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For the best of reasons

Enabling Open Discovery and Decision-Making with a Knowledge Mesh for Environmental Intelligence

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Outline

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Introduction

- A scalable framework designed to aggregate, enrich, and interconnect NOAA's environmental intelligence data.
- Uses Knowledge Graphs to create relationships between datasets
- Improves discovery and accessibility of NOAA's datasets.

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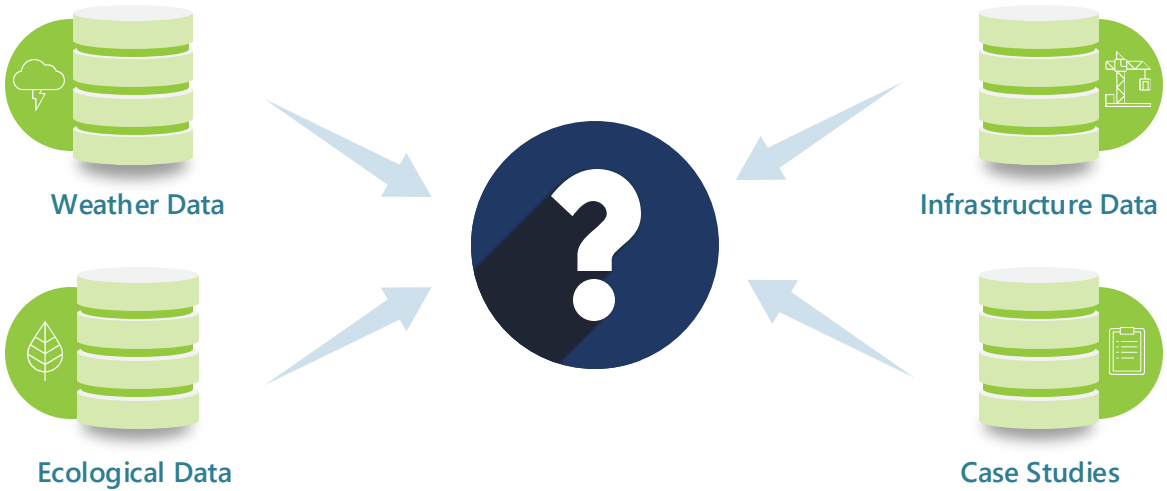
Problem Statement

- Coastal disasters like oil spills, hurricanes, and chemical leaks demand fast, data-driven responses.
- Current data systems are often siloed, inconsistent, or difficult to integrate.
- Stakeholders (Urban planners, emergency managers, ecologists, and climatologists) need a unified system for real-time insights.
- Focused on incidents and data in and around the Chesapeake Bay



Knowledge Mesh Introduction

Cross-domain Data Integration

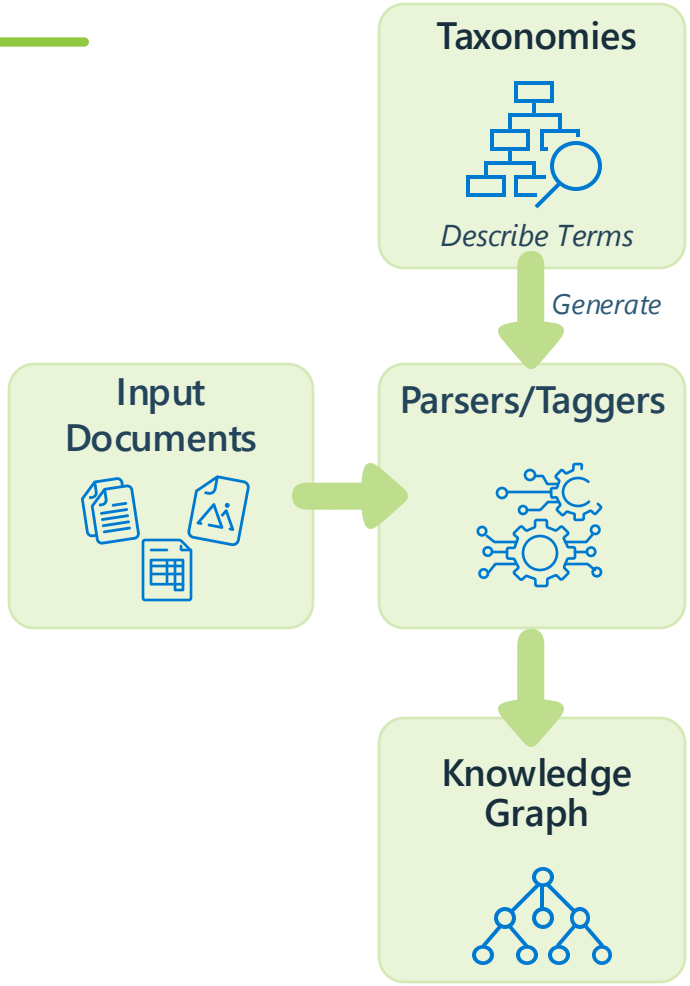
- Ocean and Tide Datasets
- Case Incident Report and Restoration Plans
- Sensitive Habitats and Infrastructure

Semantic Enrichment

- Integrating with standard taxonomies and ontologies ensures interoperability with other Knowledge Graph resources

AI & Machine Learning

- Enhancing data processing
  - Named Entity Recognition (NER) to tag terms out of restoration plans



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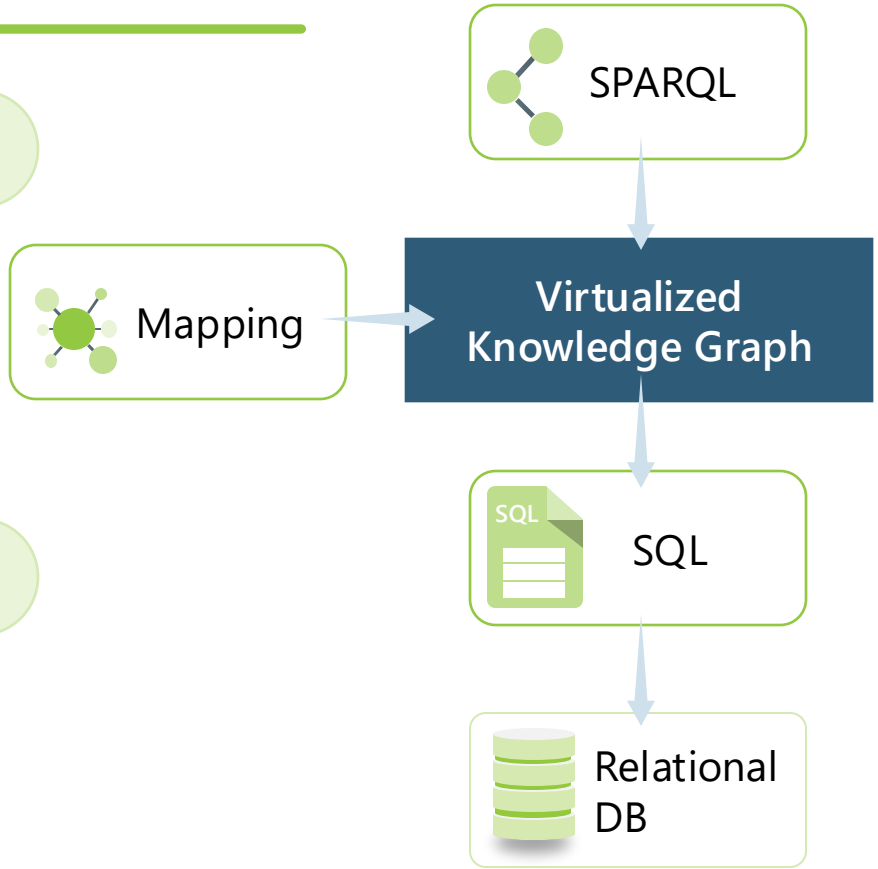
How it works

Data Aggregation and Processing

- ETL pipelines
- **Virtual Layers**
  - R2RML and RML
- Data Validation
  - SHACL

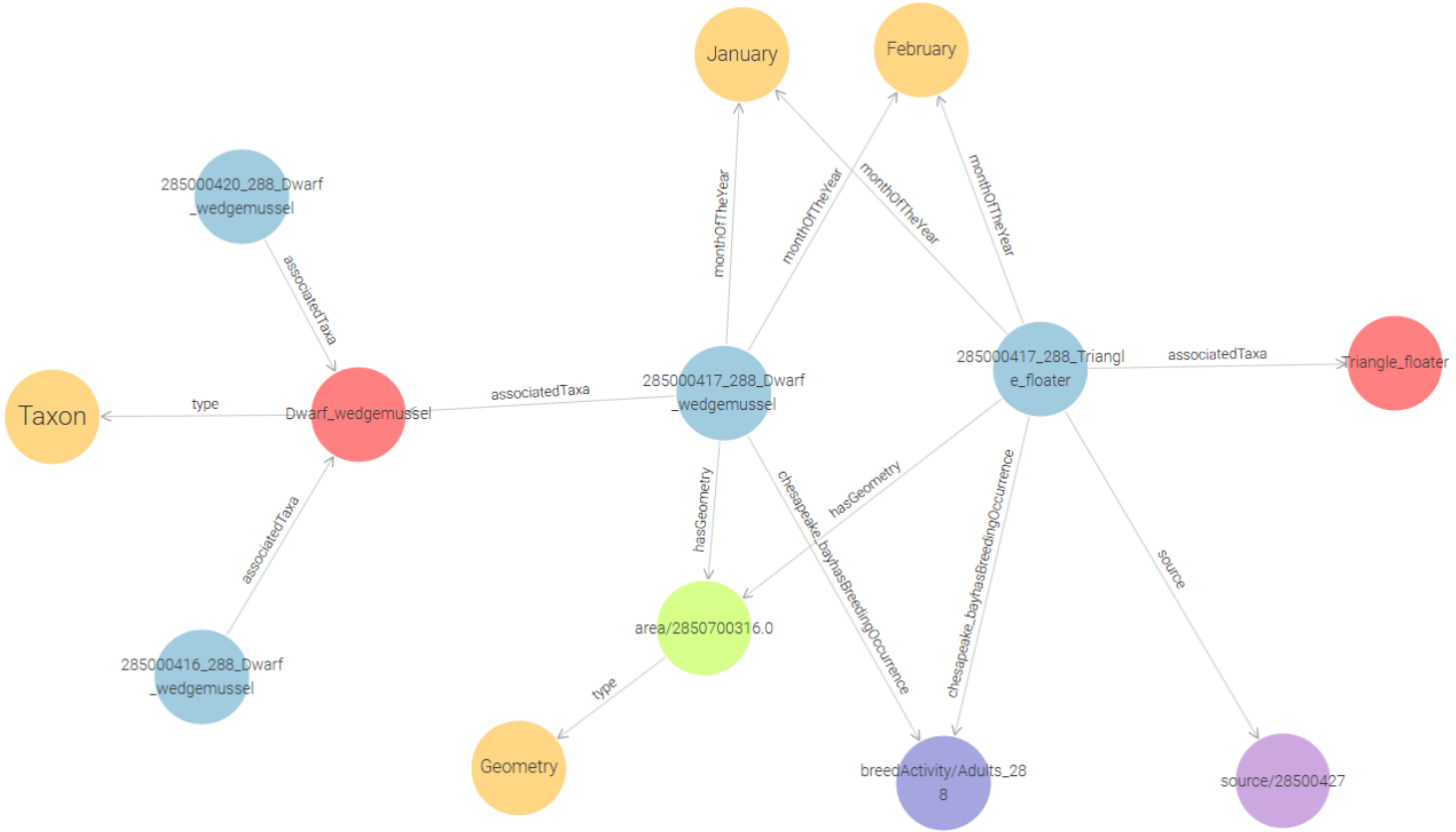
Structured and Unstructured

- Forecast data from NOAA Operation Forecast System (OFS)
- Restoration Plans from NRDAR



Source: https://arxiv.org/pdf/2311.07509

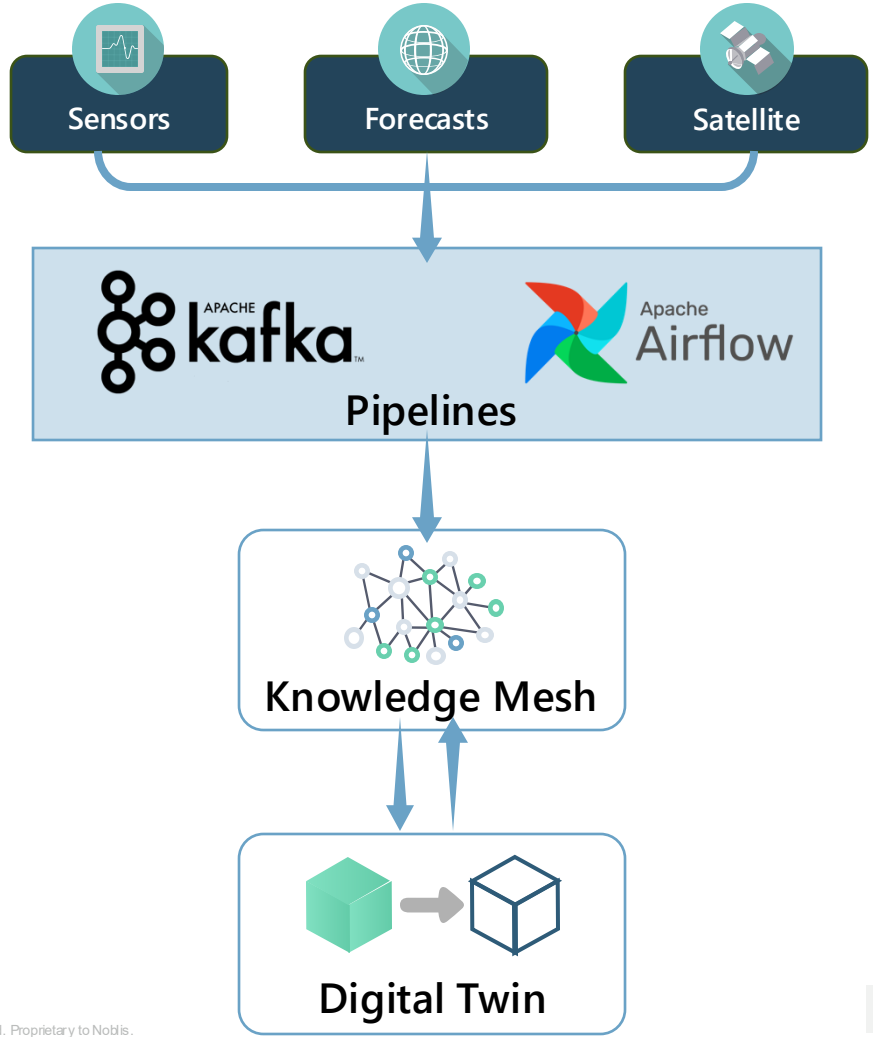
Semantic Enrichment



Screenshot taken from Ontotext GraphDB Visual Graph

Interoperability with Digital Twins

- Building real-time data feeds for the Knowledge Mesh
  - Apache Airflow & Kafka
  - For coastline oil spills
    - Live data for tides & currents
    - Forecast data for currents, wind, water temperature, and more
- Digital Twin for simulating oil spill spread
- Simulation result fed back into the Knowledge Mesh



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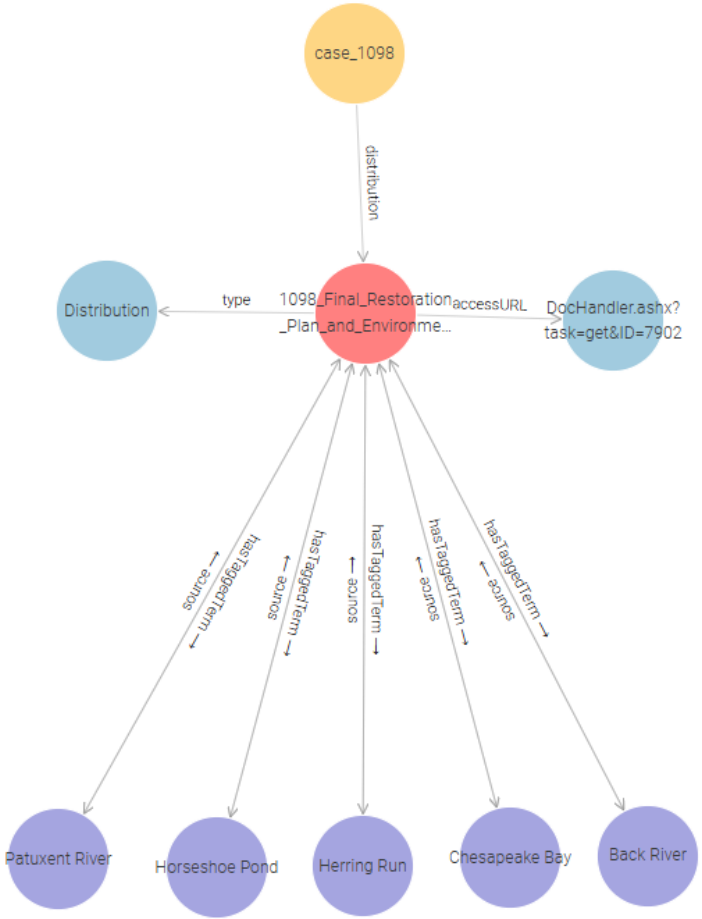
How AI Enhances the Knowledge Mesh



Building the Knowledge Mesh

- Including AI/ML techniques in ETL pipelines
  - Named Entity Recognition (NER) results

Searching the Knowledge Mesh

- Added semantic context helps LLM applications:
  - Perform semantic search
  - Text-to-query operations

Screenshot taken from Ontotext GraphDB Visual Graph

Scalability and Future Applications

Current Scope

- Monitor and simulate coastline disasters (such as oil spills and flooding) in the Chesapeake Bay
- Enable rapid response and identification of at-risk areas (habitats, infrastructure)
- Provide data-driven insights for long-term planning and policy making

Scalability

- Expand geographic regions

Future Applications

- Climate change research
- Marine biodiversity studies

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Summary and Impact

The NOAA Knowledge Mesh…

…bridges data silos, enabling faster and smarter environmental decisions.

- In many cases, this can be done my maintaining the data in place

…empower SMEs and teams building Digital Twins with a single source of truth for their data

…Lay a foundation for LLM powered search tools

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Thank You

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