Perfection in Abstract Argumentation[1]

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Alternate Title & Aims of this Talk

Perfection conditions and counterexamples for common fair argumentation semantics and the particularly nice take of stage semantics.

- What is Perfection?
- What are fair argumentation semantics and why bother?
- What is so special about stage semantics?

Abstract Argumentation I

F G

Definition (Abstract Argumentation Framework)

Framework $F \cup G = (A, R)$

- Arguments $A = \{ a, b, c \} \cup \{ x, y, z \}$
- Attacks $R = \{ (a, b), (b, c), (c, a) \} \cup \{ (x, y), (x, z), (z, z) \}$

Abstract Argumentation II

Definition (Abstract Argumentation Semantics)

Given framework $F = (A, R)$

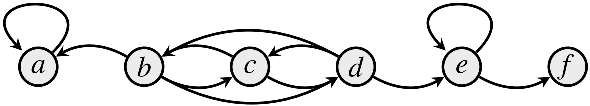
- assign set of sets of arguments $\sigma(F) \subseteq \mathcal{P}(A)$
- such that each $S \in \sigma(F)$ is reasonably acceptable

Definition

Given framework $F = (A, R)$ a set $S \subseteq A$ is called a

- *stable* extension if it is conflict-free and no arguments are undecided;
- *stage* extension if it is conflict-free and minimal in undecided arguments;
- *semi-stable* extension if it is admissible and minimal in undecided arguments.

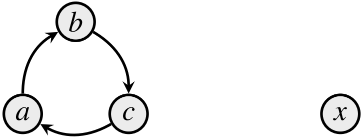
Stable, Stage, Semi-Stable I



Example (Semantical Differences)

stable:	*stage:*	*semi-stable:*
$\emptyset$	$\{b,f\}, \{d,f\}$	$\{b\}, \{d,f\}$

Stable, Stage, Semi-Stable II

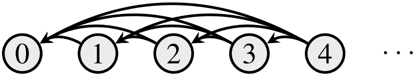


F G

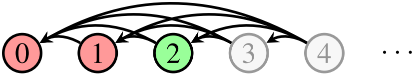
Example (Semantic Evaluation)

	$\sigma(F)$	$\sigma(G)$	$\sigma(F \cup G)$
$\sigma =$ *stable*	$\emptyset$	$\{\{x\}\}$	$\emptyset$
$\sigma =$ *stage*	$\{\{a\},\{b\},\{c\}\}$	$\{\{x\}\}$	$\{\{a,x\},\{b,x\},\{c,x\}\}$
$\sigma =$ *semi-stable*	$\{\emptyset\}$	$\{\{x\}\}$	$\{\{x\}\}$

Infinite Frameworks I



Infinite Frameworks I



Collapse of Stage Semantics.

Perfection

Definition (σ-Perfection)

Given semantics σ a framework F is called σ-perfect if every induced sub-framework $G \subseteq F$ has $\sigma(G) \neq \emptyset$.

Perfection

Theorem (Perfection I: cf,adm,comp,ground,naive,pref)

- *For $\sigma \in \{$cf,adm,comp,ground$\}$ every framework is σ-perfect.*
- *Given semantics $\sigma \in \{$preferred,naive$\}$ and assuming Axiom of Choice / Zorn's Lemma every framework is σ-perfect.*

Theorem (Perfection II: stable)

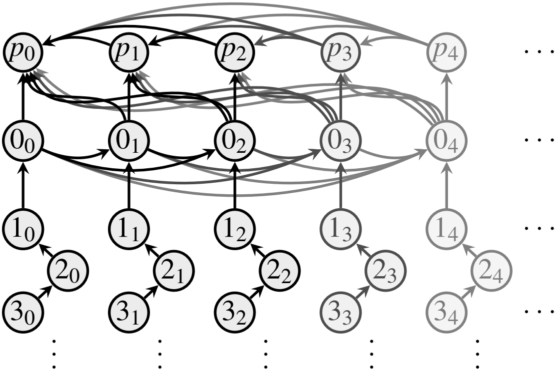
For stable semantics the following frameworks are σ-perfect:

- *bipartite, symmetric loop-free, and well-founded;*
- *finite, and every cycle of odd-length is symmetrical.*
- *finitary, and every finite induced sub-framework has stable extension;*
- *where each induced sub-framework has non-empty admissible set;*

Theorem (Perfection III: stage and semi-stable)

For $\sigma \in \{$semi-stable,stage$\}$ every finitary framework is σ-perfect.

Infinite Frameworks II



Cycle-free framework without stage or semi-stable extensions.

Collapse and the Kind

Definition (Crash, Interference, Contamination)

Given semantics σ:

- Contamination is when some framework F eats all extensions of all disjoint frameworks G;
- Interference is when for disjoint frameworks F, G some $S \in \sigma(F) \cup \sigma(G)$ is not reflected in $F \cup G$ or vice versa;
- Crash is when there are no contaminating frameworks.

Definition (Collapse)

Given semantics σ a framework F *collapses* if we have $\sigma(F) = \emptyset$.

Fair Semantics

Definition

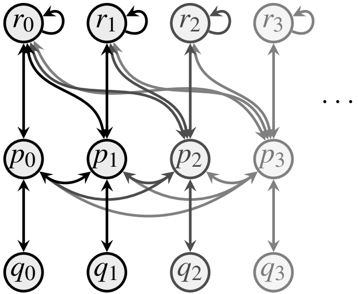
A semantics σ is called

- basic, if it accepts some argument(s) for some frameworks;
- language independent, if the names of arguments do not matter;
- component independent, if the union of disjoint frameworks can be evaluated component-wise;
- fair, if it is basic, language independent and component independent.

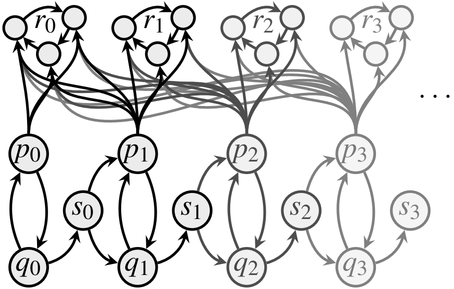
Theorem

For fair semantics the notions of contamination, interference, crash and collapse are equivalent.

Infinite Frameworks III



(a) Collapse in symmetric framework.



(b) Collapse in loop-free framework.

Perfection and Stage Semantics I

Theorem (Stage-Perfection)

Given frameworks F and G such that G results from F by adding a single argument and corresponding attacks.
If F is stage-perfect then so is G.

Corollary (By Induction)

Given some stage-perfect framework. Extending this framework with a finite amount of arguments and aribtrary attacks to/from these new arguments we still have stage-perfection.

Perfection and Stage Semantics II

Example (Symmetric Loop-free Frameworks)

- Symmetric loop-free frameworks always provide a stable extension.
- For symmetric frameworks conflict-freeness and admissibility coincide.

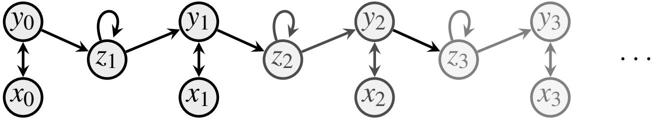
$\Rightarrow$ Symmetric frameworks with finitely many self-attacking arguments are stage- and semi-stable-perfect.

Example (Finitary Frameworks)

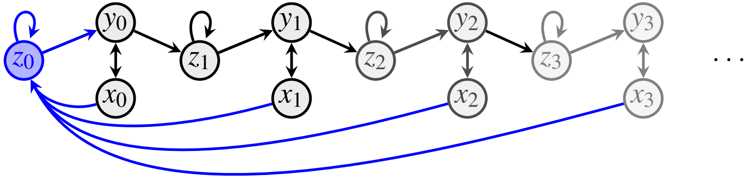
- Frameworks where each argument has only finitely many attackers do provide semi-stable and stage extensions.

$\Rightarrow$ Frameworks where only finitely many arguments have infinitely many attackers are stage-perfect.

Infinite Frameworks IV



Infinite Frameworks IV



Collapse of Semi-stable Semantics

Conclusions, Final Remarks

- σ-perfection is a semantical framework property of interest for applications where collapse is undesirable while the set of arguments involved is allowed to grow and shrink.
- Contamination, non-interference and crash resistance merely are variants of the notion of collapse $\rightarrow$ for ease of definition only use the latter!
- Stage-perfect frameworks need infinitely many additional arguments to loose perfection: nice.

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