Change in Abstract Argumentation Systems: Addition and Removal of an Argument

Pierre Bisquert, Claudette Cayrol, Florence Dupin de Saint-Cyr, Marie-Christine Lagasquie-Schiex

IRIT, Université Paul Sabatier,
118 route de Narbonne, 31062 Toulouse, France

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Plan

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Introduction

- Main topic of our work: **abstract** argumentation
  - Working with arguments and attacks without considering how they are obtained

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  - Working with arguments and attacks without considering how they are obtained
- Current subject: dynamics in argumentation
- A lot of work has been done about addition of an argument
- What about removal? Is it useful? Are there links with addition?

Four Players Game

- Four entities interacting about an argument :
  - the **prosecutor** (P) wants to make Argument 1 accepted
  - the **defense lawyer** (D) tries to make Argument 1 rejected
  - the **judge** ensures that the hearing takes places under good conditions
  - the **jury** deliberates at the end of the hearing and decides whether Argument 1 is acceptable or not

Speakers' Arguments

	Argument	Known by
1	*Mr. X is guilty of premeditated murder of Mrs. X, his wife.*	P & D
2	*The defendant has an alibi, his business associate having solemnly sworn that he had seen him at the time of the murder.*	D
3	*The close working business relationships between Mr X. and his associate induce suspicions about his testimony.*	P
4	*Mr. X loves his wife so extremely that he married her twice. Now, a man who loves his wife could not be her murderer.*	P & D
5	*Mr. X has a reputation for being promiscuous.*	P
6	*The defendant would not have had any interest to kill his wife, since he was not the beneficiary of the enormous life insurance she had contracted.*	P
7	*The defendant is a man known to be venal and his "love" for a very rich woman could be only lure of profit.*	D

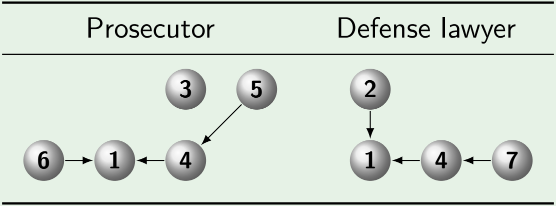
Table: Arguments concerning Mr. X's case.

Plan

Argumentation System

- According to Dung, an **abstract argumentation system** is a pair $\langle \mathbf{A}, \mathbf{R} \rangle$, where :
  - **A** is a finite nonempty set of *arguments* and
  - **R** is a binary relation on **A**, called *attack relation*
- This system can be represented by a graph denoted $\mathcal{G}$

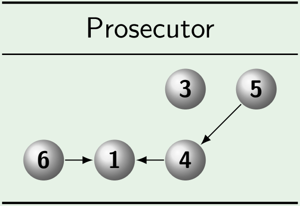
Example



Conflict-free Set, Defense, Admissibility

- A set $\mathcal{S}$ is **conflict-free** if and only if there do not exist $A, B \in \mathcal{S}$ such that A attacks B

Example



- Conflict-free set : $\{1, 3, 5\}$
  Non conflict-free set : $\{1, 6\}$

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- $\mathcal{S}$ **defends** an argument A if and only if each attacker of A is attacked by an argument of $\mathcal{S}$; the set of arguments defended by $\mathcal{S}$ is denoted by $\mathcal{F}(\mathcal{S})$

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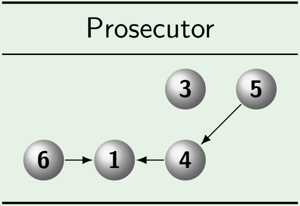

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  Set defending Argument 1 : none

Conflict-free Set, Defense, Admissibility

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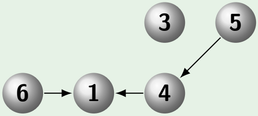
- $\mathcal{S}$ **defends** an argument A if and only if each attacker of A is attacked by an argument of $\mathcal{S}$; the set of arguments defended by $\mathcal{S}$ is denoted by $\mathcal{F}(\mathcal{S})$
- $\mathcal{S}$ is an **admissible** set if and only if it is conflict-free and it defends all its elements

Example

Prosecutor



- Conflict-free set : $\{1, 3, 5\}$
  Non conflict-free set : $\{1, 6\}$
- Set defending Argument 5 : $\{\}$
  Set defending Argument 1 : none
- Admissible set : $\{3, 5\}$
  Non-admissible set : $\{1, 3\}$

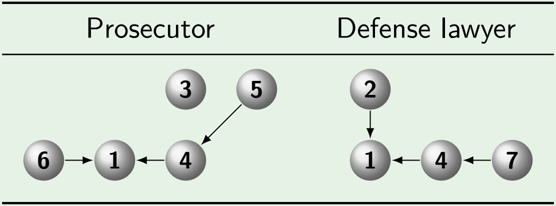
Acceptability Semantics

- An **extension** is a particular set of arguments which is "conflict-free" and able to defend itself collectively
- Status of an argument :
  - **Credulously accepted** if the argument belongs at least to one extension
  - **Skeptically accepted** if the argument belongs to all the extensions
  - **Rejected** if the argument does not belong to any extension
- The set of extensions is denoted by **E** ($\mathcal{E}_1, \ldots, \mathcal{E}_n$ standing for the extensions)

Example of Acceptability Semantics

- $\mathcal{E}$ is a **preferred extension** if and only if $\mathcal{E}$ is a maximal admissible set (with respect to set inclusion $\subseteq$)
- $\mathcal{E}$ is the **only grounded extension** if and only if $\mathcal{E}$ is the least fixed point (with respect to $\subseteq$) of $\mathcal{F}$.

Example

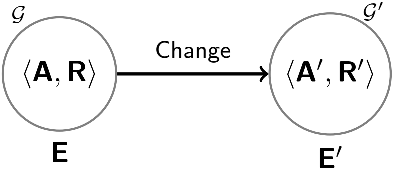


Prosecutor's preferred and grounded extension : $\mathcal{E} = \{3, 5, 6\}$

Defense lawyer's preferred and grounded extension : $\mathcal{E} = \{2, 7\}$

Plan

Change Operations



- Four elementary operations
  - **Argument removal**
  - **Argument addition**
  - Attack removal
  - Attack addition
- Same semantics before and after change

Change Operations

Definition – Removing an argument

Removing an argument $Z \in \mathbf{A}$ and $\mathcal{I}_z \subseteq \mathbf{R}$ is a change operation, denoted $\ominus_i^a$, providing a new argumentation system such that:

$$\langle \mathbf{A}, \mathbf{R} \rangle \ominus_i^a (Z, \mathcal{I}_z) = \langle \mathbf{A} \setminus \{Z\}, \mathbf{R} \setminus \mathcal{I}_z \rangle$$

where $\mathcal{I}_z$ is the set of interactions concerning Z.

Definition – Adding an argument

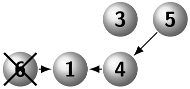
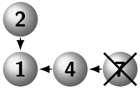
Adding an argument $Z \notin \mathbf{A}$ and $\mathcal{I}_z \not\subseteq \mathbf{R}$ is a change operation, denoted $\oplus_i^a$, providing a new argumentation system such that:

$$\langle \mathbf{A}, \mathbf{R} \rangle \oplus_i^a (Z, \mathcal{I}_z) = \langle \mathbf{A} \cup \{Z\}, \mathbf{R} \cup \mathcal{I}_z \rangle$$

where $\mathcal{I}_z$ is a set of interactions concerning Z.

Successive Turns of the Hearing

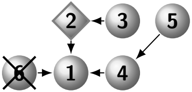
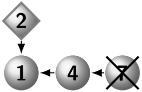
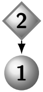
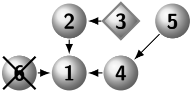
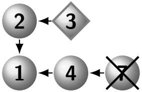
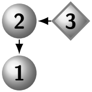
Occultation: strategic removal of argument

Turns (active players during the turn)	Prosecutor's system	Defense lawyer's system	Jury's system
0 (P)			

Argument 1: *Mr. X is guilty of premeditated murder of Mrs. X, his wife.*

Successive Turns of the Hearing

Arguing: addition of argument

Turns (active players during the turn)	Prosecutor's system	Defense lawyer's system	Jury's system
1 (D)			
2 (P)			
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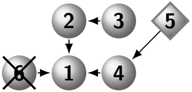
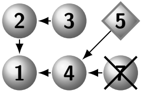
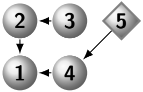
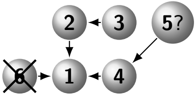
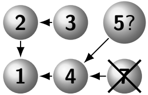
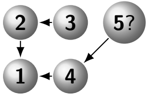
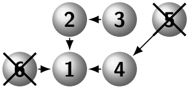
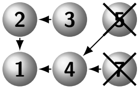
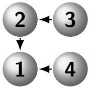
Successive Turns of the Hearing

Objection: forced removal of argument

Turns (active players during the turn)	Prosecutor's system	Defense lawyer's system	Jury's system
4 (P)			
5 (D)			

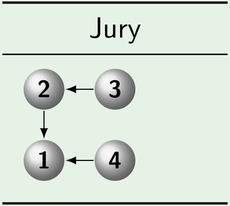
Successive Turns of the Hearing

End of the hearing

Turns (active players during the turn)	Prosecutor's system	Defense lawyer's system	Jury's system
6 — 9 (J;P;D)			

Deliberation

- Jury's argumentation system at the end of the hearing



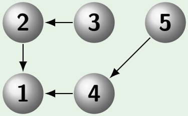
Jury's preferred extension : $\mathcal{E} = \{3, 4\}$

- Jury's decision: "M. X is **not guilty**"

Deliberation

- Jury's argumentation system *if the objection had been rejected*

Jury



Jury's preferred extension : $\mathcal{E} = \{1, 3, 5\}$

- The jury would have found M. X **guilty**

Why these changes ?

- Removal
  - Strategy (occultation)
  - Imposed by the context (objection)
- Addition
  - Natural way of arguing
  - Managing new pieces of information.

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$\Rightarrow$ **Focus** on the impact of the argument removal

Impact of the Removal of an Argument

Occulting Argument 7 and objecting to Argument 5 allowed the defense lawyer to effectively defend his client.

$\Rightarrow$ Hence, our aim is to:

- Allow agent to remove an argument in due course
- Characterize the removal operation in order to guide such a decision
- Study the **change properties**

Plan

Change Properties

- A change property defines the impact that a change operation can have on . . .
  - the structure of the set of extensions **E**
  - the acceptability of a set of arguments
  - the status of a particular argument
- Typology of change properties
- It may concern both addition and removal of an argument

Impact on the Set of Extensions

Before change

$|\mathbf{E}| = 0$

$|\mathbf{E}| = 1$, $\mathcal{E} = \varnothing$

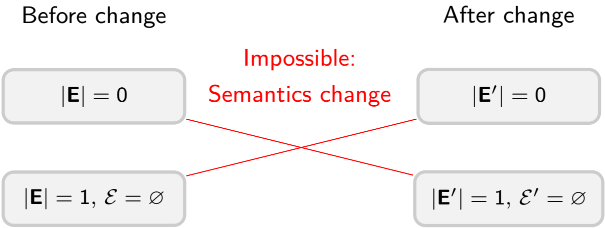
$|\mathbf{E}| = 1$, $\mathcal{E} \neq \varnothing$

$|\mathbf{E}| > 1$

Impact on the Set of Extensions

Before change	After change
$|\mathbf{E}| = 0$	$|\mathbf{E}'| = 0$
$|\mathbf{E}| = 1,\ \mathcal{E} = \varnothing$	$|\mathbf{E}'| = 1,\ \mathcal{E}' = \varnothing$
$|\mathbf{E}| = 1,\ \mathcal{E} \neq \varnothing$	$|\mathbf{E}'| = 1,\ \mathcal{E}' \neq \varnothing$
$|\mathbf{E}| > 1$	$|\mathbf{E}'| > 1$

Impact on the Set of Extensions



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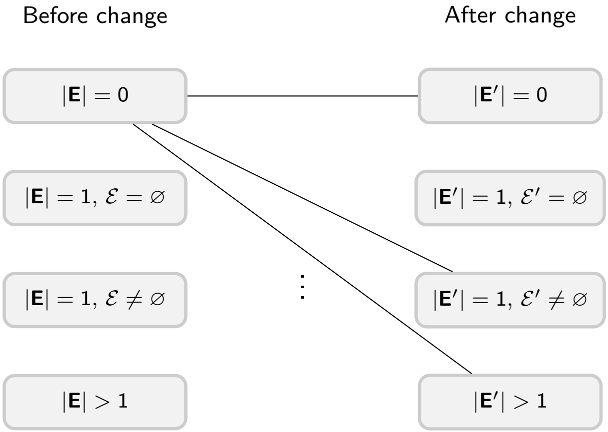
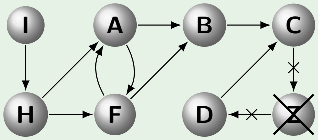


Impact on the Set of Extensions: an Example

Definition – Expansive change

- $\mathbf{E} \neq \varnothing$, $|\mathbf{E}| = |\mathbf{E}'|$
- $\forall \mathcal{E}_i \in \mathbf{E}, \exists \mathcal{E}'_j \in \mathbf{E}', \mathcal{E}_i \subset \mathcal{E}'_j$
- $\forall \mathcal{E}'_j \in \mathbf{E}', \exists \mathcal{E}_i \in \mathbf{E}, \mathcal{E}_i \subset \mathcal{E}'_j$

Example (argument removal)



Preferred semantics : $\mathbf{E} = \{\{A, I\}, \{F, I\}\}$ and $\mathbf{E}' = \{\{A, D, I\}, \{D, F, I\}\}$

Impact on the Set of Extensions: an Example

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Characterization (argument removal) – Necessary condition

When removing an argument Z under preferred semantics, if this change is expansive then

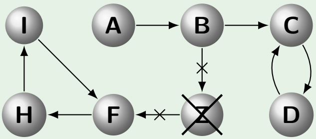
- Z does not belong to any extension of $\mathcal{G}$ and
- Z attacks at least one element of $\mathcal{G}$.

Impact on the Set of Extensions: another Example

Definition – Narrowing change

- $\mathbf{E} \neq \varnothing$, $|\mathbf{E}| = |\mathbf{E}'|$
- $\forall \mathcal{E}_i \in \mathbf{E}, \exists \mathcal{E}'_j \in \mathbf{E}', \mathcal{E}'_j \subset \mathcal{E}_i$
- $\forall \mathcal{E}'_j \in \mathbf{E}', \exists \mathcal{E}_i \in \mathbf{E}, \mathcal{E}'_j \subset \mathcal{E}_i$

Example (argument removal)



Preferred semantics : $\mathbf{E} = \{\{A, C, H, Z\}, \{A, D, H, Z\}\}$ and $\mathbf{E}' = \{\{A, C\}, \{A, D\}\}$

Impact on the Set of Extensions: another Example

Definition – Narrowing change

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- $\forall \mathcal{E}_i \in \mathbf{E}, \exists \mathcal{E}'_j \in \mathbf{E}', \mathcal{E}'_j \subset \mathcal{E}_i$
- $\forall \mathcal{E}'_j \in \mathbf{E}', \exists \mathcal{E}_i \in \mathbf{E}, \mathcal{E}'_j \subset \mathcal{E}_i$

Characterization (argument removal) – Necessary condition

When removing Z under preferred semantics, if the change is narrowing then there exists one extension $\mathcal{E}$ of $\mathcal{G}$ such that $Z \in \mathcal{E}$.

Impact on a Set of Arguments

- **Monotony**: expresses a kind of continuity in the acceptability of sets of arguments

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- Two types of monotony:
  - **Expansive**: the arguments accepted before change remain accepted after change (no loss of argument)
  - **Restrictive**: the arguments accepted after change were already accepted before change (no gain of argument)

Impact on a Set of Arguments

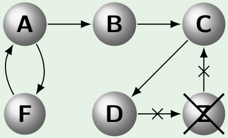
- **Monotony**: expresses a kind of continuity in the acceptability of sets of arguments
- Two types of monotony:
  - **Expansive**: the arguments accepted before change remain accepted after change (no loss of argument)
  - **Restrictive**: the arguments accepted after change were already accepted before change (no gain of argument)
- Modulation of the notion of monotony with the different cases of acceptance of an argument (credulous or skeptical acceptance)

Impact on a Set of Arguments

Definition – Simple expansive monotony

The change from $\mathcal{G}$ to $\mathcal{G}'$ satisfies simple expansive monotony *if and only if* $\forall \mathcal{E}_i \in \mathbf{E}, \exists \mathcal{E}'_j \in \mathbf{E}', \mathcal{E}_i \subseteq \mathcal{E}'_j$.

Example (argument removal)



Preferred semantics : $\mathbf{E} = \{\{A\}, \{B, D, F\}\}$ and $\mathbf{E}' = \{\{A, C\}, \{B, D, F\}\}$

Impact on a Set of Arguments

Definition – Simple expansive monotony

The change from $\mathcal{G}$ to $\mathcal{G}'$ satisfies simple expansive monotony *if and only if* $\forall \mathcal{E}_i \in \mathbf{E}, \exists \mathcal{E}'_j \in \mathbf{E}', \mathcal{E}_i \subseteq \mathcal{E}'_j$.

Characterization (argument removal) – Necessary and sufficient condition

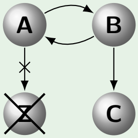
When removing an argument Z under preferred or grounded semantics, the change satisfies simple expansive monotony if and only if $\forall \mathcal{E} \in \mathbf{E}$, $Z \notin \mathcal{E}$.

Impact on a Set of Arguments

Definition – Simple restrictive monotony

The change from $\mathcal{G}$ *to* $\mathcal{G}'$ *satisfies* simple restrictive monotony *if and only if* $\forall \mathcal{E}'_j \in \mathbf{E}', \exists \mathcal{E}_i \in \mathbf{E}, \mathcal{E}'_j \subseteq \mathcal{E}_i$.

Example (argument removal)



Preferred semantics : $\mathbf{E} = \{\{A, C\}, \{B, Z\}\}$ and $\mathbf{E}' = \{\{A, C\}, \{B\}\}$

Impact on a Set of Arguments

Definition – Simple restrictive monotony

The change from $\mathcal{G}$ to $\mathcal{G}'$ satisfies simple restrictive monotony *if and only if* $\forall \mathcal{E}'_j \in \mathbf{E}', \exists \mathcal{E}_i \in \mathbf{E}, \mathcal{E}'_j \subseteq \mathcal{E}_i$.

Characterization (argument removal) – Sufficient condition

When removing an argument Z under preferred semantics, if Z does not attack any argument of $\mathcal{G}$ then,

- $\forall \mathcal{E}_i \in \mathbf{E}$, $\mathcal{E}_i \backslash \{Z\}$ is a preferred extension of $\mathcal{G}'$.
- $|\mathbf{E}| = |\mathbf{E}'|$.

So, the change satisfies simple restrictive monotony.

Impact on a Particular Argument

- Let $\mathbf{E}_X = \{\mathcal{E}_i \in \mathbf{E} \mid X \in \mathcal{E}_i\}$
- Let $\mathbf{E}'_X = \{\mathcal{E}'_j \in \mathbf{E}' \mid X \in \mathcal{E}'_j\}$

Before change

$|\mathbf{E}_X| = 0$
X is rejected in $\mathcal{G}$

$|\mathbf{E}_X| < |\mathbf{E}|$
X is only credulously accepted in $\mathcal{G}$

$|\mathbf{E}_X| = |\mathbf{E}|$
X is skeptically accepted in $\mathcal{G}$

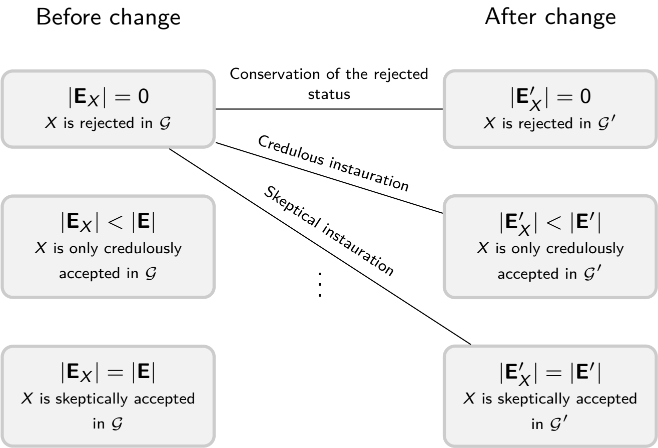
Impact on a Particular Argument

- Let $\mathbf{E}_X = \{\mathcal{E}_i \in \mathbf{E} \mid X \in \mathcal{E}_i\}$
- Let $\mathbf{E}'_X = \{\mathcal{E}'_j \in \mathbf{E}' \mid X \in \mathcal{E}'_j\}$

Before change	After change
$\lvert\mathbf{E}_X\rvert = 0$ X is rejected in $\mathcal{G}$	$\lvert\mathbf{E}'_X\rvert = 0$ X is rejected in $\mathcal{G}'$
$\lvert\mathbf{E}_X\rvert < \lvert\mathbf{E}\rvert$ X is only credulously accepted in $\mathcal{G}$	$\lvert\mathbf{E}'_X\rvert < \lvert\mathbf{E}'\rvert$ X is only credulously accepted in $\mathcal{G}'$
$\lvert\mathbf{E}_X\rvert = \lvert\mathbf{E}\rvert$ X is skeptically accepted in $\mathcal{G}$	$\lvert\mathbf{E}'_X\rvert = \lvert\mathbf{E}'\rvert$ X is skeptically accepted in $\mathcal{G}'$

Impact on a Particular Argument

- Let $\mathbf{E}_X = \{\mathcal{E}_i \in \mathbf{E} \mid X \in \mathcal{E}_i\}$
- Let $\mathbf{E}'_X = \{\mathcal{E}'_j \in \mathbf{E}' \mid X \in \mathcal{E}'_j\}$

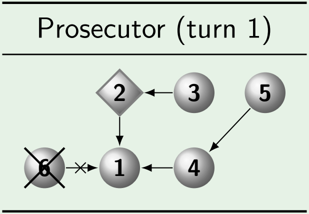


Impact on a Particular Argument

Definition – Conservation of the rejected status of X

The change from $\mathcal{G}$ to $\mathcal{G}'$ preserves the rejected status of X if and only if $\forall \mathcal{E}_i \in \mathbf{E}, X \notin \mathcal{E}_i$ and $\forall \mathcal{E}'_j \in \mathbf{E}', X \notin \mathcal{E}'_j$.

Example (argument addition)



Grounded semantics : $\mathbf{E} = \{\{1, 3, 5\}\}$ and $\mathbf{E}' = \{\{1, 3, 5\}\}$

Conservation of the rejected status of 4.

Impact on a Particular Argument

Definition – Conservation of the rejected status of X

The change from $\mathcal{G}$ to $\mathcal{G}'$ preserves the rejected status of X if and only if $\forall \mathcal{E}_i \in \mathbf{E}, X \notin \mathcal{E}_i$ and $\forall \mathcal{E}'_j \in \mathbf{E}', X \notin \mathcal{E}'_j$.

Characterization (argument addition) – Sufficient condition

When adding an argument Z under the grounded semantics, if $X \notin \mathcal{E}$ and Z does not indirectly defend X, then the change preserves the rejected status of X.

Plan

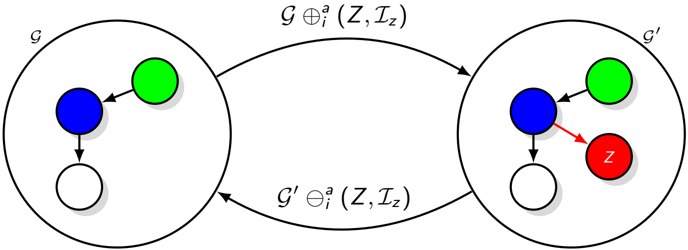
Duality Between Addition and Removal

The duality represents the link between...

- two operations
- two properties

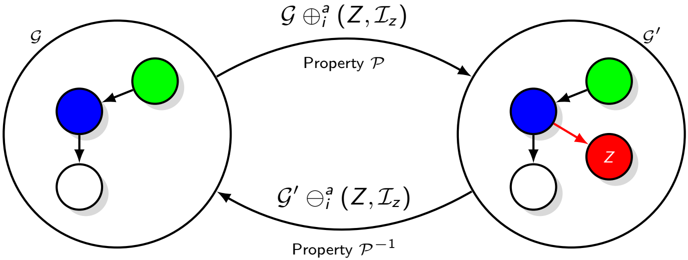
$\Rightarrow$ Enables to use the characterization of an operation to characterize its dual operation

Duality Between Addition and Removal



- $\oplus_i^a$ **dual** of $\ominus_i^a$

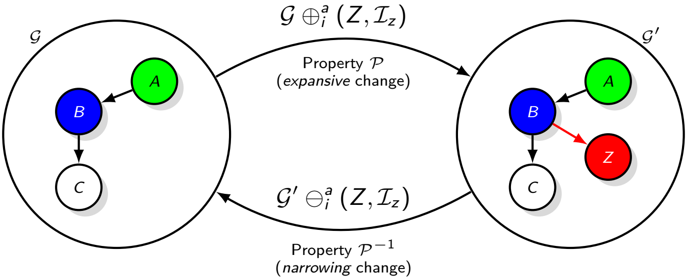
Duality Between Addition and Removal



- $\oplus_i^a$ **dual** of $\ominus_i^a$
- Property $\mathcal{P}$ **dual** of Property $\mathcal{P}^{-1}$

Duality Between Addition and Removal

$\mathbf{E}_{grounded} = \{\{A, C\}\}$ $\mathbf{E}'_{grounded} = \{\{A, C, Z\}\}$



- $\oplus_i^a$ **dual** of $\ominus_i^a$
- Property $\mathcal{P}$ **dual** of Property $\mathcal{P}^{-1}$
- Intuitively:
  - If we add an argument defended by $\mathcal{E}$ which does not attack any argument, then we have an *expansive change*.
  - $\Rightarrow$ So, if we remove an argument defended by $\mathcal{E}$ which does not attack any argument, then we have a *narrowing change*.

Duality: an Example of Result

Proposition: *When **adding** an argument Z under the grounded semantics, if $X \in \mathcal{E}$ and Z does not indirectly attack X, then $X \in \mathcal{E}'$.*

$\Downarrow$

Proposition$^{\ominus}$: *When **removing** an argument Z under the grounded semantics, if $X \notin \mathcal{E}$ and Z does not indirectly attack X, then $X \notin \mathcal{E}'$.*

Plan

Our Contribution about Change in Abstract Argumentation

- Study of change in abstract argumentation (focus on the removal of an argument and its interactions)
- Creation of a new typology of change properties
- Characterization of these properties
- Use of duality in order to complete this characterization

Perspectives

- Study of the impact still remaining from a removed argument
- Study of attack addition and attack removal
- Characterization of minimal change

Thank you