Composing Meaning via Dependent Type Semantics
Day 4: Presuppositions

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Presupposition

Joint work with Koji Mineshima

What is Presupposition? — Background content

(1) It is John who broke my iPhone.

Presupposition: *Someone broke my iPhone*.

- the background content
- its truth is usually taken for granted

Assertion: *John was the one who did it*.

- the foreground content
- the main point of an utterance

Two puzzules of Presupposition – (i) Projection

(1) It was John who broke my iPhone.

(2) Someone broke my iPhone. ((1) **presupposes** (2))

(2) projects out of all the embedded contexts in (3a–e).

(3) a. It wasn't John who broke my iPhone. **negation**

b. Maybe it was John who broke my iPhone. **modal**

c. If it was John who broke my iPhone, then he has to fix it. **the antecedent of a conditional**

d. Was it John who broke my iPhone? **question**

e. Suppose that it was John who broke my iPhone. **hypothetical assumption**

The Case of Entailment

(4) John is an American pianist.

(5) John is American. ((4) **entails** (5))

(5) does not survive in the contexts (6a–e).

(6) a. John is not an American pianist. **negation**

b. Maybe John is an American pianist. **modal**

c. If John is an American pianist, he is skillful.
the antecedent of a conditional

d. Is John an American pianist? **question**

e. Suppose that John is an American pianist.
hypothetical assumption

The Case of Entailment

(4) John is an American pianist.
american(john) $\wedge$ **pianist(john)**

(6) a. John is not an American pianist.
$\neg$(**american(j)** $\wedge$ **pianist(j)**)

b. Maybe John is an American pianist.
$\Diamond$(**american(j)** $\wedge$ **pianist(j)**)

c. If John is an American pianist, he is skillful.
american(j) $\wedge$ **pianist(j)** $\rightarrow$ **skillful(j)**

Standard semantics correctly predicts these patterns:

- (4) $\vdash$ **american(john)**
- (6a) $\nvdash$ **american(john)**
- (6b) $\nvdash$ **american(john)**
- (6c) $\nvdash$ **american(john)**

The Case of Presupposition

(1) It was John who broke my iPhone. $\boldsymbol{SR_1}$

(3) a. It wasn't John who broke my iPhone. $\neg \boldsymbol{SR_1}$

b. Maybe it was John who broke my iPhone. $\Diamond \boldsymbol{SR_1}$

c. If it was John who broke my iPhone, he has to fix it. $\boldsymbol{SR_1} \rightarrow \cdots$

What SR accounts for the following inference patterns?

- $\boldsymbol{SR_1} \Vdash \exists x(\textbf{broke}(x, \textbf{my\_iphone}))$
- $\neg \boldsymbol{SR_1} \Vdash \exists x(\textbf{broke}(x, \textbf{my\_iphone}))$
- $\Diamond \boldsymbol{SR_1} \Vdash \exists x(\textbf{broke}(x, \textbf{my\_iphone}))$
- $\boldsymbol{SR_1} \rightarrow \boldsymbol{A} \Vdash \exists x(\textbf{broke}(x, \textbf{my\_iphone}))$

Q: Can "$\Vdash$" be defined as a standard consequence relation "$\vdash$"?
A: No. If that were the case, then $\exists x(\textbf{broke}(x, \textbf{my\_iphone}))$ was a tautology (under the classical setting).

Two puzzules of Presupposition – (ii) Filteration

(7) presupposes that someone broke the window, but the conditional in (8) does not inherit this presupposition.

(7) It was John who broke the window.
⇒ Someone broke the window

(8) If the window was broken, it was John who broke it.
⇏ Someone broke the window

Similarly for (9) and (10).

(9) The king of France is wise.
⇒ France has a king.

(10) If France has a king, the king of France is wise.
⇏ France has a king.

A presupposition is **filtered** when it occurs in certain contexts.

Presupposition triggers

(11) a. **The elevator** in this building is clean. **Description**
b. There is an elevator in this building.

(12) a. **John's sister** is happy. **Possessive**
b. John has a sister.

(13) a. Bill **regrets** that he lied to Mary. **Factive**
b. Bill lied to Mary.

(14) a. John has **stopped** beating his wife. **Aspectual**
b. John has beaten his wife.

(15) a. Harry **managed** to find the book. **Implicative**
b. Finding the book required some effort.

Presupposition triggers

(16) a. Sam broke the window **again** today. **Iterative**

b. Sam broke the window before.

(17) a. **It was** Sam **who** broke the window. **Cleft**

b. Someone broke the window.

(18) a. **What** John broke **was** his typewriter. **Pseudo-cleft**

b. John broke something.

(19) a. $[\text{Pat}]_F$ is leaving, **too**. (Focus on *Pat*) **Additive**

b. Someone other than Pat is leaving.

For classical examples of presupposition triggers, see Levinson (1983), Soames (1989), Geurts (1999), and Beaver (2001), among others.

“Presupposition Is Anaphora” hypothesis

"Presupposition Is Anaphora" hypothesis

There are striking parallels between anaphoric expressions and presupposition triggers. (van der Sandt, 1992; Geurts, 1999)

Presupposition filtering:

(20) a. John has children and **John's children** are wise.
b. If John has children, **John's children** are wise.

(21) a. The window was broken and **it was** John **who** broke it.
b. If the window was broken, **it was** John **who** broke it.

Compare (20) and (21) with the paradigm examples of anaphora resolution.

Anaphora resolution:

(22) a. John owns a donkey and he beats **it**.
b. If John owns a donkey, he beats **it**.

DTS on Filtering

- The present account can explain the filtering of presupposition without further stipulation.

  (23) If France has a king, **the king of France** is wise.

$$\textbf{SR} \quad \left(u : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]\right) \rightarrow \left[\begin{array}{l} v@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \textbf{wise}(\pi_1 v) \end{array}\right]$$

Filtering: Type checking

$$\dfrac{\left(u : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]\right) \rightarrow \left[\begin{array}{l} v@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \textbf{wise}(\pi_1 v) \end{array}\right] : \text{type} \quad (\Pi F),1 \qquad \dfrac{\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] : \text{type} \qquad \dfrac{\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] : \text{type} \quad ? : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \qquad \textbf{wise}(\pi_1 v)[\,?\,/v]}{\left[\begin{array}{l} v@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \textbf{wise}(\pi_1 v) \end{array}\right]} (@) \qquad u : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]^1}{\left(u : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]\right) \rightarrow \left[\begin{array}{l} v@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \textbf{wise}(\pi_1 v) \end{array}\right] : \text{type}}$$

DTS on Filtering

$$\dfrac{\dfrac{\begin{bmatrix} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{bmatrix} \vdots}{: \text{type}} \quad \dfrac{\dfrac{}{\textbf{wise} : \text{entity} \to \text{type}}\,(CON) \quad \dfrac{\dfrac{}{u : \begin{bmatrix} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{bmatrix}}\,1}{\pi_1 u : \text{entity}}\,(\Sigma E)}{\textbf{wise}(\pi_1 u) : \text{type}}\,(\Pi E)}{\left(u : \begin{bmatrix} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{bmatrix}\right) \to \textbf{wise}(\pi_1 u) : \text{type}}\,(\Pi F),_1$$

- Type checking algorithm returns a fully-specified semantic representation.
- Presupposition filtering is performed via exactly the same process as anaphora resolution.

A takeaway message from DTS on Presupposition Filtering

A presupposition is filtered in the same way as an anaphoric expression is resolved.

DTS on Projection

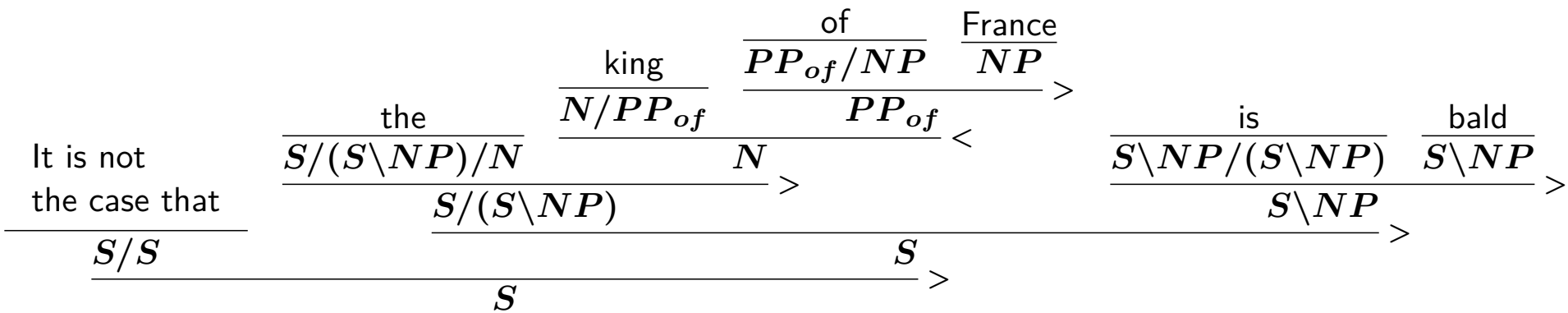
- The projection of presupposition is naturally accounted for using DTS.
- Recall that negation is defined to be an implication of the form $\neg A \equiv A \to \bot$.
- According to the formation rule $(\mathbf{\Pi F})$, the proposition A and its negation $\neg A$ have the same presupposition.

Example:

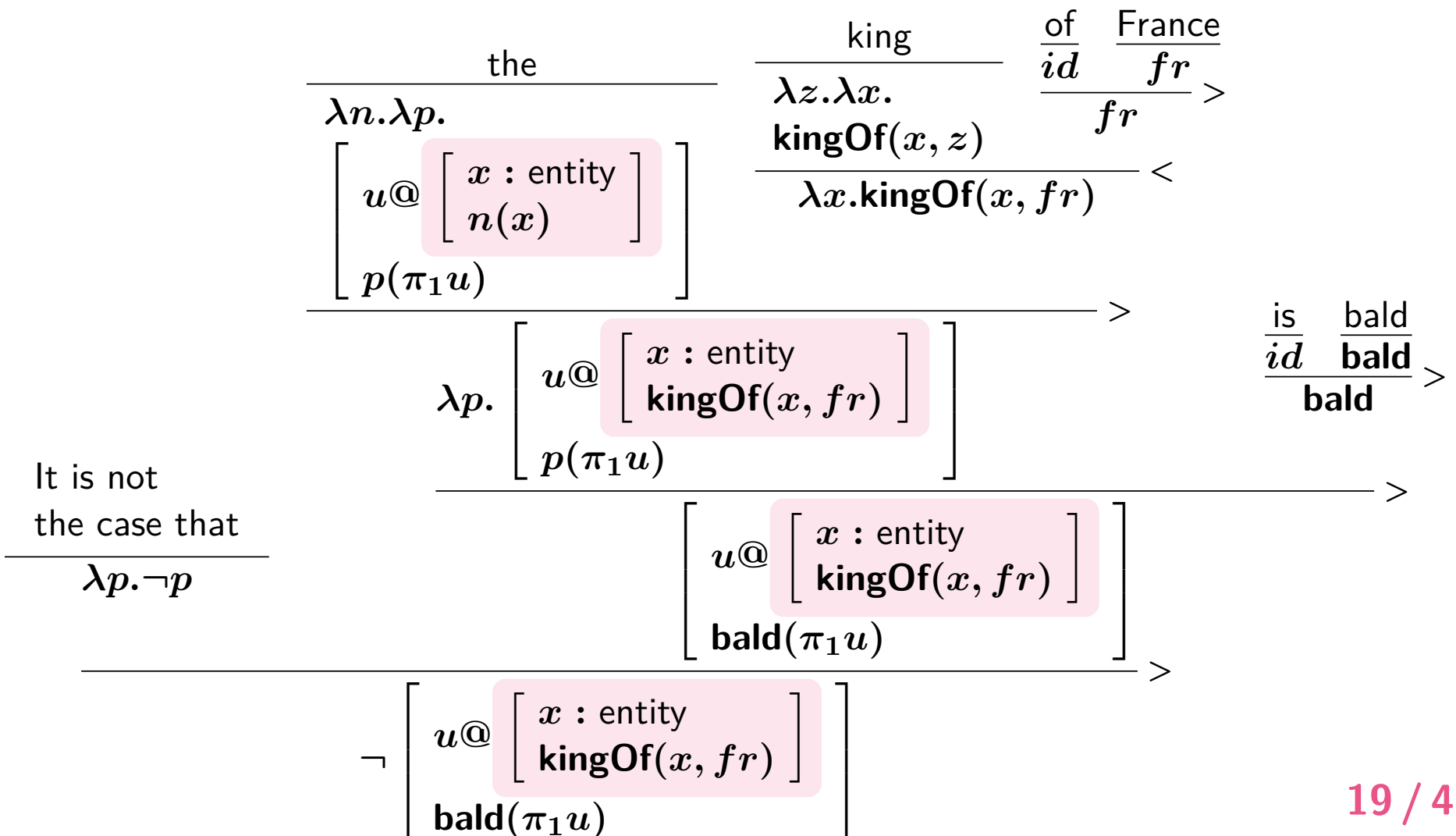
It is not the case that the king of France is bald.

$$\textbf{SR} \qquad \neg \left[\begin{array}{l} u@ \left[\begin{array}{l} x : \text{entity} \\ \textbf{king}(x, fr) \end{array} \right] \\ \textbf{bold}(\pi_1 u) \end{array} \right]$$

Projection: Syntax



Projection: Semantic Composition



Projection: Type checking

$$\dfrac{\dfrac{\vdots}{\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]} \quad ? : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \quad \neg\textbf{bald}(\pi_1 u)[\,?\,/u] : \text{type}}{\left[\begin{array}{l} u@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \neg\textbf{bald}(\pi_1 u) \end{array}\right] : \text{type}}\,(@) \qquad \dfrac{}{\bot : \text{type}}\,(\{\}F)}{\neg\left[\begin{array}{l} u@\left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right] \\ \neg\textbf{bald}(\pi_1 u) \end{array}\right] : \text{type}}\,(\Pi F)$$

- In order for the sentence "The king of France is bald" to be well-formed, the context Γ must be such that the following type inhabits a proof (namely, there exists a king of France).

$$\Gamma \vdash ? : \left[\begin{array}{l} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{array}\right]$$

DTS on Projection

- The same inference is triggered for the antecedent of a conditional sentence like (24):

  (24) If the king of France is wise, people will be happy.

$$\frac{\begin{bmatrix} u@\begin{bmatrix} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{bmatrix} \\ \textbf{wise}(\pi_1 u) \end{bmatrix} : \text{type} \qquad \textbf{happy}(people) : \text{type}}{\begin{bmatrix} u@\begin{bmatrix} x : \text{entity} \\ \textbf{kingOf}(x, fr) \end{bmatrix} \\ \textbf{wise}(\pi_1 u) \end{bmatrix} \rightarrow \textbf{happy}(people) : \text{type}} \; (\Pi F)$$

A takeaway message from DTS on Presupposition Projection

A presupposition projects because it's truth is a requirement for a sentence containing it to be *semantically well-formed*, not to be *true*.

Corollary: Existence of an antecedent is a requirement for a sentence containing anaphora to be semantically well-formed, not to be true.

Summary and History

A Unified, Compositional Theory of *Projective* Meaning

- DTS provides a unified analysis for (general) inferences and anaphora resolusion mechanisms.
- The background theory for DTS is an extention of DTT with underspecified types and the @-rule.
  - Lexical items of anaphoric expressions and presupposition triggers are represented by using underspecified types.
  - Context retrieval in DTS reduces to type checking.
  - Anaphora resolution and presupposition binding in DTS reduces to proof search.
  - Type checker translates a proof diagram of DTS into a proof diagram of DTT, by which an SR in DTT is obtained with all anaphora resolved.

Natural language semantics via dependent types: The first generation

- Donkey anaphora: Sundholm (1986)
- Translation from DRS to dependent type representations: Ahn and Kolb (1990)
- Summation: Fox (1994a,b)
- Ranta's TTG (Relative and Implicational Donkey Sentences, Branching Quantifiers, Intensionality, Tense): Ranta (1994)
- Translation from Montague Grammar to dependent type representations: Dávila-Pérez (1995)
- Presupposition Binding and Accommodation, Bridging: Krahmer and Piwek (1999), Piwek and Krahmer (2000)

Natural language semantics via dependent types: The second generation

- Type Theory with Record (TTR): Cooper (2005)
- Modern Type Theory: Luo (1997, 1999, 2010, 2012), Asher and Luo (2012), Chatzikyriakidis (2014)
- Semantics with Dependent Types: Grudzinska and Zawadowski (2014; 2017)
- Dynamic Categorial Grammar: Martin and Pollard (2014)
- **Dependent Type Semantics (DTS): Bekki (2014), Bekki and Mineshima (2017)**

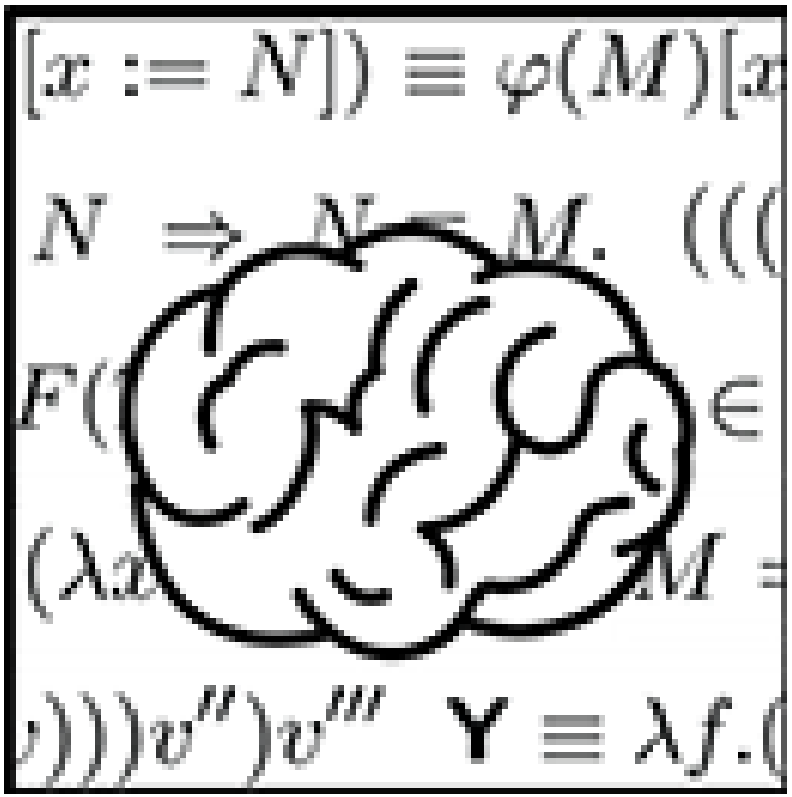
Semantic Analyses by DTS: The third generation

- Generalized Quantifiers: Tanaka (2014)
- Honorification: Watanabe et al. (2014)
- Conventional Implicature: Bekki and McCready (2015), Matsuoka et al. (2023)
- Factive Presuppositions: Tanaka et al. (2015)
- Dependent Plural Anaphora: Tanaka et al. (2017)
- Paycheck sentences: Tanaka et al. (2018)
- Coercion and Metaphor: Kinoshita et al. (2017, 2018)
- Questions: Watanabe et al. (2019), Funakura (2022)
- Comparision with DRT: Yana et al. (2019)
- The proviso problem: Yana et al. (2021)
- Weak Crossover: Bekki (2023)

Computational Aspects of DTS

- Type Checker for (the fragment of) DTS: Bekki and Sato (2015)
- Development of an automated theorem prover (for the fragment of) DTS: Daido and Bekki (2020)
- Integrating Deep Neural Network with DTS: Bekki et al. (2023, 2022)

Thank you!


$[x := N]) \equiv \varphi(M)[x$
$N \Rightarrow N = M.$ (((
$F($ $\in$
$(\lambda x$ $M =$
$v'))))v'')v'''$ $\mathbf{Y} \equiv \lambda f.($

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