On the Issue of Argumentation and Informedness

Martin Caminada

Cardiff University

Chiaki Sakama

Wakayama University

Research Questions
Formal Argumentation

- What arguments to accept?
  (Dung, 1995)
  (Baroni, Caminada & Giacomin, 2011)

- How to come to a common position?
  (Caminada & Pigozzi, 2011)
  (Awad, 2015)

- How much do positions differ?
  (Booth et al, 2012)

- Who knows more?
  THIS PRESENTATION

Who Knows More

- Straightforward if agent reasoning is based on classical logic:
  $Ag_i \leqslant Ag_j$ iff $Cn(KB_i) \subseteq Cn(KB_j)$ $\quad$ *Cn*: deductive closure

- More complex for nonmonotonic reasoning:
  what if Ag_i knows that an inference of Ag_j is inapplicable?
  $Ag_i \leqslant Ag_j$ may not imply $Cn(KB_i) \subseteq Cn(KB_j)$

- Still, the issue of "who knows more" is an important one.
  - How to assess expertise?
  - How to choose an advisor/consultant?
  - How to assess quality, if the product is information?

Philosophical Background

- knowledge: *justified true belief*
- modal logic (S4): *true belief*
- what we are interested in: *justified belief*

We believe that formal argumentation theory
can give an account of justified belief
which we shall refer to as "informedness"

Argumentation Preliminaries

AF = (*Ar*, *att*): argumentation framework

Ar: set of arguments, *att*: set of attack relations

$AF_1 \sqsubseteq AF_2 \stackrel{\text{def}}{=} Ar_1 \subseteq Ar_2 \wedge att_1 = att_2 \cap (Ar_1 \times Ar_1)$

Labelling: $L : Ar \rightarrow \{$ in, out, undec $\}$

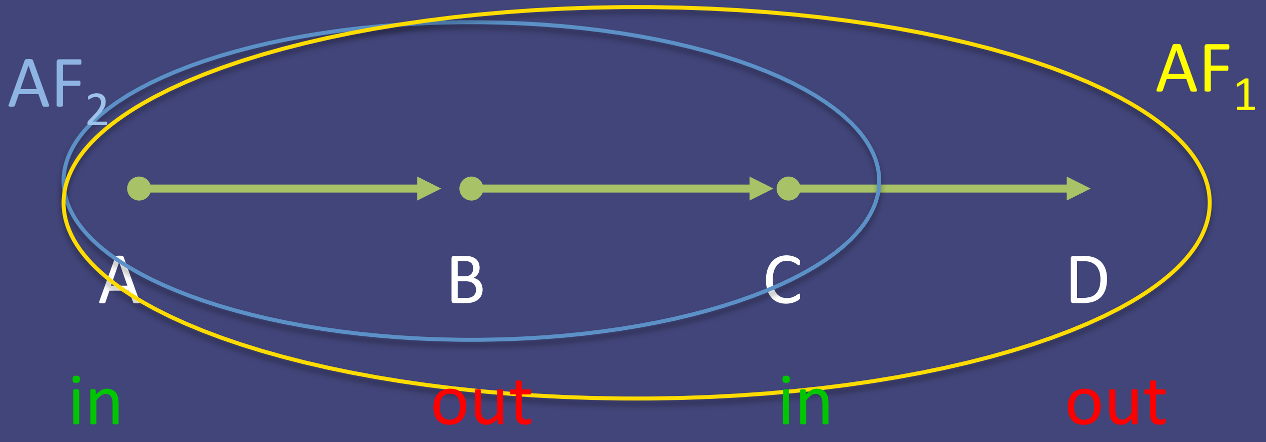
Complete Labelling:

- if in then all attackers out
- if out then there is an attacker in
- if undec then not all attackers out and no attacker in

Example

AF_1=({A,B,C,D},{(A,B),(B,C),(C,D)})

AF_2=({A,B,C},{(A,B),(B,C)})



$AF_2 \sqsubseteq AF_1$

Argument-Based Informedness

UAF = (Ar_{UAF}, att_{UAF}) : universal AF

For each agent Ag_i: $AF_i \sqsubseteq$ UAF

When Ag_i and Ag_j both have access to arguments A and B they agree on whether A attacks B

We want to define an informedness relation $\leqslant$ s.t.

1) If $AF_i \sqsubseteq AF_j$ then $AF_i \leqslant AF_j$ (subgraph refinement)
2) $AF_i \leqslant AF_i$ (reflexivity)
3) If $AF_i \leqslant AF_j$ and $AF_j \leqslant AF_k$ then $AF_i \leqslant AF_k$ (transitivity)

Informedness Based on Upstream

upstream(A): all "ancestors" of A (including A itself)
e.g. $A \leftarrow B \leftarrow C$ upstream(A)={A,B,C}

$\leqslant^A_{us}$: informedness based on upstream (w.r.t. argument A)

$AF_i \leqslant^A_{us} AF_j \stackrel{def}{=} upstream_{AFi}(A) \subseteq upstream_{AFj}(A)$

Satisfies all the three postulates:

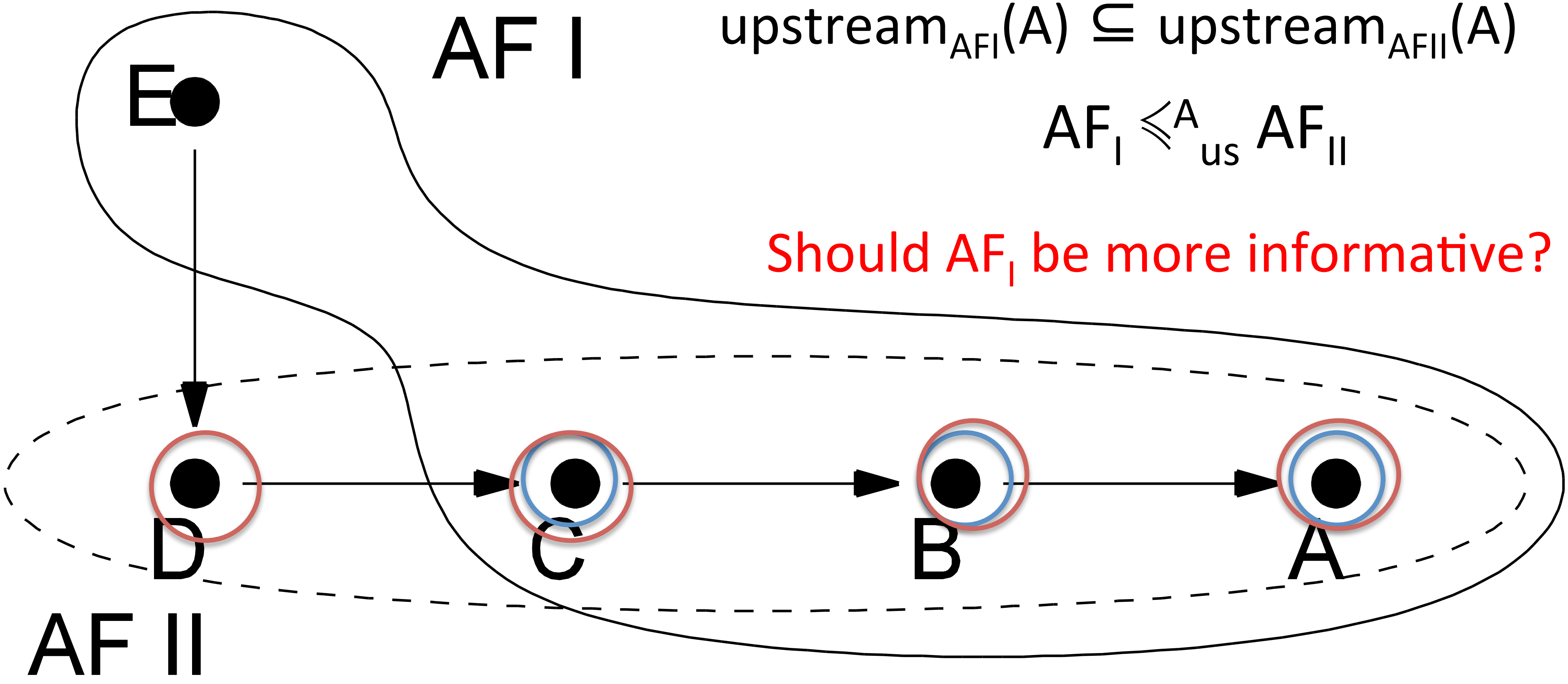
1) If $AF_i \sqsubseteq AF_j$ then $AF_i \leqslant^A_{us} AF_j$
2) $AF_i \leqslant^A_{us} AF_i$
3) If $AF_i \leqslant^A_{us} AF_j$ and $AF_j \leqslant^A_{us} AF_k$ then $AF_i \leqslant^A_{us} AF_k$

Informedness Based on Upstream

$upstream_{AFI}(A) \subseteq upstream_{AFII}(A)$

$AF_I \lessdot^A_{us} AF_{II}$

Should AF_I be more informative?



Informedness Based on Merged Status

status of A: how A is labelled by the complete labelling(s)

Merging ($AF_1 \sqcup AF_2$) :
put AF_1 and AF_2 together, including any attacks between them

$\leqslant^A_{ms}$: informedness based on status in merged AF (w.r.t. A)

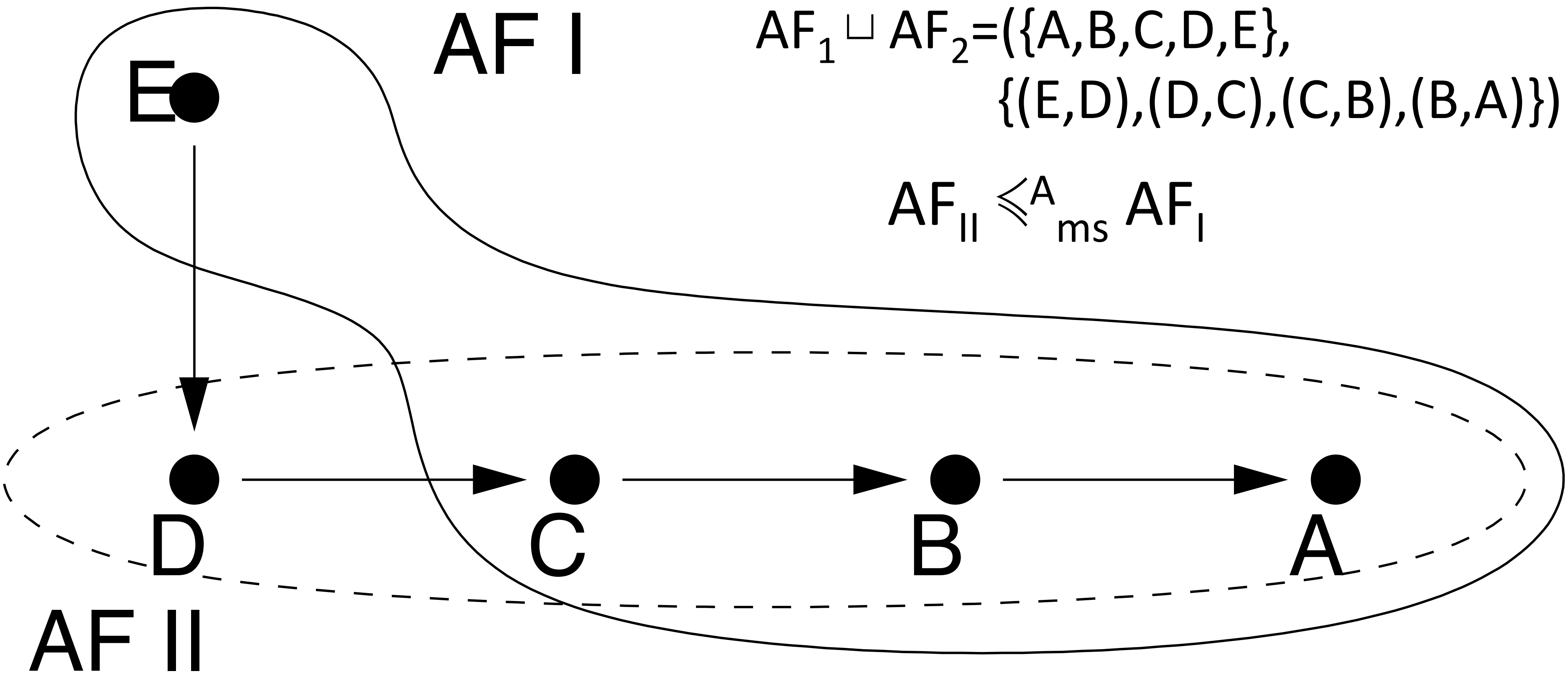
$AF_i \leqslant^A_{ms} AF_j \quad \stackrel{\text{def}}{=}$

- either AF_i and AF_j disagree about the status of A and $AF_i \sqcup AF_j$ agrees with AF_j, or
- AF_i and AF_j agree about the status of A, and for each disagreeing AF_k: if $AF_i \sqcup AF_k$ agrees, then $AF_j \sqcup AF_k$ agrees

Informedness Based on Merged Status

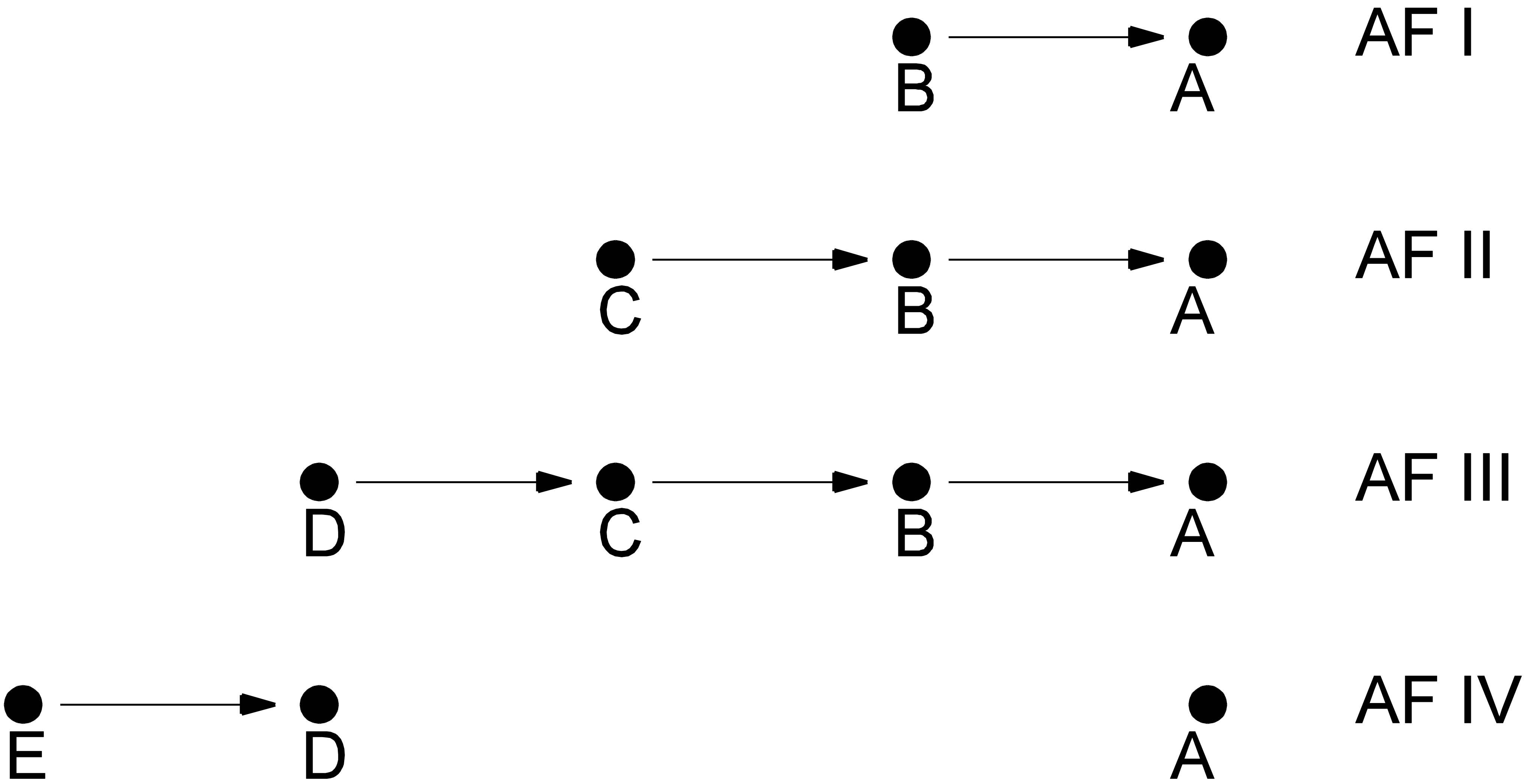
$AF_1 \sqcup AF_2 = (\{A,B,C,D,E\},$
$\{(E,D),(D,C),(C,B),(B,A)\})$

$AF_{II} \preccurlyeq^{A}_{ms} AF_I$



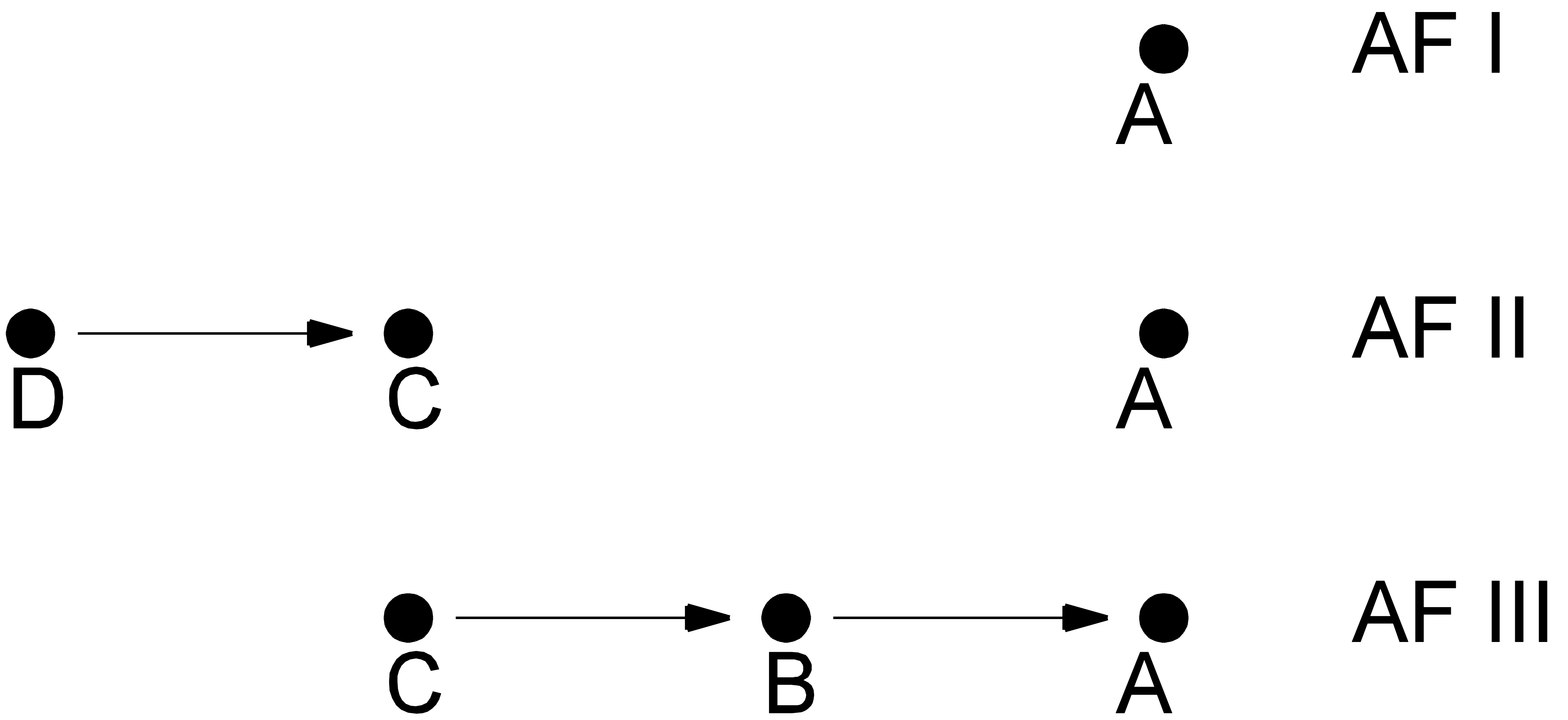
So far, so good...

Informedness Based on Merged Status



violates transitivity: $AF_{I} \preccurlyeq^{A}_{ms} AF_{II}$ and $AF_{II} \preccurlyeq^{A}_{ms} AF_{III}$ but $AF_{I} \not\preccurlyeq^{A}_{ms} AF_{III}$

Informedness Based on Merged Status



violates subgraph refinement: $AF_I \sqsubseteq AF_{II}$ but $AF_I \not\preccurlyeq^{A}_{ms} AF_{II}$

Informedness Based on Discussion Games

argument discussion game:

a protocol for uttering arguments;

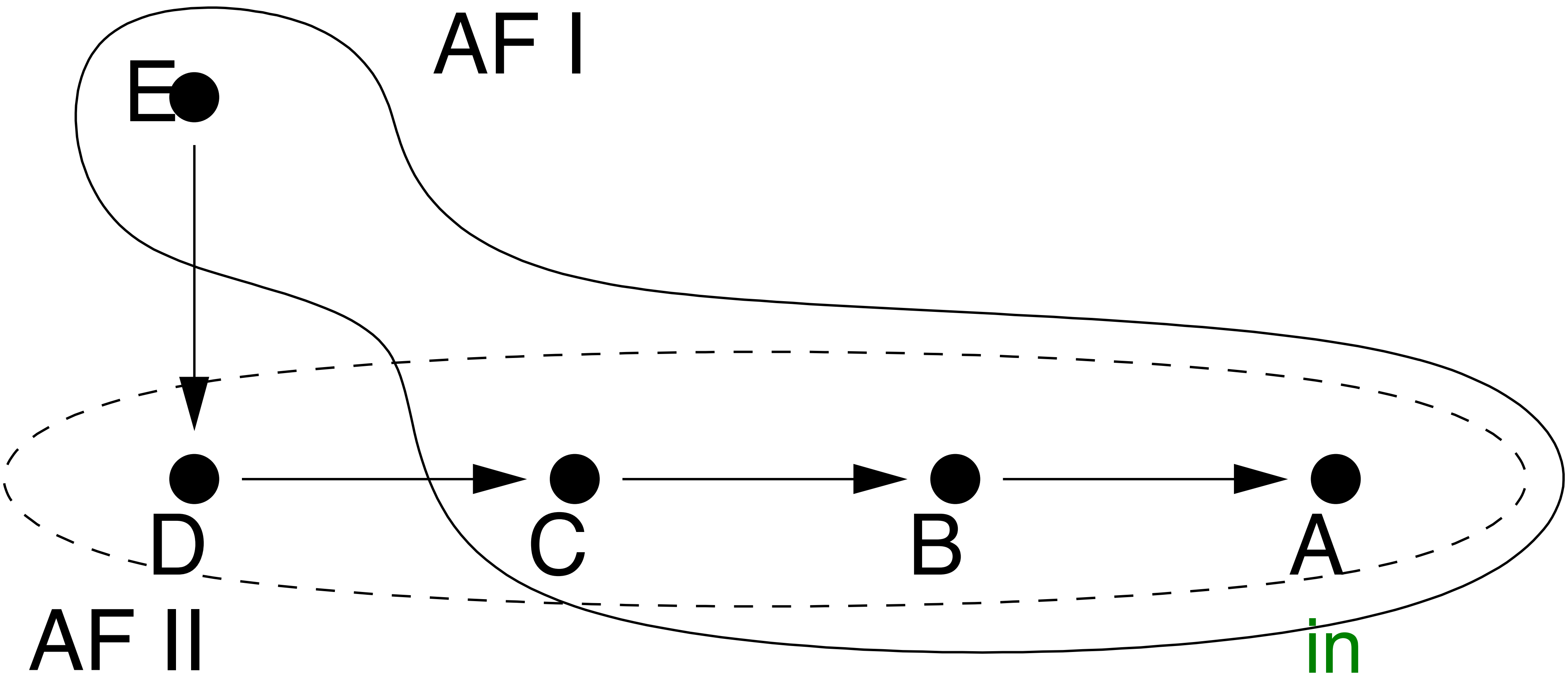
the ability to win coincides with argumentation semantics

$\leqslant^{A}_{ds}$: informedness based on discussion (w.r.t. A)

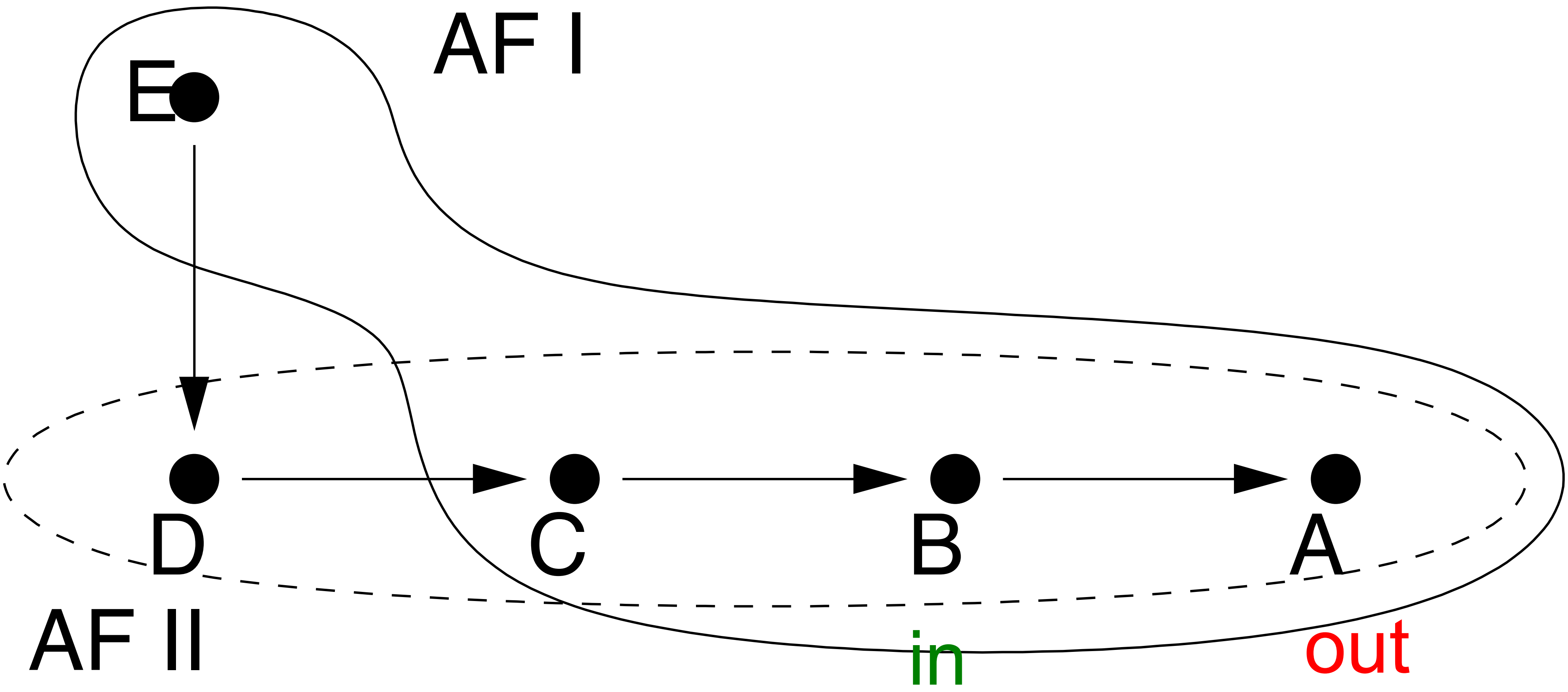
$AF_i \leqslant^{A}_{ds} AF_j \overset{def}{=}$

- either AF_i and AF_j disagree about the status of A and Ag_j wins the discussion
- AF_i and AF_j agree about the status of A, and for each disagreeing AF_k: if Ag_i can win from Ag_k then Ag_j can also win from Ag_k

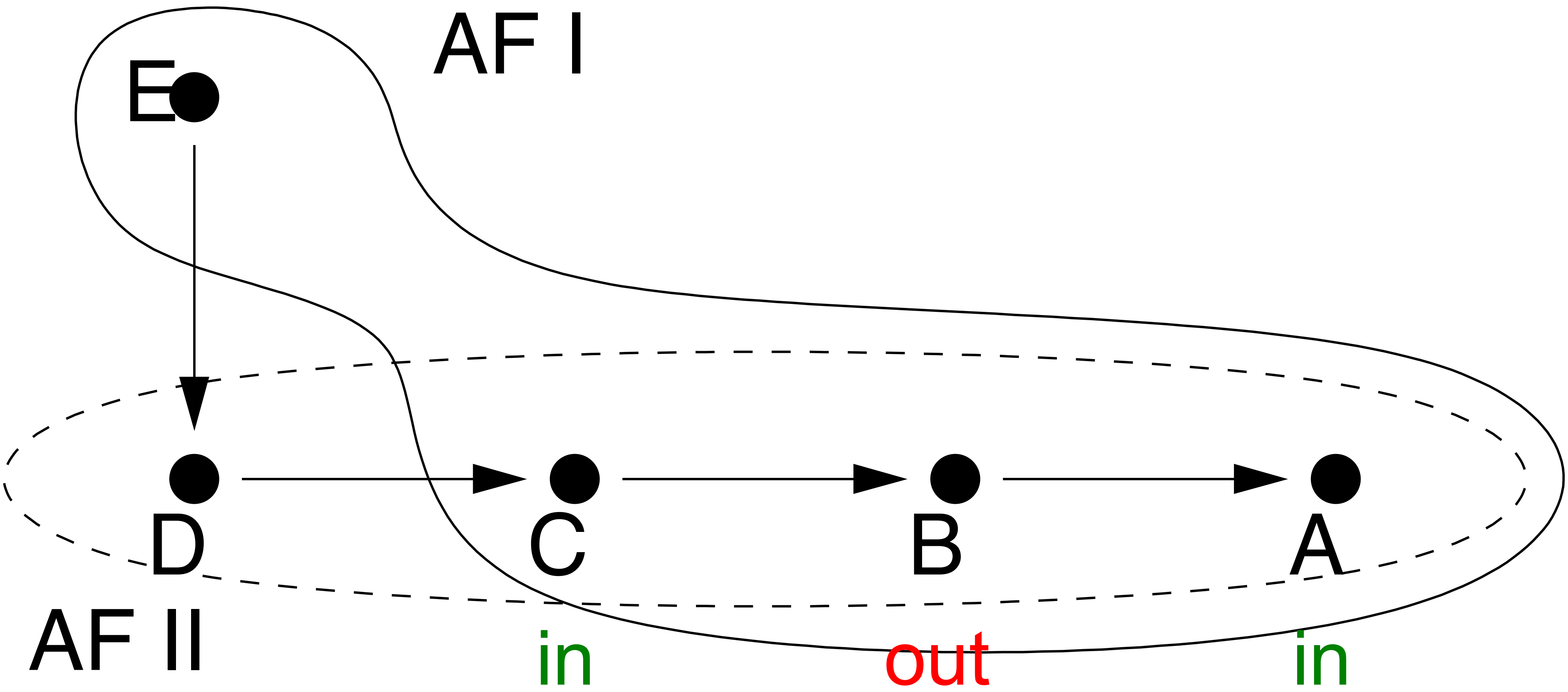
Informedness Based on Discussion Games



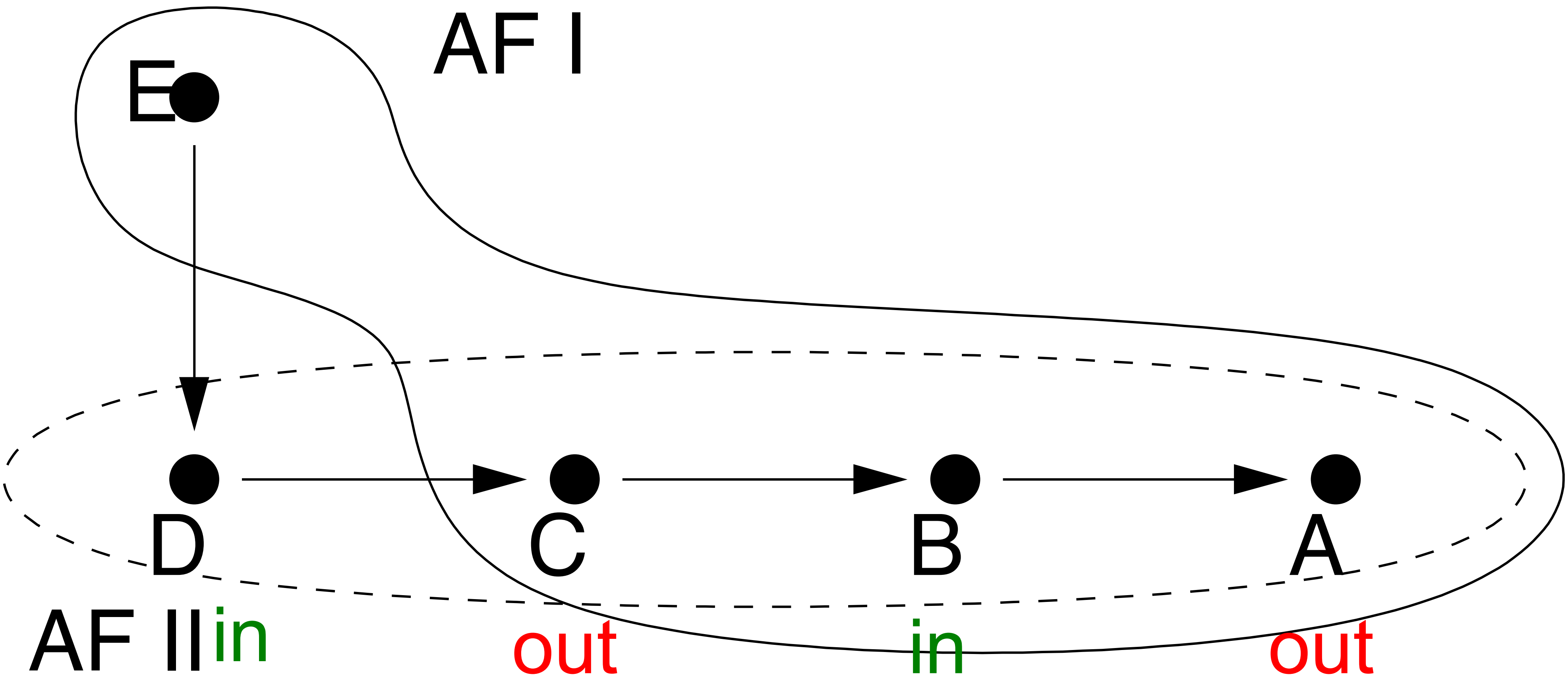
Informedness Based on Discussion Games



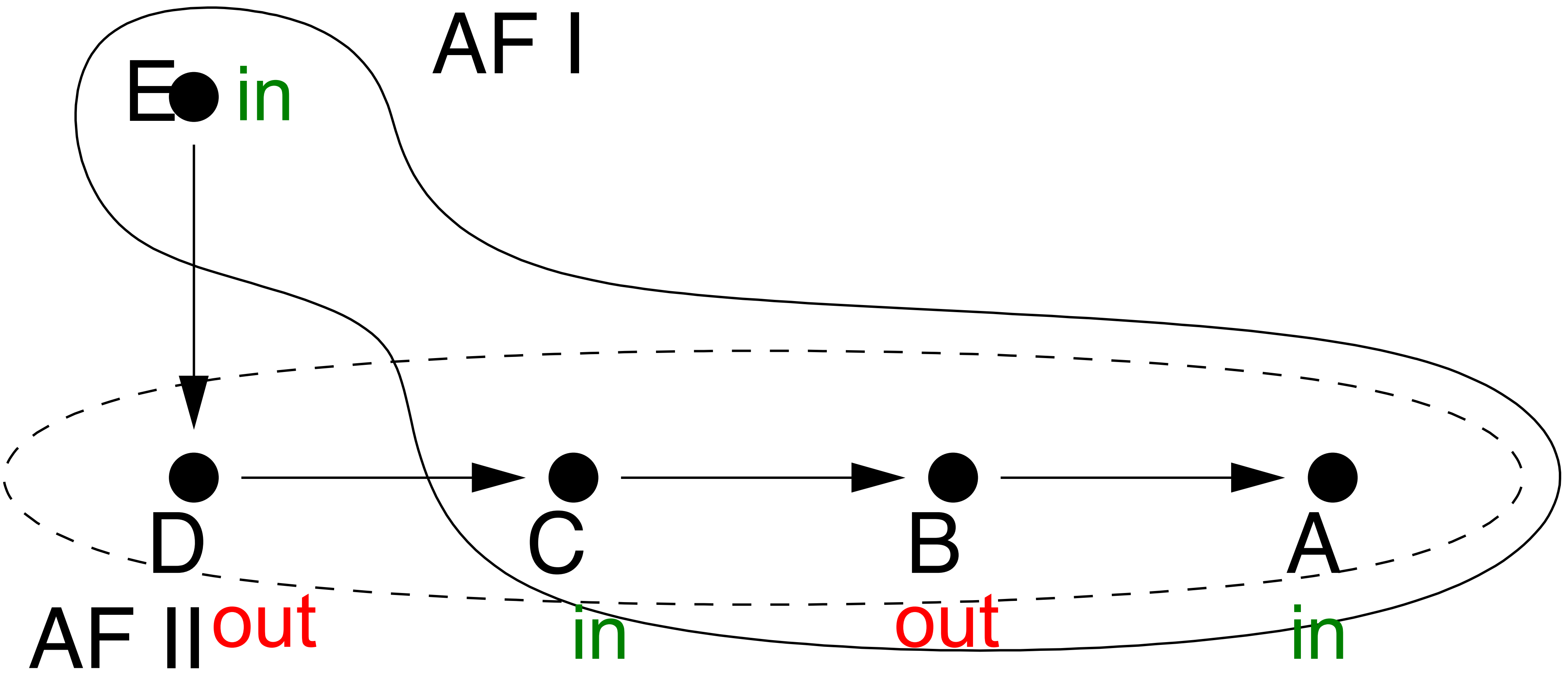
Informedness Based on Discussion Games



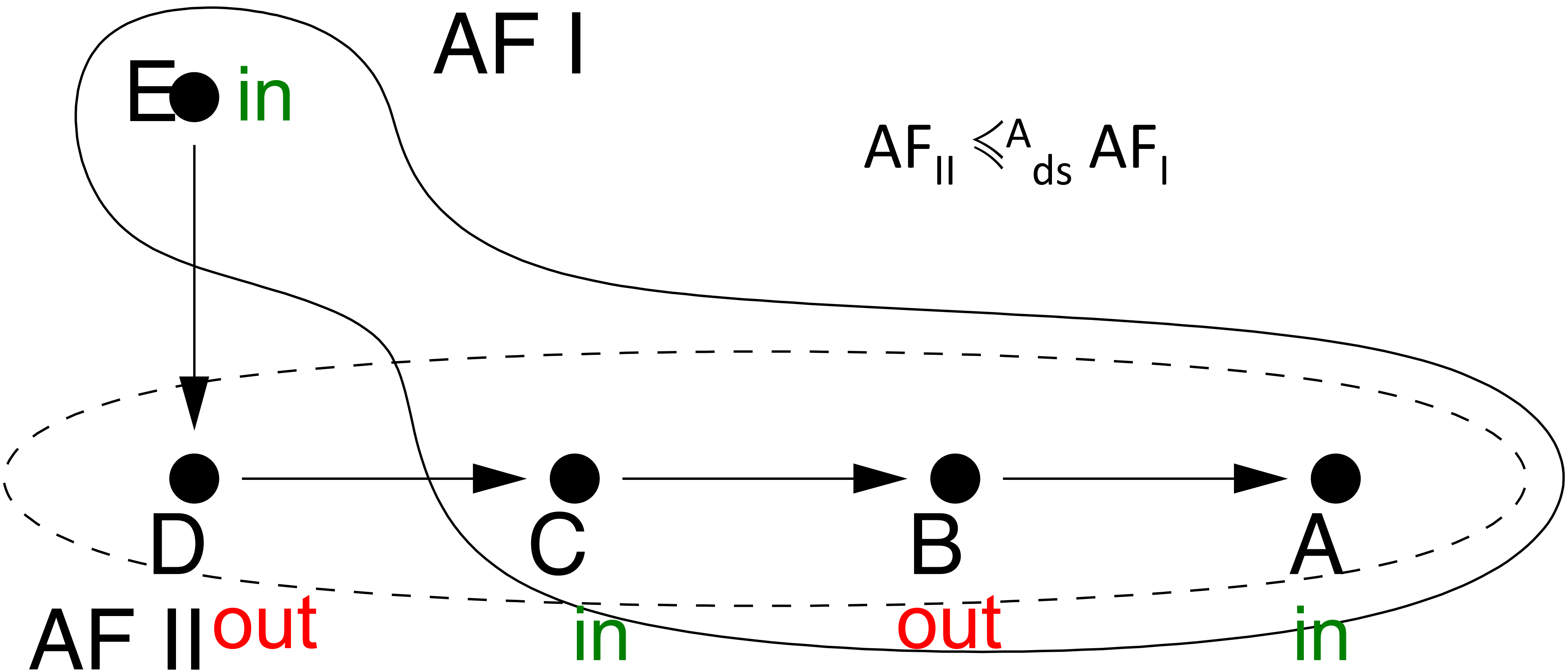
Informedness Based on Discussion Games



Informedness Based on Discussion Games

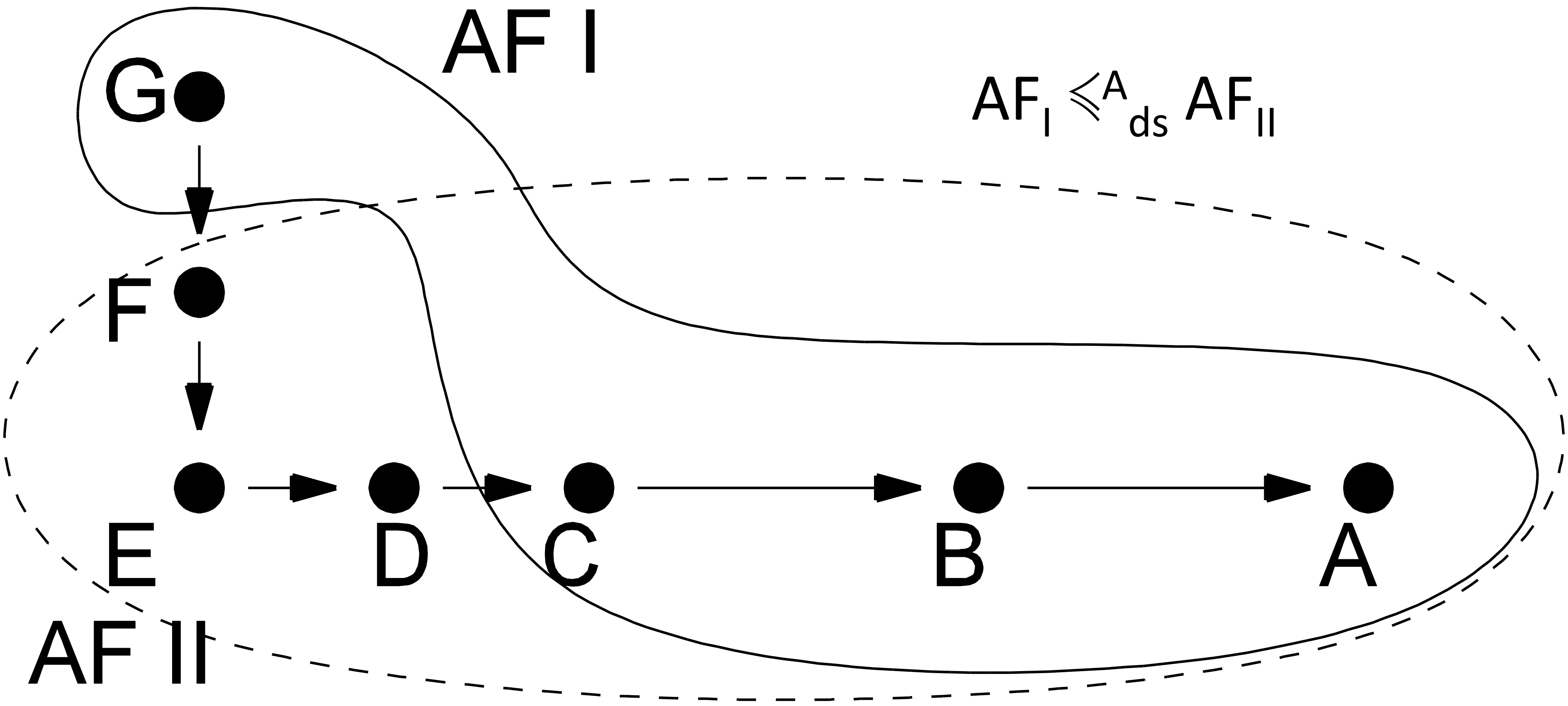


Informedness Based on Discussion Games



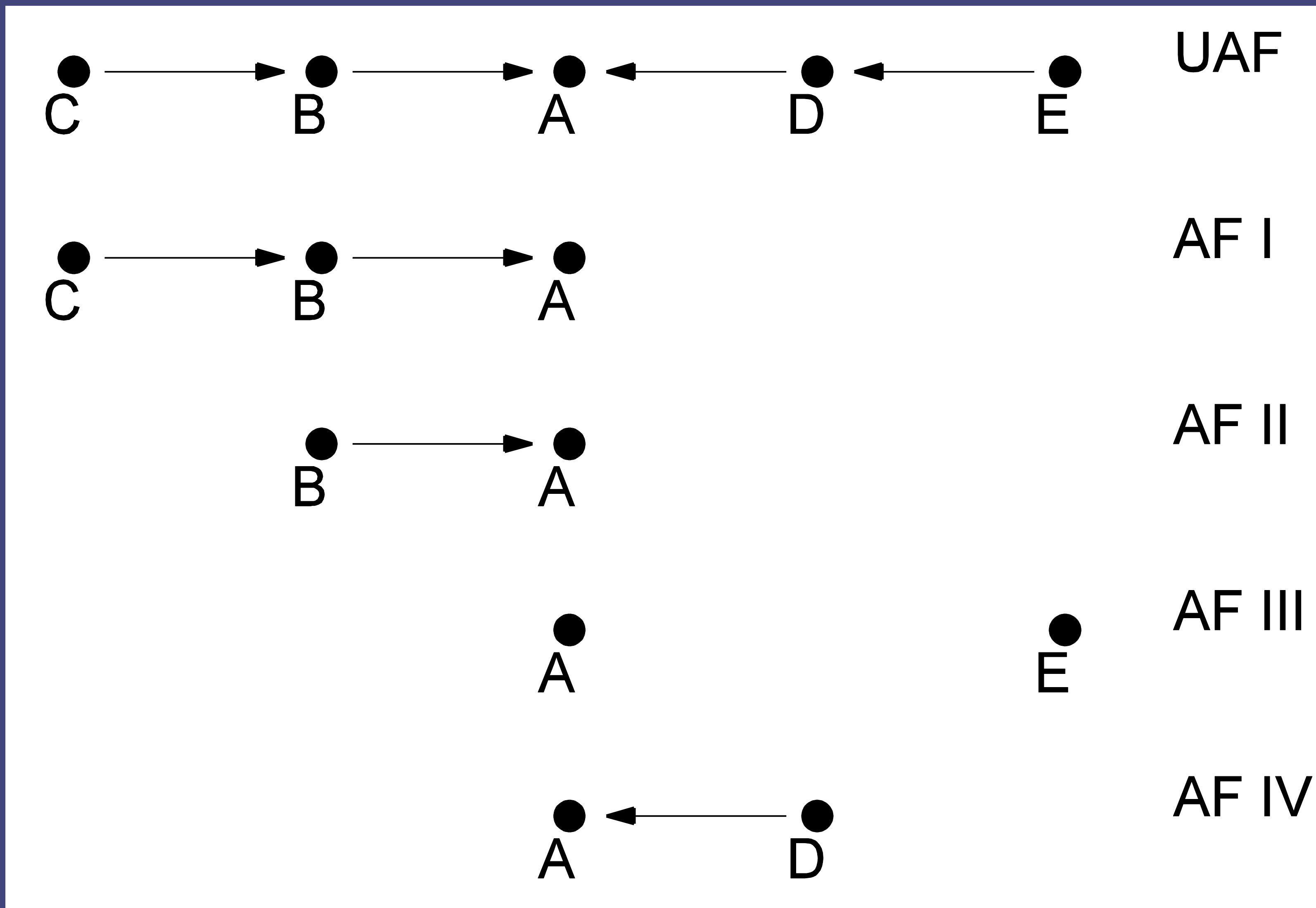
So far, so good...

Informedness Based on Discussion Games



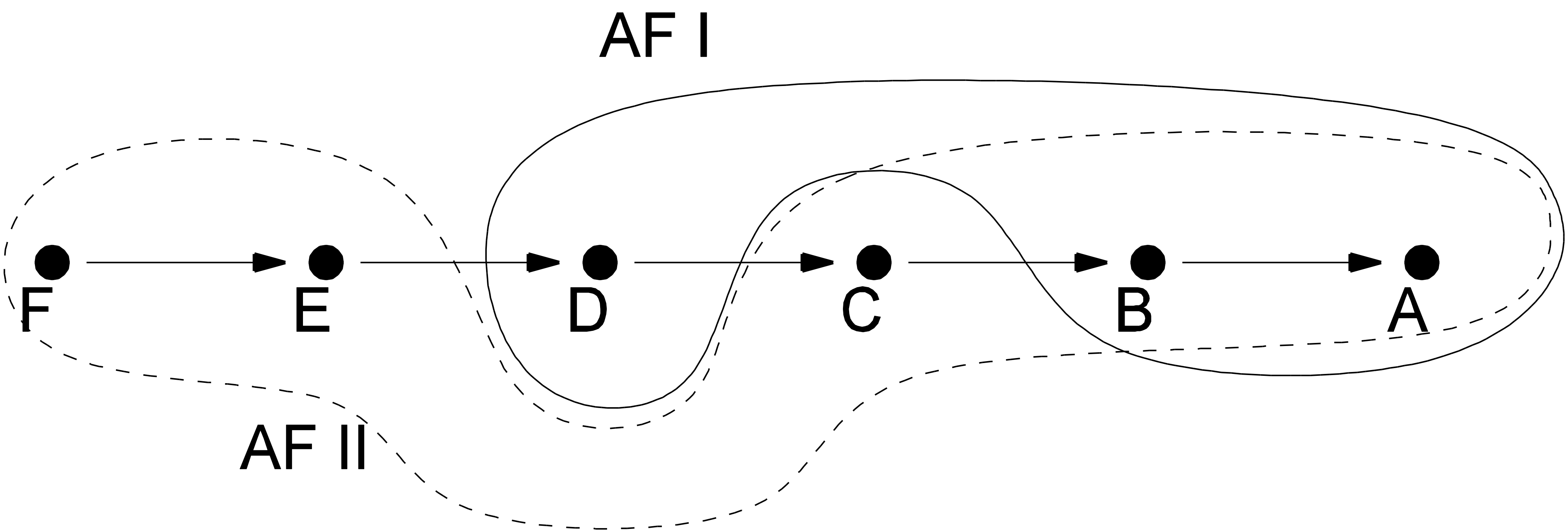
More complex examples can present problems...

Informedness Based on Discussion Games



violates transitivity: $AF_{III} \preccurlyeq^{A}_{ds} AF_{II}$ and $AF_{II} \preccurlyeq^{A}_{ds} AF_{I}$ but $AF_{III} \not\preccurlyeq^{A}_{ds} AF_{I}$

Informedness Based on Discussion Games



Ag$_{II}$ can carry on to win the discussion, even after he understands he's wrong!

Roundup

- *result:* the three informedness relations are independent from each other; none is subsumed by another
- *challenge:* find an informedness relation that satisfies the three postulates and also performs well on the examples
- What's the best strategy to assess who's best informed? (without having access to the UAF)
- What's the best strategy to appear to be more informed than one really is?