Bob would like to share a picture, which was taken on May 1, 2014 with his friends. Charlie is tagged in this picture and he does not want to show any picture that was taken on May 1, 2014.

- Can agents automatically reach an agreement if they have conflicting privacy requirements?
  - Negotiation?
  - Argumentation?
Important Criteria

- Concealment of privacy constraints (not being have to explain everything)
- Protection before exposure (checking privacy constraints prior to posting)
- Automating privacy protection (using software agents)
- Fairness (partial improvements instead of all-or-nothing approach)
Negotiation is mostly used in e-commerce.

Agents try to reach a mutually acceptable agreement.

Negotiation technique consists of various components:

- A *protocol* is a set of rules allowing agents to interact.
- A *strategy* (mostly private) is used by agents to make *offers* and *counter-offers*.
- An *agreement rule* determines when an agreement has been reached.
How to use negotiation technique in privacy context?

- Given a protocol, an agent starts a negotiation with other agents to publish a post.
- Each agent evaluates this post according to its own strategy.
  - It gives a response (accept or deny). The negotiator agent analyzes responses and takes an action.
  - It proposes a counter-offer (e.g., a new post), which should be agreed on by agents involved in the counter-offer.

In privacy context, what is ... An agreement? A protocol? A strategy? An offer? A counter-offer? An agreement rule?
Argumentation

- Argumentation is mostly used to settle disputes.
- Agents make *arguments* with *justifications* and aim to *convince* other agents to reach an agreement.
- Agents make arguments for propositions (*arguments*) and against propositions (*attacks*).
- Abstract argumentation, Structured argumentation

In privacy context, what is ...

An argument? An attack? A winning argument?
Negotiation

B: Can I share this picture taken on May 1, 2014? I also tagged you in this picture.
C: No. (Because the picture is taken on May 1, 2014.)

Argumentation

B: Can I share this picture taken on May 1, 2014? I also tagged you in this picture.
C: No, because the picture is taken on May 1, 2014; thus the picture is in Protest context. Pictures that are in Protest context should not be shared with others.
B: Right, the picture is taken on May 1, 2014 at 06:00. Protests start at 09:00. Hence, this picture is not in Protest context.
C: OK, right. You can share it.
Negotiation

B: Can I share this picture taken on May 1, 2014? I also tagged you in this picture.
C: No. (Because the picture is taken on May 1, 2014.)

Argumentation

B: Can I share this picture taken on May 1, 2014? I also tagged you in this picture.
C: No, because the picture is taken on May 1, 2014; thus the picture is in Protest context. Pictures that are in Protest context should not be shared with others.
B: Right, the picture is taken on May 1, 2014 at 06:00. Protests start at 09:00. Hence, this picture is not in Protest context.
C: OK, right. You can share it.
What is an Ontology?

- Conceptualizes of a domain
- Consists of:
  - concepts (classes): are group of instances
  - data properties: describe attributes of a concept
  - object properties: relate one instance to another
OSN Ontology

- OSN domain concepts; e.g., Agent, Post
- Relation properties: isFriendOf, isColleagueOf
- Privacy properties; e.g., canSeePost, canSeeLocationPost
- Other properties; e.g., hasMedia, isA
Privacy Rules

- Decide if a post request is acceptable
- Propose alternatives
- $P_{C_1}$: Carol does not want to show her work pictures to Filipo.
- $P_{C_2}$: Carol does not want her pictures taken on May 1st to be shown.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
</table>
| $P_{A_1}$ | $\text{hasAudience}(?\text{postRequest, ?audience}), \text{hasAudienceMember}(?\text{audience, ?audienceMember}), \text{Leisure}(?\text{context}),$  
  $\text{hasMedium}(?\text{postRequest, ?medium}), \text{isInContext}(?\text{medium, ?context}), \text{isColleagueOf}(?\text{audienceMember, :alice})$  
  $\implies \text{rejects}(:\text{alice, ?postRequest}, \text{rejectedIn}(?\text{audience, ?postRequest}), \text{rejectedBecauseOf}(?\text{audience, ?audienceMember})$ |
| $P_{B_1}$ | $\text{hasAudience}(?\text{postRequest, ?audience}), \text{hasAudienceMember}(?\text{audience, ?audienceMember}), \text{Party}(?\text{context}),$  
  $\text{hasMedium}(?\text{postRequest, ?medium}), \text{isInContext}(?\text{medium, ?context}), \text{isPartOfFamilyOf}(:\text{bob, ?audienceMember})$  
  $\implies \text{rejects}(:\text{bob, ?postRequest}, \text{rejectedIn}(?\text{audience, ?postRequest}), \text{rejectedBecauseOf}(?\text{audience, ?audienceMember})$ |
| $P_{B_2}$ | $\text{hasMedium}(?\text{postRequest, ?medium}), \text{isDisliked}(?\text{medium, true})$  
  $\implies \text{rejects}(:\text{bob, ?postRequest}, \text{rejectedIn}(?\text{medium, ?postRequest}), \text{rejectedBecauseOf}(?\text{medium, :bob})$ |
| $P_{C_1}$ | $\text{hasAudience}(?\text{postRequest, ?audience}), \text{hasAudienceMember}(?\text{audience, :filipo}), \text{hasMedium}(?\text{postRequest, ?medium}),$  
  $\text{Work}(?\text{context}), \text{isInContext}(?\text{medium, ?context})$  
  $\implies \text{rejects}(:\text{carol, ?postRequest}, \text{rejectedIn}(?\text{medium, ?postRequest}), \text{rejectedBecauseOf}(?\text{medium, ?postRequest}), \text{rejectedBecauseOf}(?\text{audience, :filipo})$ |
| $P_{C_2}$ | $\text{hasMedium}(?\text{postRequest, ?medium}), \text{dateTime}(?t), \text{equal}(?t, "2014-05-01T00:00:00Z"), \text{hasDateTaken}(?\text{medium, ?t})$  
  $\implies \text{rejects}(:\text{carol, ?postRequest}, \text{rejectedIn}(?\text{medium, ?postRequest}), \text{rejectedBecauseOfDate}(?\text{medium, ?t})$ |
Creating a Post Request

- The content owner puts together the content she wants to publish with the potential audience
- Her agent decides with whom the post is related
  - Sends the post request to those agents
  - Asks for feedback
  - Feedback: I don’t want to see Bob in the audience; I don’t want a picture on this date to be shown, etc.
  - Feedback calculated based on the Privacy Rules
  - Collects the reasons and revises the post request
Revising a Post Request

- Rejection reasons cannot conflict with each other.
- When a post request is rejected by at least one agent, the negotiator agent:
  - honors every rejection reason,
  - checks whether the resulting post request is reasonable.
- Alternatives: lots of possibilities (using priorities, past experience)
## An Example Execution

<table>
<thead>
<tr>
<th>Iter.</th>
<th>Content</th>
<th>Audience</th>
<th>Asked Agents</th>
<th>Evaluate</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>May 1 picture</td>
<td>Bob, Carol, Errol, Filipo</td>
<td>:carol</td>
<td>:carol $\rightarrow P_C$</td>
<td>:carol $\rightarrow$ -date</td>
</tr>
<tr>
<td>2</td>
<td>May 28 picture$_1$</td>
<td>Bob, Carol, Errol, Filipo</td>
<td>:carol, :bob</td>
<td>:carol $\rightarrow$ N/A, :bob $\rightarrow P_B$</td>
<td>:carol $\rightarrow$ 3, :bob $\rightarrow$ -self</td>
</tr>
<tr>
<td>3</td>
<td>May 28 picture$_2$</td>
<td>Bob, Carol, Errol, Filipo</td>
<td>:carol, :bob</td>
<td>:carol $\rightarrow$ N/A, :bob $\rightarrow$ N/A</td>
<td>:carol $\rightarrow$ 4, :bob $\rightarrow$ 4</td>
</tr>
</tbody>
</table>
Argumentation for Privacy: Scenario

Alice would like to share a picture where Bob is tagged. The picture shows a wristband that was given at Oktoberfest.
Alice would like to share a picture where Bob is tagged. The picture shows a wristband that was given at Oktoberfest.
Argumentation for Privacy: Scenario

Alice would like to share a picture where Bob is tagged. The picture shows a wristband that was given at Oktoberfest.

Alice wants to share the post and consults Bob.

Alice says that the wristband can be found in Kostebek.

Bob refuses because the wristband signals his attendance to a festival.

Bob consults a friend, who suggests that Bob should check if Kostebek is open. Bob finds out that Kostebek is closed.
Argumentation for Privacy: Scenario

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Alice wants to share the post and consults Bob.

Alice says that the wristband can be found in Kostebek.

Bob refuses because the wristband signals his attendance to a festival.

Bob consults a friend, who suggests that Bob should check if Kostebek is open. Bob finds out that Kostebek is closed.
The Social Network Domain Ontology

- Concepts denote groups of instances (e.g., Medium).
- Object properties relate instances (e.g., includesObject).
- Data properties describe instance attributes (e.g., isOrdinary).
- Every user is an Agent instance that is related to other Agent instances via relationship properties (e.g., isFriendOf).
The Social Network Domain Ontology

- Concepts denote groups of instances (e.g., Medium).
- Object properties relate instances (e.g., includesObject).
- Data properties describe instance attributes (e.g., isOrdinary).
- Every user is an Agent instance that is related to other Agent instances via relationship properties (e.g., isFriendOf).

How do we represent privacy constraints of the users?
An agent is aware of the Inference Rules (I) and Privacy Rules (P).

**Table : Semantic Rules of Alice and Bob as SWRL Rules**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_A_1$:</td>
<td>$\text{foundAt}(\text{?object, ?shop}) \rightarrow \text{isOrdinary}(\text{?object, true})$</td>
</tr>
<tr>
<td>$I_B_1$:</td>
<td>$\text{isInContext}(\text{?postRequest, ?context}), \text{hasMedium}(\text{?postRequest, ?medium}), \text{includesObject}(\text{?medium, ?object}), \text{Oktoberfest}(\text{?location}), \text{obtainedFrom}(\text{?object, ?location}), \text{isOrdinary}(\text{?object, false}) \rightarrow \text{Festival}(\text{?context})$</td>
</tr>
<tr>
<td>$I_B_2$:</td>
<td>$\text{hasUrl}(\text{?shop, ?url}), \text{isAccessible}(\text{?url, false}) \rightarrow \text{isClosed}(\text{?shop, true})$</td>
</tr>
<tr>
<td>$P_B_1$:</td>
<td>$\text{Festival}(\text{?context}), \text{isInContext}(\text{?postRequest, ?context}) \rightarrow \text{rejects(\text{bob, ?postRequest})}$</td>
</tr>
</tbody>
</table>
An argumentation framework (AF) is a directed graph that consists of arguments and attacks, $\mathcal{AF} = \langle X, \rightarrow \rangle$.

The sets of acceptable arguments are determined according to extensions.

The internal structure of arguments and attacks cannot be specified.
An argumentation framework (AF) is a directed graph that consists of arguments and attacks, $\mathcal{AF} = \langle X, \rightarrow \rangle$.

The sets of acceptable arguments are determined according to extensions.

The internal structure of arguments and attacks cannot be specified.

No guidance for the modelling of actual argumentation problems.
An ABA framework is a four-tuple $\langle \mathcal{L}, \mathcal{R}, \mathcal{A}, \mathcal{C} \rangle$.

Each rule is of the form $\sigma_1, \ldots, \sigma_m \rightarrow \sigma_0$ ($m \geq 0$, $\sigma_i \in \mathcal{L}$).

An assumption is a weak point of an argument that can be attacked by an argument. Each assumption has a contrary.

An argument is of the form $S \vdash^R \sigma$. 

Pınar Yolum

CmpE 59B: Privacy in Online Social Networks

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Derivation of Arguments

\( I_{B_1} : \) \( \text{isInContext}(\text{pr}, \text{context}), \text{hasMedium}(\text{pr}, \text{medium}), \text{includesObject}(\text{medium}, \text{wband}), \text{Oktoberfest}(?\text{location}), \text{obtainedFrom}(\text{wband}, ?\text{location}), \text{isOrdinary}(\text{wband}, \text{false}) \rightarrow \text{Festival}(\text{context}) \)

\( P_{B_1} : \) Festival(\text{context}), isInContext(\text{pr}, \text{context}) \rightarrow \text{rejects}(\text{bob}, \text{pr})

\(r_1 = \{ \rightarrow \text{isInContext}(\text{pr}, \text{context}) \} \)

\(r_2 = \{ \rightarrow \text{hasMedium}(\text{pr}, \text{medium}) \} \)

\(r_3 = \{ \rightarrow \text{includesObject}(\text{medium}, \text{wband}) \} \)

\(r_4 = \{ \rightarrow \text{Oktoberfest}(\text{location}) \} \)

\(r_5 = \{ \rightarrow \text{obtainedFrom}(\text{wband}, \text{location}) \} \)

\(\text{as}_3 = \text{isOrdinary}(\text{wband}, \text{false})\)

\[
\frac{\text{rejects}(\text{bob}, \text{pr})}{\text{Festival}(\text{context}) \quad \text{isOrdinary}(\text{wband}, \text{false})} \quad \tau
\]

An argument is of the form \( S \vdash^R \sigma \)

\( b_3 : \quad \vdash \)
Derivation of Arguments

$I_{B_1}$: \( \text{isInContext}(\text{pr}, \text{context}) \land \text{hasMedium}(\text{pr}, \text{medium}) \land \text{includesObject}(\text{medium}, \text{wband}) \land \text{Oktoberfest}(\text{location}) \land \text{obtainedFrom}(\text{wband}, \text{location}) \land \text{isOrdinary}(\text{wband}, \text{false}) \rightarrow \text{Festival}(\text{context}) \)

$P_{B_1}$: Festival(\text{context}), \text{isInContext}(\text{pr}, \text{context}) \rightarrow \text{rejects}(\text{bob}, \text{pr})

\[
\begin{align*}
\tau & = \{ \rightarrow \text{isOrdinary}(\text{wband}, \text{false}) \} \\
\end{align*}
\]

\[
\begin{align*}
r_1 & = \{ \rightarrow \text{isInContext}(\text{pr}, \text{context}) \} \\
r_2 & = \{ \rightarrow \text{hasMedium}(\text{pr}, \text{medium}) \} \\
r_3 & = \{ \rightarrow \text{includesObject}(\text{medium}, \text{wband}) \} \\
r_4 & = \{ \rightarrow \text{Oktoberfest}(\text{location}) \} \\
r_5 & = \{ \rightarrow \text{obtainedFrom}(\text{wband}, \text{location}) \} \\
\end{align*}
\]

\[
\begin{align*}
as_3 & = \text{isOrdinary}(\text{wband}, \text{false}) \\
\end{align*}
\]

An argument is of the form \( S \vdash^R \sigma \)

\[
\begin{align*}
b_3 & : \{ \text{isOrdinary}(\text{wband}, \text{false}) \} \vdash \\
\end{align*}
\]

\[
\begin{align*}
\text{rejects}(\text{bob}, \text{pr}) & \quad \text{Festival}(\text{context}) \quad \text{isOrdinary}(\text{wband}, \text{false}) \\
\end{align*}
\]
Derivation of Arguments

$I_{B_1}: \quad isInContext(:pr,:context), \ hasMedium(:pr,:medium), \ includesObject(:medium,:wband), \ Oktoberfest(?location), \ obtainedFrom(:wband,?location), \ isOrdinary(:wband,false) \rightarrow Festival(:context)$

$P_{B_1}: \ \text{Festival(:context), isLoggedIn(:pr,:context) \rightarrow rejects(:bob,:pr)}$

\begin{align*}
    r_1 &= \{ \rightarrow isLoggedIn(:pr,:context) \} \\
    r_2 &= \{ \rightarrow hasMedium(:pr,:medium) \} \\
    r_3 &= \{ \rightarrow includesObject(:medium,:wband) \} \\
    r_4 &= \{ \rightarrow Oktoberfest(:location) \} \\
    r_5 &= \{ \rightarrow obtainedFrom(:wband,:location) \}
\end{align*}

as$_3$ = isOrdinary(:wband,false)

An argument is of the form $S \vdash^R_\sigma R \sigma \vdash rejects(:bob,:pr)$
Derivation of Arguments

\[ I_{B_1}: \text{isInContext}(\text{pr}, \text{context}), \text{hasMedium}(\text{pr}, \text{medium}), \text{includesObject}(\text{medium}, \text{wband}), \]
\[ \text{Oktoberfest}(\text{location}), \text{obtainedFrom}(\text{wband}, \text{location}), \text{isOrdinary}(\text{wband}, \text{false}) \rightarrow \text{Festival}(\text{context}) \]

\[ P_{B_1}: \text{Festival}(\text{context}), \text{isInContext}(\text{pr}, \text{context}) \rightarrow \text{rejects}(\text{bob}, \text{pr}) \]

\[ r_1 = \{ \rightarrow \text{isInContext}(\text{pr}, \text{context}) \} \]
\[ r_2 = \{ \rightarrow \text{hasMedium}(\text{pr}, \text{medium}) \} \]
\[ r_3 = \{ \rightarrow \text{includesObject}(\text{medium}, \text{wband}) \} \]
\[ r_4 = \{ \rightarrow \text{Oktoberfest}(\text{location}) \} \]
\[ r_5 = \{ \rightarrow \text{obtainedFrom}(\text{wband}, \text{location}) \} \]

\[ as_3 = \text{isOrdinary}(\text{wband}, \text{false}) \]

\[ \text{rejects}(\text{bob}, \text{pr}) \]

\[ \text{Festival}(\text{context}) \quad \text{isInContext}(\text{pr}, \text{context}) \]
\[ \text{isOrdinary}(\text{wband}, \text{false}) \]
\[ \tau \]

An argument is of the form \( S \vdash^R \sigma \)

\[ b_3 : \{ \text{isOrdinary}(\text{wband}, \text{false}) \} \vdash I_{B_1} \cup P_{B_1} \cup_{i=1}^{5} r_i \text{ rejects}(\text{bob}, \text{pr}) \]
Attacks between Arguments

An argument $S_2 \vdash \sigma_2$ is attacked by an argument $S_1 \vdash \sigma_1$ if and only if $\sigma_1$ is the contrary of one of the assumptions in $S_2$.

<table>
<thead>
<tr>
<th>Index</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_2$</td>
<td>${\text{not}(\text{rejects}(\text{:alice, :pr}))} \vdash \text{not}(\text{rejects}(\text{:alice, :pr}))$</td>
</tr>
<tr>
<td>$a_3$</td>
<td>${\text{foundAt}(\text{:wband, :Kostebek})} \vdash^{I_{A_1}} \text{isOrdinary}(\text{:wband, true})$</td>
</tr>
<tr>
<td>$b_3$</td>
<td>${\text{isOrdinary}(\text{:wband, false})} \vdash^{I_{B_1} \cup P_{B_1} \cup \sum_{i=1}^{5} r_i} \text{rejects}(\text{:bob, :pr})$</td>
</tr>
<tr>
<td>$c_2$</td>
<td>$(\text{not}(\text{rejects}(\text{:alice, :pr})) = \text{rejects}(\text{:bob, :pr}))$</td>
</tr>
<tr>
<td>$c_3$</td>
<td>$(\text{isOrdinary}(\text{:wband, false}) = \text{isOrdinary}(\text{:wband, true}))$</td>
</tr>
</tbody>
</table>
Attacks between Arguments

An argument $S_2 \vdash \sigma_2$ is attacked by an argument $S_1 \vdash \sigma_1$ if and only if $\sigma_1$ is the contrary of one of the assumptions in $S_2$.

\[
\begin{align*}
a_2 &: \{ \text{not}(\text{rejekts}(\text{:alice, :pr})) \} \vdash \text{not}(\text{rejekts}(\text{:alice, :pr})) \\
a_3 &: \{ \text{foundAt}(\text{:wband, :Kostebek}) \} \vdash I_{A_1} \text{isOrdinary}(\text{:wband, true}) \\
b_3 &: \{ \text{isOrdinary}(\text{:wband, false}) \} \vdash I_{B_1 \cup P_{B_1} \cup \{ r_i \}_{i=1}^5} \text{rejekts}(\text{:bob, :pr}) \\
c_2 &= (\text{not}(\text{rejekts}(\text{:alice, :pr})) = \text{rejekts}(\text{:bob, :pr})) \\
c_3 &= (\text{isOrdinary}(\text{:wband, false}) = \text{isOrdinary}(\text{:wband, true}))
\end{align*}
\]

\[\begin{align*}
a_2 &\rightarrow b_3 \\
a_3 &\rightarrow b_3
\end{align*}\]
Attacks between Arguments

An argument $S_2 \vdash \sigma_2$ is attacked by an argument $S_1 \vdash \sigma_1$ if and only if $\sigma_1$ is the contrary of one of the assumptions in $S_2$.

\[
a_2: \{\neg(\text{rejects}(\text{:alice,:pr}))\} \vdash \neg(\text{rejects}(\text{:alice,:pr}))
\]
\[
a_3: \{\text{foundAt}(\text{:wband,:Kostebek})\} \vdash I_{A_1} \ isOrdinary(\text{:wband,true})
\]
\[
b_3: \{\text{isOrdinary}(\text{:wband,false})\} \vdash I_{B_1 \cup P_{B_1 \cup i=1}^5 r_i} \text{rejects}(\text{:bob,:pr})
\]
\[
c_2 = (\neg(\text{rejects}(\text{:alice,:pr})) = \text{rejects}(\text{:bob,:pr}))
\]
\[
c_3 = (\text{isOrdinary}(\text{:wband,false}) = \text{isOrdinary}(\text{:wband,true}))
\]

Winner!
Argumentation in Action

Table: ABA Specification

\[ \mathcal{R} = I_{A_1} \cup I_{B_1} \cup I_{B_2} \cup P_{B_1} \cup \bigcup_{i=1}^{\gamma} r_i \]
\[ r_1 = \{ \rightarrow isInRange(:pr,:context) \} \]
\[ r_2 = \{ \rightarrow hasMedium(:pr,:medium) \} \]
\[ r_3 = \{ \rightarrow includesObject(:medium,:wband) \} \]
\[ r_4 = \{ \rightarrow Oktoberfest(:location) \} \]
\[ r_5 = \{ \rightarrow obtainedFrom(:wband,:location) \} \]
\[ r_6 = \{ \rightarrow taggedPerson(:medium,:bob) \} \]
\[ r_7 = \{ \rightarrow hasUrl(:Kostebek,:url) \} \]
\[ \mathcal{A} = \{ a_{s_1}, a_{s_2}, a_{s_3}, a_{s_4} \} \]
\[ a_{s_1} = foundAt(:wband,:Kostebek) \]
\[ a_{s_2} = not(rejects(:alice,:pr)) \]
\[ a_{s_3} = isOrdinary(:wband,false) \]
\[ a_{s_4} = isAccessible(:url,false) \]
\[ \mathcal{C} = \{ c_1, c_2, c_3, c_4 \} \]
\[ c_1 = (foundAt(:wband,:Kostebek)=isClosed(:Kostebek,true)) \]
\[ c_2 = (not(rejects(:alice,:pr))=*rejects(:bob,:pr)) \]
\[ c_3 = (isOrdinary(:wband,false)=isOrdinary(:wband,true)) \]
\[ c_4 = (isAccessible(:url,false)=isAccessible(:url,true)) \]
Argumentation in Action

Table: ABA Specification

\[ R = I_A \cup I_B \cup P \cup \bigcup_{i=1}^{r} r_i \]
\[ r_1 = \{ \rightarrow isInContext(:pr,:context) \} \]
\[ r_2 = \{ \rightarrow hasMedium(:pr,:medium) \} \]
\[ r_3 = \{ \rightarrow includesObject(:medium,:wband) \} \]
\[ r_4 = \{ \rightarrow Oktoberfest(:location) \} \]
\[ r_5 = \{ \rightarrow obtainedFrom(:wband,:location) \} \]
\[ r_6 = \{ \rightarrow taggedPerson(:medium,:bob) \} \]
\[ r_7 = \{ \rightarrow hasUrl(:Kostebek,:url) \} \]

\[ A = \{ as_1, as_2, as_3, as_4 \} \]
\[ as_1 = foundAt(:wband,:Kostebek) \]
\[ as_2 = not(rejects(:alice,:pr)) \]
\[ as_3 = isOrdinary(:wband,false) \]
\[ as_4 = isAccessible(:url,false) \]

\[ C = \{ c_1, c_2, c_3, c_4 \} \]
\[ c_1 = (foundAt(:wband,:Kostebek)=isClosed(:Kostebek,true)) \]
\[ c_2 = (not(rejects(:alice,:pr))=rejects(:bob,:pr)) \]
\[ c_3 = (isOrdinary(:wband,false)=isOrdinary(:wband,true)) \]
\[ c_4 = (isAccessible(:url,false)=isAccessible(:url,true)) \]

Table: Arguments

\[ f_1 : \{ \} \vdash isInContext(:pr,:context) \]
\[ f_2 : \{ \} \vdash hasMedium(:pr,:medium) \]
\[ f_3 : \{ \} \vdash includesObject(:medium,:wband) \]
\[ f_4 : \{ \} \vdash Oktoberfest(:location) \]
\[ f_5 : \{ \} \vdash obtainedFrom(:wband,:location) \]
\[ f_6 : \{ \} \vdash taggedPerson(:medium,:bob) \]
\[ f_7 : \{ \} \vdash hasUrl(:Kostebek,:url) \]

\[ a_1 : \{ foundAt(:wband,:Kostebek) \} \vdash foundAt(:wband,:Kostebek) \]
\[ a_2 : \{ not(rejects(:alice,:pr)) \} \vdash not(rejects(:alice,:pr)) \]
\[ a_3 : \{ foundAt(:wband,:Kostebek) \} \vdash isOrdinary(:wband,true) \]
\[ b_1 : \{ isOrdinary(:wband,false) \} \vdash isOrdinary(:wband,false) \]
\[ b_2 : \{ isOrdinary(:wband,false) \} \vdash isOrdinary(:wband,false) \]
\[ b_3 : \{ isOrdinary(:wband,false) \} \vdash isOrdinary(:wband,false) \]
\[ b_4 : \{ isAccessible(:url,false) \} \vdash isAccessible(:url,false) \]
\[ b_5 : \{ isAccessible(:url,false) \} \vdash isClosed(:Kostebek,true) \]
Table: ABA Specification

\[ R = I_{A_1} \cup I_{B_1} \cup I_{B_2} \cup P_{B_1} \cup \bigcup_{r_i} r_i \]

\[ r_1 = \{ \rightarrow isInContext(:pr,:context) \} \]

\[ r_2 = \{ \rightarrow hasMedium(:pr,:medium) \} \]

\[ r_3 = \{ \rightarrow includesObject(:medium,:wband) \} \]

\[ r_4 = \{ \rightarrow Oktoberfest(:location) \} \]

\[ r_5 = \{ \rightarrow obtainedFrom(:wband,:location) \} \]

\[ r_6 = \{ \rightarrow taggedPerson(:medium,:bob) \} \]

\[ r_7 = \{ \rightarrow hasUrl(:Kostebek,:url) \} \]

\[ A = \{ as_1, as_2, as_3, as_4 \} \]

\[ as_1 = foundAt(:wband,:Kostebek) \]

\[ as_2 = not(rejects(:alice,:pr)) \]

\[ as_3 = isOrdinary(:wband,false) \]

\[ as_4 = isAccessible(:url,false) \]

\[ C = \{ c_1, c_2, c_3, c_4 \} \]

\[ c_1 = (foundAt(:wband,:Kostebek)=isClosed(:Kostebek,true)) \]

\[ c_2 = (not(rejects(:alice,:pr))=rejects(:bob,:pr)) \]

\[ c_3 = (isOrdinary(:wband,false)=isOrdinary(:wband,true)) \]

\[ c_4 = (isAccessible(:url,false)=isAccessible(:url,true)) \]

Table: Arguments

\[ f_1 : \{ \} \vdash_r isInContext(:pr,:context) \]

\[ f_2 : \{ \} \vdash_r hasMedium(:pr,:medium) \]

\[ f_3 : \{ \} \vdash_r includesObject(:medium,:wband) \]

\[ f_4 : \{ \} \vdash_r Oktoberfest(:location) \]

\[ f_5 : \{ \} \vdash_r obtainedFrom(:wband,:location) \]

\[ f_6 : \{ \} \vdash_r taggedPerson(:medium,:bob) \]

\[ f_7 : \{ \} \vdash_r hasUrl(:Kostebek,:url) \]

\[ a_1 : \{ foundAt(:wband,:Kostebek) \} \vdash foundAt(:wband,:Kostebek) \]

\[ a_2 : \{ not(rejects(:alice,:pr)) \} \vdash not(rejects(:alice,:pr)) \]

\[ a_3 : \{ foundAt(:wband,:Kostebek) \} \vdash \text{isOrdinary}(:wband,true) \]

\[ b_1 : \{ \text{isOrdinary}(:wband,false) \} \vdash \text{isOrdinary}(:wband,false) \]

\[ b_2 : \{ \text{isOrdinary}(:wband,false) \} \vdash \text{isOrdinary}(:wband,false) \]

\[ b_3 : \{ \text{isOrdinary}(:wband,false) \} \vdash \text{isOrdinary}(:wband,false) \]

\[ b_4 : \{ \text{isAccessible}(:url,false) \} \vdash \text{isAccessible}(:url,false) \]

\[ b_5 : \{ \text{isAccessible}(:url,false) \} \vdash \text{isAccessible}(:url,false) \]

\[ b_6 : \{ \text{isAccessible}(:url,false) \} \vdash \text{isAccessible}(:url,false) \]
Argumentation in Action

Table : ABA Specification

| \( R = I_{A_1} \cup I_{B_1} \cup I_{B_2} \cup P_{B_1} \cup \bigcup_{i=1}^{7} r_i \) |
| \( r_1 = \{ \rightarrow isInContext(:pr,:context) \} \) |
| \( r_2 = \{ \rightarrow hasMedium(:pr,:medium) \} \) |
| \( r_3 = \{ \rightarrow includesObject(:medium,:wband) \} \) |
| \( r_4 = \{ \rightarrow Oktoberfest(:location) \} \) |
| \( r_5 = \{ \rightarrow obtainedFrom(:wband,:location) \} \) |
| \( r_6 = \{ \rightarrow taggedPerson(:medium,:bob) \} \) |
| \( r_7 = \{ \rightarrow hasUrl(:Kostebek,:url) \} \) |
| \( A = \{ as_{1,2,3,4} \} \) |
| \( as_1 = foundAt(:wband,:Kostebek) \) |
| \( as_2 = \lnot(rejects(:alice,:pr)) \) |
| \( as_3 = isOrdinary(:wband,false) \) |
| \( as_4 = isAccessible(:url,false) \) |

\( \mathcal{A} = \{ c_{1,2,3,4} \} \)

| \( c_1 = (foundAt(:wband,:Kostebek)=isClosed(:Kostebek,\text{true})) \) |
| \( c_2 = (\lnot(rejects(:alice,:pr))=\lnot(rejects(:bob,:pr))) \) |
| \( c_3 = (isOrdinary(:wband,\text{false})=isOrdinary(:wband,\text{true})) \) |
| \( c_4 = (isAccessible(:url,\text{false})=isAccessible(:url,\text{true})) \) |

Table : Arguments

| \( f_1 : \{ \} \vdash_\mathcal{R} isInContext(:pr,:context) \) |
| \( f_2 : \{ \} \vdash_\mathcal{R} hasMedium(:pr,:medium) \) |
| \( f_3 : \{ \} \vdash_\mathcal{R} includesObject(:medium,:wband) \) |
| \( f_4 : \{ \} \vdash_\mathcal{R} Oktoberfest(:location) \) |
| \( f_5 : \{ \} \vdash_\mathcal{R} obtainedFrom(:wband,:location) \) |
| \( f_6 : \{ \} \vdash_\mathcal{R} taggedPerson(:medium,:bob) \) |
| \( f_7 : \{ \} \vdash_\mathcal{R} hasUrl(:Kostebek,:url) \) |

| \( a_1 : \{ \text{foundAt}(:wband,:Kostebek) \} \vdash \text{foundAt}(:wband,:Kostebek) \) |
| \( a_2 : \{ \lnot(rejects(:alice,:pr)) \} \vdash \lnot(rejects(:alice,:pr)) \) |
| \( a_3 : \{ \text{foundAt}(:wband,:Kostebek) \} \vdash_{l_{A_1}} isOrdinary(:wband,\text{true}) \) |
| \( b_1 : \{ isOrdinary(:wband,\text{false}) \} \vdash isOrdinary(:wband,\text{false}) \) |
| \( b_2 : \{ isOrdinary(:wband,\text{false}) \} \vdash_{l_{B_1}} \bigcup_{i=1}^{5} r_i \text{Festival}(:context) \) |
| \( b_3 : \{ isOrdinary(:wband,\text{false}) \} \vdash_{l_{B_1} \cup P_{B_1}} \bigcup_{i=1}^{5} r_i \text{rejacts}(:bob,:pr) \) |
| \( b_4 : \{ isAccessible(:url,\text{false}) \} \vdash isAccessible(:url,\text{false}) \) |
| \( b_5 : \{ isAccessible(:url,\text{false}) \} \vdash_{l_{B_2} \cup r_7} isClosed(:Kostebek,\text{true}) \) |
Argumentation in Action

How to create an ABA specification automatically?

Table: ABA Specification

\[ R = I_A \cup I_B \cup P_B \cup \bigcup_{i=1}^{r} r_i \]
\[ r_1 = \{ \rightarrow isInContext(:pr,:context) \} \]
\[ r_2 = \{ \rightarrow hasMedium(:pr,:medium) \} \]
\[ r_3 = \{ \rightarrow includesObject() \} \]
\[ r_4 = \{ \rightarrow Oktoberfest(:location) \} \]
\[ r_5 = \{ \rightarrow obtained() \} \]
\[ r_6 = \{ \rightarrow taggedPerson(:medium,:bob) \} \]
\[ r_7 = \{ \rightarrow hasUrl(:Kostebek) \} \]
\[ A = \{ a_1, a_2, a_3, a_4 \} \]
\[ a_1 = \text{foundAt}(:wband,:Kostebek) \]
\[ a_2 = \text{not}(\text{rejects}(:alice,:pr)) \]
\[ a_3 = \text{isOrdinary}(:wband,\text{false}) \]
\[ a_4 = \text{isAccessible}(:url,\text{false}) \]
\[ C = \{ c_1, c_2, c_3, c_4 \} \]
\[ c_1 = \text{foundAt}(:wband,:Kostebek) \}
\[ c_2 = \text{not}(\text{rejects}(:alice,:pr)) \}
\[ c_3 = \text{isOrdinary}(:wband,\text{false}) \}
\[ c_4 = \text{isAccessible}(:url,\text{false}) \} \]

Table: Arguments

\[ f_1 : \{ \} \vdash^r \text{isInContext}(:pr,:context) \]
\[ f_2 : \{ \} \vdash^r \text{hasMedium}(:pr,:medium) \]
\[ f_3 : \{ \} \vdash^r \text{includesObject}() \]
\[ f_4 : \{ \} \vdash^r \text{Oktoberfest}(:location) \]
\[ f_5 : \{ \} \vdash^r \text{obtained}() \]
\[ f_6 : \{ \} \vdash^r \text{taggedPerson}(:medium,:bob) \]
\[ f_7 : \{ \} \vdash^r \text{hasUrl}(:Kostebek) \]

\[ a_1 : \{ \} \vdash \text{foundAt}(:wband,:Kostebek) \]
\[ a_2 : \{ \text{not}(\text{rejects}(:alice,:pr)) \} \vdash \text{not}(\text{rejects}(:alice,:pr)) \]
\[ a_3 : \{ \text{isOrdinary}(:wband,\text{false}) \} \vdash \text{isOrdinary}(:wband,\text{true}) \]
\[ b_1 : \{ \} \vdash \text{isOrdinary}(:wband,\text{false}) \]
Evaluating a Post Request

- A’s Post Request
  - Dispute A - B
  - Agent A: \( R_C + I_C \)
  - Agent B: \( R_D + I_D \)

- PrepareCase
  - Decision: c

- ABA engine
  - Decision: yes, Share Post; no, Do not Share Post

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February 29, 2016
Evaluating a Post Request

Centralized Rules $R_C$, Centralized Instances $I_C$

$I_{A_1}: \text{foundAt}(\text{object, shop}) \rightarrow \text{isOrdinary}(\text{object, true})$

$\text{foundAt}(\text{wbond, Kostebek})$
Evaluating a Post Request

Centralized Rules $R_C$, Decentralized Instances $I_D$

$I_{A_1}$: $foundAt(?object, ?shop) \rightarrow isOrdinary(?object, true)$

$foundAt(:wb\text{\textunderscore}band, :Kostebek)$
Evaluating a Post Request

Decentralized Rules $R_D$, Centralized Instances $I_C$

$I_{B_2}: \text{hasUrl}(?\text{shop},?\text{url}), \text{isAccessible}(?\text{url},\text{false}) \rightarrow \text{isClosed}(?\text{shop},\text{true})$

$\text{hasUrl}(\text{:Kostebek},\text{:url})$
Evaluating a Post Request

Decentralized Rules $R_D$, Decentralized Instances $I_D$

$I_{B_2}: \text{hasUrl}(\text{?shop}, \text{?url}), \text{isAccessible}(\text{?url}, \text{false}) \rightarrow \text{isClosed}(\text{?shop}, \text{true})$

$\text{isAccessible}(\text{?url}, \text{false})$

$\text{hasUrl}(\text{?Kostebek}, \text{?url})$
Pseudocode for **PrepareAttack** Algorithm

**Input:** case received from other agent  
**Output:** case sent to other agent

1: get contraries to attack
2: find rules to attack contraries \( \{R_C, R_D\} \)
3: find instances to instantiate rules \( \{I_C, I_D\} \)
4: update \( R, A, C \) and \( F \)
5: if no new rules then
6: prepare a case with a stop status
7: else
8: prepare a case with an ongoing status
9: end if
10: return prepared case