

Operationalizing Epistemic Modality

P.D. Bruza
R.M. Colomb(ITEE)

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What???

- Knowledge Network is a major element in DSTC 3 planning
- Knowledge resides at nodes
- Knowledge is generated, transmitted and shared among nodes
- DSTC is about building IT things
- So we are talking about computerized knowledge - "intelligent agents"

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What might these do?

- Policy domain like drought management
- All sorts of potentially relevant knowledge
 - Weather patterns •Ecosystems
 - Climate models •Fire management
 - Agricultural practices •Water sources
 - Investment sources •Water uses
 - Insurance •River management

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So???

- Ignorant agents can't share knowledge effectively
- Agents need to know things, not just store data
- Agents need to know what they know and don't know
- This is called epistemic modality
- To build things we need to operationalize their specifications
- So we need to operationalize epistemic modality

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How?

- We need a vocabulary (metalanguage)
- Branch of logic called epistemic logic
- If p is a proposition
- Then agent A knows p is represented
 - $K_A p$
- Agent A doesn't know p
 - $\sim K_A p$

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And??

- Epistemic logic captures intuition about what people know and don't know
- What does it mean for a computer to know something?
- Can't use private experience or implementation details
- Must use observable behaviour
- Need a sort of Turing test

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Human knowing?

- Let's assume a human knows a simple thing - Canberra is capital of Australia
- What is capital of Australia? - Canberra
- What is Canberra? Capital of Australia
- Do you know the capital of Australia? Yes
- Do you know anything about Canberra? Yes
- Is there a relationship between Canberra and Australia? Yes

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How about a computer?

- Could have a database D with schema
 - Country Capital
- And a row
 - Country = Australia, Capital = Canberra
- So an SQL query Q could get the response R
- We could say $K_D(Q, R)$

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How far does this go?

- Can say D knows
 - What is capital of Australia? - Canberra
- But an SQL database can't answer
 - What is Canberra? Capital of Australia
- But an OWL DL system could. Also
 - Do you know the capital of Australia? Yes
 - Do you know anything about Canberra? Yes
- And an OWL Full system could do
 - Is there a relationship between Canberra and Australia? Yes

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How far does this go?

- Can reason from a combination of individual, schema and metaschema
- Using various forms of logic
- This way lies Cyc
- But machine readable formally structured data is expensive
- And the programs are slow and tricky

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Back to humans

- Much of human knowledge is written
- Much of written text is machine-available
- Much machine-available written text is mathematical or in highly structured language
- But we wouldn't say a search engine knows anything
- Context of any document much narrower than the collection it is in

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And???

- Statistical text processing gives useful results
- A search engine doesn't know anything, but the best text Q&A systems are right about 80% of the time
- Statistical text systems have a shallow and unreliable form of knowledge
- But they scale well

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Alternatives?

- Logical methods are reliable but don't scale well
- Statistical text methods scale well but aren't very reliable.
- Can augment text methods with logical by using ontologies, etc.
 - Problem with context
- Can use all three as tools to augment human knowledge handling
 - Information ecology moving in that direction

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Ideas we can maybe use

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Dretske on knowledge, belief and information

A person knows p if she believes that p and her believing that p (or the events in her head responsible for this belief) carries the information that p .
To the extent that our beliefs carry information about the world, they play an invaluable role in guiding our actions and in communicating with others (Barwise and Seligman, Information Flow, p10)

Things outside experience are connected to things within experience in lawlike ways. Thus, we are able to know things about the world beyond our experience.

It is the reliability of the belief producing process that constitutes the difference between knowledge and mere true belief.

There is a close connection between information flow and reliability- for a signal to carry information about a remote state of affairs it must be reliable. An unreliable process will not permit information flow..

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Knowledge

Knowledge is an "epistemic modality" residing in individuals, participants, e.g.

$K_p \varphi$ denotes "participant p knows φ "

If φ is coded, $K_p \varphi$ is *explicit knowledge*

If φ is not coded, $K_p \varphi$ is *tacit knowledge*

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Assumptions about ϕ

- "Inference has something crucial to do with information" (Barwise and Seligman)
- Information is context-, or background- sensitive
- $I = (C, d, \phi)$
- Information ϕ flows from description d placed (or interpreted) in background (context) B
- Notes:
 - Let C be a database, and d be a query description, then ϕ is the query result
 - Sometimes the context C of d is not supplied, or is only partially supplied, so C may need to be inferred (eg enthymeme resolution)
 - What is the epistemic status of C ?

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Enthymeme resolution

The problem of missing premises:

P1 (sender). Sends signal = argument A with missing premises
P2 (receiver) Guess missing premises to ensure validity of A

C = incomplete premise set
 d = conclusion of A
 ϕ = missing premises

"In most real-life situations, most articulate utterance is incomplete in some way or other"

(Gabbay and Woods, The reach of abduction, p187)

The receiver tries to 'repair' the signal.

If this repair is faulty, mis-communication results.

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Knowledge and introspection

- Positive introspection: participant p knows that it knows something

$$K_p \phi \rightarrow K_p K_p \phi$$

- Negative introspection: p knows that it doesn't know something

$$\neg K_p \phi \rightarrow K_p \neg K_p \phi$$

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Introspection and tacit knowledge

- Tacit knowledge is not positively introspective [Anklam, 2002]
 - “Tacit knowledge... cannot be formalized and is often something you don't know that you know”
- Consequently, research into mechanisms that promote introspection are needed to capture tacit knowledge and allow it to be shared.
 - *Ad ignorantiam, Ad verecundiam, Ad populum* (etc.) [see Peter]

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Introspection and KS

- Speculation: Does introspection play a role in KS? Arguably participants know a lot but aren't very “conscious” of what they know (e.g., due to scarcities of epistemic resources) producing “forgetfulness” or even “ignorance”. Therefore, do participants need to be (positively) introspective about information before they can share it?

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The point is?

- Operationalising epistemic modality leads to lots of interesting and profound research questions
- With potentially big payoffs

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