

Compositionality and the Theory of Argument Selection

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Lecture 2. Generative Lexicon as a Theory of Selection

Natural Entities

Entities formed from the application of the **FORMAL** and/or **CONST** qualia roles:

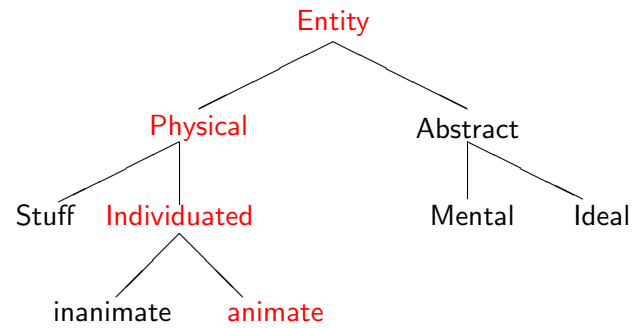
For the predicates below, e_N is structured as a join semi-lattice, $\langle e_N, \sqsubseteq \rangle$;

(1)a. *physical, human, stick, lion, pebble*

b. *water, sky, rock*

Natural Entity Types as a Lattice

(2)



Natural Entities

Entities formed from the application of the **FORMAL** and/or **CONST** qualia roles:

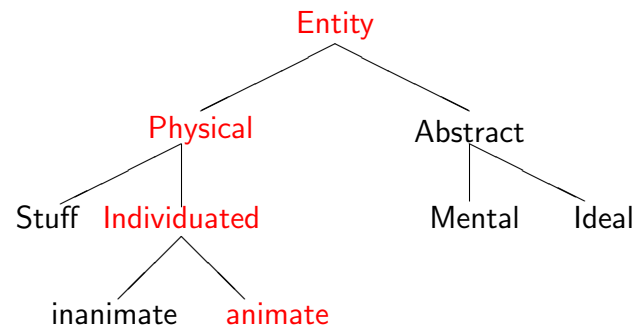
For the predicates below, e_N is structured as a join semi-lattice, $\langle e_N, \sqsubseteq \rangle$;

(3)a. *physical, human, stick, lion, pebble*

b. *water, sky, rock*

Natural Entity Types as a Lattice

(4)



Natural Predicate Types

Predicates formed with **Natural Entities** as arguments:

- (5)a. *fall*: $e_N \rightarrow t$
b. *touch*: $e_N \rightarrow (e_N \rightarrow t)$
c. *be under*: $e_N \rightarrow (e_N \rightarrow t)$

Expressed as typed arguments in a λ -expression:

- (6)a. $\lambda x: e_N [fall(x)]$
b. $\lambda y: e_N \lambda x: e_N [touch(x,y)]$
c. $\lambda y: e_N \lambda x: e_N [be-under(x,y)]$

Artifactual Entity Types: e_A

Entities formed from the Naturals by adding the **AGENTIVE** or **TELIC** qualia roles:

(7) Expressed as types:

a. **Artifact Entity**: $x : e_N \otimes_a \sigma$
 x exists because of event σ

b. **Functional Entity**: $x : e_N \otimes_t \tau$
the purpose of x is τ

c. **Default Artifactual Entity**: $x : (e_N \otimes_a \sigma) \otimes_t \tau$
 x exists because of event σ for the purpose τ

Artifactual Entity Types

Examples of types in e_A .

- (8)a. *beer*: $liquid \otimes_t drink$
 $(liquid \otimes_a brew) \otimes_t drink$ (expressing Agentive)
- b. *knife*: $phys \otimes_t cut$
 $(phys \otimes_a make) \otimes_t cut$ (expressing Agentive)
- c. *house*: $phys \otimes_t live_in$
 $(phys \otimes_a build) \otimes_t live_in$ (expressing Agentive)

Human Functional Entity Types

(9) **TELIC** and **AGENTIVE** constraints on the Natural

Type HUMAN:

a. *boss, friend*;

b. *dancer*: $human \otimes_t dance$

c. *wife, husband*: $human \otimes_a marry$

Artifactual Predicate Types

Predicates formed with **Artifactual Entities** as arguments:

(10)a. *spoil*: $e_N \otimes_t \tau \rightarrow t$

b. *fix*: $e_N \otimes_t \tau \rightarrow (e_N \rightarrow t)$

Expressed as typed arguments in a λ -expression:

(11)a. $\lambda x: e_A[\textit{spoil}(x)]$

b. $\lambda y: e_A \lambda x: e_N[\textit{fix}(x,y)]$

(12)a. **The beer** spoiled.

b. Mary fixed **the watch**.

Complex Entity Types

Entities formed from the **Naturals** and **Artifactuals** by a **product type** between the entities, i.e., the dot, ●.

(13)a. Mary doesn't believe **the book**.

b. John sold **his book** to Mary.

(14)a. John wrote **the exam** last night in under 10 minutes.

b. **The exam** lasted more than three hours this morning.

Dot Objects: e_C

(15) Expressed as types:

- a. **Complex Entity**: $x : e_i \bullet e_j$, for i, j of any level
- b. **Complex Predicate**: $P : x : e_i \bullet e_j \rightarrow t$

Wait a Second... Motivating Dot Objects

- When a single word or phrase has the ability to appear in selected contexts that are **contradictory** in type specification.

(16) If a lexical expression, α , where $\sigma \sqcap \tau = \perp$:

a. $[\text{---}]_{\sigma} X$

b. $[\text{---}]_{\tau} Y$

are both well-formed predications, then α is a **dot object** (complex type).

Dot Object Inventory

1. **Act•Proposition**: promise, allegation, lie
 - a. I doubt **John's promise of marriage**.
 - b. **John's promise of marriage** happened while we were in Prague.

Dot Object Inventory

2. State●Proposition: belief
 - a. Nothing can shake John's belief.
 - b. John's belief is obviously false.

Dot Object Inventory

3. **Attribute•Value**: temperature, weight, height, tension, strength
 - a. **The temperature** is rising.
 - b. **The temperature** is 23.

Dot Object Inventory

4. **Act•Proposition**: promise, allegation, lie
 - a. I doubt **John's promise of marriage**.
 - b. **John's promise of marriage** happened while we were in Prague.

Dot Object Inventory

5. **Event•Information**: lecture, play, seminar, exam, quiz, test

a. **My lecture** lasted an hour.

b. Nobody understood **my lecture**.

Dot Object Inventory

6. **Event•Human**: appointment
 - a. You missed **your last appointment**.
 - b. **Your next appointment** is a Serbian student.

Dot Object Inventory

7. **Event•Music**: sonata, symphony, song, performance, concert

- a. Mary couldn't hear **the concert**.
- b. The rain started during **the concert**.

Dot Object Inventory

8. **Event•Physical**: lunch, breakfast, dinner, tea
 - a. **My lunch** lasted too long today.
 - b. I pack **my lunch** on Thursdays.

Dot Object Inventory

9. **Information●Physical**: book, cd, dvd, dictionary, diary, mail, email, mail, letter

a. Mary burned **my book on Darwin**.

b. Mary believes **all of Chomsky's books**.

Dot Object Inventory

10. **Organization●(Information●Physical)**: magazine, newspaper, journal

- a. **The magazine** fired its editor.
- b. The cup is on top of **the magazine**.
- c. I disagreed with **the magazine**.

Dot Object Inventory

11. **Process●Result**: construction, depiction, imitation, portrayal, reference, rendering, decoration, display, documentation, drawing, enclosure, entry, instruction, design, invention, music, obstruction, pattern, simulation, illustration, agreement, approval, recognition, damage, compensation, contribution, disbursal, disbursement, discount, donation, acquisition, deduction, endowment, gift, categorization, classification, grouping

- a. **Linnaeus's classification of the species** took 25 years.
- b. **Linnaeus's classification** contains 12,100 species.

Reference to different Aspects of Dot Objects

(17)a. John **read** every book in the library.

b. John **stole** every book in the library.

(18)a. Mary **answered** every question in the class.

b. Mary **repeated** every question in the class.

Complex Type (Dot Object): e_C

Introduces a coherence relation as a product type between a Natural, Artifactual, or Complex type, and reifies this as a type.

- (19)a. *phys* • *info*: *book, record, DVD*;
- b. *event* • *event*: *construction, examination*;
- c. *phys* • *aperture*: *door, window*.

Complex Predicate Types

Predicates formed with **Complex Entity Types** as arguments:

$$(20) \textit{read}: \textit{phys} \bullet \textit{info} \rightarrow (e_N \rightarrow t)$$

Expressed as typed arguments in a λ -expression:

$$(21) \lambda y: \textit{phys} \bullet \textit{info} \lambda x: e_N [\textit{read}(x,y)]$$

(22) Mary read **the book**.

Enriching Compositionality

If all you have for composition is **function application**, then you need to create as many **lexical entries** for an expression as there are **environments** it appears in.

(**Weak Compositionality**)

Two ways to overcome this:

- (1) **Type Shifting Rules**: Partee-Rooth MG, CG, HPSG.
- (2) **Type Coercion Operations**: GL, Hendriks, Moens and Steedman

Maintaining Compositionality

- Generative Mechanisms of Argument Selection:
 - * Selection
 - * Accommodation
 - * Coercion:
 - (i) Introduction
 - (ii) Exploitation
- Qualia-based Type Structure:
 - * Natural,
 - * Artifactual,
 - * Complex.

Generative Mechanisms of Argument Selection

- **Pure Selection**: The type a function requires is **directly satisfied** by the argument.
- **Accommodation**: The type a function requires is **inherited** by the argument.
- **Coercion**: The type a function requires is **imposed** on the argument type. This is accomplished by either:
 - * **Exploitation**: **selecting** part of the argument's type structure to satisfy the function's typing;
 - * **Introduction**: **wrapping** the argument with the type the function requires.

Type Coercion

- **Exploitation**: selecting part of the argument's type structure to satisfy the function's typing;
- **Introduction**: wrapping the argument with the type the function requires.

Two Kinds of Coercion in Language

- **Domain-shifting**: The domain of interpretation of the argument is shifted;
- **Domain-preserving**: The argument is coerced but remains within the general domain of interpretation.

Domain-Shifting Coercion

- Entity shifts to event:
I enjoyed the beer
- Event shifts to interval:
before the party started. . .
- Entity shifts to proposition:
I doubt John.

Domain-Preserving Coercion

- **Count-mass shifting**: There's chicken in the soup.
- **NP Raising**: Mary and every child came.

Domain-Preserving Coercion

- **Count-mass shifting**: There's chicken in the soup.
- **NP Raising**: Mary and every child came.

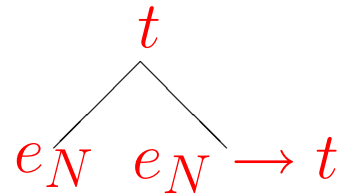
Actually, they are all over the place:

- **Natural-Artifactual shifting**:
- **Natural-Complex shifting**:
- **Complex-Natural shifting**:
- **Artifactual-Natural shifting**:
- **Complex-Artifactual shifting**:
- **Complex-Complex shifting**:
- **Artifactual-Artifactual shifting**:

Function Application with Natural Types

Function Application: If α is of type e_N , and β is of type $e_N \rightarrow t$, then $\beta(\alpha)$ is of type t .

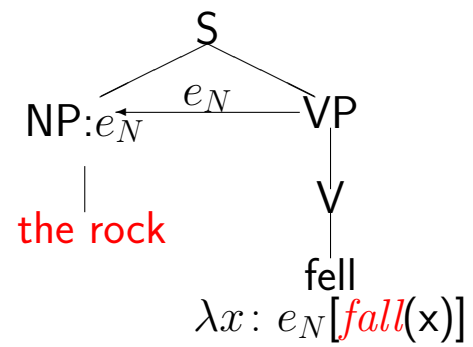
A natural type tree:



Pure Selection: Natural Type

The rock fell.

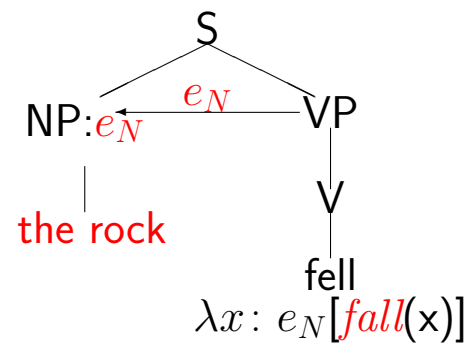
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Pure Selection: Natural Type

The rock fell.

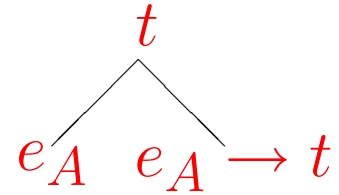
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Function Application with Artifactual Types

Function Application: If α is of type e_A , and β is of type $e_A \rightarrow t$, then $\beta(\alpha)$ is of type t .

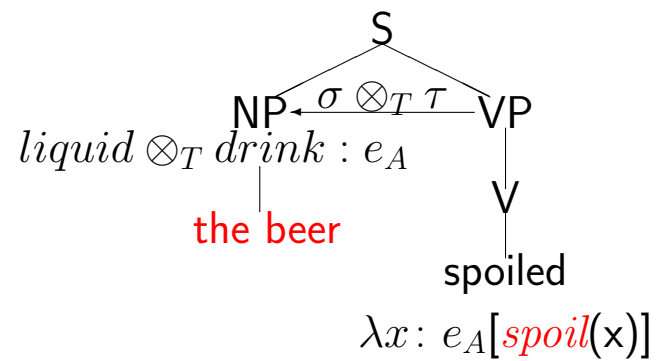
An artifactual type tree:



Pure Selection: Artifactual Type

The beer spoiled.

(25)

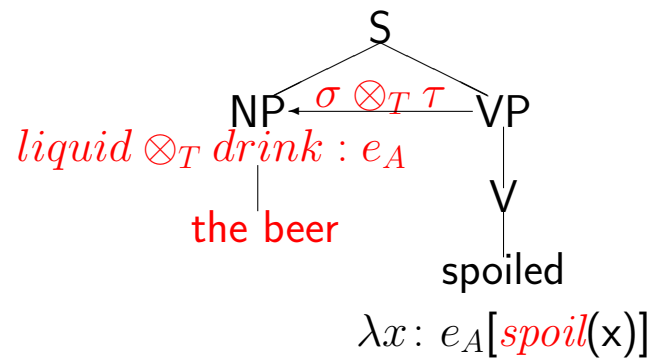


$$liquid \otimes_T drink \sqsubseteq \sigma \otimes_T \tau$$

Pure Selection: Artifactual Type

The beer spoiled.

(26)

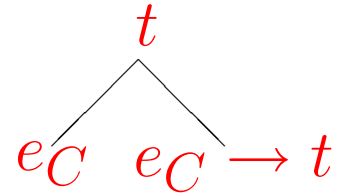


$$\textit{liquid} \otimes_T \textit{drink} \sqsubseteq \sigma \otimes_T \tau$$

Function Application with Complex Types

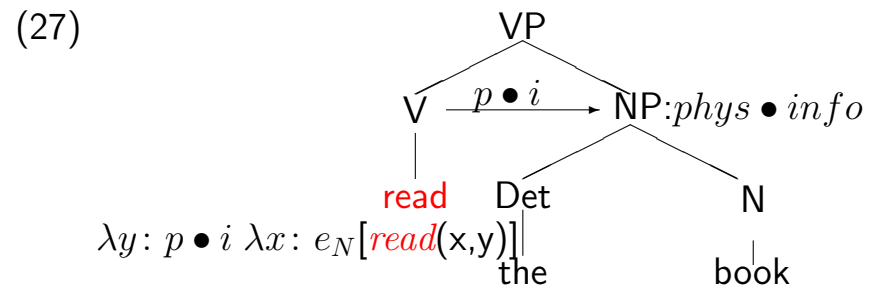
Function Application: If α is of type e_C , and β is of type $e_C \rightarrow t$, then $\beta(\alpha)$ is of type t .

A complex type tree:



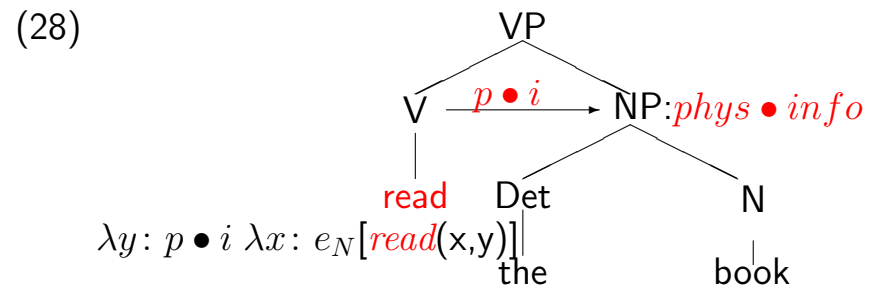
Pure Selection: Complex Type

John read the book.



Pure Selection: Complex Type

John read the book.



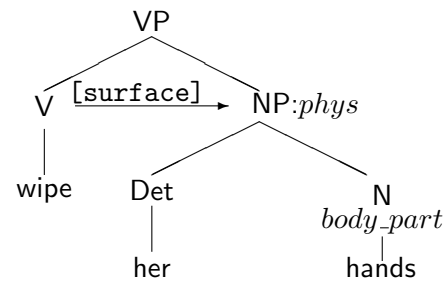
Accommodation with Natural Types

Accommodation: If α is of type σ , and β is of type $\tau \rightarrow t$, then, if $\sigma \sqcap \tau \neq \perp$, then $Acc(\beta, \alpha)$ is of type $\sigma \sqcap \tau \rightarrow t$.

Type Accommodation: Natural Types

Mary wiped her hands.

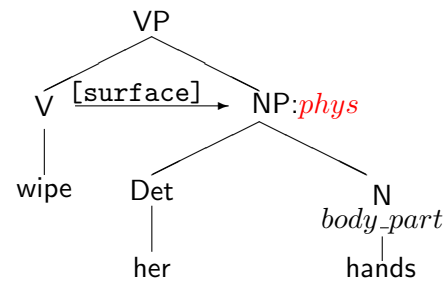
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Type Accommodation: Natural Types

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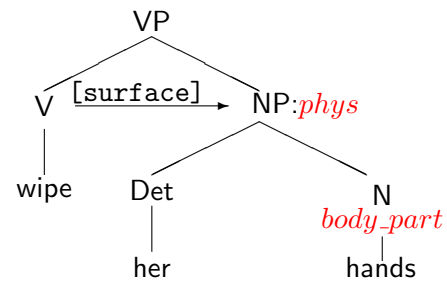
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Type Accommodation: Natural Types

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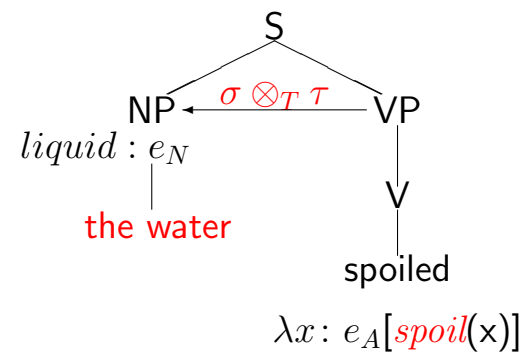
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Type Coercion: Natural to Artifactual Introduction

The water spoiled.

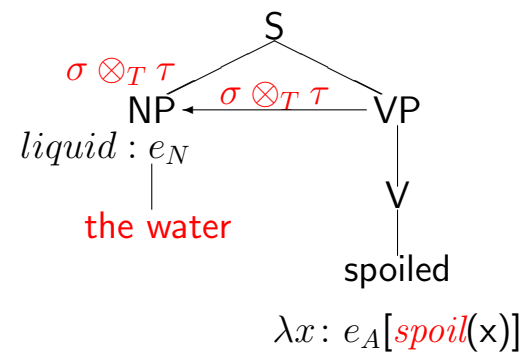
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Type Coercion: Natural to Artifactual Introduction

The water spoiled.

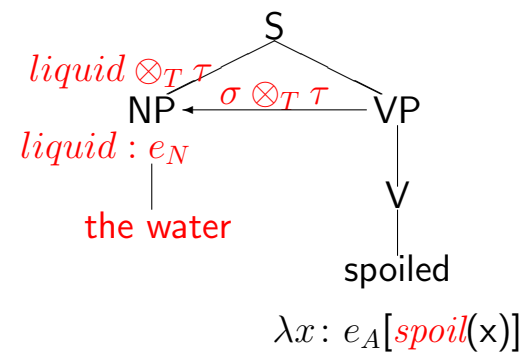
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Type Coercion: Artifactual Accommodation

The water spoiled.

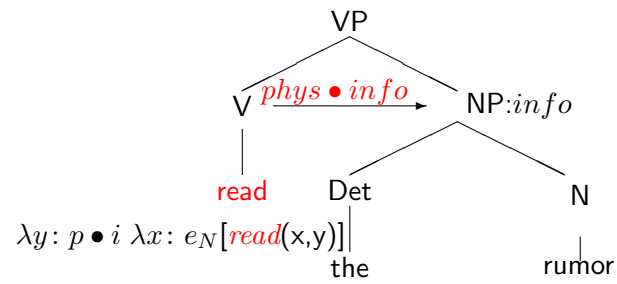
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Type Coercion: Natural to Complex Introduction

John read the rumor.

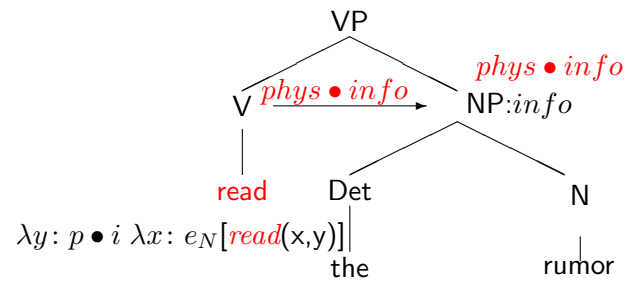
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Type Coercion: Natural to Complex Introduction

John read the rumor.

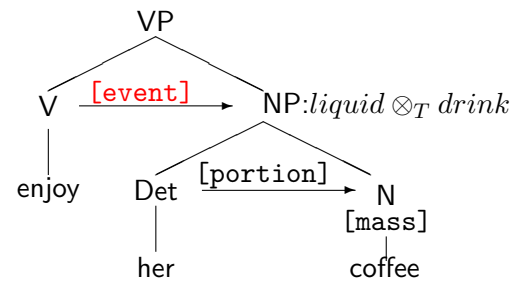
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Type Coercion: Event Introduction

Mary enjoyed her coffee.

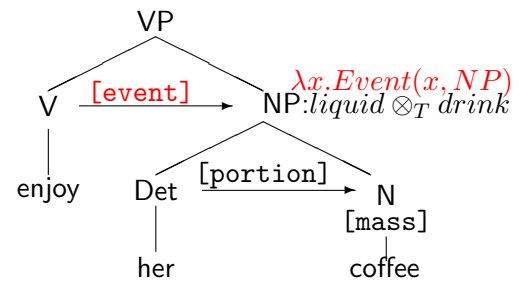
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Type Coercion: Event Introduction

Mary enjoyed her coffee.

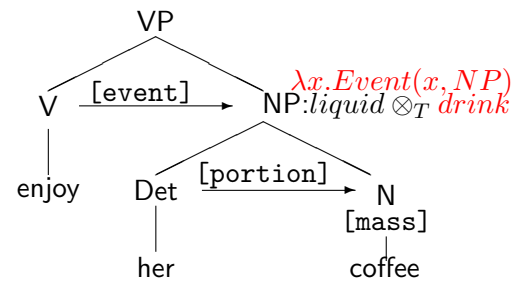
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Type Coercion: Qualia Exploitation

Mary enjoyed her coffee.

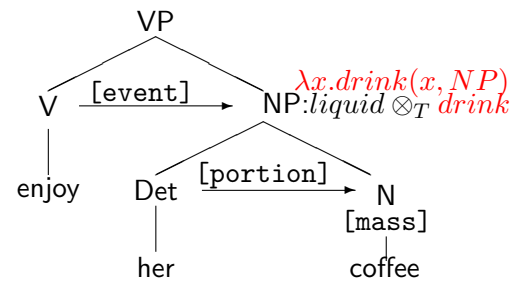
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Type Coercion: Qualia Exploitation

Mary enjoyed her coffee.

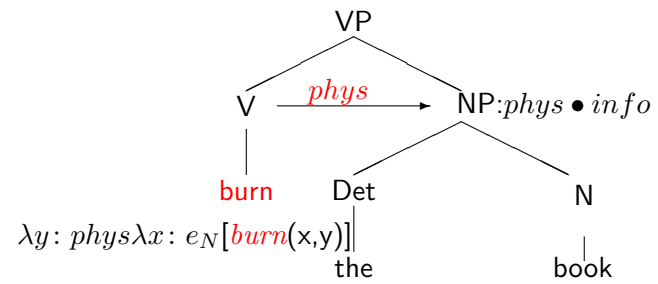
(40)



Type Coercion: Complex Exploitation

The police burned the book.

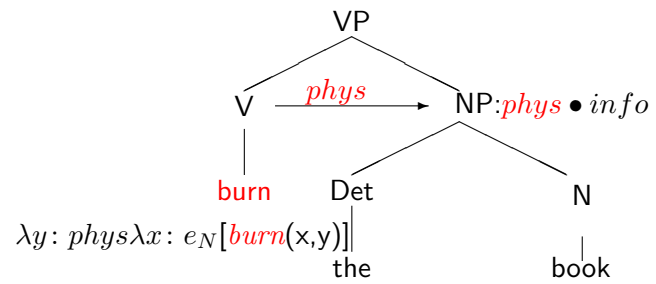
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Type Coercion: Complex Exploitation

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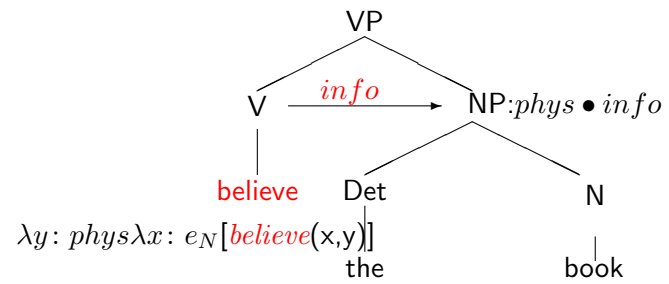
(42)



Type Coercion: Complex Exploitation

Mary believes the book.

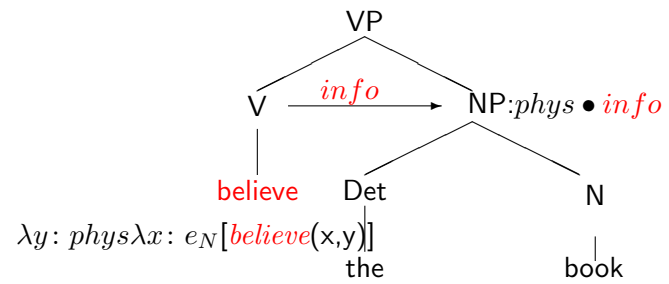
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Type Coercion: Complex Exploitation

Mary believes the book.

(44)



Types and Composition of Local Contexts

Compositionality mediated through richer selectional mechanisms:

		VERB TYPE	
COMPOSITION	Natural	Artifactual	Complex
Selection	die(x)	fix(x,y)	read(x,y)
Accommodation	wipe(x,hand)	spill(beer)	burn(x,book)
Coercion	enjoy(rock)	spoil(water)	read(x,joke)

That's all well and good, but...

That's all well and good, but. . .

What do we actually see in the corpus?