# UNIB20005 Language & Computation
## **Week 8: Analysing the meaning of sentences**

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# Searle's Chinese Room and the Turing test

- If the goal is to build a machine that "understands",
- Then, what is "understanding" and where does it reside?
- One thing we know: **syntax** is not enough for **semantics;**
- That is: syntax is not sufficient to provide and account for meaning and understanding – we need a proper theory of meaning as well.

*"On the Internet, nobody knows you're a dog."*

# Today and Wednesday

- An introduction to basic concepts in analysing meaning
- In particular, how we can build up semantic representations for syntactically analysed English sentences
- And preliminary discussion of some semantic puzzles and how we can approach them

# Key concepts

1) subject-verb **agreement**, for number (singular/plural)

this dog runs / these dogs run

BUT *these dog run / *this dogs runs

(also Determiner-Noun agreement in the NP)

S -> NP[NUM=?n] VP[NUM=?n]

VP[NUM=?n] -> V[NUM=?n] NP

NP[NUM=?n] -> Det[NUM=?n] N[NUM=?n]

2) **quantifiers:** every dog disappeared

Ax.(dog(x) -> disappear(x))

* we can put these two concepts together

# Composing a semantic analysis

- Semantics = the meanings of linguistic expressions
- “Lexical semantics” – the meanings of lexical items (words)
- “Sentential semantics” (or “propositional semantics”) – the meanings of whole sentences (actually, we need to talk about the meanings of constituents of whatever size, above the level of the word)

# Composing a semantic analysis

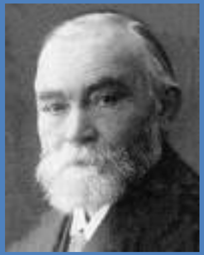
**The Principle of Compositionality**:

**The meaning of a whole is a function of the meanings of the parts and of the way they are syntactically combined.**

[cf. Ch 10, p. 385]

Often called

'Frege's principle'



**Gottlob Frege** (1848-1925)

German mathematician, logician & philosopher

# Composing a semantic analysis

- **THUS: The Principle of Compositionality** -
  **The meaning of a whole is a function of the meanings of the parts and of the way they are syntactically combined.**
- ...is interpreted to mean that we take lexical meanings as basic and work out the meanings of larger, well-formed expressions on the basis of these and the ways in which these expressions are put together grammatically – that is, grammar gives us cues to the meanings of larger expressions

‘whatever linguistic meaning is like, there must be some sort of compositional account of the interpretation of complex expressions as composed or constructed from the interpretations of their parts and thus ultimately from the interpretations of the (finitely many) simple expressions contained in them and of the syntactic structures in which they occur’

Chierchia & McConnell-Ginet, *Meaning and grammar: an introduction to semantics*, MIT Press, $2^{nd}$ ed. 2000, pp. 6-7.

# Composing a semantic analysis

- Montague's '**Rule-to-rule hypothesis**': each rule of the syntax is matched by a rule indicating how the semantics is built up in tandem with the construction of the syntactic structure:
- For each syntactic rule (or structure) there is a corresponding semantic rule (or structure).

# Richard Montague 1930-1970

- “There is in my opinion no important theoretical difference between natural language and the artificial language of logicians; indeed I consider it possible to comprehend the syntax and semantics of both kinds of languages within a single natural and mathematically precise theory” (Montague 1970b: 222)

# The Principle of Compositionality: an example – *Cyril barks.*

***A basic grammar:***

$S \rightarrow NP\ VP$

$VP \rightarrow IV$

***With associated semantics:***

S[SEM=<?vp(?np)>] $\rightarrow$
NP[SEM=?np] VP[SEM=?vp]

VP[SEM=?v] $\rightarrow$ IV[SEM=?v]

*NOTE: these rules are different from (and one possible correction of) the rules in the text, which are flawed.*

# *Cyril barks.*

In addition, we need lexical rules:

NP[SEM=<cyril>] → ‘Cyril’

IV[SEM=< \x.bark(x)>] → ‘barks’

**The property of barking (more on \ in a bit)**

# What else do we need to know?

- ... to be able to really “understand” the sentence?
- REFERENCE: Noun Phrases are used to make reference to entities in the world.

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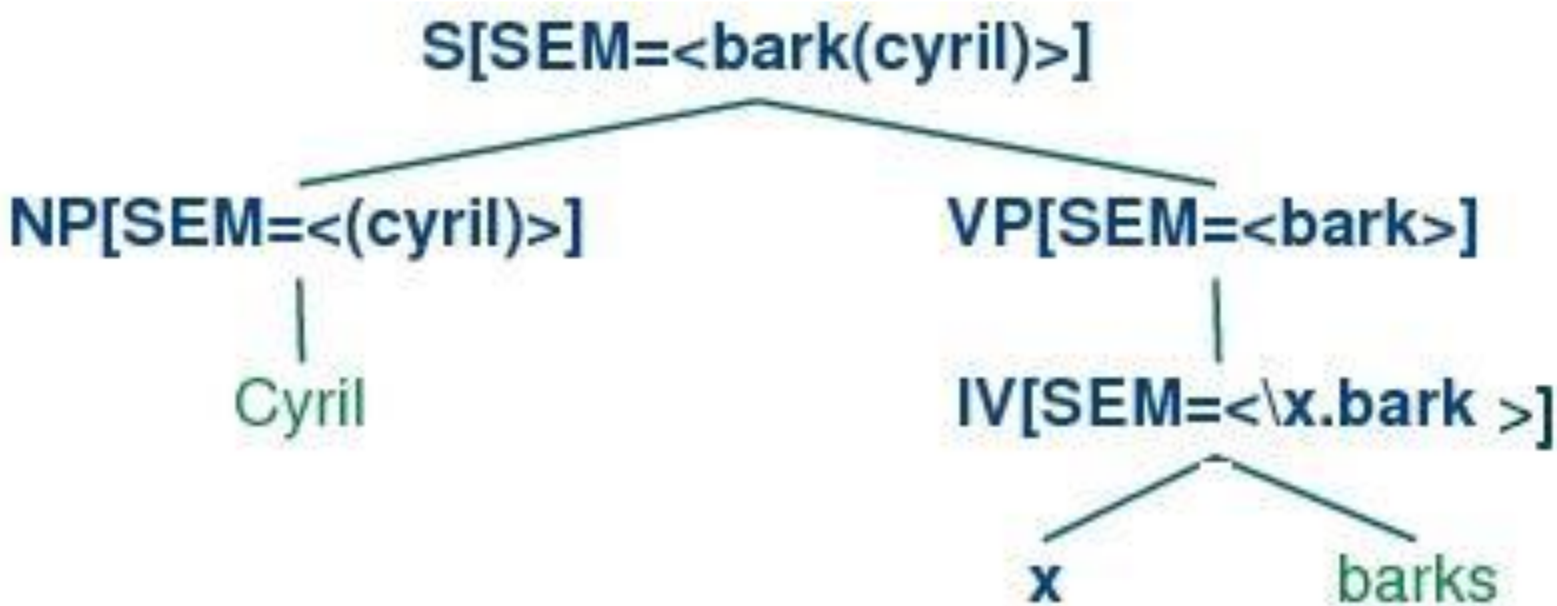
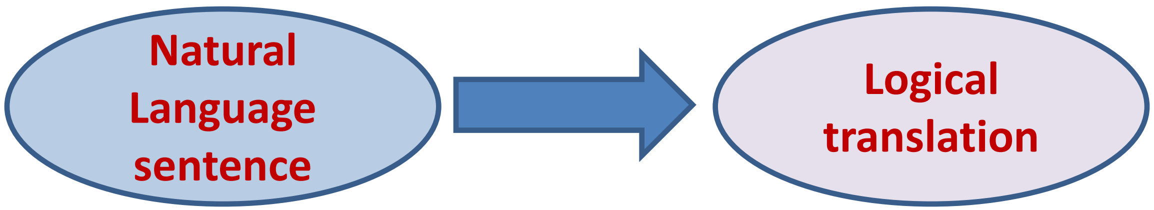
**The property of barking (more on \ in a bit)**


S[SEM=<bark(cyril)>]
NP[SEM=<(cyril)>]
VP[SEM=<bark>]
Cyril
IV[SEM=<\x.bark >]
x
barks

# NOTE:

- Observe that the semantic structures assigned to syntactic constituents are specified in their own formal language.
- For us, this is the language of First Order Logic (see Ch 10.3).
- In effect, we translate natural language sentences into a logical representation:



# The need for translation into a logical form

- **Why** do we need to translate English sentences into a logical representation before providing them with a meaning?

  Why not go straight from

  “English” ***to*** “meaning”?

# Some reasons:

- Natural language expressions are often **ambiguous**

  *Everybody admires someone.*

  all x.(person(x) $\rightarrow$ exists y.(person(y) & admire(x,y)))

  exists y.(person(y) & all x.(person(x) $\rightarrow$ admire(x,y)))

# Some reasons:

- Natural language sentences are often **incomplete**

  *He barked.*

  *He barked at me.*

  Who barked?

  When did he bark?

  Who did he bark at?

# Deixis and anaphora

"Deictic" or "indexical" expressions: link the sentence which contains them to aspects of the (non-linguistic) context of utterance,

- spatially, temporally, and with respect to the participants in the discourse (Speaker and Addressee).

*I saw you here yesterday.*

# Deixis and anaphora

"Anaphoric" expressions: link the sentence which contains them to some element in the surrounding linguistic context of utterance:

*Cyril was chagrined. He barked.*

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**relationship of coreference**

# Some reasons:

- Logical representations are **complete** and **consistent** (and can be proved to be so) – cf. Ch 10, hence we translate ...
- HOWEVER, the logical translation is still really a kind of “syntax”, which itself needs to be interpreted before we have a complete semantic analysis of the sentence

# So …

The full shape of semantic interpretation is:

**Natural Language sentence** → **Logical translation** → **Interpretation with respect to a model**

*Cyril barks.*

bark(cyril)

# Which logical language?

- Cf. *Envoi* (p 447): a range of specific languages of logical representation and methods of interpretation of these are available and can be used to translate and interpret natural language sentences.
- We assume some version of (augmented) First Order Logic as our translation language.
- Start with single sentences but note that we can extend this to discourses (Cf. Ch 10.5 on Discourse Representation Theory)

# A bit more about interpretation with respect to a model

- We need to relate expressions to the “(real) world” in order to fully comprehend their meaning ...
- Why internal meaning properties and relations are not enough

*Mabaygan dhangal uthudhin.*

# *Mabaygan dhangal uthudhin.*

- *uthudhin* is a transitive verb describing an event
- *mabaygan* is the agent of the event described
- *dhangal* is the patient
- Both are singular
- *-dhin* is a tense marker that tells us the event happened in the past

- *mabayg* is ambiguous:
- on one reading, it is synonymous with *garka* and an antonym of *ipika*
- on the other reading, it includes the meaning of *ipika*
- *dhangal* and *mabayg* (as well as *garka & ipika*) all have the superordinate expression *kaapu*
- *ETC.*

| | | |
|---|---|---|
| *Mabaygan* | *dhangal* | *uthu-dhin.* |
| man-ERG | dugong-ACC | harpoon-RemPast |

The man harpooned the dugong.

# A bit more about interpretation with respect to a model

- ... So, we need to relate expressions to the world in order to fully comprehend their meaning
- But the real world is a bit complex
- So in showing the working out of the semantic analyses of sentences, we use stand-ins for it, by defining **models**

**Let’s think in a bit more detail about the kinds of interpretations we need for different kinds of expressions**

# common nouns

‘the meaning of the word *dog* implies that it describes all of those things that actually are dogs, regardless of our ability to define it [the meaning - LS] with words or to formulate an appropriate mental concept’ [Portner, p. 11]

‘the noun *dog* describes certain things (the dogs) and not others, and so we can explain the meaning of *dog* by saying that it denotes the set of dogs’ [p. 16]

Paul Portner, *What is meaning?: Fundamentals of formal semantics.* Blackwell, 2005.

# names (proper nouns)

‘the name *Confucius* refers to the ancient Chinese philosopher, and this is the basis of its meaning (indeed, this may be all there is to its meaning)’ [p. 11]

‘many names can be used to refer to more than one person. But in a given situation, a speaker intends to refer to just one of them, and if everything goes well, she will’

# sentences

‘The knowledge of meaning involves (at least) the knowledge of the conditions under which a sentence is true, and those under which it is false.’ [p. 13]  (Truth-conditional theories say that) ‘all there is to the meaning of a sentence is its truth-conditions’ [p. 13]

‘the meaning of a sentence is called a *proposition*.  We say that a sentence *expresses* or *denotes* a proposition.’ [p. 15]

On the truth-conditional view of meaning, ‘the proposition expressed by a sentence amounts simply to its truth-conditions’ [p. 15]  ‘a proposition is a set of possible worlds’ [p. 16] – that is, the set of possible worlds in which the proposition is true.

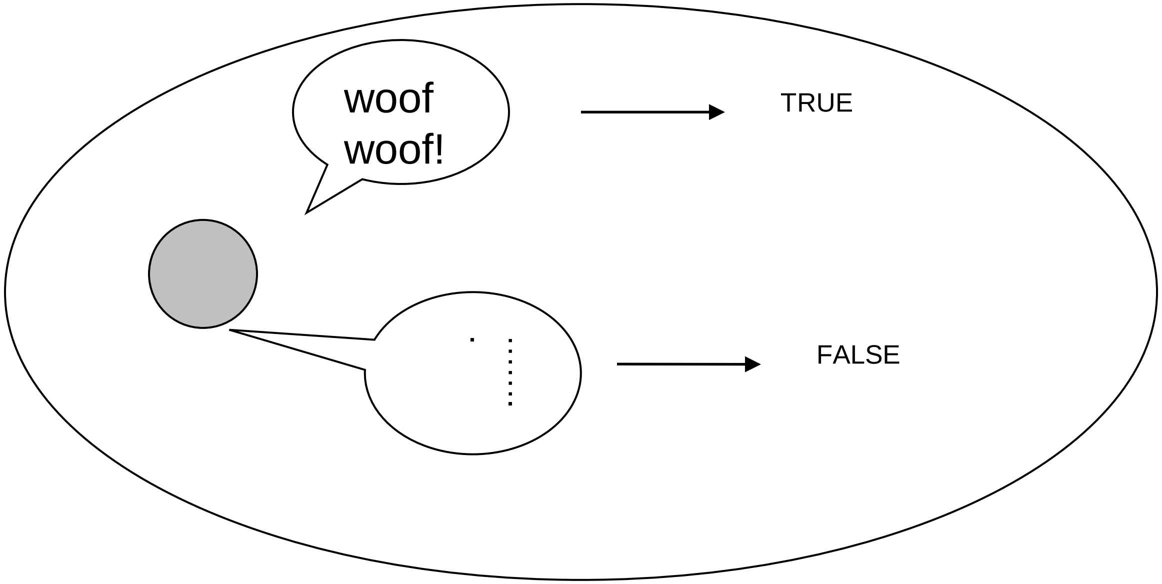
(just as for the meaning of nouns) ‘a sentence describes certain possible worlds (those in which its true) and not others, and so we can explain the its meaning by saying it denotes the set of possible worlds in which it is true’ [p. 16]

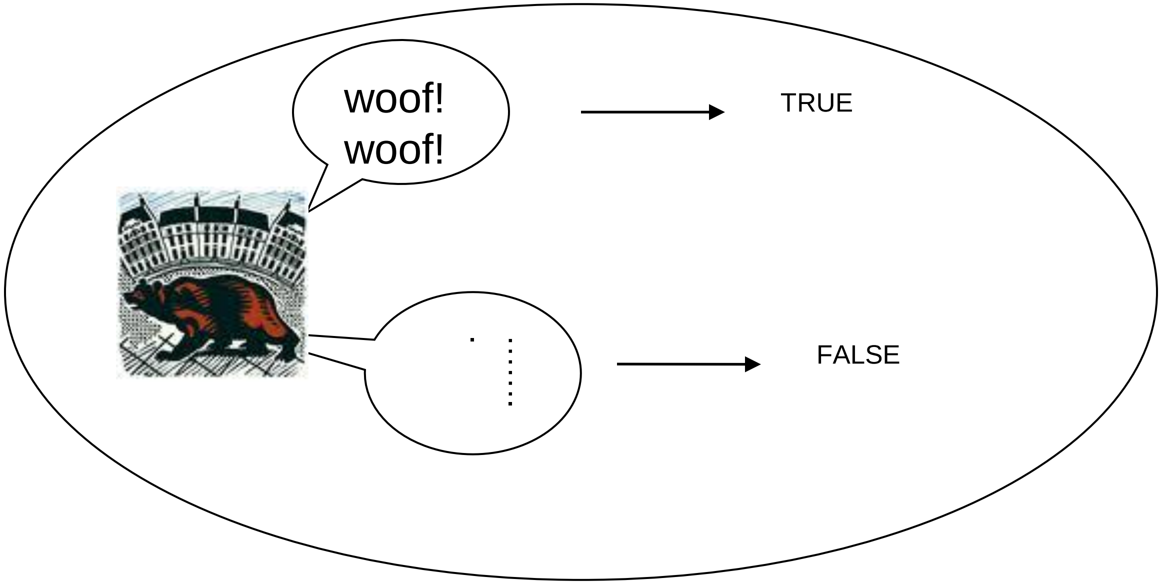
# Worlds and models

- there are infinitely many *possible worlds* or *possible situations*
- the real world is a possible world
- **Models:** We can think of a model as a partial specification of some way one possible world might be

# predicates

- Predicates denote properties
- the meaning of a one-place predicate like *bark* can be thought of as an **incomplete proposition**
- a predicate or rather the property it denotes is an **unsaturated proposition**


woof
woof!
TRUE
FALSE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TRUE
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# To do

- Background reading on features Ch 9.1
- Read Chapter 10.4
- More on Wednesday

# Terminology from 10.3 on First-Order Logic

- Predicates (arity of predicates: unary, binary)
- Arguments
- Individual constants
- Individual variables
- Types (basic, complex)
- Existential quantifier ($\exists$ or exists)
- Universal quantifier ($\forall$ or all)
- Binding of variables (scope, free, bound)
- Open and closed formulae
- *See the summary of First-order logic on p 376*