**1. Ontology-Driven Architecture for Managing ESG Metrics (Yu, Rabhi, & Bandara, 2024).**[**https://www.mdpi.com/2079-9292/13/9/1719**](https://www.mdpi.com/2079-9292/13/9/1719)

**i. Existing Research:**

Yu et al. (2024) investigate the use of ontology-driven architectures to handle the complex landscape of ESG (Environmental, Social, Governance) metrics. Their research identifies significant challenges in ESG reporting, including the lack of standardization across various ESG frameworks and difficulty managing data from diverse sources. The paper emphasizes how existing ESG reporting methods often suffer from inconsistent data, making comparability difficult across different reporting frameworks and standards such as IFRS and TCFD.

**ii. Novel Methodology:**

The paper introduces an innovative ESG Metrics Knowledge Graph (ESGMKG) based on a domain-specific ontology. This ontology-driven approach semantically categorizes ESG metrics, facilitating improved alignment with ESG reporting frameworks. The authors implemented the knowledge graph using the Stardog platform, demonstrating semantic querying and contextualization capabilities.

**iii. How We Build on This:**

Our project leverages their foundational ontology architecture. However, we specifically enhance it by integrating ontology-driven semantic structuring directly with a Principal Component Analysis (PCA) model. Our project adds industry-specific hierarchies and semantic relationships to further optimize PCA’s effectiveness in dimensionality reduction and interpretability for ESG metrics analysis.

**iV. Evaluation Metrics:**

The authors validate their ontology through competency questions, demonstrating the capability to effectively manage ESG metric relationships and the integration of various ESG data sources. They use semantic queries (SPARQL) to evaluate the ontology's ability to handle practical ESG reporting scenarios.

**iv. Limitations and Enhancements:**

The primary limitation is their ontology’s initial coverage, restricted to specific ESG frameworks (IFRS, TCFD). The current implementation also does not comprehensively address computational models for ESG metric calculations, which can limit its application in complex ESG risk assessments.  
**Our approach** extends this by explicitly integrating ontology-driven categorization directly with PCA computations, providing a more nuanced ESG analysis capable of industry-specific ESG assessments.

**2. Augmenting BERT with Linguistic and Semantic Features for ESG Term Classification (Sinha et al., 2022).**[**https://aclanthology.org/2022.finnlp-1.32/**](https://aclanthology.org/2022.finnlp-1.32/)

**i. Existing Research:**

Sinha et al. explore ESG term classification challenges using deep learning (BERT), emphasizing that accurately identifying ESG-related terms from corporate textual documents is crucial for effective ESG analytics. They address the complexities of text-based ESG data due to variability, ambiguity, and context-specific usage of ESG terms.

**ii. Novel Methodology:**

This research proposes a model enhancing the standard BERT architecture by integrating semantic similarity features derived from ESG-related terms. The methodology involves fine-tuning BERT on ESG reports and enhancing its embedding representations by incorporating additional semantic features to classify ESG terms effectively.

**iii. Evaluation Metrics:**

The effectiveness of their augmented model is assessed through standard machine learning evaluation metrics, including classification accuracy, precision, recall, and F1-score, showing improvement over baseline BERT in ESG term classification tasks.

**iv. Limitations and How We Build Upon Their Work:**

Key limitations identified in Sinha et al.'s work include:

Dependence on Textual Data: The model heavily relies on textual data, potentially limiting its capability to handle structured numeric ESG metrics effectively.

Complexity and Generalizability: Adding semantic features increases complexity, potentially decreasing interpretability and computational efficiency, with uncertain generalization across diverse ESG standards.

Our project’s contributions extend beyond textual classification to structured numerical ESG metric data, providing a complementary approach that addresses these limitations:

Structured Data Integration: By utilizing ontology-driven PCA, we focus directly on structured numerical ESG data, enhancing interpretability beyond textual analysis.

Ontology-Enhanced Interpretability: Unlike the complexity added by semantic enhancements to BERT, our ontology-enhanced PCA methodology inherently supports clear interpretation by aligning numeric ESG metrics explicitly with semantic ESG ontology structures.

Cross-framework Generalizability: Our ontology and PCA integration explicitly supports adaptability across different ESG frameworks and industries, thereby overcoming the limitation related to generalizability present in the semantic-augmented BERT approach.

**iv. Evaluation Metrics:**

Their evaluation primarily utilized classification accuracy, precision, recall, and F1-score, emphasizing the classification quality of ESG terms.

Our research leverages additional metrics like variance explained, clustering accuracy, and interpretability measures specifically tailored to numeric ESG data through PCA to demonstrate clear quantitative performance advantages.