DEC 2025

INTRODUCTION TO
KNOWLEDGE ENGINEERING

# CS RESEARCH KNOWLEDGE GRAPH

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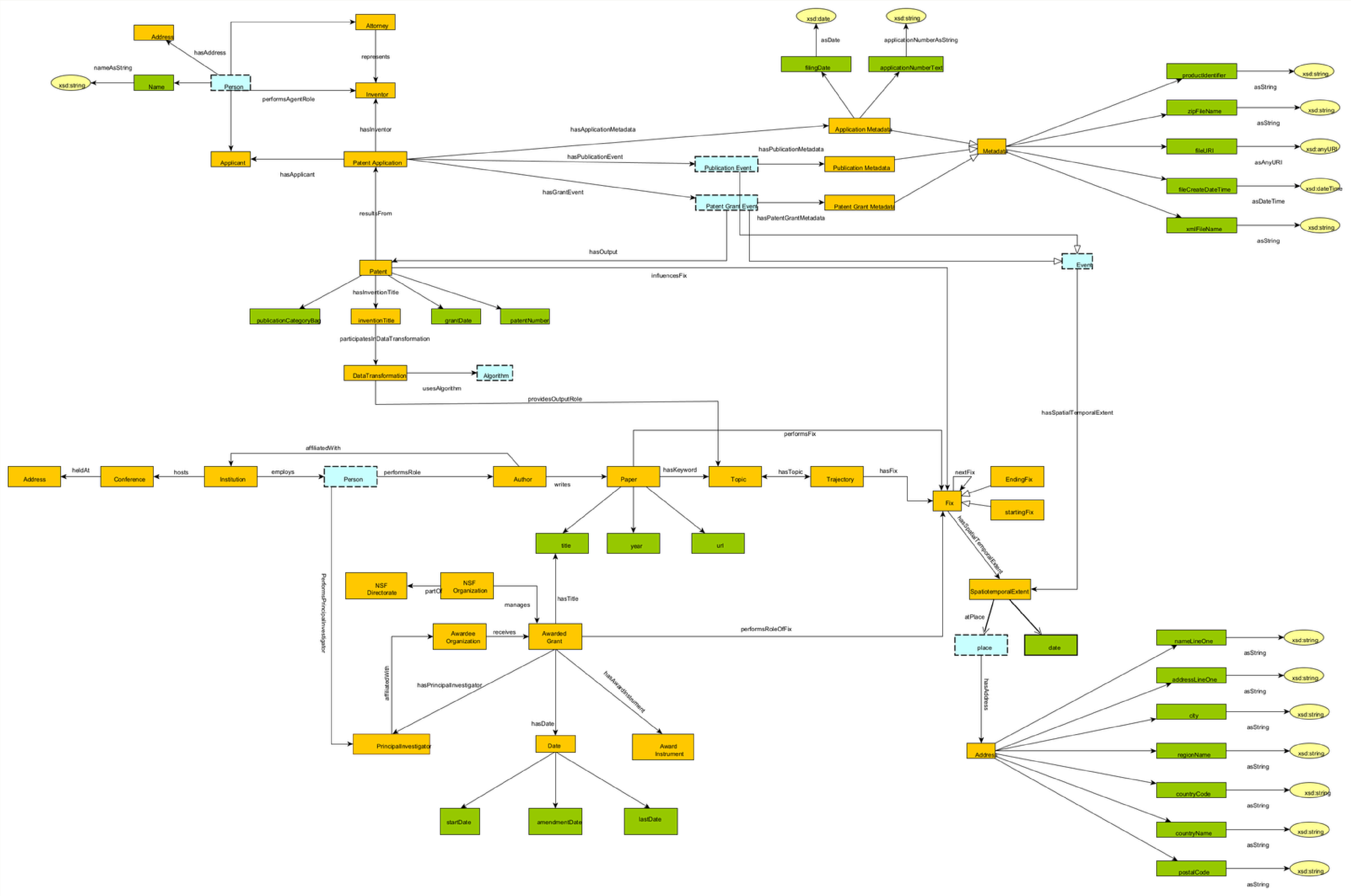
# Introduction

- Research in CS generates thousands of papers, patents, and grants every year.
- All of these are stored in different datasets: DBLP, NSF, USPTO.
- **Challenge:** lack of unified structure for analyzing CS research evolution.
- **Goal:** Create a semantic knowledge graph connecting funding, publications, innovation in the field of CS

# Schema Diagram



# Classes and Relations

- **Core classes:**

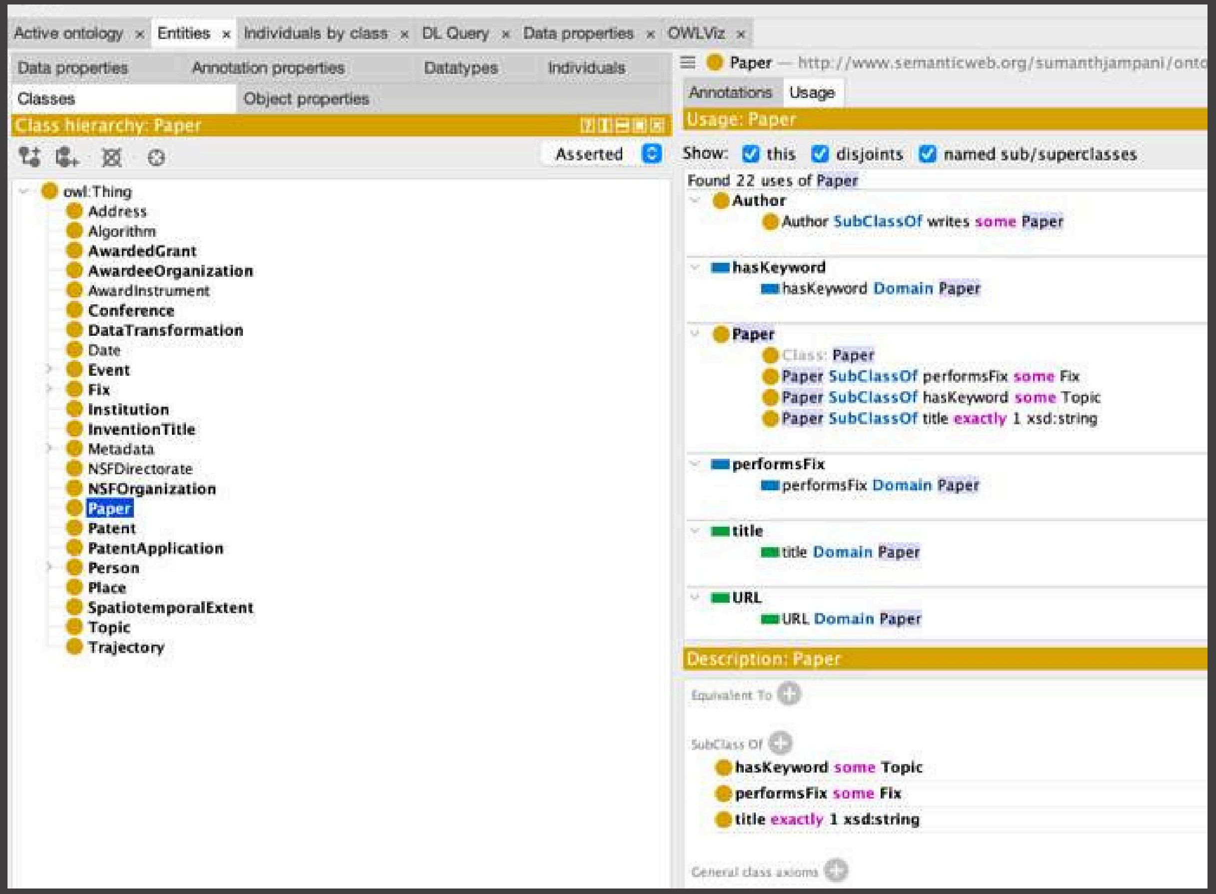
Paper, Patent, Grant, Author, Institution, Topic, Trajectory, Fix, SpatiotemporalExtent

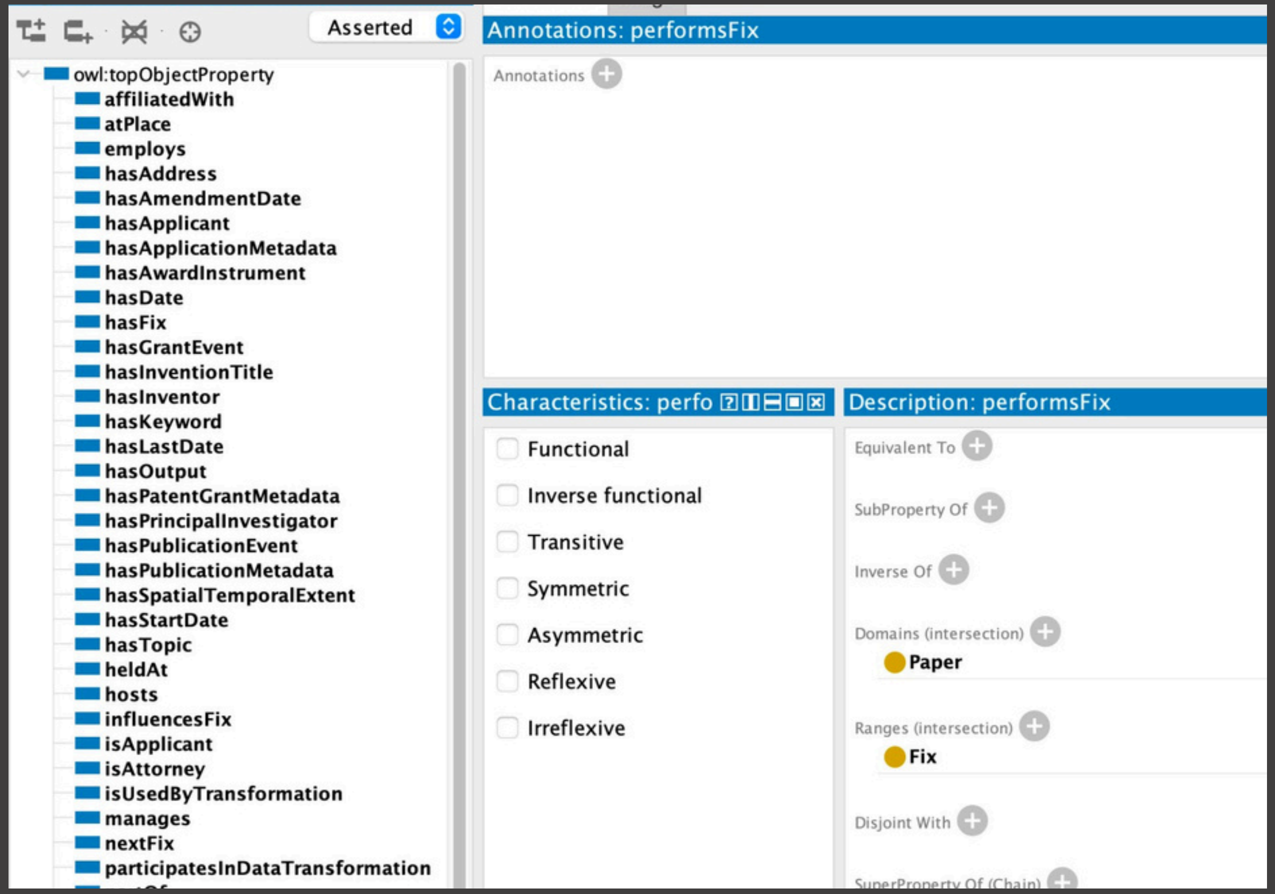
- **Key relations:**

writes, performs, manages, hasTopic, hasFix, influences, hasGrantEvent, partOfTrajectory, etc.

# Axiomatization

Axiomatization is the process of defining the core rules and constraints of a knowledge domain so that all other facts can be logically derived.




# Data Transformation

## Common Entities

- **Authors**

DBLP → authors of papers
Patents → inventors
NSF → Principal Investigators (PI/Co-PI)

- **Research Topics / Keywords**

DBLP → extracted from paper titles/keywords
Patents → extracted from abstracts/claims
NSF → topics from award abstracts/keywords

- **Temporal Information**

DBLP → publication year
NSF → award year & duration
Patents → filing date, grant date

# Data Transformation

## Data Cleaning

- Convert all dates to a single format
- Standardize author/institution names
- Normalize topics/keywords

## Topic Extraction

- TF-IDF keyword extraction
- Contextual embeddings (BERT)
- Topic modeling

## Clustering to Find Topic Groups

- Group similar papers, patents, and NSF awards together
- Creates unified topic clusters

# Competency Questions

**1Q.** Which institutions have received the most NSF grants related to AI research?

**Ans)** Grants are identified through the hasKeyword relation connecting a Paper to a Topic.

Each Grant is then linked to an Institution via the awardedTo relation.

Counting the number of grants for a particular Topic gives the answer of how much funding is going into one Research Topic.

**2Q.** How has CS topics evolved over time?

**Ans)** Each Topic has a Trajectory, made up of time-ordered Fixes, and each Fix corresponds to a Paper with a publication date.

By aggregating these fixes along the trajectory, the ontology provides a timeline showing how a CS topic has evolved over time.

**3Q.** Which NSF projects produced the highest innovation velocity?

**Ans)** The number of papers and patents that are being released in a particular Topic after a grant is issued is the innovation velocity

Using the awardDate of the grant and the hasDate values of resulting papers/patents, the ontology measures how quickly new outputs appear.

This allows computation of innovation velocity.

**4Q.** Which authors frequently publish in both academic venues (conferences/journals) and also file patents?

**Ans)** The schema links an Author to Paper and Inventors to their Patents.

Person who appear in both sets—those who have writes → Paper (Venue) and files → Patent (hasInventor) —are identified as publishing academically while also generating patents.

**5Q.** Which NSF-funded areas have produced patents most rapidly (shortest time lag)?

**Ans)** Each Grant is linked to one or more Topics and to resulting Patents.

By comparing the awardDate of a grant with the hasDate of patents connected to it, the ontology can compute the shortest time lag.

This shows which NSF-funded areas generate patents the fastest.

# THANKYOU