Meaning, Games and Dialogical Logic

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Prelude:
Playing chess against Carlsen and Anand

Board 1:

White: Magnus Carlsen (Norway, World No. 1)

Black: Helge (a *patzer*, more or less)

Board 2:

White: Helge

Black: Viswanathan Anand (India, World Champion)

Claim: Helge can score 1/2 against these two players!

How?

Copycat strategy:

Copy the opponents' moves and make them indirectly play against each other

Philosophical Background: Theories of Meaning

The standard approach to logic (model theory) is based on a denotational approach to meaning.

Denotational Semantics:
The meaning of an expression consists in a certain entity (or several entities) that is (are) associated with the expression.

Gottlob Frege (1848-1925)

- There are two entities that are associated with each linguistic expression, its **denotation** (orig.: *Bedeutung*) and its **sense** (orig.: *Sinn*).
- The denotation of a name is the designated object, its sense is the mode of presentation of the object. The denotation of a sentence is its truth-value, its sense is a thought.
- The principle of compositionality: The denotation of a complex expression only depends on the denotations of its parts; the sense of a complex expression only depends on the senses of its parts.

But there are also other, **non-denotational semantic approaches** (some examples from philosophy)

a) Charles Saunders Peirce (1839-1914)

- **Pragmatism** as a theory of meaning

“Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object.“

- Diamond-example (meaning of the word “hard”)

“[L]et us ask what we mean by calling a thing *hard*. Evidently that it will not be scratched by many other substances. The whole conception of this quality, as of every other, lies in its conceived effects. There is absolutely no difference between a hard thing and a soft thing so long as they are not brought to the test.”

(Both citations from Peirce, ‘How to Make Our Ideas Clear’, *Popular Science Monthly* 12 (January 1878), 286-302.)

b) Vienna Circle (1922-1936)

- **Verificationism** as a theory of meaning

According to a verificationist theory of meaning the meaning of a sentence consists in the method of its verification. What has (in principle) to be done in order to find out whether the sentence in question is true or false. Somebody knows the meaning of a sentence iff he knows what he (in principle) has to do to verify (or falsify) the sentence.

c) Ludwig Wittgenstein (1889-1951) in his later philosophy

- **Meaning as use**

PI §43:
“For a *large* class of cases — though not for all — in which we employ the word ‘meaning’ it can be defined thus: the meaning of a word is its use in the language.”

- **Language games**

PI §2:
“The language is meant to serve for communication between a builder A and an assistant B. A is building with building-stones: there are blocks, pillars, slabs and beams. B has to pass the stones, in the order in which A needs them. For this purpose they use a language consisting of the words "block", "pillar" "slab", "beam". A calls them out; — B brings the stone which he has learnt to bring at such-and-such a call.”

Pragmatist Semantics

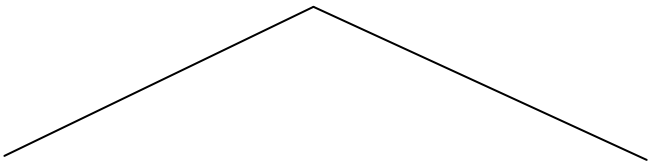
Of course, there are big differences between these conceptions, but all have something in common:

Meaning is captured via **invoking actions or rules how to act** (more directly or indirectly)

This is (very) broadly in the spirit of pragmatism (very broadly construed)

Therefore, I propose the label **“pragmatist semantics”** for this family of accounts of meaning

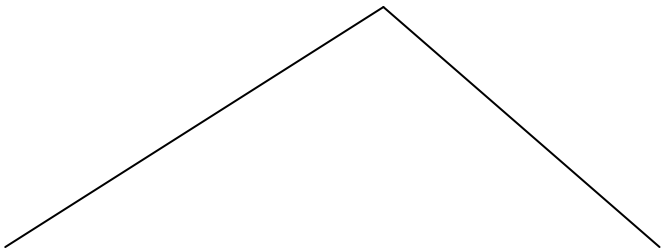
Semantic approaches



Denotational/referential approaches	Pragmatist/use-based approaches
A broadly Fregean/Wittgensteinian(I) picture of language and meaning	A broadly Wittgensteinian(II) picture of language and meaning

Pragmatist/use-based

semantic approaches (in logic)



Proof-theoretic approaches
(f.e. Natural Deduction)

Rules how to use expressions in proofs

Game-theoretic approaches
(f.e. **Dialogical Logic**)

Rules how to use expressions in (language) games

Dialogical Logic: The Basics

- Two players, the proponent (**P**) and the opponent (**O**), play a game about a certain formula according to certain rules

- The rules are divided into:

  Structural rules
  (they determine the general course of the game)

  Particle rules
  (they determine how formulas, containing the respective particles, can be attacked and defended)

- Truth is defined in terms of the existence of a winning strategy for **P**, falsity as the existence of a winning strategy for **O**

The Structural Rules

- **P** begins with the initial formula.

- Both players move alternately.

- Delaying tactics are forbidden.

- Each move is either an attack or a defense against an earlier move by the other player.

- Each play is won by one player and lost by the other. (So, dialogical games are 2-person zero-sum non-cooperative games). A player loses iff it is his turn and he can’t move.

Particle rules

	Attack	Defence
$\neg\alpha$	α	$\otimes$ (No defence, only counterattack possible)
$\alpha\wedge\beta$	?L(eft) ---------- ?R(ight) (The attacker chooses)	α ---------- β
$\alpha\vee\beta$	?	α ---------- β (The defender chooses)
$\alpha\rightarrow\beta$	α	β

Remarks:

- The particle rules are player independent

- Attacks and defences are always less complex than the attacked formula

  $\Rightarrow$ Plays unavoidably reach the atomic level

Question: What happens at the atomic level?

Dialogical Logic and the Formal Rule

The heart and soul of Dialogical Logic, its distinctive feature, is the so-called formal rule.

The deeper motivation of this rule can best be explained with a transition to **games with incomplete information**:

Suppose that there are also rules for how to attack and defend atomic formulas (how they might look like is outside the scope of logic, of course), and that **P** lacks information about the atomic level. He does not know how an atomic formula can be attacked or defended.

Question:
Is it still possible for **P** to have a winning strategy?

Answer: Yes!
Because of a copycat strategy!

If **O** has already stated an atomic formula before, **P** is safe when stating this atomic formula himself as **O** can't successfully attack because he then indirectly attacks himself. (P could always copy **O**'s attacks and defenses.) So, in this situation **P** can never loose.

This idea is captured by the formal rule:

Formal rule:
P is only allowed to state an atomic formula if **O** has stated this atomic formula before

A (very) basic example

O			P		
				((p→q)∧p)→q	(0)
(1)	(p→q)∧p	0		q	(8)
(3)	p→q		1	?L	(2)
(5)	p		1	?R	(4)
(7)	q		3	p	(6)

P wins

The dialogical conception (validity as formal truth):

Validity as the existence of a winning strategy despite lacking information about the atomic level

Or: Validity as the existence of a winning strategy when the formal rule is in effect

The Conception of Meaning in Dialogical Logic

Particle rules

⇒ Meaning of the logical connectives
(local meaning)
How to attack and defend

Particle rules + structural rules (without the formal rule) + rules for the atoms

⇒ Meaning of propositions
(global meaning)
How to play games

Adding the formal rule

⇒ Making the plays independent of the meaning of the atoms
(transition to logic!)

Plays vs. Strategies

Level of **plays**

⇒ Game rules
(How to play?)

Meaning is constituted by the game rules

Level of **strategies**

⇒ Strategic rules
(How to play well? Does a winning strategy exist?)

Concepts like **truth, validity, proof** etc are located at the level of strategies