A theory of events and situations

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An Introduction to Semantics using Type Theory with Records
ESSLLI 2012
Lecture 1, part 2

Outline

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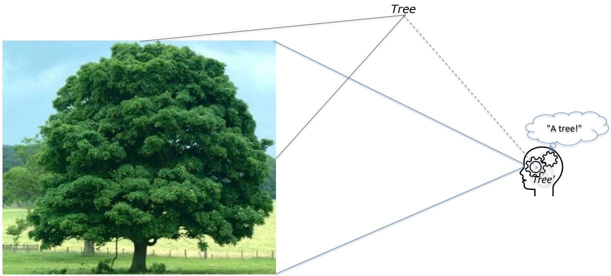
Seeing a tree (a simulation view)



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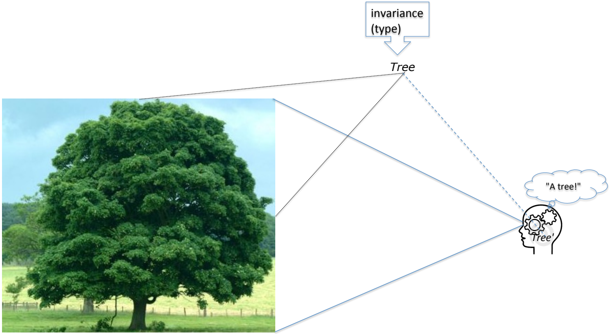

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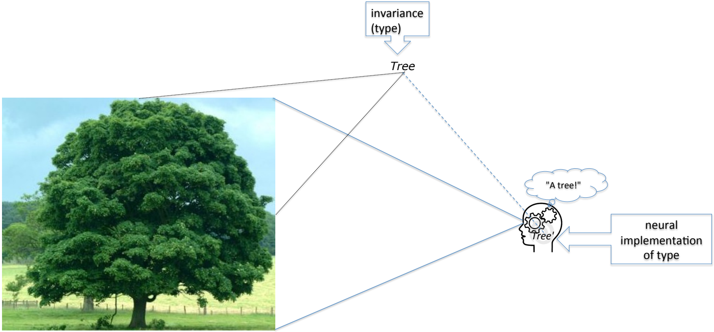

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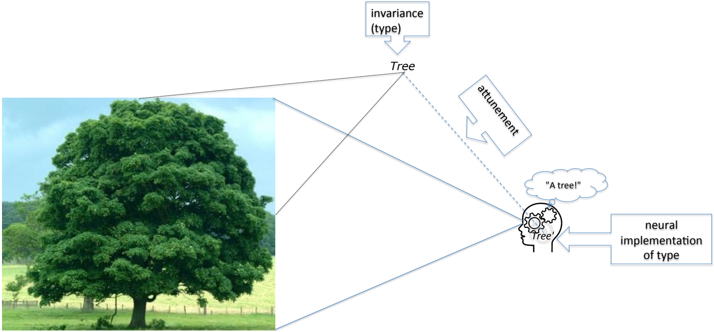

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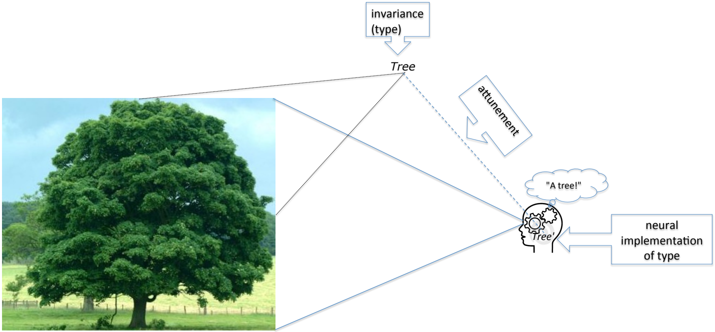

Gibson (1986); Barwise and Perry (1983)

Judgement

- (An agent judges that) object a is of type T.
- $a : T$

Outline

TTR: Type theory with records

- The most recent published reference for the details is Cooper (2012)
- Also Cooper (2005a) for an earlier detailed treatment
- Cooper (2005b) for relation to various semantic theories
- `https://sites.google.com/site/typetheorywithrecords/drafts/ch1-draft111114.pdf` for some current work in progress we will discuss here

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- *rich type theories* (e.g. Martin-Löf, 1984) provide a more general types, e.g. in our type theory, categories of objects such as *Tree*, types of situations such as *Hugging of a dog by a boy*
- two fundamental questions when characterizing a type theory:
  - what types are there?
  - for any type, what are the objects of that type?

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- $a : T$ iff $a \in A(T)$

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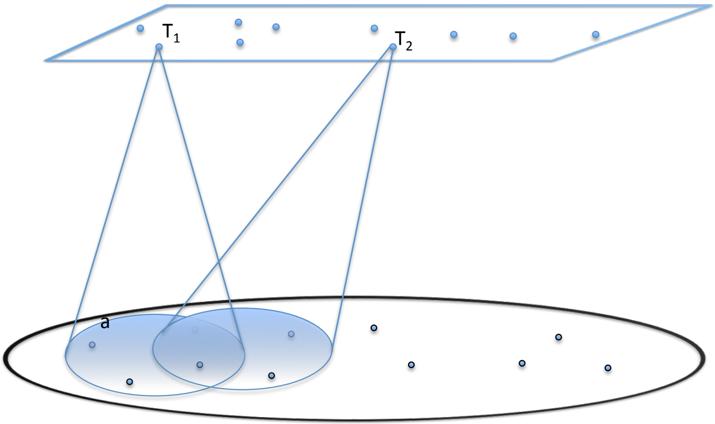
- Consequence: you can have two distinct types which have the same set of objects associated with them, i.e. $A(T_1) = A(T_2)$, $a : T_1$ just in case $a : T_2$. The types are *intensional*.

$a : T_1$



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- one kind of complex type is *ptype*, types which are constructed from predicates and objects used as arguments to the predicate
- another kind of complex type is *record type*, types which consist of a collection of types indexed by labels

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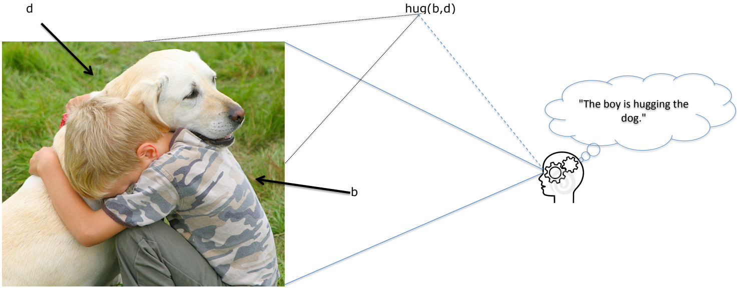
- allows us to modify by adding or removing a part (e.g. in learning new meanings or coordinating meaning with your dialogue partner)

Seeing a hugging event



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- We might also want to include time intervals and locations as part of the arities of these predicates

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- **PType** will contain all the possible ptypes for a given predicate given what is assigned to the arity for the predicate elsewhere in the system
- a system of complex types will also contain a function, F, which assigns a set, possibly empty, (of situations) to each ptype.

Models

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- A and F together, that is, $\langle A, F \rangle$, is a *model*
- a model consists of an assignment to the basic types and an assignment to the ptypes
- note that a model in this sense is *part* of the type system (not an external interpretation of it)
- this is an important difference between rich type theories and traditional model theory

Are ptypes the only types of situations?

- suppose *b* is Bill, a boy and *d* is Dinah, a dog
- we have allowed ourselves the ptype hug(b,d), the type of situation where Bill hugs Dinah
- but we have not allowed ourselves the type of “boy hugs dog” situations corresponding to *a boy hugs a dog*
- there are a number of ways to construct such types in rich type theories – we use *record types*

A boy hugs a dog

Record type – “a collection of labelled types”

$$\begin{bmatrix} \mathrm{x} & : & \mathit{Ind} \\ \mathrm{c}_{\mathrm{boy}} & : & \mathrm{boy(x)} \\ \mathrm{y} & : & \mathit{Ind} \\ \mathrm{c}_{\mathrm{dog}} & : & \mathrm{dog(y)} \\ \mathrm{e} & : & \mathrm{hug(x,y)} \end{bmatrix}$$

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. . . not quite because of dependencies

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The official notation

$$\left[\begin{array}{lll} \mathrm{x} & : & \mathit{Ind} \\ \mathrm{c}_{\text{boy}} & : & \langle \lambda v : \mathit{Ind}(\text{boy}(v)), \langle \mathrm{x} \rangle \rangle, \\ \mathrm{y} & : & \mathit{Ind} \\ \mathrm{c}_{\text{dog}} & : & \langle \lambda v : \mathit{Ind}(\text{dog}(v)), \langle \mathrm{y} \rangle \rangle \\ \mathrm{e} & : & \langle \lambda v_1 : \mathit{Ind}(\lambda v_2 : \mathit{Ind}(\text{hug}(v_1, v_2))), \\ & & \quad \langle \mathrm{x}, \mathrm{y} \rangle \rangle \end{array}\right]$$

A record of type *a boy hugs a dog*

$$\begin{bmatrix} \mathsf{x} & = & a \\ \mathsf{c}_{\mathrm{boy}} & = & s_1 \\ \mathsf{y} & = & b \\ \mathsf{c}_{\mathrm{dog}} & = & s_2 \\ \mathsf{e} & = & s_3 \end{bmatrix}$$

where:

$$\begin{array}{l} a : \mathit{Ind} \\ s_1 : \mathrm{boy}(a) \\ b : \mathit{Ind} \\ s_2 : \mathrm{dog}(b) \\ s_3 : \mathrm{hug}(a,b) \end{array}$$

Two important facts about records

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- You can construct a record of a given type just in case there are objects of the types required by its fields – i.e. the labelling is arbitrary
- A record of a given type may contain more fields than required by the type – this record also belongs to a subtype of the type where the extra fields are added

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- they allow us to model frames (as in frame semantics and FrameNet)

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Summary

- Type theory as a formal theory related to perception
- A basic introduction to TTR:
  - basic types (e.g. *Ind*)
  - ptypes (e.g. hug(Sam,Dinah))
  - models which supply objects of basic types and ptypes
  - record types
  - mentioned some of their linguistic applications

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