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Modeling Narrative Structures in Logical Overlays on top of Knowledge Repositories

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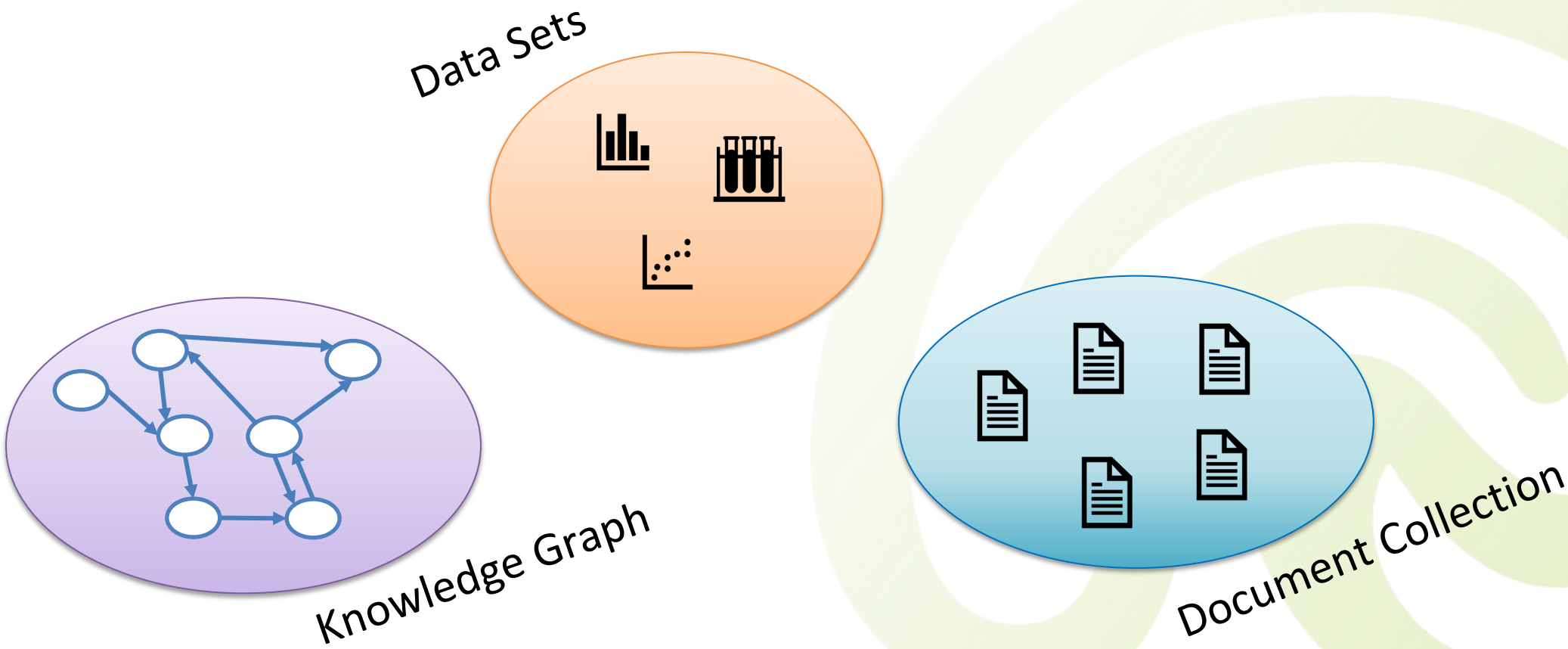
Handling Knowledge

- Knowledge is distributed in several different types of **knowledge repositories**



Building a Knowledge Base

- Integrating different knowledge repositories into a single knowledge base is an extremely difficult, nearly impossible, task

- How to retain important context information of experiments?
  - When? Who? What? Conditions?

- How to retain the argumentation of written publications?
  - An argumentation has a temporal and causal structure
  - The observation of some event might depend on several conditions

Scientific Narratives

- "A scientific narrative is a story, or more precisely, an argumentation, in which knowledge is shared."

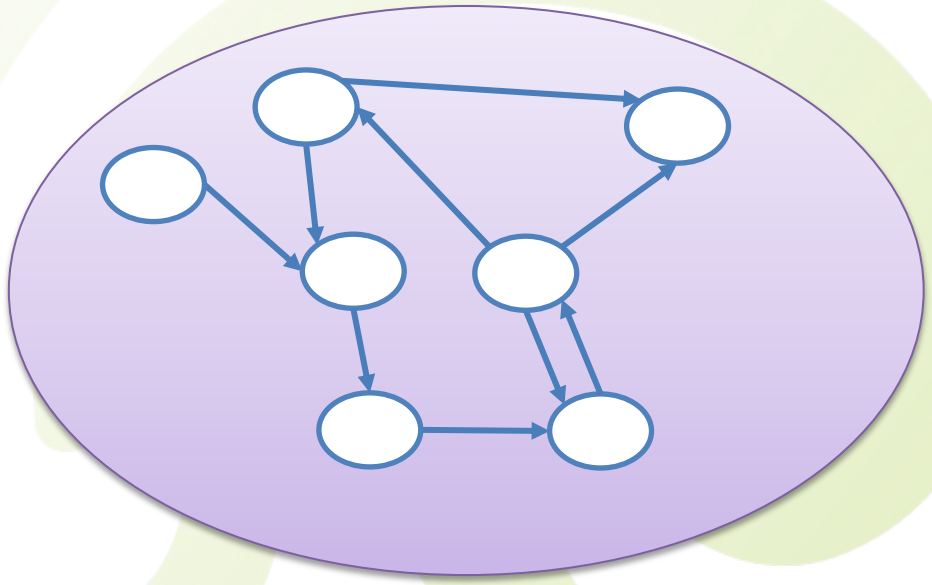
- Components of a **Narrative:**
  - **Factual knowledge** (properties, types, natural laws)
  - **Events** (labeled states or changes of states)
  - **Narrative relations** (basic structure)
  - **Narratives** (narratives are defined inductively)

- Narratives feature strong links to factual knowledge as well as actual and dynamic contexts within a single model

Factual Knowledge

- Let's stick to the well-known **Resource Description Framework** (RDF) for factual knowledge here:

- We model factual knowledge by:
  - $\mathcal{E}$ is the set of all entities
  - $\mathcal{L}$ is the set of literals
  - Σ_F is the set of factual predicate labels
  - $\boldsymbol{\mathcal{R}_F} \subseteq \mathcal{E} \times \Sigma_F \times (\mathcal{E} \cup \mathcal{L})$ is a set of factual relationships to model factual knowledge

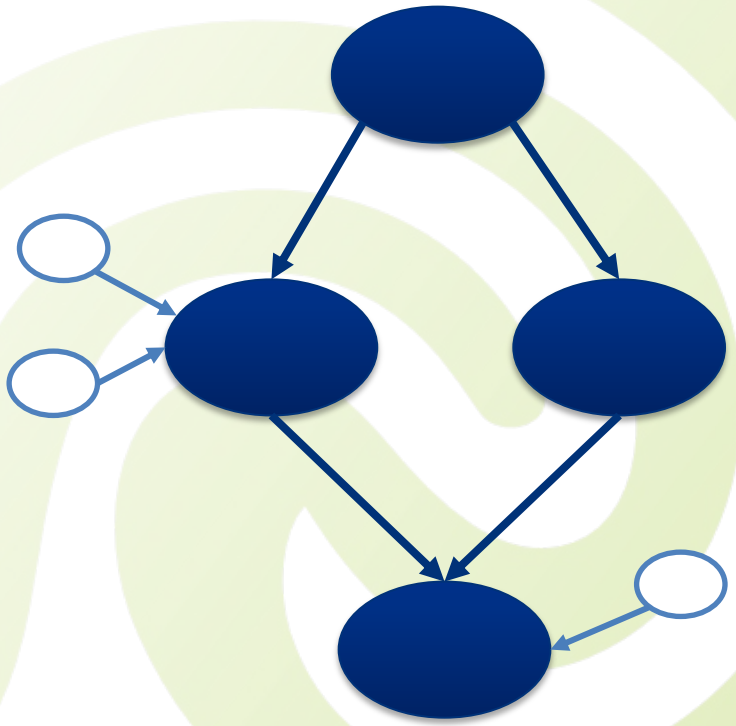


Narrative Relationships

- Besides factual knowledge, narratives usually feature **events** and **narrative relationships** between events

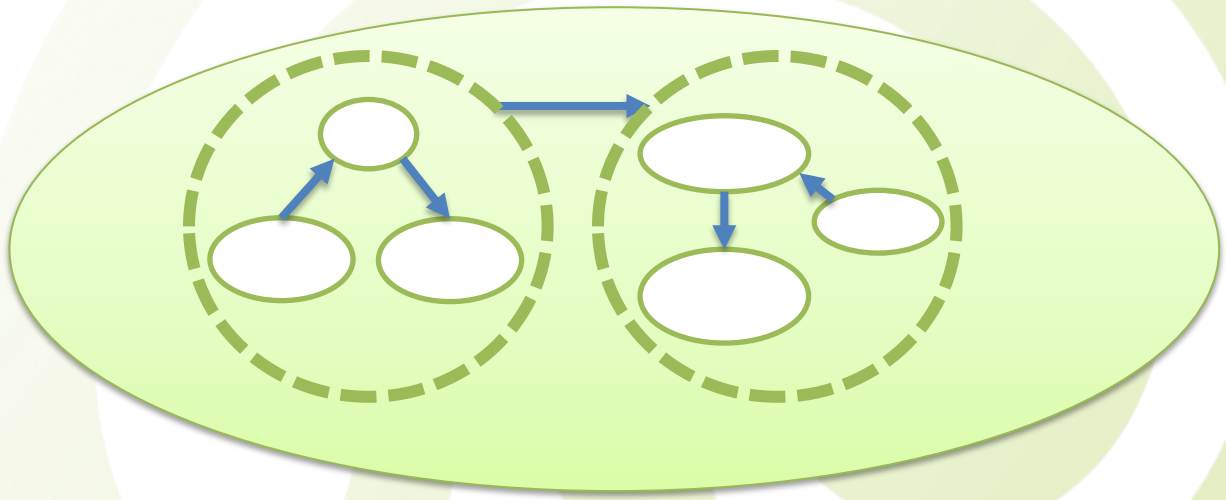
- An **event** is a labeled state or change of state

- We model narrative relations by:
  - Γ is the set of all events
  - Σ_{NR} is the set of narrative predicate labels
  - $\mathcal{R}_N \subseteq (\Gamma \times \Sigma_{NR} \times (\mathcal{E} \cup \Gamma)) \cup (\mathcal{E} \times \Sigma_{NR} \times \Gamma)$ is a set of narrative relationships

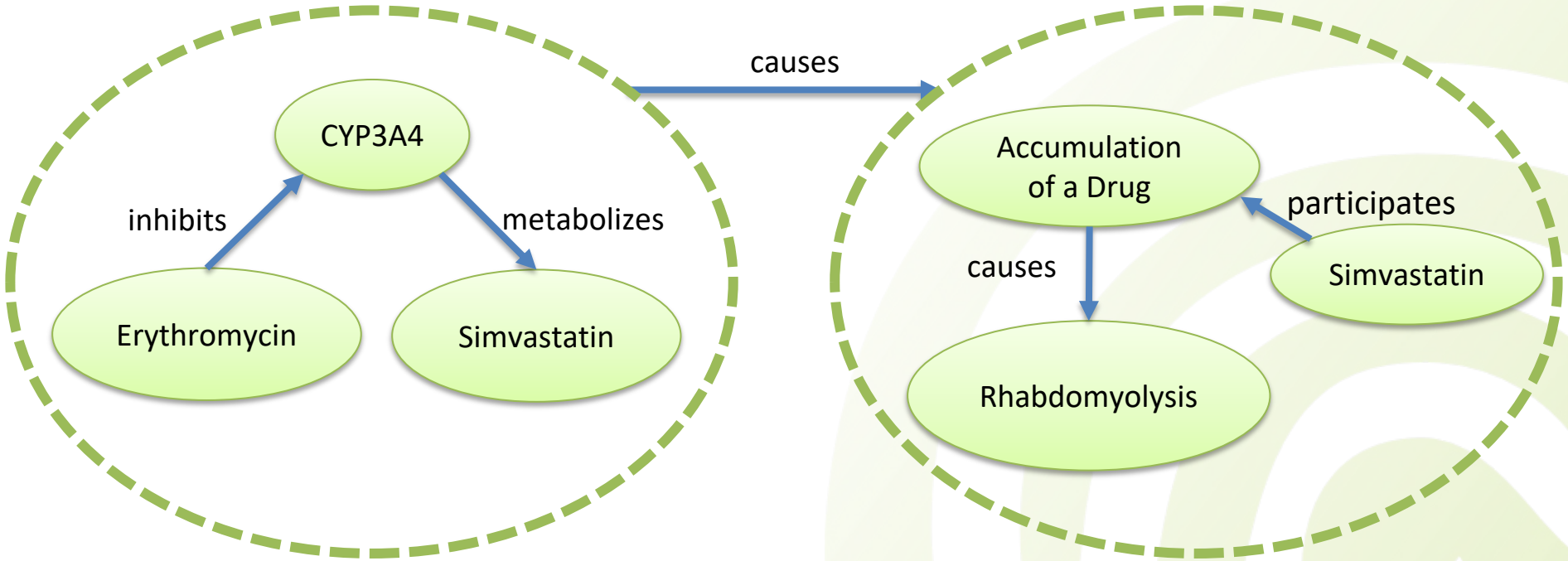


Narrative Model

- A **narrative** is defined inductively:
  - A directed edge-labeled graph (V, E) is a narrative with $V \subseteq \mathcal{E} \cup \mathcal{L} \cup \Gamma$ being nodes and $E \subseteq \mathcal{R}_F \cup \mathcal{R}_N$ being edges.
  - If n_1, n_2 are narratives and $p \in \Sigma_{NR}$, then (n_1, p, n_2) is also a narrative.

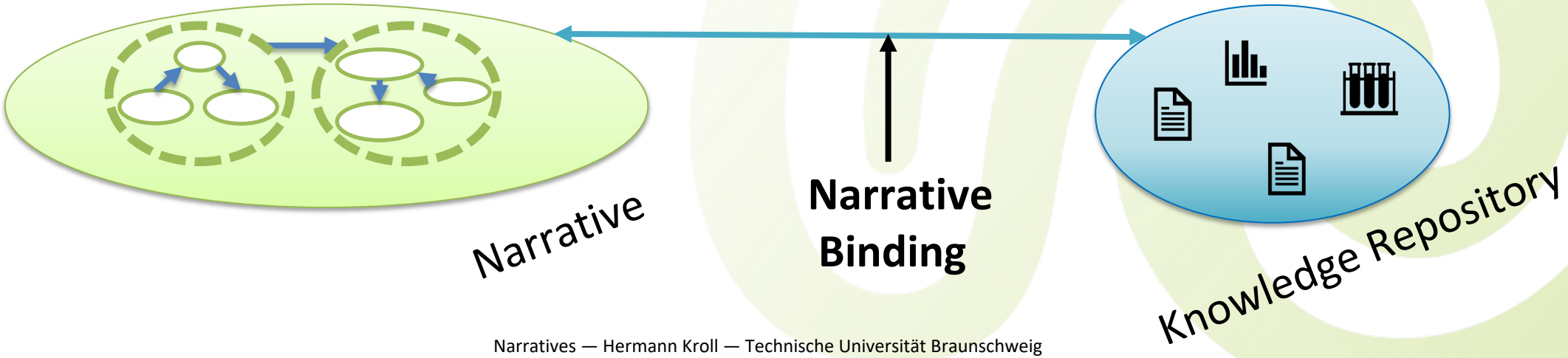


Example Narrative

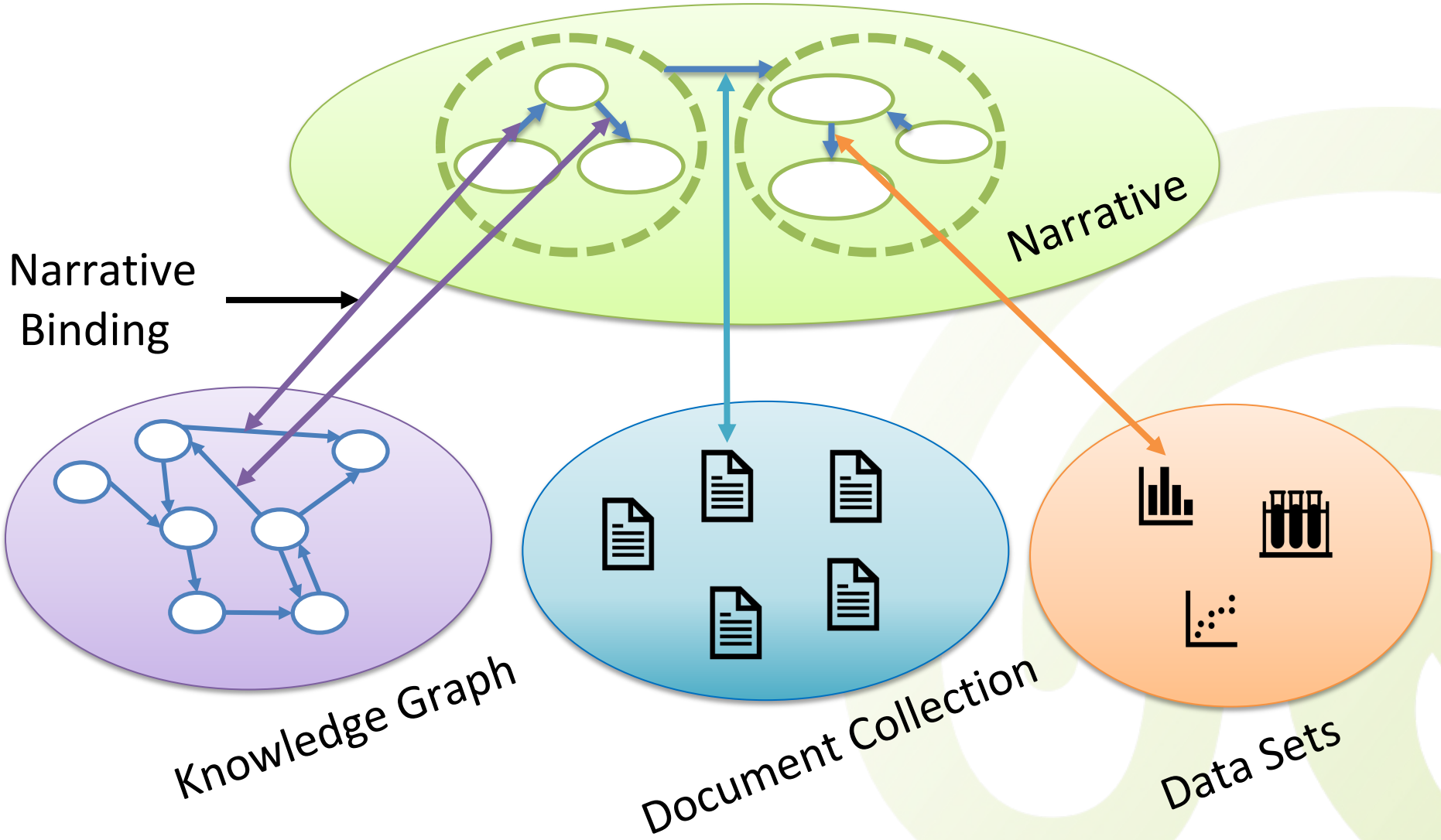


Plausibilize a scientific Narrative

- How can we plausibilize a scientific narrative?
  - Search for evidence!
- A **narrative binding** grounds a relationship of a narrative against some knowledge repository
  - **Grounding = giving evidence for a relationship**

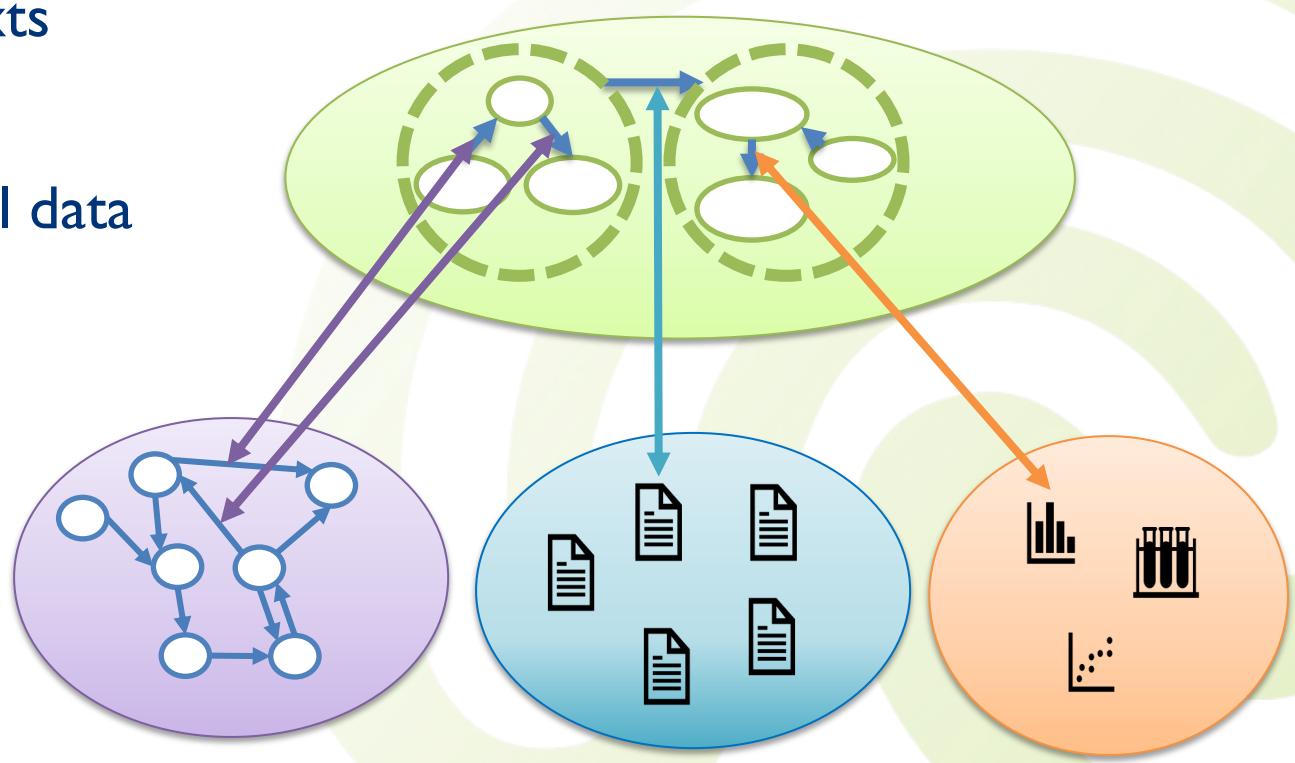


Narratives as Logical Overlays

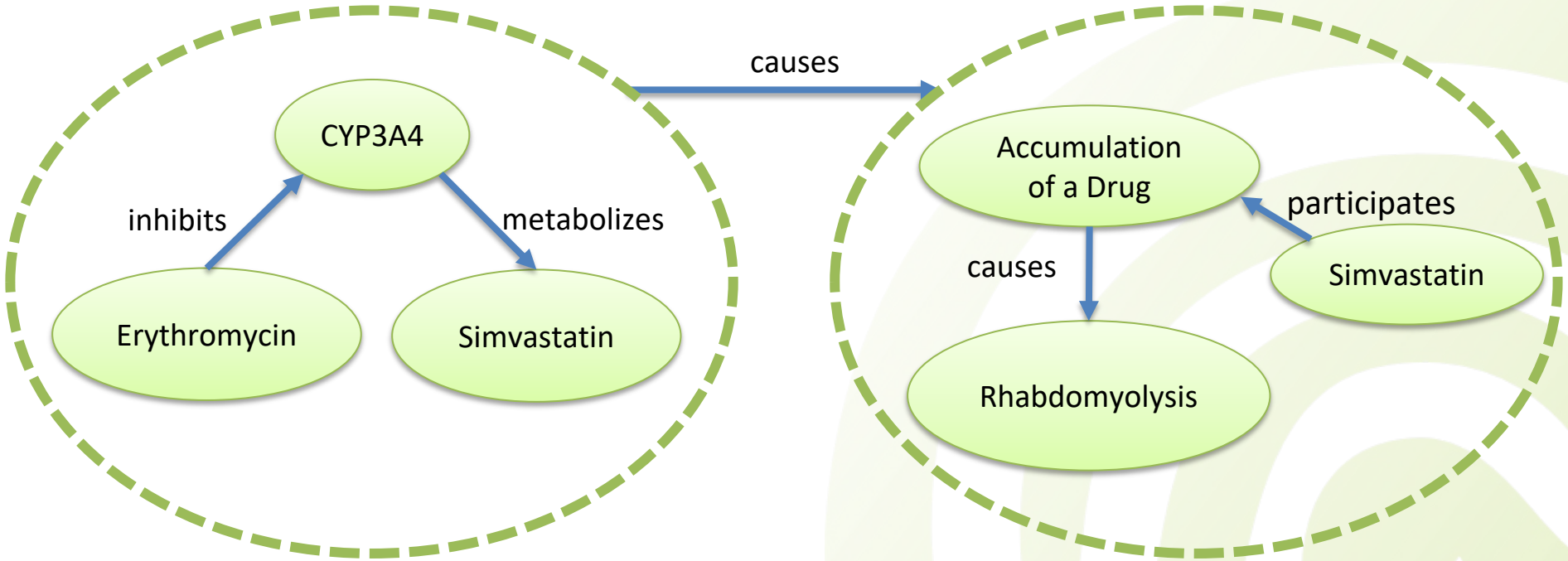


The Art of Binding

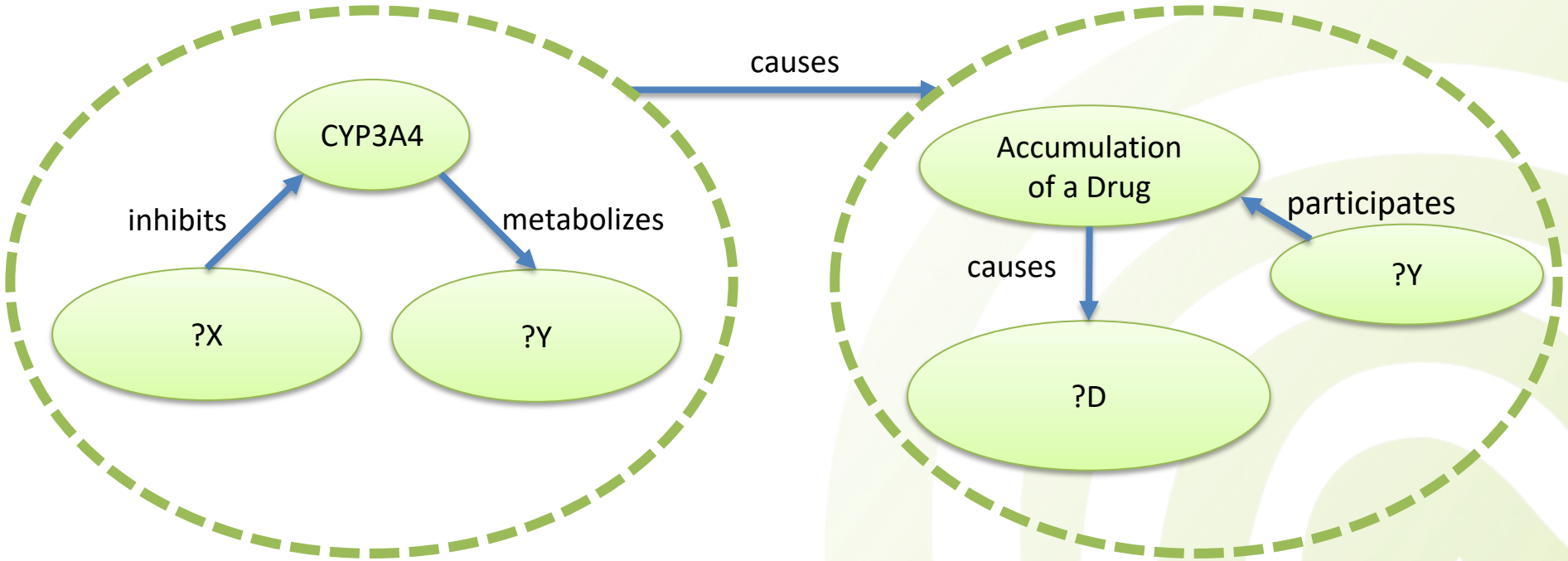
- **Factual grounding**:
  - Binds against factual knowledge
- **Anecdotal evidence**:
  - Binds against narrative texts
- **Empirical evidence**:
  - Binds against experimental data



Narrative Queries



Narrative Queries



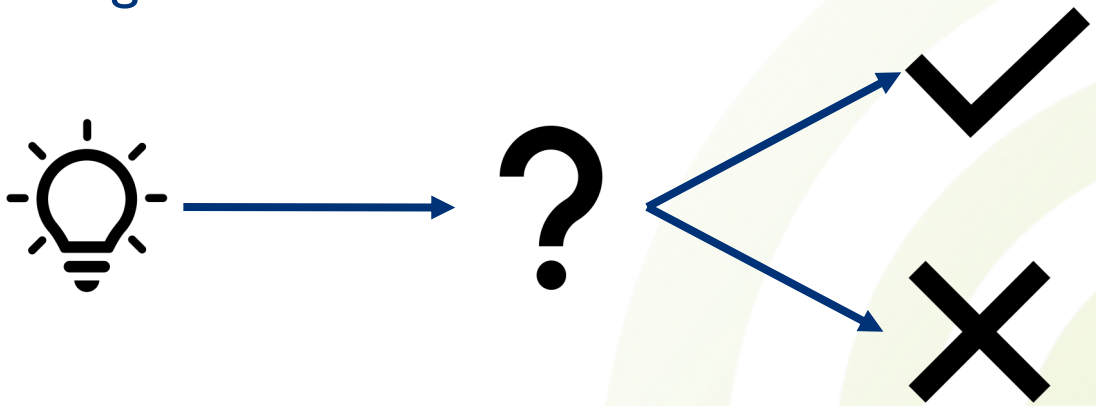
Small Demonstration

- Prototype binds the example narrative against:
  - SemMedDB2019 (containing nearly 19+ million medical facts)
  - PubMed Medline (containing nearly 30+ million documents)

- We compute 1264 possible substitutions of the variables which resulting narratives are bound against SemMedDB and PubMed
  - Narrative bindings support us with evidence for the substitutions

Applications of Narrative Queries

- Use case: hypothesis generation and testing
  - Formulate a hypothesis as a narrative query
  - Find possible substitutions automatically and test if narrative bindings can be found

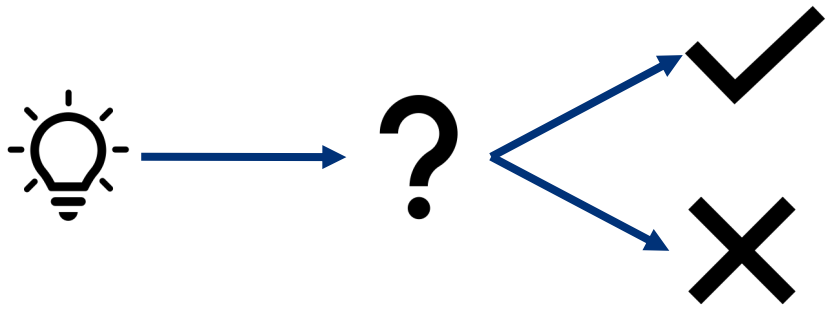


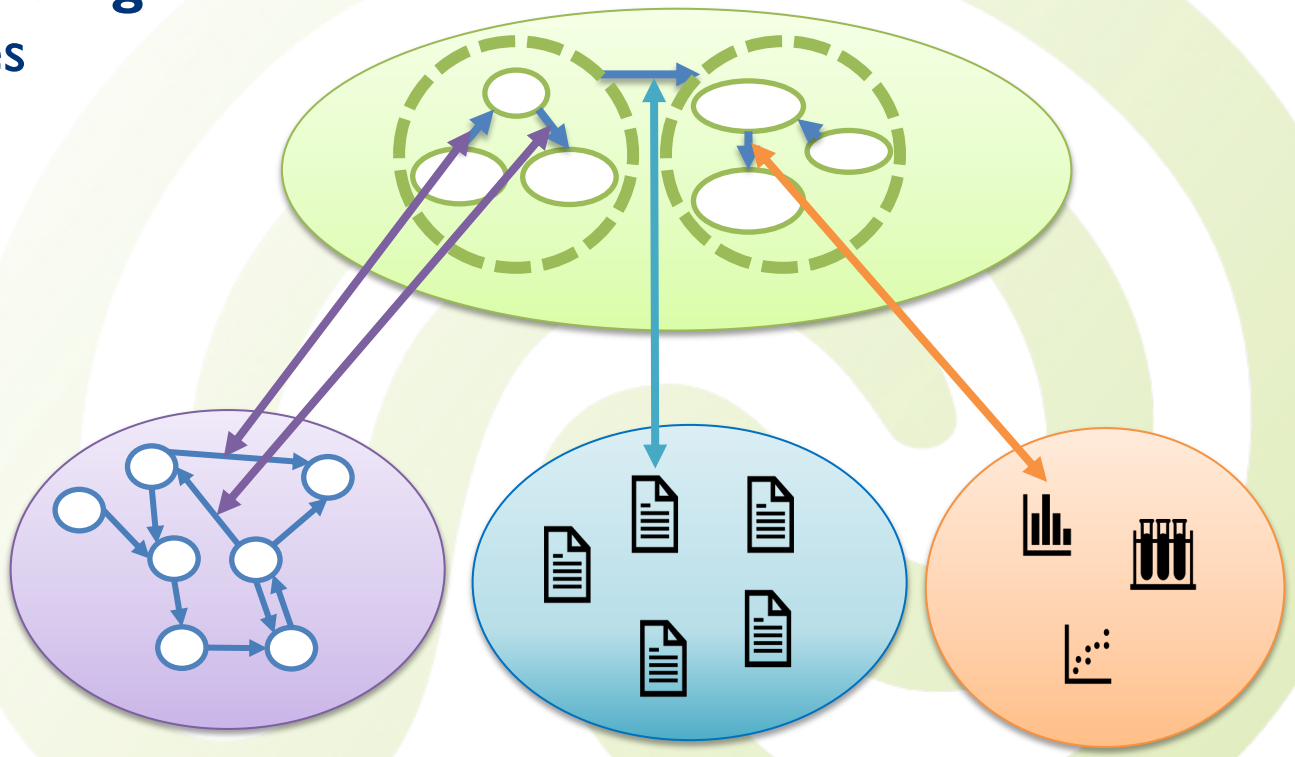
- **Vision**: Design an algorithm for narrative query processing
  - Find suitable substitutions of the variables
  - Find suitable narrative bindings for the corresponding narratives automatically

Conclusion

- Narrative are designed as **logical overlays**
  - Keep the knowledge repositories separated and share knowledge trough **narratives**
  - Give evidence for your narrative by **binding** it against different knowledge repositories

- Narrative queries are suitable to generate and test a hypothesis





Thank You!

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If you have any questions, contact me via:

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