Admissibility in Probabilistic Argumentation

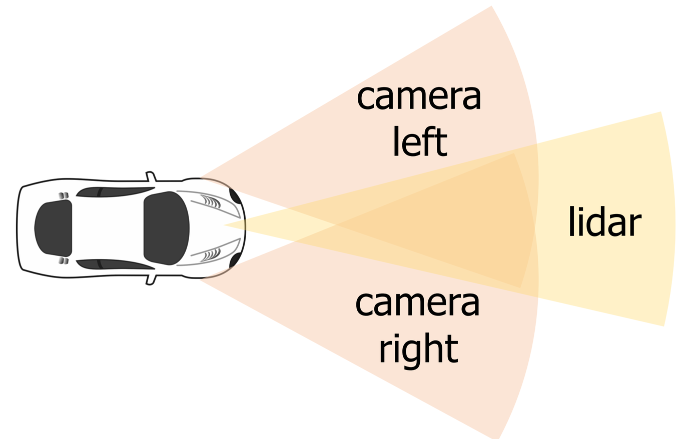
Christel Baier[1], Martin Diller[1], Clemens Dubslaff[1], Sarah Alice Gaggl[1], Holger Hermanns[2], Nikolai Käfer[1]

[1]Technische Universität Dresden, Faculty of Computer Science, Dresden, Germany
[2]Saarland University, Saarland Informatics Campus, Saarbrücken, Germany

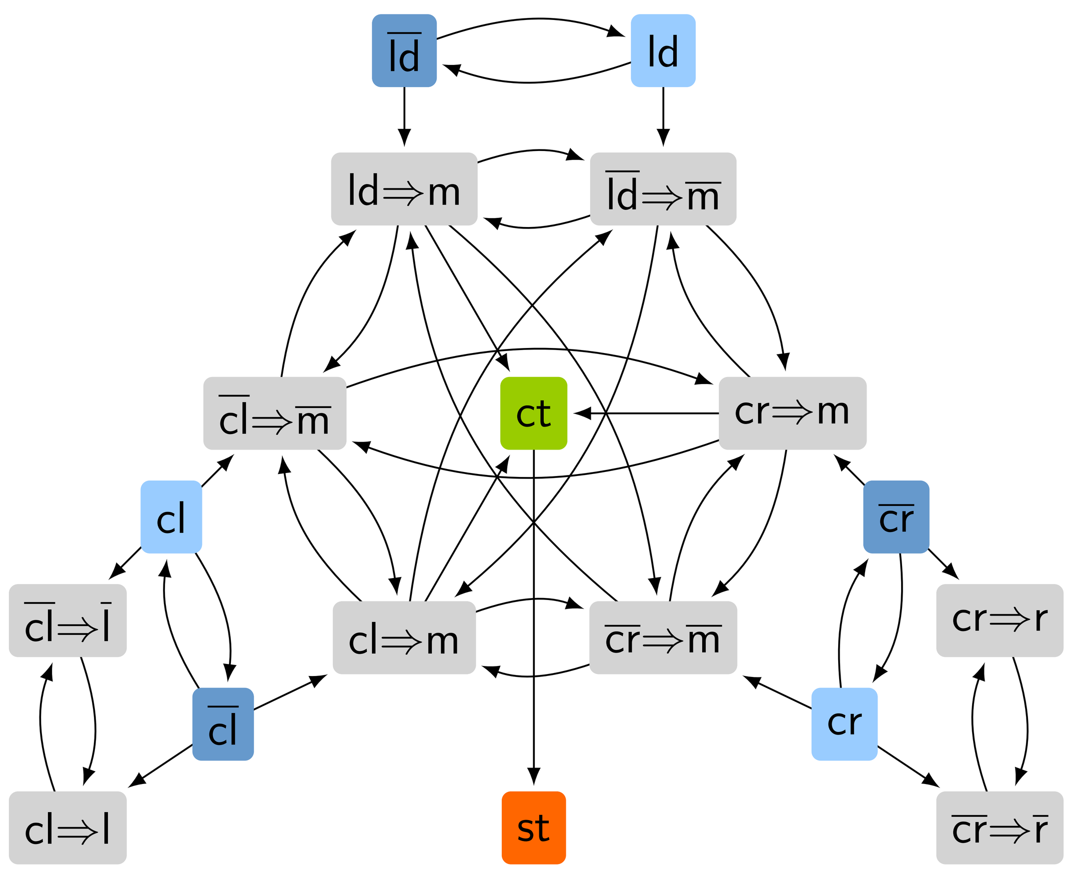
Motivation

- **Abstract argumentation frameworks** (AFs) are popular to describe contentious information
- Various **argumentation semantics** allow to draw inferences
- **Admissibility**: only **defended** arguments may be accepted
- Recently extended to the probabilistic setting, e.g., to handle uncertain information

Example AF

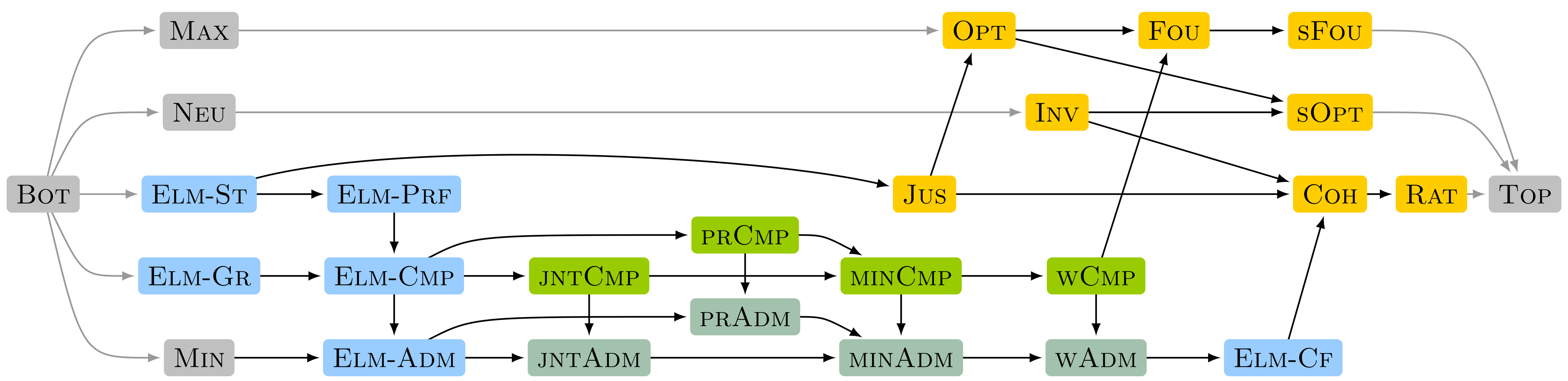


- Semi-autonomous vehicle with partially overlapping sensors: left and right camera (cl, cr) and lidar (ld)
- An obstacle may appear left (l), right (r), or in the middle (m)
- Should the vehicle stop (st) or continue (ct)?
- Induced argumentation framework:



- $\overline{\text{ld}}$ indicates that the lidar does not detect an object
- ld⇒m is the argument that if the lidar detects something, it is in the middle

Taxonomy of probabilistic argumentation semantics



Let μ be a probability distribution over the boolean assignments of an AF's arguments.

PrAdm: μ is **probabilistically admissible** iff for all $B \in Arg$: $\mu(\bigvee_{C \in B^{\rightarrow}} C) \leq \mu(\bigvee_{A \in {}^{\rightarrow}B} A)$

JntAdm: μ is **joint-attack admissible** iff for all $C \in Arg$: $\mu(C) \leq \mu(\Delta(C))$ (denoted by $(\leq_{\mu}\Delta)$)

MinAdm: μ is **min-admissible** iff for all $C \in Arg$: $\mu(C) \leq \min_{B \in {}^{\rightarrow}C} \mu(\bigvee_{A \in {}^{\rightarrow}B} A)$

wAdm: μ is **weakly admissible** iff for all $C \in Arg$: $\mu(C) = 1 \rightarrow \mu(\Delta(C)) = 1$ (or $Arg_{\mu} \subseteq asDefend(\mu)$)

PrCmp: μ is **probabilistically complete** iff it satisfies PrAdm and $(\geq_{\mu}\Delta)$

JntCmp: μ is **joint-attack complete** iff it satisfies $(=_{\mu}\Delta)$

MinCmp: μ is **min-complete** iff it satisfies MinAdm and $(\geq_{\mu}\Delta)$

wCmp: μ is **weakly complete** iff $Arg_{\mu} = asDefend(\mu)$

Elm-σ: element-wise lifting of classical semantics σ

Jus–Rat: probabilistic semantics by Hunter and Thimm

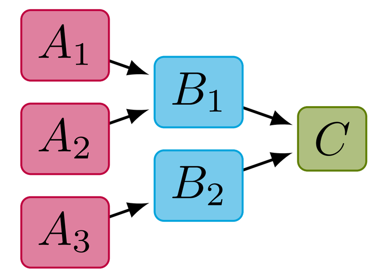
Proof-of-concept implementation

- Python tool utilizing SMT- and convex optimization solvers
- Find distributions satisfying one or multiple semantics
- Maximize or minimize the probability of certain arguments
- For convex solution spaces, export the corner distributions of the solution polytope
- Allows to specify additional context-specific constraints in SMT-LIB format
- Available at perspicuous-computing.science/cpraa

Background

- An AF $\mathcal{F}$ is a pair $\langle Arg, Att \rangle$ with Arg a finite set of arguments and $Att \subseteq Arg \times Arg$ the **attack relation**
- ${}^{\rightarrow}B = \{A : (A, B) \in Att\}$ is the set of **attackers** of B
- $B^{\rightarrow} = \{C : (B, C) \in Att\}$ is the set of B's **attackees**
- An **assignment** is a function $\beta : Arg \rightarrow \{\mathtt{T}, \mathtt{F}\}$
- $\Delta(C)$ is the set of all assignments which **defend** C:

$$\Delta(C) = \bigwedge_{B \in {}^{\rightarrow}C} \bigvee_{A \in {}^{\rightarrow}B} A$$



Further questions?
Contact me!
nikolai.kaefer@tu-dresden.de

TECHNISCHE UNIVERSITÄT DRESDEN
CPEC CENTER FOR PERSPICUOUS COMPUTING
UNIVERSITÄT DES SAARLANDES