Dialogue Games on Abstract Argumentation Graphs[1]

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Der Wissenschaftsfonds.

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Fact Check I

a

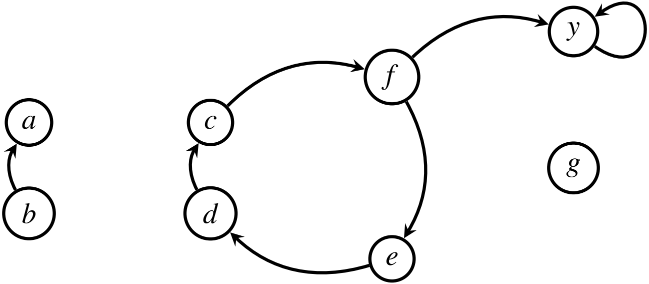
some argument

Fact Check II

$\longrightarrow$

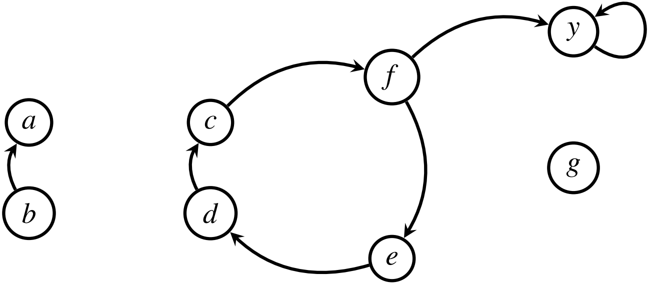
some attack

Fact Check III



some argumentation framework

Fact Check III



some argumentation semantics

$$nav(F) = \{\{a,d,f,g,h\},\{a,d,f,g,i\},\{a,c,e,g,h\},\{a,c,e,g,i\}\} \cup prf(F)$$
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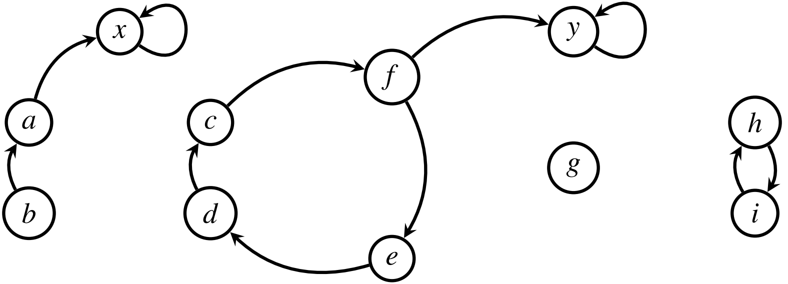

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What is an Argument?

https://www.youtube.com/watch?v=Lvcnx6-0GhA

An Argument Dialogue

...

MICHAEL PALIN: I came here for a good argument!

JOHN CLEESE: Ah, no you didn't, you came here for an argument!

MP: An argument isn't just contradiction.

JC: Well, it can be!

MP: No it can't! An argument is a connected series of statements intended to establish a proposition.

JC: No it isn't!

MP: Yes it is! It isn't just contradiction.

JC: Look, if I *argue* with you, I must take up a contrary position!

MP: Yes but it isn't just saying 'no it isn't'.

JC: Yes it is!

MP: No it isn't!

JC: Yes it is!

...

An Argument Dialogue

MP: I came here for a good argument! a
JC: Ah, no you didn't, you came here for an argument! b
MP: An argument isn't just contradiction. c
JC: Well, it can be! d
MP: No it can't! An argument is a connected series of statements intended to establish a proposition. e
JC: No it isn't! f
MP: Yes it is! It isn't just contradiction. c
JC: Look, if I *argue* with you, I must take up a contrary position! g
MP: Yes but it isn't just saying 'no it isn't'. h
JC: Yes it is! i
MP: No it isn't! h
JC: Yes it is! i

An Argument Dialogue

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JC: Yes it is!

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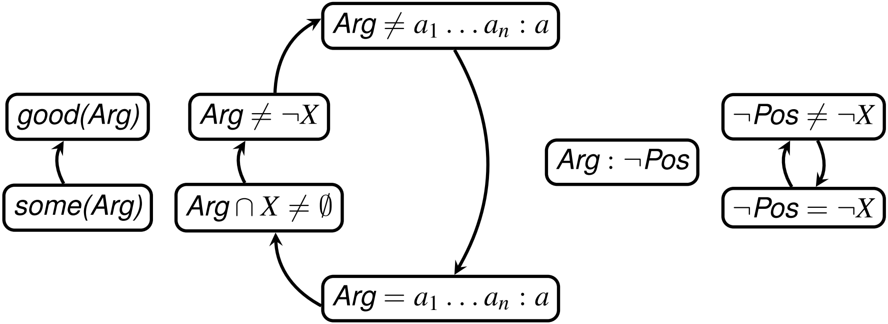
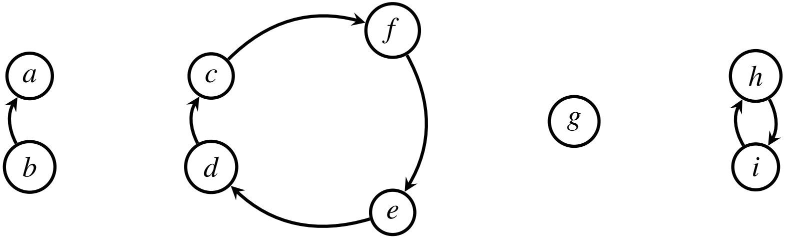
An Argument Dialogue

MP:	I came here for a good argument!	*good(Arg)*
JC:	Ah, no you didn't, you came here for an argument!	*some(Arg)*
MP:	An argument isn't just contradiction.	$Arg \neq \neg X$
JC:	Well, it can be!	$Arg \cap X \neq \emptyset$
MP:	No it can't! An argument is a connected series of statements intended to establish a proposition.	$Arg = a_1 \ldots a_n : a$
JC:	No it isn't!	$Arg \neq a_1 \ldots a_n : a$
MP:	Yes it is! It isn't just contradiction.	$Arg \neq \neg X$
JC:	Look, if I *argue* with you, I must take up a contrary position!	$Arg : \neg Pos$
MP:	Yes but it isn't just saying 'no it isn't'.	$\neg Pos \neq \neg X$
JC:	Yes it is!	$\neg Pos = \neg X$
MP:	No it isn't!	$\neg Pos \neq \neg X$
JC:	Yes it is!	$\neg Pos = \neg X$

An Argumentation Framework



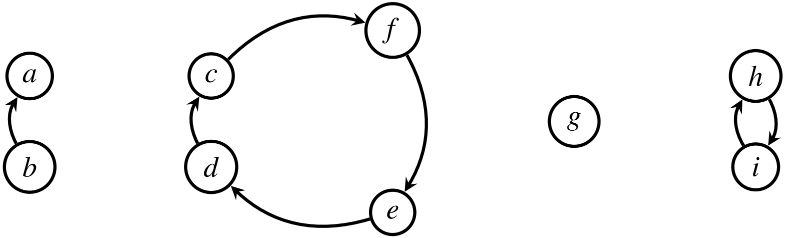
Who wins the Argument?



Question

- *Who wins the argument?*

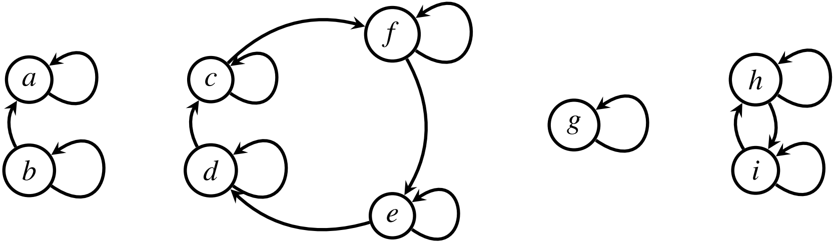
Who wins the Argument?



Question

- *Who wins the argument?*
- *Who is right?*

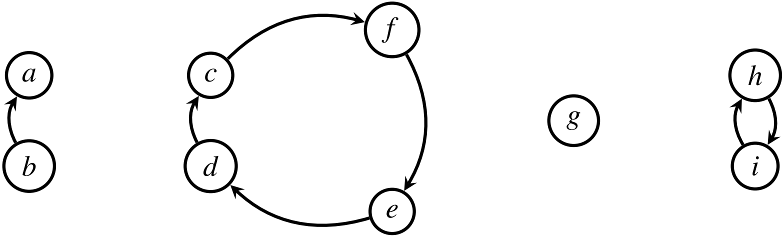
Who wins the Argument?



Question

- *Who wins the argument?*
- *Who is right?*
- *Is there a justifiable (set of) argument(s)?*

Who wins the Argument?



Question

- *Who wins the argument?*
- *Who is right?*
- *Is there a justifiable (set of) argument(s)?*
- *Which (sets of) arguments are justifiable?*

Games vs. Semantics

Games on Argument Graphs

- Players alternate selecting arguments
- Winning condition decides existence of a justifiable set or acceptance status of initial arguments

Abstract Argumentation Semantics

- Semantical properties such as conflict-freeness, self-defense, maximality are defined
- If a set of arguments is justifiable all of these arguments are (credulously) acceptable

Fact Check I

a

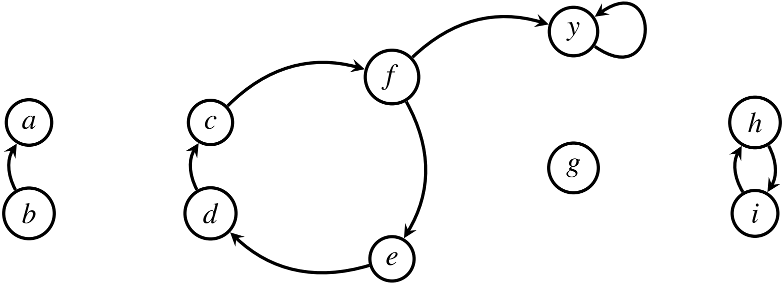
some argument

Fact Check II

$$\longrightarrow$$

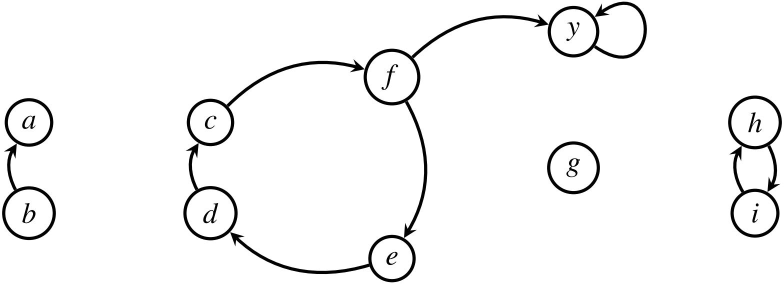
some attack

Fact Check III



some argumentation framework

Fact Check III



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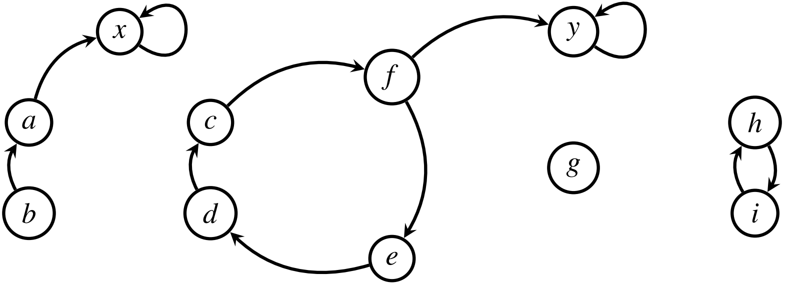

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Abstract Argumentation Frameworks

Definition

An Abstract Argumentation Framework (AF) is a pair $F = (A, R)$, where A is a finite set of arguments and $R \subseteq A \times A$ represents its attack relation.

Definition

A set of arguments $S \subseteq A$ is called *conflict-free* if it does not contain any conflicts, for all $a, b \in S$ we have $(a, b) \notin R$. S is a *naive* extension, if it is conflict-free and maximal.

Simple Oxyliquit Game I

Definition (wikipedia)

Oxyliquit is an explosive material which is a mixture of liquid oxygen with a suitable fuel, such as *carbon*.

Definition

Given some AF $F = (A, R)$ and argument a.

- opponent (O) pours liquid oxygen on the output of a
- proponent (P) places carbon on the field a
- liquid oxygen flows to all arguments b with $a \rightarrowtail b$
- O wins if there is an explosion
- otherwise P wins

Observation

P has a winning strategy iff a is (credulously) justified by conflict-free semantics (i.e. $(a, a) \notin R$).

Simple Oxyliquit Game II

Definition

Given some AF $F = (A, R)$ and argument b.

- O chooses a with $a \rightarrowtail b$ or $b \rightarrowtail a$
- Players swap roles and play the credulous acceptance game starting with a

Observation

P has a winning strategy iff b is (skeptically) justified by conflict-free semantics (i.e. b is in conflict only with self-attacking arguments).

Selected Decision Problems of Abstract Argumentation

Given some AF F and some semantics σ

Definition (Non-Empty Existence)

$$\exists S \in \sigma(F) : S \neq \emptyset$$

Additionally given some argument a

Definition (Credulous Acceptance)

$$\exists S \in \sigma(F) : a \in S$$

Definition (Skeptical Acceptance)

$$\forall S \in \sigma(F) : a \in S$$

Admissibility

Definition

A set of arguments $S \subseteq A$ is called *admissible* if it is conflict-free and for each $a \in A \setminus S$ with $a \rightarrowtail S$ there is some $b \in S$ with $b \rightarrowtail a$.
S is a *preferred* extension if it is admissible and maximal.

Poison Game [Duchet and Meyniel, 1993]

Definition (wikipedia)

Poisons are substances which cause disturbances to organisms.

Definition

Given some AF $F = (A, R)$ and argument a_0.

- O selects some argument a_{i+1} with $a_{i+1} \rightarrowtail a_i$ and leaves poison on the field
- P selects some argument a_{i+2} with $a_{i+2} \rightarrowtail a_{i+1}$
- repeat
    - if P runs out of moves (or ends up on a poisoned field) then O wins
    - if the game runs on forever or O runs out of moves then P wins

Observation

P has a winning strategy iff there is an admissible set S with $a_0 \in S$.

Principles of Locality

Observation (Levels of Attack-Locality)

1. *moves* y *may only be arguments attacking the previous move*
   $x + 1 = y, y \rightarrowtail x$
2. *moves* y *may only be arguments in conflict with the previous move*
   $x + 1 = y, y \rightarrowtail x$ *or* $x \rightarrowtail y$
3. *moves* y *may only be arguments attacking some previous move*
   $x < y, y \rightarrowtail x$
4. *moves* y *may only be arguments in conflict with some previous move*
   $x < y, y \rightarrowtail x$ *or* $x \rightarrowtail y$

Observation (Levels of Labelling)

1. *labels may be applied to arguments of the current move*
2. *labels may be applied to arguments that are in conflict with the current move*

Stability

Definition

The range of a set of arguments S is defined as

$$S^+ = S \cup \{a \in A \mid S \rightarrowtail a\}.$$

Definition

A set of arguments $S \subseteq A$ is called a *stable* extension if it is conflict-free and $S^+ = A$.

Observation

A local game cannot decide whether some argument is stable justified.

Advanced Oxyliquit Game

Definition

We make use of *bomb traps* that contain liquid oxygen and carbon in separated but fast degrading disintegrating containers.

Definition

Given some AF $F = (A, R)$ and argument a_0. Place carbon on a_0.

- O selects some arbitrary argument a_{i+1} and leaves a bomb trap
- P can either pour the liquid oxygen down a_{i+2}'s output (then $a_{i+2} = a_{i+1}$, or select some argument a_{i+2} with $a_{i+2} \rightarrowtail a_{i+1}$ and move the bomb there to pour the liquid down a_{i+2}'s output
- in either case carbon ends up on field a_{i+1}
- if an explosion occurs then O wins
- if the game goes on forever then P wins
- repeat

Advanced Oxyliquit Game

Definition

Given some AF $F = (A, R)$ and argument a_0. Place carbon on a_0.

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- in either case carbon ends up on field a_{i+1}
- if an explosion occurs then O wins
- if the game goes on forever then P wins
- repeat

Observation

P has a winning strategy iff a is (credulously) justified by stable semantics. In such case every argument can be pre-selected as candidate carbon or candidate liquid oxygen.

Advanced Oxyliquit Game

Definition

Given some AF $F = (A, R)$ and argument a_0. Place carbon on a_0.

- O selects some arbitrary argument a_{i+1} and leaves a bomb trap
- P can either pour the liquid oxygen down a_{i+2}'s output (then $a_{i+2} = a_{i+1}$, or select some argument a_{i+2} with $a_{i+2} \rightarrowtail a_{i+1}$ and move the bomb there to pour the liquid down a_{i+2}'s output
- in either case carbon ends up on field a_{i+1}
- if an explosion occurs then O wins
- if the game goes on forever then P wins
- repeat

Observation

The same game followed by a fresh start where O and P swap roles and O gets to select a_1 witnesses skeptical acceptance.

Stage semantics

Definition

The range of a set of arguments S is defined as

$$S^+ = S \cup \{a \in A \mid S \rightarrowtail a\}.$$

Definition

A set of arguments $S \subseteq A$ is called a *stable* extension if it is conflict-free and $S^+ = A$.

Definition

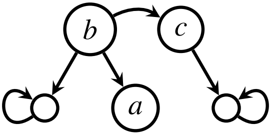
A set of arguments $S \subseteq A$ is called a *stage* extension if it is conflict-free and there is no $T \subseteq A$ such that $S^+ \subsetneq T^+$.

Stage Observation I

Observation

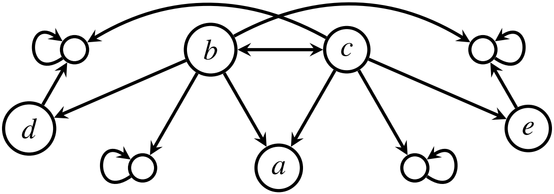
Given some game for credulous acceptance of stage semantics we can use it to build one for sceptical acceptance, and vice versa. We swap the roles. If a *is sceptically accepted, then no* b *that is in conflict with* a *can be credulously accepted.*

Stage Observation II



For a stage game it does not suffice to let players select attacking arguments only.

Stage Observation III



For a stage game it does not suffice to let the players stay local.

References

Duchet, P. and Meyniel, H. (1993).
Kernels in directed graphs: a poison game.
Discrete Mathematics, 115(1):273–276.

Dung, P. M. (1995).
On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games.
Artif. Intell., 77(2):321–358.

Verheij, B. (2003).
Deflog: on the logical interpretation of prima facie justified assumptions.
J. Log. Comput., 13(3):319–346.