Ambiguity in Requirements Engineering

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Scope

- Ambiguity in written requirements (a little)
- Ambiguity in requirements elicitation interviews (a little more)
- I will not mention ambiguity in other phases (analysis, negotiation)
- Pointers to papers will be provided

(Sorry if you already saw part of the content of this presentation)

Definition(s) of Ambiguity (from Berry, Kamsties and Krieger, 2003)

- Focus on WRITTEN natural language (NL) requirements
- **Dictionary Definition:** (1) the capability of being understood in two or more possible senses or ways; (2) uncertainty
- **Software Engineering:** There are two major types of ambiguities:
  - Language ambiguities (lexical, syntactic, etc.)
  - Software engineering ambiguities – depend on the domain involved, require domain knowledge to be identified
- Some authors consider only expression inadequacy as source of ambiguity
- Others consider missing information as an additional source – people leave out self-evident facts
- Ambiguity is related to incompleteness

"ambiguity" is ambiguous!

Ambiguity in RE (from Berry, Kamsties and Krieger, 2003)

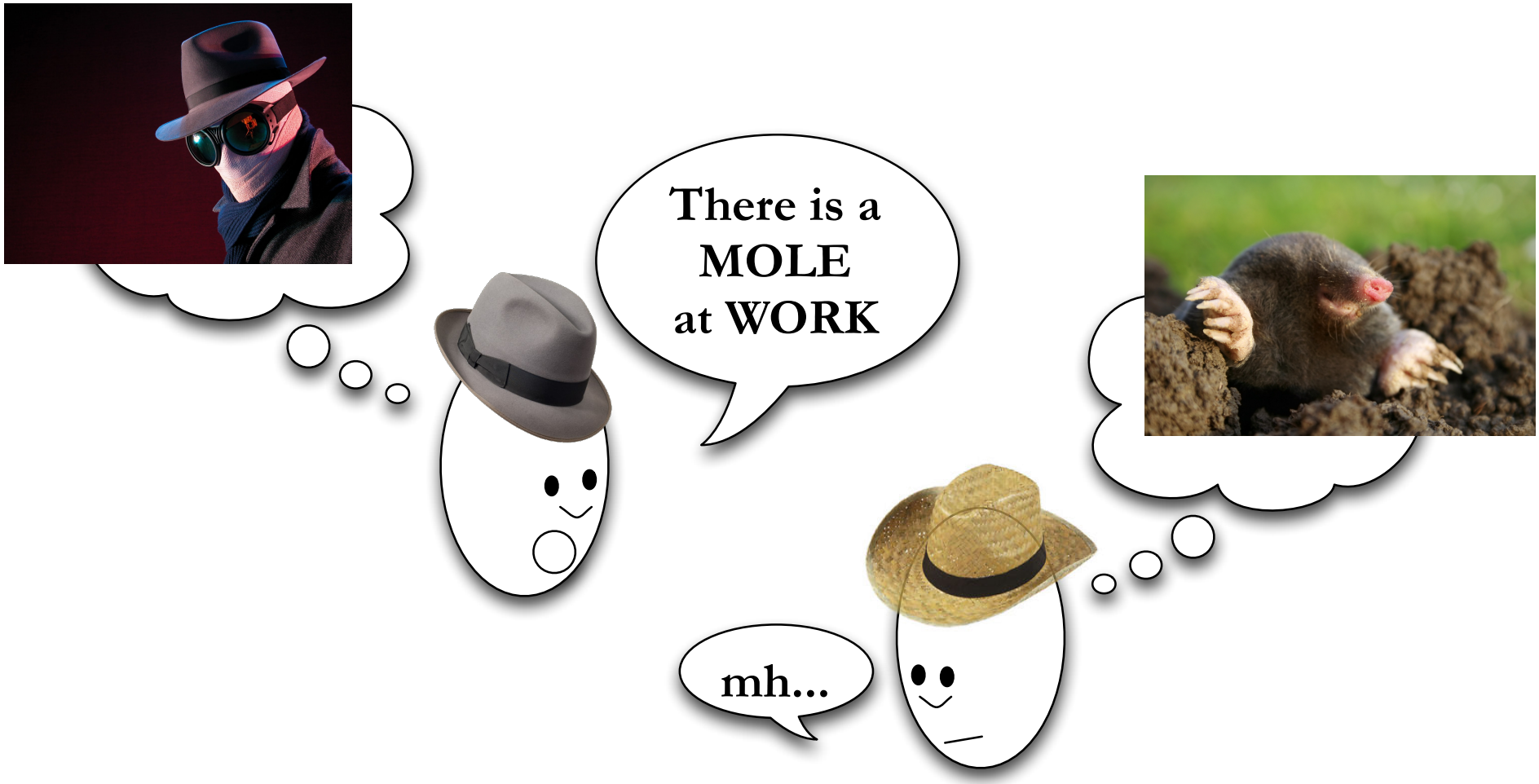
Property of an expression of being interpreted in multiple ways

- **Vagueness:** the sentence admits borderline cases (e.g., *Avoid long C functions*)
- **Generality:** the sentence/term needs to be specified more (e.g., *The interface shall be coded in Java*)

- **Lexical ambiguity:** term has different unrelated vocabulary meanings (e.g., *bank*)
- **Syntactic ambiguity:** sentence has more than one syntax tree (e.g., *Structured approaches and tools*)
- **Semantic ambiguity:** sentence can be translated into more than one logic expression (e.g., *All lights have a switch*)

Pragmatic ambiguity: the meaning depends on the context – other sentences, domain knowledge, common-sense, viewpoint

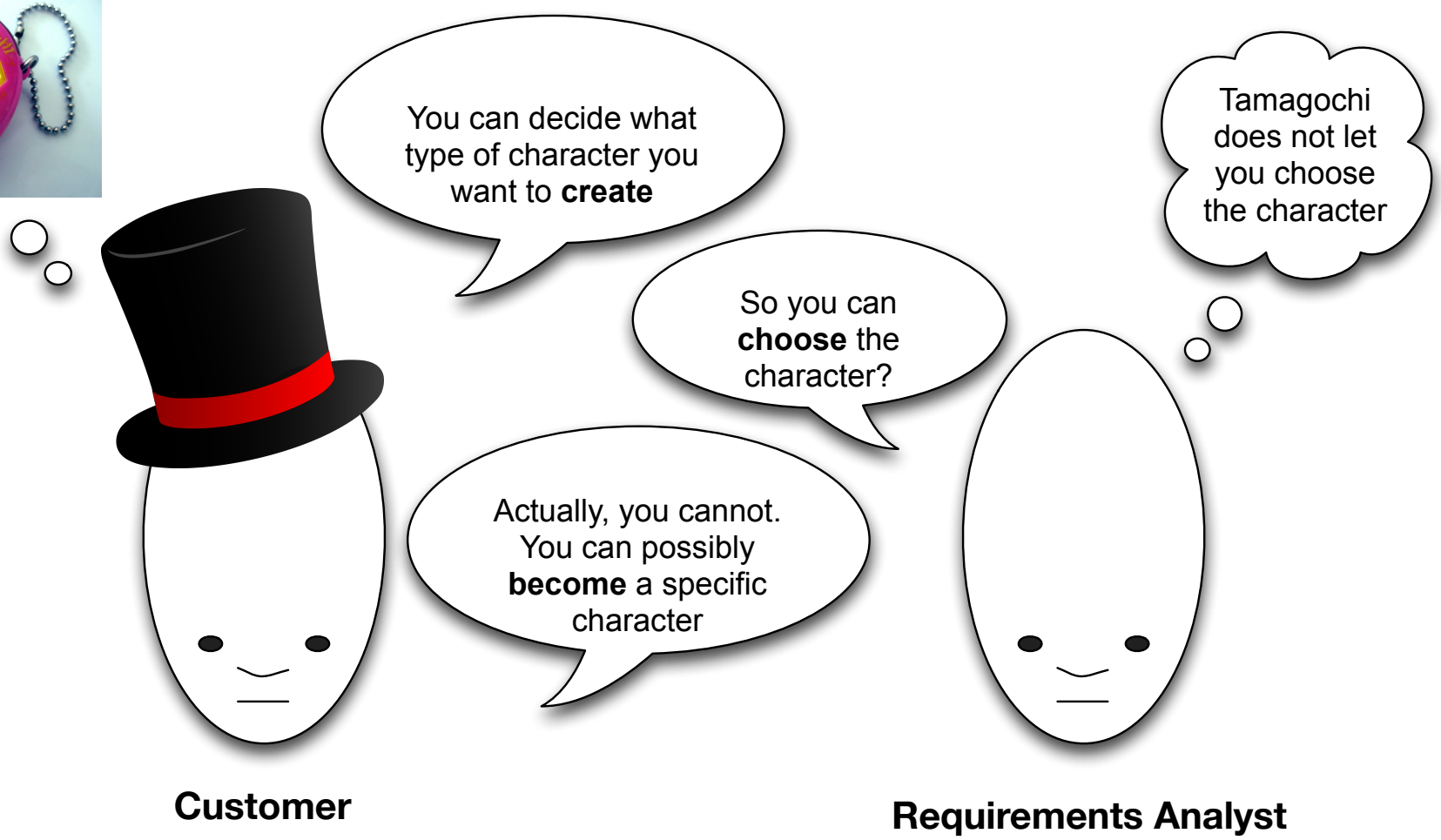
Pragmatic Ambiguity (RE'12, AIRE'14)



Towards Ambiguity in Interviews (RE'15)

- Several automated procedures for other types of ambiguity (QuARS, ARM, SREE, etc.)
- We wanted to study pragmatic ambiguities, but we needed data
- With **Paola Spoletini**, we started to perform interviews, to get the data we needed
- We performed 34 unstructured interviews
- We annotated all the cases that the analyst perceived as ambiguous (232)
- It became clear that a new classification was needed

Example: Fitness Tamagochi



Example: Train Protection System

I want the train to stop within 50 meters if a red signal is passed

It may not be possible if you go at 130 km/h

I meant, in shunting mode [max: 30 km/h]

Trains going at full speed need hundreds of meters to stop

Customer

Requirements Analyst

Ambiguity seemed to be connected to incompleteness and inconsistency!

Definition of Ambiguity

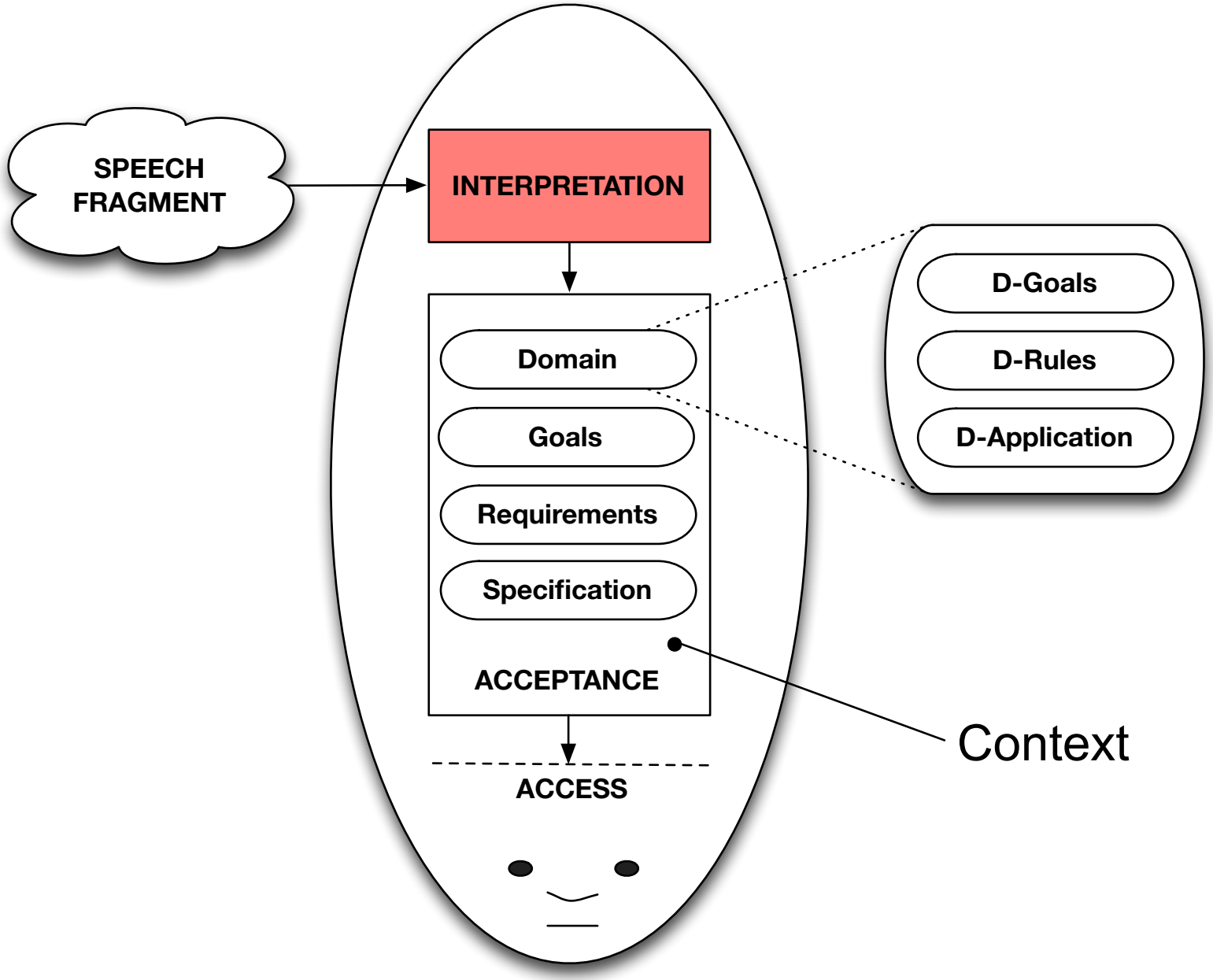
Ambiguity in Interviews

An ambiguity occurs in a requirements elicitation interview when a customer articulates a unit of information, and the meaning assigned by the requirements analyst to this articulation differs from the meaning intended by the customer.

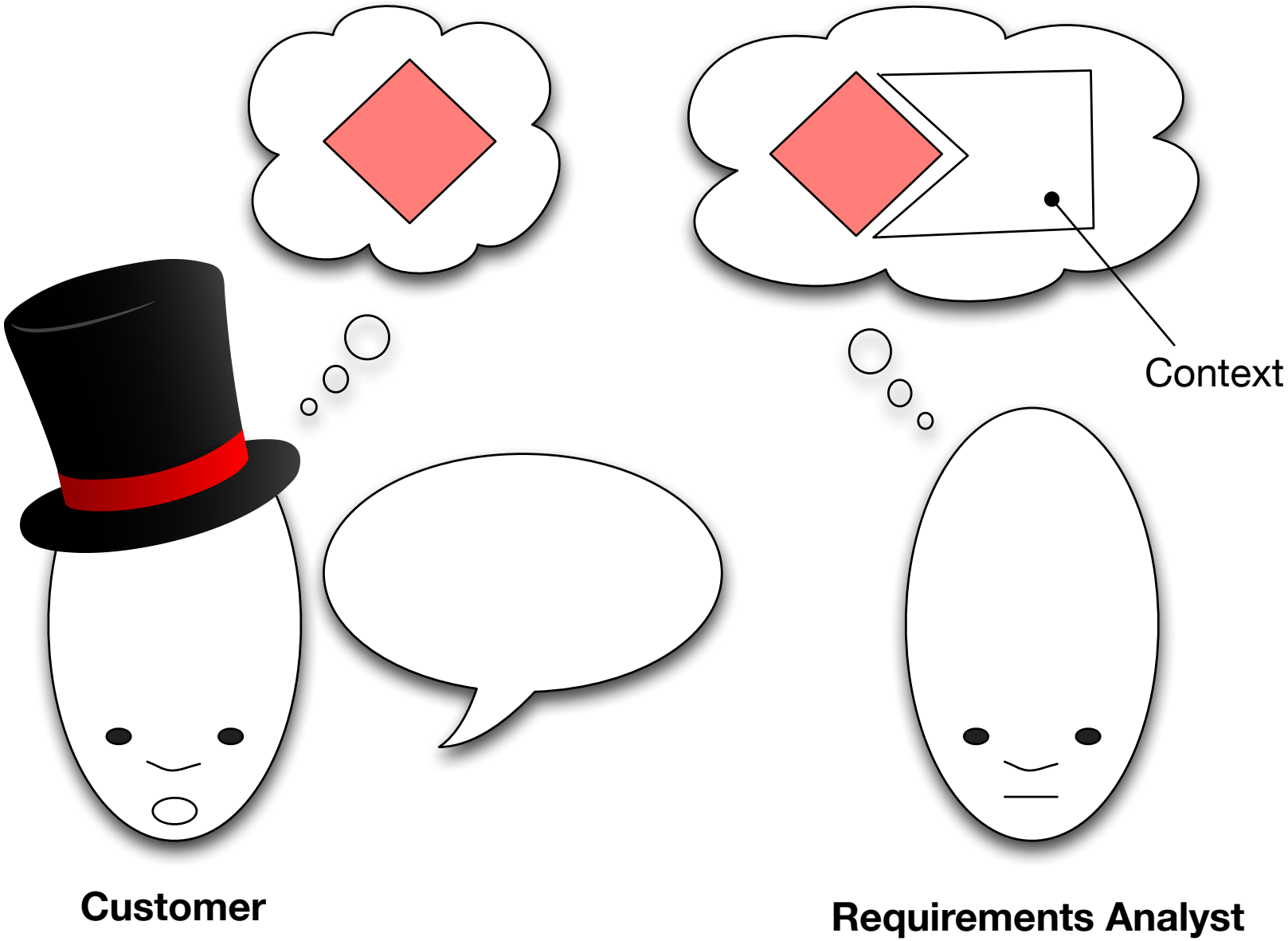
- **Unit of information:** system need or domain-related aspect
- **Articulation:** any speech fragment
- **Meaning:** contextual meaning

We include cases in which the analyst cannot give any interpretation

The Context of the Analyst (REJ'16)



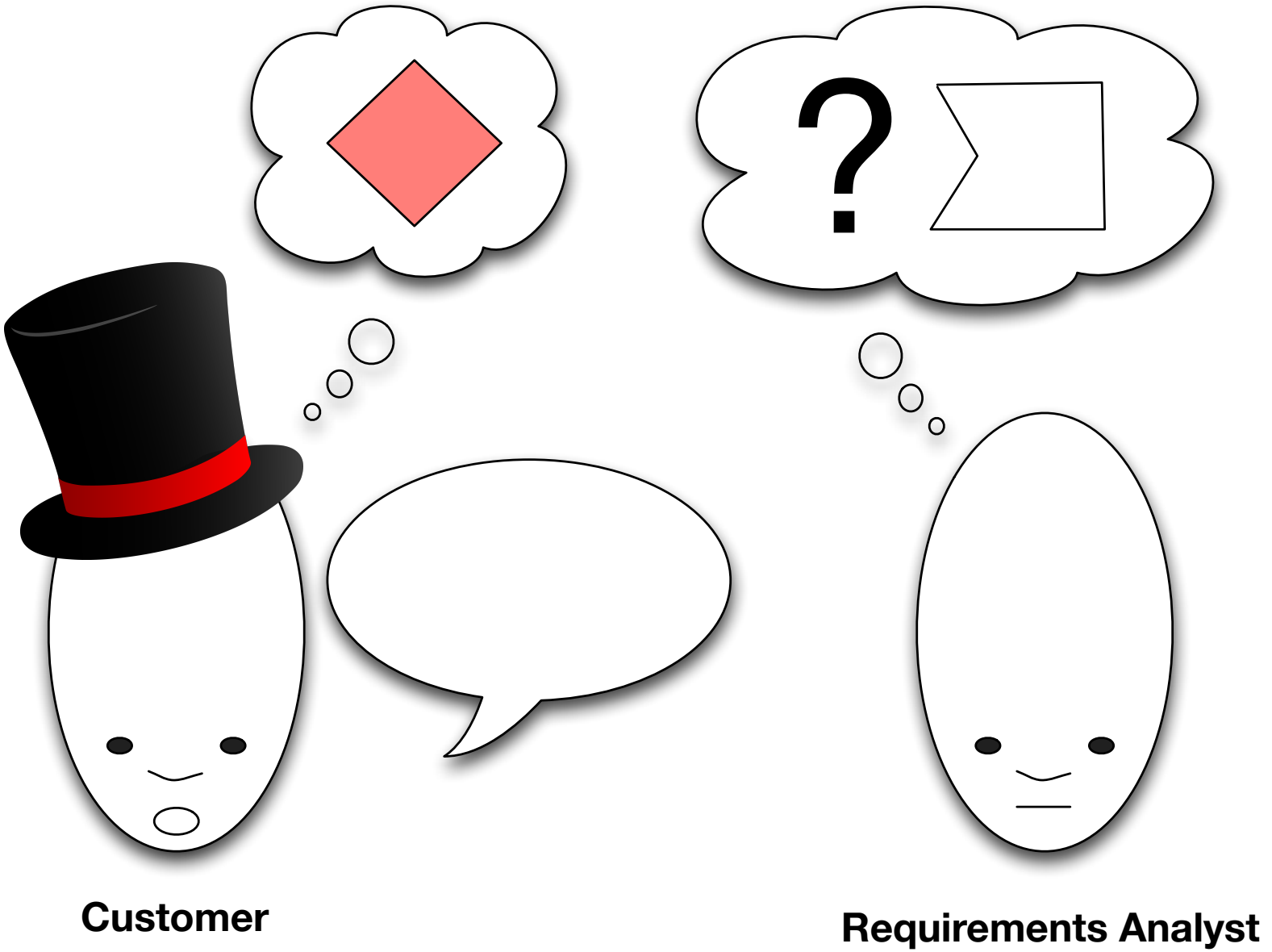
Ambiguity Types: Correct Disambiguation



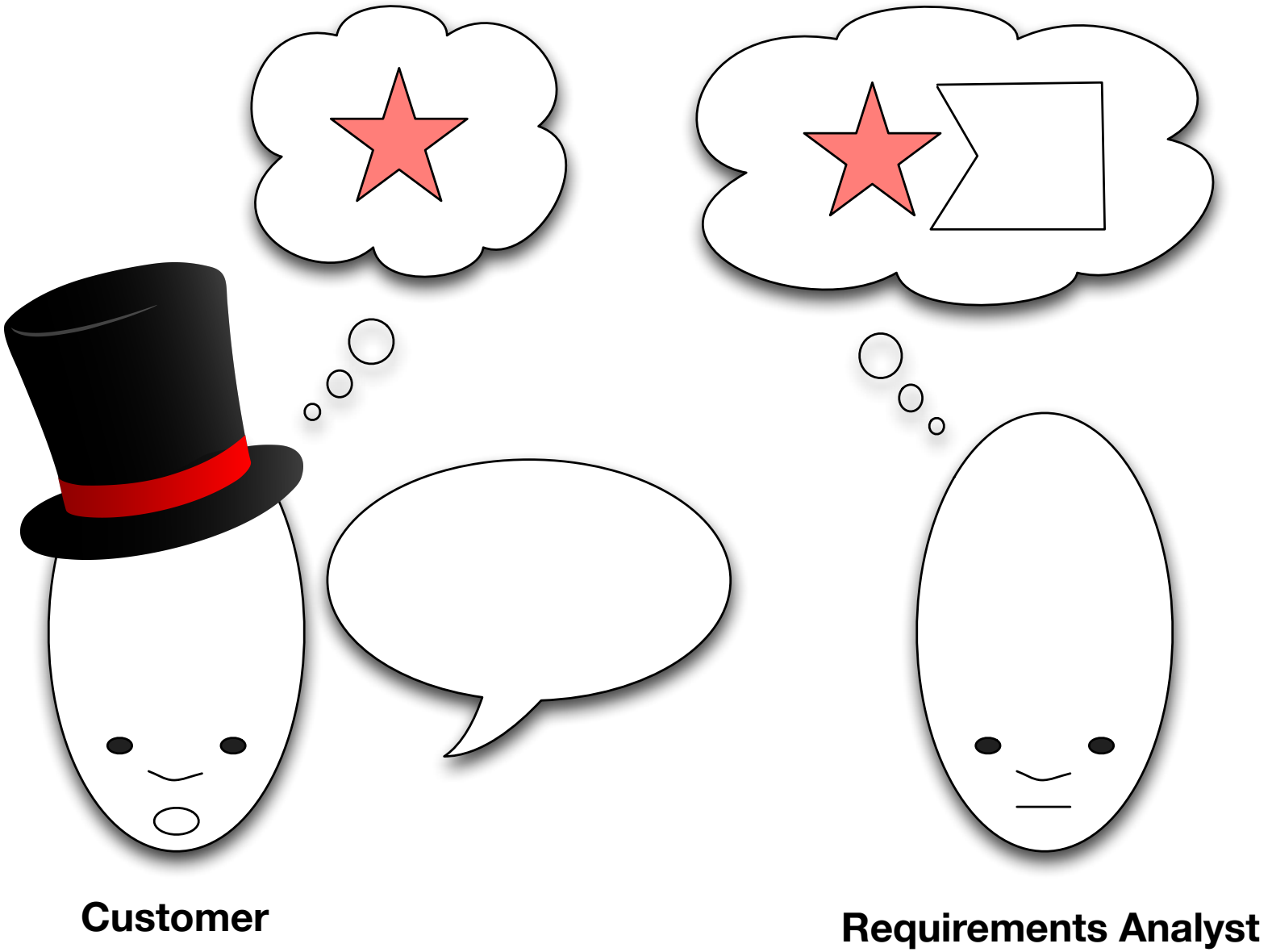
Ambiguity Types: Correct Disambiguation

- What I hear has an interpretation
- The interpretation matches with the one intended by the customer
- The interpretation is consistent with the context
- The interpretation appears sufficiently complete

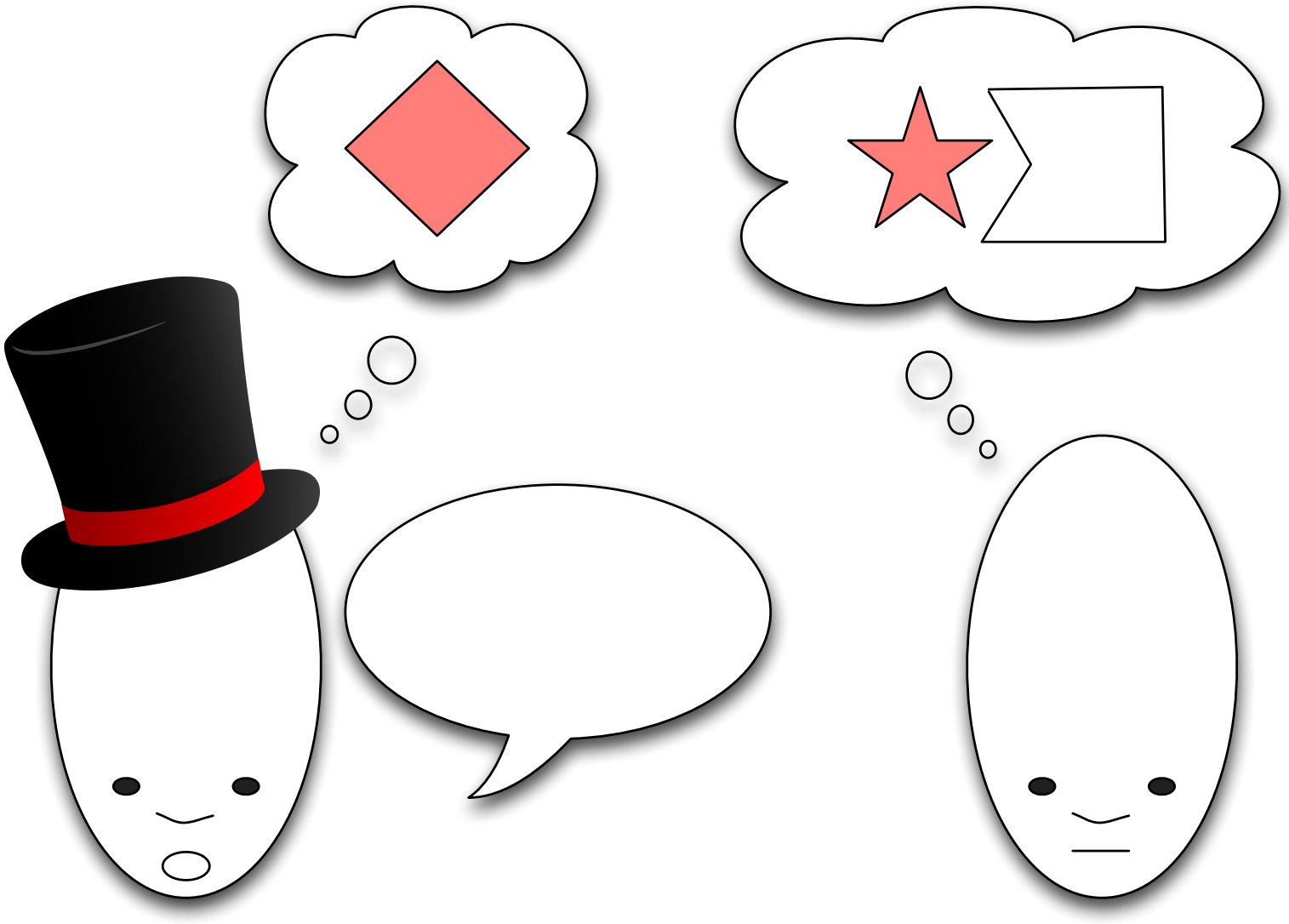
Ambiguity Types: Interpretation Unclarity



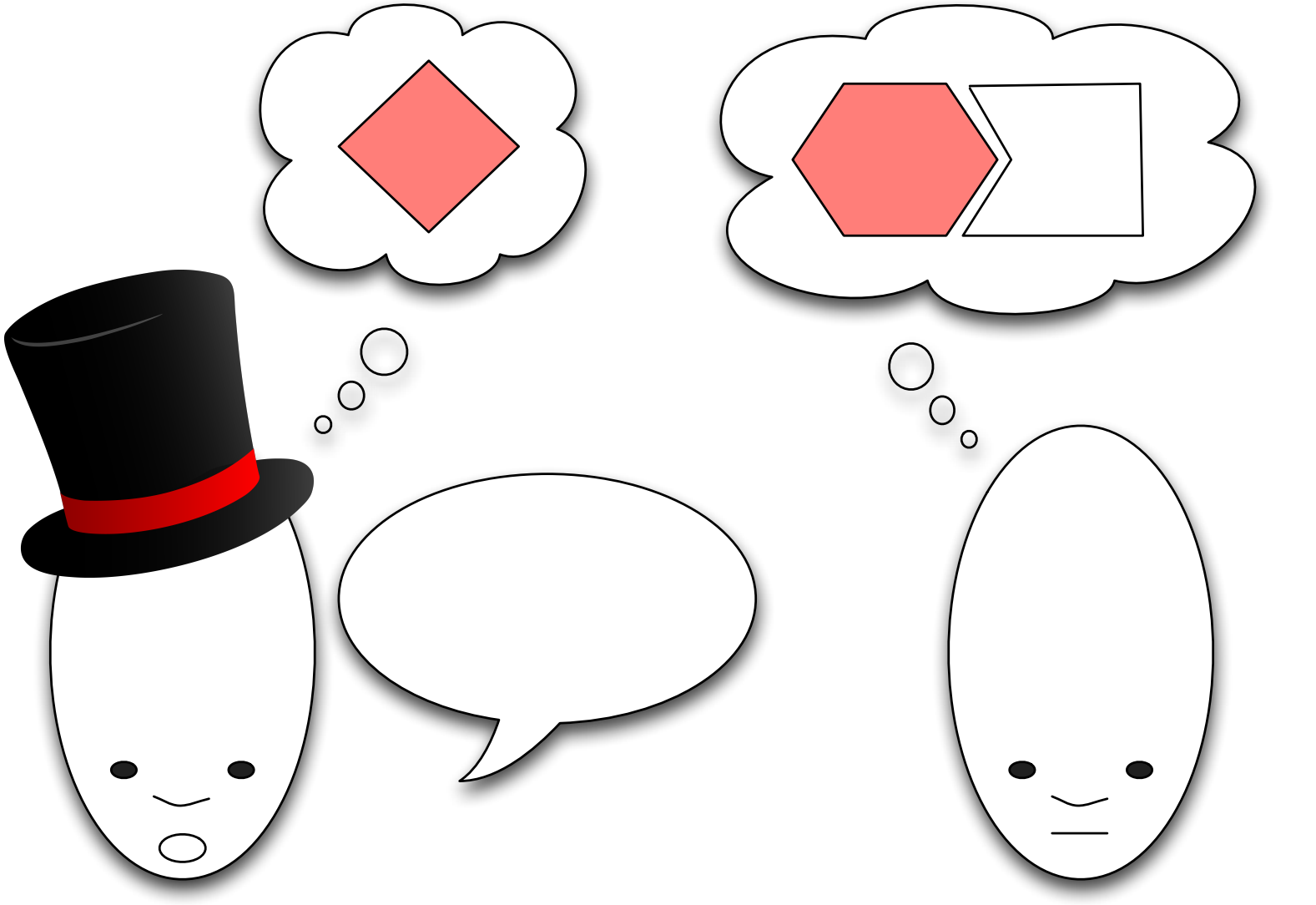
Ambiguity Types: Acceptance Unclarity (Train)



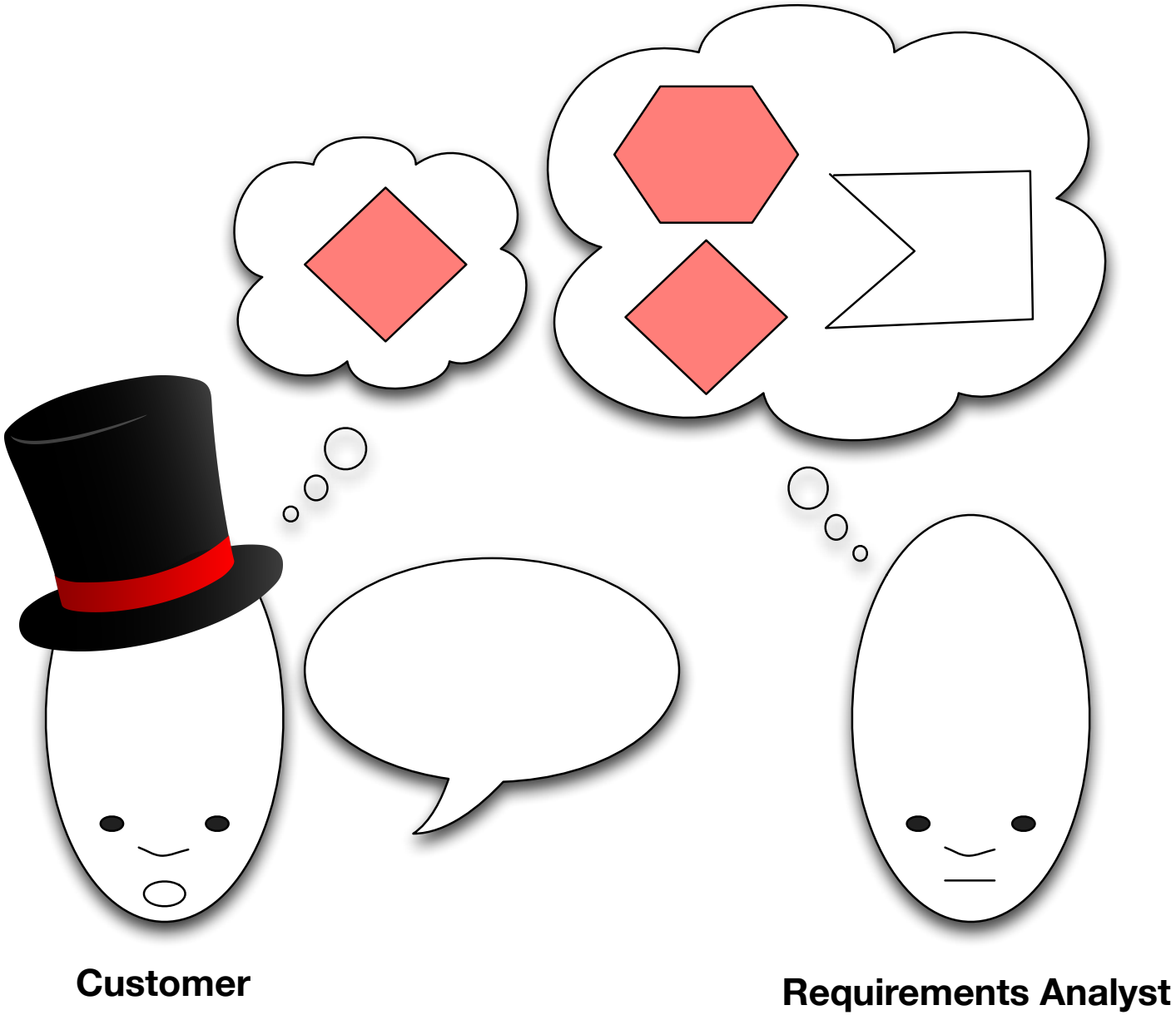
Ambiguity Types: Detected Incorrect Disambiguation (Tamagochi)



Ambiguity Types: Undetected Incorrect Disambiguation



Ambiguity Types: Multiple Understanding



Which are the Triggers? (RE'16)

- **Under-specified terms (U):** people, knowledge, movement, area, rule, data, category, interface, thing, detail
  - *"The interface shall be coded in Java"*
- **Vague terms (V):** minimal, as much as possible, later, taking into account, based on, appropriate
  - *"The loading time shall be minimal"*
- **Pronouns (P):** he, she, it, this, those, which, that
  - *"The system sends a message to the receiver, and it sends an acknowledge message"*
- **Quantifiers (Q):** all, for each, many, some, both
  - *"All lights have a switch"*
- **Domain-specific terms (D-S):** connoisseurship method, herpes zoster, systemic disease, Program

Same Category of Trigger, but Different Ambiguity Type

Example 1 - Under-specified Term $\rightarrow$ Multiple Understanding

- Mobile application that monitors the use of the mobile phone
- **Example:** *"Maybe the system could give me also some recommendations"*
- Interpretations: positive (this app could be useful to you) or negative recommendations (do not use this app)

Same Category of Trigger, but Different Ambiguity Type

Example 2 - Under-specified Term → Undetected Incorrect Disambiguation

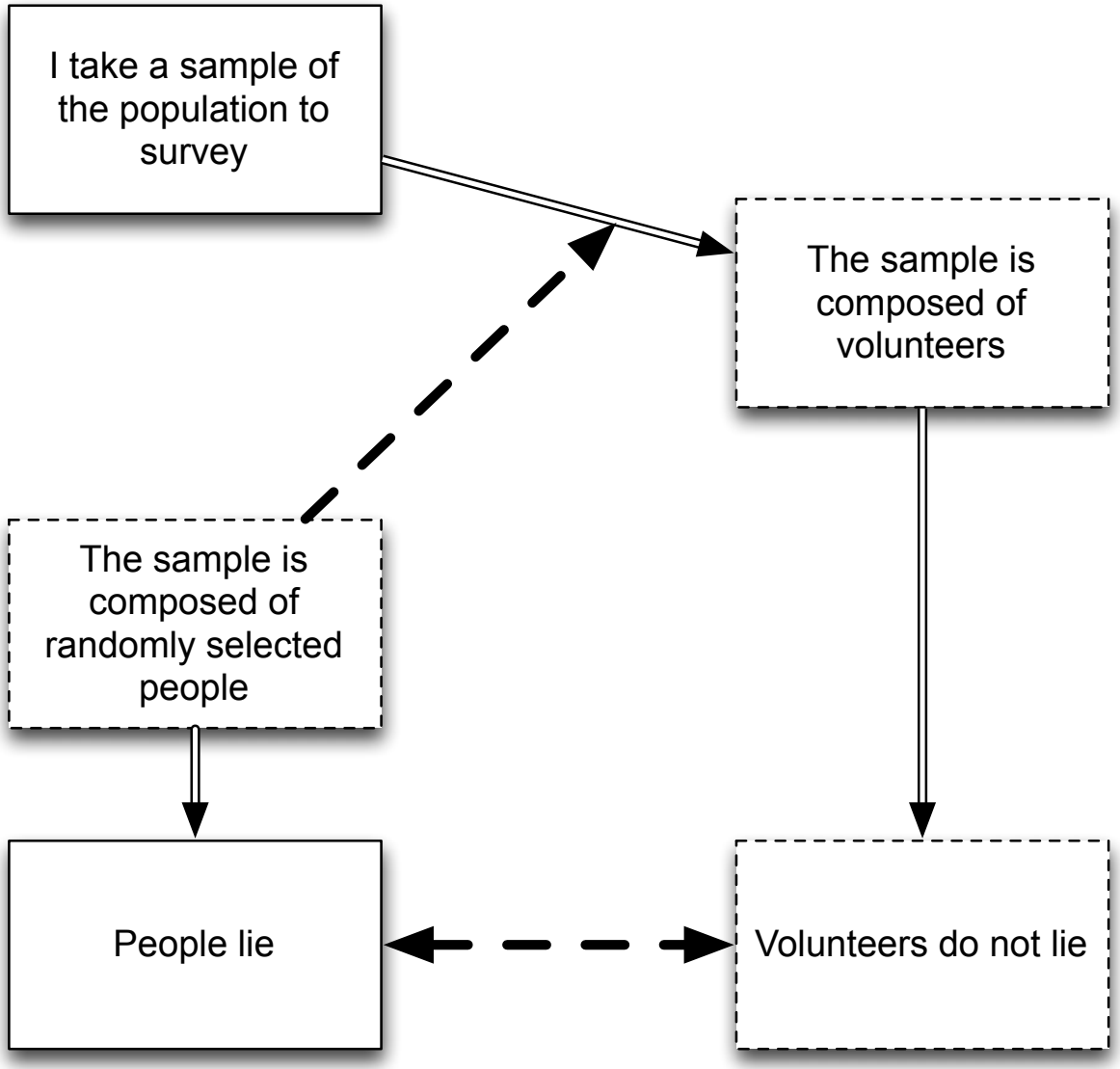
- A system to monitor the diet of patients for research purposes
- **Example:** *"We analyse a representative sample of the population"*
- representative sample == volunteers (Undetected incorrect disambiguation)
- *"People tell lies about their diet"* (Acceptance unclarity)
- representative sample == randomly selected people

Observations

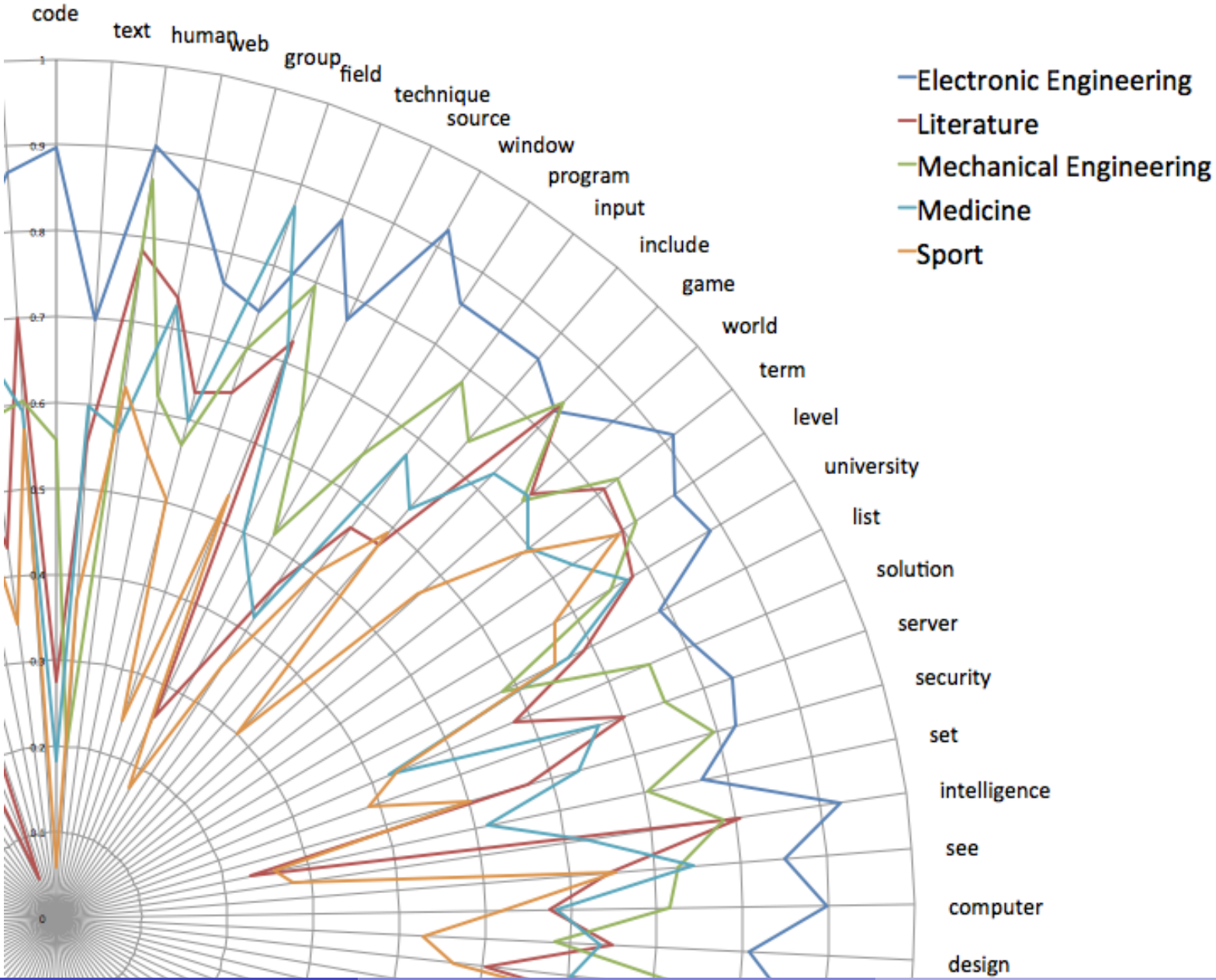
- The majority of ambiguity cases were due to **under-specified** terms and by **fragments**
- Example: *“I want the train to stop within 15 meters if a red signal is passed”*; *“I can go and ask for a product”* (go WHERE?)

- Current research concerning triggers in NL requirements accounts for about 10% of the ambiguity cases in interviews (pronouns, quantifiers and vague terms)
- The remaining 90% of the cases (under-specified, domain-specific and fragments) require further research

Current Research: Using Argumentation (RE'17)



Current Research: Domain-specific Ambiguity (AIRE'17)



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