

# Collective Trust and Normative Agents

Clara Smith<sup>1</sup> and Antonino Rotolo<sup>2</sup>

<sup>1</sup>Facultad de Informática, University of La Plata, Argentina

<sup>2</sup>CIRSFID, University of Bologna, Italy

Workshop *NormMAS 2008*, Luxembourg, 15-16 July 2008

*Research supported by Project PICT 2006-00842 (ANPCyT, Argentina) and the EU project ESTRELLA (IST-2004-027655).*

# Layout

- Collective trust: Why? Three informal examples.

- Collective trust: Why? Three informal examples.
- The starting point: Individual trust. Reformulation of Castelfranchi & Falcone's (2001) definition.

- Collective trust: Why? Three informal examples.
- The starting point: Individual trust. Reformulation of Castelfranchi & Falcone's (2001) definition.
- Collective trust. Step 1: Joint trust.

- Collective trust: Why? Three informal examples.
- The starting point: Individual trust. Reformulation of Castelfranchi & Falcone's (2001) definition.
- Collective trust. Step 1: Joint trust.
- Collective trust. Step 2: Reliance.

- Collective trust: Why? Three informal examples.
- The starting point: Individual trust. Reformulation of Castelfranchi & Falcone's (2001) definition.
- Collective trust. Step 1: Joint trust.
- Collective trust. Step 2: Reliance.
- Collective trust. Step 3: Collective trust.

- Collective trust: Why? Three informal examples.
- The starting point: Individual trust. Reformulation of Castelfranchi & Falcone's (2001) definition.
- Collective trust. Step 1: Joint trust.
- Collective trust. Step 2: Reliance.
- Collective trust. Step 3: Collective trust.
- Collective trust. Step 4: Deontic conditions, effects, and trust deception.



# Collective trust: Three examples (1)

# Collective trust: Three examples (1)

- Example 1

Suppose that agent  $y$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $y$ , expecting that  $y$  will raise her hand and stop the bus.

# Collective trust: Three examples (1)

- Example 1

Suppose that agent  $y$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $y$ , expecting that  $y$  will raise her hand and stop the bus.

- Example 2

It is Mary's birthday. Her co-workers give some money to  $y$ , another co-worker who is going downtown, delegating to  $y$  the search and purchase of a gift. Everyone trusts that  $y$  will do so.

# Collective trust: Three examples (2)

## Collective trust: Three examples (2)

- Example 3

Every December, student bands build up street-puppets filled with fireworks, which are to be burned on New Year's day. Each band builds its chosen puppet-of-the-year from scratch. The town administration institutionalized a competition and settled an award for the best figure. Bands' custom establishes that figures ought to be watched and protected day and night, this because a very common practice is to burn other bands' figures before the New Year's day by sending one band member (a saboteur). The consequence of successful sabotages is the exclusion of opponents from the competition. Assume that  $s$ , band  $G$ 's saboteur, is deliberately sent by  $G$  to burn band  $H$ 's figure.

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,
- $x$  believes that  $y$  does  $A$ ,



# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,
- $x$  believes that  $y$  does  $A$ ,
- $x$  intends not to do  $A$  himself but that  $y$  does it,

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,
- $x$  believes that  $y$  does  $A$ ,
- $x$  intends not to do  $A$  himself but that  $y$  does it,
- $x$  has the goal that  $y$  intends  $A$ ,

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,
- $x$  believes that  $y$  does  $A$ ,
- $x$  intends not to do  $A$  himself but that  $y$  does it,
- $x$  has the goal that  $y$  intends  $A$ ,
- $x$  believes that  $y$  intends that  $A$ .

# Individual trust: Castelfranchi & Falcone 2001 (simplified)

Agent  $x$  trusts agent  $y$  with respect to  $A$  whenever

- $x$  has goal  $A$ ,
- $x$  believes that  $y$  does  $A$ ,
- $x$  intends not to do  $A$  himself but that  $y$  does it,
- $x$  has the goal that  $y$  intends  $A$ ,
- $x$  believes that  $y$  intends that  $A$ .

$$\text{Trust}_y^x A \equiv \text{Goal}_x A \wedge \text{Bel}_x \text{Does}_y A \wedge \text{Int}_x (\text{Does}_y A \wedge \neg \text{Does}_x A) \wedge \\ \text{Goal}_x \text{Int}_y A \wedge \text{Bel}_x \text{Int}_y A$$

# Joint trust

In the bus example (Example 1) there is no “common front”, but simply that

# Joint trust

In the bus example (Example 1) there is no “common front”, but simply that

- $x_1 \in G$  trusts that  $y$  stops the bus,

In the bus example (Example 1) there is no “common front”, but simply that

- $x_1 \in G$  trusts that  $y$  stops the bus,
- $x_2 \in G$  trusts that  $y$  stops the bus,
- $\vdots$

In the bus example (Example 1) there is no “common front”, but simply that

- $x_1 \in G$  trusts that  $y$  stops the bus,
- $x_2 \in G$  trusts that  $y$  stops the bus,
- $\vdots$
- $x_n \in G$  trusts that  $y$  stops the bus,



In the bus example (Example 1) there is no “common front”, but simply that

- $x_1 \in G$  trusts that  $y$  stops the bus,
- $x_2 \in G$  trusts that  $y$  stops the bus,
- $\vdots$
- $x_n \in G$  trusts that  $y$  stops the bus,

$$\text{JTrust}_y^G A \equiv (\bigwedge_{i \in G} \text{Trust}_y^i A)$$

In the birthday-gift example (Example 2) there is a “common front”:

In the birthday-gift example (Example 2) there is a “common front”:

- All co-workers jointly trust that  $y$  buys the gift for Mary;

In the birthday-gift example (Example 2) there is a “common front”:

- All co-workers jointly trust that  $y$  buys the gift for Mary;
- Everybody intends that everybody jointly trusts  $y$ ,

In the birthday-gift example (Example 2) there is a “common front”:

- All co-workers jointly trust that  $y$  buys the gift for Mary;
- Everybody intends that everybody jointly trusts  $y$ ,
- Everybody intends that everybody intends that jointly trusts  $y$ ,
- ⋮

In the birthday-gift example (Example 2) there is a “common front”:

- All co-workers jointly trust that  $y$  buys the gift for Mary;
- Everybody intends that everybody jointly trusts  $y$ ,
- Everybody intends that everybody intends that jointly trusts  $y$ ,
- $\vdots$

$$\text{Rel}_y^G A \equiv \text{JTrust}_y^G A \wedge \text{MInt}^G(\text{JTrust}_y^G A)$$

where

In the birthday-gift example (Example 2) there is a “common front”:

- All co-workers jointly trust that  $y$  buys the gift for Mary;
- Everybody intends that everybody jointly trusts  $y$ ,
- Everybody intends that everybody intends that jointly trusts  $y$ ,
- $\vdots$

$$\text{Rel}_y^G A \equiv \text{JTrust}_y^G A \wedge \text{MInt}^G(\text{JTrust}_y^G A)$$

where

$$\text{MInt}^G A \equiv \left( \bigwedge_{i \in G} \text{Int}^i(A \wedge \text{MInt}^G A) \right)$$

For full axiomatization and semantics see Dunin-Keplicz & Verbrugge 2002.

# Collective trust

In the street-puppet example (Example 3) there is a strong “common front”



# Collective trust

In the street-puppet example (Example 3) there is a strong “common front”

- Student band  $G$  relies on  $s$  to burn  $H$ 's puppet;

# Collective trust

In the street-puppet example (Example 3) there is a strong “common front”

- Student band  $G$  relies on  $s$  to burn  $H$ 's puppet;
- Student band  $G$  deliberately intends so, namely, knows what it chooses and what intends as a group.

# Collective trust

In the street-puppet example (Example 3) there is a strong “common front”

- Student band  $G$  relies on  $s$  to burn  $H$ 's puppet;
- Student band  $G$  deliberately intends so, namely, knows what it chooses and what intends as a group.

$$CTrust_s^G A \equiv Rel_s^G A \wedge CBel^G (Rel_s^G A)$$

where

# Collective trust

In the street-puppet example (Example 3) there is a strong “common front”

- Student band  $G$  relies on  $s$  to burn  $H$ 's puppet;
- Student band  $G$  deliberately intends so, namely, knows what it chooses and what intends as a group.

$$CTrust_s^G A \equiv Rel_s^G A \wedge CBel^G(Rel_s^G A)$$

where

$$CBel^G A \equiv \left( \bigwedge_{i \in G} Bel^i(A \wedge CBel^G A) \right)$$

For full axiomatization and semantics see Dunin-Keplicz & Verbrugge 2002.

# Connections among trust degrees

# Connections among trust degrees

$$\text{CTrust}_s^G A \vdash \text{Rel}_s^G A$$

# Connections among trust degrees

$$\text{CTrust}_s^G A \vdash \text{Rel}_s^G A$$

$$\text{Rel}_s^G A \vdash \text{JTrust}_s^G A$$

# Generalizations: Trust between groups



# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

$$\text{JTrust}_H^G A \equiv (\bigvee_{j \in H} \text{JTrust}_j^G A)$$

# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

$$\text{JTrust}_H^G A \equiv (\bigvee_{j \in H} \text{JTrust}_j^G A)$$

- Reliance:

# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

$$\text{JTrust}_H^G A \equiv (\bigvee_{j \in H} \text{JTrust}_j^G A)$$

- Reliance:

$$\text{Rel}_H^G A \equiv \text{JTrust}_H^G A \wedge \text{MInt}^G (\text{JTrust}_H^G A)$$

# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

$$\text{JTrust}_H^G A \equiv (\bigvee_{j \in H} \text{JTrust}_j^G A)$$

- Reliance:

$$\text{Rel}_H^G A \equiv \text{JTrust}_H^G A \wedge \text{MInt}^G(\text{JTrust}_H^G A)$$

- Collective trust:

# Generalizations: Trust between groups

- Joint trust:

Suppose that group  $H$  is at the bus stop, and there is a group  $G$  of people standing not at the bus stop but close to  $H$ , expecting that  $G$  will stop the bus.

$$\text{JTrust}_H^G A \equiv (\bigvee_{j \in H} \text{JTrust}_j^G A)$$

- Reliance:

$$\text{Rel}_H^G A \equiv \text{JTrust}_H^G A \wedge \text{MInt}^G(\text{JTrust}_H^G A)$$

- Collective trust:

$$\text{CTrust}_H^G A \equiv \text{Rel}_H^G A \wedge \text{CBel}^G(\text{Rel}_H^G A)$$

# Deontic : *In solidum* legal obligations

## Deontic : *In solidum* legal obligations

- *In solidum* obligations raise a “common front” of agents: for example, each member of the front can behave, in principle, as creditor or debtor of the whole.



## Deontic : *In solidum* legal obligations

- *In solidum* obligations raise a “common front” of agents: for example, each member of the front can behave, in principle, as creditor or debtor of the whole.
- What happens to one agent is propagated, in principle, to the others: what an agent  $j$  does as a member of the front is imputed to the other members, as long as  $j$  acts in representation of a communal interest.

## Deontic : *In solidum* legal obligations

- *In solidum* obligations raise a “common front” of agents: for example, each member of the front can behave, in principle, as creditor or debtor of the whole.
- What happens to one agent is propagated, in principle, to the others: what an agent  $j$  does as a member of the front is imputed to the other members, as long as  $j$  acts in representation of a communal interest.
- Example:

A group  $C$  of creditors and a group  $D$  of debtors, agreed that  $D$  will reimburse by a certain date an amount of money  $C$  lend to  $D$ . In “solid” obligations it is often the case that the payment made by one member  $d$  of the co-debtors sets the others free:

$$Does_d reimbursement \rightarrow CTrust_d^D released$$

# Deontic significance: other examples

# Deontic significance: other examples

**Example:** Agent  $i$ , member of Firm  $F$ , an organization of accountants, is entrusted by  $F$  to enter into negotiations with the owner  $j$  of an office block, Group  $G$ , with the view of renting space for their new office.

# Deontic significance: other examples

**Example:** Agent  $i$ , member of Firm  $F$ , an organization of accountants, is entrusted by  $F$  to enter into negotiations with the owner  $j$  of an office block, Group  $G$ , with the view of renting space for their new office.

Before signing the contract, Firm  $F$  finds an equivalent offer but at a lesser rent. Group  $G$  is induced by  $i$  of Firm  $F$  to believe in the future conclusion of a contract. On account of this, if Firm  $F$ , abandons negotiations without justification, it violates standards of contractual correctness and it is under the obligation to restore the damage suffered by  $G$ .

# Deontic significance: other examples

**Example:** Agent  $i$ , member of Firm  $F$ , an organization of accountants, is entrusted by  $F$  to enter into negotiations with the owner  $j$  of an office block, Group  $G$ , with the view of renting space for their new office.

Before signing the contract, Firm  $F$  finds an equivalent offer but at a lesser rent. Group  $G$  is induced by  $i$  of Firm  $F$  to believe in the future conclusion of a contract. On account of this, if Firm  $F$ , abandons negotiations without justification, it violates standards of contractual correctness and it is under the obligation to restore the damage suffered by  $G$ .

Let  $i \in F$ :

$$((CTrust_F^G A) \wedge (\neg Does_i A)) \rightarrow Obl^G(Does_i \textit{compensate})$$

## Deontic significance: other examples

**Example:** Agent  $i$ , member of Firm  $F$ , an organization of accountants, is entrusted by  $F$  to enter into negotiations with the owner  $j$  of an office block, Group  $G$ , with the view of renting space for their new office.

Before signing the contract, Firm  $F$  finds an equivalent offer but at a lesser rent. Group  $G$  is induced by  $i$  of Firm  $F$  to believe in the future conclusion of a contract. On account of this, if Firm  $F$ , abandons negotiations without justification, it violates standards of contractual correctness and it is under the obligation to restore the damage suffered by  $G$ .

Let  $i \in F$ :

$$((C\text{Trust}_F^G A) \wedge (\neg\text{Does}_i A)) \rightarrow \text{Obl}^G(\text{Does}_i \textit{compensate})$$

Or

$$((C\text{Trust}_F^G A) \wedge (\neg\text{Does}_i A)) \rightarrow \text{Obl}^G\left(\bigvee_{k \in F} \text{Does}_k \textit{compensate}\right)$$

The logical system (Dunin-Keplicz & Verbrugge 2002) on which our analysis is based



The logical system (Dunin-Keplicz & Verbrugge 2002) on which our analysis is based

- is EXPTIME complete;

The logical system (Dunin-Keplicz & Verbrugge 2002) on which our analysis is based

- is EXPTIME complete;
- suffers the logical omniscience problem.

The logical system (Dunin-Keplicz & Verbrugge 2002) on which our analysis is based

- is EXPTIME complete;
- suffers the logical omniscience problem.

We proposed a logical methodology based on DL for modelling individual trust and good faith that avoids these difficulties (Rotolo, Sartor & Smith, forthcoming): How to extend this system to cover collective trust is a matter of future research.

# Thank you!