Intertranslatability of Abstract Argumentation Frameworks

Polberg Sylwia
University College London

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Roadmap

Scenarios I

So let us assume you want to use argumentation in your project and know what sort of features you will need...

Scenario 1

- You find two argumentation frameworks that are "almost" good, but each one would have to be extended with a missing feature that is present in the other structure
- What do you do?
  - Create another framework joining the two?
  - Perhaps find an easy way to simulate the missing feature?

Scenarios II

Scenario 2

- You find two argumentation frameworks that have what you want, but you have problem choosing between them...
- ...and what you keep finding are interesting observations about their differences, but no hard facts that you can really use to defend your choice
- What do you do?
  - Go with the general opinion?
  - Throw a dice?
  - Or see what it would take for one framework to emulate the behaviour of the other?

Scenarios III

Scenario 3

- You find an argumentation framework that is just right.
- ...but it's computational complexity is not analyzed and it does not have an implementation
- What do you do?
  - Find a different framework?
  - Fill in the research gaps yourself?
  - ...or just use a translation?

Scenarios IV

Scenario 4

- You find an argumentation framework that is just right and work with it
- ...but then a reviewer complains your choice was unnecessary and that "with a bit of effort the Dung's framework could have handled it"
- What do you do?
  - Talk about your preferences? How the framework is easier to use in your application than Dung's? Hope he/she will get that?
  - ...or, if it is helpful, show him actual translations, their computational complexity, the impossibility proofs, straight facts that he or she cannot deny?

Scenarios V

Scenario 5

- You had to create a new framework to handle what you want...
- ...and now need to explain how it is related to other works in the field
- It would be awesome if you could create:
  - Scenarios handled differently between the frameworks
  - A way for your framework to handle the existing ones
  - The effort it would take for other structures to emulate yours
- How can you come up with such things?

Our Work I

Our motivation

Intertranslatibility research can be used in:

- Designing argumentation–based software
- Widening the application and instantiation range of a given framework
- Research of framework dedicated solvers
- Comparing expressive power of given frameworks
- Studying the meaning and the “added value” of framework components
- Establishing the connections between different framework components

Our Work II

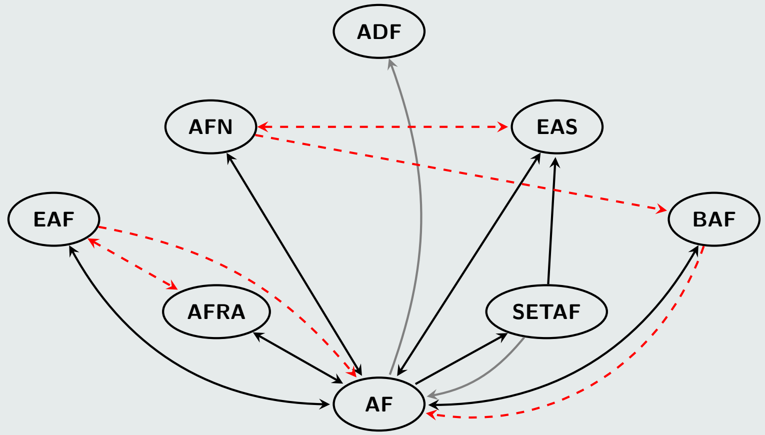
Argumentation Frameworks

Abstract argumentation is more than Dung's framework. There exist many different types (BPW14), including:

- Attack frameworks:
  - Dung's Frameworks (AF) (Dun95)
  - Framework with Sets of Attacking Arguments (SETAF) (NP07)
  - Framework with Recursive Attack (AFRA) (BCGG11)
  - Extended Argumentation Framework (EAF) (Mod09)
- Support frameworks:
  - Bipolar Argumentation Framework (BAF) (CLS09; CLS13)
  - Argumentation Framework with Necessities (AFN) (Nou13)
  - Evidential Argumentation System (EAS) (ORL10; PO14)
  - Abstract Dialectical Framework (ADF) (BW10; BES+13; Pol15)

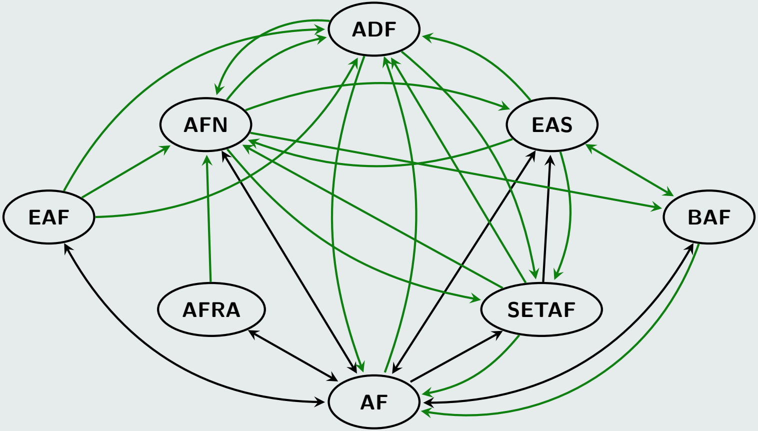
Contributions

Existing translations



Contributions

New translations

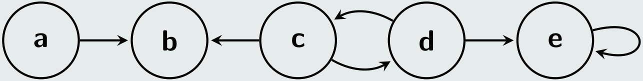


Dung's Framework (Dun95)

Dung's framework

A **Dung's abstract argumentation framework** (AF) is a pair (A, R), where A is a set of **arguments** and $R \subseteq A \times A$ represents the **attack** relation.

Example

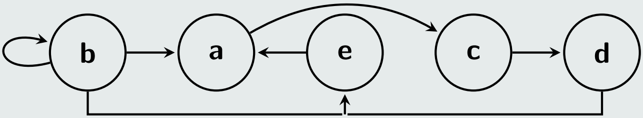


Framework with Sets of Attacking Arguments (NP07) I

Framework with Sets of Attacking Arguments

A **Framework with Sets of Attacking Arguments** (SETAF) is a pair (A, R), where A is a set of **arguments** and $R \subseteq (2^A \setminus \emptyset) \times A$ represents the **attack** relation.

Example

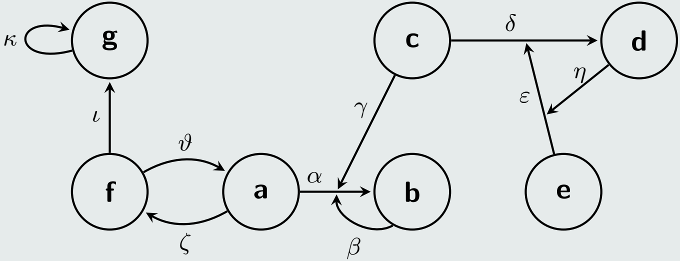


Argumentation Framework with Recursive Attacks (BCGG11)

Argumentation Framework with Recursive Attacks

An **argumentation framework with recursive attacks** (AFRA) is a pair (A, R) where A is a set of **arguments** and R is a set of **attacks**, namely pairs (a, X) s.t. $a \in A$ and $X \in A \cup R$.

Example

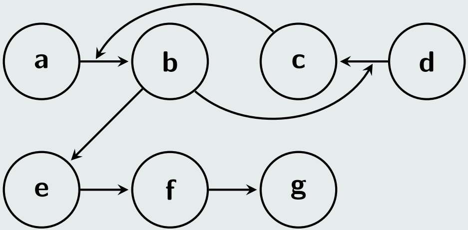


Extended Argumentation Framework (MP10)

Extended Argumentation Framework

The **extended argumentation framework** (EAF) is a tuple (A, R, D), where A is a set of **arguments**, $R \subseteq A \times A$ is the **attack** relation, $D \subseteq A \times R$ is the **defense attack** relation.

Example

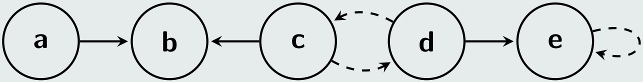


Bipolar Argumentation Frameworks (CLS13)

Bipolar Argumentation Framework

The **bipolar argumentation framework** (BAF) is a tuple (A, R, S), where A is a set of **arguments**, $R \subseteq A \times A$ represents the **attack** relation and $S \subseteq A \times A$ the **support** relation.

Example

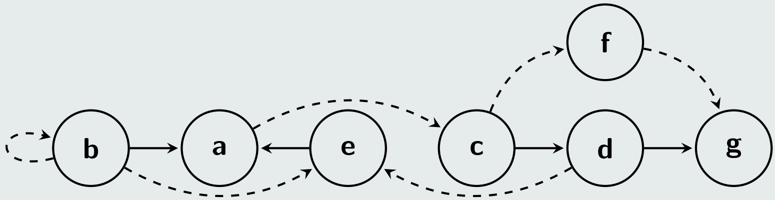


Argumentation Framework with Necessities (Nou13) I

Argumentation Framework with Necessities

An **argumentation framework with necessities** is a tuple (A, R, N), where A is the set of **arguments**, $R \subseteq A \times A$ represents (binary) **attacks**, and $N \subseteq (2^A \setminus \emptyset) \times A$ is the **necessity relation**.

Example



Argumentation Framework with Necessities (Nou13) II

Argumentation Framework with Necessities

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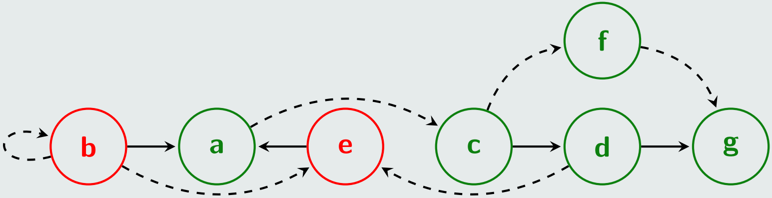
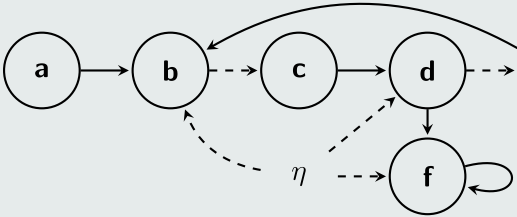


Evidential Argumentation System (ON08; ORL10; PO14)

Evidential Argumentation System

An **evidential argumentation system** (EAS) is a tuple (A, R, E) where A is a set of **arguments**, $R \subseteq (2^A \setminus \emptyset) \times A$ is the **attack** relation, and $E \subseteq (2^A \setminus \emptyset) \times A$ is the **support** relation. We distinguish a special argument $\eta \in A$ s.t. $\nexists (X, y) \in R$ where $\eta \in X$; and $\nexists X$ where $(X, \eta) \in R$ or $(X, \eta) \in E$.

Example



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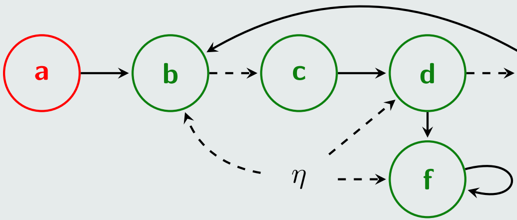


Abstract Dialectical Framework (BES+13; Pol15) I

Definition

An **abstract dialectical framework** (ADF) is a tuple (S, L, C), where:

- S is a set of abstract **arguments** (nodes, statements),
- $L \subseteq S \times S$ is a set of **links** (edges) and
- $C = \{C_s\}_{s \in S}$ is a set of **acceptance conditions**, one condition per each argument.

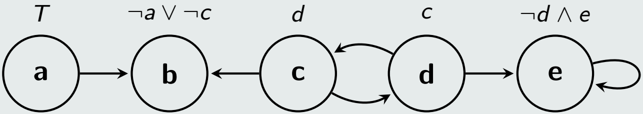
Important: links now do not represent relations anymore; the precise nature of the interaction between arguments is specified by the acceptance conditions.

Acceptance conditions

- They represent the relation of an argument to its parents
- Can be represented as functions $C_s : 2^{par(s)} \to \{in, out\}$
- More commonly defined as propositional formulas

Abstract Dialectical Framework (BES+13; Pol15) II

Example



Semantics

- Labeling–based (BES+13): implemented in DIAMOND (ES13)
- Extension–based (Pol15): four families (AA, CC, AC, CA_1 and CA_2), to be implemented

Translation

Intuition

" *...translation can be understood as a* **function** *Tr which maps theories from one formalism into another such that intended models of a theory* Δ *from the source formalism are in a* **certain relation** *to the intended models of* $Tr(\Delta)$. " ((DW11, 1))

Abstract Argumentation Translations

Let S, T be two framework types between which we want to translate and σ, δ source and target semantics. We distinguish:

- Semantics translations – same framework type, different semantics (DW11)
- Framework translations – different framework types, same semantics
- Normal form translations – same framework type, same semantics (CK14)

Properties of Translations I

Functional Properties

Look at a translation as a function:

- Can it handle any source framework, or just some subclass?
- Can any target framework be produced, or just some subclass?
- Does it produce same target framework for more than one source framework?
- If yes, what is the relation between the source frameworks?

Properties of Translations II

Complexity Properties

Look at how difficult the translation is:

- Is it purely structural, or does it require computing some basic semantics?
- Is it modular?
- What is the computation time?
- Does it cause any blow up in size of the target framework?

Syntactical Properties

Look at what it does to framework components:

- Does it change the type of arguments or not?
- Does it introduce auxiliary arguments and relations or not?
- Does it remove certain arguments and relations or not?

Properties of Translations III

Semantical Properties

Look at how the semantics of the frameworks behave:

- Is the translations specialized for a particular semantics, or is it generic?
- Is the semantics' domain the same?
- How strong is the translation?
- Is the translation bijective?
- Does the translation introduce auxiliary arguments in the extensions?

Existing Notions

Typical translation properties include (Got95; Lib14; Jan99):

- Modularity
- Efficiency, polynomiality
- Exactness, faithfulness

Properties of Translations IV

Exactness and Faithfulness

- Strong translation – every target extension corresponds to a source one and vice versa
- Semantics bijective translation – it's strong and there is a one to one relation between target and source extensions
- Faithful translation – it's semantics bijective and the original extensions are retrieved by removing auxiliary arguments
- Exact translation – it's semantics bijective and the target extensions are exactly the same as source ones

Translation Approaches I

Possible Approaches

Some translations are **easy** and our target framework can handle everything that the source one does. Some however, **are not**. When one structure possesses a feature the other does not, we can:

- Hide it
- Simulate it
- Remove it
- Limit ourselves to cases in which it does not occur

Translation Approaches II

Translation Types

We can distinguish four main types of translations (BGvdTV09; MBC11; CLS13; CL15; ORL10; PO14; BGvdTV10):

- **Basic** – when going from less to more complex frameworks, usually target framework can handle all elements of the source one
- **Coalition** – from more to less complex structures, not handled elements are hidden away in argument structure
- **Attack Propagation** – from more to less complex structures, effect of not handled elements is simulated by handled ones
- **Defender** – from more to less complex structures, not handled elements are translated into handled ones with the use of auxiliary arguments

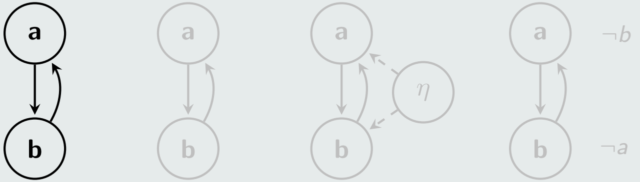
Basic Translation I

Basic translation

- A simple translation, often a generalization
- Never semantical
- On average, it does not require too many auxiliary arguments
- Preserves the structure of the source framework
- Generic, usually preserves all standard semantics in at least faithful manner

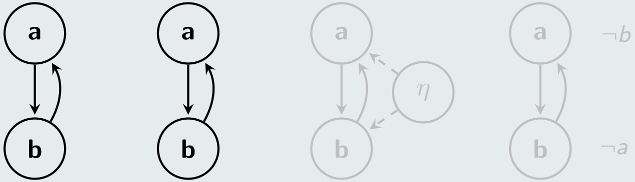
Basic Translation II

Example



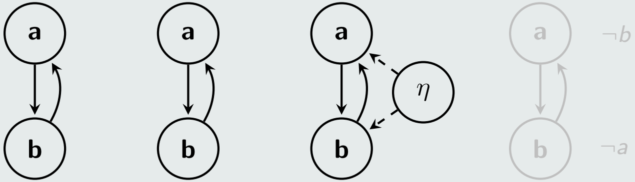
Basic Translation III

Example



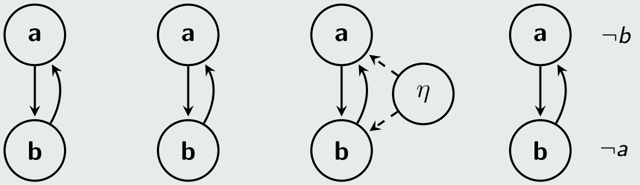
Basic Translation IV

Example



Basic Translation V

Example



Basic Translation: Summary

	AF	AFRA	SETAF	EAF	BAF	AFN	EAS	ADF
AF	x	✓ [green]	✓ [green]	✓ [green]	✓ [green]	✓ [green]	✓ [green]	✓ [green]
AFRA	✓ [red], ✓ [red]	x			✓ [green]	✓ [green]		
SETAF	✓ [red], ✓ [red]		x			✓ [red]	✓ [green]	✓ [green]
EAF	✓ [red]	✓ [blue]	✓ [blue]	x		✓ [blue], ✓ [blue]		✓ [blue], ✓ [green]
BAF	✓ [red], ✓ [red]				x	✓ [blue]	✓ [blue]	
AFN					✓ [blue]	x	✓ [green]	✓ [blue], ✓ [green]
EAS					✓ [blue]	✓ [blue], ✓ [red]	x	✓ [blue], ✓ [green]
ADF								x

✓ [green] – translation
✓ [red] – hybrid translation
✓ [blue] – subclass translation

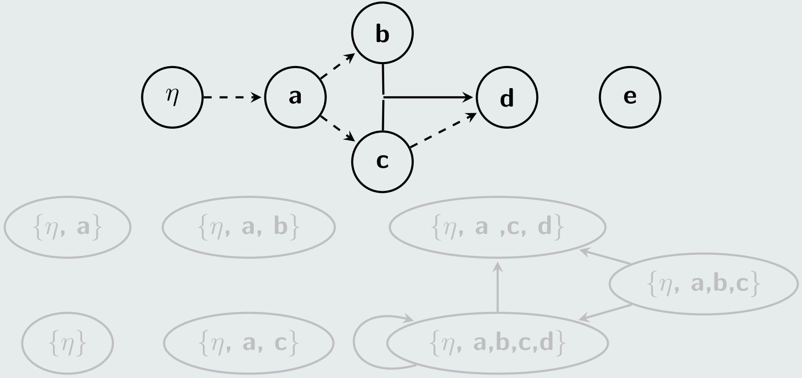
Coalition Translation I

Coalition translation

- Arguments in the target framework are collections of source arguments that are tied by support or ability to carry out a group attack
- Almost always semantical
- Exponential increase in amount of required auxiliary arguments
- Translation is lossy, it removes arguments from the source framework
- Usually preserves most of the standard semantics in a strong to semantics bijective manner

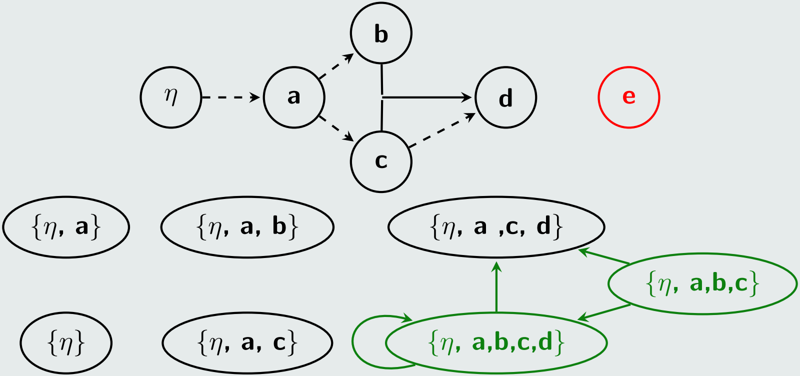
Coalition Translation II

Example



Coalition Translation III

Example



Coalition Translation: Summary

	AF	AFRA	SETAF	EAF	BAF	AFN	EAS	ADF
AF	x							
AFRA		x						
SETAF	✓		x			✓		
EAF				x				
BAF	✓				x			
AFN	✓					x		
EAS	✓		✓			✓	x	
ADF	✓, ✓, ✓, ✓		✓					x

✓ – translation
✓ – hybrid translation

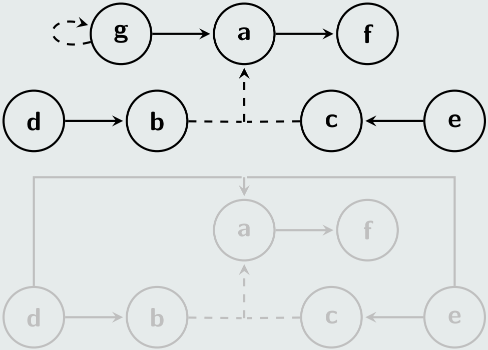
Attack Propagation Translation I

Attack propagation translation

- Completes the source framework with various types of indirect attacks
- Does not require auxiliary arguments
- Removes some of the arguments in the source framework
- In principle, the translation is semantical; can be structural only for particular normal forms
- Preserves completeness–based semantics in an exact manner

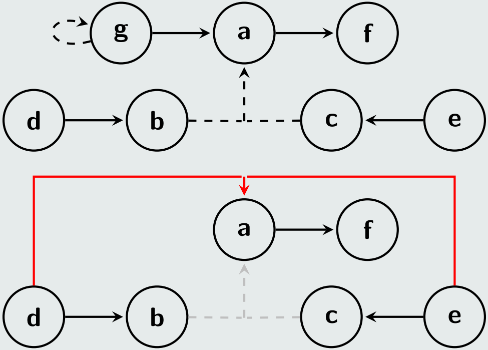
Attack Propagation Translation II

Example



Attack Propagation Translation III

Example



Attack Propagation: Summary

	AF	AFRA	SETAF	EAF	BAF	AFN	EAS	ADF
AF	x							
AFRA	✓ (red)	x						
SETAF			x					
EAF				x				
BAF	✓ (red)				x			
AFN			✓			x		
EAS			✓				x	
ADF			✓					x

✓ – translation

✓ (red) – hybrid translation

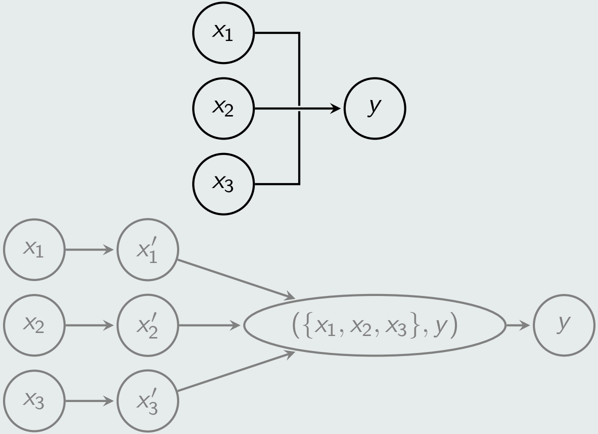
Defender Translation

Defender translation

- Exploit defense to e.g. simulate support or to connect arguments
- Does not remove arguments from the source framework
- For attack–based frameworks, the translation:
  - is structural
  - can require exponentially may auxiliary arguments
- For support–based frameworks:
  - it is semantical and can be structural only for particular normal forms
  - requires polynomially many auxiliary arguments
- Usually preserves semantics that are at least admissible in a strong to faithful manner

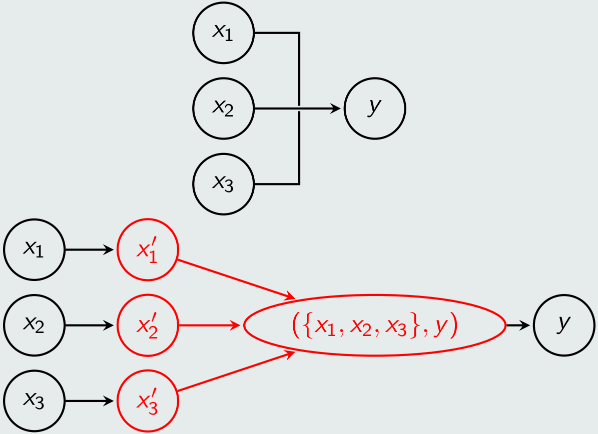
Defender Translation

Example



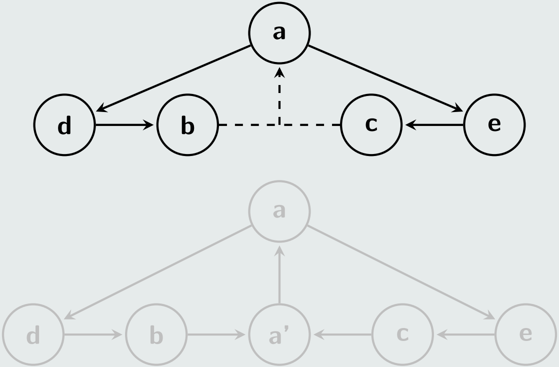
Defender Translation

Example



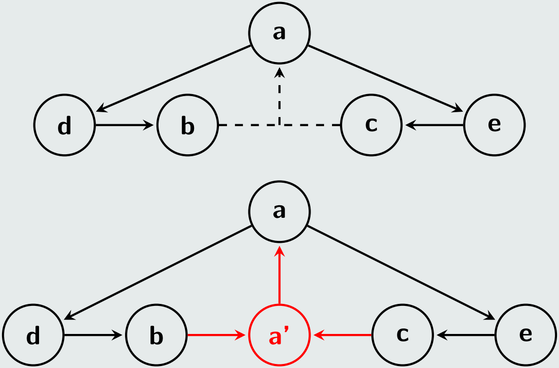
Defender Translation

Example



Defender Translation

Example



Defender Translation

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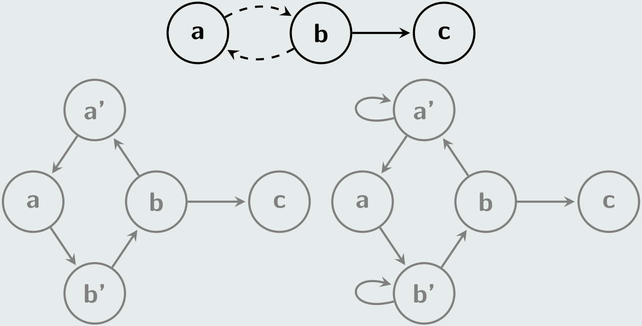
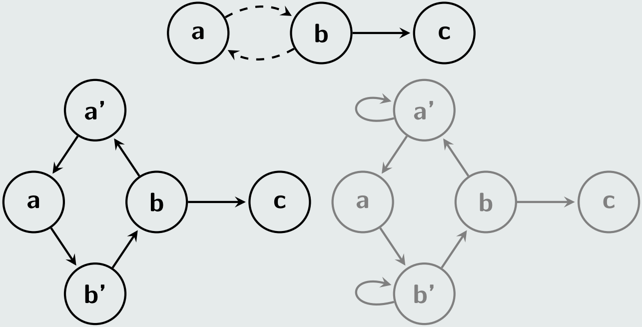


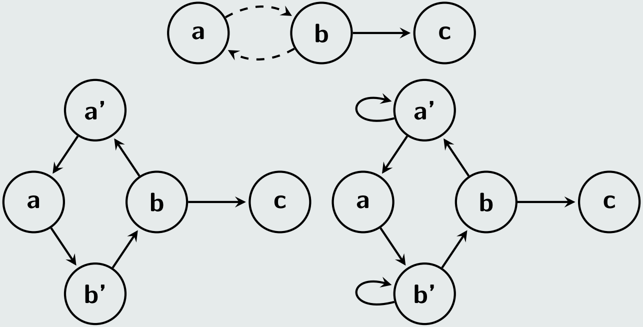
Defender Translation

Example



Defender Translation

Example



Defender Translation: Summary

	AF	AFRA	SETAF	EAF	BAF	AFN	EAS	ADF
AF	x							
AFRA	✓	x						
SETAF	✓		x					
EAF	✓			x				
BAF					x			
AFN			✓			x		
EAS			✓				x	
ADF	✓, ✓		✓					x

✓ – translation

✓ – hybrid translation

Improving Translations

	AF	AFRA	SETAF	EAF	BAF	AFN	EAS	ADF
AF	x	✓	✓	✓	✓	✓	X	✓
AFRA	✓	x			✓	✓	X	
SETAF	X		x			X	✓	✓
EAF	X	X	X	x	X	X	X	✓
BAF					x			
AFN	✓ (green)		✓			x	X	✓
EAS	X		✓			X	x	✓
ADF	X	X	X	X?	X	X	X	x

✓ – is exact

✓ (green) – exact might exist

X – exact most likely does not exist


this is how I finish a presentation:
happymonsters.tumblr.com
Soo...
uhh
...yeah.

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