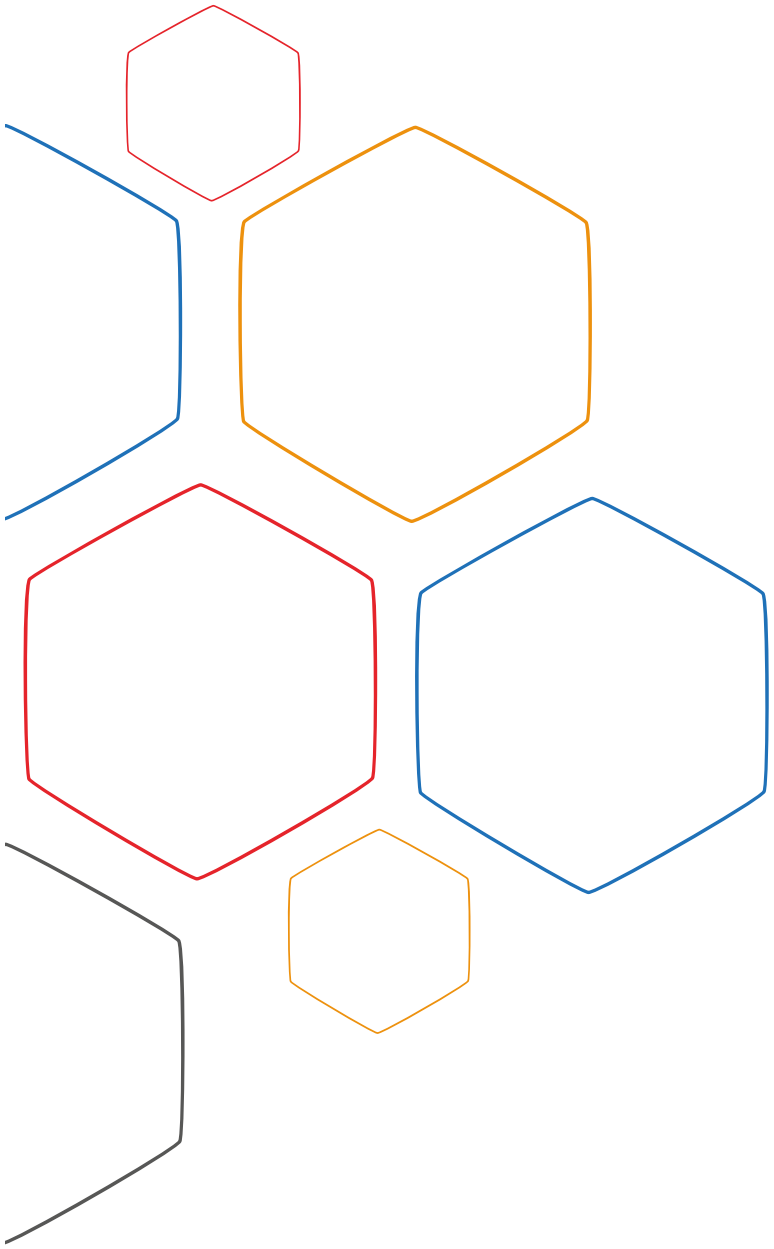

LIRMM

Complexity Results in Optimistic/Pessimistic Preference Reasoning

ICTAI, November 2016, San Jose

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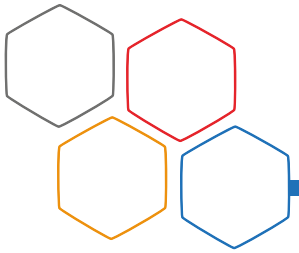
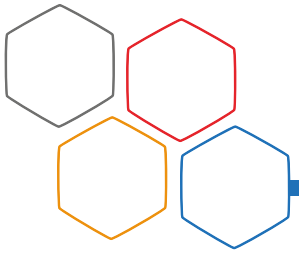


Summary

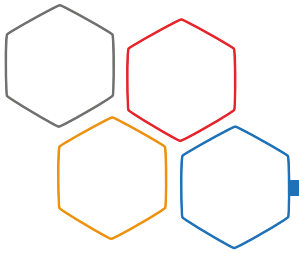
- Background in preference reasoning
  - Semantics
  - Main problems
- Contributions
  - Complexity study of main problems in preference reasoning
  - Knowledge compilation : improving through pre-processing



How express a preference ?

Suppose the preference « I prefer salad to tomato »

- Quantitative preference
  - " I like a salad with weight 0.7 and tomato with weight 0.3 "
- Qualitative preference
  - " I prefer salad rather than tomato"

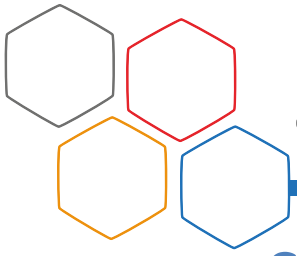


Main problems

- Undominated
  - " Does it exist an outcome which is the most preferred? "
- Dominance
  - " Given two outcomes ω, ω' , is ω strictly preferred as ω'? "
- Consistency
  - " Is the network consistent ? " (absence of dominance cycle)

Formalisms - Complexity

	Dominance	Consistency
CP-nets[1]	PSPACE-complete[4]	PSPACE-complete[4]
Conditionnal Logic[2]	?	?
Prototypical preference logic[3]	PSPACE-complete[3]	PSPACE-complete[3]



Semantics – How to interpret a preference?

Suppose the preference « I prefer salad to tomato »

1:Optimistic

[Pearl, 1990]

at least one salad meal is strictly preferred to all tomato meals

2:Strong (called strict)

[Boutilier, 1994]

all salad meals are strictly preferred to all tomato meals regardless main dish / wine

3:Ceteris paribus

[Hansson, 1996]

Salad meals are strictly preferred to tomato meals all other things being equal

4:Pessimistic

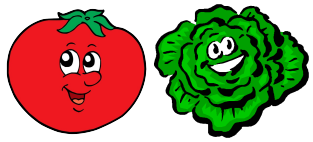
[Benferhat et al., 2002]

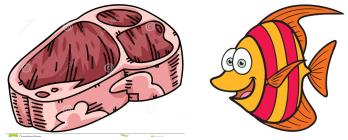
at least one tomato meal is less preferred to all salad meals

Notations

Guideline example

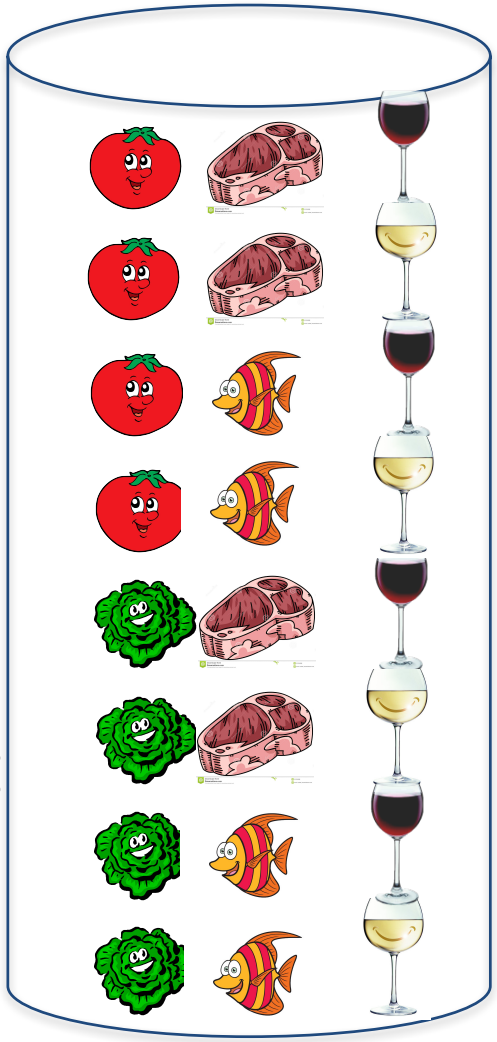
Choosing a meal according to

Starter ={  }

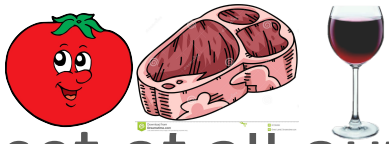
Main dish ={  }

Wine={  }

Ω

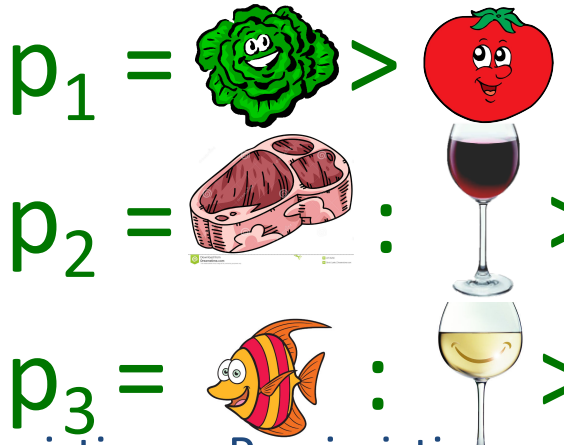


- An outcome ω is a complete assignment

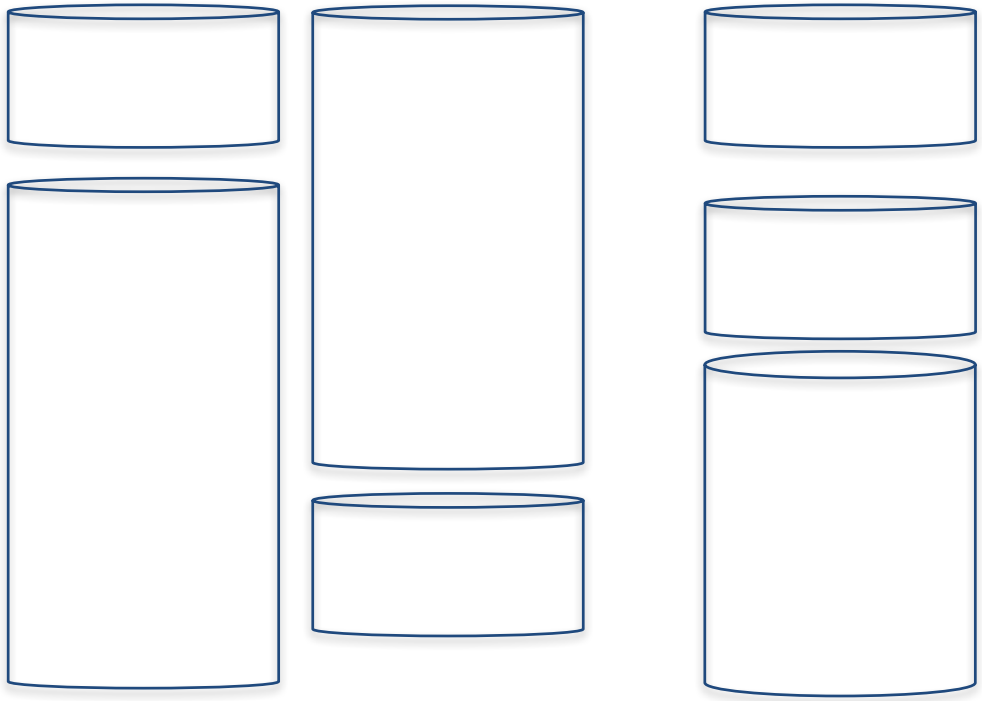


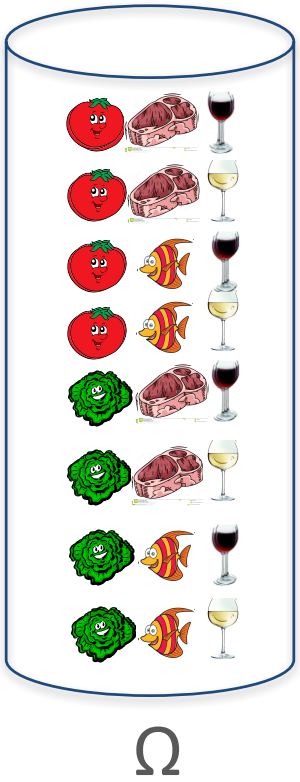
- The set of all outcomes Ω

Framework – Conditionnal logic formalism



Semantic = Optimistic Pessimistic Optimistic Strong=p1





State of the art - Conditionnal logic formalism

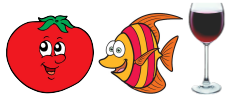
Layers are explicitely built :

Algorithm Exponential in space

- Undominated

  Choose an outcome in $Layer_0$

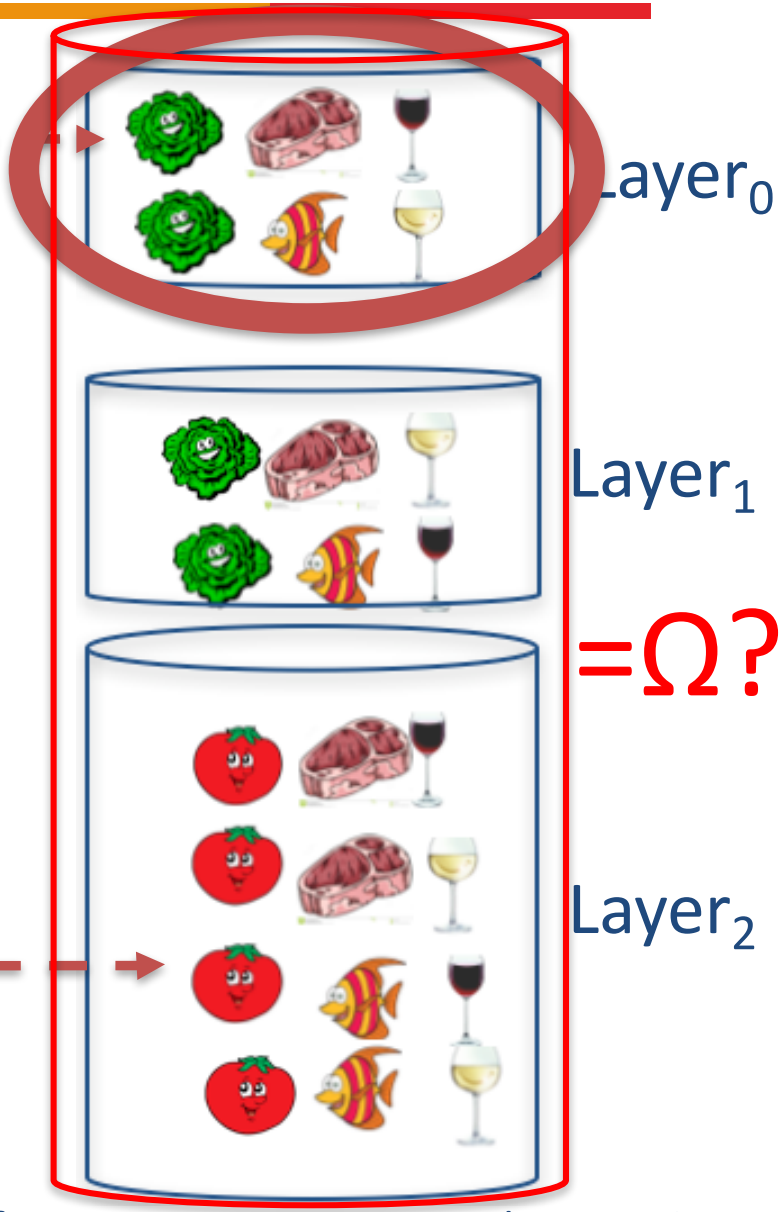
- Dominance ()

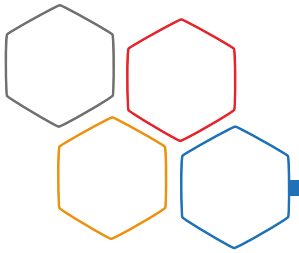
  Layer  < Layer 

  Yes

- Consistency

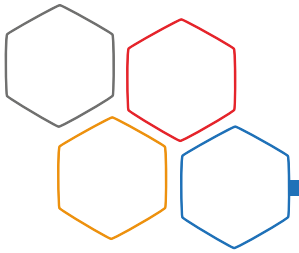
  Check that $Layer_0 \cup \ldots \cup Layer_n = \Omega$





Contributions - Complexity map

Problem	Strong Preferences	Optimistic	Pessimistic
Undominated	All		
	Not All		
Consistency	All		
	Not All		
Dominance	All		
	Not All		



Contributions - Complexity map

Problem	Strong Preferences	Optimistic	Pessimistic
Undominated	All	NP-complete	Polynomial
	Not All	NP-complete	NP-complete
Consistency	All		
	Not All		
Dominance	All		
	Not All		

- Complexity depends on the semantic

Contributions - Complexity map

Problem	Strong Preferences	Optimistic	Pessimistic
Undominated	All	NP-complete	Polynomial
	Not All	NP-complete	NP-complete
Consistency	All	Polynomial	Polynomial
	Not All	NP-complete	NP-complete
Dominance	All		
	Not All		

- Complexity depends if all preferences are strong

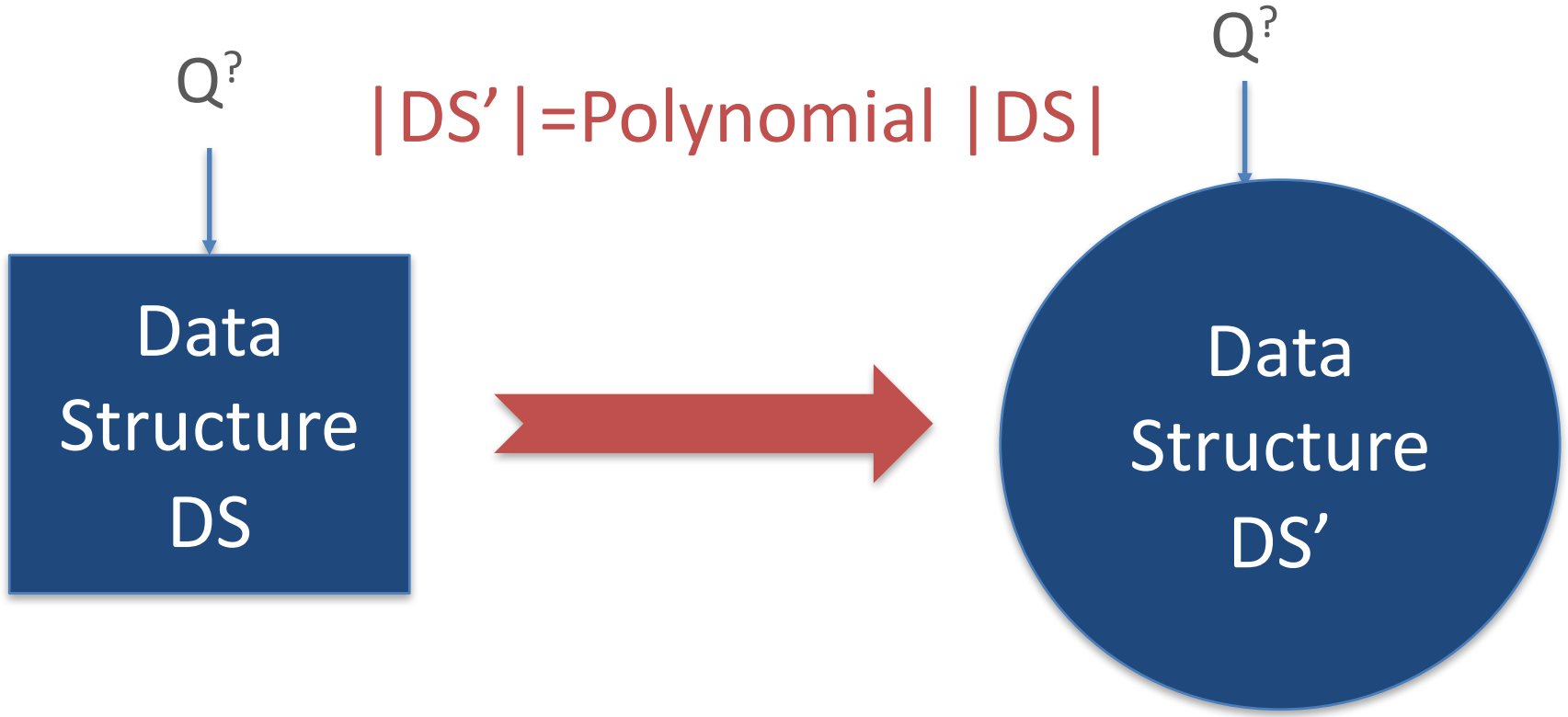
Contributions - Complexity map

Problem	Strong Preferences	Optimistic	Pessimistic
Undominated	All	NP-complete	Polynomial
	Not All	NP-complete	NP-complete
Consistency	All	Polynomial	Polynomial
	Not All	NP-complete	NP-complete
Dominance	All	Polynomial	Polynomial
	Not All	DP-complete	DP-complete

- Dominance is the only problem called several times
  - Many different pairs (ω, ω')
  - Unfortunately DP-complete

Knowledge compilation- Background

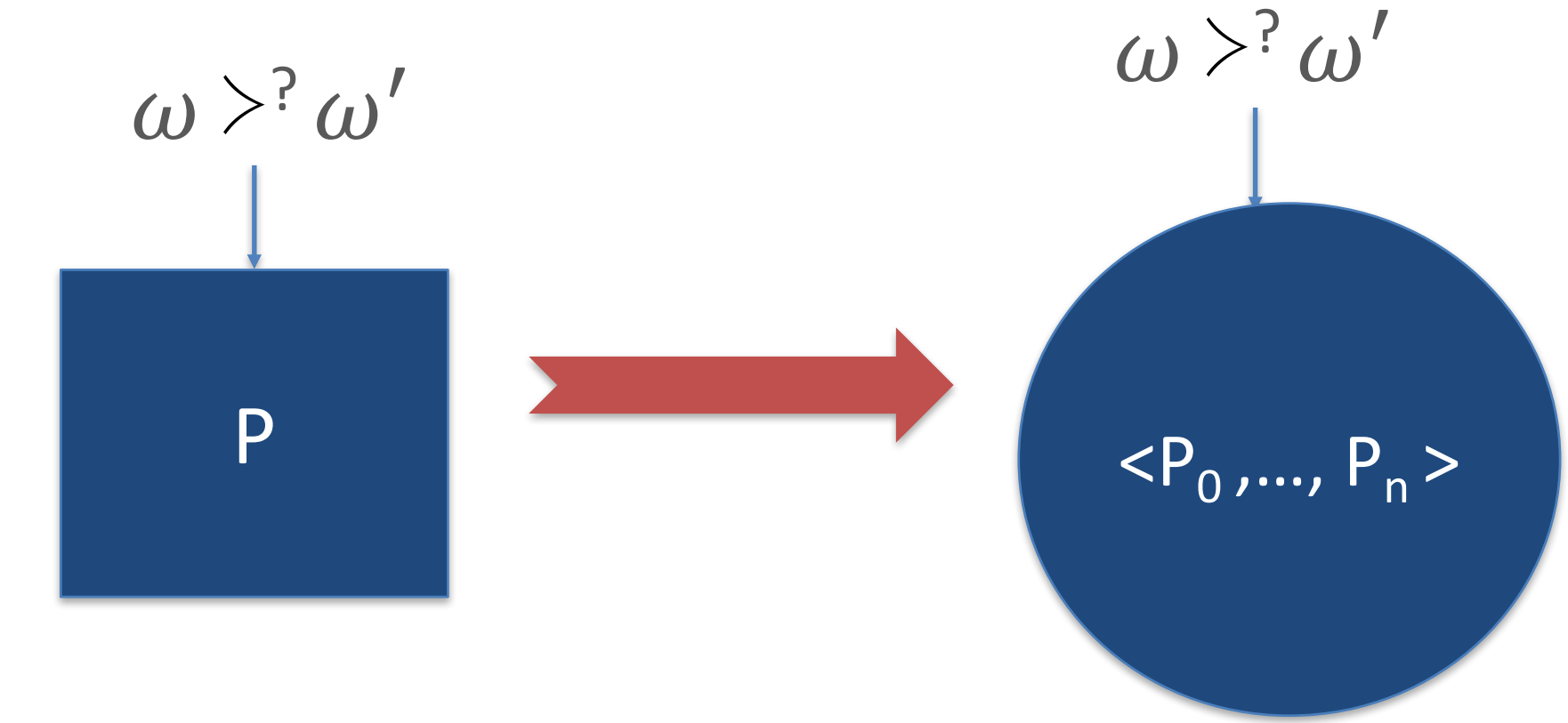
Take as much time as needed



Complexity of $Q^?$: Hard

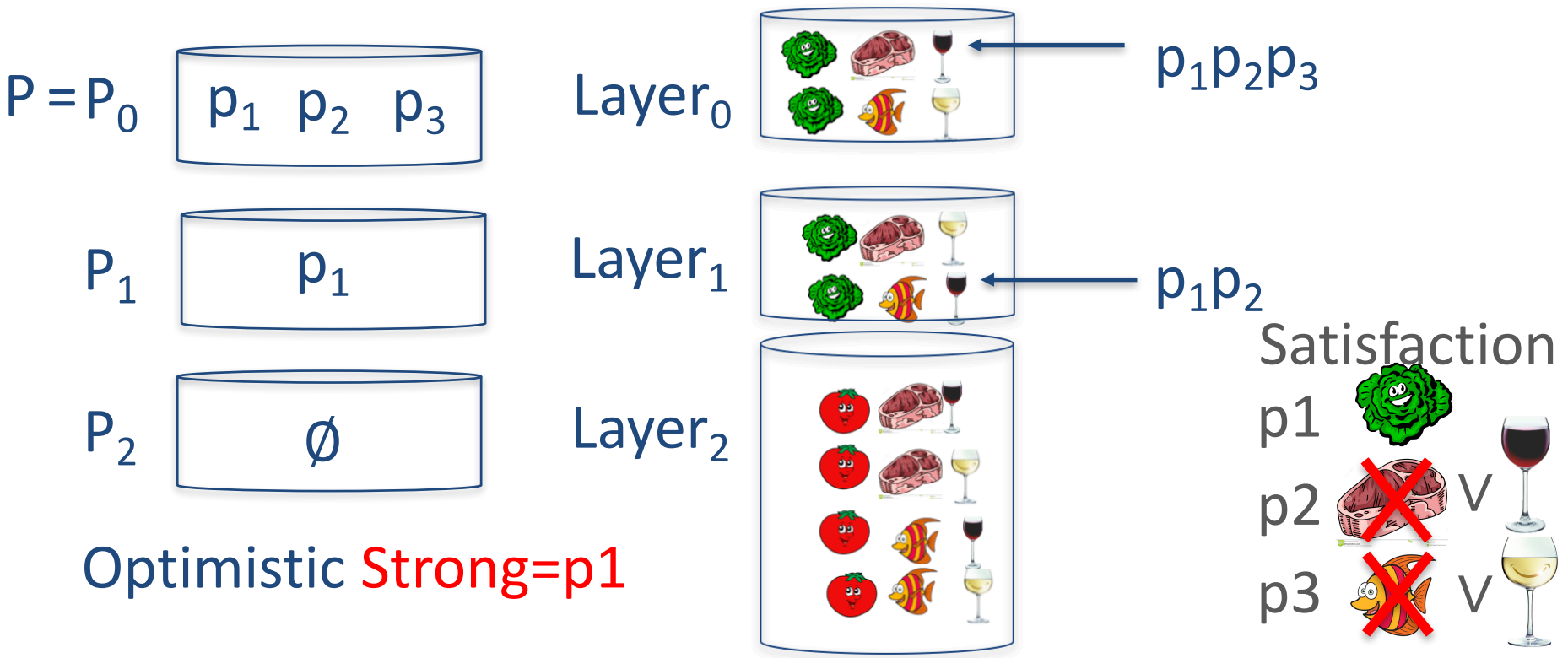
Complexity of $Q^?$: Easier

Knowledge compilation- Dominance



Compiled preferences - Equivalence

- Outcomes in $Layer_i$ are those which :
  - satisfy all preferences in P_i
  - violate at least one preference in $P_{i-1} \backslash P_i$



Optimistic Strong=p1

Compiled preferences - Complexity

p_1 =  > 

p_2 =  :  > 

p_3=  :  > 

Optimistic Strong=p1

Satisfaction

p1 

p2  V 

p3  V 

Full Satisfaction

p1 

p2  Λ 

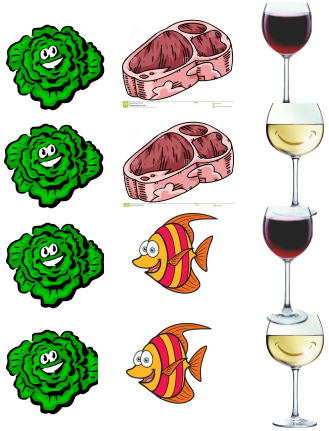
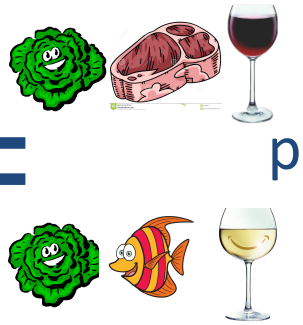
p3  Λ 

$P = P_0$ | p_1 p_2 p_3

P_1 | p_1

Deactivation of p_1

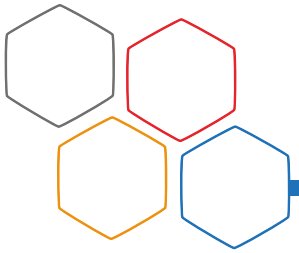
{fully satisfaction p_1} = {satisfaction p_1 and p_2 and p_3}

 ≠ 

p_1 is not deactivated

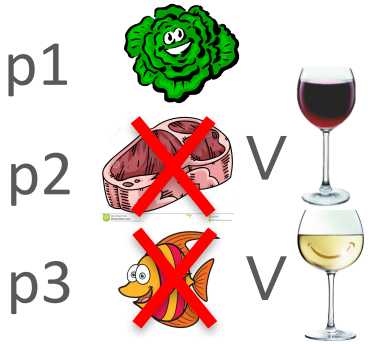
The deactivation of a strong preference is Polynomial

Compiled preferences - Complexity

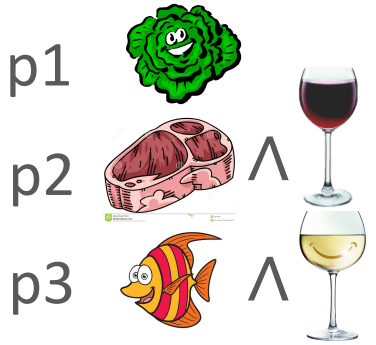


Optimistic Strong=p1

Satisfaction

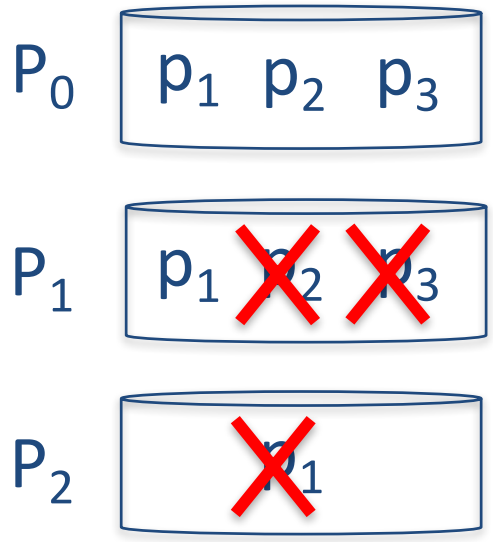


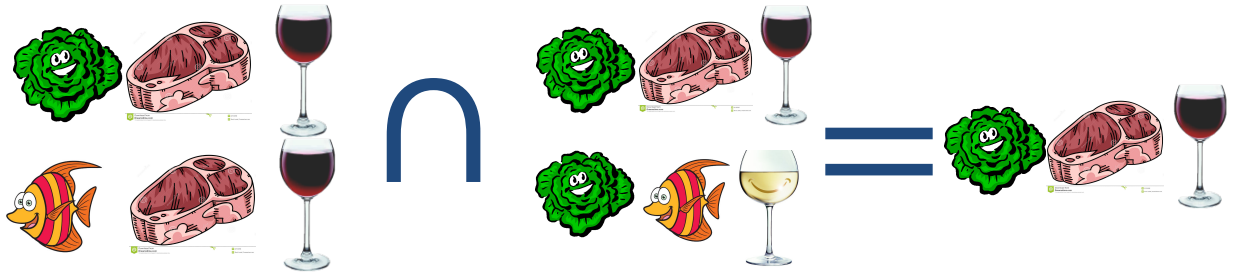
Full Satisfaction



Deactivation of p_2

{fully sat p_2} ∩ {sat p_1 and p_2 and p_3} ≠ ∅

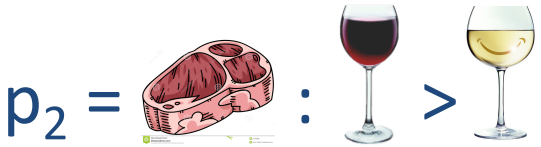


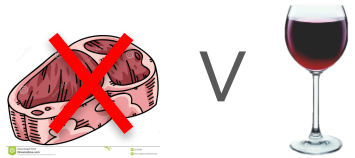


p_2 is deactivated

The deactivation of a preference is NP-complete

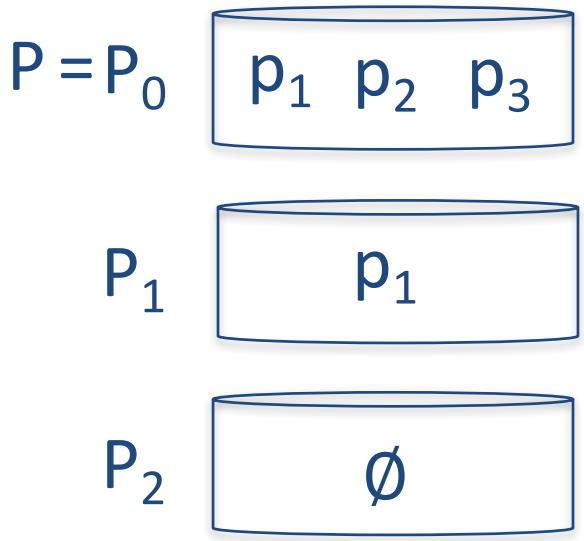
Contributions: Dominance(<P_0,…,P_n>) is Polynomial*

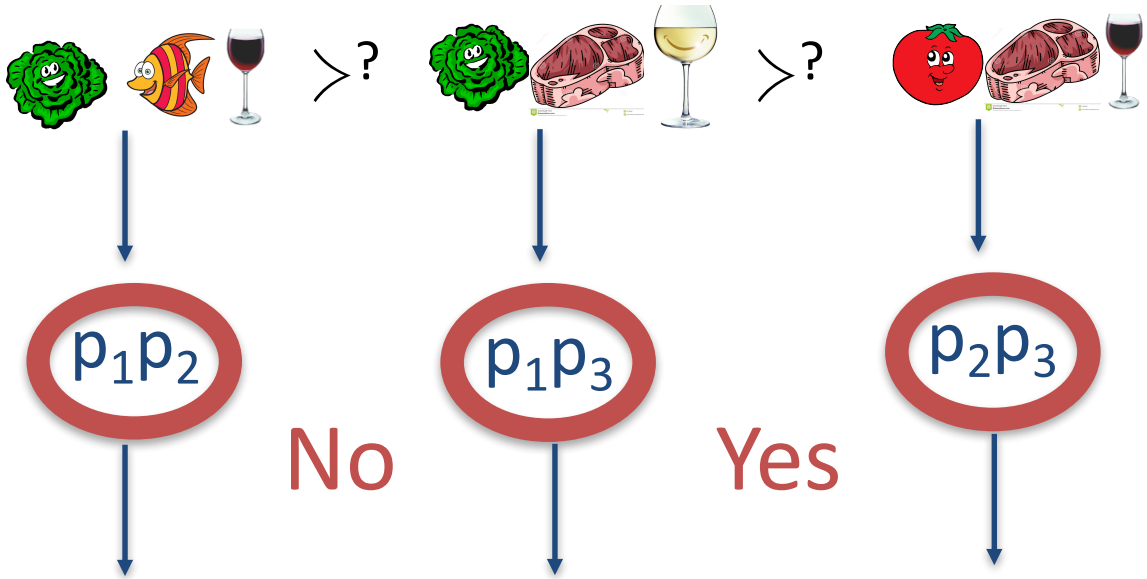




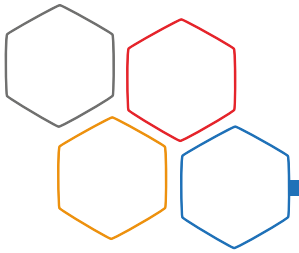
Optimistic Strong=p1

Satisfaction





*Linear with an index encoding



Conclusion

- Complexity study of main problems in preference reasoning in an existing framework
  - Depends on the semantic S
  - Depends on the set of strong preferences Str
- Dominance is compilable to polynomial time

Thank you for your attention