Meaning in NL — Semantics

- Complex Q: "What's the nearest coffee shop?"

$?x: \forall y: CS(y) \wedge dist(y, SPEAKER) \geq dist(x, SPEAKER) \rightarrow CS(x)$

"... second-closest ..."

- Multi-hop reasoning ... fact-checking
- APIs for DB/KB or devices/robots

Map ① NL → Meaning Repr.

1. Unambig: ≤ 1 meaning per NL stmt.
2. Link to knowledge, or actions or observations
3. Can do inference
4. Expressive to cover NL

② NL → NL

Denotational Semantics

$[\![\text{expr}]\!]_M = \underbrace{\text{value}}_{\text{from world model } M}$

M: model

$[\![5+3]\!] = 8$

$\ulcorner 5+3 \urcorner = \ulcorner 2*2+1+3 \urcorner$

Model-theoretic semantics

Logic

- Boolean / prop. logic

"If A, then B"

$A \rightarrow B \iff \neg A \vee B$

- Predicate Logic & Entities

$\ulcorner$ Bob is sleeping $\urcorner$ = IsSleeping(Bob)

A ∨ B

¬A

B

IsParent(x, y) = "x is y's parent"

IsParent(a, b) ∧ IsParent(b, c) → IsGrandparent(a, c)

Entailment $\ulcorner A \urcorner \models \ulcorner B \urcorner$

Natural Logic

MacCartney & Manning

A entails B

A: "I saw the cat" ⊂ "I saw the animal" = B

"Set of meanings" ~ "set of situations/objects"

cat $\subset$ animal (hypernym relationship WN or CN)

[[I didn't see the cat]] $\supset$ [[I didn't see the animal]]

"Downward Monotone"

"Nat Lang Inference"

(A, B) $A \stackrel{?}{\models} B$

(A,B) => ENTAIL
NOT_ENTAIL