Bipolar Abstract Argumentation

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ICIC CONICET UNS

Bipolar Argumentation Frameworks

Mostly following Cayrol and Lagasquie-Schiex (2005, *2007, 2009, 2010*)

A Cohen, S Gottifredi, A J García, G R Simari: A Survey of Different Approaches to Support in Argumentation Systems. Knowledge Eng. Review 29(5): 513-550 (2014)

Abstraction is a double-edged sword

Fundamentally, Computer Science is a science of abstraction —creating the right model for thinking about a problem and devising the appropriate mechanizable techniques to solve it.

…

However, abstraction in the sense we use it implies simplification, the replacement of a complex and detailed real-world situation by an understandable model within which we can solve a problem. That is, we "abstract away" the details whose effect on the solution to a problem is minimal or non-existent, thereby creating a model that lets us deal with the essence of the problem.

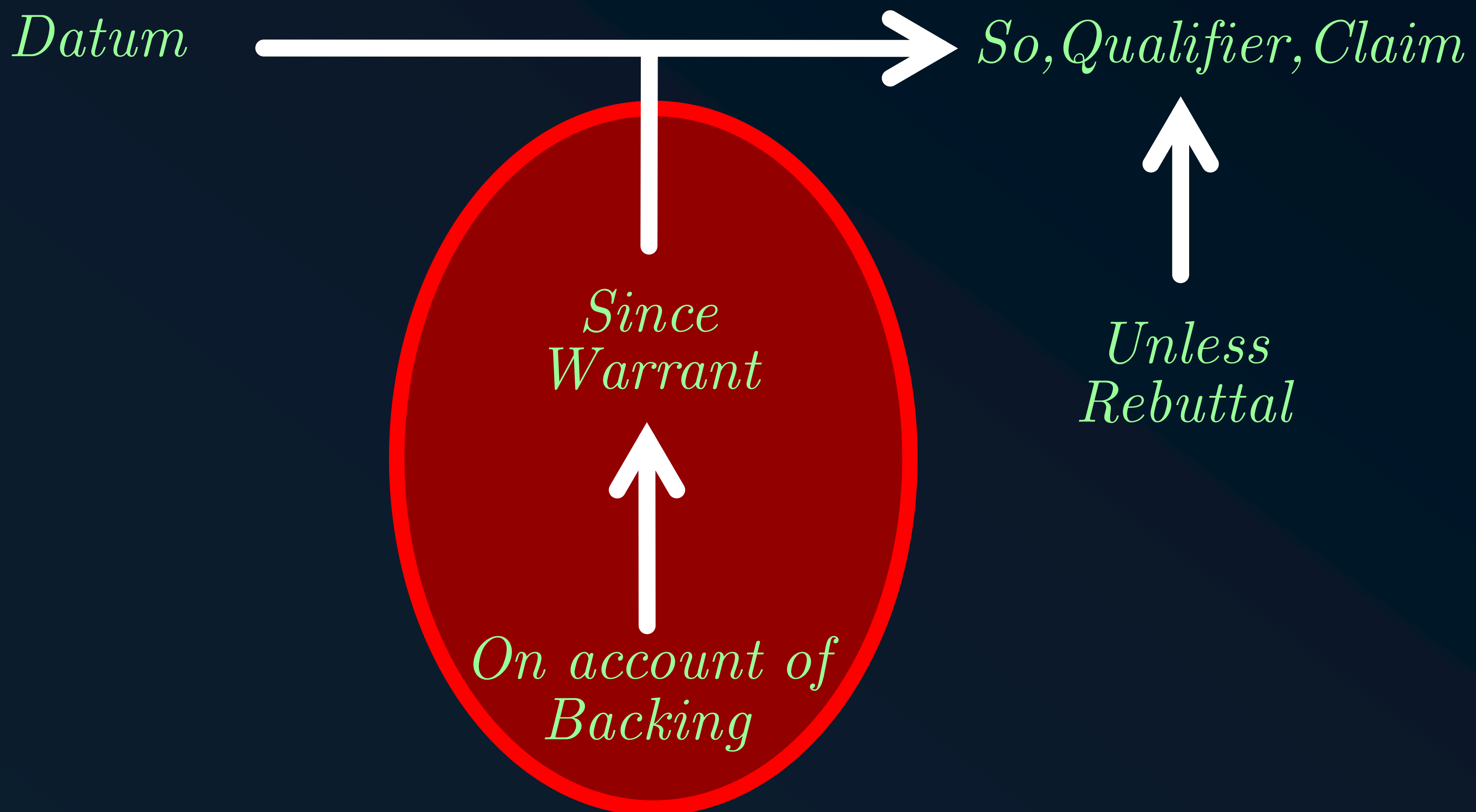
A. Aho, J. Ullman, Foundations of Computer Science (*1995*)

Abstraction is a tool for collective thought. It results in more cohesive APIs & tooling across projects because people are thinking & collaborating about things with a similar language.

Merrick Christensen

https://www.merrickchristensen.com/articles/abstraction/

Toulmin's General Model of Layout of Arguments



An Example

The following exchange of arguments happens during a meeting of the editorial board of a newspaper:

$\mathcal{I}$ *information* I *concerning person* P *should be published.*

$\mathcal{P}$ *information* I *is private; so,* P *denies publication.*

$\mathcal{M}$ P *is the new prime minister; so, all related to* P *is public.*

$\mathcal{S}$ I *is an important information concerning* P*'s son.*

Some conflicts appear during the above discussion:

- *There is conflict between arguments* $\mathcal{P}$ *and* $\mathcal{I}$*, and between arguments* $\mathcal{M}$ *and* $\mathcal{P}$.
- *But, the relation between* $\mathcal{P}$ *and* $\mathcal{S}$ *clearly is not a conflict; also,* $\mathcal{S}$ *provides information related to* $\mathcal{P}$.

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$\mathcal{S}$ $\mathcal{P}$ $\mathcal{I}$

$\mathcal{M}$

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$$\mathcal{S} \qquad \mathcal{P} \rightleftarrows \mathcal{I}$$

$$\mathcal{M}$$

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$$
\begin{tikzcd}
\mathcal{S} & \mathcal{P} \arrow[r, shift left] & \mathcal{I} \arrow[l, shift left] \\
 & \mathcal{M} \arrow[u] &
\end{tikzcd}
$$

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$$\begin{tikzcd}
\mathcal{S} \arrow[rr, bend left] \arrow[dr] & \mathcal{P} \arrow[r, shift left] & \mathcal{I} \arrow[l, shift left] \\
& \mathcal{M} \arrow[u] &
\end{tikzcd}$$

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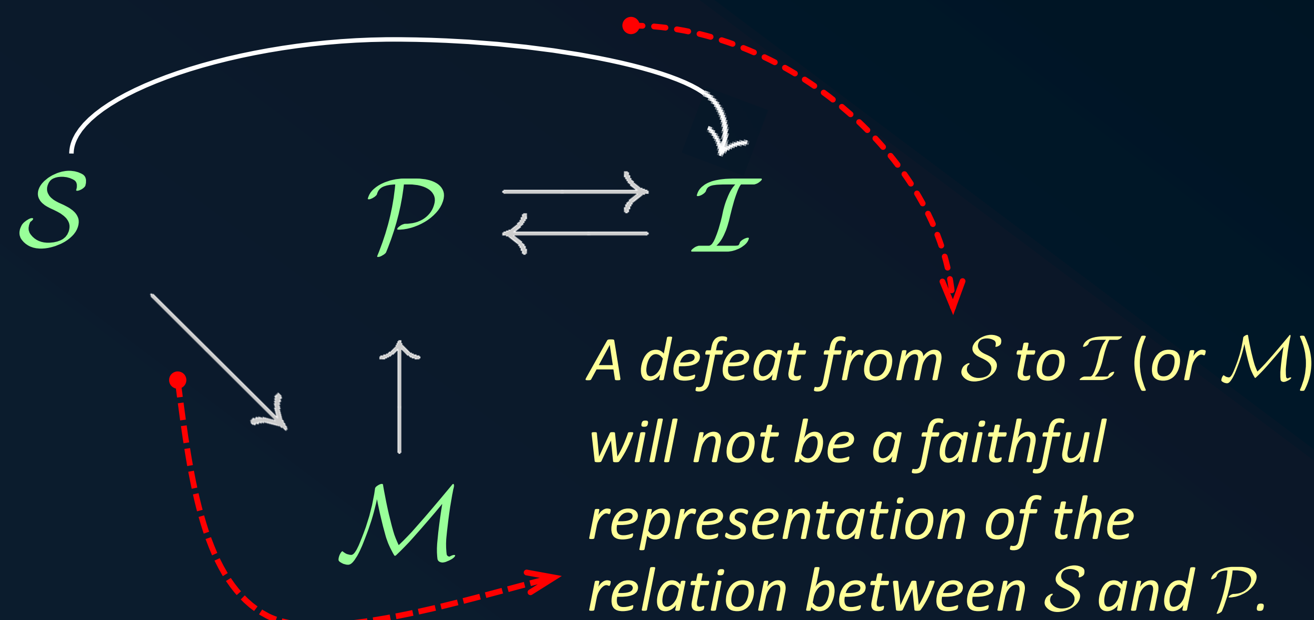

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$$\begin{tikzcd} \mathcal{S} \arrow[r, Rightarrow, "?"] & \mathcal{P} \arrow[r, shift left] & \mathcal{I} \arrow[l, shift left] \\ & \mathcal{M} \arrow[u] & \end{tikzcd}$$

A defeat from $\mathcal{S}$ *to* $\mathcal{I}$ (*or* $\mathcal{M}$) *will not be a faithful representation of the relation between* $\mathcal{S}$ *and* $\mathcal{P}$.

Support in Argumentation

- *The goal is not to change the existing arguments or introduce defeats that do not quite exist; an alternative is to consider a new and independent relation defined over the set of arguments.*
- *The objective is to provide tools to attempt to represent all the types of interactions between the arguments.*
- *A relation of support will provide the required representational elements without loosing the abstract flavor of the classic argumentation frameworks.*

About Support in Argumentation

Deductive Support:

Captures the intuition that if $\mathcal{A}$ supports $\mathcal{B}$ then the acceptance of $\mathcal{A}$ implies the acceptance of $\mathcal{B}$, and as a reflection the non-acceptance of $\mathcal{B}$ implies the non-acceptance of $\mathcal{A}$.

$\mathcal{A} \Longrightarrow \mathcal{B}$, *then $\mathcal{B}$ is accepted, and*

$\mathcal{B}$ *is not accepted, then $\mathcal{A}$ is not accepted*

About Support in Argumentation

Necessary Support:

Reflects the intuition that if $\mathcal{A}$ supports $\mathcal{B}$ then the acceptance of $\mathcal{A}$ is necessary to get the acceptance of $\mathcal{B}$, or equivalently the acceptance of $\mathcal{B}$ implies the acceptance of $\mathcal{A}$.

About Support in Argumentation

Evidential Support: Permits to distinguish between prima-facie and standard arguments; prima-facie arguments do not require any support from other arguments, whereas standard arguments must be supported by at least one prima-facie argument.

Bipolar Argumentation Frameworks (*BAFs*)

Bipolar Argumentation Frameworks

A *Bipolar Argumentation Framework* (BAF) is a triple:

$$\langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$$

$$\mathbb{R}_s \subseteq \mathbb{A} \times \mathbb{A}$$

is a support relation between arguments

$$\mathbb{R}_d \subseteq \mathbb{A} \times \mathbb{A}$$

is a defeat relation between arguments

$\mathbb{A}$ *is a finite, non-empty set of arguments*

Example (contd.)

$\mathcal{I}$ *information I concerning person P should be published.*

$\mathcal{P}$ *information I is private so, P denies publication.*

$\mathcal{S}$ *I is an important information concerning P's son.*

$\mathcal{M}$ *P is the new prime minister so, everything related to P is public.*

The BAF in the figure can be put in terms of the previous definition as

$BAF = \langle\, \mathbb{A},\, \mathbb{R}_d,\, \mathbb{R}_s \,\rangle$ *where:*

$$\mathbb{A} = \{\mathcal{I}, \mathcal{M}, \mathcal{P}, \mathcal{S}\}$$

$$\mathbb{R}_d = \{\, (\mathcal{P},\, \mathcal{I}),\, (\mathcal{I},\, \mathcal{P}),\, (\mathcal{M},\, \mathcal{P})\}$$

$$\mathbb{R}_s = \{\, (\mathcal{S},\, \mathcal{P})\,\}$$

$$\begin{tikzcd} \mathcal{S} \arrow[r, Rightarrow] & \mathcal{P} \arrow[r, shift left] & \mathcal{I} \arrow[l, shift left] \\ & \mathcal{M} \arrow[u] & \end{tikzcd}$$

Bipolar Interaction Graph

$$
\begin{tikzcd}
\mathcal{B} \arrow[r, Rightarrow] & \mathcal{C} \arrow[r, Rightarrow] \arrow[d, Rightarrow] & \mathcal{E} \arrow[r] & \mathcal{F} \arrow[d, shift left] & \mathcal{H} \arrow[l, Rightarrow] \\
\mathcal{A} \arrow[u] & \mathcal{D} & & \mathcal{G} \arrow[ll, Rightarrow] \arrow[u, Rightarrow, shift left]
\end{tikzcd}
$$

Example

$$
\begin{tikzcd}
\mathcal{B} \arrow[r, Rightarrow] & \mathcal{C} \arrow[r, Rightarrow] \arrow[d, Rightarrow] & \mathcal{E} \arrow[r] & \mathcal{F} \arrow[d, shift left] & \mathcal{H} \arrow[l, Rightarrow] \\
\mathcal{A} \arrow[u] & \mathcal{D} & & \mathcal{G} \arrow[ll, Rightarrow] \arrow[u, Rightarrow, shift left] &
\end{tikzcd}
$$

Example

Supported and Secondary Defeats

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $\mathcal{A}$, $\mathcal{B} \in \mathbb{A}$

– *A supported defeat from* $\mathcal{A}$ *to* $\mathcal{B}$ *is a sequence*

$$\mathcal{A}=\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n = \mathcal{B},\ \ n \geq 3,$$

such that $\mathrm{R}_i = \mathbb{R}_s$ *for* $1 \leq\ i \leq\ n\text{-}2$, *and* $\mathrm{R}_{n\text{-}1} = \mathbb{R}_d$, *i.e.,*

$$\mathcal{A}_1 \Rightarrow \mathcal{A}_2 \Rightarrow \cdots \mathcal{A}_{n\text{-}1} \rightarrow \mathcal{A}_n = \mathcal{B}$$

Supported defeat

$$\begin{tikzcd}
\mathcal{B} \arrow[r, Rightarrow] \arrow[rrr, bend left, dashed] & \mathcal{C} \arrow[r, Rightarrow] \arrow[d, Rightarrow] \arrow[rr, bend left, dashed] & \mathcal{E} \arrow[r] & \mathcal{F} \arrow[d, shift left] & \mathcal{H} \arrow[l, Rightarrow] \\
\mathcal{A} \arrow[u] & \mathcal{D} & & \mathcal{G} \arrow[ll, Rightarrow] \arrow[u, Rightarrow, shift left]
\end{tikzcd}$$

$\mathcal{B} \Rightarrow \mathcal{C} \Rightarrow \mathcal{E} \rightarrow \mathcal{F}$ $\mathcal{C} \Rightarrow \mathcal{E} \rightarrow \mathcal{F}$ $\mathcal{E} \rightarrow \mathcal{F}$

A *supported defeat* from $\mathcal{A}$ to $\mathcal{B}$ is a sequence $\mathcal{A}=\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n = \mathcal{B}$, $n \geq 3$, such that $\mathrm{R}_i = \mathbb{R}_s$ *for* $1 \leq i \leq n\text{-}2$, and $\mathrm{R}_{n\text{-}1} = \mathbb{R}_d$.

Supported defeat

$$
\begin{tikzcd}
\mathcal{B} \arrow[r, Rightarrow] & \mathcal{C} \arrow[r, Rightarrow] \arrow[d, Rightarrow] & \mathcal{E} \arrow[r] & \mathcal{F} \arrow[d, shift left, red] & \mathcal{H} \arrow[l, Rightarrow] \\
\mathcal{A} \arrow[u] & \mathcal{D} & & \mathcal{G} \arrow[ll, Rightarrow] \arrow[u, Rightarrow, shift left, green] \arrow[loop right, dashed, red] &
\end{tikzcd}
$$

$\mathcal{G} \Rightarrow \mathcal{F} \to \mathcal{G}$ $\qquad\qquad$ $\mathcal{F} \to \mathcal{G}$

A *supported defeat* from $\mathcal{A}$ to $\mathcal{B}$ is a sequence $\mathcal{A}{=}\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n{=}\ \mathcal{B}$, $n \geq 3$, such that $\mathrm{R}_i = \mathbb{R}_s$ *for* $1{\leq}\ i \leq n\text{-}2,$ and $\mathrm{R}_{n\text{-}1} = \mathbb{R}_d$.

Supported and Secondary Defeats

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $\mathcal{A}, \mathcal{B} \in \mathbb{A}$

– *A supported defeat from* $\mathcal{A}$ *to* $\mathcal{B}$ *is a sequence*

$$\mathcal{A}{=}\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n{=}\ \mathcal{B},\ \ n \geq 3,$$

such that $\mathrm{R}_i = \mathbb{R}_s$ *for* $1\leq\ i \leq\ n\text{-}2$*, and* $\mathrm{R}_{n\text{-}1} = \mathbb{R}_d$*, i.e.,*

$$\mathcal{A}_1 \Rightarrow \mathcal{A}_2 \Rightarrow \cdots \mathcal{A}_{n\text{-}1} \rightarrow \mathcal{A}_n = \mathcal{B}$$

– *A secondary defeat from* $\mathcal{A}$ *to* $\mathcal{B}$ *is a sequence*

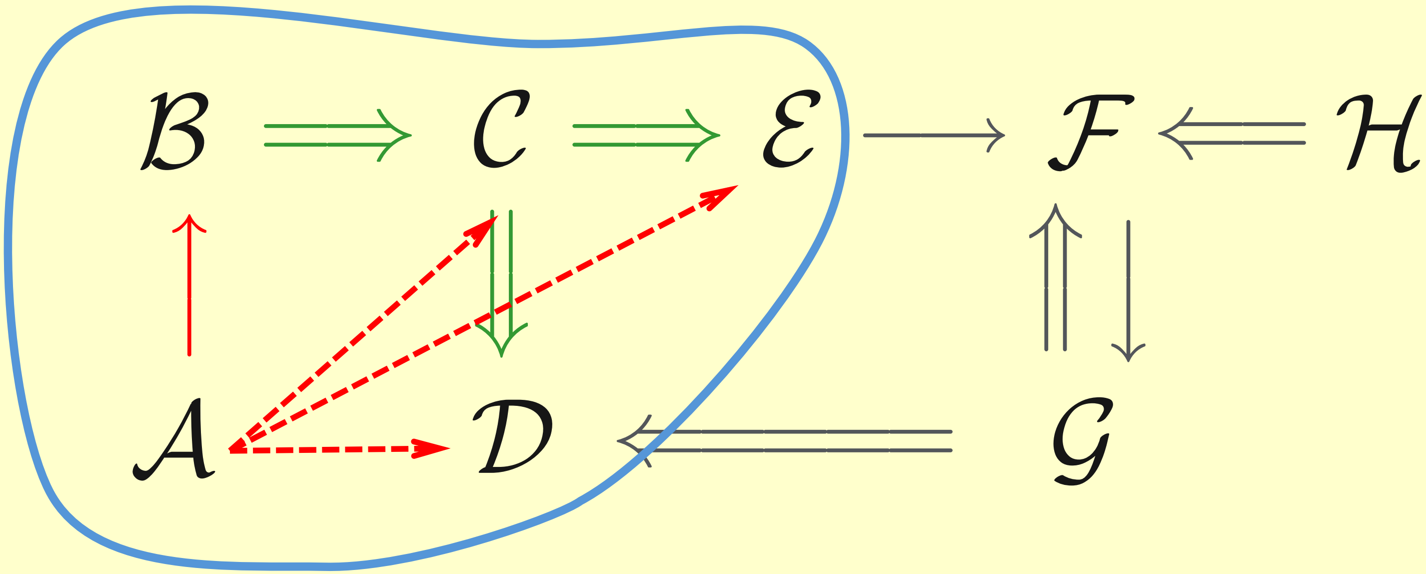
$$\mathcal{A}{=}\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n{=}\ \mathcal{B},\ \ n \geq 3,$$

such that $\mathrm{R}_1 = \mathbb{R}_d$ *and* $\mathrm{R}_i = \mathbb{R}_s$ *for* $2 \leq\ i \leq\ n\text{-}1$*, i.e.,*

$$\mathcal{A}_1 \rightarrow \mathcal{A}_2 \Rightarrow \cdots \Rightarrow \mathcal{A}_n{=}\ \mathcal{B}$$

A direct defeat $\mathcal{A} \rightarrow \mathcal{B}$ *is also a supported defeat.*

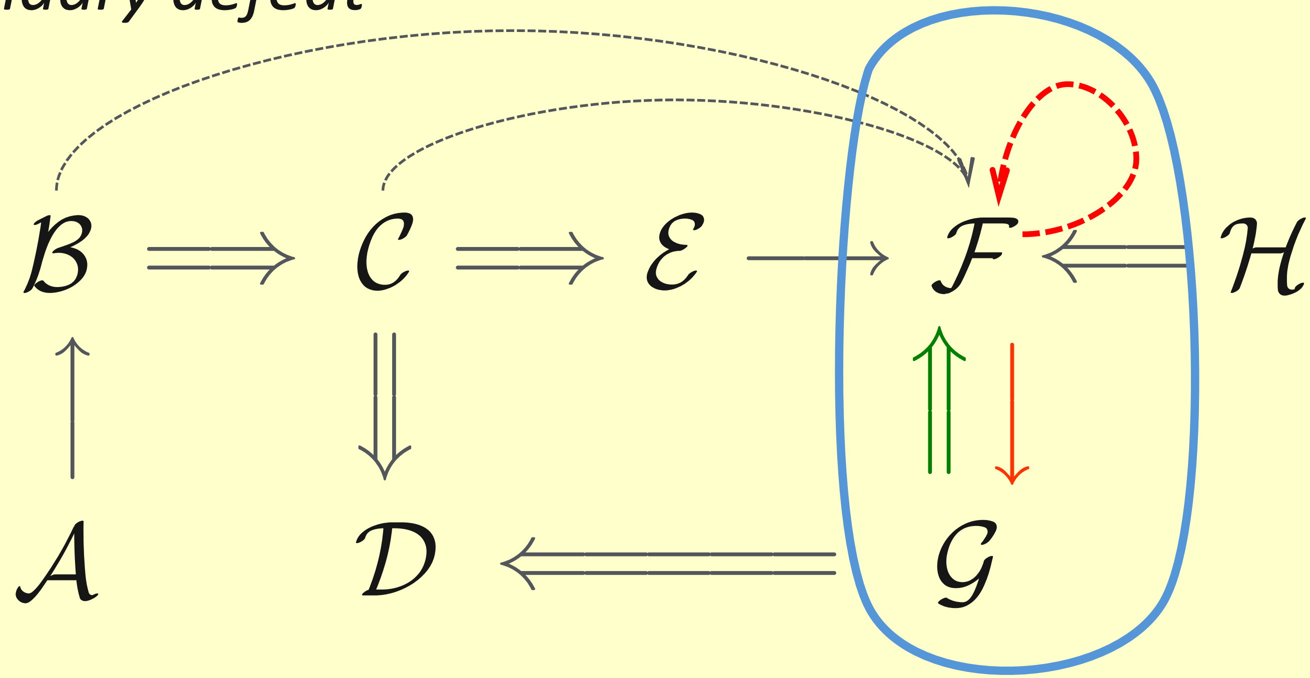
Secondary defeat



$\mathcal{A} \rightarrow \mathcal{B} \Rightarrow \mathcal{C} \Rightarrow \mathcal{E}$ and $\mathcal{A} \rightarrow \mathcal{B} \Rightarrow \mathcal{C} \Rightarrow \mathcal{D}$

A *secondary defeat* from $\mathcal{A}$ to $\mathcal{B}$ is a sequence $\mathcal{A}=\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n= \mathcal{B}$, $n \geq 3$, such that $\mathrm{R}_1 = \mathbb{R}_d$ and $\mathrm{R}_i = \mathbb{R}_s$ *for* $2 \leq i \leq n\text{-}1$.

Secondary defeat



$\mathcal{F} \longrightarrow \mathcal{G} \Rightarrow \mathcal{F}$

A *secondary defeat* from $\mathcal{A}$ to $\mathcal{B}$ is a sequence $\mathcal{A}{=}\mathcal{A}_1\ \mathrm{R}_1 \ldots \mathrm{R}_{n\text{-}1}\ \mathcal{A}_n{=}\ \mathcal{B}$, $n \geq 3$, such that $\mathrm{R}_1 = \mathbb{R}_d$ and $\mathrm{R}_i = \mathbb{R}_s$ *for* $2 \leq i \leq n\text{-}1$.

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such that $\mathrm{R}_i = \mathbb{R}_s$ for $1 \leq\ i \leq\ n$-2, and $\mathrm{R}_{n\text{-}1} = \mathbb{R}_d$, i.e.,

$$\mathcal{A}_1 \Rightarrow \mathcal{A}_2 \Rightarrow \cdots \mathcal{A}_{n\text{-}1} \rightarrow \mathcal{A}_n = \mathcal{B}$$

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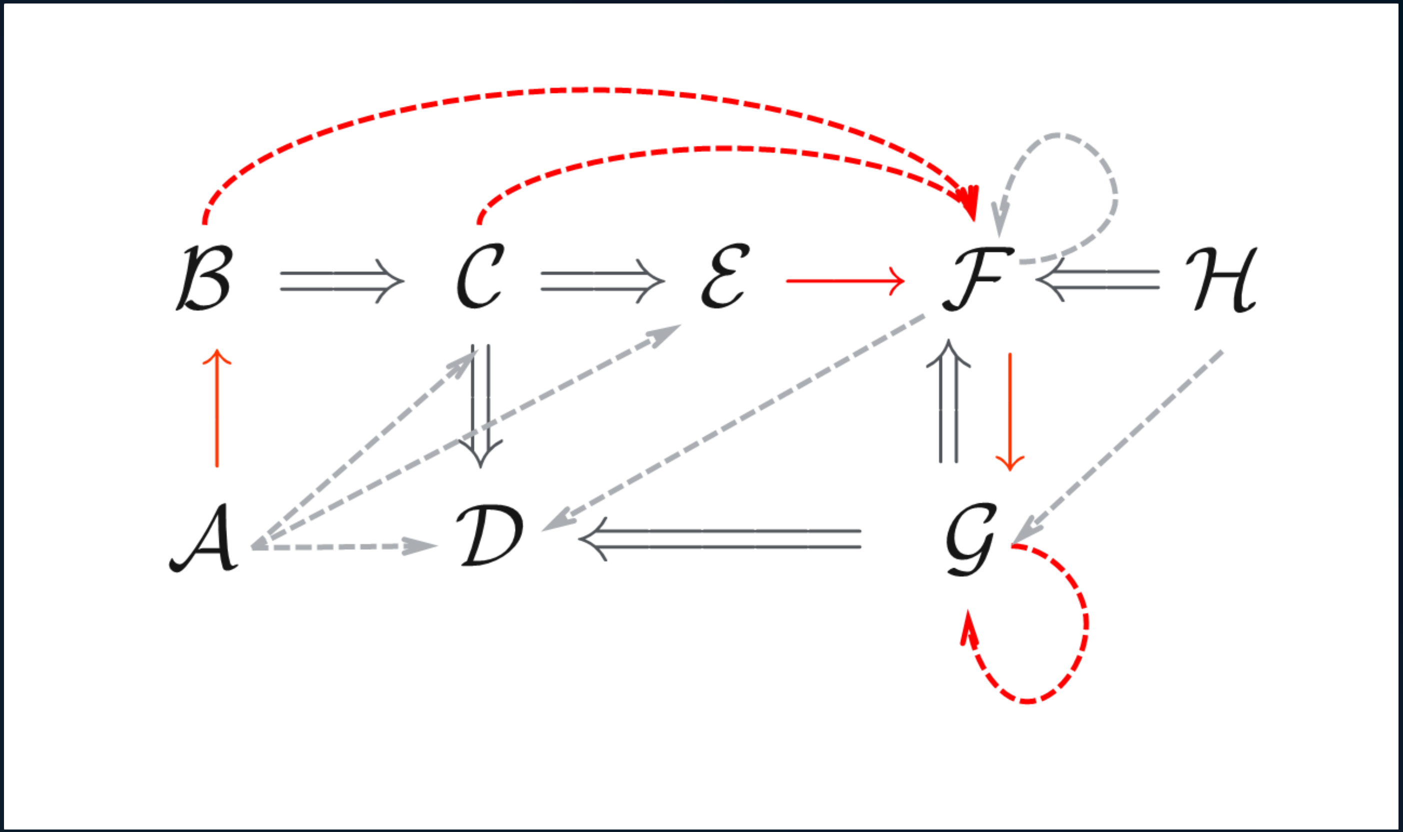
such that $\mathrm{R}_1 = \mathbb{R}_d$ and $\mathrm{R}_i = \mathbb{R}_s$ for $2 \leq\ i \leq\ n$-1, i.e.,

$$\mathcal{A}_1 \rightarrow \mathcal{A}_2 \Rightarrow \cdots \Rightarrow \mathcal{A}_n{=}\ \mathcal{B}$$

A *direct defeat* $\mathcal{A} \rightarrow \mathcal{B}$ is also a *supported defeat*.

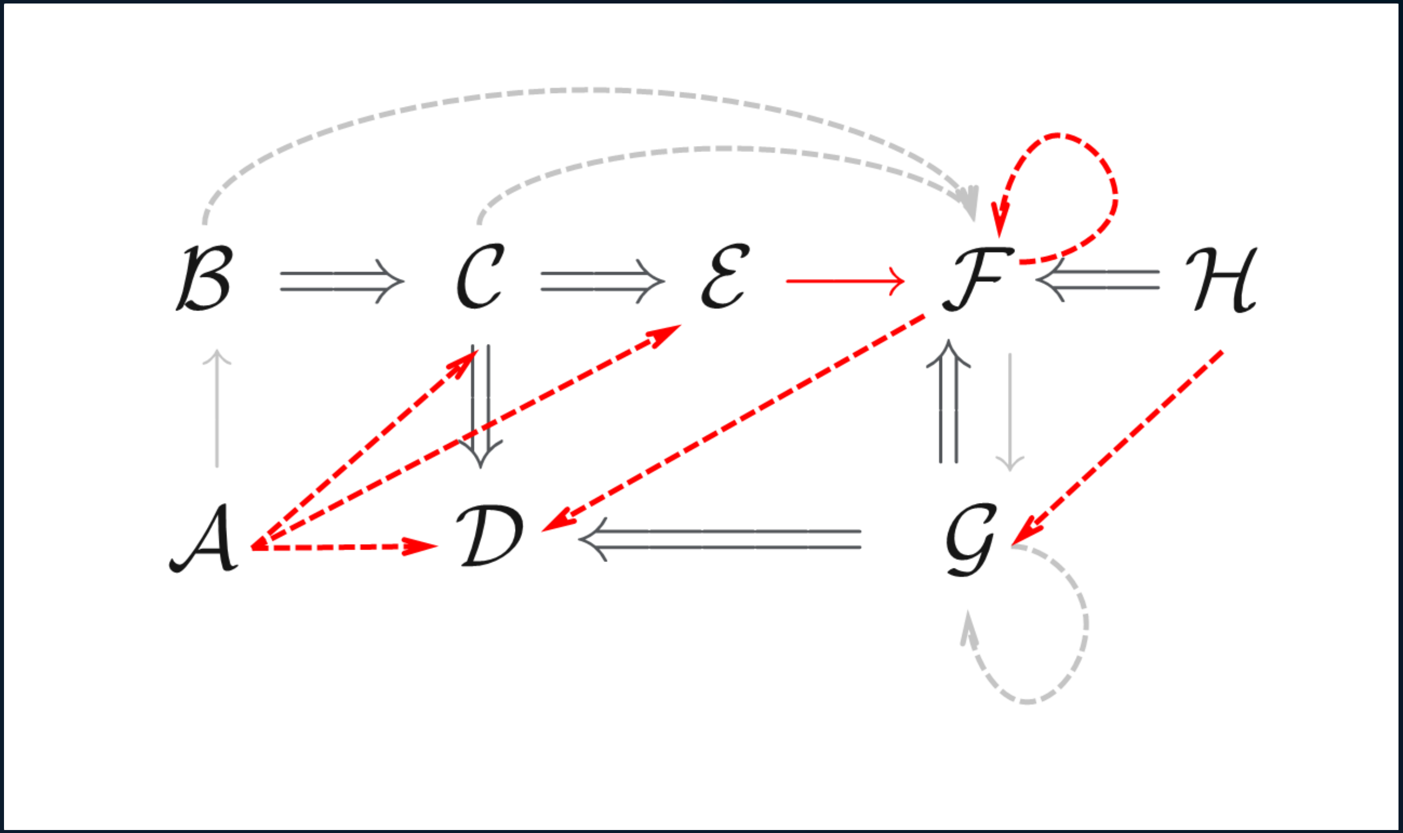
Supported and Secondary Defeats

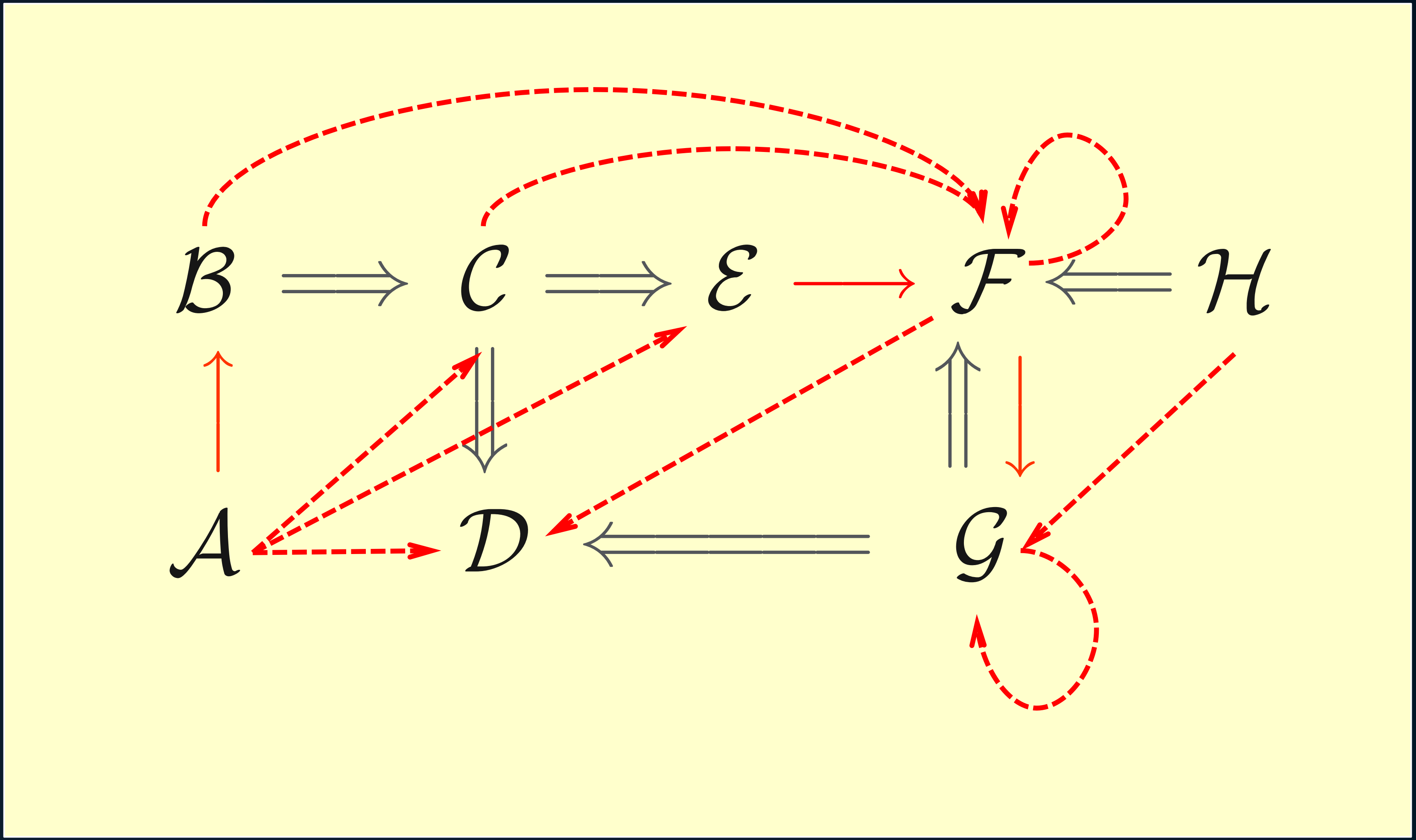
– *a path* $\mathcal{A}_1 \Rightarrow \mathcal{A}_2 \ldots \Rightarrow \mathcal{A}_k \rightarrow \mathcal{B}$ *in the bipolar interaction graph leads to* k *__supported defeats__ from each* $\mathcal{A}_i$ *to* $\mathcal{B}$ $(1 \leq i \leq k)$*; and,*



Supported and Secondary Defeats

- a path $\mathcal{A}_1 \Rightarrow \mathcal{A}_2 \ldots \Rightarrow \mathcal{A}_k \rightarrow \mathcal{B}$ in the bipolar interaction graph leads to k <u>supported defeats</u> from each $\mathcal{A}_i$ to $\mathcal{B}$ $(1 \leq i \leq k)$; and,
- a path $\mathcal{B} \rightarrow \mathcal{A}_1 \Rightarrow \mathcal{A}_2 \ldots \Rightarrow \mathcal{A}_k$ in the bipolar interaction graph leads to k <u>secondary defeats</u> from $\mathcal{B}$ to each $\mathcal{A}_i$ $(1 \leq i \leq k)$.





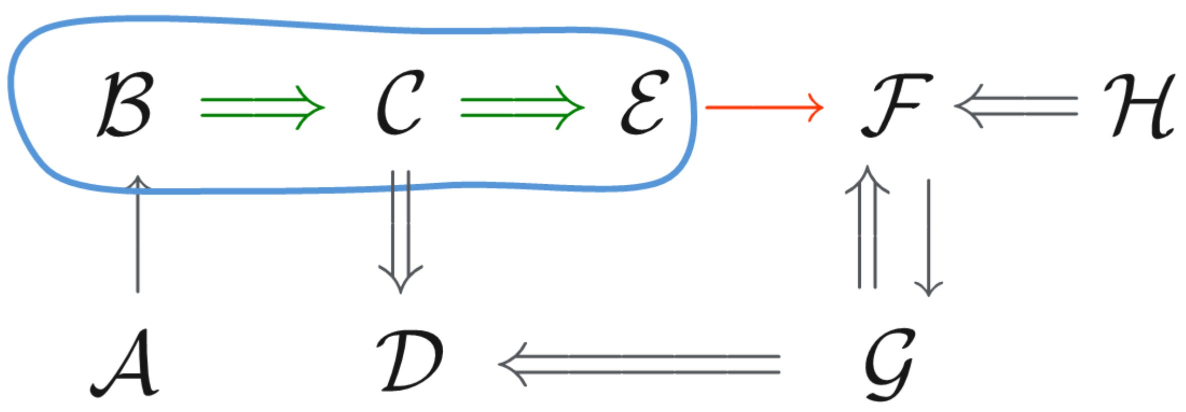
In red all the defeats (supported and secondary) are shown together with the supports in grey.

Handling Conflict

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $S \subseteq \mathbb{A}$, $\mathcal{A} \in \mathbb{A}$, *then:*

– S *set-defeats* $\mathcal{A}$ *iff there exists a supported defeat or a direct defeat for* $\mathcal{A}$ *from an element of* S.

$S = \{\ \mathcal{B},\ \mathcal{C},\ \mathcal{E}\ \}$ *set-defeats* $\mathcal{F}$



$\mathcal{B} \Rightarrow \mathcal{C} \Rightarrow \mathcal{E} \rightarrow \mathcal{F}$

Handling Conflict

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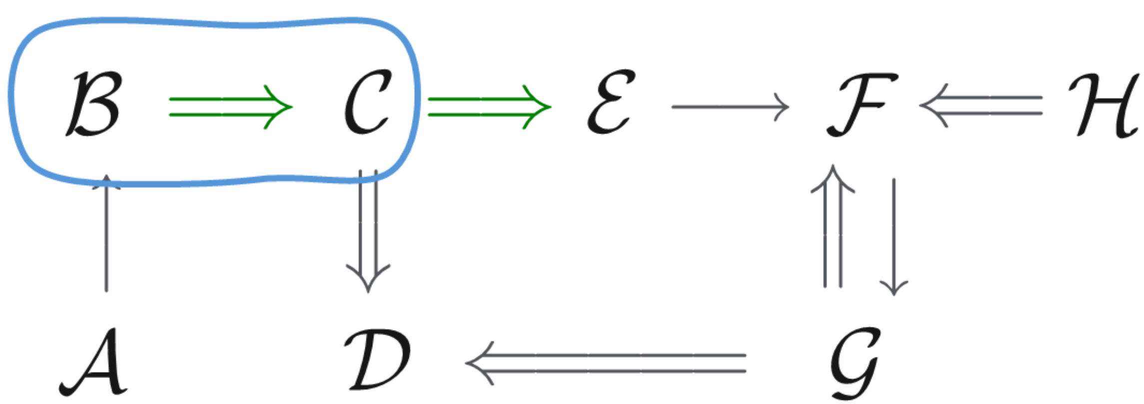
– S *set-defeats* $\mathcal{A}$ *iff there exists a supported defeat or a direct defeat for* $\mathcal{A}$ *from an element of* S.

– S *set-supports* $\mathcal{A}$ *iff there exists a sequence of supports for* $\mathcal{A}$ *from an element of* S.

$S = \{\ \mathcal{B}, \mathcal{C}\ \}$ *set-supports* $\mathcal{E}$



$\mathcal{B} \Rightarrow \mathcal{C} \Rightarrow \mathcal{E}$

Handling Conflict

In AAF, acceptable sets of arguments must be conflict-free (a form of coherence); in BAFs, the notion of coherence can be extended in two different ways:

- *Disallowing both direct defeats <u>and</u> the proper supported defeats enforces a kind of internal coherence:*

  A set S of arguments that set-defeats one of its elements, is rejected.

- *Extending the consistency constraint between support and defeat relations leads to external coherence:*

  A set S of arguments which set-defeats and set-supports the same argument, is not accepted.

Conflict Freeness and Safety

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $S \subseteq \mathbb{A}$

- S is *+conflict-free iff there is no pair* $\mathcal{A}, \mathcal{B} \in S$ *such that there is a supported or a secondary defeat from* $\mathcal{A}$ *to* $\mathcal{B}$*.*
- S is *safe iff there is no* $\mathcal{A} \in \mathbb{A}$ *and no pair* $\mathcal{B}, \mathcal{C} \in S$ *such that there is a supported or a secondary defeat from* $\mathcal{B}$ to $\mathcal{A}$*, and either there is a sequence of support from* $\mathcal{C}$ *to* $\mathcal{A}$*, or* $\mathcal{A} \in S$*.*

Altenatively,

- S is *+conflict-free iff there is no pair* $\mathcal{A}, \mathcal{B} \in S$ *such that* $\{\mathcal{A}\}$ *set-defeats* $\mathcal{B}$.
- S is *safe iff there is no* $\mathcal{A} \in \mathbb{A}$ *such that* S *set-defeats* $\mathcal{A}$*, and either* S *set-supports* $\mathcal{A}$ *or* $\mathcal{A} \in S$*.*

Conflict Freeness and Safety

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The notion of +conflict-freeness is more restrictive than simple conflict-freeness since +conflict-freeness considers supported and secondary defeats, and supported defeats include direct defeat.

Conflict Freeness and Safety

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $S \subseteq \mathbb{A}$

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Also, it has been shown that if a set is safe it is also +conflict-free, although the converse does not hold (example follows); but, if a set is +conflict-free and closed under the support relation then it is also safe (*closed: if* $\mathcal{A} \Rightarrow \mathcal{B}$*, and* $\mathcal{A} \in S$*, then* $\mathcal{B} \in S$).

Conflict Freeness and Safety

Definition: Let $BAF = \langle\ \mathbb{A},\ \mathbb{R}_d,\ \mathbb{R}_s\ \rangle$ *be a Bipolar Argumentation Framework and* $S \subseteq \mathbb{A}$

- S is +conflict-free *iff there is no pair* $\mathcal{A}$, $\mathcal{B} \in S$ *such that* $\{\mathcal{A}\}$ *set-defeats* $\mathcal{B}$.
- S is safe *iff there is no* $\mathcal{A} \in \mathbb{A}$ *such that* S *set-defeats* $\mathcal{A}$, *and either* S *set-supports* $\mathcal{A}$ *or* $\mathcal{A} \in S$.

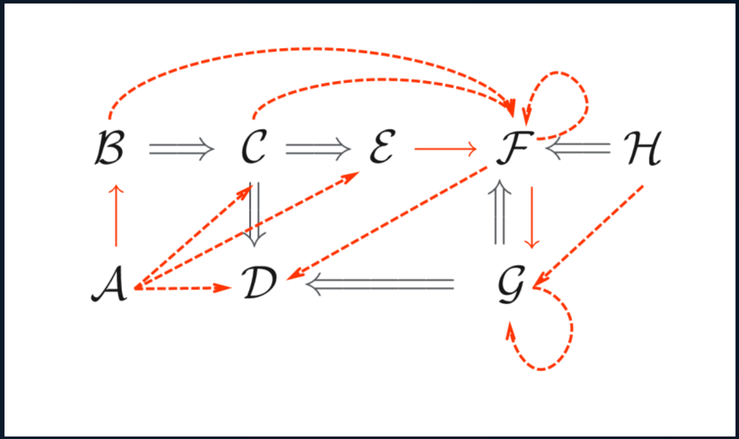
$\{\mathcal{A},\mathcal{F}\}$ *is conflict-free and +conflict-free.*

$\{\mathcal{A},\mathcal{C}\}$ *is conflict-free but not +conflict-free.*

$\{\mathcal{G}\}$ *is conflict-free but not +conflict-free.*

$\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{E},\mathcal{H}\}$ *is +conflict-free but not safe.*

$\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{E}\}$ *and* $\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{H}\}$ *are both safe.*



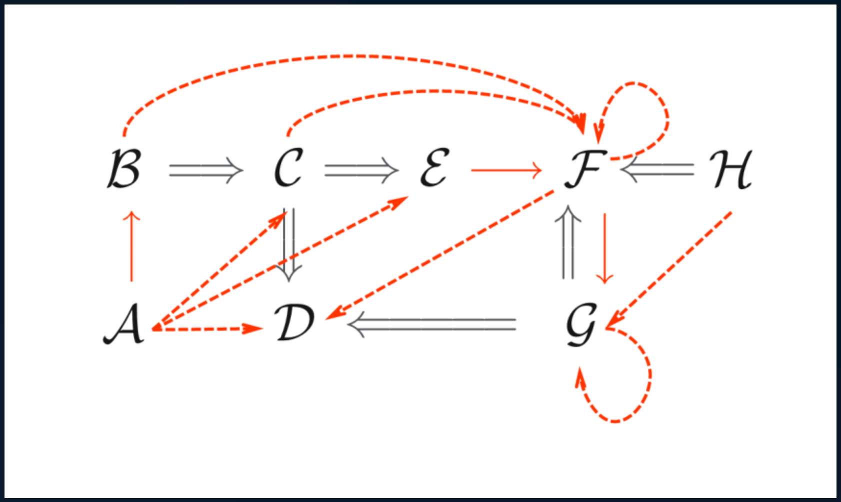
Conflict Freeness and Safety

$\{\mathcal{A},\mathcal{C}\}$ *is conflict-free but not +conflict-free.*

$\{\mathcal{G}\}$ *is conflict-free but not +conflict-free.*

$\{\mathcal{A},\mathcal{F}\}$ *is conflict-free and +conflict-free.*

The notion of +conflict-freeness is more restrictive than simple conflict-freeness since considers supported and secondary defeats, and supported defeats include direct defeat.

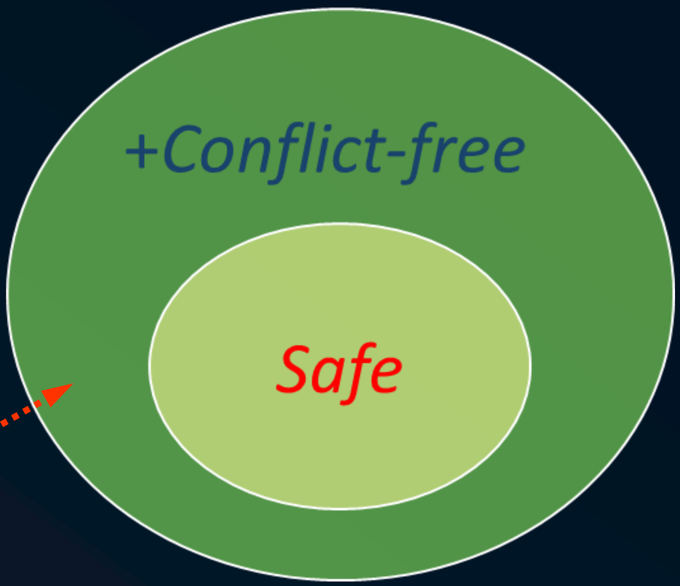


Conflict Freeness and Safety

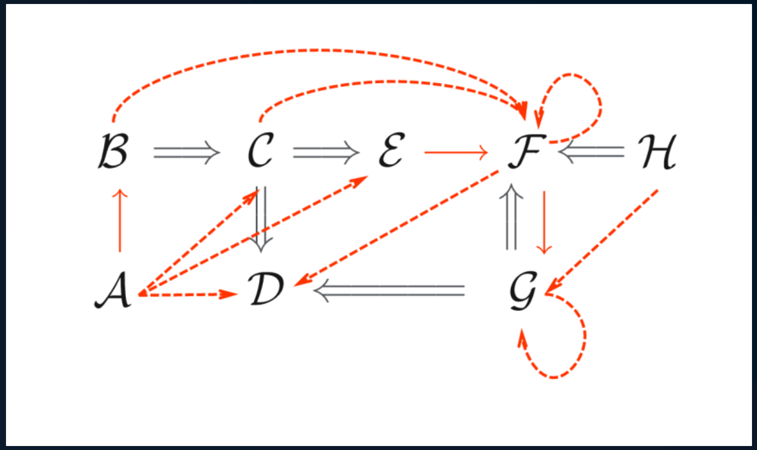
If a set is safe it is also +conflict-free, although the converse does not hold.

If a set is +conflict-free and closed under the support relation then it is also safe.

(*closed: if* $\mathcal{A} \Rightarrow \mathcal{B}$, *and* $\mathcal{A} \in \mathcal{S}$, *then* $\mathcal{B} \in \mathcal{S}$)



$\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{E},\mathcal{H}\}$ *is +conflict-free but not safe.*



BAFs Acceptability Semantics

- *Various notions of coherence, and two kinds of defeat (direct and supported) are available, we may extend the notion of defense in different ways.*
- *However, we will restrict to the classical defense, for the following reasons:*
  - *The purpose of this introduction is to present the basic principles central to bipolar frameworks, and*
  - *It has been postulated in the literature that support does not have the same strength as defeat.*
- *Thus, an argument can be considered as defended if and only if its direct defeaters are directly defeated.*

BAFs Admissibility

- *Three different definitions for admissibility are possible, and they will be given from most general to most specific.*
- *First, Dung's definition in the context of BAFs provides the definition of d-admissibility ("d" means "in Dung's AAF).*
- *The consideration of external coherence renders the concept to s(afe)-admissibility.*
- *Finally, external coherence can be strengthened by requiring that an admissible set be closed for $\mathbb{R}_s$ (the support relation), obtaining the definition of c(losed)-admissibility.*

BAFs Admissibility

Let us recall that in AFs, $S \subseteq \mathbb{A}$ is said to be conflict free iff there are no $\mathcal{A}, \mathcal{B} \in S$ such that $\mathcal{A}$ defeats $\mathcal{B}$, and that $S \subseteq \mathbb{A}$ is said to be admissible iff S is conflict free and defends all its elements.

In $BAFs$ a set $S \subseteq \mathbb{A}$ is +conflict-free iff there is no pair $\mathcal{A}$, $\mathcal{B} \in S$ such that $\{\mathcal{A}\}$ set-defeats $\mathcal{B}$, and S is safe iff there is no $\mathcal{A} \in \mathbb{A}$ such that S set-defeats $\mathcal{A}$, and either S set-supports $\mathcal{A}$ or $\mathcal{A} \in S$.

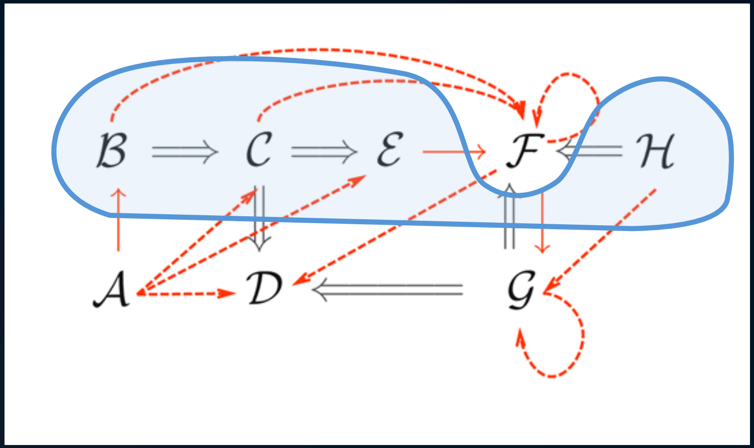
Definition: Let $S \subseteq \mathbb{A}$, then it said that:

- *S is d-admissible iff S is +conflict-free and defends all its elements.*
- *S is s-admissible iff S is safe and defends all its elements.*
- *S is c-admissible iff S is +conflict-free, closed for $\mathbb{R}_s$ and defends all its elements.*

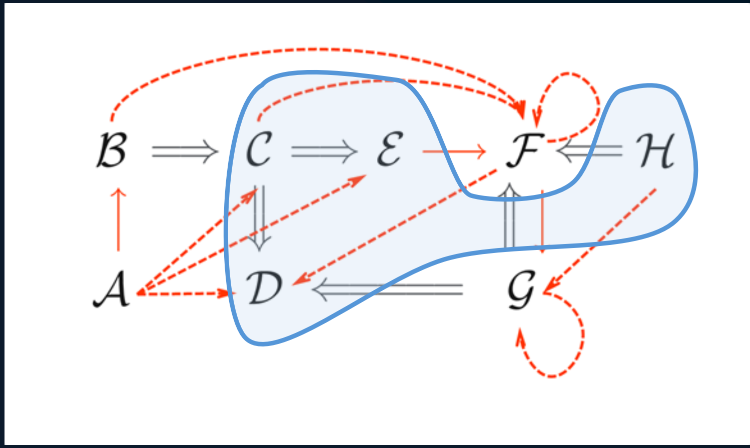
Examples

$S \subseteq \mathbb{A}$, S is *d-admissible* iff S is +conflict-free and defends all its elements.

$\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{E},\mathcal{H}\}$ is not d-admissible since, although it is +conflict-free, it does not defend $\mathcal{B}$ against the direct defeat from $\mathcal{A}$.



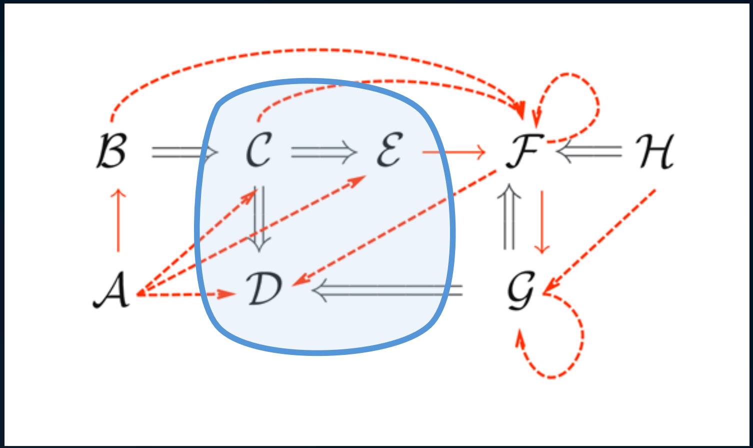
$\{\mathcal{C}, \mathcal{D}, \mathcal{E}, \mathcal{H}\}$ is d-admisible



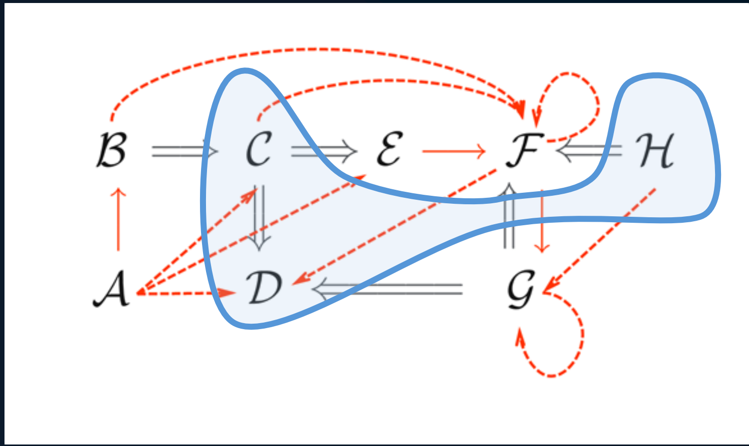
Examples

$S \subseteq \mathbb{A}$, S is s-admissible *iff S is safe (i.e., there is no $\mathcal{A} \in \mathbb{A}$ s.t. S set-defeats $\mathcal{A}$, and either S set-supports $\mathcal{A}$ or $\mathcal{A} \in S$) and defends all its elements.*

$\{\mathcal{C}, \mathcal{D}, \mathcal{E}\}$ is s-admissible



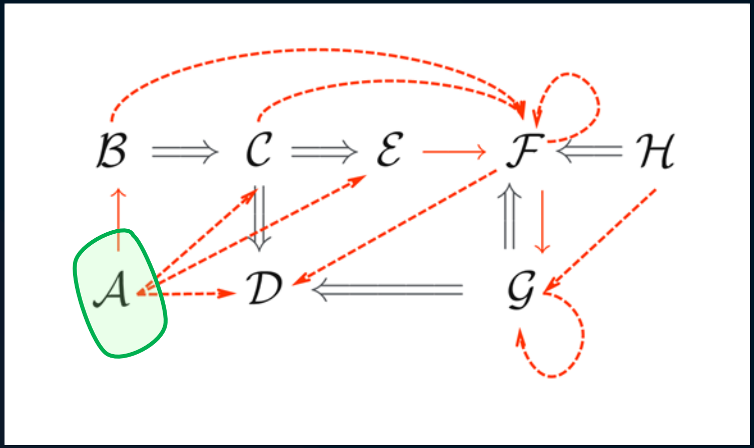
$\{\mathcal{C}, \mathcal{D}, \mathcal{H}\}$ is s-admissible



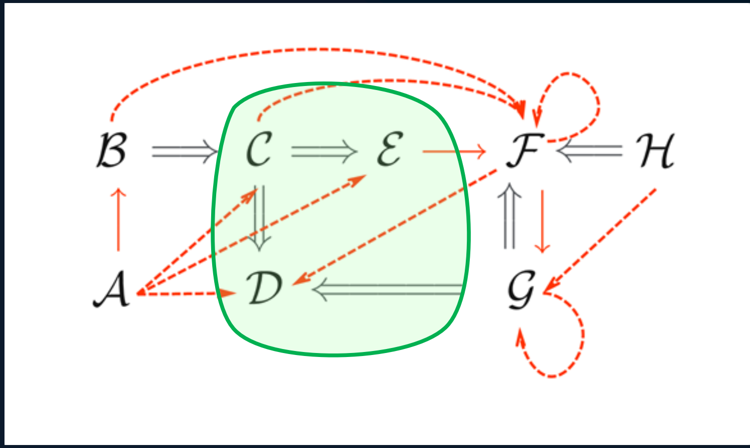
Examples

$S \subseteq \mathbb{A}$, S is c-admissible iff S is +conflict-free, closed for $\mathbb{R}_s$, and defends all its elements.

$\{\mathcal{A}\}$ is c-admissible



$\{\mathcal{C}, \mathcal{D}, \mathcal{E}\}$ is c-admissible

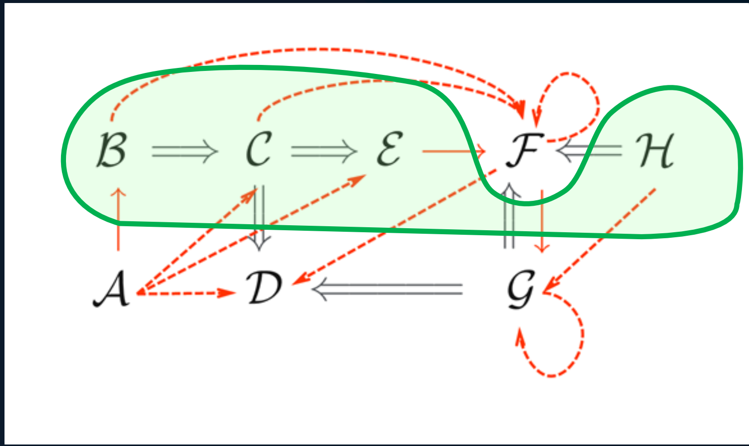


BAFs Acceptability Semantics

Definition: Let $\langle\ \mathbb{A},\ \mathbb{R}_{\mathrm{d}},\ \mathbb{R}_{\mathrm{s}}\ \rangle$ *be a BAF and let* $S \subseteq \mathbb{A}$, S is a *d-preferred* (resp. *s-preferred*, *c-preferred*) *extension iff* S *is* $\subseteq$*-maximal among the d-admissible (resp. s-admissible, c-admissible) subsets of* $\mathbb{A}$.

Definition: Let $\langle\ \mathbb{A},\ \mathbb{R}_{\mathrm{d}},\ \mathbb{R}_{\mathrm{s}}\ \rangle$ *be a BAF and let* $S \subseteq \mathbb{A}$, S *is a stable extension iff* S *is +conflict-free and for all* $\mathcal{A} \notin S$*, the set* S *set-defeats* $\mathcal{A}$.

$\{\mathcal{B},\mathcal{C},\mathcal{D},\mathcal{E},\mathcal{H}\}$ *is not d-admissible since, although it is +conflict-free, it does not defend* $\mathcal{B}$ *against the direct defeat from* $\mathcal{A}$.



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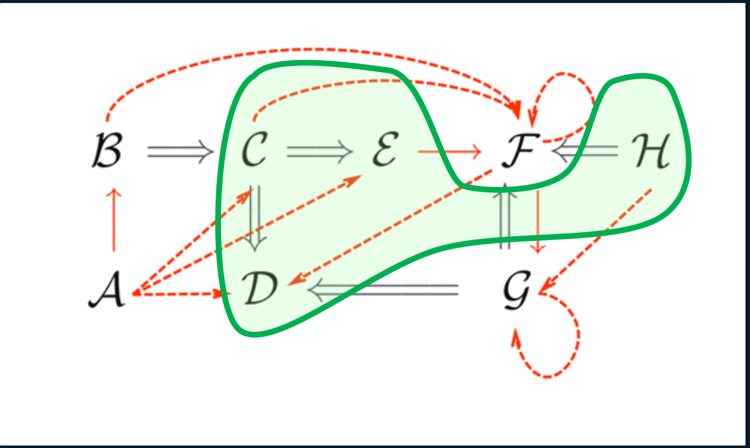

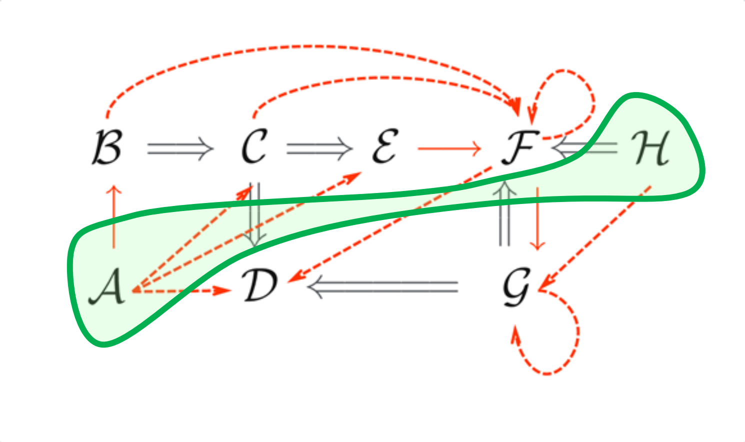

The d-preferred extensions are $\{\mathcal{C},\ \mathcal{D},\ \mathcal{E},\ \mathcal{H}\}$ *and* $\{\mathcal{A},\mathcal{H}\}$.

BAFs Acceptability Semantics

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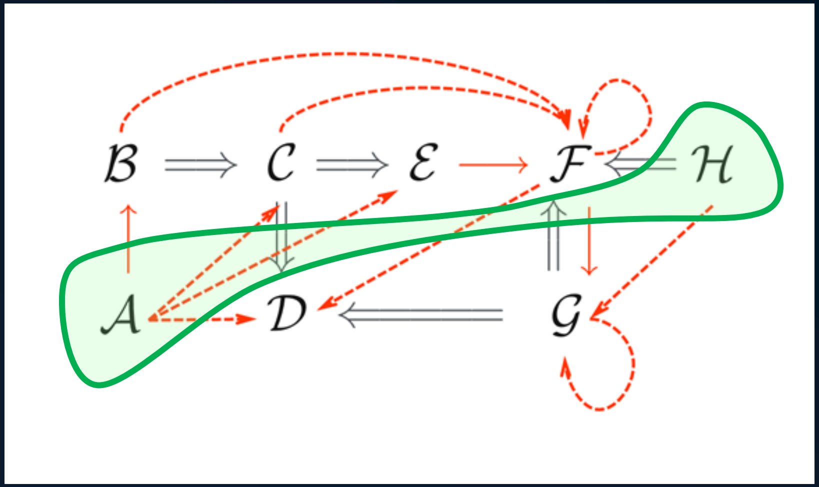
However, since $\{\mathcal{C},\ \mathcal{D},\ \mathcal{E},\ \mathcal{H}\}$ *is not safe since* $\mathcal{E} \rightarrow \mathcal{F}$ *and* $\mathcal{H} \Rightarrow \mathcal{F}$ *the s-preferred extensions are* $\{\mathcal{A},\mathcal{H}\}$, $\{\mathcal{C},\mathcal{D},\mathcal{E}\}$, $\{\mathcal{C},\mathcal{D},\mathcal{H}\}$



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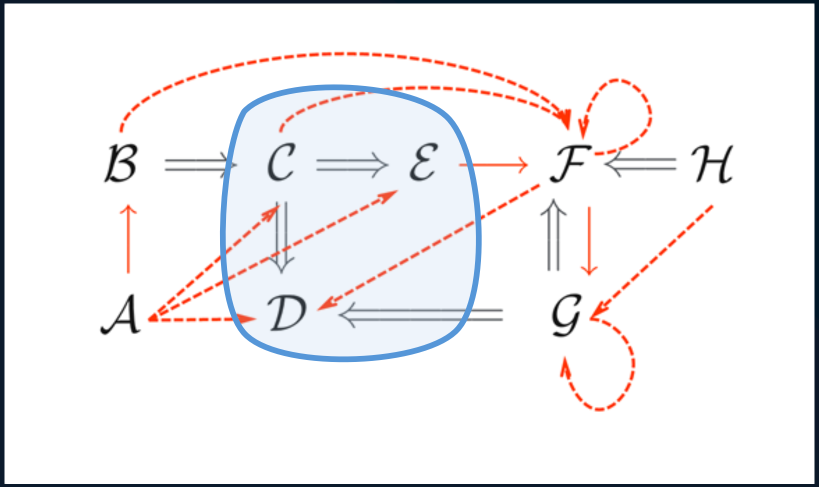

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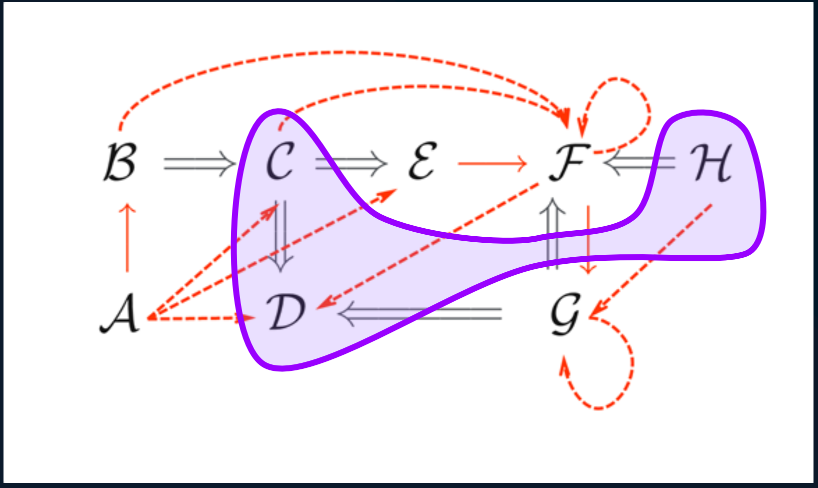

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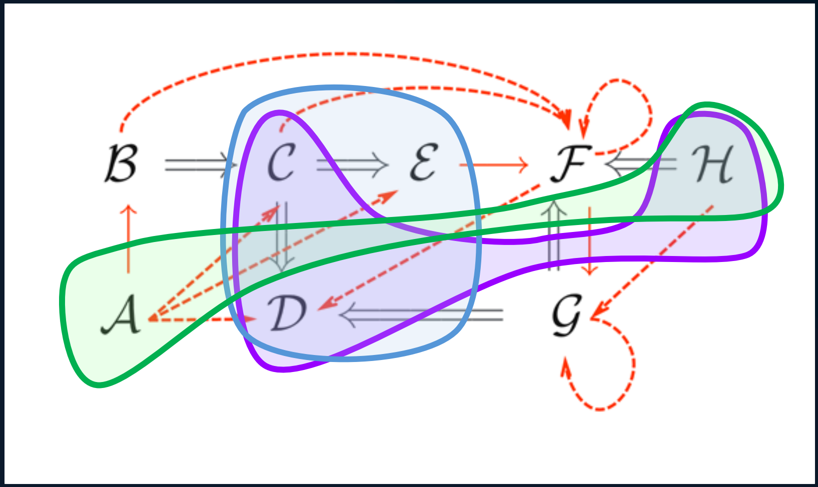

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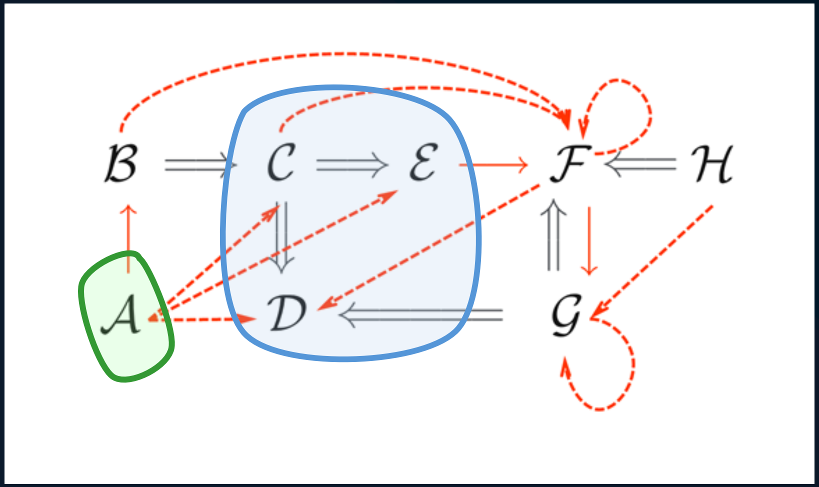
$\{\mathcal{A},\mathcal{H}\}$, $\{\mathcal{C},\mathcal{D},\mathcal{H}\}$ are not c-admissible since $\mathcal{H} \Rightarrow \mathcal{F}$ and $\mathcal{F}$ does not belong to these sets; thus, the c-preferred extensions are $\{\mathcal{A}\}$ and $\{\mathcal{C},\mathcal{D},\mathcal{E}\}$.



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Thank you!

Questions?