CS 784: Computational Linguistics
Lecture 17: Pragmatics

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March 18, 2025

Implicatures
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Pragmatic Phenomena
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The Rational Speech Act Framework
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Announcements

Assignment 2: For GPT-2 conditional entropy/probability calculation, since there is no official start-of-sentence token, we cannot directly calculate a well-defined $P(w_0)$. Instead, you may just start from the second word.

Final Exam: Apr 11, 2025, 4:00pm-6:30pm, MC 2034. It will be open-book, open-notes, and open-internet.

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Pragmatics: Meanings Beyond Semantics

A diplomat who says yes means maybe, a diplomat who says maybe means no, and a diplomat who says no is no diplomat.
—Talleyrand

Pragmatics: Meanings Beyond Semantics

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What one communicates may differ from what one literally says.

Pragmatics: the study of the underlying communication intentions and goals of speakers.

Near-Side vs. Far-Side Pragmatics

- **Near-side pragmatics** focuses on facts relevant to what is said.

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Stop at the car.   *I'm running late.*

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Near-Side vs. Far-Side Pragmatics

- **Near-side pragmatics** focuses on facts relevant to what is said.
- **Far-side pragmatics** focuses on what happens beyond.

Stop at the car.
Near-side: the speaker is talking about where to park the car (among multiple options).

I'm running late.
Far-side: the speaker is implying that the listener (the driver) should hurry up.

Grice's Maxims

- **Quantity**: Make your contribution as informative as is required.
  1. Make your contribution as informative as is required (for the current purposes of the exchange).
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- **Relation**: Be relevant.

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- **Manner**: Be perspicuous.
  - Unclear statements usually carry more information.

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  - Unclear statements usually carry more information.

  A and B are talking about a mutual friend, C, who is now working in a bank. A asks B how C is getting on in his job, and B replies: Oh quite well, I think; he likes his colleagues, and he hasn't been to prison yet.

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Q-Based and R-Based Implicatures

Q(uantity-1)-based implicature: make your contribution as informative as is required.

Some students passed the exam.

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- At least one (or two) student passed the exam.
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R(elation; quantity-2)-based implicature: say no more than is required.

I broke a finger yesterday.

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R(elation; quantity-2)-based implicature: say no more than is required.

I broke a finger yesterday.

- I broke my own finger. There is no reason to say *my* finger as it can be inferred.

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Implicatures

- The speaker had said that p (utterance).

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- They know (**and know that I know that they know**) that I can see that the supposition that they think that q is required.
- They have done nothing to stop me thinking that q.
- They intended me to think, or at lease willing to allow me to think, that q; and so they have implicated that q.

Scalar Implicature

You know that there are three apples on the table, but only I can see them. You hear me say, *some of the apples are red.*

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[Source: Scontras et al.; https://www.problang.org/]

Indirect Scalar Implicature

Direct implicature: *some* means *some but not all*.

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You know that there are three apples on the table, but only I can see them. You hear me say, *not all apples are red*.
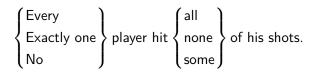
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Indirect Scalar Implicature

Direct implicature: *some* means *some but not all*.

You know that there are three apples on the table, but only I can see them. You hear me say, *not all apples are red.*

How many apples do you think are red?

Indirect implicature: *not all* means *some* (i.e., at least one).

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Embedded Implicature

$$\left\{\begin{array}{l}\text{Every} \\ \text{Exactly one} \\ \text{No}\end{array}\right\} \text{player hit} \left\{\begin{array}{l}\text{all} \\ \text{none} \\ \text{some}\end{array}\right\} \text{of his shots.}$$

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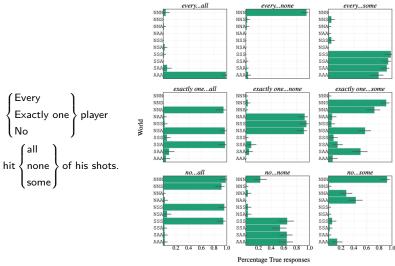
Exactly one player hit some of his shots.

False ◯◯ True

Continue

[Source: Potts et al., 2015]

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Embedded Implicature

Humans show clear preferences on world states.

$$\left\{\begin{array}{l}\text{Every}\\\text{Exactly one}\\\text{No}\end{array}\right\}\text{ player}$$

$$\text{hit}\left\{\begin{array}{l}\text{all}\\\text{none}\\\text{some}\end{array}\right\}\text{ of his shots.}$$

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Question Under Discussion

I've been waiting for a million years.
I paid one thousand dollars for the coffee.

Question Under Discussion

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Communication intents are relevant to what question under discussion (QUD) a speaker is likely addressing with their utterances.

Comparison Class

*Look at the **big** tree near the **small** lake.*

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Comparison Class

*Look at the **big** tree near the **small** lake.*

The *small lake* is larger than the *big tree* anyway.

This is because we infer the different comparison classes for them.

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Overinformativeness and Politeness

(In a coffee shop)
Q: Do you have iced tea?
*A: No, but we do have **iced coffee**.*

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People often violate the informativeness rule.

Overinformativeness and Politeness

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People often violate the informativeness rule.

In such a scenario, pragmatic inference happens when choosing the substitution:

- * *No, but we do have **muffins**.*
- * *No, but we do have **laptops**.*

Referential Communication Game

[Source: Frank & Goodman, 2012]

You and your friend are playing a referential communication game.

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- The **speaker** knows the correct object and tells the listener.

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Referential Communication Game

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You and your friend are playing a referential communication game.

- The **speaker** knows the correct object and tells the listener.
- The **listener** picks up **one** object following the speaker's instruction.
- Both players will be rewarded if the listener picks up the correct object.
- The speaker can only refer to the intrinsic properties of objects (no "middle" or "left" etc.).

Referential Communication Game: Example

[Source: Frank & Goodman, 2012]

For simplicity, we assume the speakers will only use **color** and/or **shape** to refer to objects.

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For simplicity, we assume the speakers will only use **color** and/or **shape** to refer to objects.

Suppose you are the **listener** and hear "**square**."

Which object will you pick?

Referential Communication Game: Example

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Which object will you pick? Most participants say the **first**.

Referential Communication Game: Example

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Suppose you are the **listener** and hear "**square**."

Which object will you pick? Most participants say the **first**.

Suppose you are the **speaker** and want to refer to the third object.

Which word will you use, **green** or **square**?

Referential Communication Game: Example

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Suppose you are the **listener** and hear "**square**."

Which object will you pick? Most participants say the **first**.

Suppose you are the **speaker** and want to refer to the third object.

Which word will you use, **green** or **square**?

A: **green** as it's less ambiguous.

The Rational Speech Act (RSA) Framework

[Source: Frank & Goodman, 2012]

Computationally models the process that "square" refers to the first object.

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A Bayesian approach: derive posterior (pragmatics) from the prior (semantics/literal meanings).

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Computationally models the process that "square" refers to the first object.

A Bayesian approach: derive posterior (pragmatics) from the prior (semantics/literal meanings).

We need a set of pre-defined **world states** (i.e., possible choices) S and possible **utterances** U:

$$S = \{\text{blue-square, blue-circle, green-square}\}$$
$$U = \{\text{blue, green, square, circle}\}$$

RSA: Literal Listener L_0

[Source: Frank & Goodman, 2012]

$S = \{\text{blue-square, blue-circle, green-square}\}$

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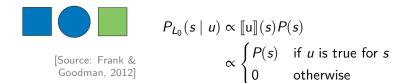
$U = \{\text{blue, green, square, circle}\}$

[Source: Frank & Goodman, 2012]

$$P_{L_0}(s \mid u) \propto [\![u]\!](s)P(s)$$
$$\propto \begin{cases} P(s) & \text{if } u \text{ is true for } s \\ 0 & \text{otherwise} \end{cases}$$

$$[\![\text{blue}]\!][\text{blue-square}] = 1$$
$$[\![\text{blue}]\!][\text{green-square}] = 0$$
$$[\![\text{green}]\!][\text{green-square}] = 1$$

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RSA: Literal Listener with an Example

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Suppose $P(s)$ is uniform over all s, here is $[\![u]\!](s)P(s)$:

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$U \backslash S$	blue-square	blue-circle	green-square
blue	1/3	1/3	0
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P_{L_0} is a **probability distribution**, so we normalize the table:

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RSA: Pragmatic Speaker S_1

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Suppose the pragmatic speaker S_1 has the **theory of mind** of literal listener L_0, and therefore knows the distribution $P_{L_0}(s \mid u)$.

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S_1 will choose the utterance u that maximizes the probability of the listener picking the correct object:

$$P_{S_1}(u \mid s) \propto P_{L_0}(s \mid u)$$

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In real-practice, S_1 also considers the cost of utterances.

$$U(u; s) = \log P_{S_1}(u \mid s) - \text{cost}(u) \qquad \text{(utility function)}$$
$$P_{S_1}(u \mid s) \propto \alpha \exp(U(u; s)) \qquad (\alpha : \text{hyperparameter})$$

RSA: Pragmatic Speaker with an Example

[Source: Frank & Goodman, 2012]

$$U(u; s) = \log P_{S_1}(u \mid s) - \text{cost}(u)$$
$$P_{S_1}(u \mid s) \propto \alpha \exp(U(u; s))$$

Assume 0 cost function and $\alpha = 1$, $P_{S_1}(u \mid s) \propto P_{L_0}(s \mid u)$.

RSA: Pragmatic Speaker with an Example

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$$P_{L_0}(s \mid u)$$

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$$U(u; s) = \log P_{S_1}(u \mid s) - \text{cost}(u)$$

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Normalize the column to form a well-defined probability distribution: $P_{S_1}(u \mid s) \propto P_{L_0}(s \mid u)$.

$$P_{S_1}(u \mid s)$$

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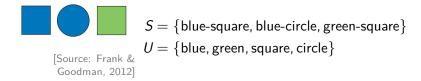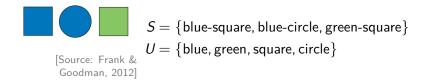
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The pragmatic listener L_1 has the **theory of mind** of the pragmatic speaker S_1, and therefore knows the distribution $P_{S_1}(u \mid s)$.

L_1 will infer the world state s from the utterance u:

$$P_{L_1}(s \mid u) \propto P_{S_1}(u \mid s)P(s)$$

RSA: Pragmatic Listener with an Example

$$P_{L_1}(s \mid u) \propto P_{S_1}(u \mid s)P(s)$$

[Source: Frank & Goodman, 2012]

Assume uniform prior over world states. Normalize the rows to form a well-defined probability distribution: $P_{L_1}(s \mid u) \propto P_{S_1}(u \mid s)$.

$$P_{S_1}(u \mid s)$$

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$$P_{L_1}(s \mid u)$$

$U\backslash S$	blue-square	blue-circle	green-square
blue	3/5	2/5	0
green	0	0	1
square	3/5	0	2/5
circle	0	1	0

Summary: RSA

$$P_{L_0}(s \mid u) \propto [\![u]\!](s)P(s)$$
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Caveat: While being supported by human behavioral data, RSA is just one (among arguably infinite) approach to modeling human pragmatic reasoning behaviors

Summary: RSA

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$$U(u; s) = \log P_{S_1}(u \mid s) - \text{cost}(u)$$
$$P_{S_1}(u \mid s) \propto \alpha \exp(U(u; s))$$
$$P_{L_1}(s \mid u) \propto P_{S_1}(u \mid s)P(s)$$

Caveat: While being supported by human behavioral data, RSA is just one (among arguably infinite) approach to modeling human pragmatic reasoning behaviors

More at https://www.problang.org/

Next

Linguistic typology and computational multilingualism.