PREDICATION, MODIFICATION, PRESUPPOSITION

ENGLISH SEMANTICS • LECTURE 3

Moreno Mitrović

The Saarland Lectures on Formal Semantics

THE λ-CALCULUS

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RECAP

- Before we move onto this, let's recall our CHAR_f-notation for intransitive verbs.

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- What about transitive verbs?

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b. ⟦**loves**⟧(Ann, Jan) = 1 (iff Ann actually loves Jan)

- Imagine we were interpreting an expression containing just the two words: noun **Maggie** and verb **love(s)**
  - We first need to construct a tree. In our case, there are two possible trees since something is missing.

(3)

(4)

$\boxed{\lambda x}$.LOVES(**Mary**, $\boxed{x}$)

denotes the characteristic function of the set of individuals that **Maggie loves**.

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- The last notation can be read 'if there was an x, $[\![\text{smoke}]\!]$ could be true.'

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For example

Expression BORED(x) **denotes the result of applying** the function denoted by **bored** to the value of x.

Another example

(7) $\left[\lambda x.\textsc{loves}(\text{Maggie})(x)\right]$

Another example

(7) $\left[\lambda x.\textsc{loves}(\text{Maggie})(x)\right](\text{Bill})$

- 7 denotes the result of applying the function **is loved by Maggie** to **Bill**.
- This is then equivalent to (8)

(8) $\textsc{loves}(\text{Maggie})(\text{Bill})$

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- This 'conversion' process is known as **β-conversion** or **β-reduction**.

- We all remember formulae like (9) from high school.

(9) $f(x) = x + 7$

a. Now let $x = 5$.

b. Then we have:
$f(x) = x + 7 \rightsquigarrow f(5) = 5 + 7$

- (9) is the same as (11)

(10) a. $f(x) = x + 7 \rightsquigarrow \lambda x.x + 7$

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λ-abstraction with numbers: a sketch

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- That's all λ-abstraction is:
  - abstraction with a λ-clause specifies the conditions under which the **value description** (11a)
  - β-reduction (β-conversion), **reduces** or **converts** the variable *x* into whatever value we feed it – in our case, number 5.

QUESTIONS?

EXERCISES

(12) $29 \in \{x \in \mathbb{N} : x \neq 0\}$ iff $29 \neq 0$

(13) Massachusetts $\in \{x \in D :$ California is a western state$\} = D$ iff California is a Western state.

(14) $\{x \in D :$ California is a western state$\} = D$ if California is a western state.

(15) $\{x \in D :$ California is a western state$\} = \varnothing$ if California is not a western state.

(16) $\{x \in \mathbb{N} : x \neq 0\} = \{y \in \mathbb{N} : y \neq 0\}$

(17) $[\lambda x \in D[\lambda y \in D[\lambda z \in D.z \text{ introduced } x \text{ to } y]]](\text{Ann})(\text{Sue})$

(18) $[\lambda x \in \mathbb{N}[\lambda y \in \mathbb{N}.y > 3 \text{ and } y < 7](x)]]]$

- We've written λ-functions in the following way:

(19) $\lambda x \,.\, \varphi$
"We need x to saturate φ" (x 'completes' φ)

- We can write a λ-abstracted function in more detail:

(20) $\lambda \alpha : \gamma \,.\, \varphi$

(21) $\lambda\alpha : \gamma . \varphi$

- The colon here provides the **domain condition** and the full stop the **value description**.
- For instance, this applies to (23a), which we can reduce to (23b).

(22) a. $\lambda x : x \in D_{\mathbf{e}} . x$ SMOKES

b. $\lambda x \in D_{\mathbf{e}} . x$ SMOKES

(23) a. $\lambda x : x \in D_e$. x SMOKES
"the function which maps every x, such that x is an individual, to 1 if x smokes, and to 0 otherwise."
"any x, such that x is an individual, is suitable to make the function SMOKES true if x smokes and untrue if x does not smoke."
"find an x, such that x is an individual, which can make the function SMOKE true if x smokes and untrue if x does not smoke..

b. $\lambda x \in D_e$. x SMOKES
"map any x which is an individual to 1 if x smokes, and to 0 otherwise."

λs ARE NOT JUST BRIDGES TO TRUTH

- So far, we've dealt with examples where a λ is needed to 'meet the condition' of a truth-value denoting predicate (like **smoke**).
- It doesn't have to.

(24) Read $[\lambda\alpha : \gamma \,.\, \varphi]$ as either (i) or (ii), whichever makes sense.

i. "the function which maps every α, such that γ, to 1, if φ, and to 0 otherwise." (e.g., intr-V – give an ex.)

ii. "the function which maps every α, such that γ, to φ." (e.g., tr-V – give an ex.)

(25) $[\lambda f : f \in D_{\langle \mathbf{e},\mathbf{t} \rangle}$. there is some $x \in D_{\mathbf{e}}$ such that $f(x) = 1]$

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- Can you think of an example that would work with (25)?

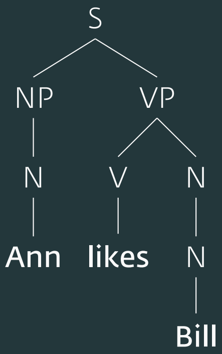
THE λ-CALCULUS

λS IN TREES

- A transitive verb like ⟦**likes**⟧ takes **two arguments**, hence is a **2-place function**.
- In λ-abstracted form, it looks something like (26)

(26) $[\![\textbf{likes}]\!] = \left[\lambda x \in D[\lambda y \in D \,.\, y \text{ likes } x]\right]$

- We know both x, y are in D so we could drop "$\in D$". Since want to be precise, we are not going to.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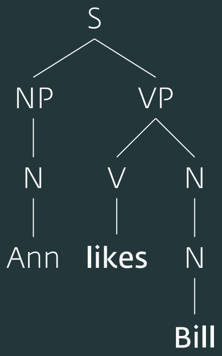
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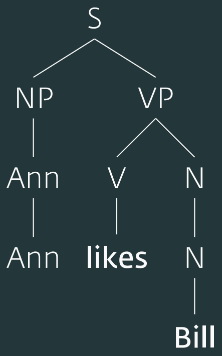
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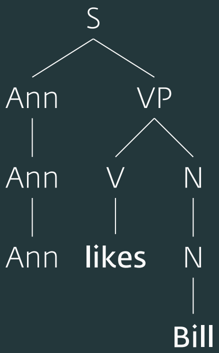
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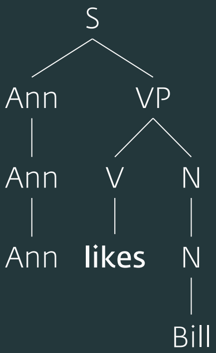
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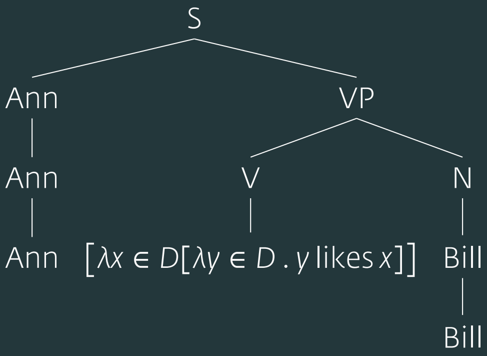
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[λx ∈ D[λy ∈ D . y likes x]]
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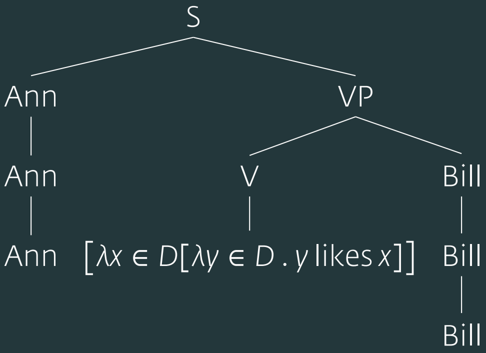
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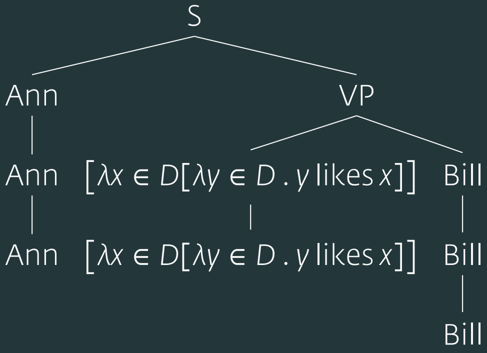
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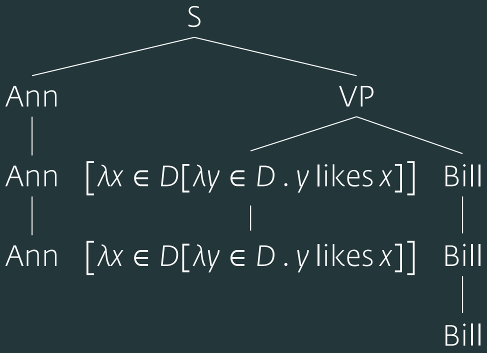
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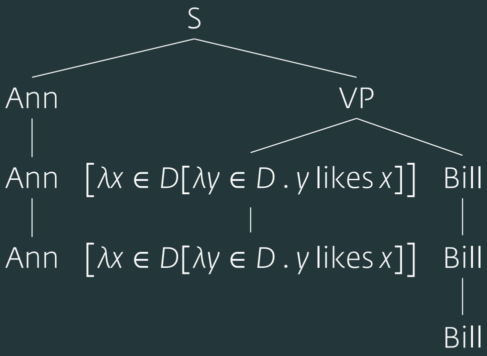
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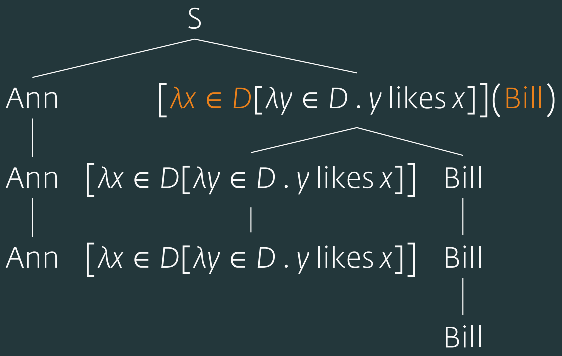
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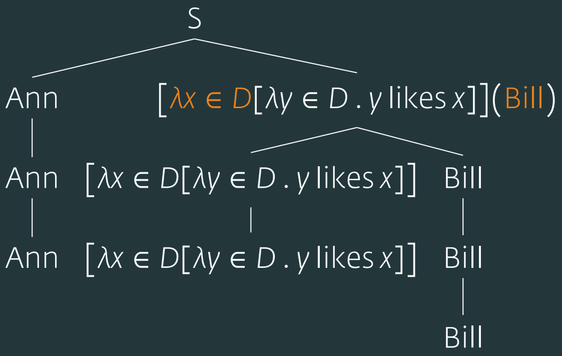
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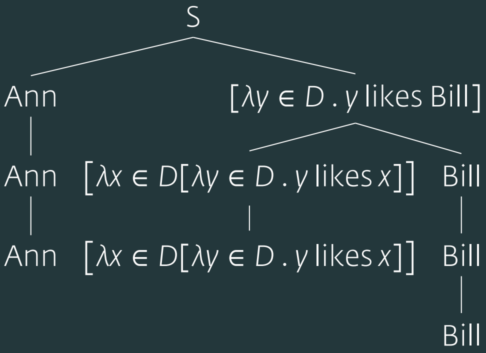
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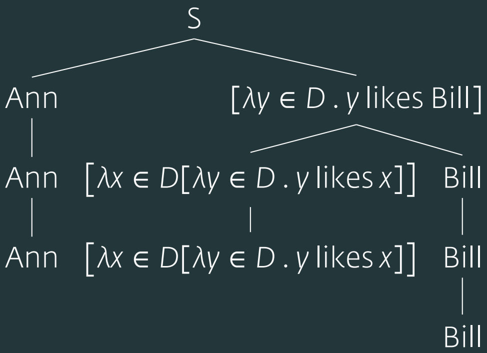
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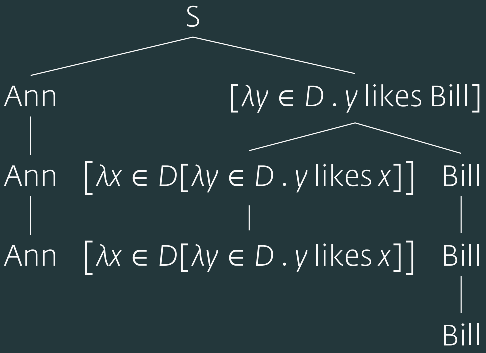
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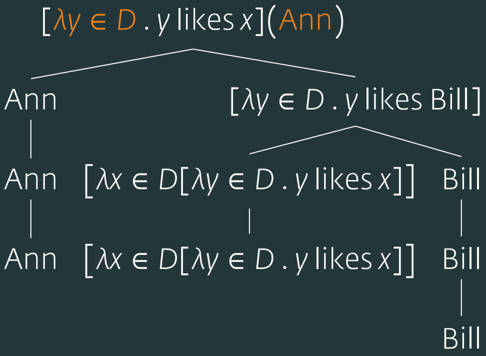
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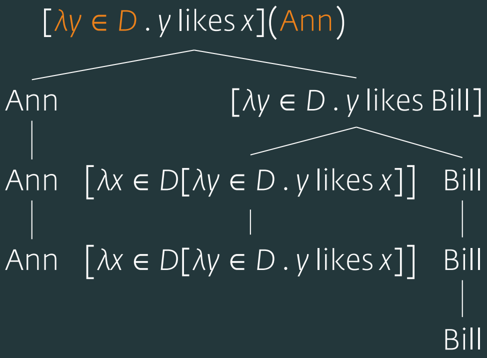
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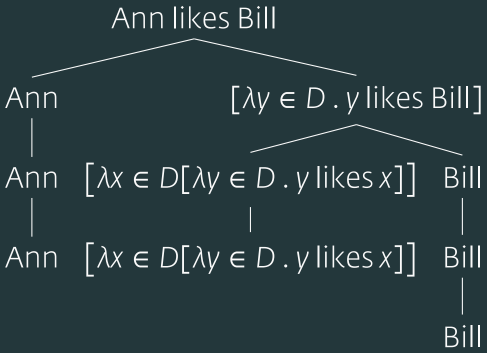
Ann likes Bill
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Ann
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a. $\big[\lambda x \in D\,.\,[\lambda y \in D\,.\,y \text{ loves } x](\text{Sue})\big]$
$= \lambda x \in D\,.\,\text{Sue loves } y$

b. $\big[\lambda x \in D\,.\,[\lambda y \in D\,.\,y \text{ loves } x]\big](\text{Sue})$
$= \lambda y \in D\,.\,y \text{ loves Sue}$

SOME MORE EXERCISES

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$(\lambda y \in D_{\mathbf{e}}\,.\,y \text{ is a cat})$

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(34) $[\lambda x \in \mathbb{N}\,.\,[\lambda y \in \mathbb{N}\,.\,y > 3 \text{ and } y < 7](x)]$

(28) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y]]\Big](\text{Ann})(\text{Sue})$

(29) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y](\text{Ann})](\text{Sue})\Big]$

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(32) $[\lambda f \in D_{\langle \mathbf{e},\mathbf{t}\rangle}\,.\,[\lambda x \in D_{\mathbf{e}}\,.\,f(x) = 1 \text{ and } x \text{ is grey}]]$
$(\lambda y \in D_{\mathbf{e}}\,.\,y \text{ is a cat})$

(33) $[\lambda f \in D_{\langle \mathbf{e},\langle \mathbf{e},\mathbf{t}\rangle\rangle}\,.\,[\lambda x \in D_{\mathbf{e}}\,.\,f(x)(\text{Ann}) = 1]]$
$([\lambda y \in D_{\mathbf{e}}\,.\,[\lambda z \in D_{\mathbf{e}}\,.\,z \text{ saw } y]])$

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MORE OF ENGLISH

SEMANTIC VACUITY

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(36) a. $[\![\text{of John}]\!] = [\![\text{John}]\!]$
b. $[\![\text{be rich}]\!] = [\![\text{rich}]\!]$
c. $[\![\text{a cat}]\!] = [\![\text{cat}]\!]$

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b. ⟦be rich⟧ = ⟦rich⟧

c. ⟦a cat⟧ = ⟦cat⟧

- What is the meaning of items **of**, **be**, and **a** above so that the equivalences hold? (3mins)

NONVERBAL PREDICATION

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b. fond
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d. from

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b. student
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- What are the meanings of each of these?

- What is the denotation of **in Texas**?

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- Let's calculate the truth-conditions of the following:

(37) a. Joes is in Texas.
b. Joe is fond of Kaline.
c. Kaline is a cat.

- What about the meaning of **a grey cat**?
- Try composing it. (2mins)

PREDICATE MODIFICATION

- We need a new rule that can handle cases where Functional Application (FA) cannot apply.

Predicate Modification (PM)

If α is a branching node, $\{\beta, \gamma\}$ is the set of α's daughters, and $[\![\beta]\!]$ and $[\![\gamma]\!]$ are both in $D_{\langle \mathbf{e},\mathbf{t} \rangle}$, then

$$[\![\alpha]\!] = \lambda x \in D_{\mathbf{e}} . [\![\beta]\!](x) = [\![\gamma]\!](x) = 1$$

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$[\![\alpha]\!] = \lambda x \in D_{\mathbf{e}} . [\![\beta]\!](x) = [\![\gamma]\!](x) = 1$
($= \lambda x \in D_{\mathbf{e}}$. x is $[\![\beta]\!]$ <u>and</u> x is $[\![\gamma]\!]$)

- We can now calculate the truth conditions of (38).

(38) $[\![$**city in Texas**$]\!]$=

- We can now calculate the truth conditions of (38).

(38) ⟦**city in Texas**⟧=

(39) Denver is a city in Texas.

PRESUPPOSIONS & THE DEFINITE ARTICLE

- Common nouns, like 'cat', denote the characteristic functions of sets of individuals. (What type are they, again?)

THE DEFINITE ARTICLE

- Common nouns, like 'cat', denote the characteristic functions of sets of individuals. (What type are they, again?)
- What does this imply for the semantic analysis of determiners? Let's just focus on **the** for now.

- Basic intuition:

- Basic intuition: "the NP" denotes individuals, just like proper names.
- **student** denotes a (CHAR$_f$ of a) set of students.
- **the student** denotes a unique individual. (Russell, cf. Frege who thought so too.)

(40) a. $[\![$**the**$]\!]([\![$**German chancellor**$]\!])$ =Angela Merkel

b. $[\![$**the**$]\!]([\![$**opera by Beethoven**$]\!])$ =Fidelio

c. $[\![$**the**$]\!]([\![$**negative square root of 4**$]\!]) = -2$

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- **The** is a **function**.
- What is its domain? Its range?

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- **The** is a **function**.
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(41) For ant $f \in D_{\langle \mathbf{e,t} \rangle}$ such that there is exactly one x for which $f(x) = 1$, $[\![\textbf{the}]\!](f)$ = the unique x for which $f(x) = 1$.

- What about *f*s that do not maps exactly one individual to 1? What would ⟦**the**⟧ yield?

(42) **the escalator in South College**

(43) **the stairway in South College**

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NB There are no escalators in South College and there is more than one stairway.

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- No objects are denoted. The function cannot apply since ⟦**the escalator in South College**⟧ and ⟦**the stairway in South College**⟧ **are not in the domain of** ⟦**the**⟧.
- If they are not in the domain of ⟦**the**⟧, then ⟦**the**⟧ cannot apply to them – we cannot apply FA to calculate a semantic value for (44) and (45).

- The generalisation that emerges regarding the domain of ⟦**the**⟧ is the following:

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(46) The domain of ⟦**the**⟧ contains just those functions $f \in D_{\langle \mathbf{e,t} \rangle}$ which satisfy the condition that there is exactly one x for which $f(x)$.

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(46) The domain of ⟦**the**⟧ contains just those functions $f \in D_{\langle \mathbf{e},\mathbf{t} \rangle}$ which satisfy the condition that there is exactly one x for which $f(x)$.

- The semantics of ⟦**the**⟧ is then the following (recall the colon in λ-terms):

(47) ⟦**the**⟧ $= \lambda f : f \in$
$D_{\langle \mathbf{e},\mathbf{t} \rangle}$ and there is exactly one x such that $f(x)$.
the unique y such that $f(y) = 1$.

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- Does it map totally? Are all $x \in D_{\langle \mathbf{e,t} \rangle}$ in the domain of ⟦**the**⟧?

  A **partial** function from A to B is a function from a **subset** of A to B.