

# ***Inconsistent-Tolerant DL-Lite Reasoning: An Argumentative Approach***

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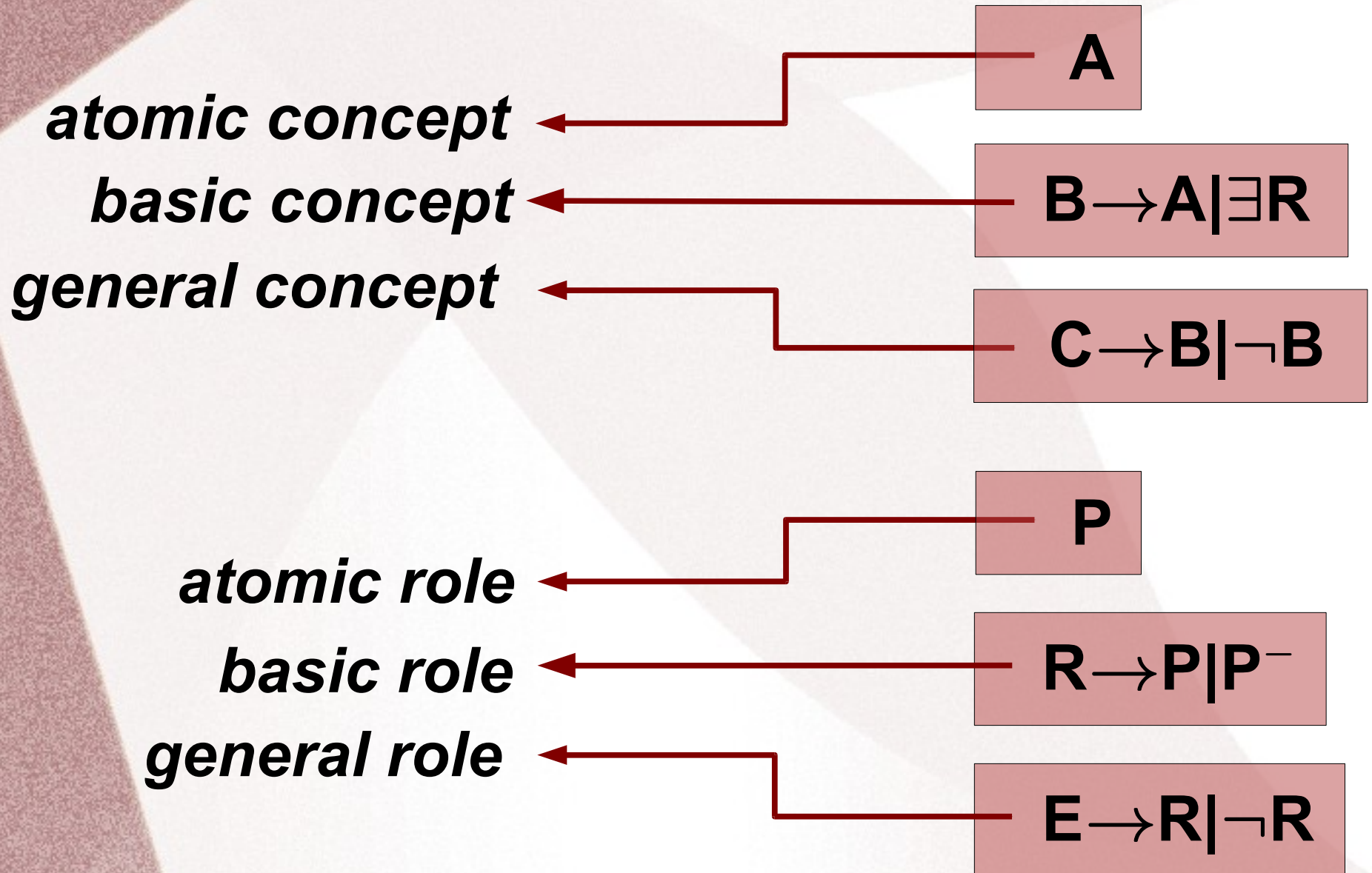
***University of São Paulo (USP)***

***BRAZIL***

***DL-Lite<sub>A</sub>***

# *DL-Lite<sub>A</sub>*

## *Grammar*



## Knowledge Base

### DL-Lite Grammar:

$B \rightarrow A | \exists R$        $C \rightarrow B | \neg B$

$R \rightarrow P | P^-$        $E \rightarrow R | \neg R$



TBox

$B \sqsubseteq C$

$R \sqsubseteq E$

*(funct R)*

ABox

$A(a)$

$P(a,b)$

## *Reasoning Services*

*Subsumption*

$$\left\{ \begin{array}{l} \Sigma \models \mathbf{C}_1 \sqsubseteq \mathbf{C}_2 \\ \Sigma \models \mathbf{E}_1 \sqsubseteq \mathbf{E}_2 \end{array} \right.$$

*Functionality*

$$\left\{ \begin{array}{l} \Sigma \models (\mathit{funct} \mathbf{R}) \\ \Sigma \models \neg(\mathit{funct} \mathbf{R}) \end{array} \right.$$

*Query Answering*

$$\left\{ \Sigma \models q(\tilde{y}) \right.$$

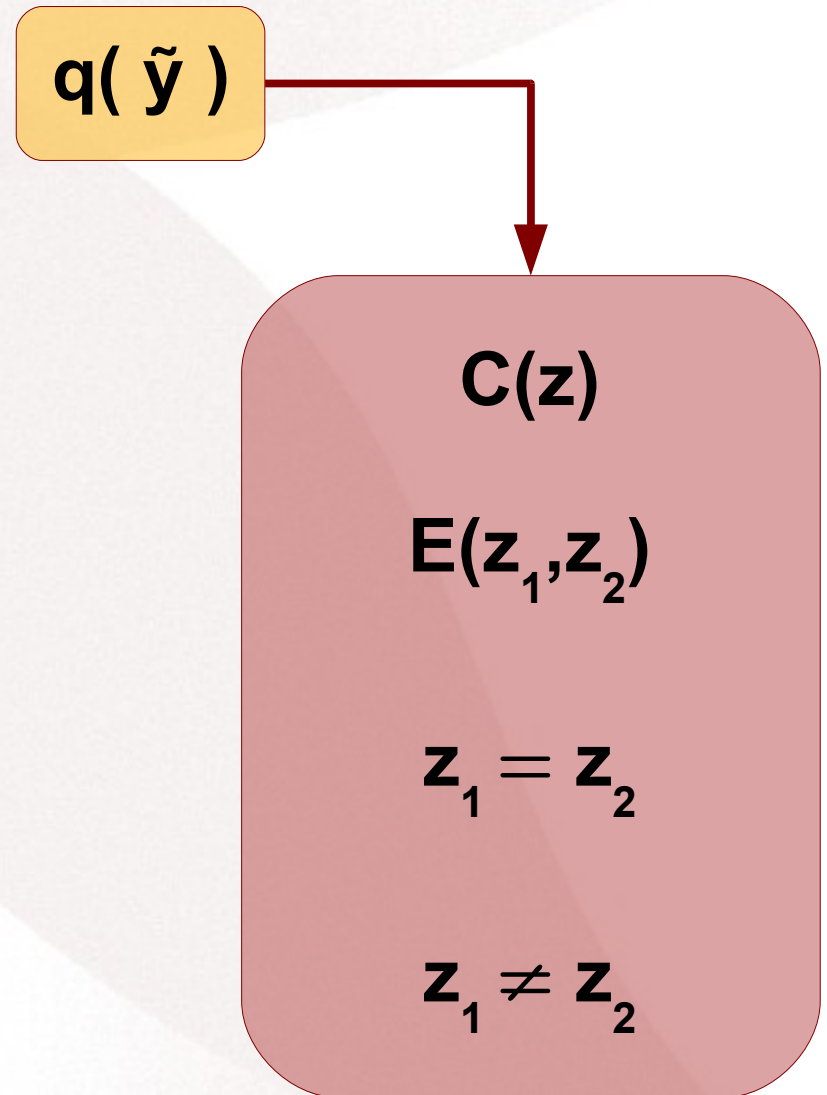
### **DL-Lite Grammar:**

$\mathbf{B} \rightarrow \mathbf{A} \mid \exists \mathbf{R} \quad \mathbf{C} \rightarrow \mathbf{B} \mid \neg \mathbf{B}$

$\mathbf{R} \rightarrow \mathbf{P} \mid \mathbf{P}^- \quad \mathbf{E} \rightarrow \mathbf{R} \mid \neg \mathbf{R}$

# Conjunctive Queries

**DL-Lite<sub>A</sub>**

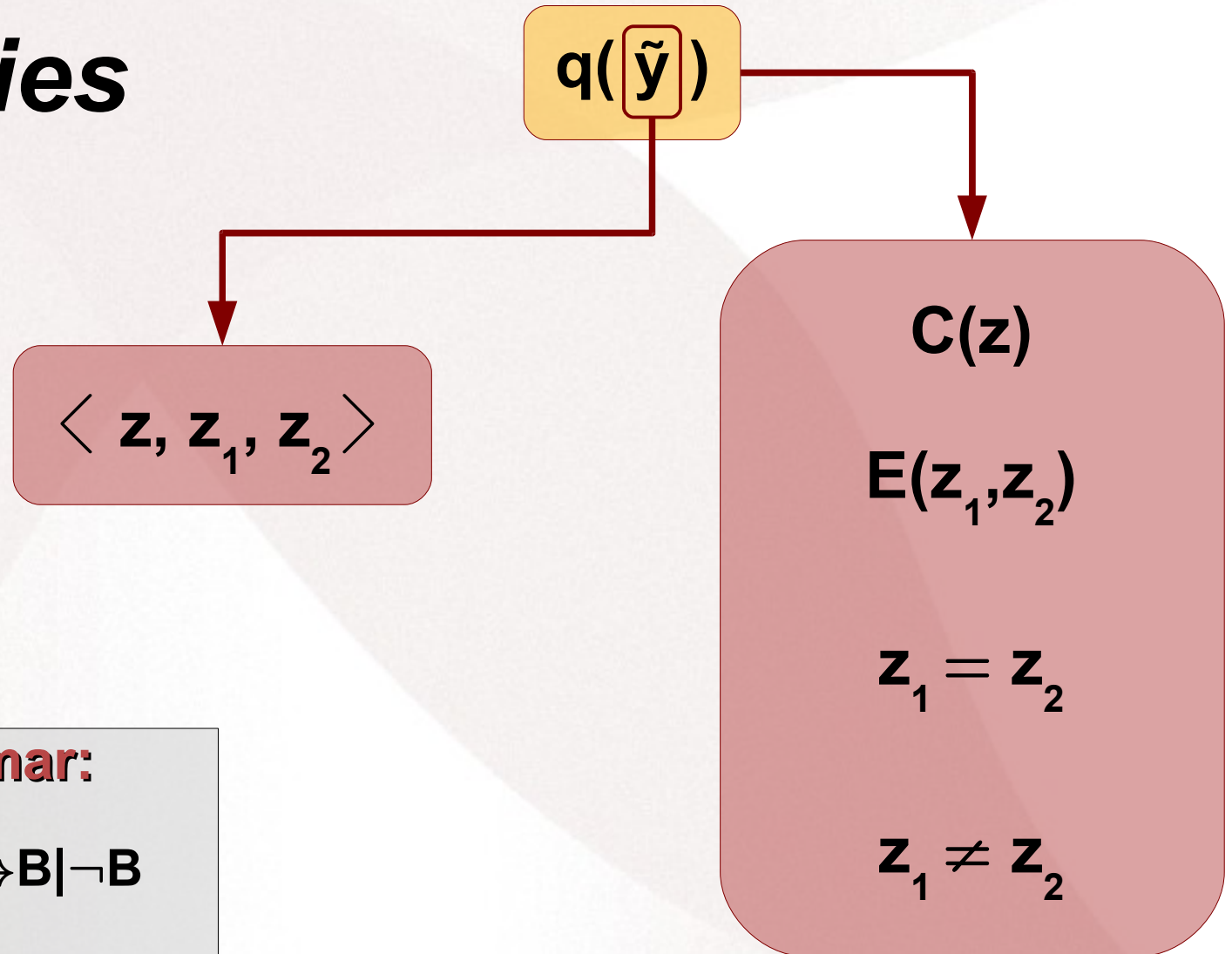


## DL-Lite Grammar:

$B \rightarrow A | \exists R$        $C \rightarrow B | \neg B$

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## Conjunctive Queries

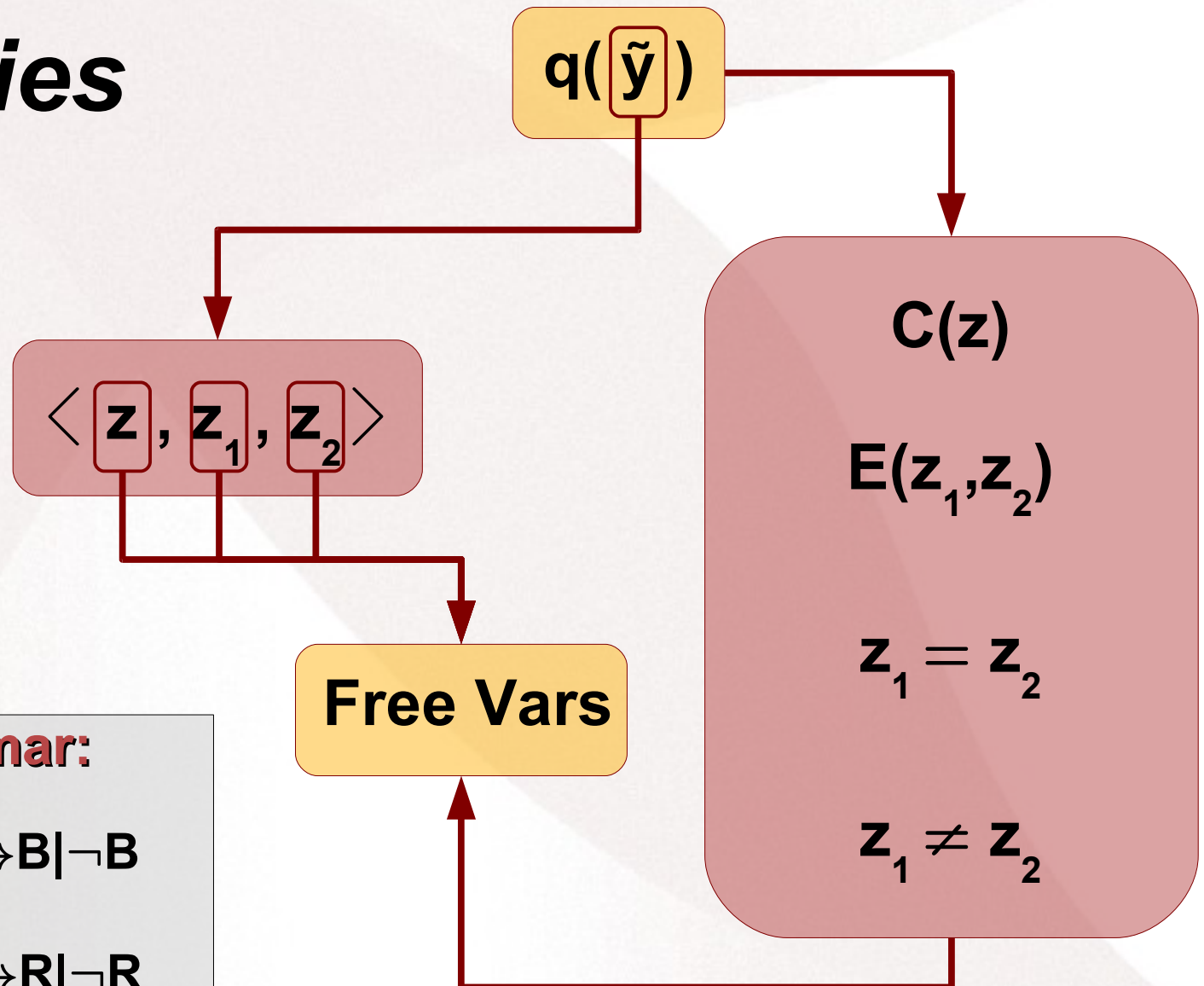


### DL-Lite Grammar:

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## Conjunctive Queries



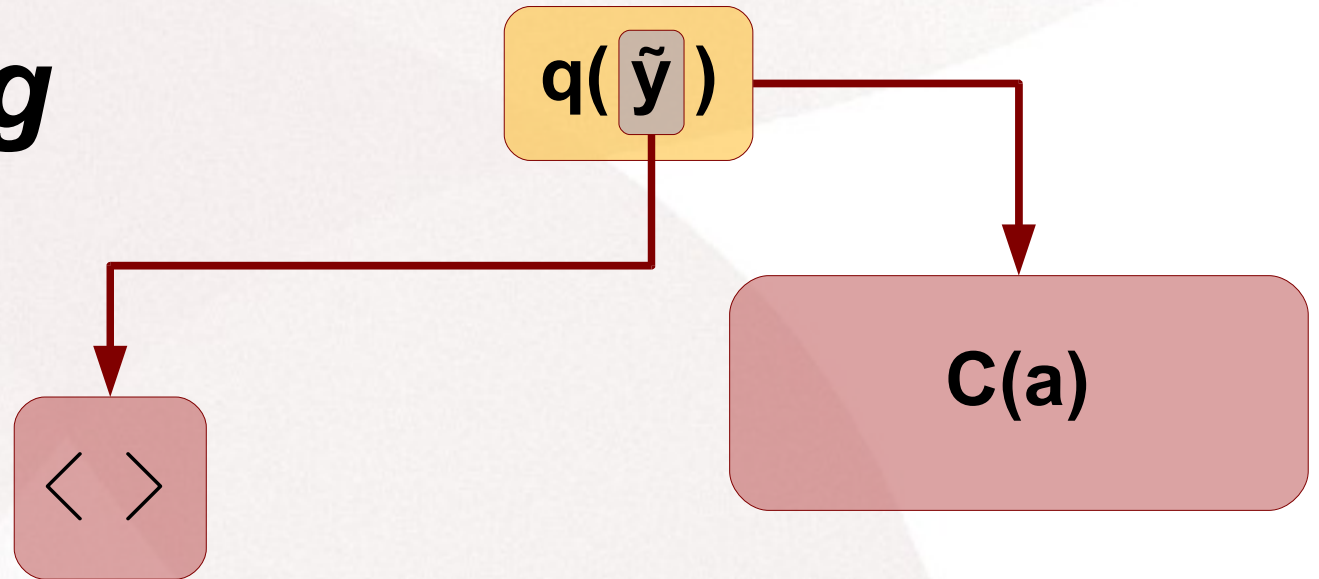
### DL-Lite Grammar:

$B \rightarrow A | \exists R$        $C \rightarrow B | \neg B$

$R \rightarrow P | P^-$        $E \rightarrow R | \neg R$

# Instance Checking

*DL-Lite*<sub>A</sub>



## DL-Lite Grammar:

$B \rightarrow A \mid \exists R$        $C \rightarrow B \mid \neg B$

$R \rightarrow P \mid P^-$        $E \rightarrow R \mid \neg R$



***DL-Lite Argumentation:  
Foundations***

# *Argumentation*

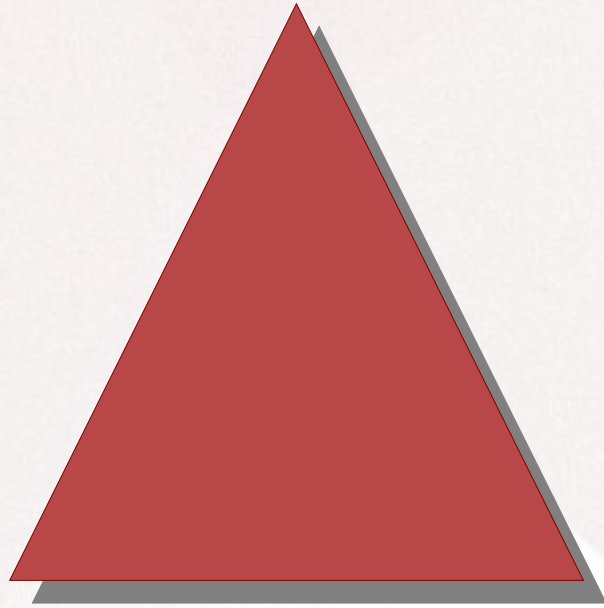
# *Argumentation*

## **Intuition:**

*Basis by which people protect their beliefs or self-interests in rational dialogue, in common parlance, and during the process of arguing.*

# ***Argumentation***

## ***Arguments***

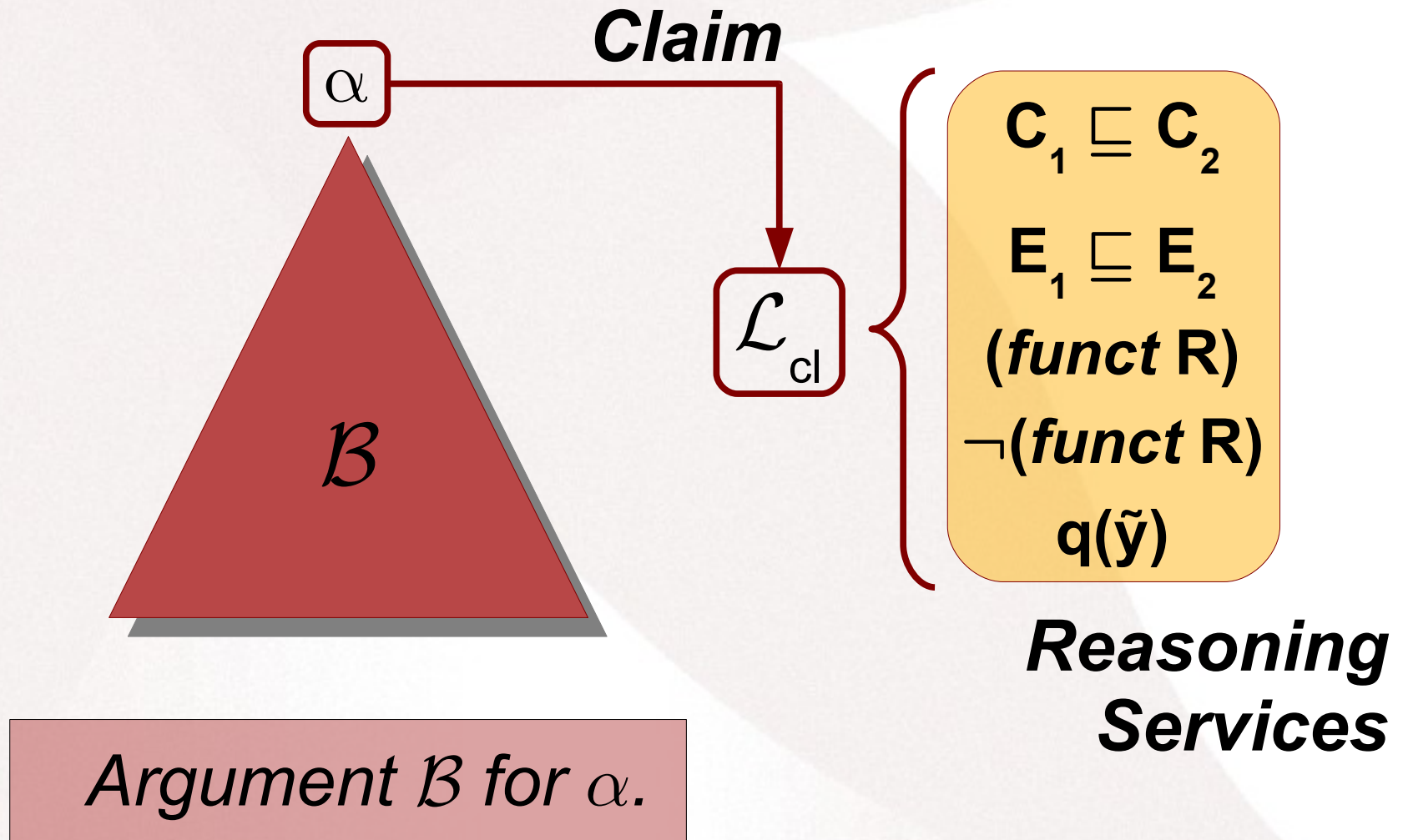


### ***Intuition:***

*Set of interrelated pieces of knowledge supporting a claim.*

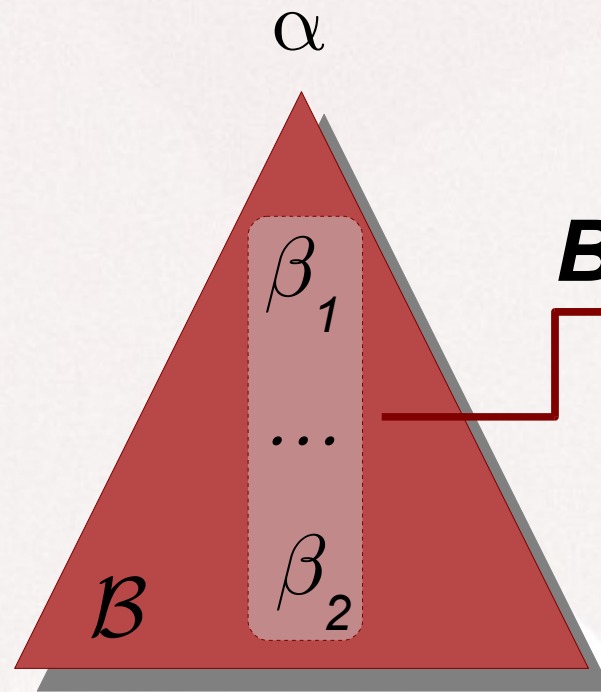
# DL-Lite Argumentation

## Arguments



# Argumentation

## Arguments



$$(1) \Delta \subseteq \Sigma$$

$$(2) \Delta \models \alpha$$

$$(3) \Delta \neq \perp$$

$$(4) \nexists X \subset \Delta : X \models \alpha$$

Argument  $B$  for  $\alpha$ .

# *Arguments*

## *Examples*

$\neg(\text{funct } P)$

$P(a,b)$

$P'(a,c)$

$P' \sqsubseteq P$

# Arguments supporting the user's query

User's query

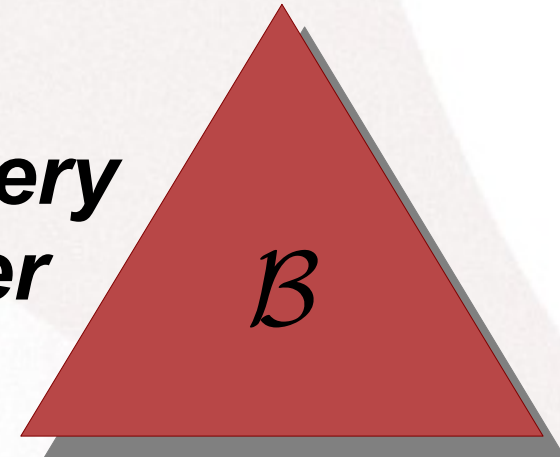
$$\Sigma \models \alpha$$

$\beta$  unifies  
with  $\alpha$

$$\beta$$

Possible query  
supporter

$\mathcal{B}$



# Arguments supporting the user's query

User's query

$$\Sigma \models \alpha$$

$\beta$  unifies  
with  $\alpha$

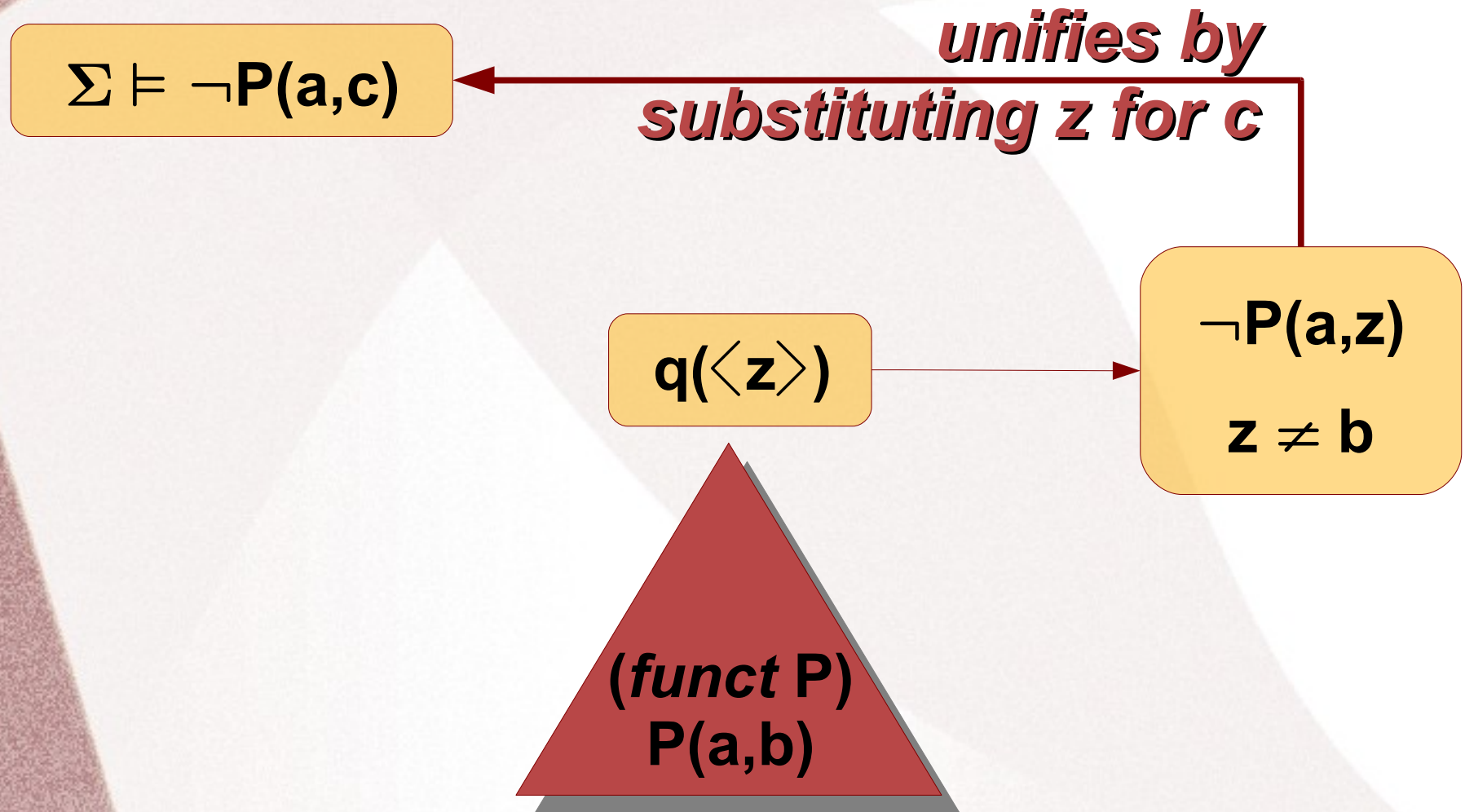
$$\beta$$

Should be  
warranted

$\beta$

# Arguments supporting the user's query

## Examples

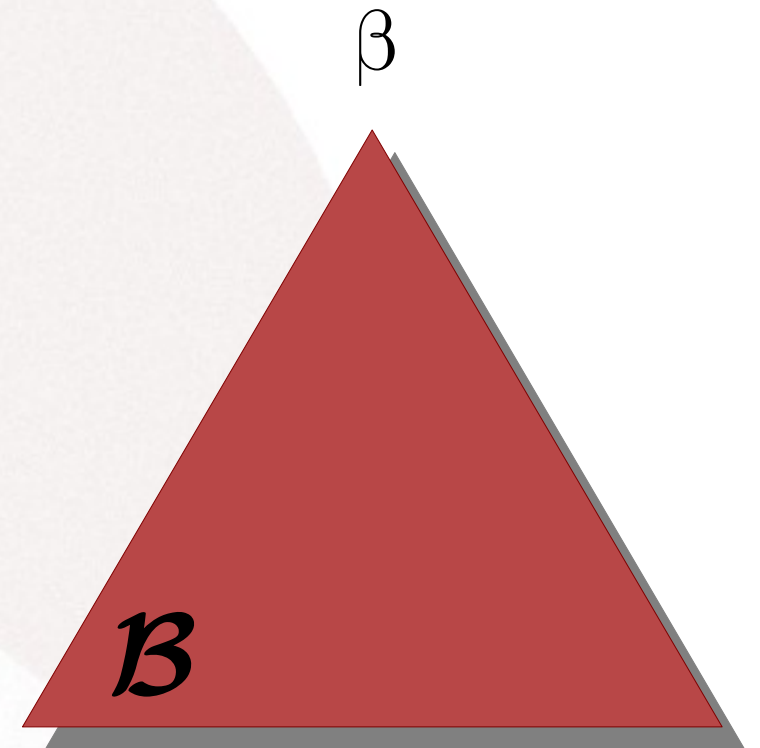
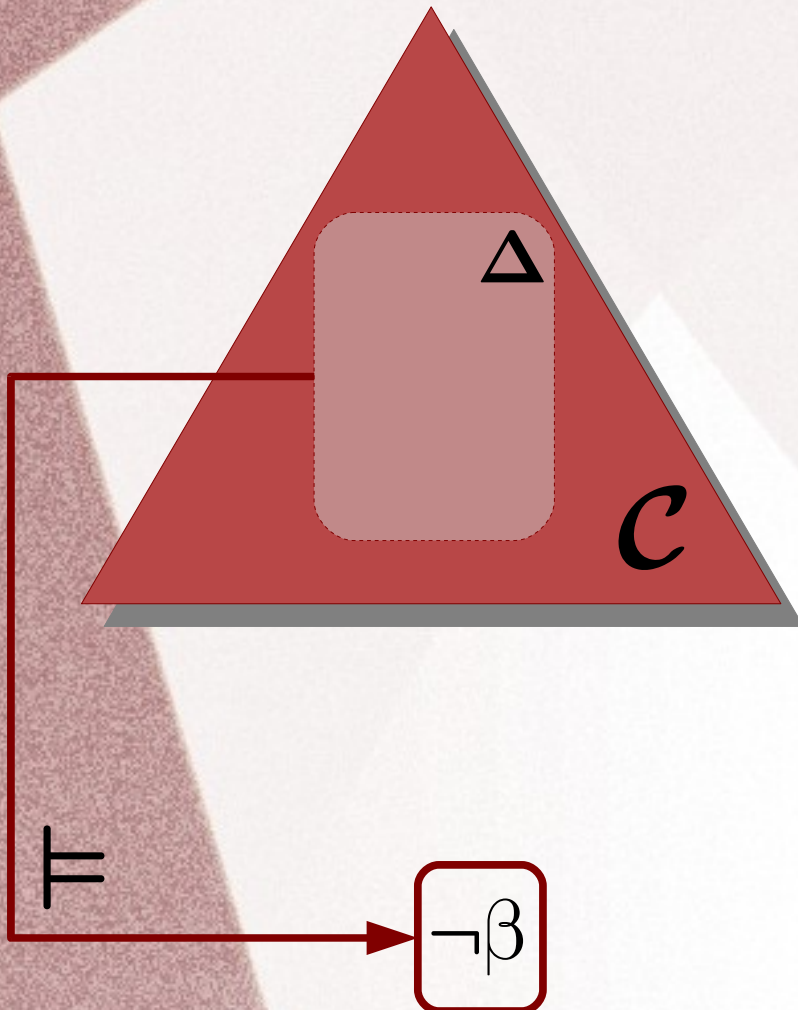




***DL-Lite Argumentation:  
Conflict and Attack***

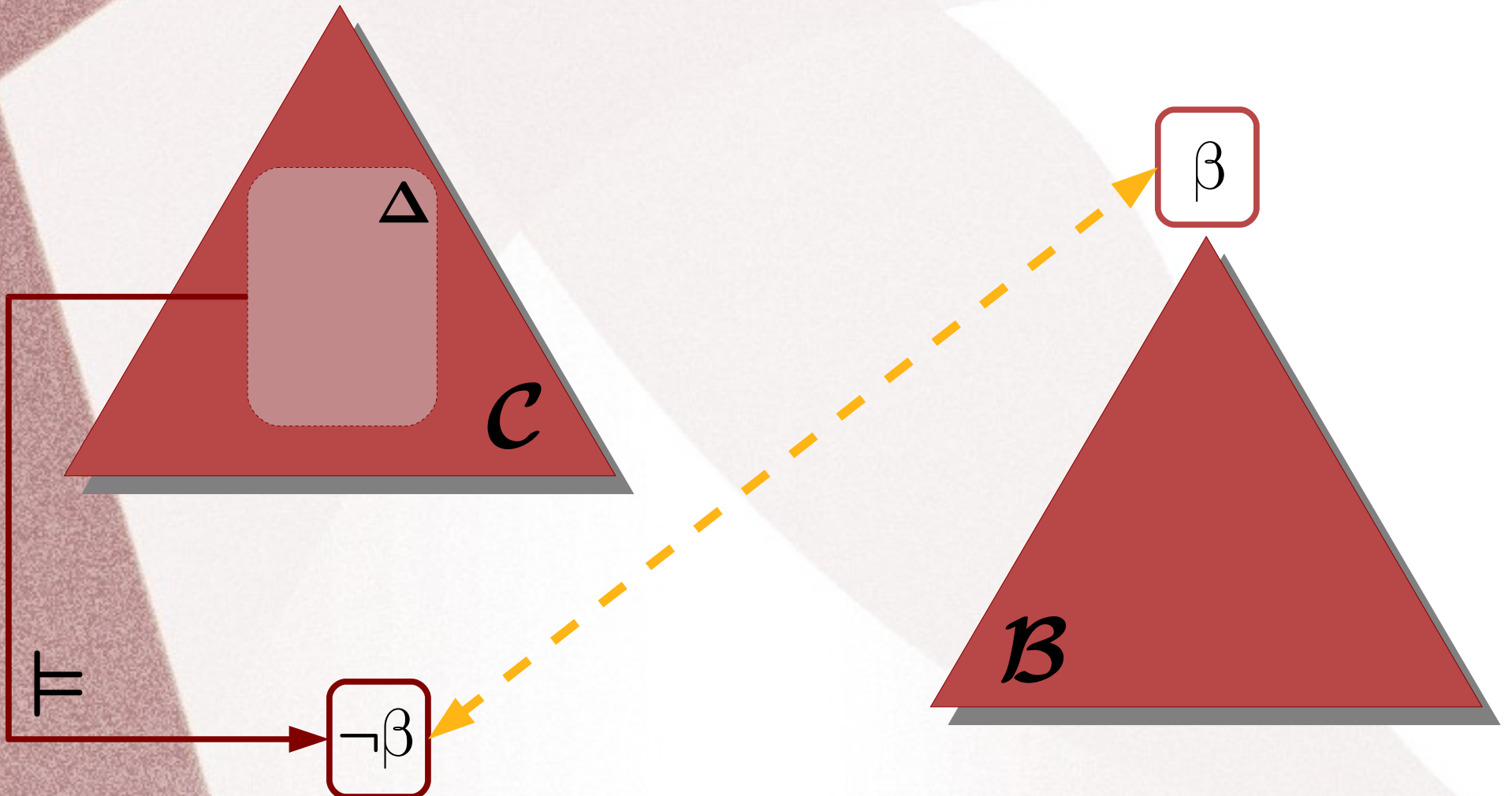
***Conflict***

***$\mathcal{B}$  counterargvs  $\mathcal{C}$***



***Conflict***

***$\mathcal{B}$  counterargvs  $\mathcal{C}$***



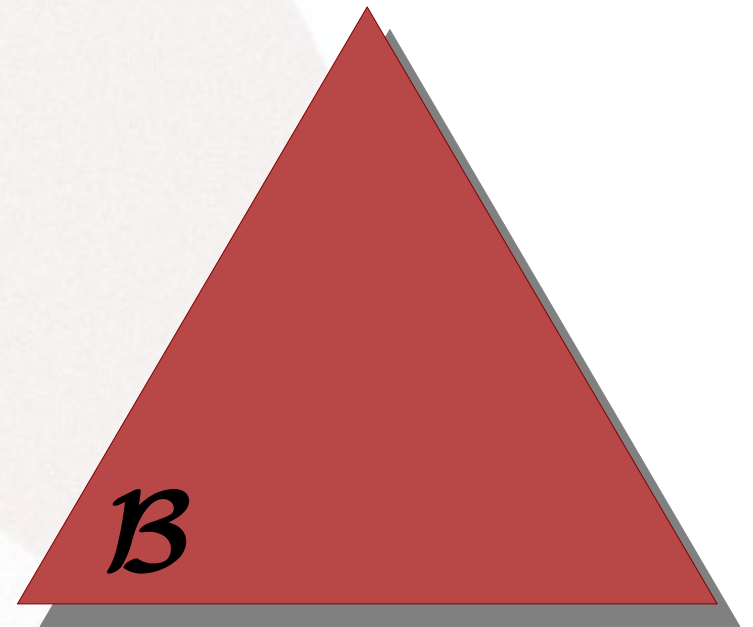
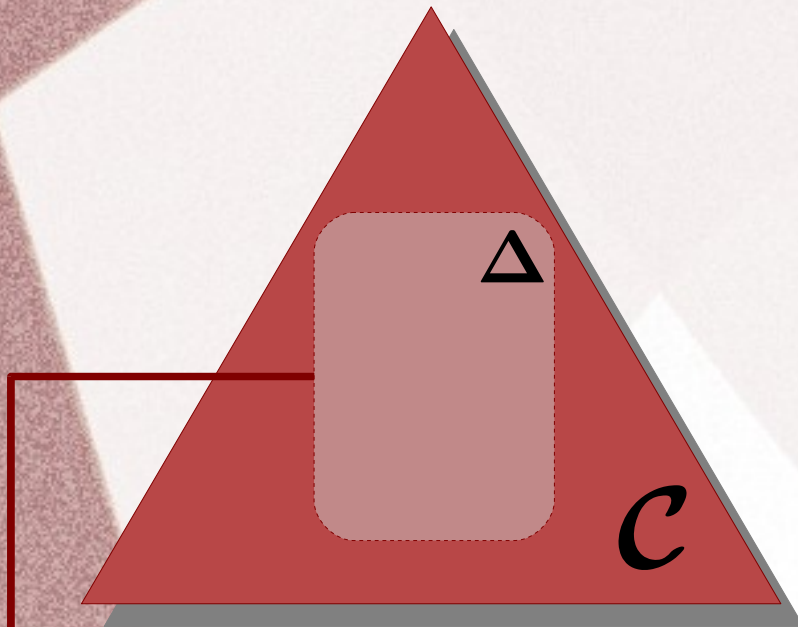
# Conflict

$\mathcal{B}$  counterargvs  $\mathcal{C}$

Reasoning  
Services

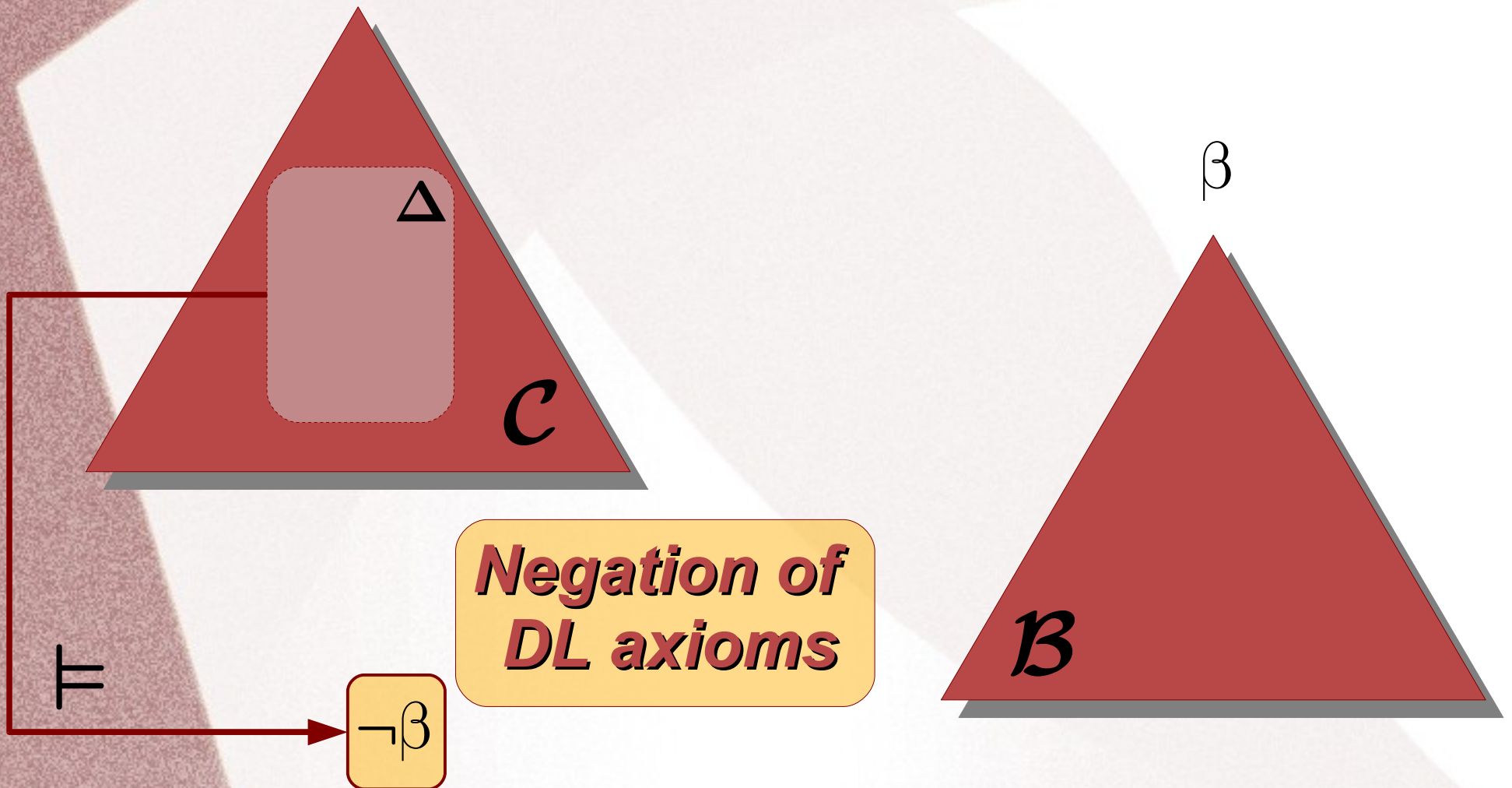
$\mathcal{L}_{cl}$

$\beta$



# Conflict

$\mathcal{B}$  counterargvs  $\mathcal{C}$



**Conflict**

# ***Negation of DL Axioms***

*In AAAI 2006 (G.Flouris et al.)*

**$B \sqsubseteq C$**

***Coherency  
Negation***

**$\sim(B \sqsubseteq C)$**

**$B \sqsubseteq \neg C$**

# Conflict

## Negation of DL Axioms

In AAAI 2006 (G.Flouris et al.)

$B \sqsubseteq C$

**Consistency  
Negation**

$\neg(B \sqsubseteq C) \longrightarrow \exists(B \sqcap \neg C)$

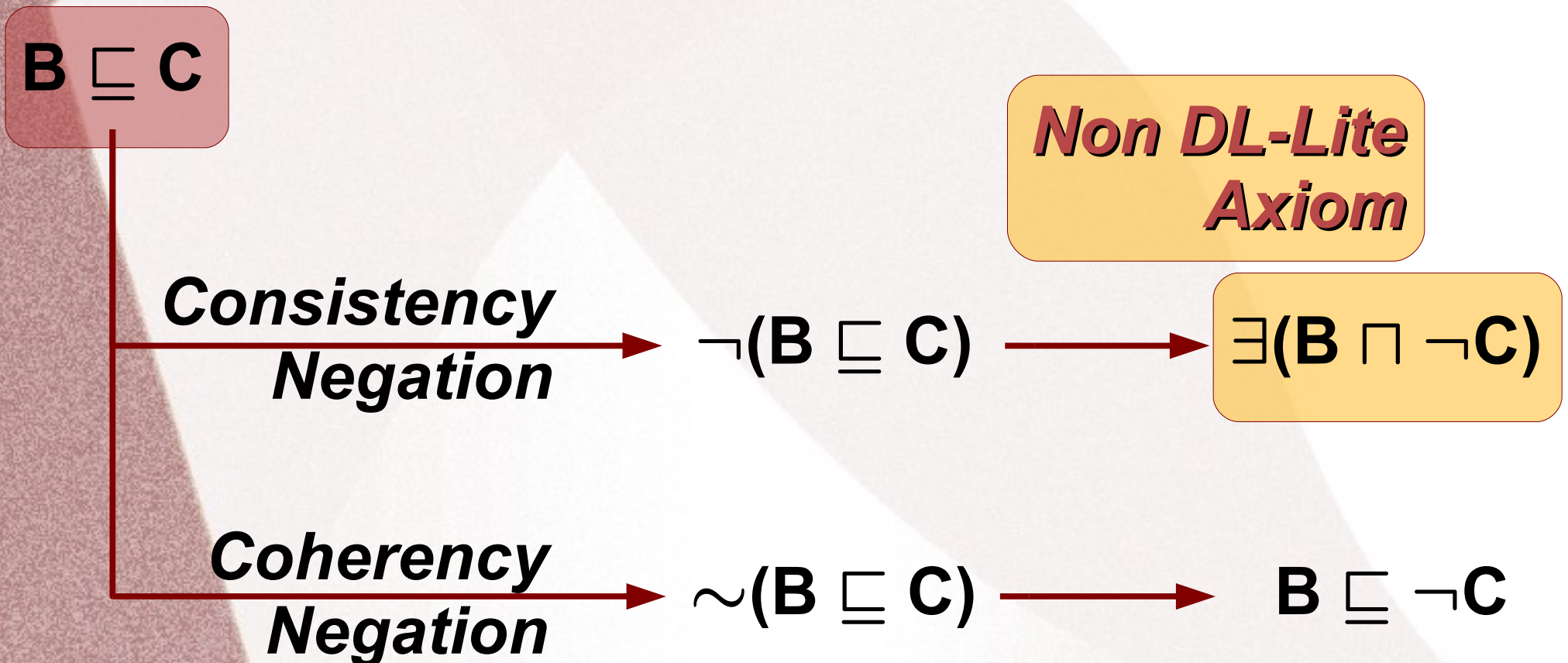
**Coherency  
Negation**

$\sim(B \sqsubseteq C) \longrightarrow B \sqsubseteq \neg C$

# Conflict

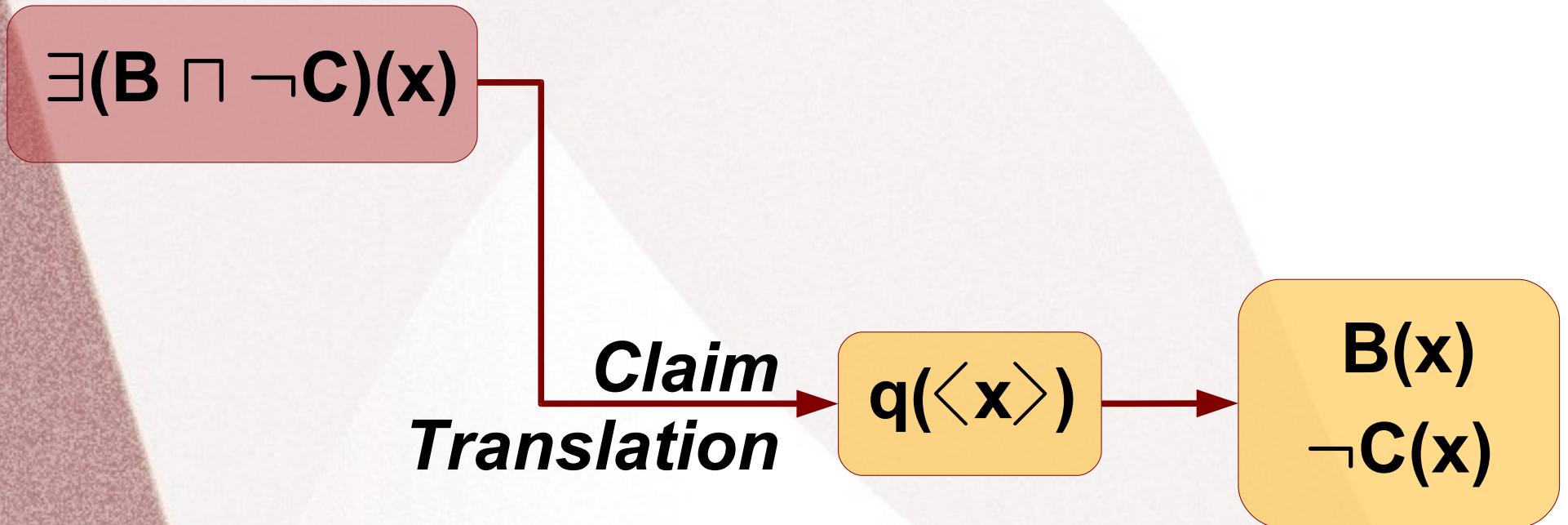
## Negation of DL Axioms

In AAAI 2006 (G.Flouris et al.)



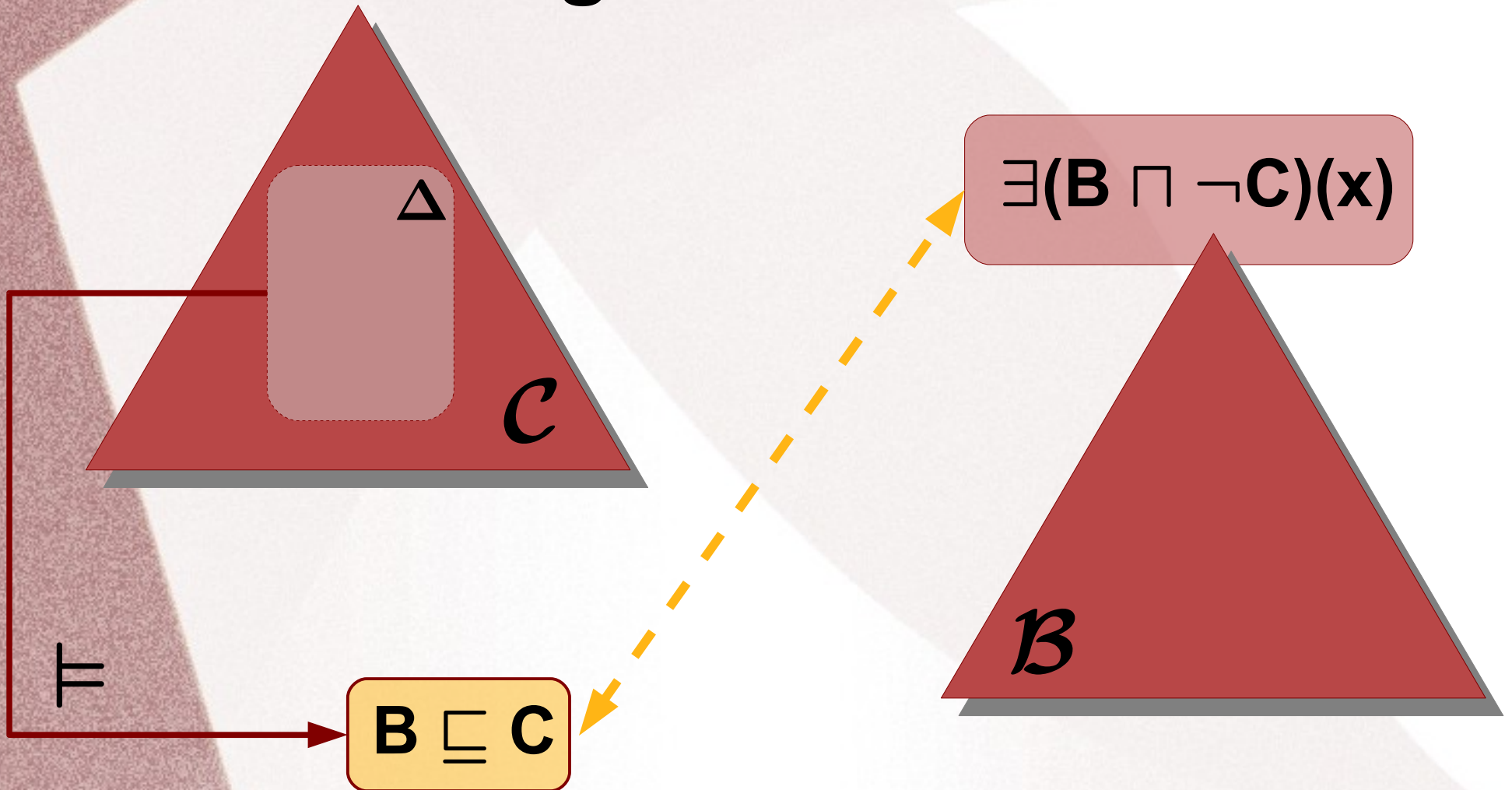
# Consistency Negation

**Conflict**



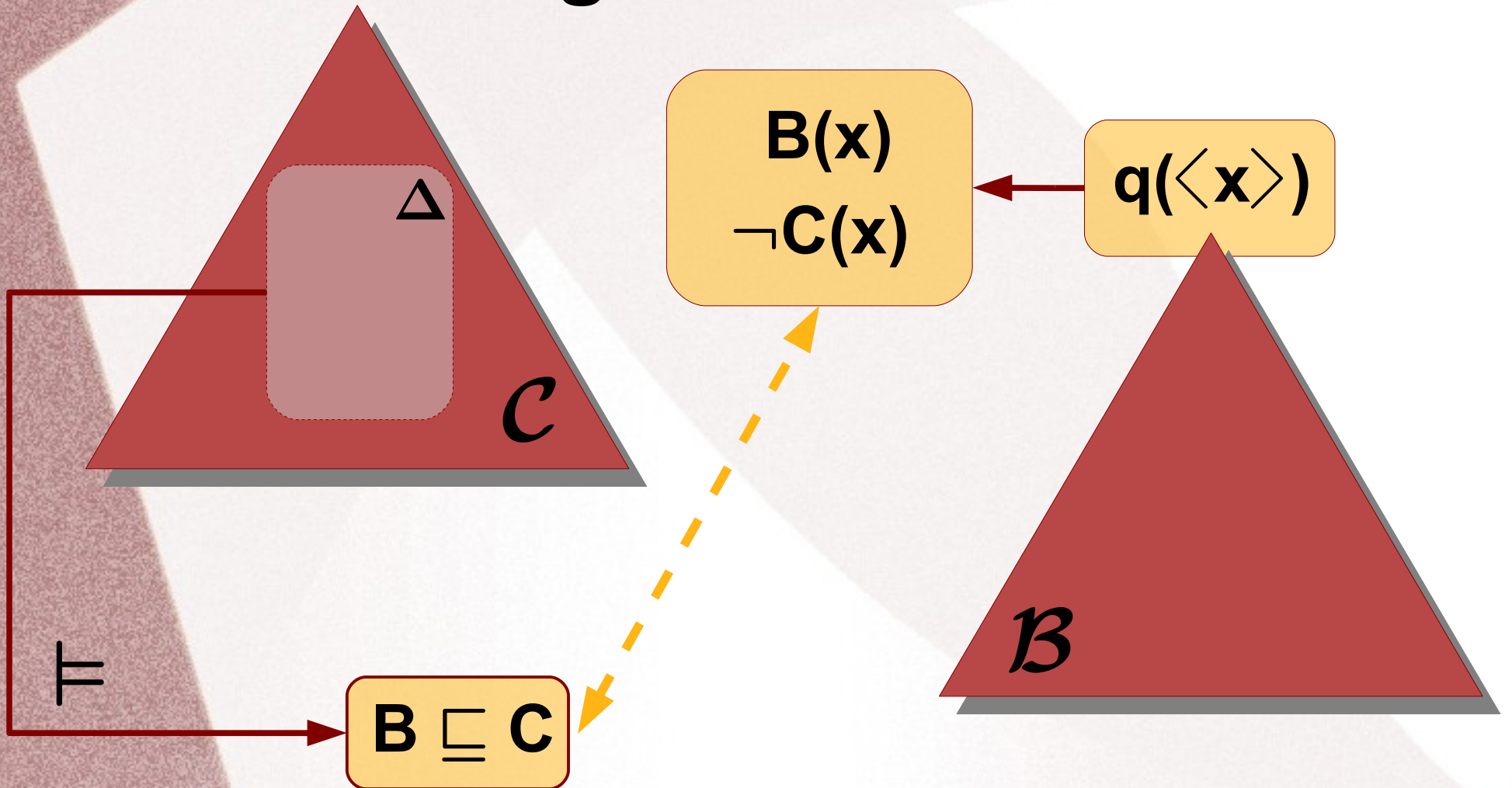
# Consistency Negation

# Conflict



***Conflict***

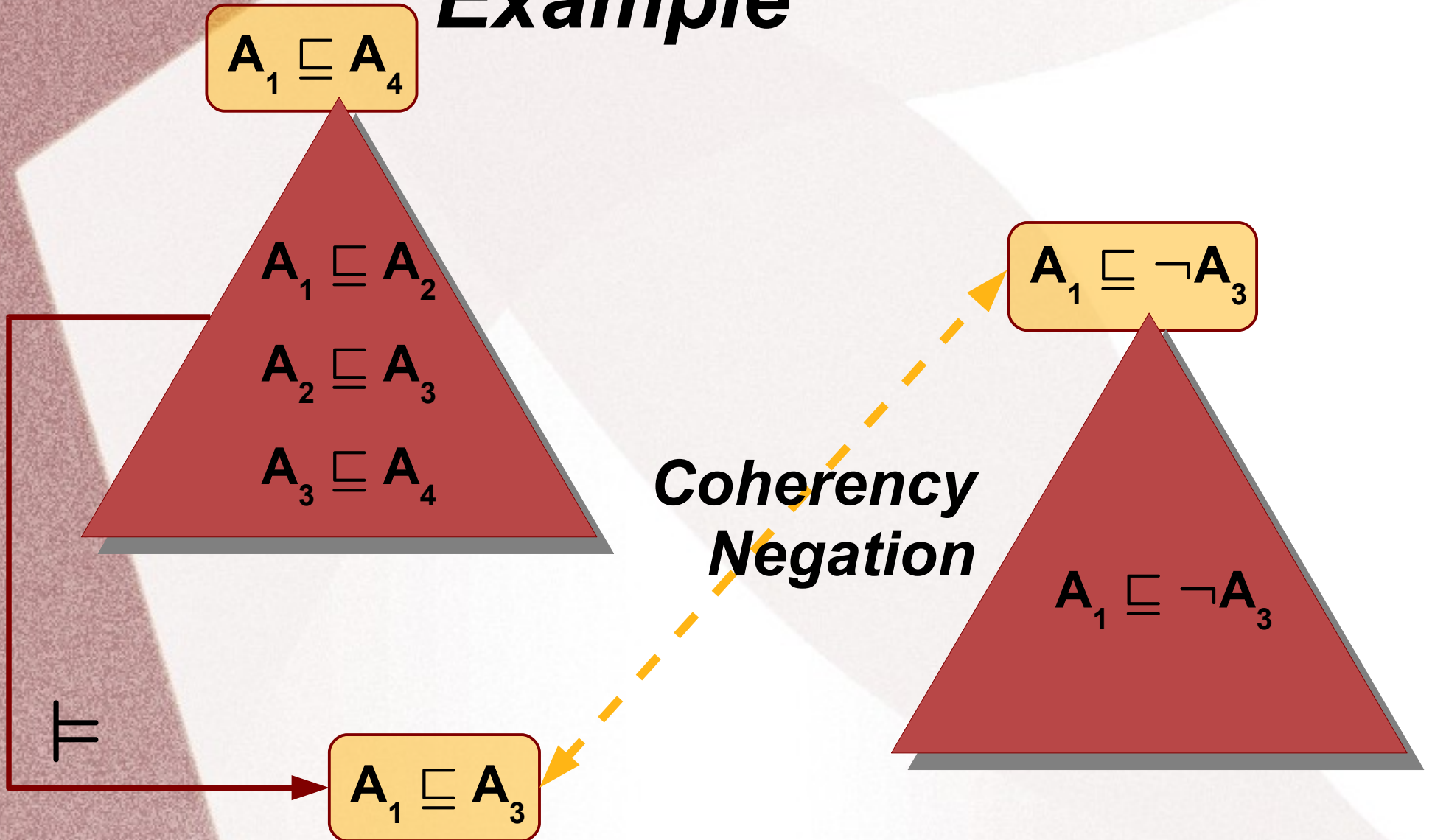
***Consistency  
Negation***





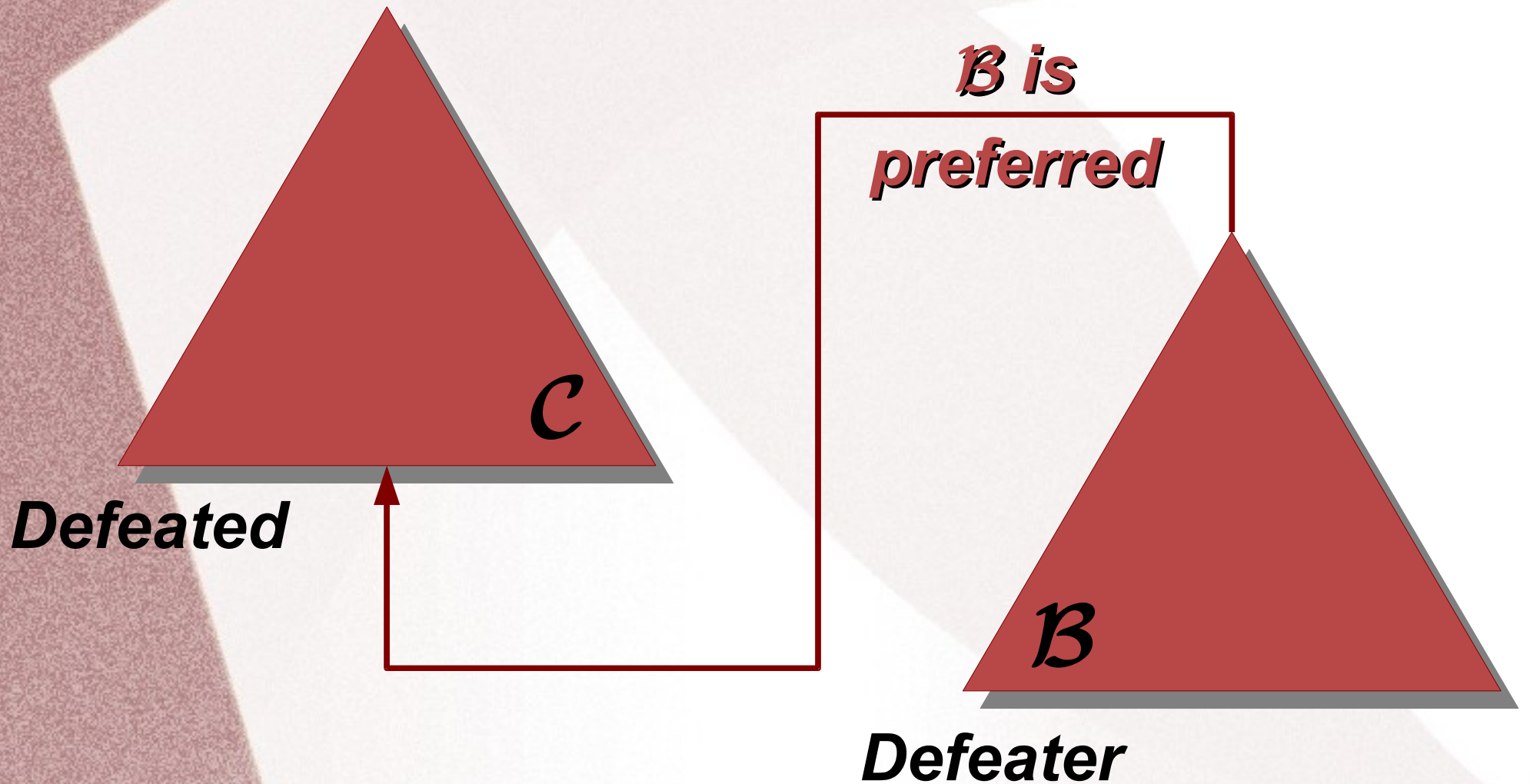
# Conflict

## Example



***Attack***

***B* counterargvs *C***

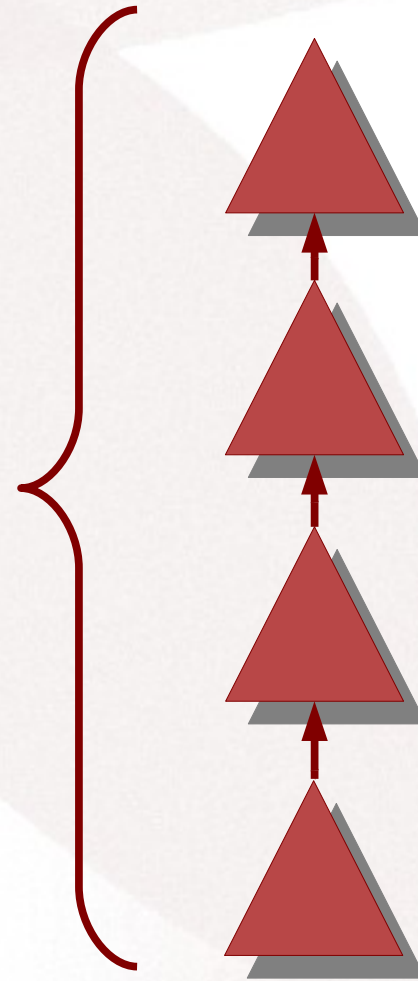




***Dialectical  
Argumentation***

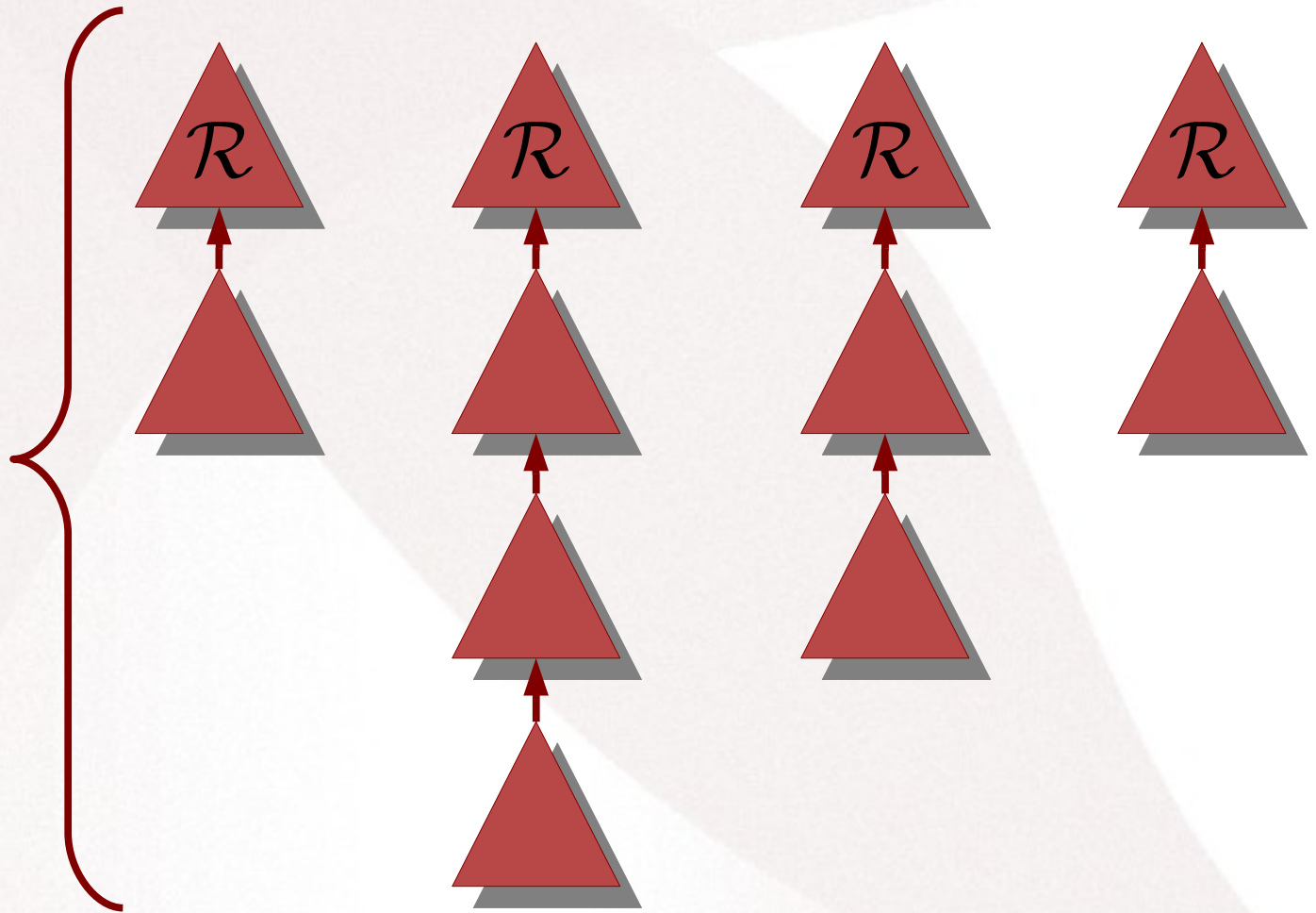
# *Argumentation Lines*

*Arguments*



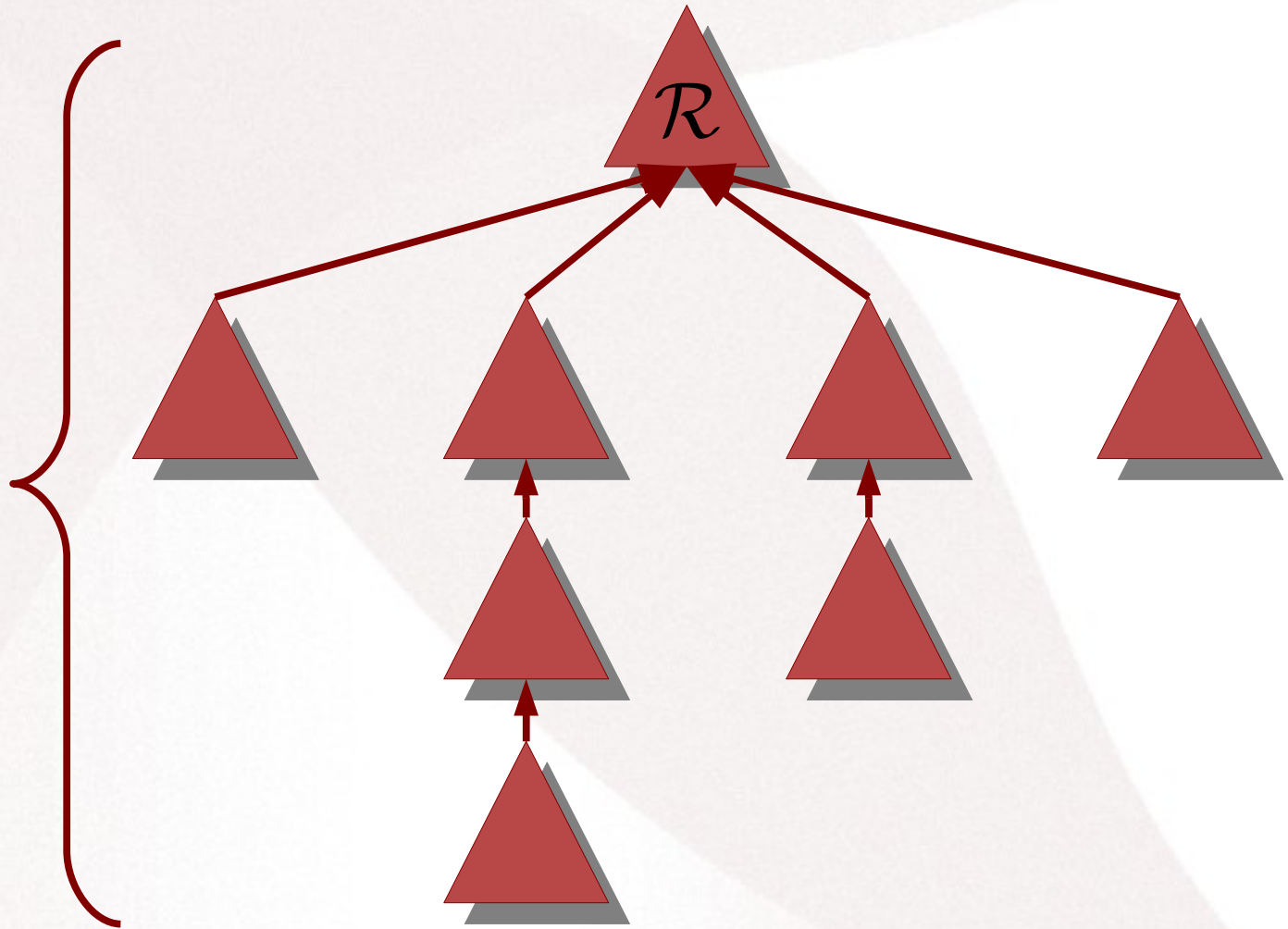
# ***Bundle Set***

***Arg. Lines***



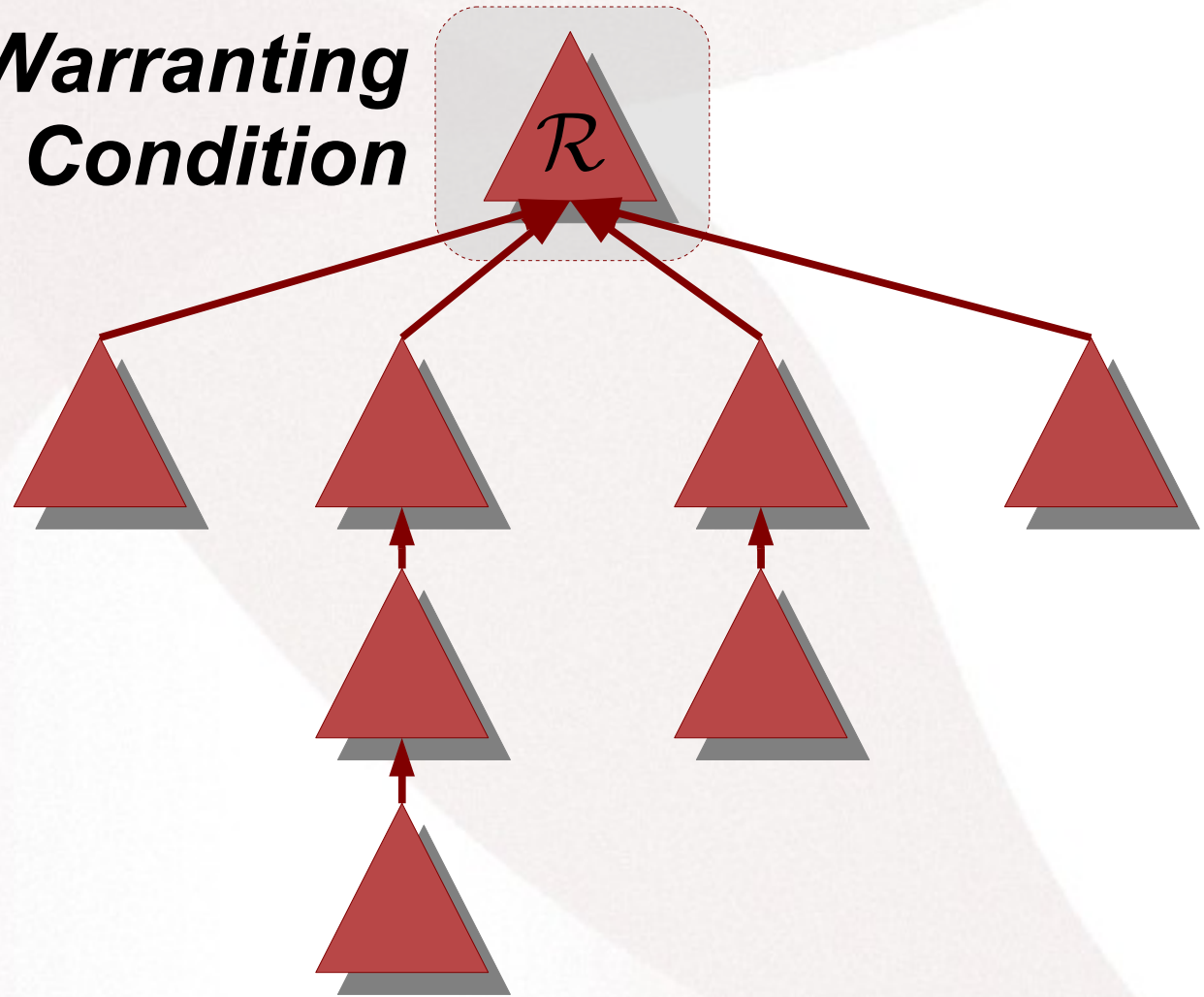
# ***Dialectical Tree***

***Arg. Lines***



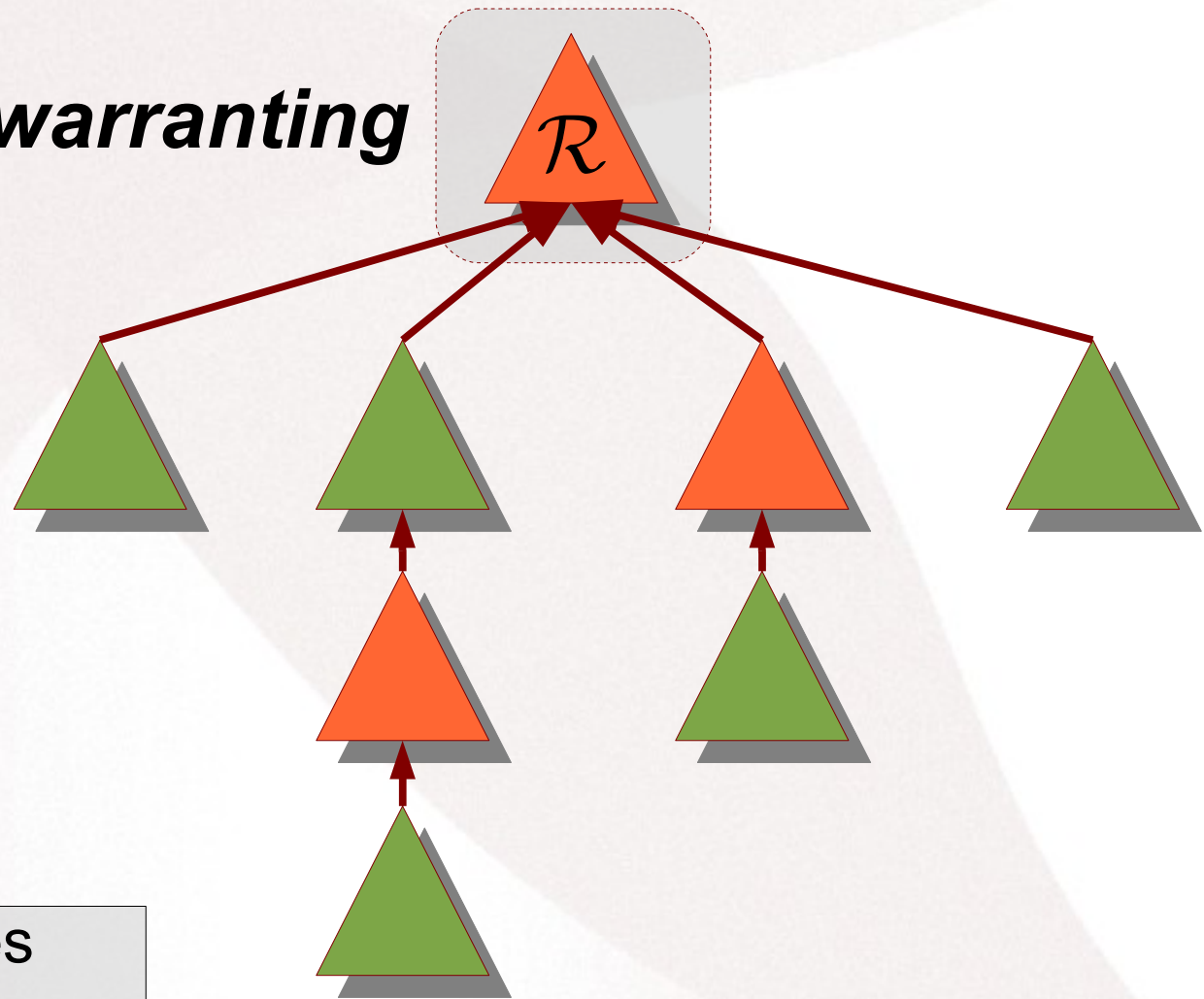
# ***Dialectical Tree***

***Warranting  
Condition***



# Marking Criterion

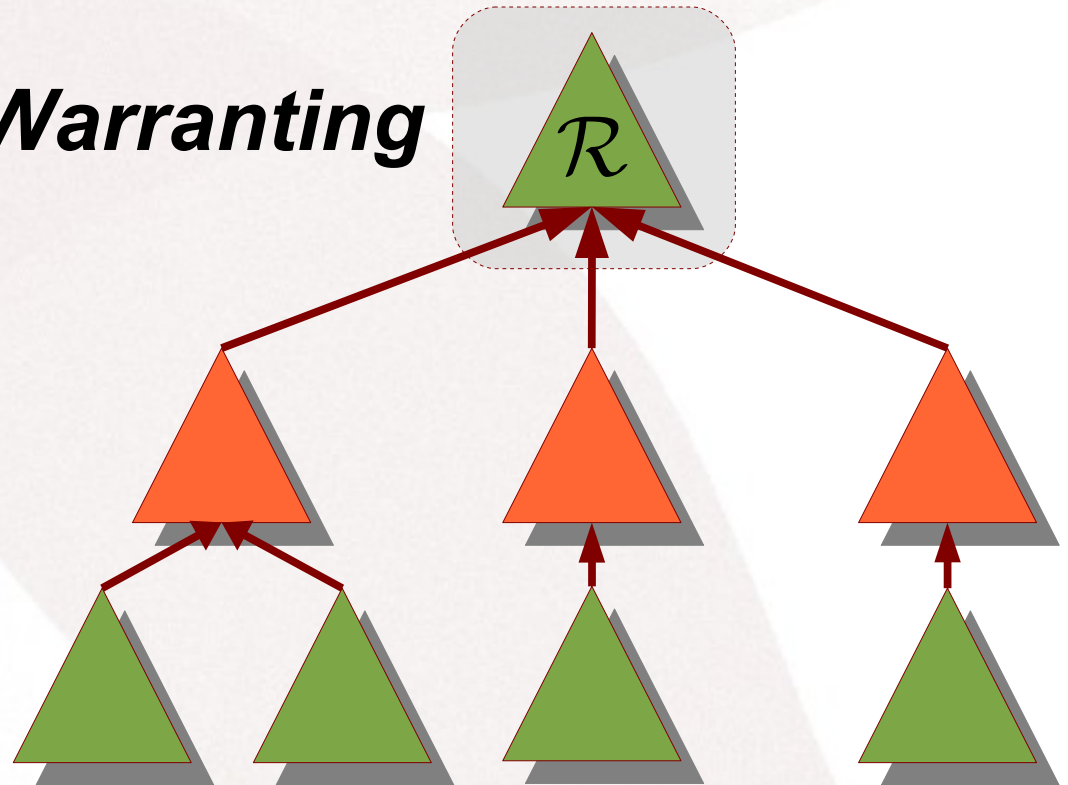
*Non-warranting*



**Undefeated:** leaves  
and nodes whose  
defeaters are defeated.

# Marking Criterion

*Warranting*



**Undefeated:** leaves and nodes whose defeaters are defeated.



***Inconsistent-tolerant  
DL-Lite Reasoning***

# Inconsistent-tolerant DL-Lite Reasoning

User's query

$$\Sigma \models \alpha$$

$\beta$  unifies  
with  $\alpha$

$$\beta$$

**Warranted**

$\mathcal{B}$



# ***Inconsistent-tolerant DL-Lite Reasoning***

$\Sigma \models \alpha$  iff there exists a warranted supporter  $\mathcal{B}$ .

# Example

*User's query*

$\Sigma \models B(a)$

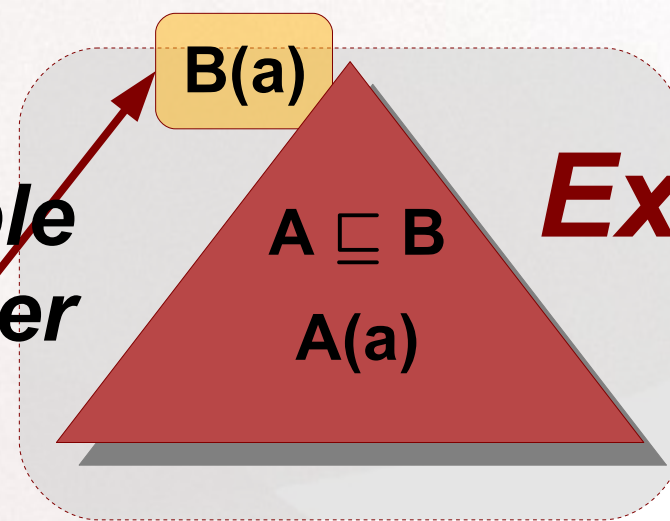
$\Sigma$

$A \sqsubseteq B, A \sqsubseteq C,$

$C \sqsubseteq \neg B, D \sqsubseteq A,$

$A(a), C(b), D(b)$

*Possible supporter*



*User's query*

$\Sigma \models B(a)$

$\Sigma$

$A \subseteq B, A \subseteq C,$

$C \subseteq \neg B, D \subseteq A,$

$A(a), C(b), D(b)$

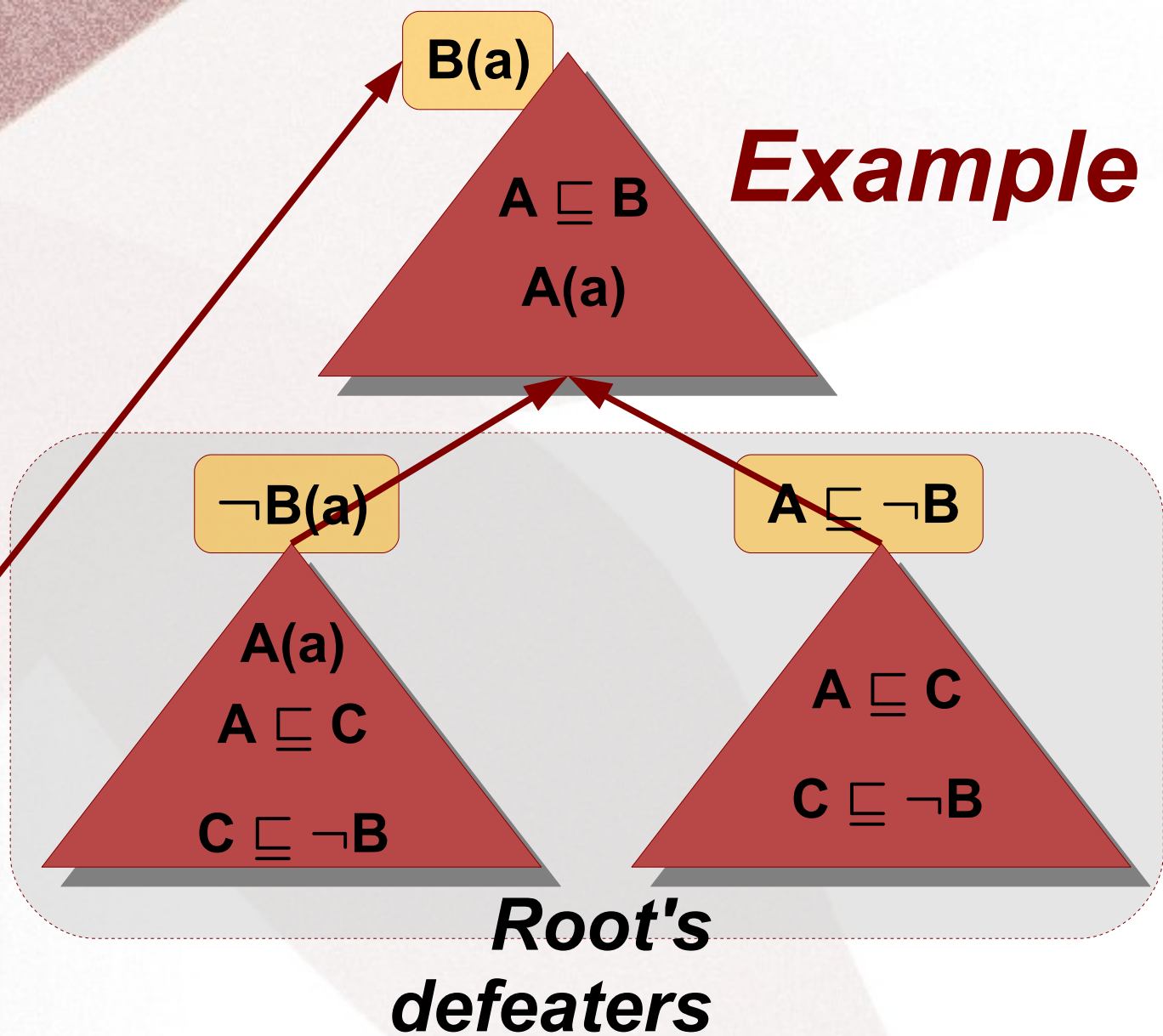
# Example

User's query

$$\Sigma \models B(a)$$

$\Sigma$

$A \sqsubseteq B, A \sqsubseteq C,$   
 $C \sqsubseteq \neg B, D \sqsubseteq A,$   
 $A(a), C(b), D(b)$



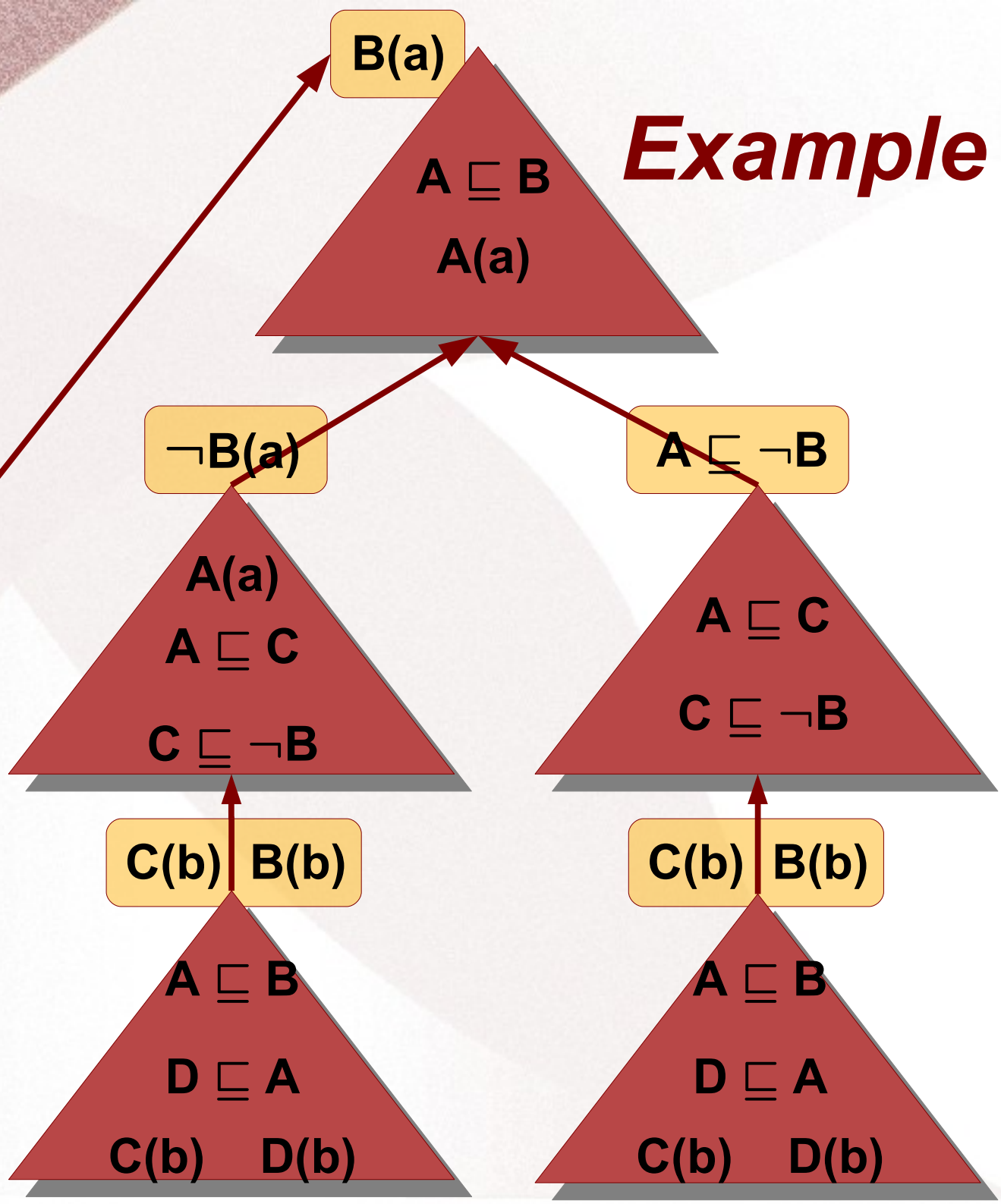
# Example

User's query

$$\Sigma \models B(a)$$

$\Sigma$

$A \sqsubseteq B, A \sqsubseteq C,$   
 $C \sqsubseteq \neg B, D \sqsubseteq A,$   
 $A(a), C(b), D(b)$



# Example

Warranted supporter

User's query

$\Sigma \models B(a)$

$\Sigma$

$A \sqsubseteq B, A \sqsubseteq C,$   
 $C \sqsubseteq \neg B, D \sqsubseteq A,$   
 $A(a), C(b), D(b)$

$B(a)$

$A \sqsubseteq B$

$A(a)$

$\neg B(a)$

$A(a)$

$A \sqsubseteq C$

$C \sqsubseteq \neg B$

$A \sqsubseteq \neg B$

$A \sqsubseteq C$

$C \sqsubseteq \neg B$

$C(b) \quad B(b)$

$A \sqsubseteq B$

$D \sqsubseteq A$

$C(b) \quad D(b)$

$C(b) \quad B(b)$

$A \sqsubseteq B$

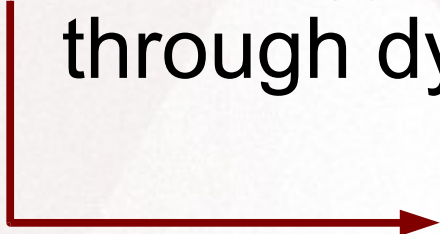
$D \sqsubseteq A$

$C(b) \quad D(b)$



***Final Remarks***

# *Ongoing Work*

- More expressive DLs may be handled with the argumentative approach.
- Ontology change may be tackled through dynamics of arguments.  

- Argument Theory Change

*In AAI 2008  
(Moguillansky et al.)*



***Thank you.***