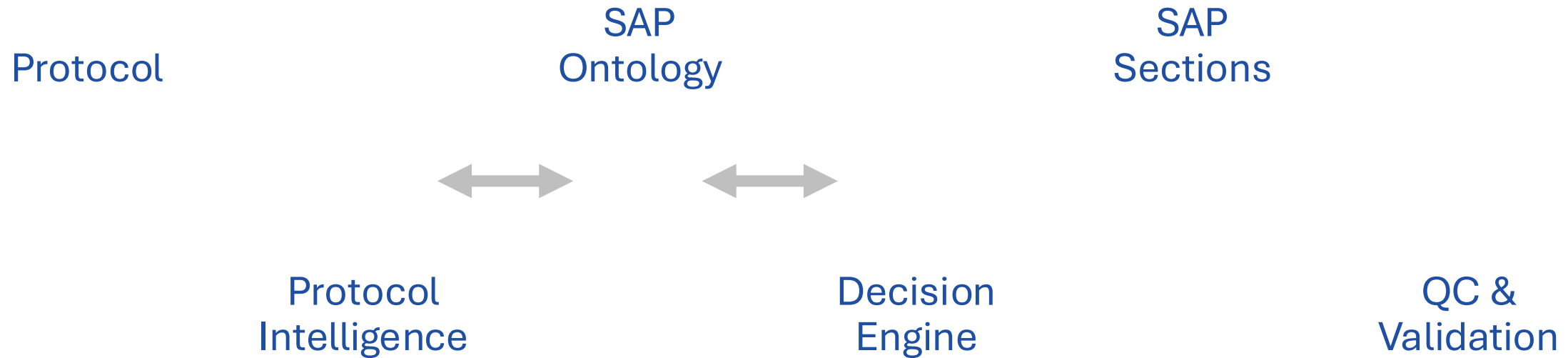
- Significant reduction in SAP authoring time
- Consistent structure across studies
- Clear rationale for every statistical choice
- Faster review and fewer revision cycles
- Easy impact assessment for protocol changes

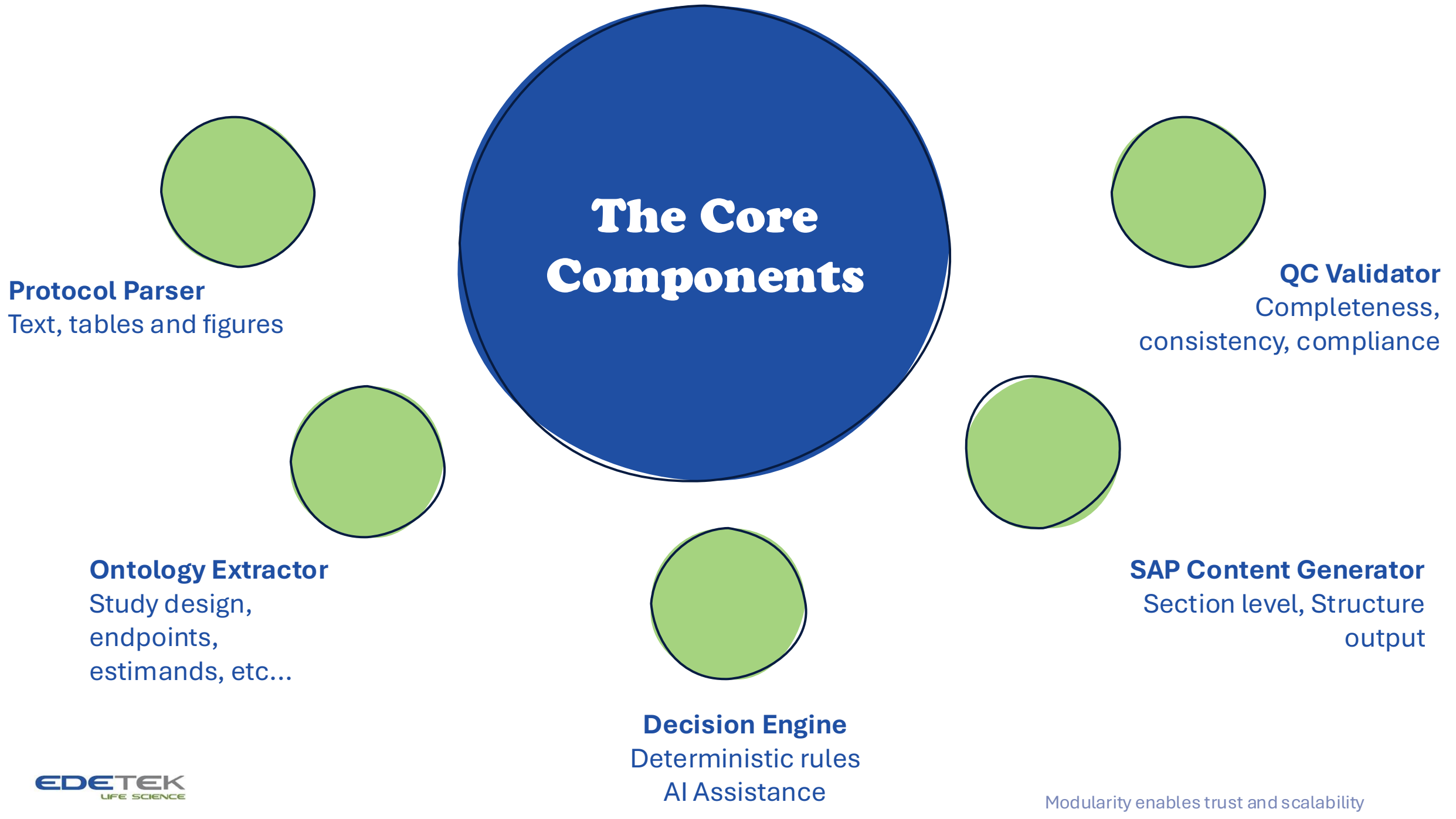




Architecture Overview

End to End Architecture





The diagram features a central blue circle with the text "The Core Components" in white. Surrounding this central circle are five green circles, each representing a different component. Each green circle is accompanied by a title in bold blue text and a description in regular blue text. The components are arranged in a circular pattern around the center.

The Core Components

Protocol Parser

Text, tables and figures

QC Validator

Completeness,
consistency, compliance

Ontology Extractor

Study design,
endpoints,
estimands, etc...

SAP Content Generator

Section level, Structure
output

Decision Engine

Deterministic rules
AI Assistance

Deterministic vs AI Logic

Role of LLMs

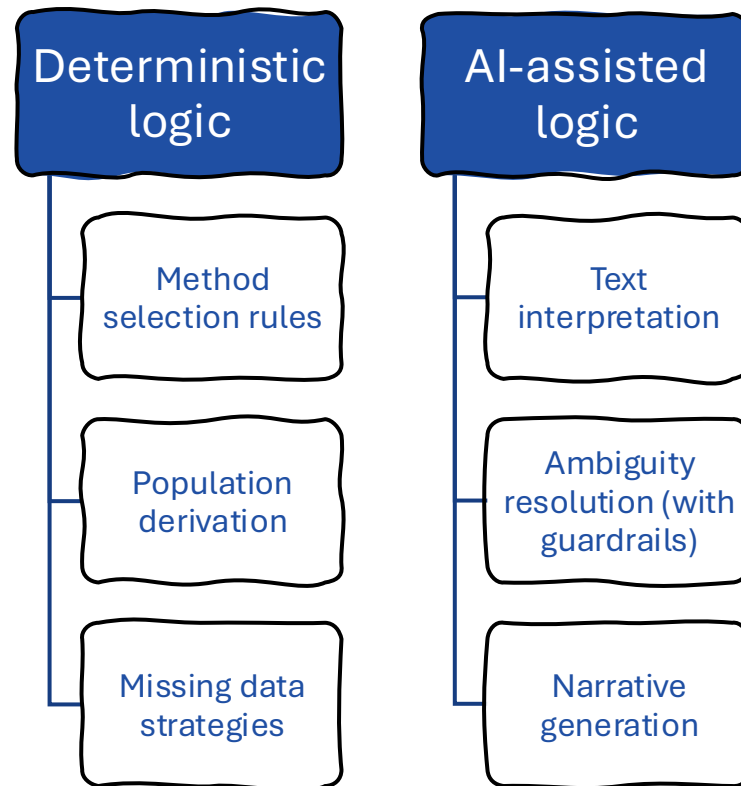
Semantic interpretation of protocol text

Normalization of clinical language

Explanation of decisions in human-readable form

Drafting SAP narrative from structured inputs

Deterministic vs AI Logic



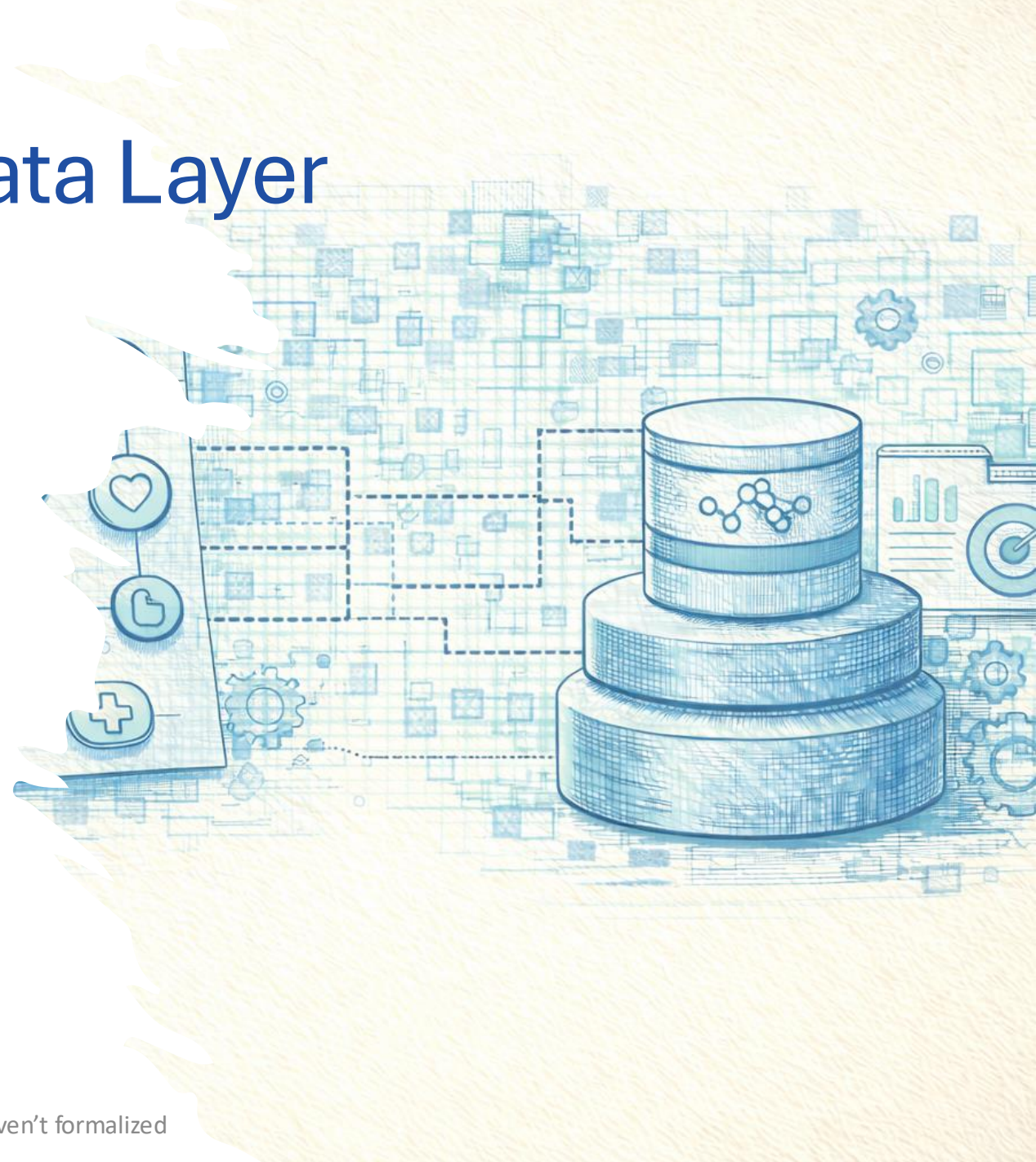
SAP Ontology & Metadata Layer

Protocol Intelligence

- CDISC USDM based
- Study design elements enhanced
- Endpoints and objectives
- Analysis population

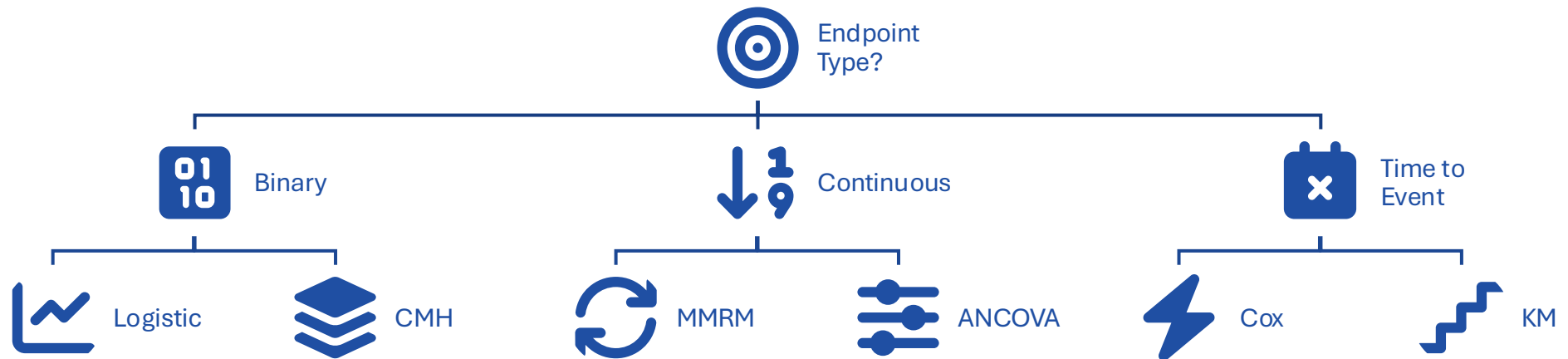
SAP Ontology

- Estimands (per ICH E9(R1))
- Intercurrent events & handling strategies
- Analysis method selection
- Missing data strategy



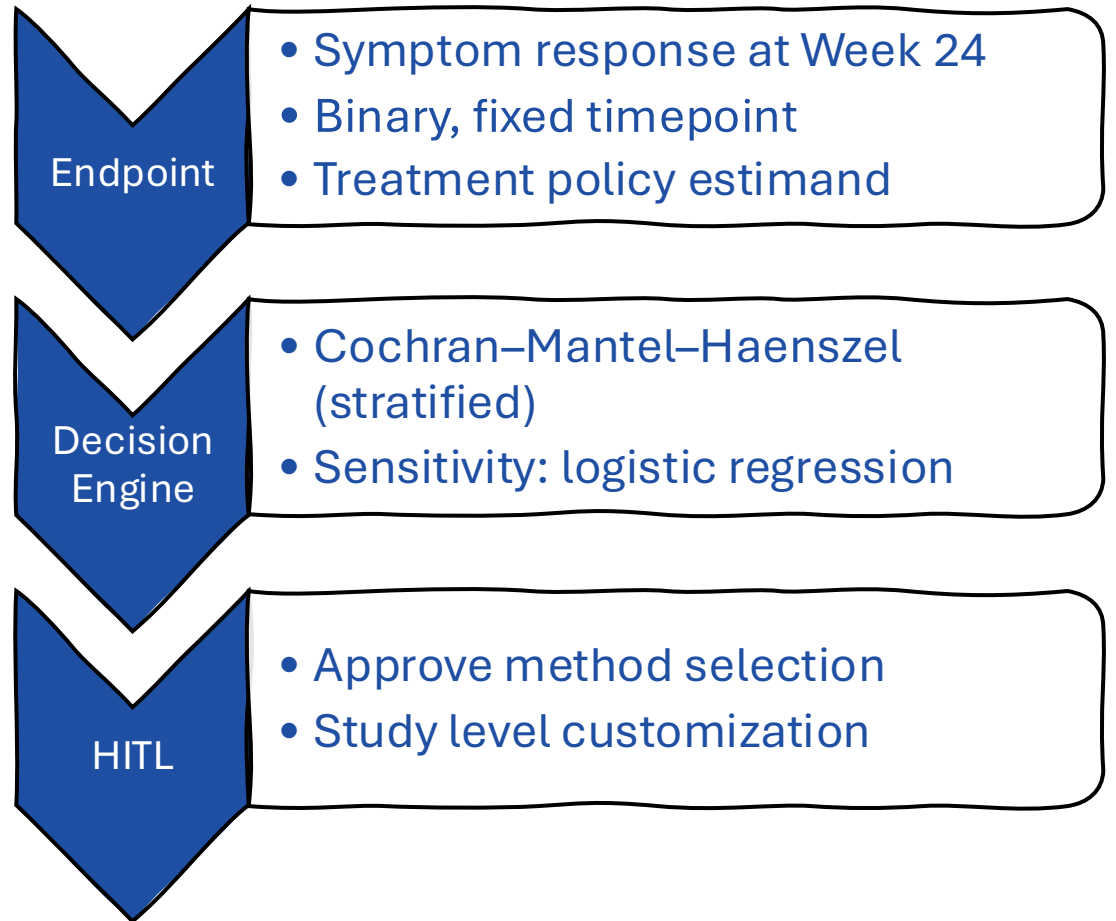
Decision Engine

- Encodes statistical best practices
- Transparent, editable, reviewable



Example: From Endpoint Definition to Analysis Method

- Endpoint characteristics drive method choice
- Method selection is rule-driven, not ad hoc.
- Human in the loop to confirm and approve selected method.



Generated SAP Text



Human-
readable



Reviewer-
ready



Structured
underneath

Endpoint

- Category: Efficacy
- Scale: Binary
- Description: Proportion of subjects achieving symptom response
- Timepoint: Week x

Decision

- Method: Stratified Cochran–Mantel–Haenszel (CMH) test

“The primary efficacy endpoint is the proportion of subjects achieving Symptom response at Week X. The primary analysis will be performed on the ITT population using a stratified Cochran–Mantel–Haenszel test...”

Population

- Category: Intent-to-Treat (ITT)
- Description: All randomized subjects, analyzed as randomized

QC

- Endpoint type is consistent with selected method
- ITT population aligns with primary efficacy objective
- Stratified CMH is appropriate for fixed-timepoint proportion comparison

Validation & QC

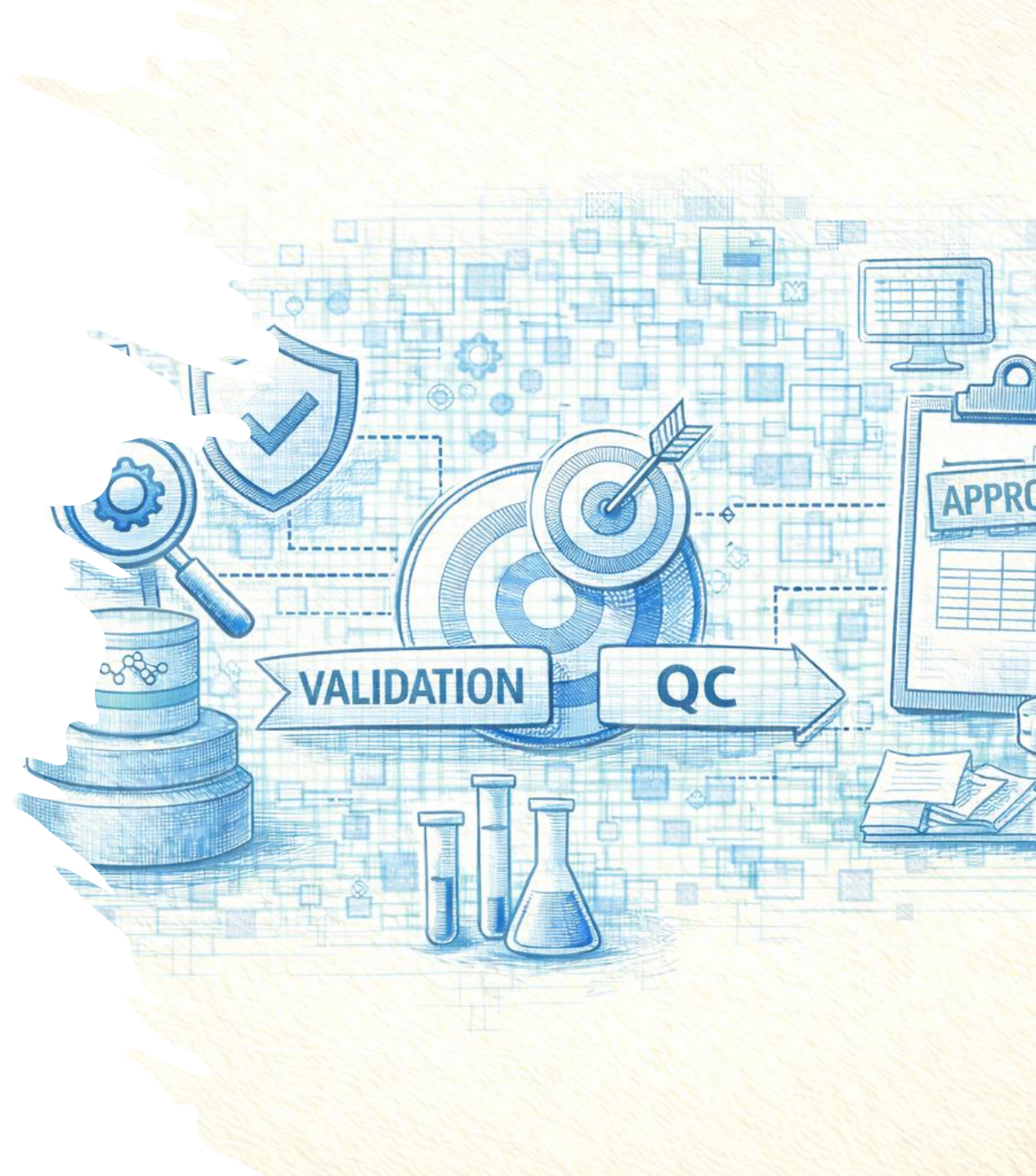
Completeness checks (all required sections present)

Consistency checks across SAP sections

Logical validation of decisions

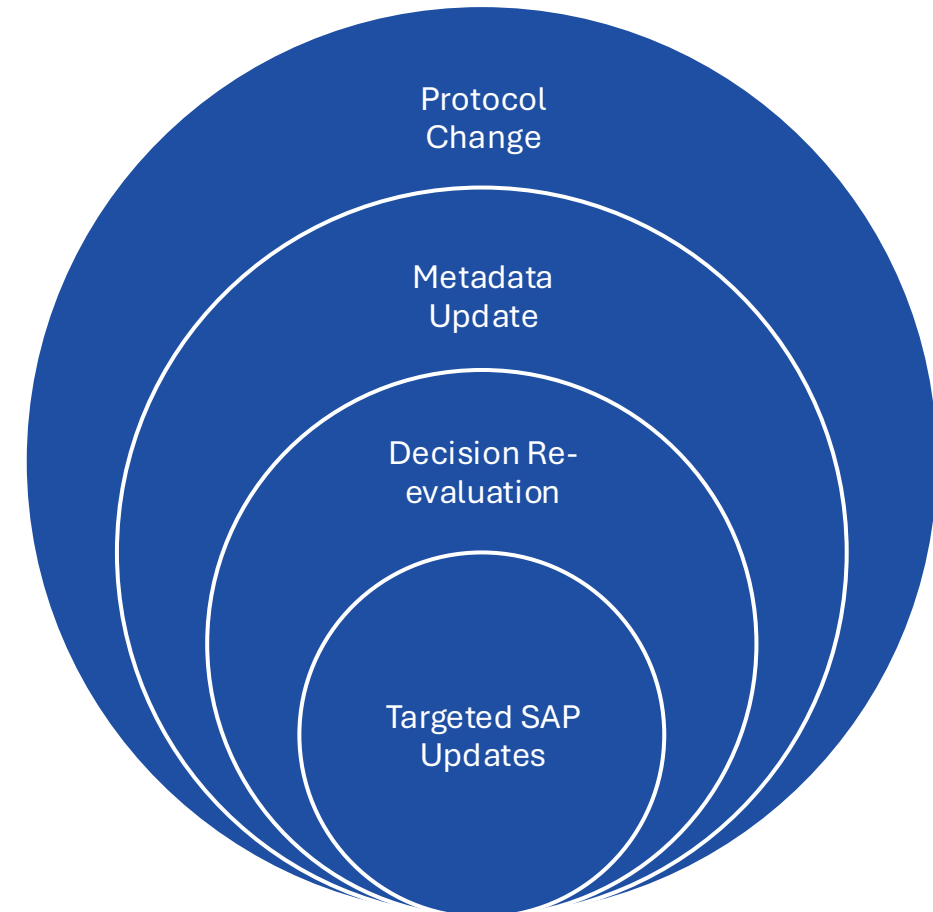
Regulatory guardrails enforced

Customized validation rules



Change Handling

- Protocol amendments are inevitable
- Changes propagate through metadata, not text
- Impacted SAP sections identified automatically
- Decision logic re-evaluated consistently





Impact & Summary

Impact of Automated SAP Generation



Faster SAP timelines



Higher consistency and quality



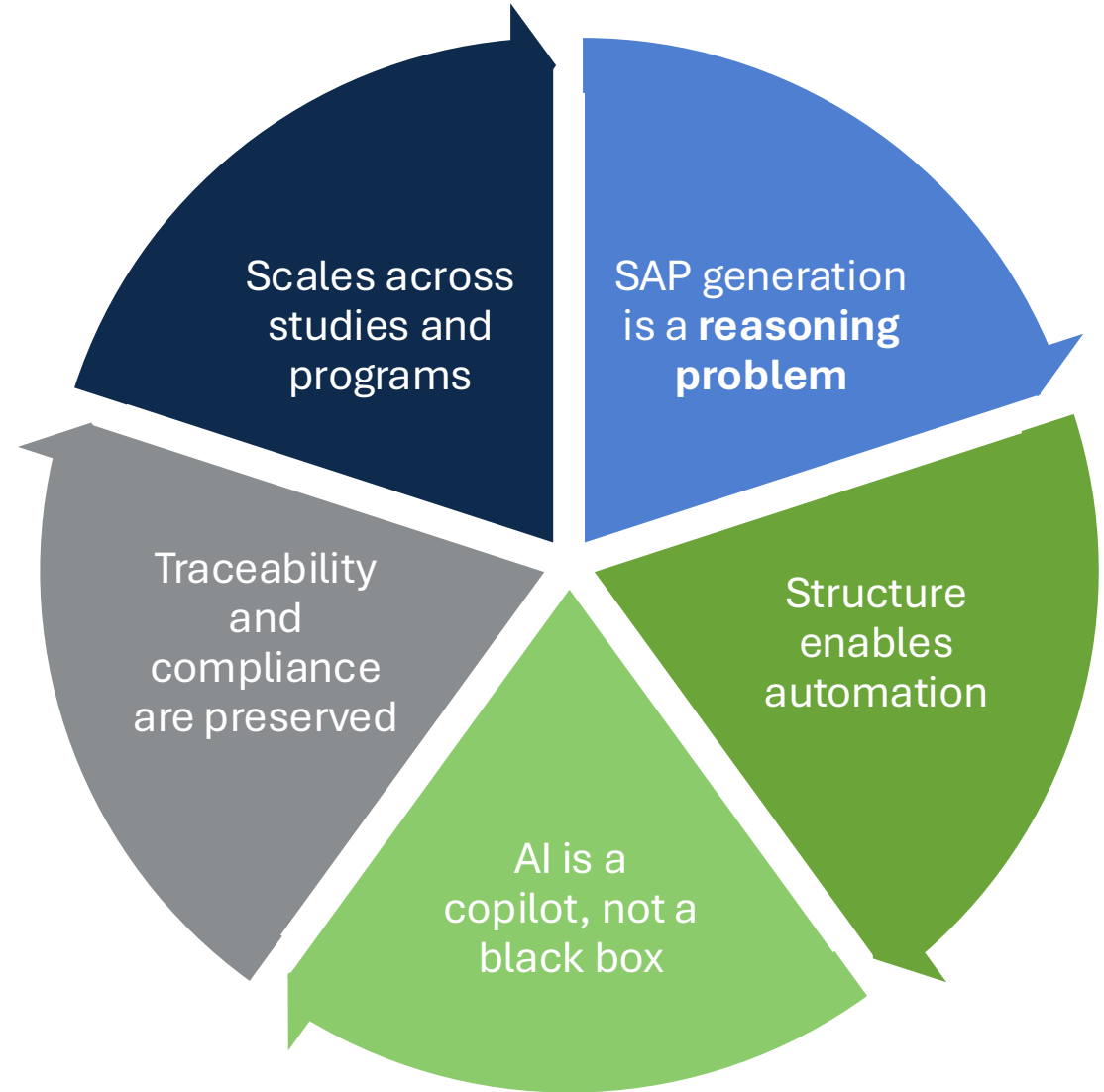
Reduced review cycles



Scales across studies and programs



Summary & Takeaways





Thank you! Any questions?

Qingyuan Zhang (jason.zhang@edetek.com)