A BRIEF INTRODUCTION TO SEQUENTIAL ARGUMENTATION - THE SHKOP APPROACH

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with T. Kampik

Preliminary Paper: *Gabbay, Kampik. A Brief Introduction to the Shkop Approach to Conflict Resolution in Formal Argumentation.*

SHKOP PRINCIPLE FOR RESOLVING LOOPS

- Arises in Talmudic logic, we modify it for argumentation
- Shkop: if an action causes a loop in a system, do not allow it

Abraham, Gabbay, Schild. *The handling of loops in talmudic logic, with application to odd and even loops in argumentation*. 2014.

SIMPLE EXAMPLE: J.K. ROWLING

J.K. Rowling and her father.

SIMPLE EXAMPLE: J.K. ROWLING

- Time_0: J.K. Rowling gives father signed first edition Harry Potter books
  Implied obligation: do not sell
- Time_1: Father sells books
- Loop: father sells → gift cancelled → sale not legal
  → not sold → gift not cancelled

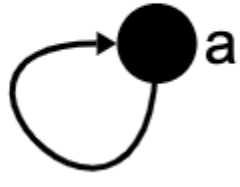
SIMPLE EXAMPLE: J.K. ROWLING

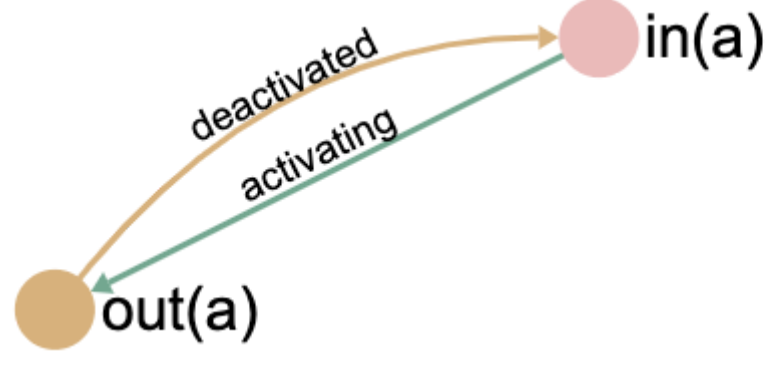
a: gift books; a is in

b: sell books; b is out; sale is not "legal"!

ADVANCED EXAMPLE I: LIAR'S PARADOX

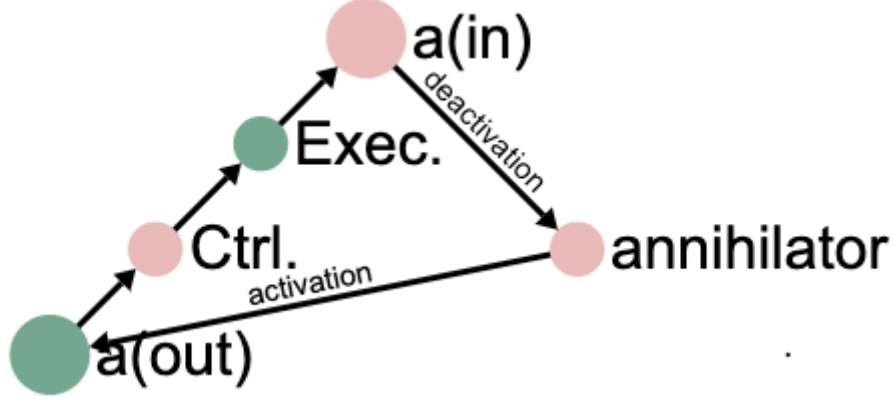
"I am lying." = a, modeled by $out(a)$ and $in(a)$;
$in(a)$ activates the attack from $out(a)$ to $in(a)$





ADVANCED EXAMPLE I: LIAR'S PARADOX

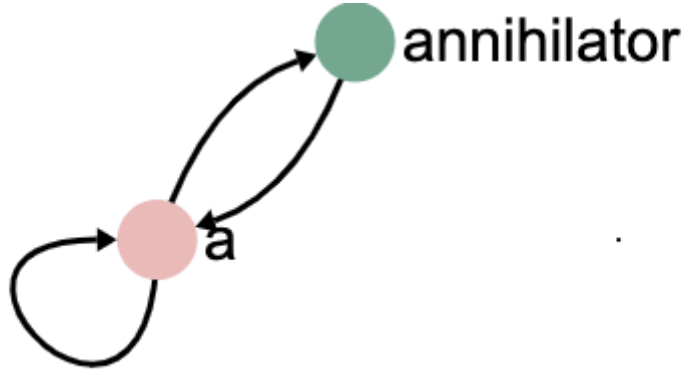
Map to abstract argumentation framework
1. start with $a(in)$, check annihilator
2. Annihilator is out, hence start with $a(out)$



Either: apply sequential approach, such that annihilator is in
Or: since $a(out) = a(in) = a$, and a attacking itself, this figure is reduced in standard formal argumentation to the next figure.

ADVANCED EXAMPLE I: LIAR'S PARADOX

Our only extension is the set that consists of the annihilator a cannot be in.

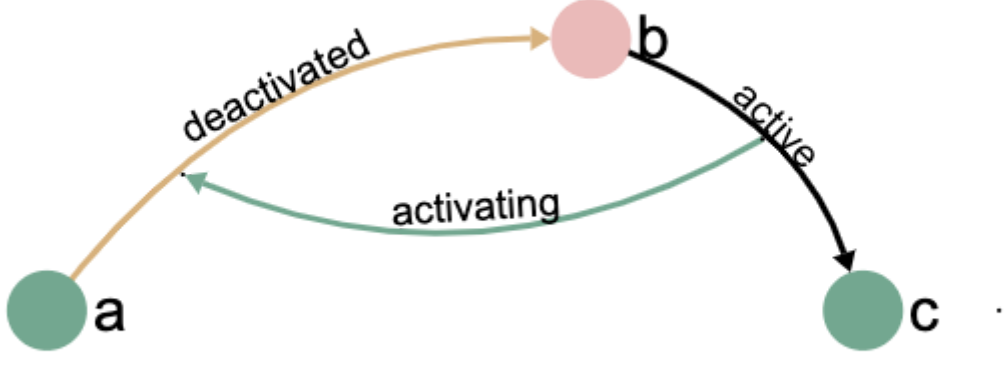


ADVANCED EXAMPLE II: ACTIVATION OF ATTACKS

- Security: an attack on an argument activates an attack of the attacker
- Intrusion in a server room activates self-destruction of the server

Gabbay, Horne, Mauw, Van der Torre. *Argumentation-based Semantics for Attack-Defense Networks*. 2020.

ADVANCED EXAMPLE II: ACTIVATION OF ATTACKS



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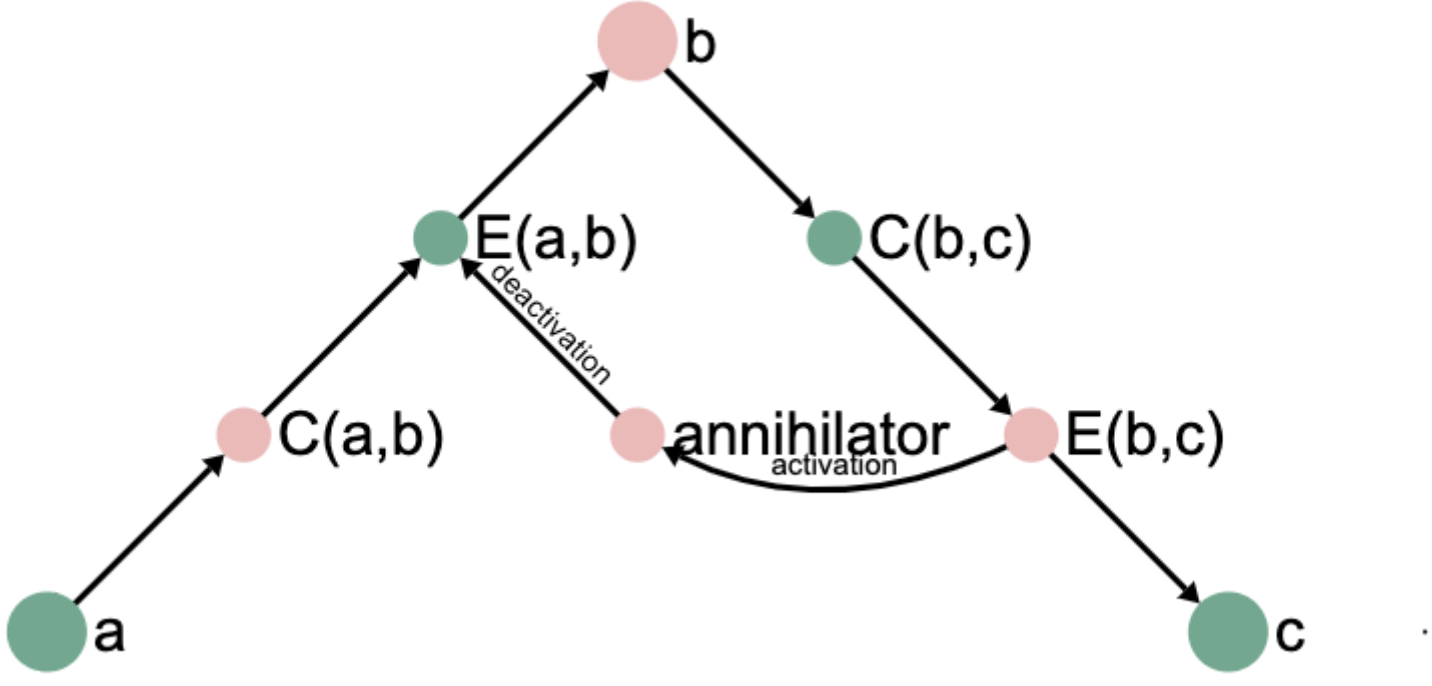
ADVANCED EXAMPLE II: ACTIVATION OF ATTACKS

Map to abstract argumentation framework



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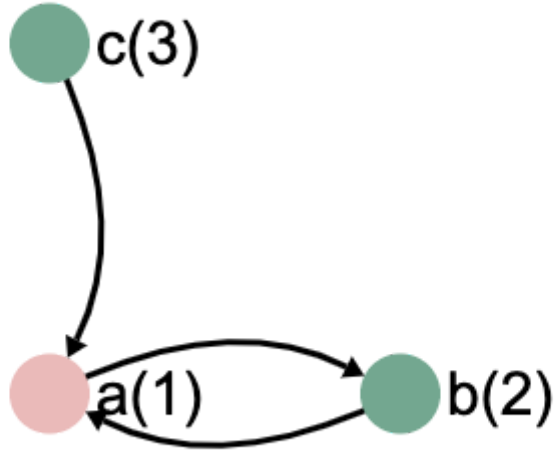
WE NEED AN ALGORITHM



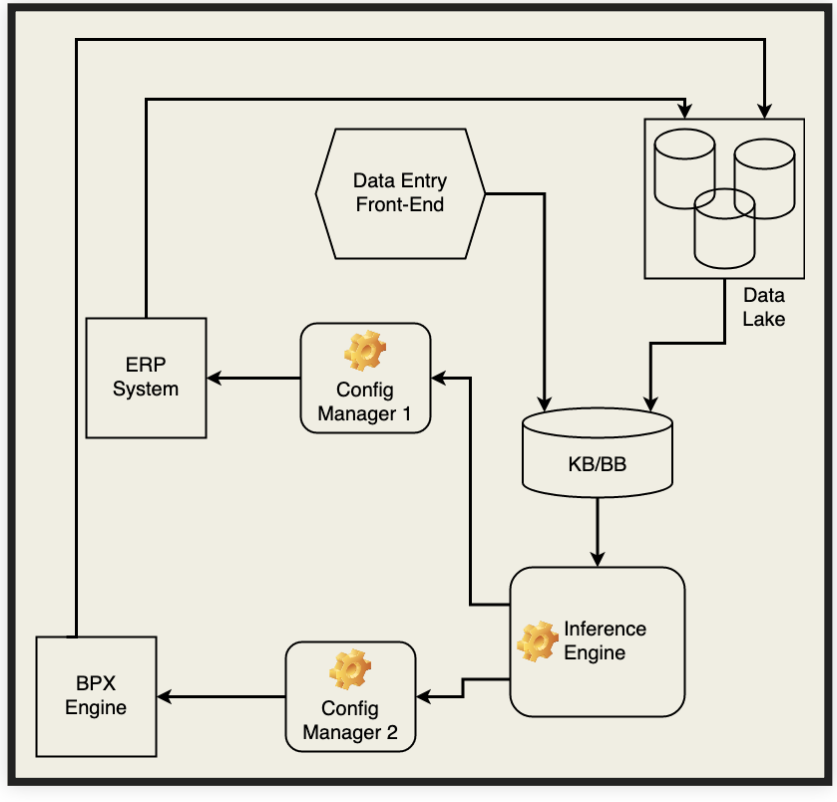
b closes the loop, but is "saved" by c.

We need an algorithm to support this intuition.

OUTLINE, KNOWLEDGE-BASED SYSTEMS PERSPECTIVE

- We start with an empty knowledge base
- We add statements (arguments) one-by-one (total order)
- If we can, we remain monotonic
- If we do not have a total order, we consider all possible orders that respect the partial order established by the acyclic SCC graph. This gives us an argumentation semantics.
- We go argument-by-argument, not SCC-by-SCC!

YET ANOTHER EXAMPLE: KNOWLEDGE-BASED SYSTEMS



Landscape of knowledge-based systems.

EXAMPLE: KNOWLEDGE-BASED SYSTEMS

- We want to repeatedly draw inferences from an expanding knowledge base
- Change of inference is costly (change requirements propagate through landscape)
- We only change in face of overwhelming evidence

SEQUENTIAL APPROACH

- We start with an empty AF and an empty set of conclusions E
- We normally expand AF to add one argument a and any number of attacks from or to a
- We pre-test: do we need to re-arrange our order to respect the partial order of the acyclic SCC graph? If so, we do it!
- We *test*: do we have to reject E without any doubt?
  - If no, we add a to E iff $E \cup a$ is conflict-free; otherwise, we stay with E
  - If yes, we re-arrange our sequence again

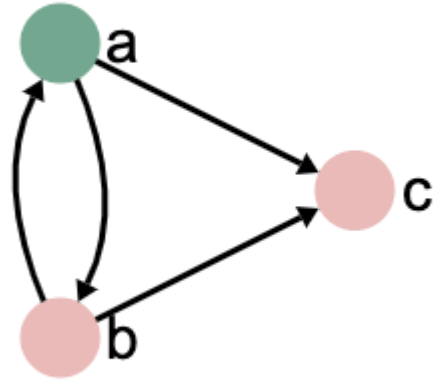
TESTING THE CURRENT INFERENCE RESULT

- Boolean test function takes the current inference result and the newly added argument 'against' the current argumentation framework
- What is a good test function?
- Test for strong admissibility, given what we already have inferred 'upstream'
- Roughly: 'can we keep the current inference result'?

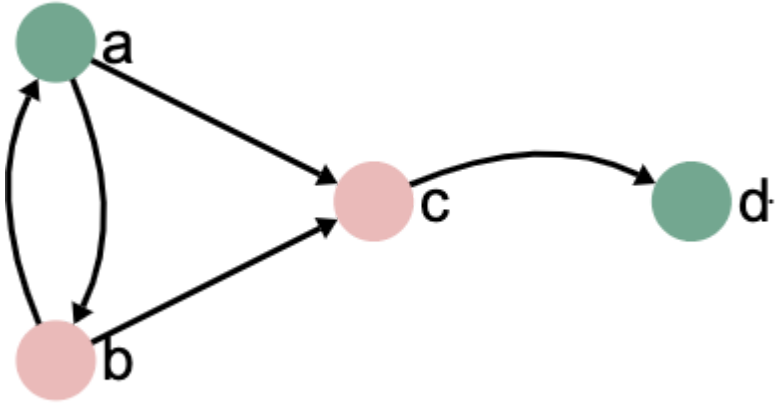
TEST FOR STRONG ADMISSIBILITY

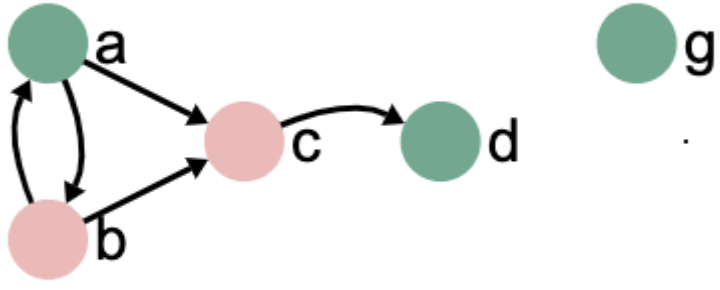
- Given $AF = (AR, AT), a \in AR, E \subseteq AR$:
- Restrict AF to $AF' \downarrow_{AR'}$ so that AR' only contains arguments that are:
  - Either in S
  - Or reachable from a (or a itself)
- Is E attacked by the grounded extension of AF'? Then, discard it!

EXAMPLE

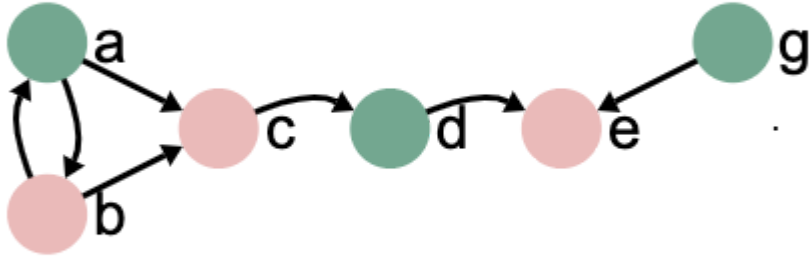


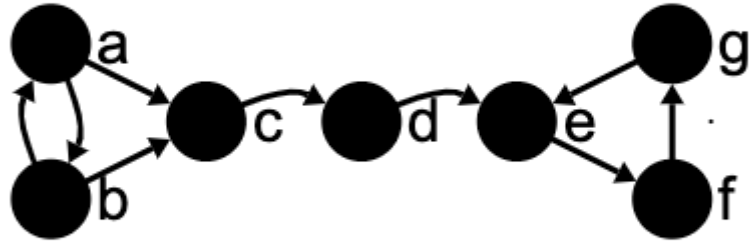
EXAMPLE





EXAMPLE

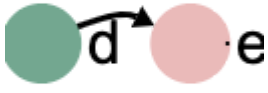


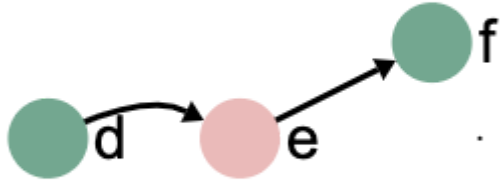


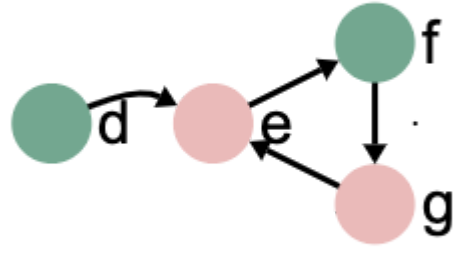
WHAT IF THE TEST FAILS?

- We swap the argument we just added with its predecessor and repeat until we find the right order

EXAMPLE



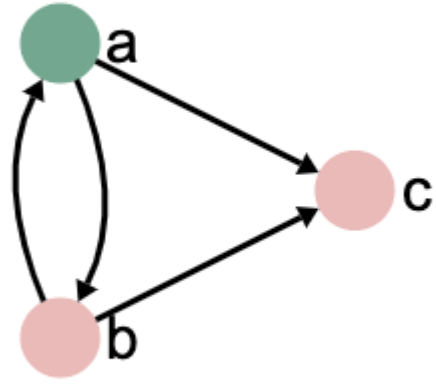




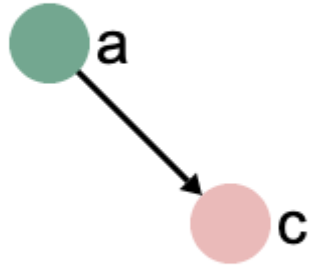
WHAT IF WE CANNOT ASSUME A TOTAL ORDER?

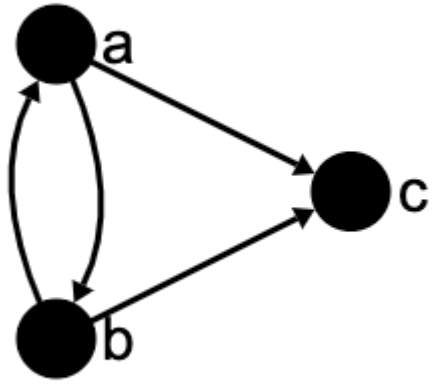
- We check all orders we can assume
- Our approach searches for 'intuitive' orders
- Example: $AF = (\{a, b, c\}, \{(a, b), (b, a), (a, c), (b, c)\})$

EXAMPLE - ORDER 1

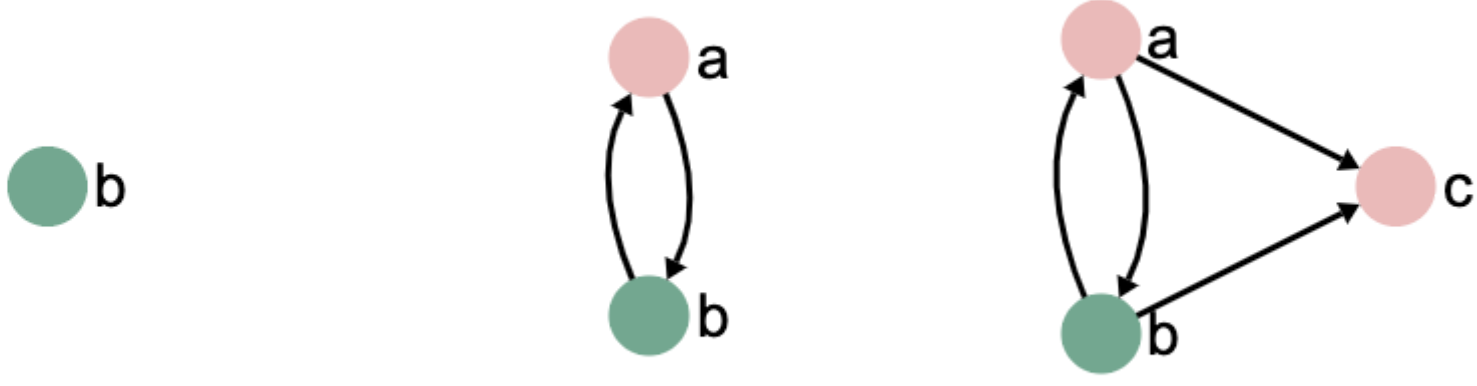


EXAMPLE - ORDER 2

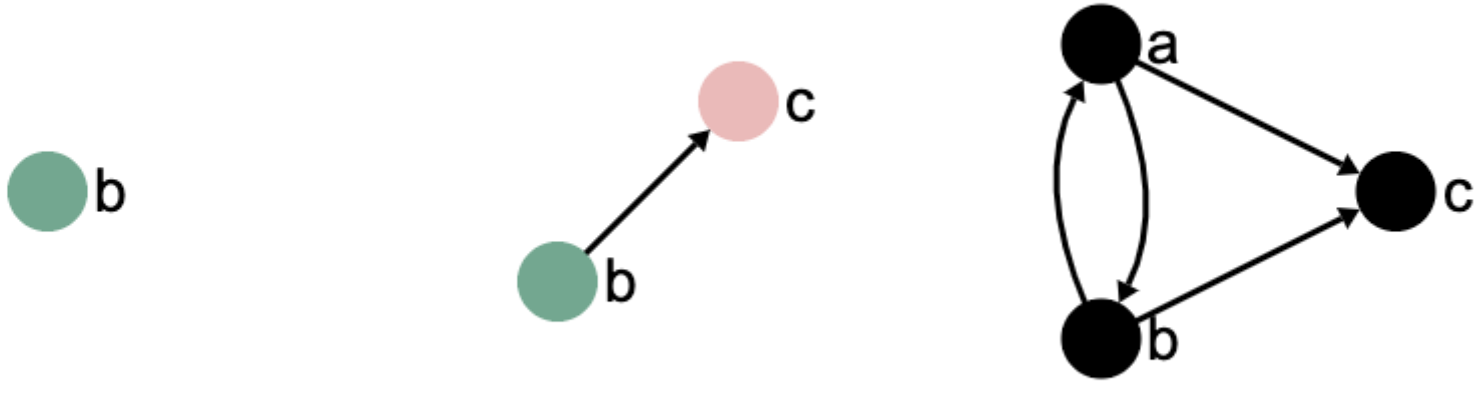




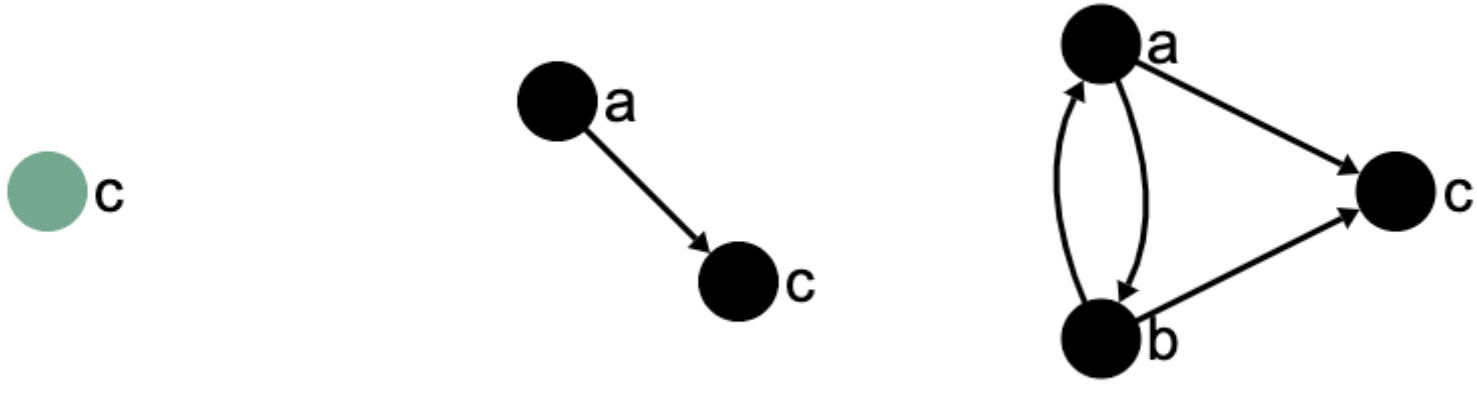
EXAMPLE - ORDER 3



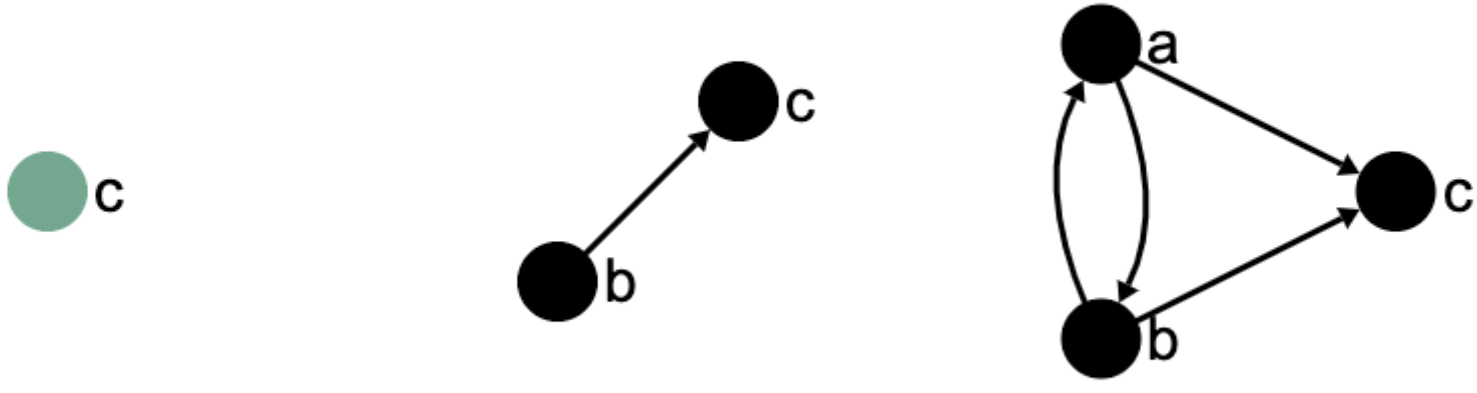
EXAMPLE - ORDER 4



EXAMPLE - ORDER 5



EXAMPLE - ORDER 6



EXAMPLE - UNION

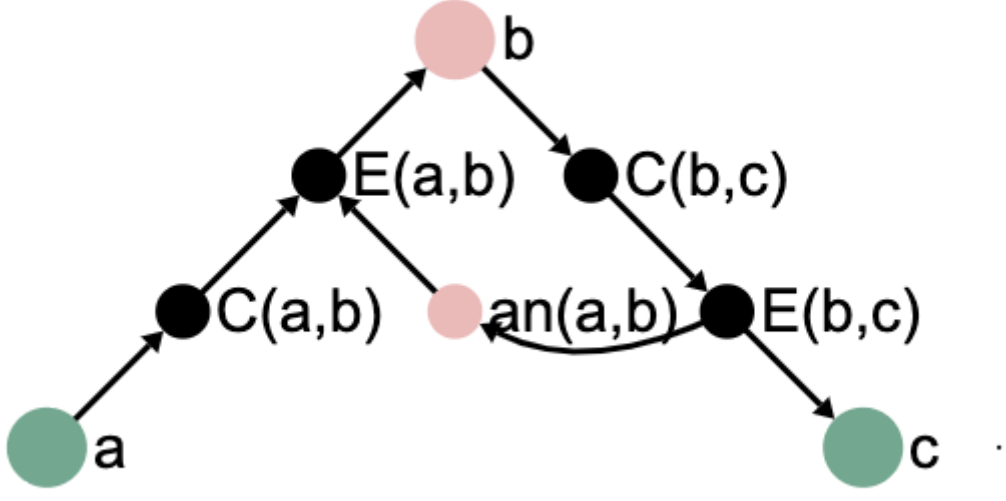
- We get: $\{a\}, \{b\}$
- We have to reject the sequences that start with c
- Hence, we get $\{\{a\}, \{b\}\}$

ARGUMENTATION SEMANTICS

- If we cannot assume any order, we get an argumentation semantics
- This argumentation semantics is naive set-based, directional, and universally defined
- It is CF2-like, but does not exhibit a problem that CF2 has with some even-length cycles

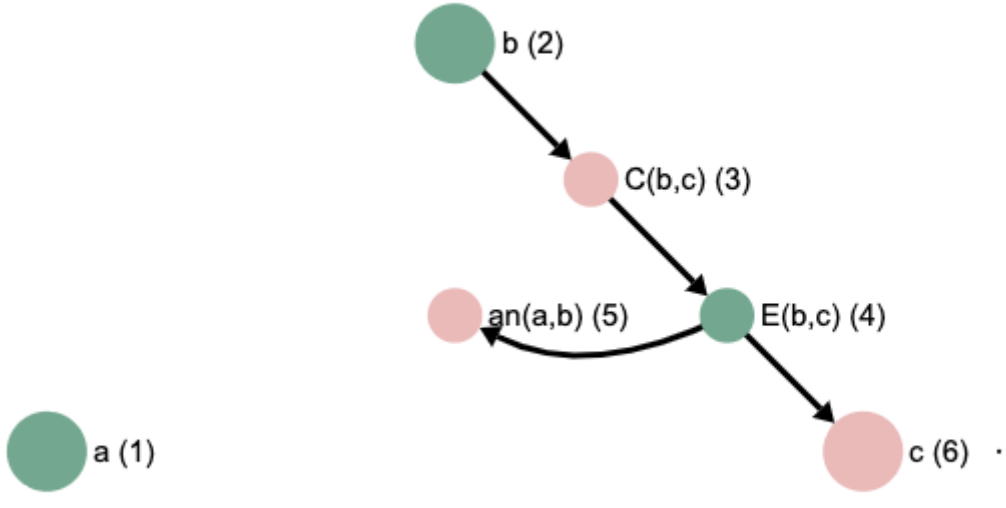
Baroni, Giacomin, Guida. *SCC-recursiveness: a general schema for argumentation semantics.* 2005.

ATTACK-DEFENSE TREES WITH ACTIVATION OF ATTACKS I



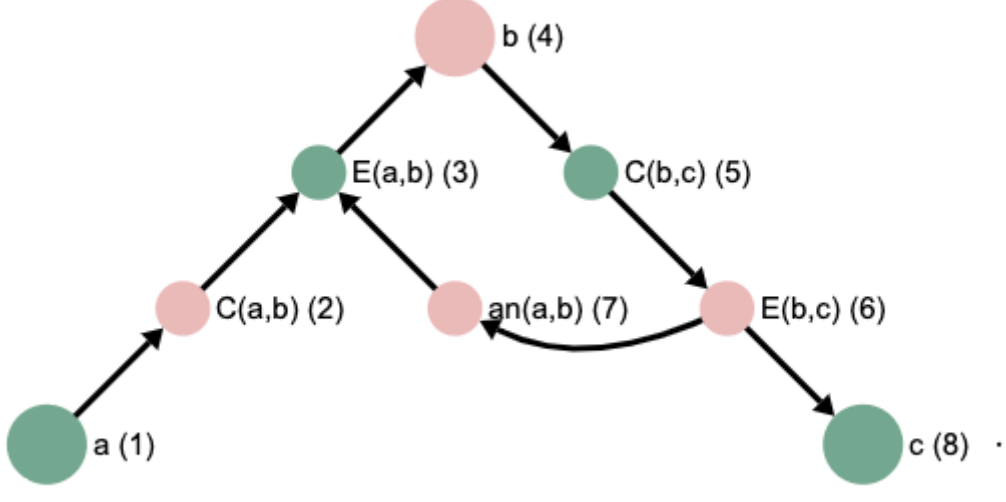
ATTACK-DEFENSE TREES WITH ACTIVATION OF ATTACKS II

Consider attack-defense tree without attacks that need activation:
Annhilator is out



ATTACK-DEFENSE TREES WITH ACTIVATION OF ATTACKS III

Annhilator is out → executor is in: activate attack and expand from therre



DIFFERENCE TO VALUE-BASED ARGUMENTATION

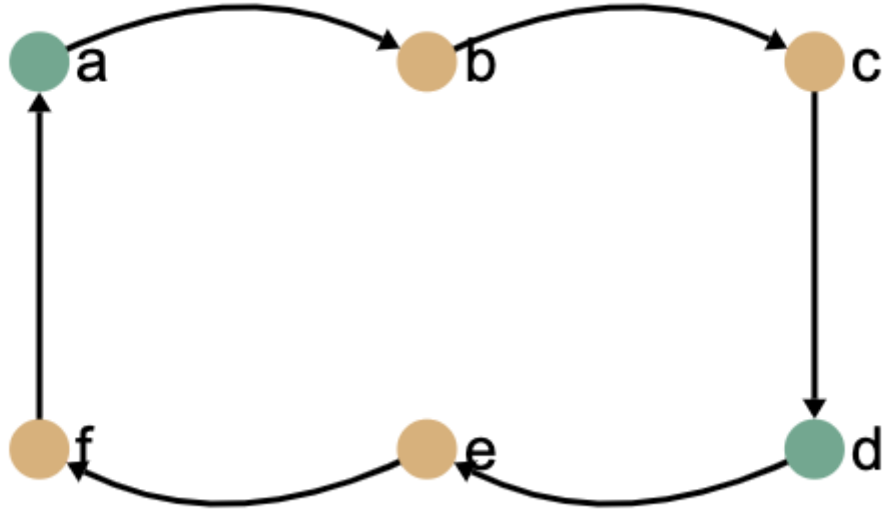
- Value-based: a attacks b, but b is preferred over a: cancel attack
- Shkop: Establish 'intuitive' order on arguments; sequential perspective on managing uncertainty
- Shkop is similar to, but technically different from, 'burdens of persuasions'

Bench-Capon. *Persuasion in Practical Argument Using Value-based Argumentation Frameworks*. 2003.
Calegari, Riveret, Sartor. *The burden of persuasion in structured argumentation*. 2021.

WHAT IS NEW?

- Argumentation with ordered values
- Starting point: total order on the arguments in an argumentation framework
- If there is a loop: delete all attacks emanating from highest value in the loop that "closes" the loop

THE EVEN-LENGTH CYCLE PROBLEM



EVEN-LENGTH CYCLE PROBLEM

Shkop allows for the following total orders (and only these):

- $\langle a, b, c, d, e, f \rangle$
- $\langle b, c, d, e, f, a \rangle$
- $\langle c, d, e, f, a, b \rangle$
- $\langle d, e, f, a, b, c \rangle$
- $\langle e, f, a, b, c, d \rangle$
- $\langle f, a, b, c, d, e \rangle$

EVEN-LENGTH CYCLE PROBLEM

- stage2 semantics fixes the problem by combing SCC-recursion with a much more skeptical semantics on SCC-revel
- SCF2 semantics fixes the problem by defining a principle that 'catches' even length cycle issues and filtering out extensions that would imply a violation of the principle
- Shkop semantics does not need an explicit fix for the even-length cycle problem. It fixes the problem automatically

Dvořák & Gaggl. *Stage semantics and the SCC-recursive schema for argumentation semantics.* 2014.
Cramer & Van der Torre. *SCF2-an argumentation semantics for rational human judgments on argument acceptability.* 2019.

OPEN QUESTIONS

- How does the semantics we get compare to SCF2 semantics?
- Can we show that the approach is useful in traditional application domains of formal argumentation?
  E.g., legal reasoning
- Is this approach relevant for argumentation approaches that
  - Extend abstract argumentation? E.g., value-based argumentation
  - Are fundamentally different? E.g., gradual argumentation

THANK YOU. QUESTIONS?