

The Logic of Email Communication

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Modeling Email Communication

We want to model the **knowledge-theoretic** effects of emails.

How does the knowledge of agents change when they receive an email?

Why is this interesting?

Arnold sends Bob an email stating p .

So, Bob gets to know p .

Simple, right?

The result of email communication



K_{BP}

The result of email communication



$K_{BP}, K_A K_{BP}$

The result of email communication



$K_{BP}, K_A K_{BP}, K_B K_A K_{BP}$

The result of email communication



$K_{BP}, K_A K_{BP}, K_B K_A K_{BP}, K_A K_B K_A K_{BP}, \dots$

The result of email communication



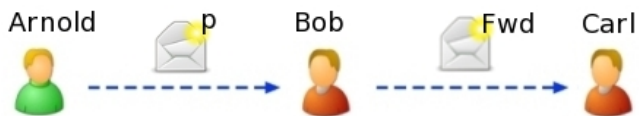
$C_{A,BP}$

The result of sending a forward



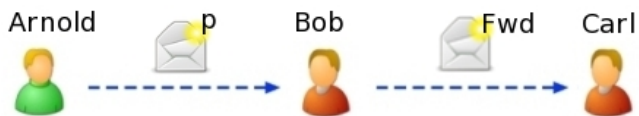
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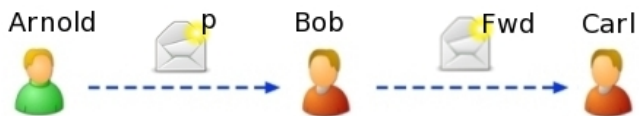
$C_{A,BP}$, $C_{B,CP}$

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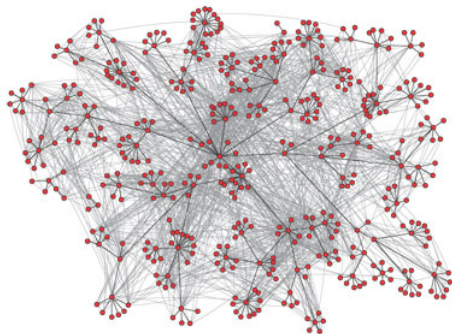
$C_{A,BP}, C_{B,CP}, C_{B,C}C_{A,BP}$

The result of sending a forward



$C_{A,BP}, C_{B,CP}, C_{B,C}C_{A,BP}, \neg K_A C_{B,C}C_{A,BP}$

Corporate email communication



Pattern of e-mail communication among 436 employees of HP Research Lab
(From Adamic and Adar, 2005)

$K_1 K_2 p?$

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- ▶ I forwarded it to my supervisor **Krzysztof**.
- ▶ He replied to my forward **only** to **Loes** with a **BCC** to me.

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- ▶ I got an email from my fellow student **Loes**, with a **CC** to her supervisor **Rohit**.
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- ▶ So I forwarded the last email to **Loes** and **Rohit** with a **BCC** to **Krzysztof**.

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How to formalise this?

Modeling an email

Agent i sends a note n to group of recipients G , with BCC's to group B :

$$s(i, n, G)_B$$

Modeling a forward

If we send a **forward**, the set of BCC recipients is **not** included
Let $s(j, n, H)_C$ be an email with BCC group C .

Agent i forwards:

$$f(i, m, G)_B$$

The original BCC group C is not in the forward.

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Logical analysis

Did I rectify my supervisor's mistake?

No! With our framework we can show:

$$\{m_1, m_2, m_3, m_4\} \models \neg K_L K_K K_R m_3$$

[Loes](#) does not know that in the last email [Krzysztof](#) was in the BCC list.

Logical analysis

If Krzysztof sent his forward to all recipients in the first place, there would be common knowledge

$$C_{\{L,R,F,K\}}m_2$$

With our framework we prove: common knowledge can only be achieved by an email to the **entire** group.

The only way to correct the mistake is to send a forward with the **whole group** as CC recipients:
 $f(F, m_3, \{L, R, K\})$.

Current status

Long-term objectives:

- ▶ Sound and complete axiomatization
- ▶ Proving decidability of the state checking in this framework
- ▶ Implementation using a model checker

References

Message Passing in a Dynamic Epistemic Logic Setting, Floor Sietsma and Jan van Eijck. To be presented at TARK, July 2011.

Common Knowledge in Email Exchanges, Floor Sietsma and Krzysztof R. Apt. Under submission.

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