INTRODUCTION TO LOGIC

Lecture 8
Identity and Definite Descriptions

Dr. James Studd

> The analysis of the beginning would thus yield the notion of the unity of being and not-being—or, in a more reflected form, the unity of differentiatedness and non-differentiatedness, or the identity of identity and non-identity.
>
> Hegel
> The Science of Logic

Outline

(1) The language of predicate logic with identity: $\mathcal{L}_=$

- Syntax
- Semantics
- Proof theory

(2) Formalisation in $\mathcal{L}_=$

- Numerical quantifiers
- Definite descriptions

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None of these uses of 'identical' is the logicians' use.

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- Minor difference: we write $a = b$ (rather than $=ab$).

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The other definitions from Chapter 5 carry over directly to $\mathcal{L}_=$.

- Valid
- Logical truth
- Contradiction
- Logically equivalent
- Semantically consistent

These are defined just as before replacing '$\mathcal{L}_2$' with '$\mathcal{L}_=$'.

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So: Let γ assign x to 1 and y to 2 (otherwise agreeing with α) Then $|x|^{\gamma} \neq |y|^{\gamma}$; so $|x = y|^{\gamma}_{\mathcal{A}} = \text{F}$. QED

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If s and t are constants, the result of appending $\phi[t/v]$ to a proof of $\phi[s/v]$ and a proof of $s = t$ or $t = s$ is a proof of $\phi[t/v]$.

$$\dfrac{\begin{array}{cc} \vdots & \vdots \\ \phi[s/v] & s = t \end{array}}{\phi[t/v]}\,=\text{Elim} \qquad \dfrac{\begin{array}{cc} \vdots & \vdots \\ \phi[s/v] & t = s \end{array}}{\phi[t/v]}\,=\text{Elim}$$

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Adequacy

Soundness and Completeness still hold.

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Let Γ be a set of $\mathcal{L}_=$-sentences and ϕ an $\mathcal{L}_=$-sentence.

Theorem (adequacy)

$\Gamma \vdash \phi$ if and only if $\Gamma \models \phi$.

Formalisation with identity

Using = one can formalise 'is [identical to]' in English.

Formalise:

William II is Wilhelm II.

Formalisation: $a = b$.
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Here 'is' forms part of the predicate 'is an emperor.'

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Definite descriptions

Examples of definite descriptions:

- ‘the Queen’
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But this isn’t perfect…

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Source of the trouble:

- $\mathcal{L}_=$-constants always refer to an object in a $\mathcal{L}_=$-structure.
- definite descriptions may fail to pick out a unique object.

Russell's theory of descriptions.

There's a better way to formalise definite descriptions in $\mathcal{L}_=$.

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(It doesn't matter what the extension of R is here.)

Multiple descriptions

We deal with these much like multiple quantifiers.

Formalise

The author of Ulysses likes the author of the Odyssey

Dictionary: U: ...is an author of Ulysses
O: ...is an author of the Odyssey. L: ...likes ...

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It's helpful to break this into two steps.

Partial formalisation:

$$\exists x_1 \big(Ux_1 \land \forall y_1 (Uy_1 \to y_1 = x_1) \land x_1 \text{ likes the author of the Odyssey} \big)$$

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It remains to formalise 'x_1 likes the author of the Odyssey'.

x_1 likes the author of the Odyssey

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x_1 likes the author of the Odyssey

Paraphrase: the author of the Odyssey is liked by x_1.

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Finally, we put this together with what we had before.

The author of Ulysses likes the author of the Odyssey

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x_1 likes the author of the Odyssey

Paraphrase: the author of the Odyssey is liked by x_1.

Formalisation: $\exists x_2\big(Ox_2 \wedge \forall y_2(Oy_2 \to y_2 = x_2) \wedge Lx_1x_2\big)$.

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- See Tarski 'What are Logical Notions?' *History and Philosophy of Logic 7*, 143–154.

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See the finals paper 127: Philosophical Logic.

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