Reasoning: evocation, erotetic implication

Szymon Chlebowski

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Outline

Questions and inferences

Andrzej Wiśniewski, “Questions and inferences”, Logique et Analyse 173-175, 2001, pp. 5-23

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- What are the strengths and limitations of IEL?
- Is Wiśniewski doing logic, or is he actually describing a virtue of good inquiry?

Evocation of questions — intuitions

(C1) (transmission of truth into soundness) If the premises are all true, then the question which is the conclusion must be sound.

(C2) (informativeness) A question which is the conclusion must be informative with respect to the premises.

Andrew is rich.
Andrew is happy.
$\therefore$ Is Andrew happy?

Andrew is happy.
Mariusz is happy.
$\therefore$ Does Mariusz = Andrew?

Mechanic

1. Imagine that a mechanic after inspecting your car says to you:
   - ★ We need to fix the clutch or the transmission will stop working at the end of next month.

   List questions that come to your mind in this scenario.
2. From the questions listed choose only purely informative questions. For each of them come up with a set of direct answers.

Mechanic

1. Check which questions that you listed in 1. are evoked from the ★ sentence, according to the definition.
2. Are the following questions evoked from ★?
   - Will the transmission stop working?
   - What is the dependence between the clutch and the transmission?
   - I don't want the transmission to stop working next month, do I need to fix the clutch?
   - Is the earth flat?
   - What colour is my car?

Story of a Woodcutter

Once upon a time, in a small village, there lived a woodcutter named Jack and his wife, Sarah. Jack was known for his exceptional woodcutting skills and Sarah for her delicious cooking. One day, while Jack was cutting wood in the forest, he stumbled upon a lost boy. The boy was hungry and scared, so Jack brought him home to Sarah. Sarah gave the boy some food and they both fell in love with him instantly. They decided to take care of the boy and raise him as their own child. Over the years, the boy grew up to be a fine young man and helped Jack with his woodcutting business. Sarah became very proud of him and treated him like her own son. The family lived happily ever after, grateful for the unexpected addition to their lives.

Story of a Woodcutter

Check if the following questions are evoked from the Woodcutter story:

- What was the name of the small village where Jack and Sarah lived?
- What did Jack find in the forest one day?
- Is water a solid at room temperature?
- Did Jack teach the boy how to cut wood?
- What do you do for a living?
- Did Sarah have any other special skills besides cooking?

Minimal Erotetic Semantics

Partition of declaratives

A partition of a set of declarative formulas ($\mathscr{D}_{\mathscr{L}}$) of a given language is a pair

$$\mathsf{P} = \langle \mathsf{T_P}, \mathsf{U_P} \rangle$$

where $\mathsf{T_P} \cap \mathsf{U_P} = \emptyset$ and $\mathsf{T_P} \cup \mathsf{U_P} = \mathscr{D}_{\mathscr{L}}$.

But only some partitions are admissible.

Entailment, mc-entailment

Multiple-conclusion entailment

$X \mid\!\models Y$ iff there is no admissible partition $\mathsf{P} = \langle \mathsf{T_P}, \mathsf{U_P} \rangle$ such that $X \subset \mathsf{T_P}$ and $Y \subset \mathsf{U_P}$.

Soundness

A question Q is sound in a partition $\mathsf{P} = \langle \mathsf{T_P}, \mathsf{U_P} \rangle$ iff $dQ \cap \mathsf{T_P} \neq \emptyset$.

A question is safe if it is sound in every admissible partition. Otherwise it is risky.

Andrzej Wiśniewski, "Questions and inferences"

Definition (Evocation of Questions)

A set of declarative well-formed formulae X evokes a question Q (in symbols $\mathrm{E}(X, Q)$) iff
1. $X \mid\!\models dQ$ and
2. for each $A \in dQ : X \mid\!\not\models \{A\}$

where dQ denotes the set of all direct answers to the question Q, and $X \mid\!\models dQ$ refers to multiple-conclusion entailment (mc-entailment) as explained by Wiśniewski in the following way:

> [...] mc-entailment between X and Y holds just in case the truth of all the d-wffs in X warrants the presence of some true d-wff(s) in Y: whenever all the d-wffs in X are true [...], then at least one d-wffs in Y is true.

Non-classical example —Łukasiewicz 3-valued logic

Truth values: 1 (truth), 1/2 (possibility), 0 (falsity).

$$v : Var \mapsto \{1, 1/2, 0\}$$

$$v(A \wedge B) = min(v(A), v(B))$$

$$v(A \vee B) = max(v(A), v(B))$$

$$v(\neg A) = 1 - v(A)$$

Exercises — classical logic

1. Check whether a given question is evoked by the set of sentences.
   - 1.1 $X = \{p \to q\}$, $Q = ?q$
   - 1.2 $X = \{p \vee q\}$, $Q = ?\{p, q\}$
   - 1.3 $X = \{p \vee q\}$, $Q = ?\{p \wedge q, p \wedge \neg q, \neg p \wedge q\}$
2. Find questions that are evoked by a given set of sentences.
   - 2.1 $X = \{(p \wedge q) \to r, \neg r\}$
   - 2.2 $X = \{r \to \neg(p \wedge q), p\}$
3. Find a set of sentences that evokes a given question.
   - 3.1 $Q = ?\{p, q \vee r\}$
   - 3.2 $Q = ?\{p \wedge q, p \wedge r\}$
   - 3.3 $Q = ?\{(p \wedge q) \wedge \neg r, (p \wedge r) \wedge \neg q, (p \wedge q) \wedge r\}$

Exercises — Łukasiewicz logic (L3)

1. Define basic concepts of Minimal Erotetic Semantics for *L*3. Is there a unique way of defining the notion of soundness of a question.
2. Find examples of evocation of questions in *L*3.

Erotetic implication — intuitions

(C3) (transmission of soundness/truth into soundness) if the initial question is sound and all the declarative premises are true, then the question which is the conclusion must be sound.

Where did Andrew leave for: Chicago or New York?

$\therefore$ Did Andrew leave for the US?

Erotetic implication — intuitions

(C4) (open-minded cognitive usefulness) each direct answer to the question which is the conclusion is potentially useful, on the basis of declarative premises, for finding an answer to the initial question.

Where did Andrew leave for: Chicago or New York?

$\therefore$ Did Andrew leave for the US?

Examples

How old is Andrew?
Andrew is as old as Peter.
$\therefore$ How old is Peter?

Where does Andrew live?
Andrew lives in a University town in Western Poland
$\therefore$ Which towns in Western Poland are university towns?

Erotetic implication

Erotetic implication

A question Q implies a question Q_1 on the basis of a set of d-wffs X (in symbols $\mathbf{Im}(Q, X, Q_1)$) iff:

1. for each $A \in dQ : X \cup \{A\} \mid\!\models dQ_1$, and
2. for each $B \in dQ_1$ there exists a non-empty proper subset Y of dQ such that $X \cup \{B\} \mid\!\models Y$.

If $X = \emptyset$ we talk about pure erotetic implication.

Excercises

1. Check whether the following pure erotetic implications hold:
   1.1 $\mathbf{Im}(?A, ?\neg A)$
   1.2 $\mathbf{Im}(?\{A \wedge B, A \wedge \neg B, \neg A\}, ?A)$
   1.3 $\mathbf{Im}(?\forall_x P(x), ?\exists_x \neg P(x))$
2. Check whether the following erotetic implications hold:
   2.1 $\mathbf{Im}(?A, B \rightarrow A?\{A, \neg A, B\})$
   2.2 $\mathbf{Im}(?A, A \rightarrow B?\{A, \neg A, \neg B\})$
3. Assume $\mathbf{Im}(Q_1, Q_2))$ and $\mathbf{Im}(Q_2, Q_3))$. Is it also the case that $\mathbf{Im}(Q_1, Q_3))$?

Homework — red category

Take your favorite non-classical logic (many-valued, intuitionistic, modal) and find examples of question evocation and erotetic implication that work and does not work in this logic. Explain why.

Graham Priest, Introduction to Non-Classical Logics, Cambridge University Press, 2008

Essay 1

- SC: Read one of the short Sherlock Holmes stories by Arthur Conan Doyle. Represent Holmesian reasoning in terms of erotetic search scenarios (use Classical Propositional Calculus as the logical basis, if possible; if not, go First-Order). Identify deductive and abductive inferences. Are there any other types of inferences involved?

Essay 2

- SC: Define Abductive Question-Answer System for your favourite non-classical logic (intuitionistic, modal, many-valued, non-Fregean, relevant). Show how it works on examples. Describe how to evaluate abductive hypotheses generated.

Essay 3

- SC: Consider an example of reasoning to the best explanation (read Poe, Doyle or dive into the history and philosophy of science). Try to discover all hidden assumptions and model the argument using Abductive Question-Answer System.