Resolution-based argumentation semantics

Pietro Baroni, Massimiliano Giacomin

{baroni, giacomin}@ing.unibs.it

DEA - Dipartimento di Elettronica per l'Automazione
Università degli Studi di Brescia (Italy)

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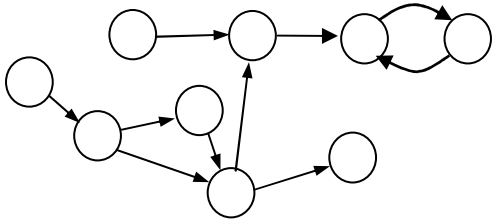
The context: Dung's Argumentation Framework

AF = <*A*, →>

attack relation

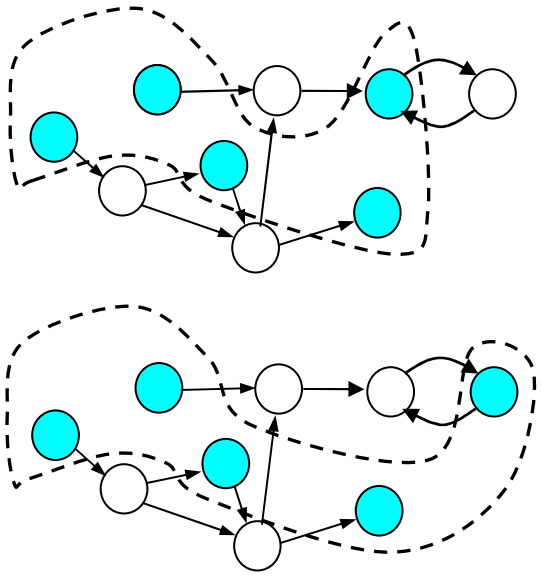
arguments



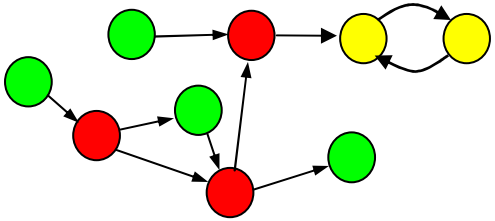
Defeat graph

Semantics S

Set of extensions $\mathcal{E}_{\mathbf{s}}$(AF)



Defeat Status
(Justification Status)



[Justified arguments:
belong to all extensions]

Previous results

Several argumentation semantics

- Grounded Semantics
- Preferred Semantics
- Recent proposals, e.g. prudent, semistable, CF2 semantics

How to evaluate and compare them [without examples]?

- General criteria considering conflict definition (Amgoud, Caminada 07)
- General criteria focusing on semantics definition (Baroni, Giacomin 06)

  - strong admissibility
  - admissibility
  - [weak, CF] reinstatement
  - Directionality
  - I-maximality
  - Skepticism-Adequacy
  - Resolution-Adequacy

NONE OF TRADITIONAL AND RECENT SEMANTICS SATISFY ALL OF THEM

Aim of the work and presentation plan

CAN DESIRABLE CRITERIA
BE SATISFIED ALTOGETHER?

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YES!!! ⇐ RESOLUTION-BASED SCHEME OF SEMANTICS DEFINITION: (see also Modgil 06)

From S to S*

- Resolution-based grounded semantics
- Resolution-based preferred semantics

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From S to S*

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PRESENTATION PLAN

1) Review of desirable criteria definitions

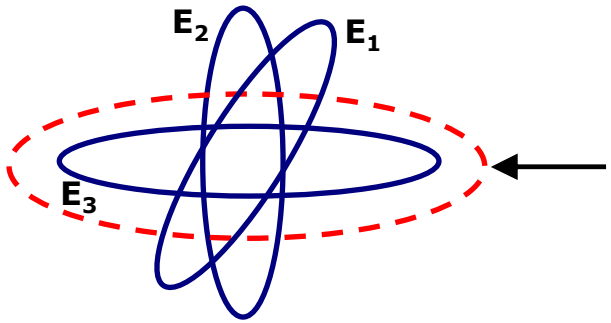
2) Definition and evaluation of resolution-based semantics

I-maximality principle

I-maximality principle

A semantics S satisfies the "I-maximality principle" iff

$$\forall AF,\ \forall E_1, E_2 \in \mathcal{E}_S(AF) \text{ if } E_1 \subseteq E_2 \text{ then } E_1 = E_2$$



it is not the case

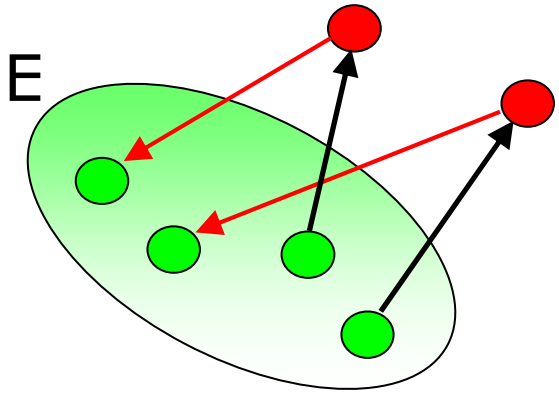
- Grounded and preferred (as well as prudent, semistable, ideal and CF2-semantics) satisfy I-maximality
- Complete semantics do not

Admissibility and reinstatement principles

Admissibility

$\forall$ AF, $\forall$ E $\in \mathcal{E}_{\mathbf{s}}$(AF)

- E is conflict-free
- E defends all of its arguments

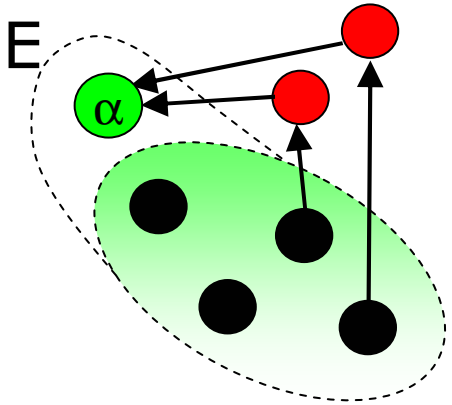


Reinstatement

$\forall$ AF, $\forall$ E$\in \mathcal{E}_{\mathbf{s}}$(AF)

- if E "defends" α then $\alpha \in$ E

[weak and CF reinstatement entailed]



Admissibility + reinstatement = complete extensions

- Grounded and preferred (as well as complete-based) semantics: YES
- CF2 semantics: NO (admissibility is not satisfied)

Directionality principle

Basic idea

Extension membership of an argument is determined by its ancestors, while it is not affected by the arguments it defeats

Definition

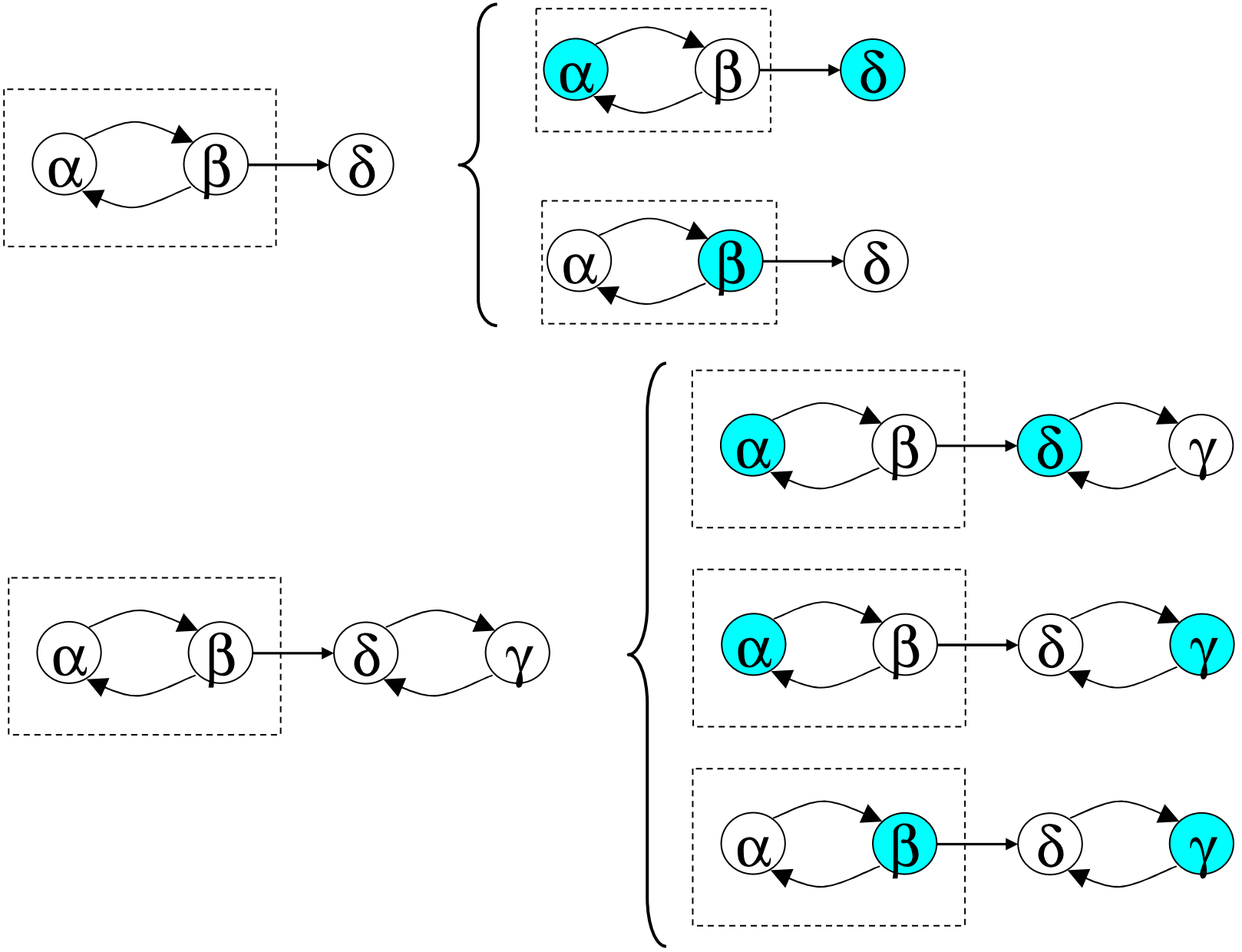
$\forall$ AF, $\forall$ U "unattacked set" of AF,

$$\{(E \cap U) \mid E \in \mathcal{E}_{\mathbf{s}}(AF)\} \quad = \quad \mathcal{E}_{\mathbf{s}}(AF_{\downarrow U})$$

Semantics behavior

- Both preferred and grounded semantics satisfy directionality

Directionality: example with preferred semantics



Skepticism related criteria

The informal notion of skepticism

Making "less|more committed choices" for arguments,
i.e. assigning to them "less|more decided" justification states.

Two kinds of skepticism relations

A *basic skepticism relation* $\preceq^{E}$ between <u>sets of</u> extensions:

$\mathcal{E}_1 \preceq^{E} \mathcal{E}_2$ denotes that $\mathcal{E}_1$ is "at least as skeptical as"

(or "not more committed" than) $\mathcal{E}_2$

A *skepticism relation* $\preceq^{A}$ between argumentation frameworks:

$AF_1 \preceq^{A} AF_2$ denotes that AF_1 is "at least as skeptical as" AF_2

Adequacy criteria

Skepticism relations between AF_i $\Leftrightarrow$ Skepticism relations between $\mathcal{E}_i$

Skepticism relations between sets of extensions

Comparison between two extensions E_1 and E_2: $E_1 \subseteq E_2$

A direct generalization: the $\preceq^{E}_{\cap}$ relation

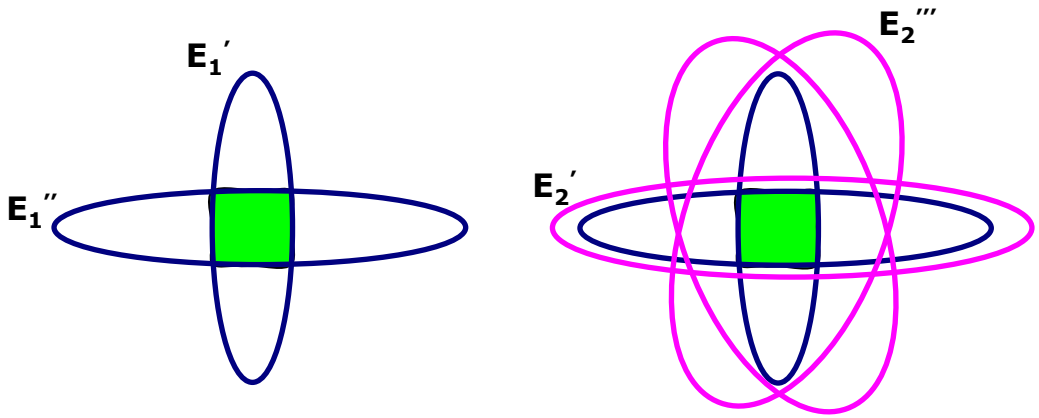
$$\mathcal{E}_1 \preceq^{E}_{\cap} \mathcal{E}_2 : \bigcap \mathcal{E}_1 \subseteq \bigcap \mathcal{E}_2$$

A finer generalization: the $\preceq^{E}_{W}$ relation

Comparison between an extension E_1 and a set of extensions $\mathcal{E}_2$:

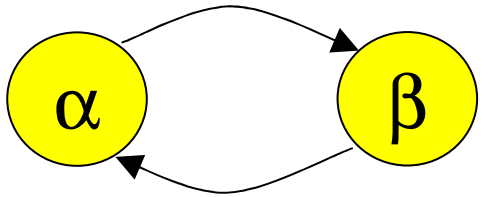
$\forall E_2 \in \mathcal{E}_2$ $E_1 \subseteq E_2$ (e.g. GE_{AF} contained in any pref. extension)

$$\mathcal{E}_1 \preceq^{E}_{W} \mathcal{E}_2 : \forall E_2 \in \mathcal{E}_2, \exists E_1 \in \mathcal{E}_1 : E_1 \subseteq E_2$$

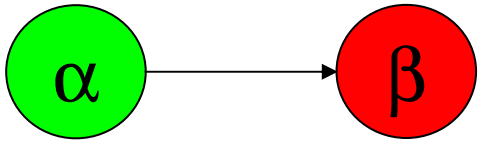


Skepticism relation between argumentation frameworks

The Basic idea



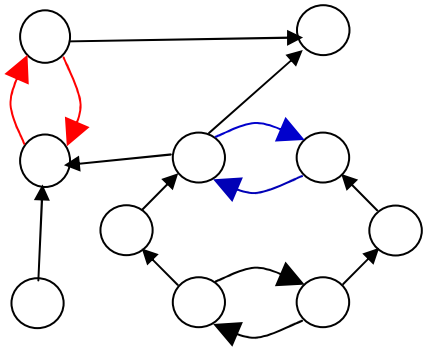
vs.



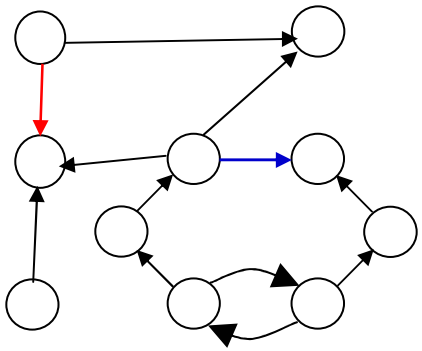
More skeptical
(less committed)

Less skeptical
(more committed)

The General relation



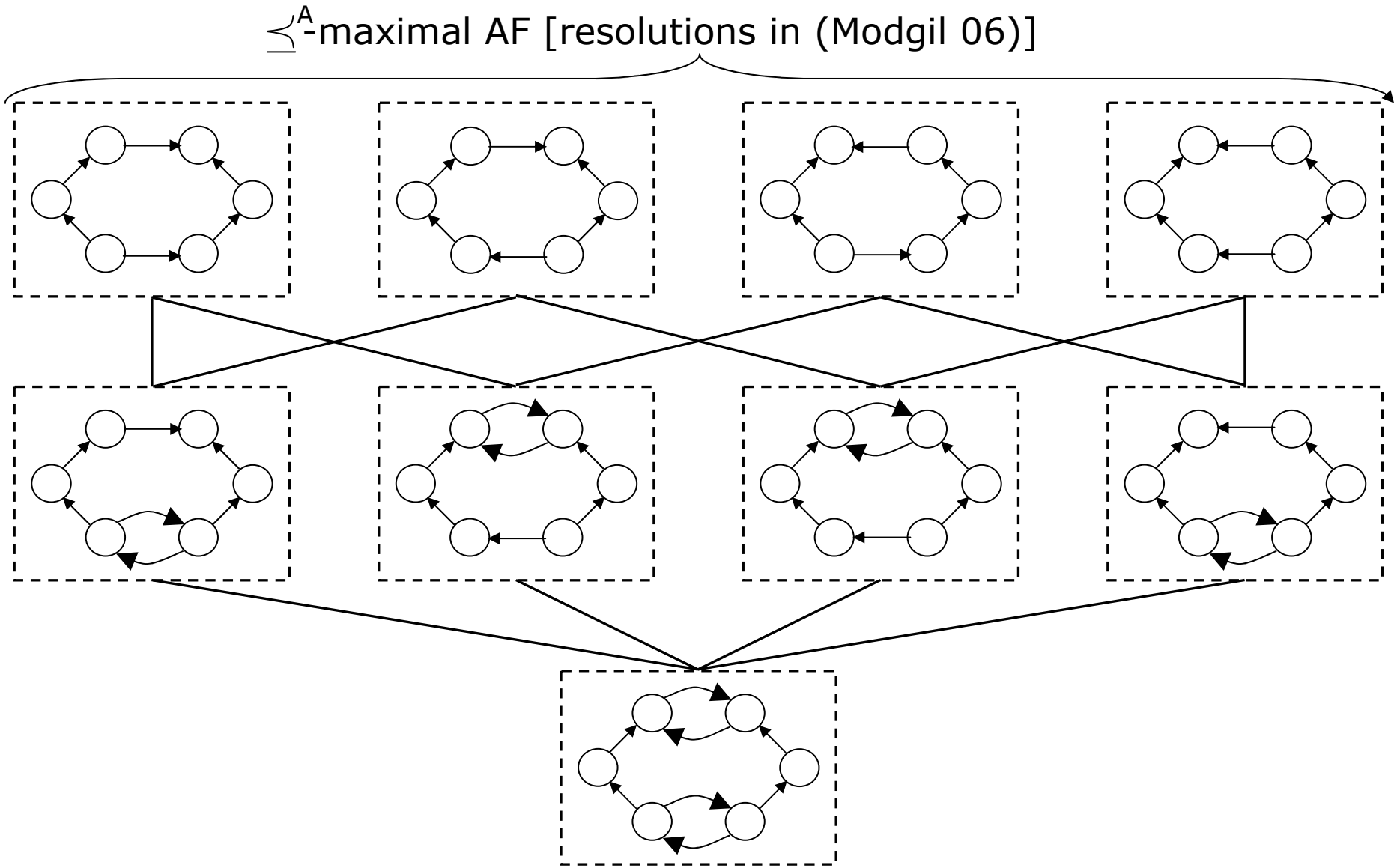
AF_1



AF_2

$AF_1 \sqsubseteq^A AF_2$

Skepticism relation between argumentation frameworks



Skepticism-related criteria definition

Skepticism-adequacy of a semantics

Given a skepticism relation $\preceq^E$ between sets of extensions, a semantics S is $\preceq^E$-adequate iff for any AF_1, AF_2

$$AF_1 \preceq^A AF_2 \Rightarrow \mathcal{E}_S(AF_1) \preceq^E \mathcal{E}_S(AF_2)$$

Resolution-adequacy of a semantics

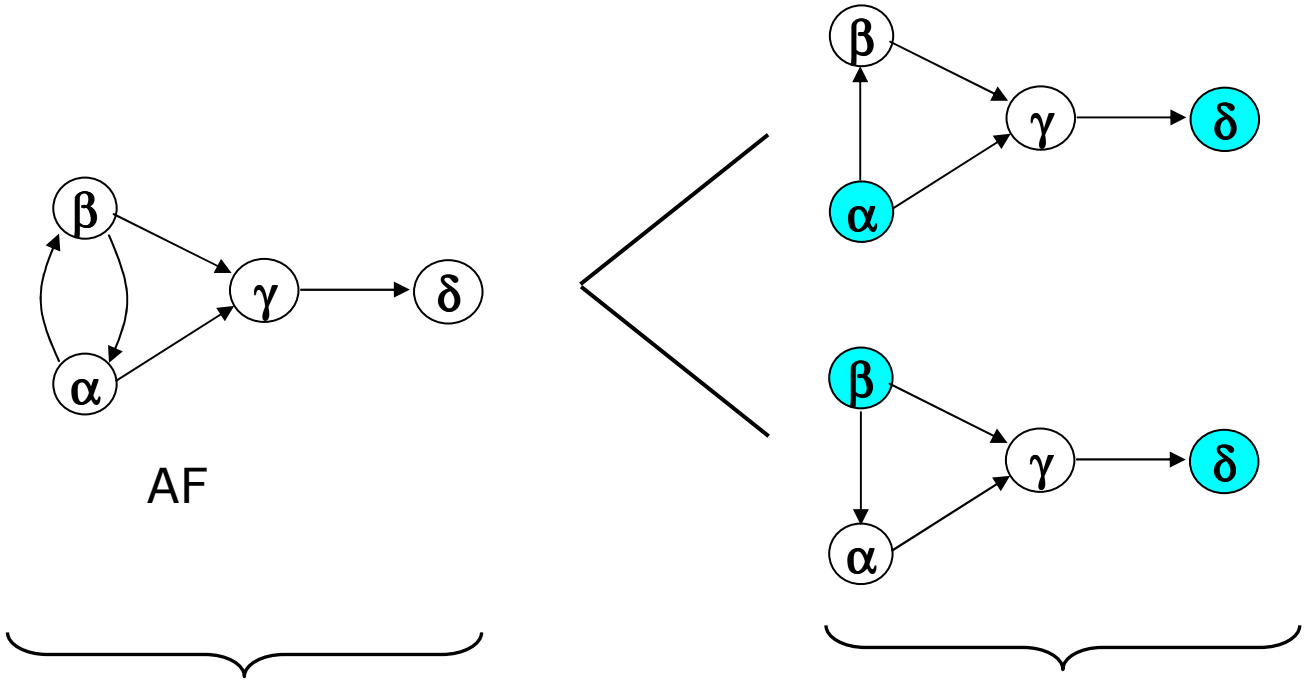
Given a skepticism relation $\preceq^E$ between sets of extensions, a semantics S is $\preceq^E$-resolution-adequate iff for any AF

$$\bigcup_{AF' \in RES(AF)} \mathcal{E}_S(AF') \preceq^E \mathcal{E}_S(AF)$$

Implication orders

- $\preceq^E_W$-adequacy $\Rightarrow$ $\preceq^E_\cap$-adequacy
- $\preceq^E_W$-resolution-adequacy $\Rightarrow$ $\preceq^E_\cap$-resolution-adequacy

Adequacy criteria in action: grounded vs. preferred semantics



$\mathcal{E}_{GR}$ (AF)={ø}

$\mathcal{E}_{PR}$ (AF)= {{α, δ}, {β, δ}}

$U_{AF' \in RES(AF)}$ $\mathcal{E}_{S}$ (AF')={{α, δ}, {β, δ}}

Preferred semantics: resolution adequate

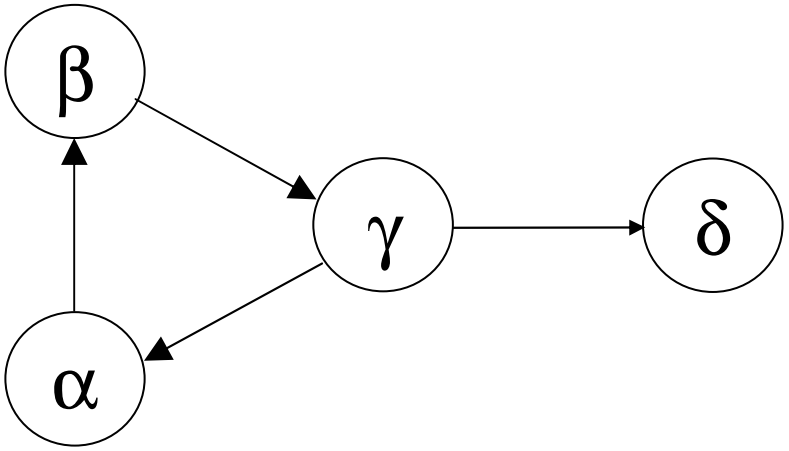
Grounded semantics: NO

Adequacy criteria in action: grounded vs. preferred semantics

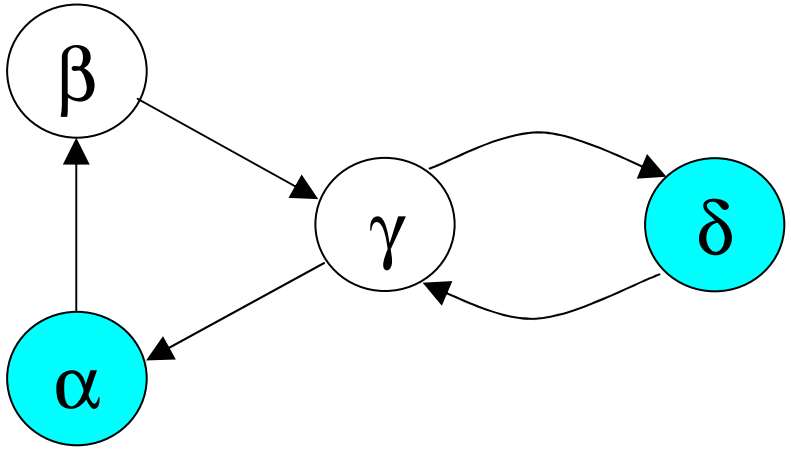
- Grounded semantics: skepticism adequate

$$GE_{AF^{\leftrightarrow(\beta,\,\alpha)}} \subseteq GE_{AF} \Rightarrow \preceq_W \text{- adequate}$$

- Preferred semantics: NO



All arguments provisionally defeated



α and β definitely justified

Defining resolution-based semantics

The Basic idea

A semantics should be…

$\mathcal{E}_S(AF) \preceq^E \mathcal{E}_S(AF')$ — **More** skeptical w.r.t. extensions of **a** resolution

$U_{AF'} \mathcal{E}_S(AF') \preceq^E \mathcal{E}_S(AF)$ — **Less** skeptical w.r.t. extensions of **all** resolutions

[Grounded semantics: too much skeptical, preferred: too much committed]

The definition

Given a semantics S, its resolution-based version is S* such that

$$\mathcal{E}_{S*}(AF) = \text{MIN}\left(U_{AF' \in \mathbf{RES(AF)}} \mathcal{E}_S(AF') \right)$$

General desirable properties

I-maximality

- Achieved by definition: $\mathcal{E}_{S*}$ (AF) = MIN (...)

Skepticism-adequacy

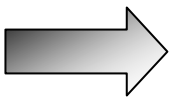
- For any semantics S, S* satisfies $\preceq_W$ -skepticism-adequacy

Resolution-adequacy

- S is I-maximal $\Rightarrow$ S* satisfies $\preceq_W$-resolution-adequacy

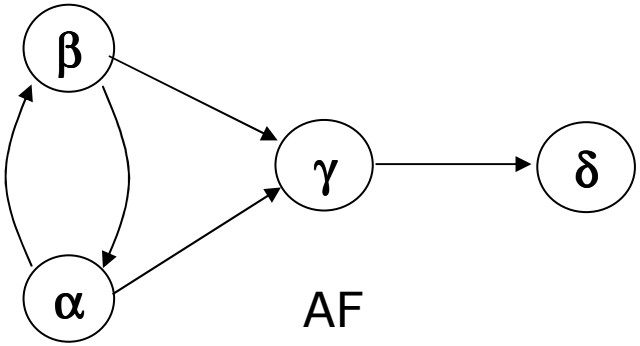
Admissibility and reinstament

- S: complete extensions $\Rightarrow$ S* satisfies admissibility and reinstatement

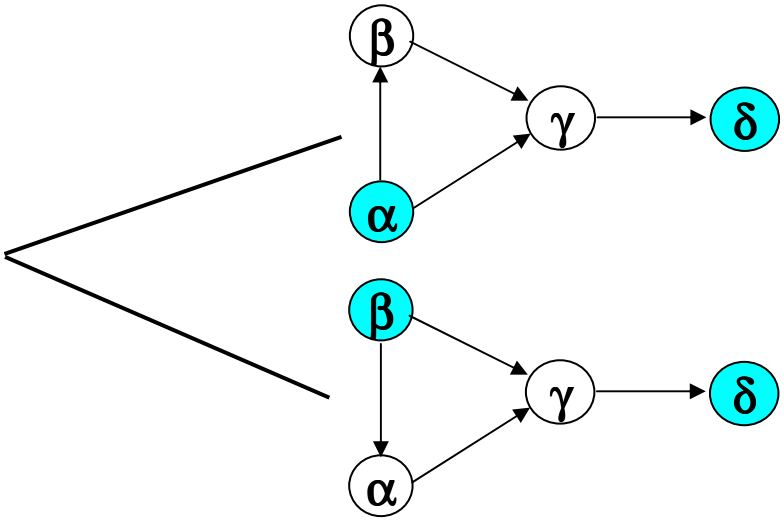


BOTH RESOLUTION-BASED GROUNDED AND PREFERRED SEMANTICS SATISFY ALL OF THESE PRINCIPLES

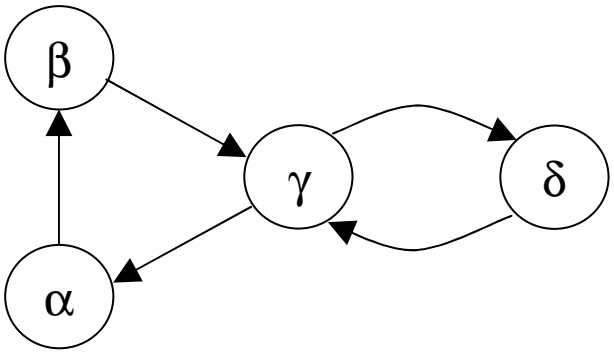
Examples

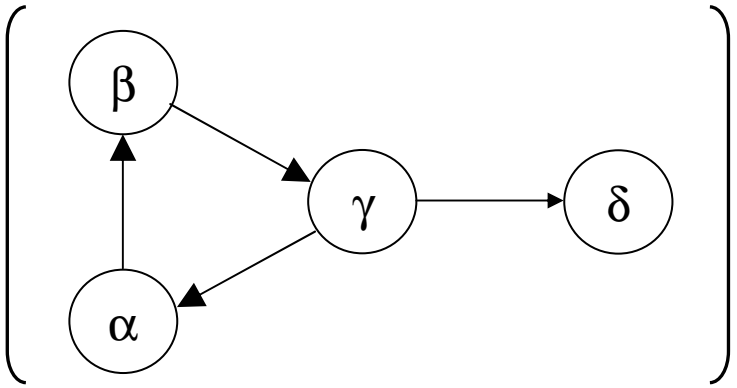


AF



$\mathcal{E}_{PR*}$ (AF)= $\mathcal{E}_{GR*}$ (AF) = {{α, δ}, {β, δ}}





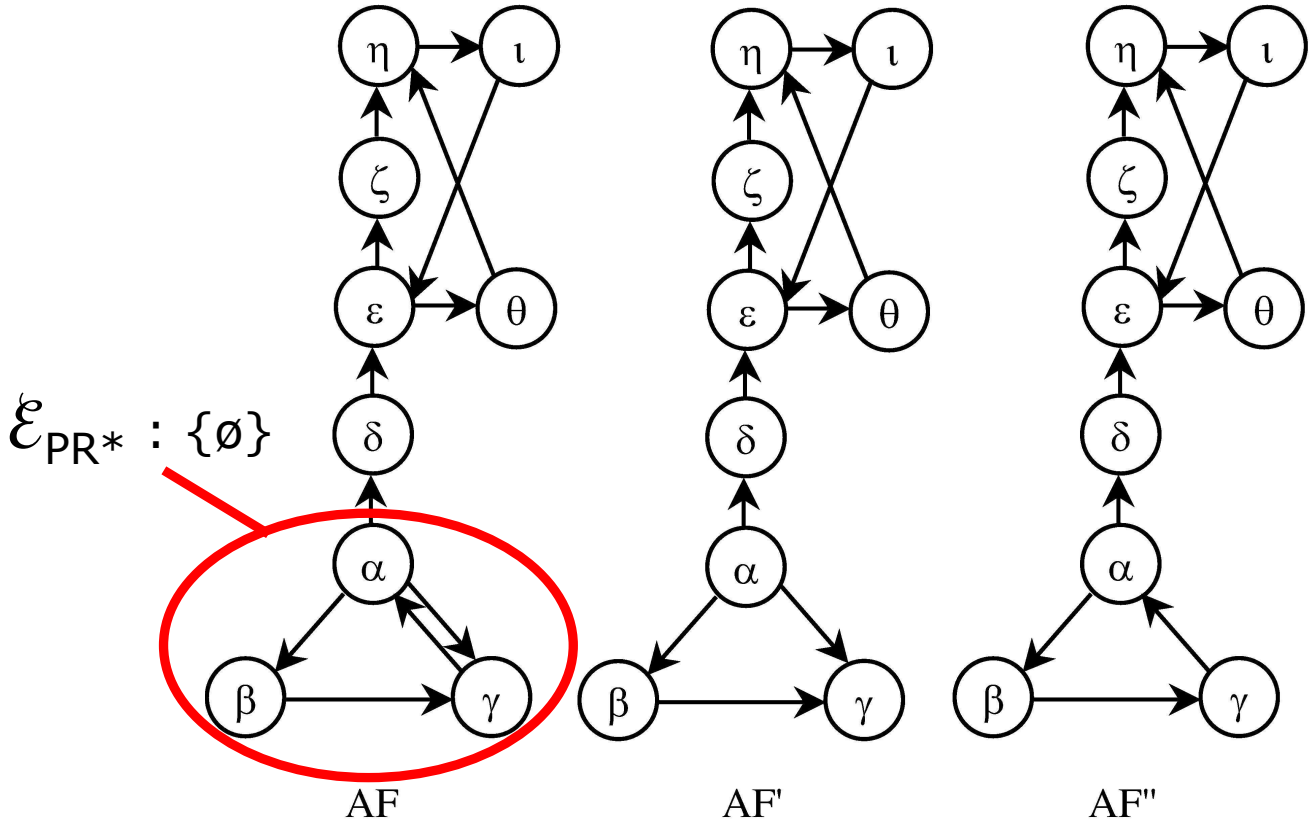
$\mathcal{E}_{PR*}$ (AF)= $\mathcal{E}_{GR*}$ (AF) = {ø}

And directionality?

- Resolution-based **grounded semantics satisfies** directionality

  [see the paper for a –complicated– proof]

- Resolution-based **preferred semantics does not**



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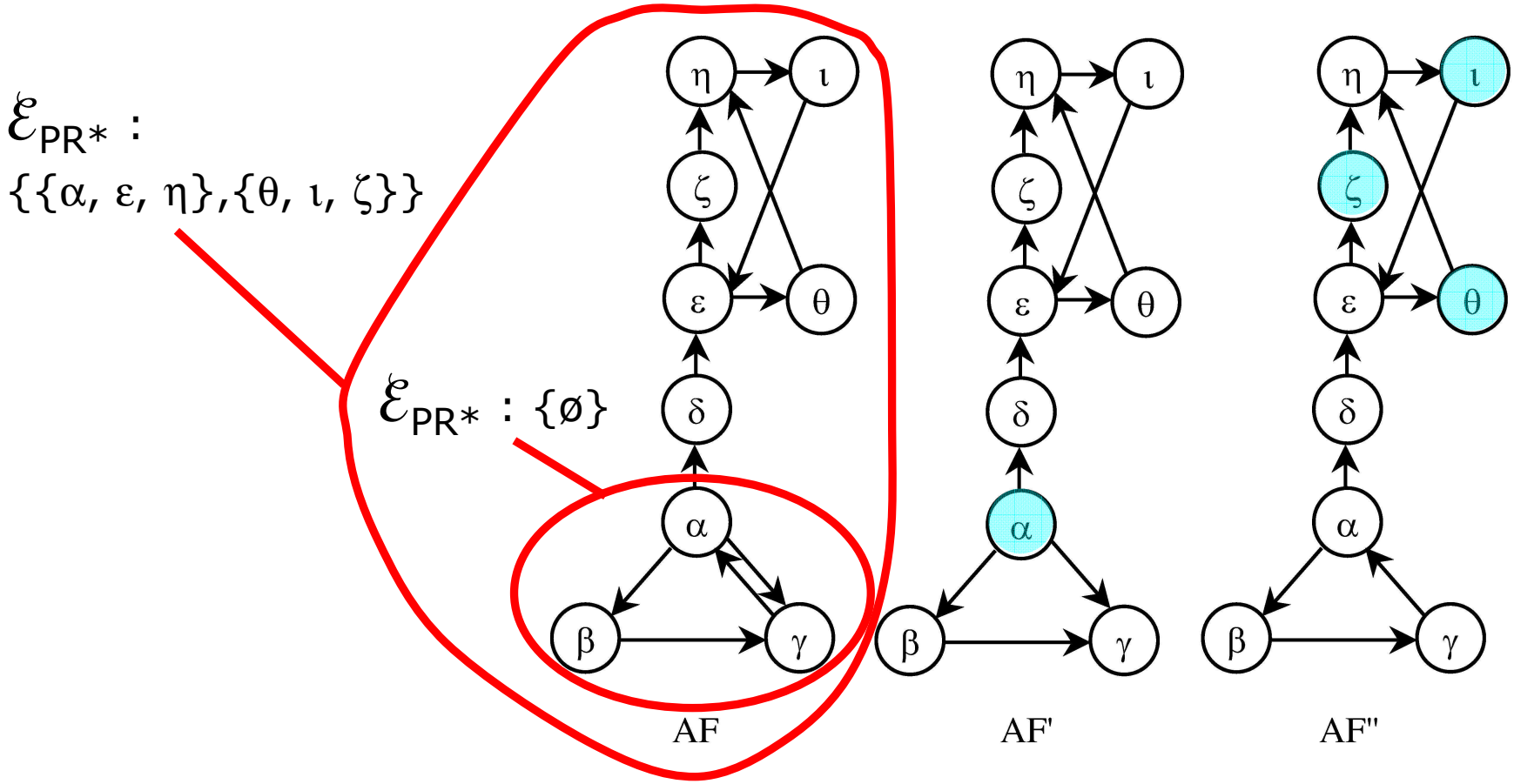

Conclusions

- All desirable criteria (I-maximality, admissibility, reinstatement, directionality, skepticism adequacy, resolution adequacy) can be satisfied altogether
- Resolution-based version of traditional semantics:
  - GR*: satisfies all desirable criteria
  - PR*: does not satisfy directionality

- Future work:
  - resolution-based version of other semantics
  - is GR* useful in practice?
    … algorithms and complexity…