Preferential Query Answering in the Semantic Web with Possibilistic Networks

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Conditional Preferences

rent a car in Klagenfurt

Conditional Preferences

rent a car in Klagenfurt

?

?

Conditional Preferences

rent a car in Klagenfurt

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User preferences

$$\text{hybrid} \succ \text{gasoline}$$
$$\text{hybrid}: \text{automatic} \succ \text{manual}$$
$$\text{gasoline}: \text{manual} \succ \text{automatic}$$

Conditional Preferences

rent a car in Klagenfurt

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User preferences

hybrid $\succ$ gasoline

hybrid : automatic $\succ$ manual

gasoline : manual $\succ$ automatic

CP-theories

- 2 variables (E – engine, T – transmission)
- order of outcomes: ha $\succ$ hm $\succ$ gm $\succ$ ga

Conditional Preferences

rent a car in Klagenfurt

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CP-theories

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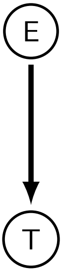
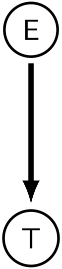
Possibilistic Networks



$\pi(\text{E})$	
hybrid	1
gasoline	0.8

$\pi(\text{T} \mid \text{E})$	hybrid	gasoline
automatic	1	0.5
manual	0.3	1



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π(T $\mid$ E)	hybrid	gasoline
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Possibility distribution

$$\pi(\mathsf{E}, \mathsf{T}) = \pi(\mathsf{E}) \cdot \pi(\mathsf{T} \mid \mathsf{E})$$

$$o_1 \succ o_2 \text{ iff } \pi(o_1) > \pi(o_2)$$

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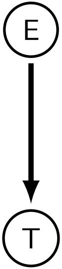

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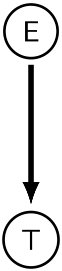

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$$1.0 > 0.8 > 0.4 > 0.3$$

Advantages

- weighted preferences: ha $\succ$ hm is stronger than h $\succ$ g
- lower complexity of deciding $o_1 \succ o_2$ (P vs. PSPACE)

Ontological Possibilistic Networks (OP-nets)

table001

€80	gasoline	manual
€120	hybrid	automatic

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€80	gasoline	manual
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cars

c_1	€75
c_2	€80

features

c_1	hybrid	1
c_1	automatic	2
c_2	gasoline	1
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Aggregated view:

offer

a_1	€80	s_1
a_1	€120	c_1
a_2	€75	c_1
a_2	€80	c_2

specs

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$$\text{table001}(P, E, T) \to \exists S.\text{offer}(a_1, P, S) \wedge \text{specs}(S, E, T)$$

$$\text{cars}(C, P) \wedge \text{features}(C, E, 1) \wedge \text{features}(C, T, 2) \to \text{offer}(a_2, P, C) \wedge \text{specs}(C, E, T)$$

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π(transmission | engine)	hybrid	gasoline
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Ontological Possibilistic Networks (OP-nets)

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€80	gasoline	ma
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Database D

features		
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c_1	automatic	2
c_2	gasoline	1
c_2	automatic	2

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cars(... $E, T)$

Ontology (Datalog$^{\pm}$ program) Σ

engine → transmission

π(engine)	
hybrid	
gasoline	

gasoline
0.5
1

Possibilistic network Γ

Reasoning Problems

OP-net (D, Σ, Γ)

Consistency (of Γ w.r.t. Σ)

- there exists a consistent outcome
- no two equivalent (consistent) outcomes have different possibilities

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Answering conjunctive queries (CQs)

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skyline answer

Complexity of skyline answering

Datalog$^{\pm}$ language	**Combined** D, Σ, Γ, q	**Bounded arity** arity $\leq c$	**Fixed program** D, Γ, q	**Data** D
L, LF, AF	PSPACE	Δ_3^{P}	Δ_2^{P}	in AC^0
S, SF	EXP	Δ_3^{P}	Δ_2^{P}	in AC^0
F, GF	EXP	Δ_3^{P}	Δ_2^{P}	P
G	2EXP	EXP	Δ_2^{P}	P
WS, WA	2EXP	2EXP	Δ_2^{P}	P
WG	2EXP	EXP	EXP	EXP

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Other kinds of preferences

- at least PSPACE for CP-theories
- upper bounds apply to any polynomial total order $\prec$

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Thank you!

[Boutillier et al., UAI'99] CP-nets, conditional preferences $u : x \succ x'$

[Wilson, AAAI'04] CP-theories, more expressive preferences $u : x \succ x' \, [W]$

[Goldsmith et al., JAIR'08] complexity of CP-nets

[Benferhat et al., IJAR'02] possibilistic networks for modeling uncertainty, possibilistic counterpart of Bayesian networks

[Ben Amor et al., SUM'14] possibilistic networks for quantitative modeling of preferences, alternative to CP-nets

[Di Noia et al., IJCAI'15] CP-theories with Datalog$^\pm$ ontologies

[Borgwardt et al., IJCAI'16] CP-nets with Datalog$^\pm$ ontologies