

# Formalizing Explanatory Dialogues

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# The Dur-Dur project

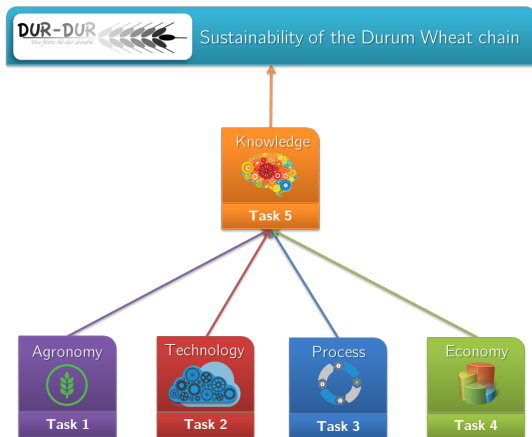


Figure: Knowledge integration in Dur-Dur.

## The micro setting

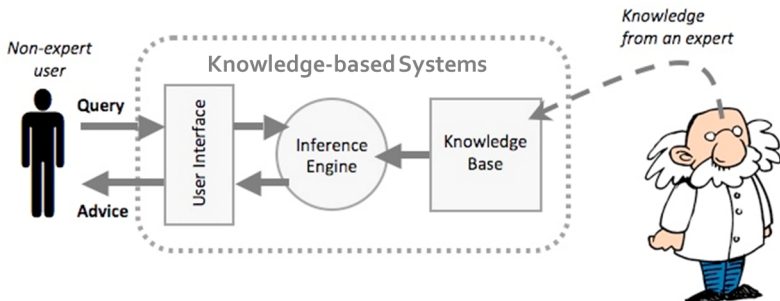


Figure: Explanation in knowledge-based systems.

# The problem

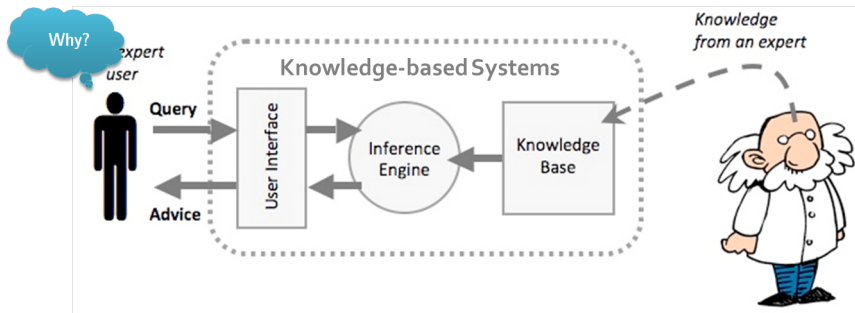


Figure: A curious user asking for an explanation.

# Motivation - facilitating interdisciplinary debate in Dur-Dur

Figure: The multidisciplinary setting of the Dur-Dur project.



## Outline of the solution

The mechanism that facilitates the answer to why questions should be characterized as follows :

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***Explanatory Dialogue***  
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## Explanatory Dialogue

We propose an extension of Walton's CE system of explanation dialogue <sup>1</sup> called the Extended CE system (**ECE**) which is characterized as follows:

- **Participants:** Explainer and Examinee.

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- **Turn-taking:** non-deterministic, one can speak until one switches the turn (not in EC).

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## Components - Explanatory model

The ECE system is based on abstract explanatory model to account for explanations (not proposed in CE) :

- Each participant  $i \in \{\text{Explainer}, \text{Explainee}\}$  has an explanatory model  $\mathcal{E}_i = \langle L_T, \Vdash_x, E \rangle$ .
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- The parameter  $x$  varies over a common and non-empty set  $E$  of explanation types.
- An explanation contains an *explanandum* which is the thing to be explained and *explanans* which are the formulae that *bear* explanatory relevance to the explanandum.

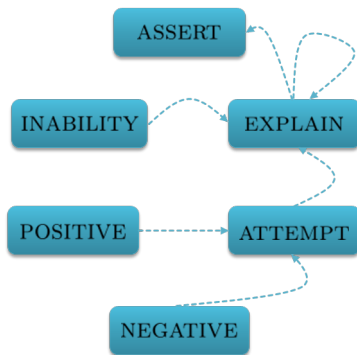
## Components - Communication language

The ECE system has the following locutions :

- ASSERT: Explainer reports a factual statement.
- EXPLAIN: Explainee requests an explanation for a statement.
- ATTEMPT: Explainer gives an explanation.
- POSITIVE: Explainee understands the explanation.
- NEGATIVE: Explainee doesn't understand the explanation.
- INABILITY: Explainer has no explanation.

## Components - Reply relation

The ECE system has the following reply relation between locutions :



**Figure:** The edges stand for "replies to". EXPLAIN replies to EXPLAIN is not in CE.



## Components - Stores

In the ECE system we extend CE by adding commitment and understanding stores:

- **Understanding store:** a set of statements which **has not yet** understood by the Explainee in the dialogue (dedicated to the Explainee only).
  
- **Commitment store:** a set of statements whose truthfulness is adheres to by the Explainer only.

## Components - Stores (2)

The goal of these stores is to:

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- Avoid circular explanations. This means that it is forbidden to explain  $\psi$  by  $\{\varphi\}$  such that  $\varphi$  is asked to be explained (this could provoke the infinite chain  $\text{EXPLAIN}(\varphi), \text{ATTEMPT}(\{\psi\}, \varphi), \text{EXPLAIN}(\psi), \text{ATTEMPT}(\{\varphi\}, \psi), \dots, \text{etc.}$ ).

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- $\mathcal{R}_5$  : Do not explain a statement by two different and contradictory explanations (commitment store).

## Explanatory Dialogue - Dialectical shift

The ECE system (unlike CE) shifts to an argumentation dialogue whenever the Explainee spots an anomaly in the explanation:

- **Goal of the shift:** to evaluate the plausibility, anomaly-freeness and sense-making of explanations.

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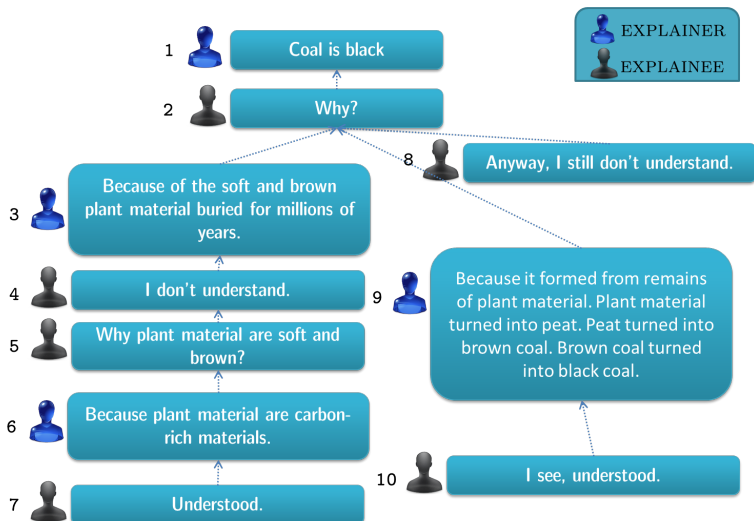
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- At the end of the shift the commitment and understanding stores are updated according to the output of the argumentation dialogue.

## Explanatory Dialogue - Example (no shift)



## Explanatory Dialogue - Results

The ECE system has the following properties:

- The explanatory dialogue is *successful* iff the understanding store is empty.
- It terminates if and only if the explanatory dialogue is finite.
- It terminates in exponential steps (the cost of adding nested explanation request).
- The evolution of the space occupied by the stores is *linear*.



## Summary - ECE and CE (a comparison)

In what follows we show the difference between the ECE system and Walton's CE system :

| Propositions  | ECE | CE       |
|---|-----|----------|
| (1) Adheres to an abstract explanatory model              | ✓   | ×        |
| (2) Formalized in the meta-level                          | ✓   | ✓ (semi) |
| (3) Formalized in the logical-level                       | ✓   | ×        |
| (4) Nested explanation requests                           | ✓   | ×        |
| (5) Commitment and understanding stores                   | ✓   | ×        |
| (6) General account of shifts                             | ✓   | ×        |
| (7) Shift to Argumentation dialogue                       | ✓   | ×        |
| (8) Shift to Examination dialogue                         | ×   | ✓        |
| (9) Illusion of understanding by questioning <sup>2</sup> | ×   | ✓        |
| (10) Feedback   | ×   | ✓        |

<sup>2</sup>This alongside with (8) can be accounted for in the general shift model of (7).

## Future work

- Use ECE to compare the state-of-the-art explanatory dialogues in KBS.
- Use ECE to explain the output of an *inconsistent* KBS applied to agronomy.
- Evaluate to which extent the impact of this type of explanatory dialogue on the acceptance of KBS by users.

## Future work - Semantics (some thoughts)

- Propose a semantics for explanatory dialogue:

**The easy way:** instantiate the abstract explanatory model:

*E.g. for a causal-based explanatory dialogue instantiate the abstract explanatory model to causal theories (e.g. Pearl's theory).*

**The hard way:** give a formal account of understanding:

*E.g. (1) an agent  $E$  understands a statement  $\varphi$  if she possesses a causal knowledge about  $\varphi$ . Or, (2) an agent  $E$  understands a statement  $\varphi$  if she can tell what would happen if  $\varphi$  were not to hold (counter-factual).<sup>3, 4</sup>*

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<sup>3</sup>See, Henk W. de Regt. *Understanding and explanation: Living apart together?*, studies in History and Philosophy of Science 44 (2013) 505-509.

<sup>4</sup>See, Stephen R Grimm. *Understanding as knowledge of causes*. In *Virtue Epistemology Naturalized*, pages 329-345, 2014.

# Thank you...

For questions and follow-ups contact:  
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