Databases and Artificial Intelligence Group

TU Wien, Institute of Logic and Computation

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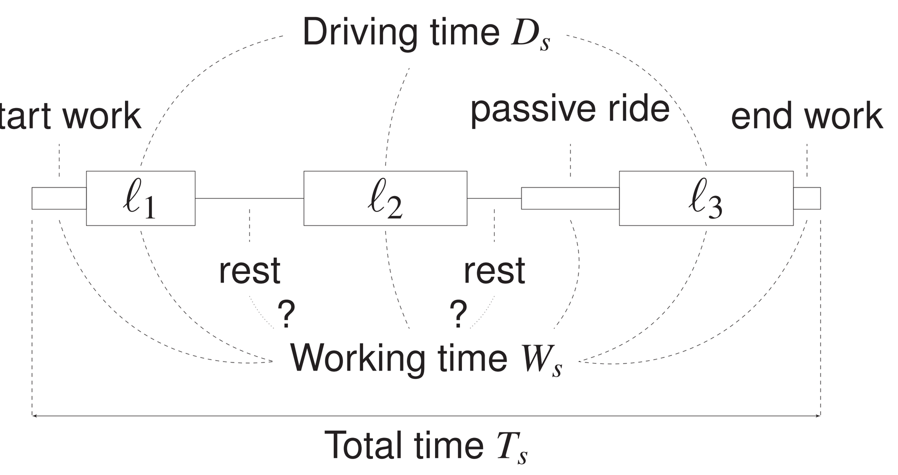
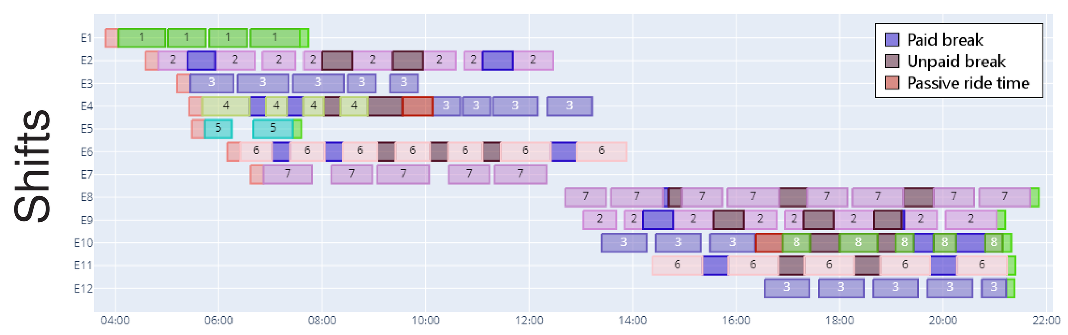
AI and Optimization for Planning and Scheduling

Bus Driver Scheduling

- Cover tours with complex rules for shifts:





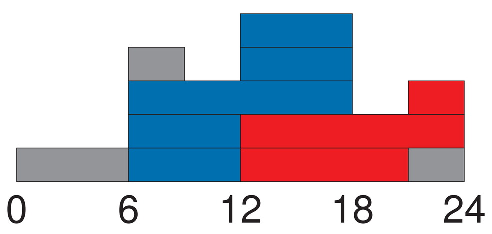
Rotating Workforce Scheduling

- Generate a rotating schedule with constraints on sequences of shifts:

Empl.	Mo	Tu	We	Th	Fr	Sa	Su
1	D	D	D	D	N	N	-
2	-	-	A	A	A	A	N
3	N	N	-	-	D	D	D
4	A	A	N	N	-	-	-

Minimum Shift Design

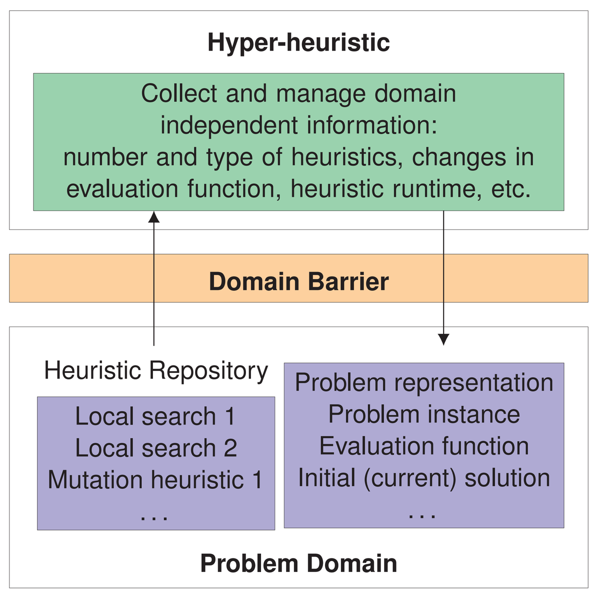
- Cover demand minimizing different shifts:



shift start	shift end	empl.
6:00	18:00	3
12:00	24:00	2
21:00	9:00	1

Solution Methods

- Constraint programming, meta-heuristics, branch-and-price, hybrid methods
- Algorithm selection and analysis

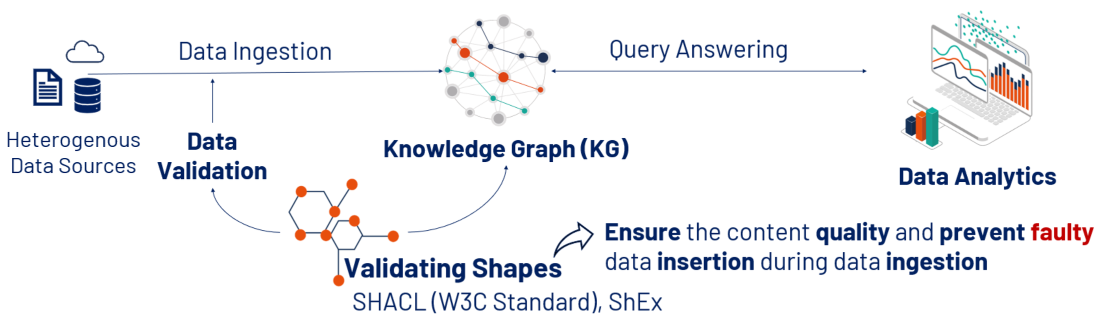


- **Hyper-heuristics**: problem- / domain-independent
- Choose among a set of low-level heuristics
- Identify good chains (Luby)
- Top results with reinforcement learning

Knowledge Graphs

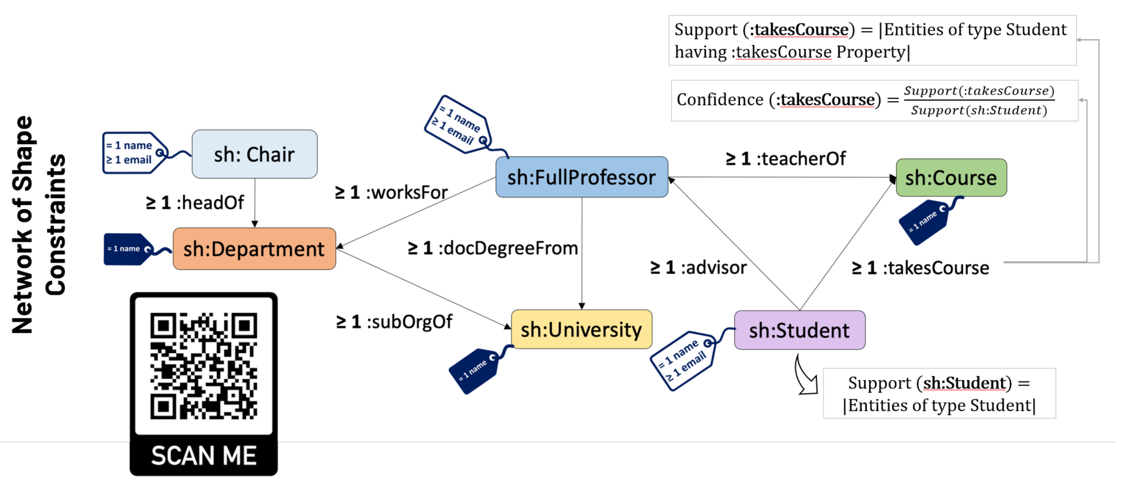
Validating Shapes for Knowledge Graphs

- Extracting (SHACL) shapes from large-scale knowledge graphs with **QSE** (Quality Shapes Extraction)



SHACTOR: SHapes ExtrACTOR

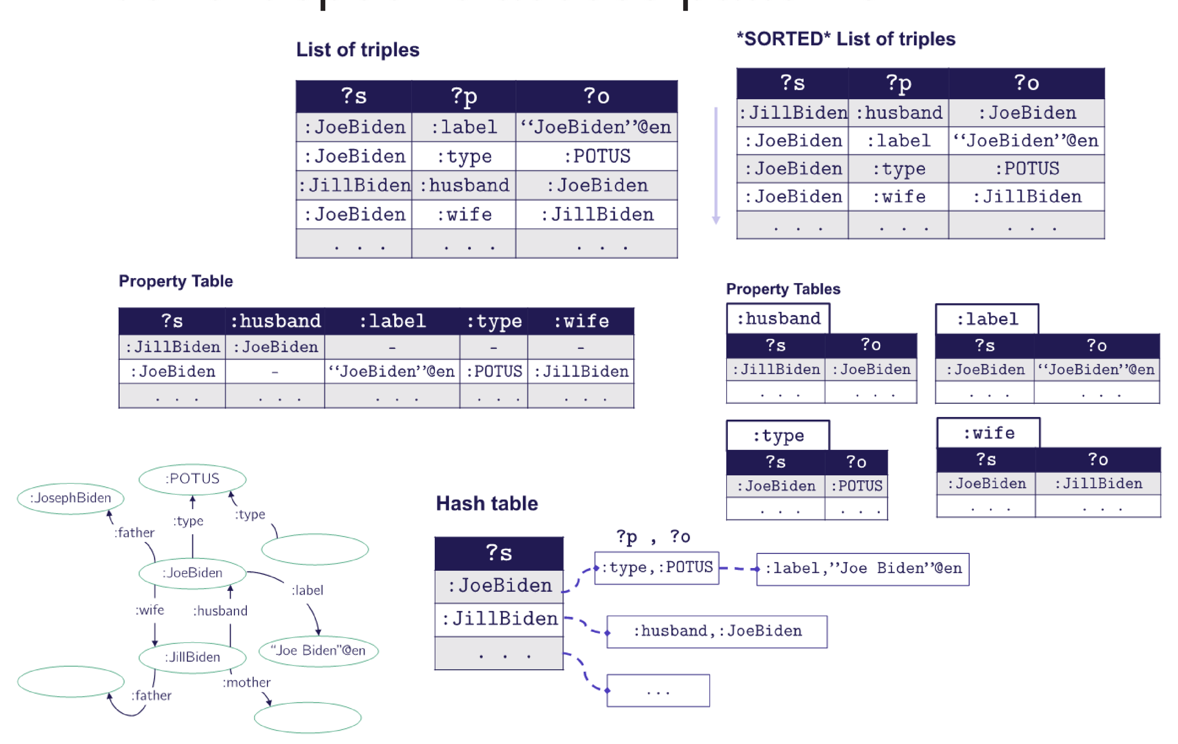
- Interactive shapes extraction and updates
- Extract meaningful shapes



Understanding RDF Data Representations

Design space for triplestores

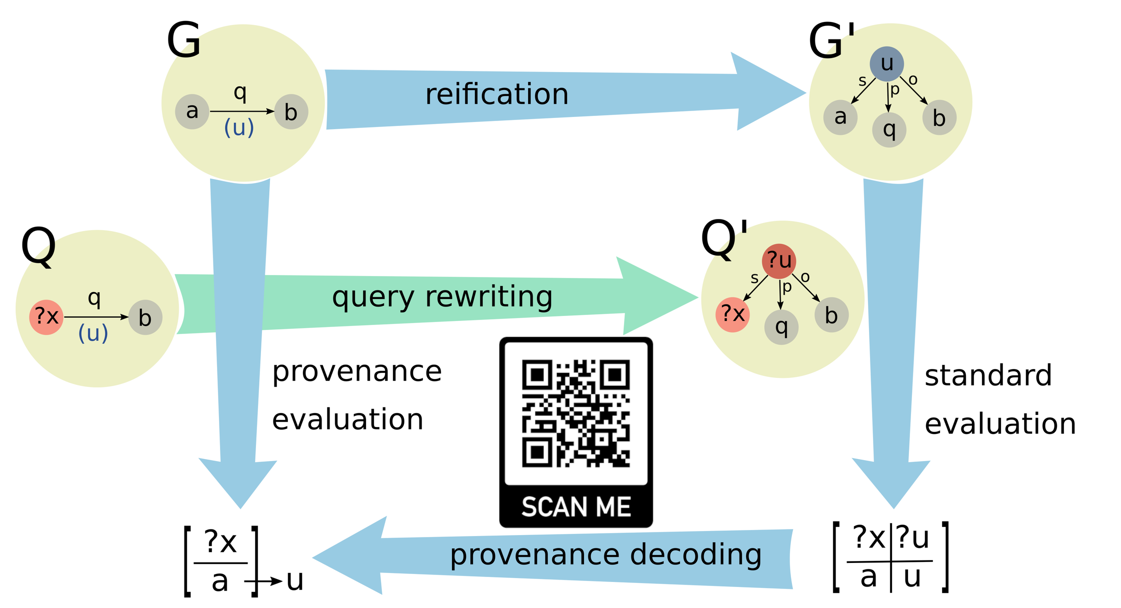
- Subdivision: How is the data fragmented to reduce the search space?
- Compression: How is the data compressed to reduce storage space?
- Redundancy: How is the data replicated to benefit specific access patterns?



How-Provenance Explanations

- How-provenance: Which triples of a knowledge graph contributed to a SPARQL query result?
- Expressed via commutative semi-rings of polynomials

⇒ **SPARQLprov**: Applies query rewriting and works on top of standard RDF stores



- Demo: Scan QR (sparqlprov.cs.aau.dk)

Computational Argumentation

Representation of Arguments and Attacks

Definition

An argumentation framework (AF) $F = (A, R)$ consists of arguments A and attacks $R \subseteq A \times A$.

A set $E \subseteq A$ is

- **conflict-free** iff $(a, b) \notin R$ for all $a, b \in E$
- **stable** iff it is conflict-free and attacks all other arguments

Example AF

$u \leftarrow x \leftrightarrow y \rightarrow v$ Stable: $\{x, v\}$ and $\{y, u\}$

- AFs with **collective attacks** (SETAFs): $R \subseteq (2^A \setminus \emptyset) \times A \rightarrow$ *directed hypergraphs*
- **Claim-augmented AFs (CAFs)**: (A, R) to $(A, R, cl) \rightarrow$ *directed labelled graphs*
- CAFs can represent Logic Programs (LPs)

Tractability via Backdoor-Treewidth

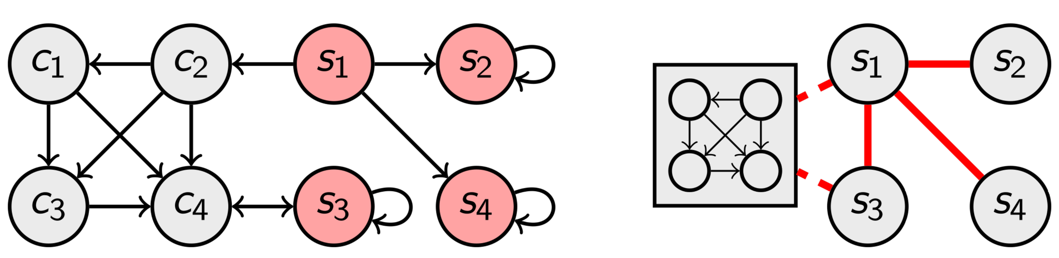
AFs are comprehensive and expressive - but computationally expensive

- Treewidth: measures "tree-likeness"
- Backdoors: removing few nodes leads to easy fragment
- **Backdoor-Treewidth**: combines the two

Definition

Given AF $F = (A, R)$, $S \subseteq A$ is **a backdoor** (to acyclicity), if removing S breaks all directed cycles.

Construct the **torso**, an aggregated version of the AF that we reason on:

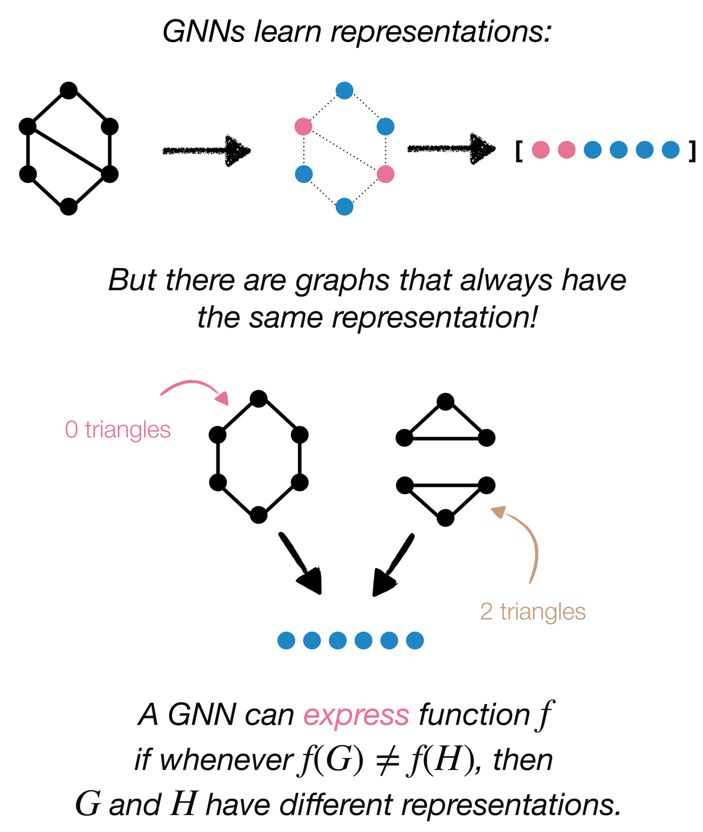


Graph Motif Parameters

$\Gamma : Graphs \rightarrow \mathbb{Q}$ is a graph motif parameter (gmp) if it is of the form:

$$\Gamma(G) = \sum_{F \in \mathcal{F}_\Gamma} \alpha_F \cdot \mathrm{homs}(F, G)$$

finite $\mathcal{F}_\Gamma$ rational coefficients



When can a GNN express a function?

- Weisfeiler-Leman graph isomorphism test

Poster prepared by Lucas Kletzander. Based on work and posters by Lucas Kletzander, Nysret Musliu, Florian Mischek, Kashif Rabbani, Matteo Lissandrini, Katja Hose, Tomer Sagi, Torben Bach Pedersen, Luis Galárraga, Daniel Hernández, Anas Katim, Michael Bernreiter, Wolfgang Dvořák, Matthias König, Anna Rapberger, Stefan Woltran, Matthias Lanzinger, and Pablo Barceló.

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