Possibilistic Qualitative Spatial and Temporal Reasoning

Institut für Informatik
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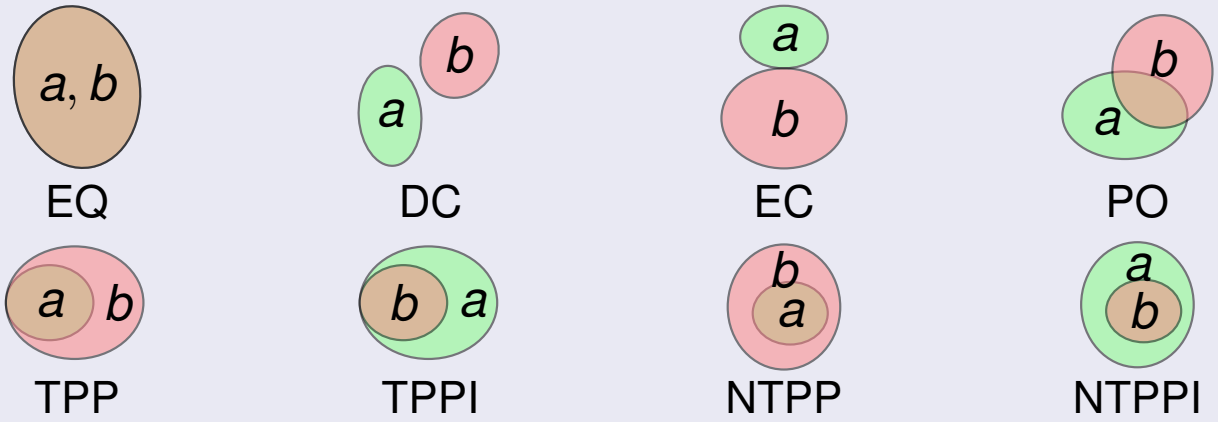
Bachelor/MasterArbeit

Constraint-based Qualitative Reasoning

Reasoning about qualitative aspects of time and/or space (infinite!) with finitely many qualitative relations between entities of interest e.g., *before*, *during*, *part of*, ...

Formal relational language $\mathcal{L}$ as a set of relations, usually jointly exhaustive and pairwise disjoint.

Example (8)



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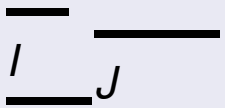
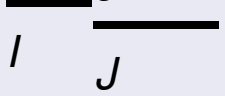
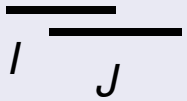
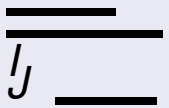
Example (Allen's Interval Calculus - AIC)

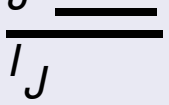
I before *J* 

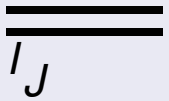
I meets *J* 

I overlaps *J* 

I during *J* 

I starts *J* 

I finishes *J* 

I equals *J* 

+ converse relations

Qualitative Constraints

Using relations as constraints

Consider reasoning problems, e.g.:

$$\varphi := \exists x, y, z \in : x \text{ (PO or DC) } y \wedge y \text{ PO } z \wedge x \text{ DC } z$$

$\rightsquigarrow$ satisfiable if there exists a consistent atomic refinement

Consistency?

Inference rules on triples of the form:

$$\forall x, y, z \in : (x\ R'\ y \wedge y\ R''\ z) \rightarrow \neg(x\ R\ z)$$

also known as “composition”

complete set of valid rules is refutation complete for non-dijunctive relations

Motivation

- The previous framework is defined relatively to first-order logic;
- Sometimes preferences can appear between relations: why not a multi-valued logic?

Disconnection $>$ Overlapping

Possibilistic Logic

Possibilistic logic uses two values to characterize an event:

- Possibility value (Π): measuring if the event is compatible with the current knowledge.
- Necessity value (N): measuring how forced is the event. (Litteraly how compatible the negation of the event is).

Merits:

- Very easy representation of uncertainty: $\Pi(x) = 1$ and $N(x) = 0$.
- Not too intractable ($\mathcal{O}(NP^{log\ n})$).

What we are looking for?

- Embed possibilistic logic within QSTR and realize an implementation based on the GQR solver!

Example

$$\varphi := \exists x, y, z \in : \begin{array}{r} \langle x \text{ PO } y, 0.4\rangle \vee \langle x \text{ DC } y, 1\rangle \quad \wedge \\ \langle y \text{ PO } z, 0.9\rangle \quad \wedge \\ \langle x \text{ DC } z, 1\rangle \end{array}$$