

Graph Formalisms and Technologies Support to Systems Engineering Modeling and Analysis

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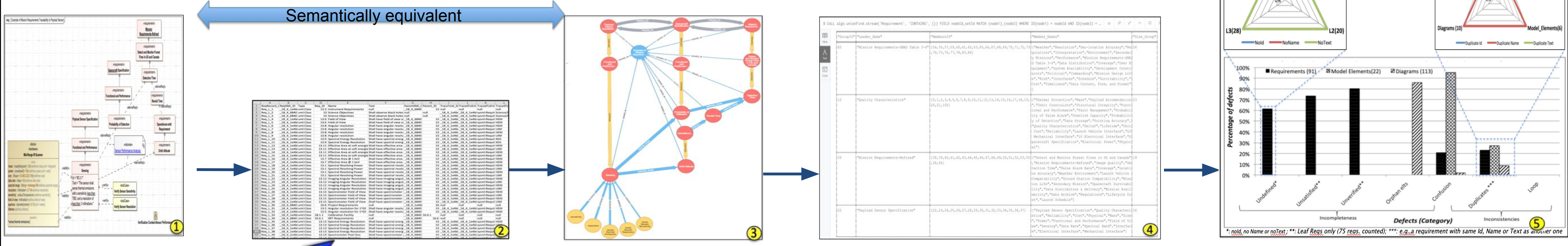
Motivation

- Future digital engineering applications require defect and ambiguity-free architecture models as contributors to the design "source of truth".
- State-of-the-art capabilities are rigid and fail to provide deep insights beyond "point checks".
- Need novels (semi) automated approaches enabling across layers and domains evaluation and analysis of models throughout the design lifecycle

Contributions

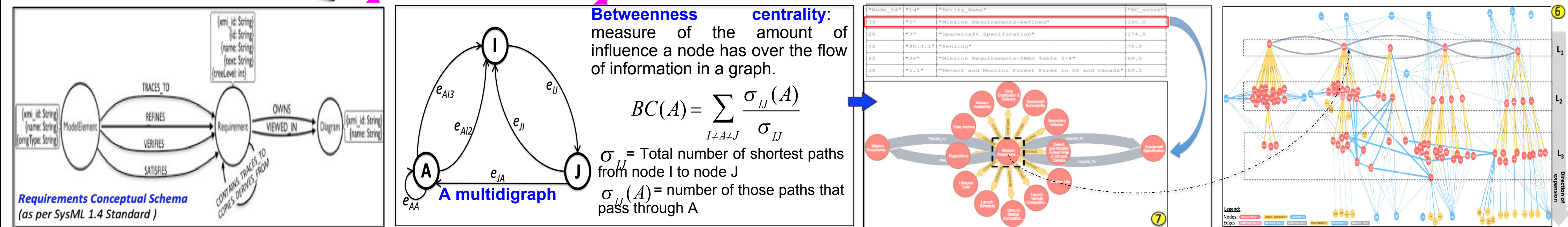
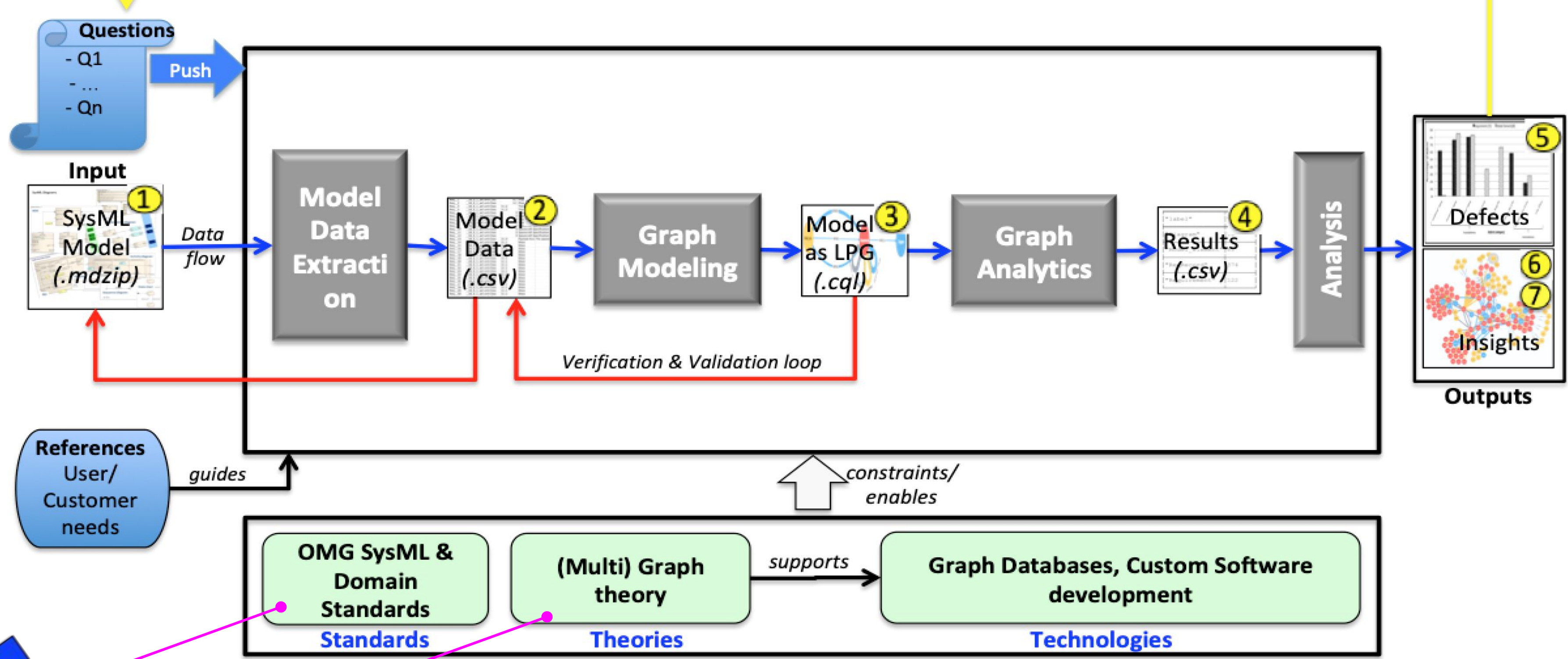
- A multigraph-based framework for quality assessment (i.e., completeness, consistency, correctness) and dynamic probing of architecture models
- Semantic equivalence of Labeled Property Graphs (LPG) and System Modeling Language (SysML) representations of models is established
- Illustration on a spacecraft requirements model

Graph-based Framework for Architecture Model Analysis



Spacecraft Requirements Model Example:

- Fig.1:** Input model partial view (a SysML requirement diagram)
- Fig.2:** Extracted requirements data
- Fig.3:** Requirement diagram as Labeled Property Graph (LPG)
- Fig.4:** Listing of top four largest requirements (by containment size)
- Fig.5:** Distribution of selected defects in the requirement submodel
- Fig.6:** Spacecraft requirements graph (a LPG) model
- Fig.7:** Betweenness centrality scores for identification of most impactful requirements



Conclusion & Future Work

- A semi-automated procedure to analyze architecture models represented as labeled property graphs (LPG) subsequently transformed and queried for defects and insights in hidden complex patterns
- Need to scale up framework to multiple, interrelated and complex pillars of the architecture languages (such as the SysML), full automation of the procedure as well as architecture-specific graph algorithms
- Artificial Intelligence for model content analysis and understanding: Natural Language Processing (NLP), Machine Learning (ML), Ontologies and knowledge graphs processing.

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