The pragmatics of questions and answers

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This lecture

1. A brief, semi-historial overview of linguistic pragmatics
2. A few notes on the SUBTLE project
3. Some illustrative examples
4. The partition semantics for questions
5. A decision-theoretic approach
6. Research challenges

Useful follow-up reading: Chapters 23 and 24 of Jurafsky and Martin (chapters 18 and 19 of the 1st edition)

The merest sketch

Figure 0.1
Rembrandt sketch

The merest sketch

Figure 0.1
Rembrandt sketch

"So here is the miracle: from a merest, sketchiest squiggle of lines, you and I converge to find adumbration of a coherent scene"

"The problem of utterance interpretation is not dissimilar to this visual miracle. An utterance is not, as it were, a verdical model or 'snapshot' of the scene it describes"

—**Levinson (2000)**

The birth of Gricean pragmatics

In the early 1960s, Chomsky showed us how to give compact, general specifications of natural language syntax.

In the late 1960s, philosopher and linguist H. Paul Grice had the inspired idea to do the same for (rational) social interactions.

Rules and maxims

Rules

$$
\begin{aligned}
S &\Rightarrow NP \quad VP \\
NP &\Rightarrow N | PN \\
N &\Rightarrow \textit{hippo} | \cdots \\
VP &\Rightarrow V_s \quad S \\
VP &\Rightarrow V_{trans} \quad NP \\
V_s &\Rightarrow \textit{realize} | \cdots
\end{aligned}
$$

Maxims

Quality Above all, be truthful!
Relevance And be relevant!
Quantity Within those bounds, be as informative as you can!
Manner And do it as clearly and concisely as possible!

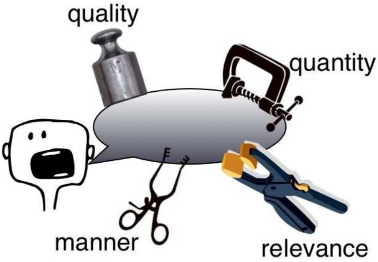
Syntactic rules are like physical laws.

Breaking them should lead to nonsense (or falsification).

Pragmatic rules (maxims) are like laws of the land.

Breaking them can have noteworthy consequences.

Pragmatic pressures



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“Then a miracle occurs”

The maxims do not yield easily to a treatment in the usual terms of semantic theory. One can usually be precise up to a point, but then . . .

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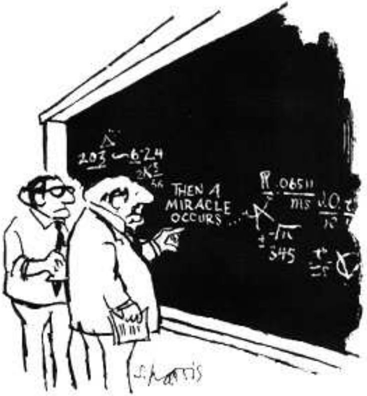


"I think you should be more explicit here in step two."

The probability of formalizing the maxims

Some are skeptical:

- Beaver (2001:29) calls formalization in this area "notoriously problematic".
- Bach (1999) is more decisive, offering various reasons why "it seems futile for linguists to seek a formal pragmatics".
- Devitt and Sterelny (1987:§7.4) strike a similar chord.

It's a harsh verdict. Maxims (at least one) are the main engine behind all pragmatic theories.

A probable breakthrough

Things are looking up.

Researchers are making significant progress with decision-theoretic and game-theoretic models.

The chief innovation

A shift in emphasis from truth-conditions to probabilities.

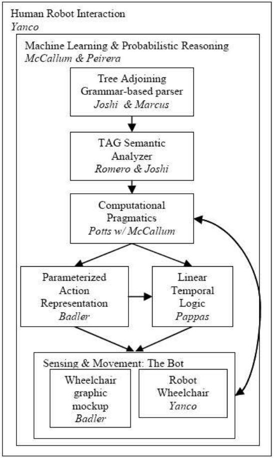
SUBTLE

Situation Understanding Bot Through Language & Environment

SUBTLE Team

"we must move from robust *sentence processing* to robust *utterance understanding*"

Mitch Marcus, Norm Badler, Aravind Joshi, George Pappas, Fernando Pereira, Maribel Romero (Penn); Andrew and me (UMass Amherst); Holly Yanco (UMass Lowell)



Pragbot data-gatherer

- Pragbot is a game played on the Net, in a browser.
- The players comunicate via an Instant Messaging function that logs all their messages and actions in the game world.
- Pragbot scenarios mirror search-and-rescue scenarios, but with simplifications that make linguistic modelling more tractable.

(Pragbot was developed by Andrew McCallum, Chris Potts, and Karl Shultz, and coded by Karl Schultz.)

A screenshot

Fast and flexible data collection

Pragbot is lightweight and flexible. We have changed the interface and the task descriptions a number of times, with each change bringing in linguistically richer interactions.

Illustrative data

We begin with a range of cases involving questions and their answers. The primary question:

What counts as a resolving answer?

We chose the data with the following general scenario in mind: a human operator is querying a bot. The bot should give resolving answers (where his knowledge base permits them).

Mention-all vs. mention-some

Where can we buy supplies?

Mention-all vs. mention-some

Where can we buy supplies?

Mention-all

- **Context**: We're writing a comprehensive guide to the area.
- **Resolvedness condition**: An exhaustive listing of the (reasonable) shopping places.

Mention-all vs. mention-some

Where can we buy supplies?

Mention-all

- **Context**: We're writing a comprehensive guide to the area.
- **Resolvedness condition**: An exhaustive listing of the (reasonable) shopping places.

Mention-some

- **Context**: We're low on food and water.
- **Resolvedness condition**: Mentioning the best (closest, safest, etc.) place, or a few good options.

Mention-all vs. mention-some

Who has a light?

Mention-all vs. mention-some

Who has a light?

Mention-all

- **Context**: Speaker needs to ensure that no one in the group is going to get stopped by airport security.
- **Resolvedness condition**: Listing of everyone who has a light.

Mention-all vs. mention-some

Who has a light?

Mention-all

- **Context**: Speaker needs to ensure that no one in the group is going to get stopped by airport security.
- **Resolvedness condition**: Listing of everyone who has a light.

Mention-some

- **Context**: Speaker needs to light her cigar.
- **Resolvedness condition**: Just name one (friendly, willing, nearby) person with a lighter.

Domain restrictions

What cards do you have?

Domain restrictions

What cards do you have?

Wide domain

- **Context**: Speaker dealt the cards and noticed that some were missing.
- **Resolvedness condition**: List everything you're holding.

Domain restrictions

What cards do you have?

Wide domain

- **Context**: Speaker dealt the cards and noticed that some were missing.
- **Resolvedness condition**: List everything you're holding.

Narrowed domain

- **Context**: Speaker folds. He wants to know what beat him.
- **Resolvedness condition**: Just name the good cards (if there are any).

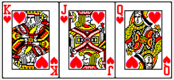
Domain restrictions

Example (Pragbot data)

`Did you find anything?`

Domain restrictions

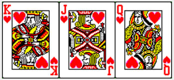
Example (Pragbot data)

Context: Player 2 is looking for 

```
Player 2:  Did you find anything?
           [...]
Player 1:  yep, h at the top exit
```

Domain restrictions

Example (Pragbot data)

Context: Player 2 is looking for 

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Player 2:   Did you find anything?
            [...]
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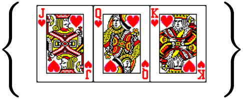


Domain restrictions

Example (Pragbot data)

`Have you found anything?`

Domain restrictions

Example (Pragbot data)

Context: The players are trying to get six consecutive hearts, but they are still in the process of deciding which six.

```
Player 2:  i got 2H
Player 1:  I found a 3H
Player 2:  sweet.
           [...]
Player 1:  Have you found anything?
Player 2:  no, just 2H
```

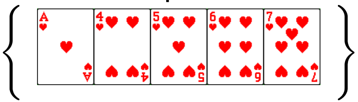
Domain restrictions

Example (Pragbot data)

Context: The players are trying to get six consecutive hearts, but they are still in the process of deciding which six.

Player 2: i got 2H
Player 1: I found a 3H
Player 2: sweet.
[...]
Player 1: Have you found anything?
Player 2: no, just 2H

No suggestion that Player 2 didn't see 3D, KD, etc.



Identification conditions

Who is Arnold Schwarzenegger?

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- *The governor of California.*

Identification conditions

Who is Arnold Schwarzenegger?

- *A famous bodybuilder.*

Identification conditions

Who is Arnold Schwarzenegger?

- *The Terminator.*

Identification conditions

Who is Arnold Schwarzenegger?

- *That guy over there.*

Identification conditions

Who is Arnold Schwarzenegger?

- *The governor of California.*
- *A famous bodybuilder.*
- *The Terminator.*
- *That guy over there.*

Levels of specificity

Who was at the meeting?

Levels of specificity

Who was at the meeting?

General

- **Context**: The speaker wants to get a sense for what kind of meeting it was.
- **Resolvedness condition**: *Some linguists, some computer scientists, some mathematicians.*

Levels of specificity

Who was at the meeting?

General

- **Context**: The speaker wants to get a sense for what kind of meeting it was.
- **Resolvedness condition**: *Some linguists, some computer scientists, some mathematicians.*

Specific

- **Context**: The speaker is checking against a list of likely attendees.
- **Resolvedness condition**: *Chris, Alan, Mitch, . . .*

Granularity

Where are you from?

Granularity

Where are you from?

- *Massachusetts.*

Granularity

Where are you from?

- *The U.S.*

Granularity

Where are you from?

- *Planet earth.*

Granularity

Where are you from?

- *Connecticut.* (My birthplace.)

Granularity

Where are you from?

- *UMass Amherst.* (My university.)

Granularity

Where are you from?

- *Belgium.* (My ancestral home.)

Granularity

Where are you from?

- *Massachusetts.*
- *The U.S.*
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Granularity

Pragbot players can't see each other, but they must coordinate their movements. As a result, they ask many versions of

Where are you?

They answer at different levels of granularity depending on

- the task they were assigned
- the current subtask
- the nature of the environment
- their current knowledge of each other's whereabouts

Granularity

Example (Pragbot data)

Player A: Where are you?

```
Player B:  in the first box-like region in the
           center, 2nd row
Player B:  I'm sort of in the middle.
Player B:  still at the right bottom corner
```

- Unattested: "In the pragbot world"
  (redundant in context)
- Attested confusion: "In Northampton"
  (at the start of the game; players not yet fully engaged)

Polarity variation

How high is a helicopter permitted to fly?

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Lower bound

- **Context**: We need to avoid the powerlines while still getting close to the ground.
- **Resolvedness condition**: The lowest safe height.

Polarity variation

How high is a helicopter permitted to fly?

Lower bound

- **Context**: We need to avoid the powerlines while still getting close to the ground.
- **Resolvedness condition**: The lowest safe height.

Upper bound

- **Context**: We need to be sure the atmosphere isn't too thin.
- **Resolvedness condition**: The highest safe height.

Gradable modifiers

Is the door open?

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Maximal interpretation

- **Context**: We need to get a vehicle out of the building. It barely fits through the doorway.
- **Intended**: Is the door *completely* open?

Gradable modifiers

Is the door open?

Maximal interpretation

- **Context**: We need to get a vehicle out of the building. It barely fits through the doorway.
- **Intended**: Is the door *completely* open?

Minimal interpretation

- **Context**: We need to secure the building.
- **Intended**: Is the door *even a little bit* open?

Plurals

Are the windows are open?

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Existential reading

- **Context**: We need to ensure the building is locked up.
- *the windows* $\approx$ some of the windows

Plurals

Are the windows are open?

Existential reading

- **Context**: We need to ensure the building is locked up.
- *the windows* ≈ some of the windows

Universal reading

- **Context**: We are painting the sills.
- *the windows* ≈ all the windows

Pragmatically required over-answering

Ali calls a hotel

Ali:	Is Lisa Simpson in Room 343?	
Clerk A:	She's in room 400.	(implicit "no")
Clerk B:	She checked out yesterday.	(implicit "no")
Clerk C:	#No.	

Pragmatically required over-answering

Example (Pragbot data)

`Can you take the inside of the cube.`

The answers expected by the form ("yes", "no") are infelicitous because their content is mutually known. (The players have freedom of movement.)

Pragmatically required over-answering

Example (Pragbot data)

Context: The players are planning their search strategy

```
Player 1:  Can you take the inside of the cube.
Player 2:  ok I take the inside
Player 1:  I'll look on the outside
```

The answers expected by the form ("yes", "no") are infelicitous because their content is mutually known. (The players have freedom of movement.)

Pragmatically required over-answering

Example (Worcester Cold Storage Fire)

Context: Firemen lost inside a large, maze-like building with a floor-plan that effectively changed by the minute as rooms filled with smoke and walls collapsed.

`Car 3`	`Okay, do we have fire coming up through the roof yet?`
`L-1/P1`	`We have a lot of hot embers blowing through.`

Inferred pragmatically No, but . . .

(A mere "no" would be disastrous here.)

Devious exploitation of pragmatic inferencing

From Bronston v. United States

Q: Do you have any bank accounts in Swiss banks, Mr. Bronston?

A: No, sir.

Q: Have you ever?

A: The company had an account there for about six months, in Zurich.

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A: The company had an account there for about six months, in Zurich.

The truth

Bronston once had a large personal Swiss account.

The issue

The cooperative inference of the previous slide has gotten us into trouble here.

Partition semantics and answer values

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Answering

- Fully congruent answers identify a single cell.
- Partial answers overlap with more than one cell.
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Groenendijk (1999) is a dynamic logic of questions and their answers. ten Cate and Shan (2007) give it a proof theory and show that it is fruitfully thought of from a variety of perspectives. Vermeulen (2000) is, in a sense, an extension to genuinely strategic, multi-agent settings.

Polar questions

$[\![$**Did Sam laugh?**$]\!] =$

$$\Big\{\{v \in W \mid v \in [\![\textbf{laughed(sam)}]\!] \text{ iff } w \in [\![\textbf{laughed(sam)}]\!]\} \;\Big|\; w \in W$$

$[\![\textbf{laughed(sam)}]\!]$	$W - [\![\textbf{laughed(sam)}]\!]$

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Answers

"Yes"

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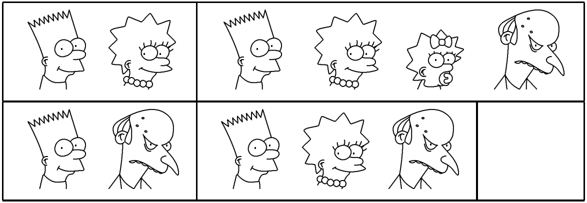
Answers

"No"

Constituent questions

$$[\![\textbf{Who laughed?}]\!] =$$

$$\Big\{ \{ v \in W \mid \forall d.\, [\![\textbf{laugh}]\!](d)(v) \text{ iff } [\![\textbf{laugh}]\!](d)(w) \} \;\Big|\; w \in W \Big\}$$



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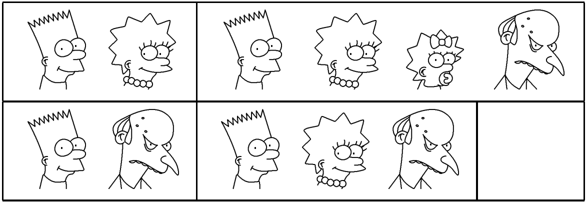

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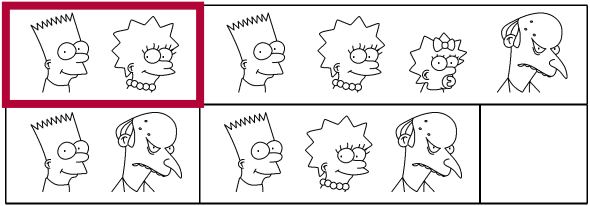

Answers

"Bart and Lisa"

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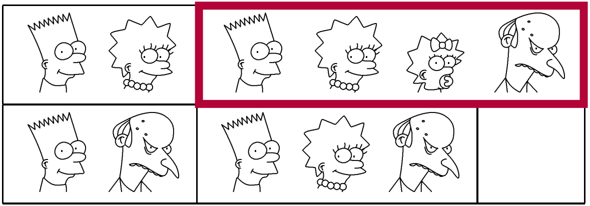

Answers

"Bart, Lisa, Maggie, and Burns"

Constituent questions

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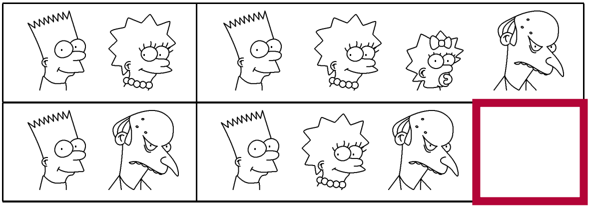

Answers

"No one"

Answer values

We get a rough measure of the extent to which p answers Q by inspecting the cells in Q with which p has a nonempty intersection:

Definition (Answer values)

$$\mathrm{Ans}(p, Q) = \{q \in Q \mid p \cap q \neq \emptyset\}$$

Example

Bart: Did Sam laugh?

Lisa:

$[\![\textbf{laughed(sam)}]\!]$	$W - [\![\textbf{laughed(sam)}]\!]$

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Lisa: Yes. $|\mathrm{Ans}| = 1$

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Example

Bart: Did Sam laugh?

Lisa: No. $|\mathrm{Ans}| = 1$

$[\![\mathbf{laughed(sam)}]\!]$	$\boxed{W - [\![\mathbf{laughed(sam)}]\!]}$

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Definition (Answer values)

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Example

Bart: Did Sam laugh?

Lisa: I heard some giggling. $\quad |\mathrm{Ans}| = 2$

$[\![\textbf{laughed}(\textbf{sam})]\!]$	$W - [\![\textbf{laughed}(\textbf{sam})]\!]$

Over-informative answers

Ans values are a bit too blunt, since $\mathrm{Ans}(p, Q) = \mathrm{Ans}(p', Q)$ wherever $p' \subseteq p$, for all questions Q.

Example

Bart: Is Sam happy at his new job?

Lisa:

$[\![\textbf{happy}(\textbf{sam})]\!]$	$W - [\![\textbf{happy}(\textbf{sam})]\!]$

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Example

Bart: Is Sam happy at his new job?

Lisa: Yes, and he hasn't been to jail yet. $|\text{Ans}| = 1$

$[\![\textbf{happy}(\textbf{sam})]\!]$	$W - [\![\textbf{happy}(\textbf{sam})]\!]$

A preference ordering

Definition (Relevance (G&S, van Rooij))

$$p \succ_Q q \quad \text{iff} \quad \begin{array}{l} \mathrm{Ans}(p, Q) \subset \mathrm{Ans}(q, Q) \text{ or} \\ \mathrm{Ans}(p, Q) = \mathrm{Ans}(q, Q) \text{ and } q \subset p \end{array}$$

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Example

In the previous example,

$$[\![\mathbf{happy(sam)}]\!] \succ_{[\![?\mathbf{happy(sam)}]\!]} [\![\mathbf{happy(sam)} \wedge \mathbf{no\text{-}jail(sam)}]\!]$$

While their Ans values are the same, the first is a superset of the second.

Example: Granularity

Example

$$\textbf{Where are you from?} \begin{cases} \approx \textbf{Which planet are you from?} \\ \approx \textbf{Which country are you from?} \\ \approx \textbf{Which city are you from?} \\ \qquad \ldots \end{cases}$$

Example: Granularity

Example

$$\textbf{Where are you from?} \begin{cases} \approx \textbf{Which planet are you from?} \\ \approx \textbf{Which country are you from?} \\ \approx \textbf{Which city are you from?} \\ \quad \ldots \end{cases}$$

Definition (Fine-grainedness (van Rooy, 2004))

A question Q is more fine-grained than question Q' iff

$$Q \sqsubseteq Q' \text{ iff } \forall q \in Q \; \exists q' \in Q' \; q \subseteq q'$$

If Q is more fine-grained than Q', then an exhaustive answer to Q is more informative than an exhausitive answer to Q'.

Conversational implicatures

Partial answers

Ans values bring us part of the way towards understanding relevance implicatures.

Example (Partial answer)

Tom:	Which city does Barbara live in?	
Jerry:	Barbara lives in Russia.	$(\mid \text{Ans} \mid > 1)$

- Implicature: Jerry doesn't know which city.

Partial answers

Ans values bring us part of the way towards understanding relevance implicatures.

Example (Partial answer)

Tom:	Which city does Barbara live in?	
Jerry:	Barbara lives in Russia.	$(\lvert \text{Ans} \rvert > 1)$

- Implicature: Jerry doesn't know which city.

Example (Complete answer)

Tom:	Which country does Barbara live in?	
Jerry:	Barbara lives in Russia.	$(\lvert \text{Ans} \rvert = 1)$

- No implicature about Jerry's city-level knowledge.

Over-answer implicatures

When speakers over-answer, they seem to communicate that the original QUD is not (quite) appropriate. They address their answers to a different QUD.

Example

Bart:	Is Sam happy at his new job?
Lisa:	Yes, and he hasn't been to jail yet.

Example

Sam:	Do you know what time it is?
Sue:	Yes, it's 4:15.

Pragmatic principles

Let Q be the question under discussion (QUD).

For speakers

Answer Q with a proposition p such that

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For hearers

Let p be the speaker's answer. For all q such that such that $q \succ_Q p$, the speaker is not positioned to offer q felicitously.

- If $q \subset p$, then the speaker lacks sufficient evidence for q.
- If $p \subset q$, then the speaker is answering a different QUD, thereby implicating that Q is not the right QUD.

Desiderata

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Desiderata

1. Discourse participants negotiate the nature of questions. What motivates them?
2. It is essential that we achieve more precise statements of the implicatures and their calculations.
3. Ideally, we would reduce the pragmatic principles involved in relevance implicature calculations to something more fundamental.
4. We'd like an account of the pragmatic variability of questions discussed earlier (mention-some vs. mention-all, and so forth).

Decision problems

Decision problems

As a first step towards satisfying our desires for this analysis, we'll inject some decision theory into our pragmatics, as a way of making sense primarily of answers.

Definition (Decision problems)

A decision problem is a structure $DP = (W, S, P_S, A, U_S)$:

- W is a space of possible states of affairs;
- S is an agent;
- P_S is a (subjective) probability distribution (for agent S);
- A is a set of actions that S can take; and
- U_S is a utility function for S, mapping action–world pairs to real numbers.

Example: Schlepp the umbrella?

Example (The decision problem Schlepp)

- $W = \{w_1 \dots w_{10}\}$. Assume it rains in $\{w_1 \dots w_7\}$ and not in $\{w_8 \dots w_{10}\}$.
- $P_S(\{w_i\}) = P_S(\{w_j\})$ for all $w_i, w_j \in W$
- $A = \{\textbf{umbrella}, \textbf{no-umbrella}\}$
- $$\begin{aligned} U(\textbf{umbrella}, w_i) &= 2 && \text{if it rains in } w_i \\ U(\textbf{umbrella}, w_i) &= -2 && \text{if it doesn't rain in } w_i \\ U(\textbf{no-umbrella}, w_i) &= -8 && \text{if it rains in } w_i \\ U(\textbf{no-umbrella}, w_i) &= 4 && \text{if it doesn't rain in } w_i \end{aligned}$$

	rain	no rain
umbrella	2	−2
no-umbrella	−8	4

S is deciding under uncertainty. What's his best move?

Expected utilities

Expected utilities take risk into account when measuring the usefulness of performing an action.

Definition

For decision problem $DP = (W, S, P_S, A, U_S)$ the *expected utility* of an action $a \in A$

$$\mathrm{EU}_{DP}(a) = \sum_{w \in W} P(\{w\}) \cdot U(a, w)$$

Solving decision problems

Definition (Utility value of a decision problem)

Let $DP = (W, S, P_S, A, U_S)$ be a decision problem.

$$\mathrm{UV}(DP) = \max_{a \in A} \mathrm{EU}_{DP}(a)$$

Definition (Solving a decision problem)

Let $DP = (W, S, P_S, A, U_S)$ be a decision problem. The solution to DP is

$$\text{choose } a \text{ such that } \mathrm{EU}_{DP}(a) = \mathrm{UV}(DP)$$

Solving the umbrella problem

	rain (.7)	no rain (.3)	EU
umbrella	2	-2	.8
no-umbrella	-8	4	-4.4

- $$\begin{aligned} \mathrm{UV}(\mathrm{Schlepp}) &= \max_{a \in \{\textbf{umbrella}, \textbf{no-umbrella}\}} \mathrm{EU}(a) \\ &= .8 \end{aligned}$$
- The optimal action is **umbrella**.

Utility value of new information

Incoming information might change the decision problem by changing the expected utilities.

Definition (Conditional expected utility)

Let $DP = (W, S, P_S, A, U_S)$ be a decision problem.

$$\mathrm{EU}_{DP}(a|p) = \sum_{w \in W} P(\{w\}|p) \cdot U(a, w)$$

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Example

- $\mathrm{EU}(\textbf{no-umbrella}) = -4.4$
- $\mathrm{EU}(\textbf{no-umbrella}|\{w_8, w_9, w_{10}\}) = 4$ (given no rain)
- $\mathrm{EU}(\textbf{umbrella}) = .8$
- $\mathrm{EU}(\textbf{umbrella}|\{w_8, w_9, w_{10}\}) = -2$ (given no rain)

Changes to the utility value

The utility value of new information is a measure of the extent to which it changes the utility value of the decision problem.

Definition

$$\mathrm{UV}_{DP}(p) = \max_{a \in A} \mathrm{UV}_{DP}(a|p) - \mathrm{UV}(DP)$$

Example

For the umbrella example, the utility value jumps from .8 to 4 when we learn that it will be sunny. Thus:

$$\mathrm{UV}_{\mathrm{Schlepp}}(\{w_8, w_9, w_{10}\}) = 3.2$$

Applications

Action propositions

Definition

If $DP = (W, S, P_S, A, U_S)$ is a decision problem and a is an action in A, then

$$a^* = \{w \in W \mid U_S(a, w) \geqslant U_S(a', w) \text{ for } a' \in A\}$$

If there is a unique optimal action in every world, then A^*, the set of propositions $a^* \in A$, is a partition. But we won't impose this condition.

Example: Visiting Barbara

- $$W = \{w_1, \ldots, w_4\}$$
  $$[\![B \textit{ lives in Moscow}]\!] = \{w_1\} \quad [\![B \textit{ lives in Prague}]\!] = \{w_3\}$$
  $$[\![B \textit{ lives in Petersburg}]\!] = \{w_2\} \; [\![B \textit{ lives in Budapest}]\!] = \{w_4\}$$
- $P_S(\{w_i\}) = P_S(\{w_j\})$ for all $w_i, w_j \in W$
- $A = a_x$, where
  $x \in \{\text{Moscow}, \text{Petersburg}, \text{Prague}, \text{Budapest}\}$
- $U(a_x, w) = 10$ if Barbara lives in x in w, else
  $U(a_x, w) = 0$.

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Action propositions

$$\begin{array}{rclrcl} a^*_{\text{Moscow}} & = & \{w_1\} & a^*_{\text{Prague}} & = & \{w_3\} \\ a^*_{\text{Petersburg}} & = & \{w_2\} & a^*_{\text{Budapest}} & = & \{w_4\} \end{array}$$

Resolving the problem

Example

Assume the decision problem that Bart's question gives rise to (or, the one that gives rise to his question) is as before.

Bart: Where does Barbara live?

$$\left\{\begin{array}{cc} \{w_1\} & \{w_2\} \\ \{w_3\} & \{w_4\} \end{array}\right\}$$

Lisa: Russia.

$\Rightarrow$ Does not resolve the decision problem.

Lisa: Petersburg (Moscow, Prague, ...).

$\Rightarrow$ Resolves the decision problem

Example: Which country?

- $$W = \{w_1, \ldots, w_4\}$$
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$$\left\{ \begin{array}{c} a^*_{\text{Russia}} = \{w_1, w_2\} \\ a^*_{\text{Czech}} = \{w_3\} \quad a^*_{\text{Hungary}} = \{w_4\} \end{array} \right\}$$

Resolving the problem

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Lisa: Petersburg (Moscow, Prague, ...).

$\Rightarrow$ Resolves the decision problem but provides too much information.

Resolving the problem

$$\left\{ \begin{matrix} \{w_1\} & \{w_2\} \\ \{w_3\} & \{w_4\} \end{matrix} \right\}$$

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$$p \succ_Q q \quad \text{iff} \quad \begin{array}{l} \text{Ans}(p, Q) \subset \text{Ans}(q, Q) \text{ or} \\ \text{Ans}(p, Q) = \text{Ans}(q, Q) \text{ and } q \subset p \end{array}$$

$$p \succ_{A*} q \quad \text{iff} \quad \begin{array}{l} \text{Ans}(p, A^*) \subset \text{Ans}(q, A^*) \text{ or} \\ \text{Ans}(p, A^*) = \text{Ans}(q, A^*) \text{ and } q \subset p \end{array}$$

Mention-some questions

Example (Craige Roberts)

I'm working on a rush plumbing project and need some parts.

Where can one buy faucet washers?

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Domain restrictions

Example (van Rooy 2003)

I fold. I'm curious about whether I did the right thing.

What (cards) do you have?

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What (cards) do you have?

A choice of domain leads to a choice of granularity for A^*.
The order $\succ_{A^*}$ can then home in on the optimal choice.

Expected utility values of questions

$\mathrm{EUV}_{DP}(Q)$ gives the average utility of the members of Q.

Definition

Let $DP = (W, S, P_S, A, U_S)$ be a decision problem. Then

$$\mathrm{EUV}_{DP}(Q) = \sum_{q \in Q} P_S(q) \cdot UV_{DP}(q)$$

The following ordering is determined largely by EUV, but it resorts to the measure of granularity to resolve ties.

Definition

$$Q \succ_{DP} Q' \text{ iff } \begin{array}{l} \mathrm{EUV}_{DP}(Q) > \mathrm{EUV}_{DP}(Q') \text{ or} \\ \mathrm{EUV}_{DP}(Q) = \mathrm{EUV}_{DP}(Q') \text{ and } Q' \sqsubset Q \end{array}$$

Pragmatic principles, decision-theoretically

Let $DP_{I,J} = (W, S, P_{I,J}, A, U_{I,J})$ be a pair of decision problems differing only in the agent (I or J).

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In both cases, the speaker's behavior is shaped by the decision problem.

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   - Situations (what counts as minimal?)
   - Reference (which mode is best?)
   - Comparatives (which contextual standard?)
2. Further articulate the role of decisions by moving to a game-theoretic setting.
3. Get a better grip on how these pragmatic factors can influence embedded readings.

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