

Introduction to Formal Semantics

Lecture 2: Inferences

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02.05.2022



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Overview for today

- Announcements
- Recap: entailments, models and compositionality
- Presupposition
- Presupposition problems and projection
- Semantic vs Pragmatic View
- Trivalent Semantics



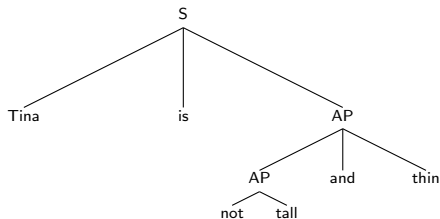
Reading:

- Coppock, E., and Champollion, L. (2021). Invitation to formal semantics. Manuscript, Boston University and New York University (Ch.1 & Ch.8)

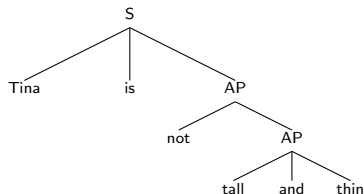
Tutorial Nr 1 on 4.05.2022 will be held **online in Teams**

Quizz (last week)

a.



b.



Expression	Denotations in example models with $E = \{a, b, c, d\}$		
	M_1	M_2	M_3
Tina	a	b	b
tall	$\{b, c\}$	$\{b, d\}$	$\{a, b, d\}$
thin	$\{a, b, c\}$	$\{b, c\}$	$\{a, c, d\}$
not tall	$\{a, d\}$	$\{a, c\}$	$\{c\}$
[not tall] and thin	$\{a\}$	$\{c\}$	$\{c\}$
Tina is [[not tall] and thin]	1	0	0
tall and thin	$\{b, c\}$	$\{b\}$	$\{a, d\}$
not [tall and thin]	$\{a, d\}$	$\{a, c, d\}$	$\{b, c\}$
Tina is [not [tall and thin]]	1	0	1
Tina is thin	1	1	0

Inference

- Simple matching of knowledge base will not always give the appropriate answer to the request
- The system should have the ability to draw valid conclusions based on the meaning representation of inputs and the stored background knowledge

Determine the TRUE or FALSE of the input propositions - inference

Entailment

p entails q

- whenever p is true, q must be true
- a situation describable by p must be also describable by q
- p and $\neg q$ is contradictory (cannot be true in any situation)

Entailment (examples)

Example

(1) entails all propositions from (2) to (8)

- ① The police officers drove the fast cars.
- ② The police officers drove.
- ③ The policemen drove something.
- ④ Some law enforcement officers drove the fast cars.
- ⑤ Someone drove fast cars.
- ⑥ Some fast cars were driven by someone.
- ⑦ The police officers did something.
- ⑧ Some police officers did something to vehicles.

Entailment (examples, cont.)

Example

(1) does not entail any of the propositions (2) to (7)

- ① The police officers drove the fast cars.
- ② Not everyone drove fast cars.
- ③ Some people drove slow cars.
- ④ The police officers drove fast.
- ⑤ The police officers wanted to drive fast cars.
- ⑥ The probationary police officers drove fast cars.
- ⑦ The police officers were in uniform.

the propositions might be true but not entailed by (1), we could imagine a world where (1) is true but the 2-7 propositions are not

Proposition vs Presupposition

Entailments

- (1) a. Tina is tall and thin \implies Tina is thin
b. Tina ran to the station \implies Tina ran
c. Tina danced \implies Tina moved

Entailment: (i) infeasible; (ii) speakers intuitively accept S2 whenever they accept S1.

The following relations are also entailments:

- (2) a. The king of France is bald \implies France has a (unique) king
b. Tina has stopped smoking \implies Tina used to smoke
c. It was Tina who shot Malcolm X \implies Someone shot Malcolm X
d. Tina regretted visiting LA \implies Tina visited LA

Is there a reason to distinguish the entailments in (1) and (2)?

Presupposition

p entails q iff q is true whenever p is true

Example

- ① The fortieth pope was a German.
- ② There was a fortieth pope.

Presupposition (cont.)

Presuppositions are special entailments. Ordinary entailments disappear when the sentence is *negated*, turned into a *question*, or embedded under a *possibility modal* like maybe:

Example

- ① Alice has a cute dog.
- ② \implies Alice has a dog.
- ③ b. Alice doesn't have a cute dog.
- ④ c. Does Alice have a cute dog?
- ⑤ d. Maybe Alice has a cute dog.
- ⑥ (b-d): $\not\implies$ Alice has a dog.

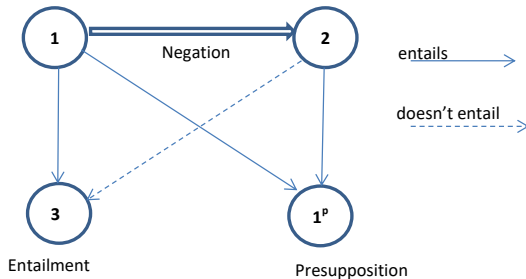
Presupposition (cont.)

But presuppositions survive in all of these environments (we also say: presuppositions project):

Example

- ① Bob's sister is a professional wrestler.
- ② \implies Bob has a sister.
- ③ b. Bob's sister is not a professional wrestler.
- ④ c. Is Bob's sister a professional wrestler?
- ⑤ d. Maybe Bob's sister is a professional wrestler.
- ⑥ (b–d): \implies Bob has a sister.

Presupposition (cont.)



1 It stopped raining.

2 It didn't stop raining.

3 There was a time (after the reference time of (1)) during which no drops of water were falling from the sky.

1^P the proposition that it was raining before.

Presupposition vs Entailment

1. Presuppositions differ from semantic entailments because:

- presuppositions **survive** in contexts where entailments disappear (e.g. negation, modals, attitude verbs)
- presuppositions are **defeasible** e.g. they can disappear in contexts where entailments survive

⇒ **Presupposition projection problem**

Presupposition Projection: presupposition survival

Negation: Presuppositions survive under negation, entailments don't.

Modals: Presuppositions survive under modal operators, entailments don't.

The sheriff constable arrested three men.

» There is a sheriff.

⇒ The sheriff arrested two men.

The sheriff **could** have arrested three men.

» There is a sheriff.

⇏ The sheriff arrested two men.

Presupposition Projection: presupposition survival (cont.)

Conditionals:

If the two thieves were caught again last night, John will get promoted.

» The two thieves were caught before.

\Rightarrow A thief was caught last night.

Disjunctions:

Either the two thieves were caught again last night **or** John will lose his job.

» The two thieves were caught before.

\Rightarrow A thief was caught last night.

Presupposition Defeasibility/Cancellation

Contextual defeasibility: the presupposition can be cancelled by the linguistic or non-linguistic context within the context of the same sentence or beyond the sentence, in the larger discourse context.

Surface-structure defeasibility: the presupposition is cancelled by a given surface-structure context (e.g. if-then, or) – *presupposition projection* problem

Contextual Defeasibility

A presupposition can be cancelled under the following type of contexts:

(i) When sentence context makes presupposition inconsistent.

Example

I don't know that Bill came.

✗ S knows that Bill came

although

John doesn't know that Bill came.

⇒ S knows that Bill came

(ii) When is it common knowledge that the presupposition is false.

Example

A. John has failed to get into a medicine degree.

B. At least John won't have to regret that he did medicine.

B's utterance does not presuppose that John did medicine.

Contextual Defeasibility (cont.)

(iii) When what is said, taken together with background assumptions (i.e. relevant world knowledge), is inconsistent with what is presupposed.

Example

Sue died before she finished her thesis. \nrightarrow Sue finished her thesis.

although

Sue cried before she finished her thesis. \gg Sue finished her thesis.

(iv) When evidence for truth of presupposition is being weighed and rejected.

Example

We've got to find out if Serge is a KGB infiltrator. Alexis would know. I've talked to him and he is not aware that Serge is on the KGB payroll. \nrightarrow Serge is on the KGB payroll

although

Alexis is not aware that Serge is on the KGB payroll. \gg Serge is on the KGB payroll

Surface-Structure Defeasibility

There are cases of **intra-sentential cancellation or suspension** of presuppositions.

These cases are handled under the projection discussion as they have to do with the general problem of how presuppositions of complex sentences are built from the presupposition of their parts.

Presupposition Projected vs Suspended vs Filtered

There are three ways in which the presuppositions of the parts can *project* to participate in the presuppositions of the whole:

- A presupposition can “survive” i.e. project. We saw cases of this when the intra-sentential context contains *a negation, a modal, a disjunction and a conditional*.
- A presupposition can be “overtly cancelled or suspended” by the intra-sentential context.
- A presupposition can be “filtered” (i.e. partially let through) by intra-sentential contexts such as *and, if ... then, but, suppose that*

Presupposition Cancelling and Suspending

Example

John does not regret studying medicine **because in fact he never did study medicine.**

The (potential) presupposition *Jon studied medicine* is explicitly **cancelled**, i.e., S is committed to *Jon studied medicine* being false.

John did not cheat again **if in fact he ever did.**

The presupposition *Jon cheated before* is **suspended**, i.e. S is not committed to *Jon cheated before* being either true or false.

Presupposition Filtering

Some linguistic items (e.g. *if ...then*, *or*) let some(times) presuppositions through but not all (always).

Example

If John cheated **again**, he will **regret** it.

» *Jon cheated before* but ✗ *Jon cheated again*.

Either Jon will not do linguistics, or he will **regret** doing it.

✗ *Jon will do linguistics*.

Presupposition Filtering: restrictions

[1] In a sentence of the form *if p then q* and *p and q*, the presuppositions of the parts will be inherited by the whole unless:

(i) q presupposes r and (ii) $p \implies r$.

Example

- a. If Peter has sons, then Peter's sons are bald.
- b. If baldness is heritable, then Peter's sons are bald.

Presupposition *Peter has sons* is filtered in (a) but projected in (b). Projected in case of $q \gg r$ and $\neg(p \implies r)$

Presupposition Filtering: restrictions (cont.)

[2] In a sentence of the form p or q , the presuppositions of the parts will be inherited by the whole unless

(i) q presupposes r and (ii) $\neg p \implies r$.

Example

- a. Either Peter has no sons or Peter's sons are bald.
- b. Either baldness is not heritable or Peter's sons are bald.

Presupposition *Peter has sons* is filtered in (a) but projected in (b). Projected in case of $q \gg r$ and $\neg(p \implies \neg r)$

Frege's Theory of Presupposition

Example

Kepler died in misery

» "Kepler" designates something.

Example

After the separation of Schleswig-Holstein from Denmark, Prussia and Austria quarelled.

» There is a past event such that S-H separated from Denmark.

- Referring phrases and temporal clauses carry presuppositions to the effect that they refer.
- Presuppositions are not part of the conventional meaning of a sentence.
- A sentence/assertion has a truth value only if its presuppositions are true
- A sentence and its negative counterpart share the same set of presuppositions.

Russell's Theory of Descriptions

Bertrand Russell (1872-1970) came to quite different conclusions than Frege about the meaning of referring expressions. He held that sentences such as

Example

The King of France is wise.

were simply false (hence meaningful) if France has no King at the time of utterance. He obtains this result by assigning the following semantic representation:

Example

$$\exists x (Kx \wedge \neg \exists y ((y \neq x) \wedge Ky) \wedge Wx)$$

i.e. there is a King of France who is wise and there's no one else who's King of France.

Explicit cancelling of presuppositions

An important advantage of Russell's approach is that it correctly predicts that

Example

The King of France is not wise because there is no such person

can be true (in Frege's account this sentence would have no truth-value).

This prediction follows from the fact that one possible semantic representation is:

Example

$$\neg \exists x(Kx \wedge \neg \exists y((y \neq x) \wedge Ky) \wedge Wx)$$

which is true in a context where there is no King of France

Semantic Presupposition: problems

Problem 1 Presupposition failure (= the presupposition is false in context)

(3) King of France is bold.

When uttered on May 13 2005, the presupposition is false

Problem 2 Presupposition cancellation (= the presupposition is “removed” in context)

(4) I don't know that Bill came.

This utterance does not presuppose that speaker knows that Bill came.

(5) A: Peter failed to study medicine.

B: Peter will not regret to study medicine.

B's utterance does not presuppose that Peter studied medicine.

Semantic Presupposition: problems (cont.)

- (6) If it is sunny, Jon's wife likes gardening.
Either Jon learnt to manage his time or his wife is helping him with work.
≫ Jon has a wife.
- (7) If Jon has a wife, she (Jon's wife) likes gardening.
If Jon is married, his wife likes gardening.
Either Jon got a divorce or his wife is helping him with work.
⋈ Jon has a wife.

Semantic Theories of Presuppositions

Attempt to handle presupposition within truth-conditional semantic theory, as a special kind of entailment.

*Sentence ϕ **semantically presupposes** a sentence ψ iff:*

(i) $\phi \implies \psi$

(ii) $\neg \phi \implies \psi$

where $\phi \implies \psi$ stands for **semantic entailment**:

*Sentence ϕ **semantically entails** a sentence ψ iff:*

every situation that makes ϕ true, makes ψ true

(or: in all worlds in which ϕ is true, ψ is also true)

Semantic Presupposition: problems

Problem 1: Classical logic cannot handle presupposition failure.

- 1 ϕ presupposes ψ
- 2 Hence by definition, $\phi \implies \psi$ and $\neg\phi \implies \psi$
- 3 ϕ is true or ϕ is false (bivalence)
- 4 ϕ is true or $\neg\phi$ is true (negation)
- 5 Hence ψ (the presupposition) **must always be true**

Thus, classical logic cannot capture presupposition failure; nor can it explain why sentences whose presuppositions are not satisfied are odd.

To remedy this, semantic theories of presuppositions use **multi-valued logics**, which include true, false and neither-true-nor-false as possible truth-values.

Semantic Presupposition: problems

Problem 2 Classical entailment cannot handle presupposition cancellation.

Classical entailment is **monotonic**, i.e.,

if $\phi \implies \psi$ then no matter how much information γ is added to ϕ , it is necessarily the case that $\phi, \gamma \implies \psi$

i.e., no matter how much information is added to the discourse, entailments remain true.

This cannot account for the cancelling of presuppositions due to information available in the context. A possible remedy is to use a **non-monotonic logic**.

Semantic Presupposition: problems

Problem 3

Moreover, many cases of what one would want to call presupposition are **not truth-conditional effects**, and are also strongly context-dependent. Therefore, the distinction between **semantic** and **pragmatic** presupposition is untenable and has been abandoned.

Strawson's Pragmatic Theory

- Peter Frederick Strawson (1919-2006) solution is similar to Frege
- Introduces an important distinction namely the distinction between **sentences** and **use of sentences** i.e. **statements**.
- Sentences aren't true or false; Statements, i.e. $\langle \text{Sentence, Context} \rangle$ pairs, are.

Example

The King of France is wise

- True in 1670.
- False in 1770.
- Neither true nor false in 1970.

Presuppositions are conventions about **use** of referring expressions: **a statement A presupposes a statement B** iff **B is a precondition for the truth or falsity of A.**

Semantic vs Pragmatic View

- An important difference between Strawson's view and the semantic view is that the latter takes the presupposition relation to hold between "sentences" whereas Strawson insists it holds between "statements".
- The semantic view tries to bring presuppositions into the realm of logical semantics; Strawson's view is a pragmatic view which makes the role of context central to the analysis of presupposition
- Semantic theories of presuppositions require some fundamental changes in the kind of logic used to model NL semantics; The logic must be multi-valued or allow for truth-value gaps.

Russell-Strawson debate

(8) The king of France is bald

Russell:

- is quantificational. It is logically equivalent to: “exactly one entity has the property King of France, and that entity is bald”
- Thus, if there is no unique King of France, (8) is **false**.

Strawson:

- Any use of (8) raises the following presupposition: “exactly one entity, call it x, has the property King of France”
- Under this presupposition, (8) means: “x is bald”
- Thus, if there is no unique King of France, (8) is neither **true** nor **false**.

Russell-Strawson debate (cont.)

(3) The king of France is bald.

a The king of France is bald.

Russell: $\exists x.KOF = \{x\} \wedge \mathbf{bald}(x)$

Strawson: $\exists x.KOF = \{x\} : \exists x.KOF = \{x\} \wedge \mathbf{bald}(x)$

b Tina has stopped smoking.

Russell: $(US(\mathbf{tina}) \wedge \neg S(\mathbf{tina}))$

Strawson: $US(\mathbf{tina}) : \neg S(\mathbf{tina})$

c It was Tina who shot Malcolm X.

Russell: $\mathbf{shoot}(\mathbf{malcolmx})(\mathbf{tina})$

Strawson: $\exists x.\mathbf{shoot}(\mathbf{malcolmx})(x) : \mathbf{shoot}(\mathbf{malcolmx})(\mathbf{tina})$

Challenge for Russell

- (1) If Tina has stopped smoking, Harry is happy ? Tina used to smoke
- (2) If Tina used to smoke and doesn't smoke now, Harry is happy $\not\Rightarrow$ Tina used to smoke

Russell's strategy expects no contrast between (1) and (2):

$$[(US(tina) \wedge \neg S(tina)) \rightarrow H] \not\Rightarrow US(tina)$$

Advantages for Strawsonian semantics, with all presuppositions

Trivalent Strawsonian semantics

$$\text{assertible:} = \begin{cases} \text{true} : 1 \\ \text{false} : 0 \end{cases} \quad \text{non-assertible} : *$$

Tina has stopped smoking

$$(US(\mathbf{tina} : \neg S(\mathbf{tina})) = \begin{cases} 1 : (US(\mathbf{tina} : \neg S(\mathbf{tina})) \\ 0 : (US(\mathbf{tina} : S(\mathbf{tina})) \\ *\neg US(\mathbf{tina}) \end{cases}$$

Tina used to smoke

$$(\top : US(\mathbf{tina})) = \begin{cases} 1 : US(\mathbf{tina}) \\ 0 : \neg US(\mathbf{tina}) \end{cases}$$

Notation: $\llbracket \top \rrbracket = 1$ in every model $\llbracket \perp \rrbracket = 0$ in every model

Trivalent Strawsonian semantics (cont.)

$$\llbracket S \rrbracket^M = \phi : \psi$$

ϕ indicates whether S is assertible in M

ψ indicates whether S is true in M

Definition: the colon operator ('transplication'):

$$(\phi : \psi) = \begin{cases} \psi & \phi = 1 \\ * & \phi = 0 \end{cases}$$

where ϕ and ψ are bivalent truth-values. Blamey (1986) suggests the possibility of reading the transplication connective as a type of conditionals of the form 'if ϕ then ψ ' which are neither true nor false when ϕ is false. They are also neither true nor false when either ϕ or ψ is neither true nor false.

Russell or Strawson?

- (1) a. The king of France is bald \implies b. France has a (unique) king
- (2) a. Tina has stopped smoking \implies b. Tina used to smoke
- (3) a. It was Tina who shot Malcolm X \implies b. Someone shot Malcolm X

Russell:

No semantic presuppositions – (1)-(3) are ordinary entailments. When sentence (1b/2b/3b) is false, sentence (1a/2a/3a) is also false.

Strawson:

When sentence (1b/2b/3b) is false, the truth-value of sentence (1a/2a/3a) is undefined (or “undefined”).

Entailment and Presupposition in Trivalent Semantics

Projection distinguishes presuppositions from other entailments. To model this distinction, we define informally:

Entailment $S_1 \implies S_2$: if S_1 is assertible and true, then S_2 is assertible and true as well.

Presupposition $S_1 \rightsquigarrow S_2$: if S_1 is assertible (i.e. true or false), then S_2 is true
— — > Sub-species of entailment

When S_1 entails S_2 but does not presuppose S_2 , we say that S_2 is part of the assertion in S_1 .

Entailment and Presupposition in Trivalent Semantics (examples)

Tina is tall and thin **asserts** Tina is thin.

Tina likes smoking **asserts** Tina likes something.

The king of France is bald **presupposes** there is a king of France

Tina has stopped smoking **presupposes** Tina used to smoke.

The king of France is bald **asserts** someone is bald.

Tina has stopped smoking **asserts** Tina does not smoke.

Tarskian Truth-Conditionality Criterion

Empirically, S_1 entails S_2 if whenever S_1 is assertible and true, S_2 is assertible and true.

\Rightarrow		$\llbracket S_1 \rrbracket$		
		*	0	1
$\llbracket S_2 \rrbracket$	*	y	y	y
	0	y	y	y
	1	n	n	y

TCC: $S_1 \Rightarrow S_2$ iff $\forall M$. if $\llbracket S_1 \rrbracket^M = 1$ then $\llbracket S_2 \rrbracket^M = 1$ Note: Tarskian TCC generalizes the bivalent TCC.

Example 1

Tina has stopped smoking \Rightarrow Tina used to smoke
 $A = (US(tina) : \neg S(tina))$ $B = (\top : (US(tina)))$
 Whenever **A** is assertible and true, **B** is assertible and true

Example 2

Tina has stopped smoking \Rightarrow Tina doesn't smoke
 $A = (US(tina) : \neg S(tina))$ $C = (\top : (\neg S(tina)))$
 Whenever **A** is assertible and true, **C** is assertible and true

Example 3

Tina doesn't smoke \nRightarrow Tina has stopped smoking
 $C = (\top : (\neg S(tina)))$ $A = (US(tina) : \neg S(tina))$
C can be assertible and true, **A** is not assertible

Tarskian Truth-Conditionality Criterion (cont)

Equivalence examples

A Tina has stopped smoking

$(US(tina) : \neg S(tina))$

\Leftrightarrow

B Tina used to smoke and doesn't smoke now.

$\top : (US(tina) : \neg S(tina))$

A is assertible and true iff **B** is assertible and true

If **A** is assertible and false then **B** is assertible and false

If **A** is not assertible then **B** is assertible and false

Conclusion: the trivalent propositions **A** and **B** are equivalent, although their presuppositions and assertions are different.

Pragmatic Theories of Presuppositions

Besides the (mostly abandoned) semantic attempts of modelling the projection problem, there are two main types of theories:

- (i) Theories based on a “static” semantics: Gazdar (1979), Karttunen (1973)
 - (ii) Theories based on dynamic semantics: Karttunen (1974), Heim (1982), Van der Sandt (1988, 1992), Beaver (1995), Geurts (1997), etc.
- Presuppositions are neither viewed as referring expressions nor as semantic entailments but as context-dependent (i.e. pragmatic) phenomena.
 - When a presupposition conflicts with previous information, this presupposition
 - does not give rise to inconsistency
 - is lifted (i.e. cancelled) or altered (i.e. filtered) to resolve the conflict.

Quizz for Today

John left work early again.

- (a) generate ordinary entailments and all possible presuppositions
- (b) generate all possible presupposition projections (HINT: think about negations, modals, conditionals and disjunctions)
- (c) give an example of context in which one of the possible presuppositions is cancelled, i.e. defeat the presupposition