DIALOGUE MODELING & REASONING

Maria Boritchev

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Orange Labs, Lannion, France

A simple dialogue

A_1 Does Charlie want tea or coffee?

A simple dialogue

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A simple dialogue

A_1 Does Charlie want tea or coffee?

A simple dialogue

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have?

➔ Semantics: compositionality

A simple dialogue

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have?

➔ Semantics: compositionality

➔ Context: dynamicity

A simple dialogue

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have?

A_3 Earl Grey

B_4 I think Charlie would rather have coffee

➔ Semantics: compositionality

➔ Context: dynamicity

A simple dialogue

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have?

A_3 Earl Grey

B_4 I think Charlie would rather have coffee

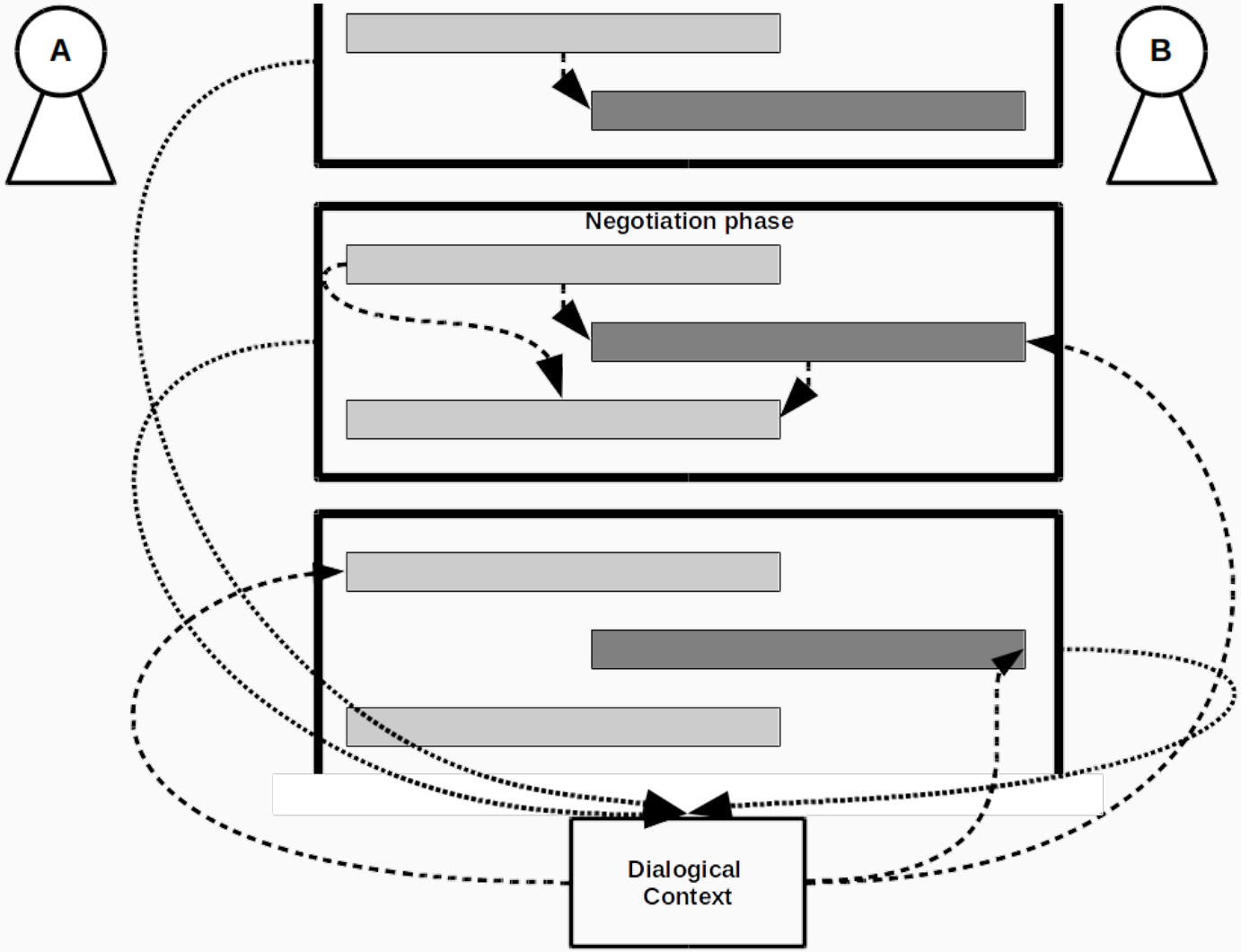
➔ Semantics: compositionality

➔ Context: dynamicity

➔ Reasoning: logic

Negotiation phases

Picturing questions and answers – a formal approach to SLAM, Maria Boritchev, Maxime Amblard, (In)coherence of discourse – Formal and Conceptual issues of Language, Springer, 2021.



Our (ideal) aim

We want to:

- Produce formal models for semantics of natural languages (**logical, compositional, dynamic**)
- Produce formal models for semantics of dialogue (**negotiation phases**)
- That would behave well on non-controlled data (**lexicality, flexibility**)
- And provide stable grounds for reasoning studies

Towards:

➔ Better quality data generation

➔ Hybrid approaches: combining machine learning techniques and logic representations

➔ Dialogue studies: clinical applications

Outline

Dialogue annotation for modeling

Formal semantics – dialogue & models

Dialogues and reasoning

DIALOGUE ANNOTATION FOR MODELING

Annotation schema

Toward Dialogue Modeling: A Semantic Annotation Scheme for Questions and Answers, Maria-Andrea Cruz-Blandón, Gosse Minnema, Aria Nourbakhsh, Maria Boritchev, Maxime Amblard, LAW XIII 2019 – The 13th Linguistic Annotation Workshop, 2019.

Tag	Name
YN	yes/no-question
WH	wh-question
DQ	disjunctive question
CS	completion suggestion
PQ	phatic question

Table: Set of question tags.

Question annotation

File	ID	Question	YN	WH	CS	DQ	PQ	N/A
ding3-1.txt.ufo	985	O:[dés]						
ding3-1.txt.ufo	986	W:[rire]						
ding3-1.txt.ufo	987	W:**pourquoi c'est toujours comme ça ?**		1				
ding3-1.txt.ufo	988	O:[dés]						
ding3-1.txt.ufo	989	R:10						

O [dice]

W [laugh]

W why is it always like that?

O [dice]

R 10

Question annotation – corrected

File	ID	Question	YN	WH	CS	DQ	PQ	N/A
ding3-1.txt.ufo	985	O:[dés]						
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O [dice]

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R 10

Annotation results

English Saarbrücken Corpus of Spoken English (SCoSE), corpus of face-to-face conversations [Norrick, 2017]

Spanish CallFriend corpus for Spanish, corpus of phone conversations [Canavan and Zipperlen, 1996]

Dutch Spoken Dutch Corpus (CGN), corpus of phone conversations [Oostdijk, 2001]

French Dialogues in Games corpus (DinG), corpus of face-to-face conversations, A Multi-Party Dialogue Ressource in French, Maria Boritchev, Maxime Amblard, LREC 2022 – 13th Edition of Language Resources and Evaluation Conference, 2022

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	YN	WH	DQ	CS	PQ
SCoSE	42.2%	23.5%	1.2%	1.7%	31.5%
CallFriend	39.9%	33.0%	1.6%	1.1%	24.5%
CGN	64.4%	26.4%	1.2%	0%	8.1%
DinG	57.78%	23.82%	3.90%	0.32%	12.18%

Table: Annotation results and comparision

FORMAL SEMANTICS – DIALOGUE & MODELS

Few existing works in formal semantics of NL

MS Montague semantics, [Montague, 1973]

CSDS Compositional Style Dynamic Semantics, [de Groote, 2006]

NDES Neo-Davidsonian Event Semantics, [Parsons, 1995],
Quantificational Event Semantics [Champollion, 2011],
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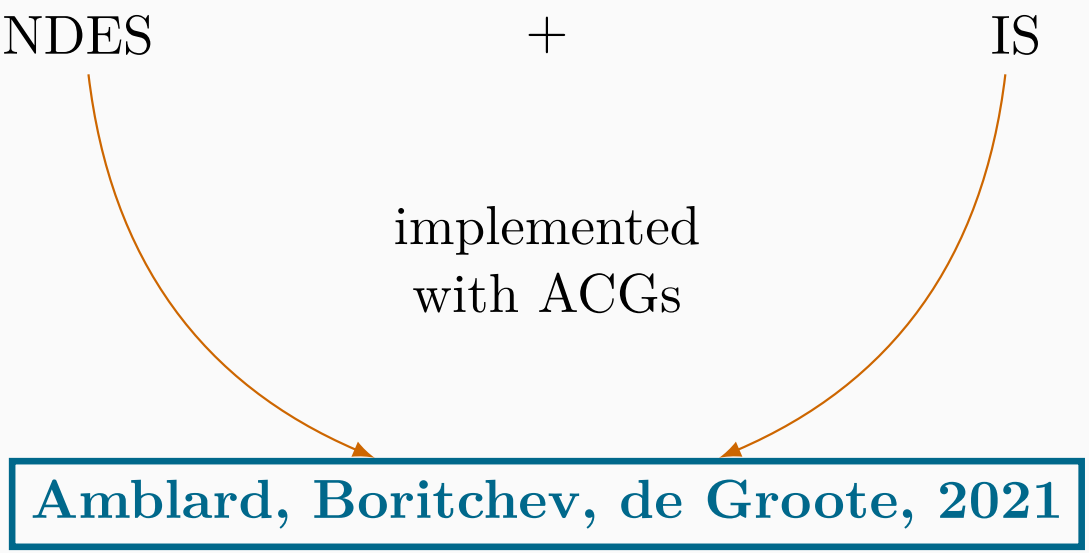
➔ Declarative and interrogative sentences

Family photo



Neo-Davidsonian Event Semantics (NDES)

every farmer fed a donkey

Neo-Davidsonian Event Semantics (NDES)

every farmer fed a donkey

event

Neo-Davidsonian Event Semantics (NDES)

every farmer fed a donkey

Agent event Patient

Neo-Davidsonian Event Semantics (NDES)

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Agent event Patient

$$\forall x.\exists y.\exists e.\text{fed}(e) \wedge \text{farmer}(x) \wedge \text{donkey}(y) \wedge \text{Agent}(e, x) \wedge \text{Patient}(e, y)$$

Questions?

$$\forall x.\exists y.\exists e.\text{fed}(e) \wedge \text{farmer}(x) \wedge \text{donkey}(y) \wedge \textbf{Agent}(e, x) \wedge \textbf{Patient}(e, y)$$

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Who fed a donkey?

Whom did every farmer feed?

Questions?

$$\forall x.\exists y.\exists e.\text{fed}(e) \wedge \text{farmer}(x) \wedge \text{donkey}(y) \wedge \textbf{Agent}(e, x) \wedge \textbf{Patient}(e, y)$$

Who fed a donkey?

Whom did every farmer feed?

Which is the agent of the feeding event whose patient is a donkey?

Which is the patient of the feeding event whose agent is every farmer?

In perspective

- NDES is compositional.
- We can interrogate the content of thematic roles.
- How to compute the semantic representation of interrogative sentences?

Donkey (D)

Unicorn (U)

Inquisitive semantics

Donkey (D)

Unicorn (U)

Are they hungry?

Donkey (D)

Unicorn (U)

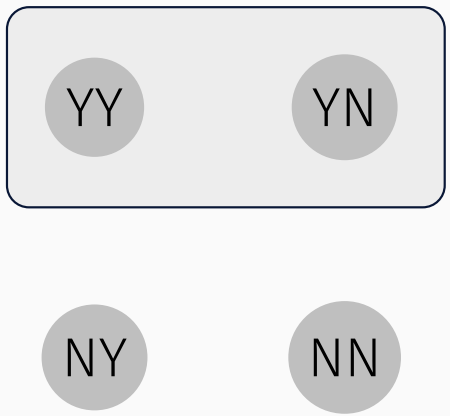
Are they hungry?

Figure: Possible worlds

$$[\![\text{D is hungry}]\!] = [\![\phi_1]\!] = \{\{\text{YY}, \text{YN}\}, \{\text{YY}\}, \{\text{YN}\}, \emptyset\}$$

Inquisitive semantics

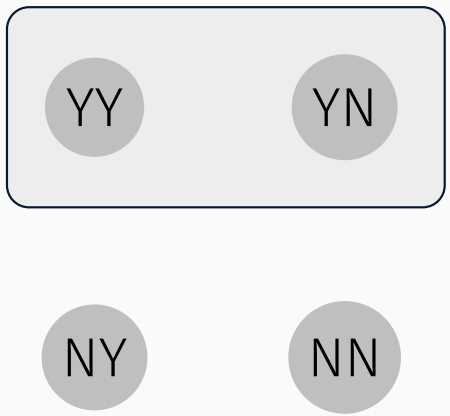
$$[\![\text{D is hungry}]\!] = [\![\phi_1]\!] = \{\{\text{YY}, \text{YN}\}, \{\text{YY}\}, \{\text{YN}\}, \emptyset\}$$



(a)

Inquisitive semantics

$$[\![\text{D is hungry}]\!] = [\![\phi_1]\!] = \{\{\text{YY}, \text{YN}\}, \{\text{YY}\}, \{\text{YN}\}, \emptyset\}$$
$$[\![\text{U is hungry}]\!] = [\![\phi_2]\!] = \{\{\text{YY}, \text{NY}\}, \{\text{YY}\}, \{\text{NY}\}, \emptyset\}$$



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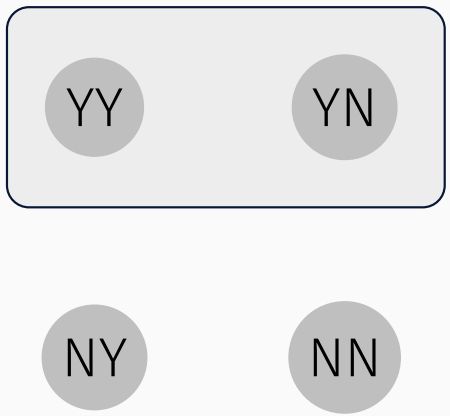
$$[\![\text{D is hungry}]\!] = [\![\phi_1]\!] = \{\{\text{YY}, \text{YN}\}, \{\text{YY}\}, \{\text{YN}\}, \emptyset\}$$
$$[\![\text{U is hungry}]\!] = [\![\phi_2]\!] = \{\{\text{YY}, \text{NY}\}, \{\text{YY}\}, \{\text{NY}\}, \emptyset\}$$



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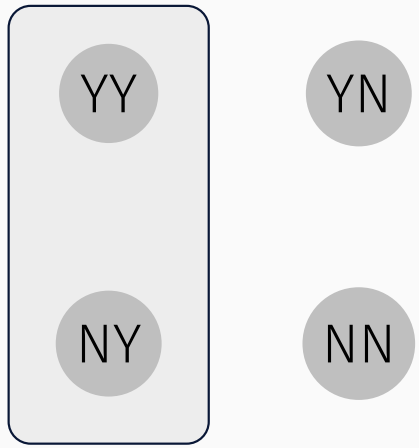

(b)

Inquisitive semantics

$$\begin{aligned}[\![\phi_1 \vee \phi_2]\!] &= [\![\phi_1]\!] \cup [\![\phi_2]\!] \\ &= \{\{\mathsf{YY}, \mathsf{YN}\}, \{\mathsf{YY}, \mathsf{NY}\}, \{\mathsf{YY}\}, \{\mathsf{YN}\}, \{\mathsf{NY}\}, \emptyset\}\end{aligned}$$

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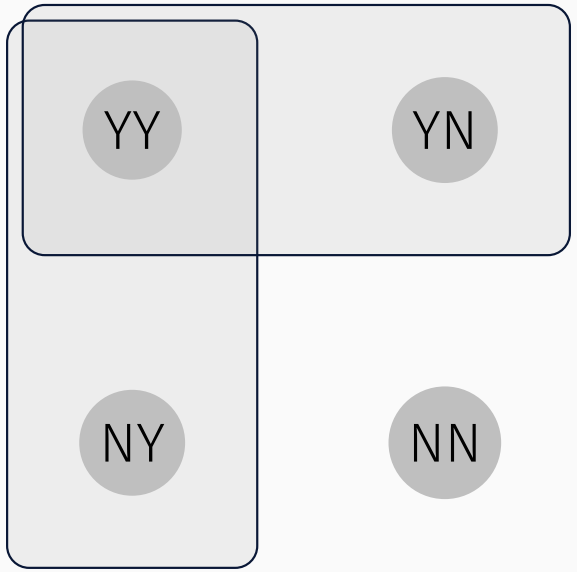
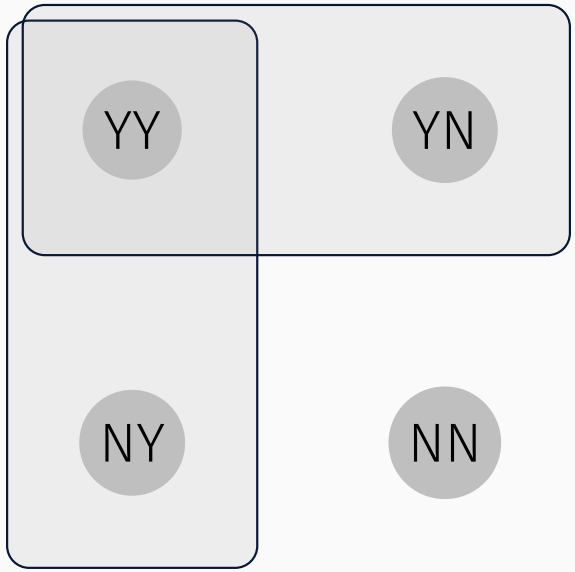
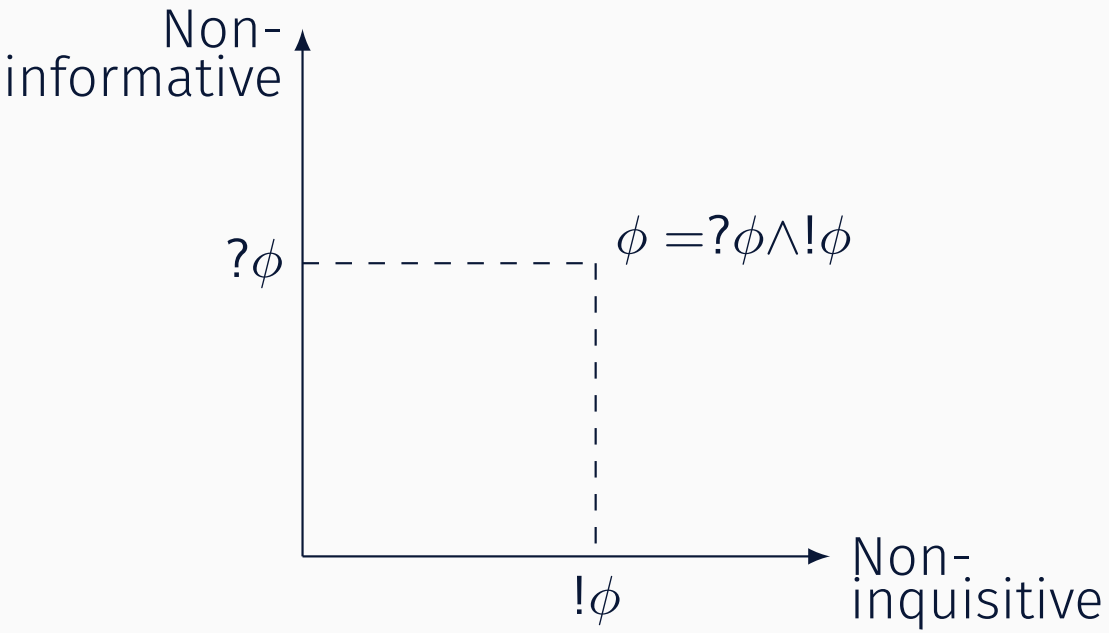


$$[\![\phi_1 \vee \phi_2]\!] = [\![\phi_1]\!] \cup [\![\phi_2]\!]$$
$$= \{\{YY, YN\}, \{YY, NY\}, \{YY\}, \{YN\}, \{NY\}, \emptyset\}$$



“is D or U hungry?” (knowing that someone is hungry)

Inquisitive semantics



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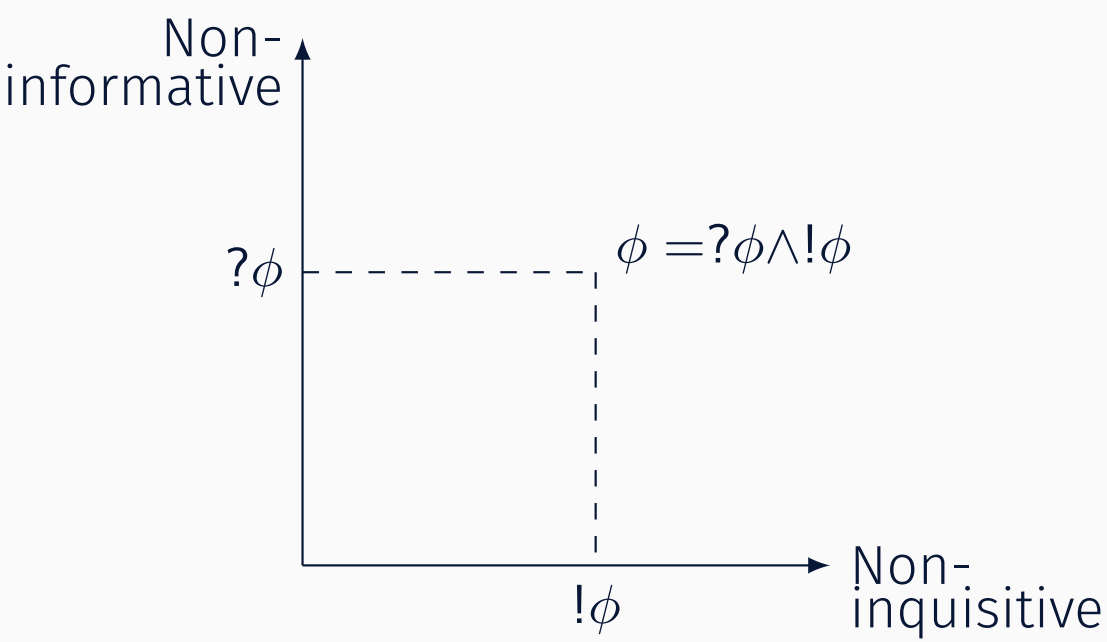
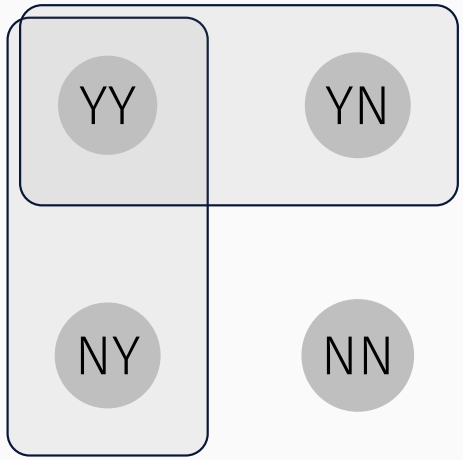
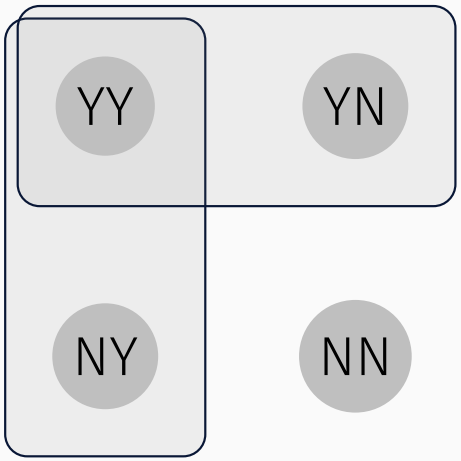




$[\![\phi_1 \vee \phi_2]\!]$

Inquisitive semantics



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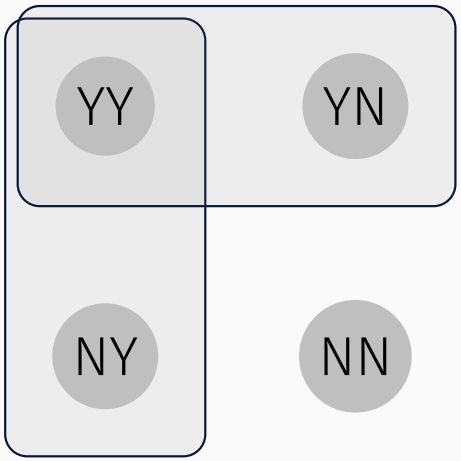

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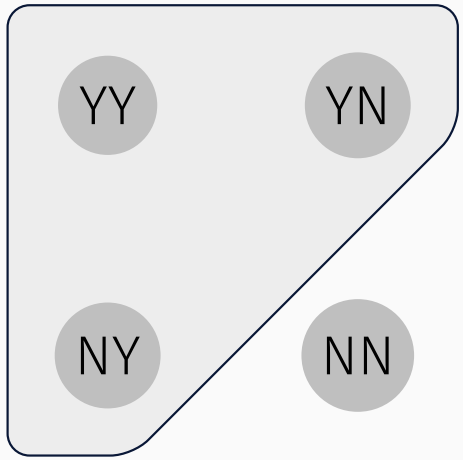

$[\![!(\phi_1 \vee \phi_2)]\!]$

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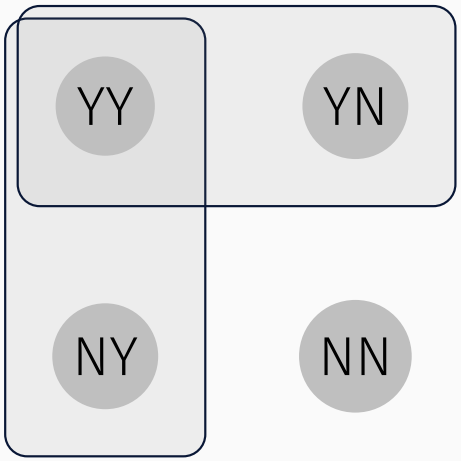

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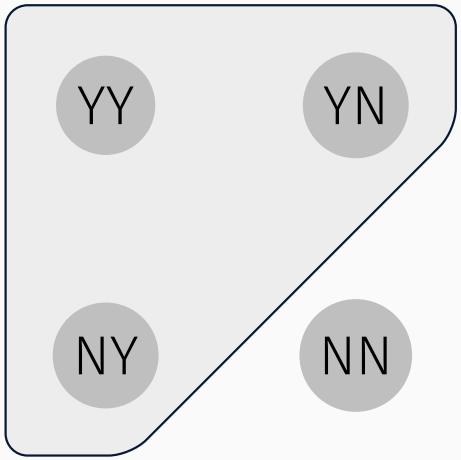
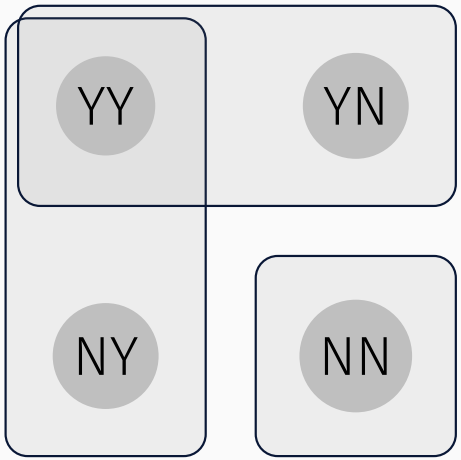


$[\![!(\phi_1 \vee \phi_2)]\!]$



$[\![?(\phi_1 \vee \phi_2)]\!]$

Inquisitive semantics

In a model $\mathcal{M} = \langle D, W, I \rangle$, given a valuation ξ from $\mathcal{X}$ to D:

$$[\![\exists x.\phi]\!]_\xi = \bigcup_{d \in D} [\![\phi]\!]_{\xi[x:=d]}$$

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(1) $\exists$x.hungry x

(1) Somebody's hungry. Who?

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(1) $\exists$x.hungry x

(2) !$\exists$x.hungry x

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(2) Somebody's hungry.

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(1) $\exists$x.hungry x
(2) !$\exists$x.hungry x
(3) ?$\exists$x.hungry x

(1) Somebody's hungry. Who?
(2) Somebody's hungry.
(3) Who is hungry?

In perspective

- NDES gives us access to thematic roles, through a unique wh-word WHICH

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Surface Forms

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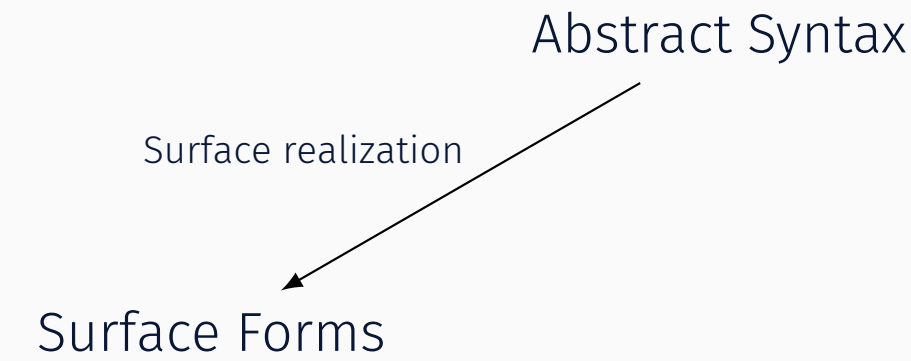

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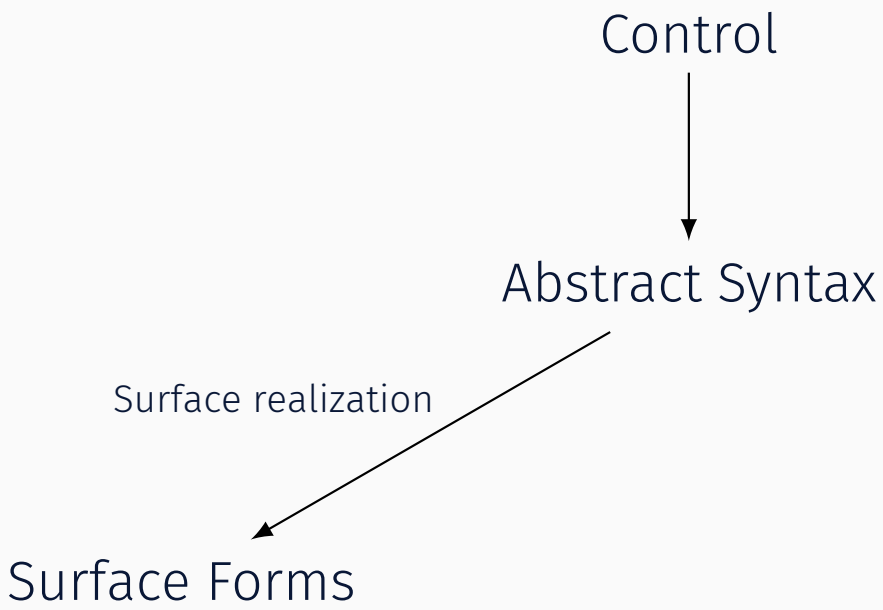

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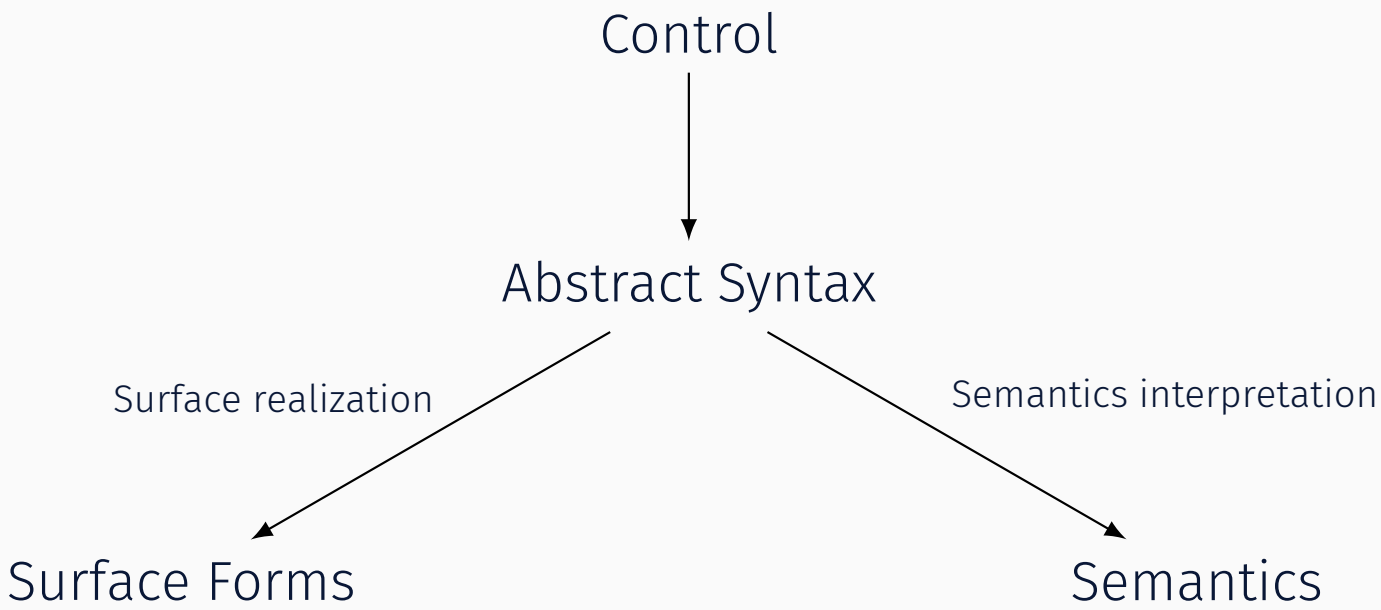
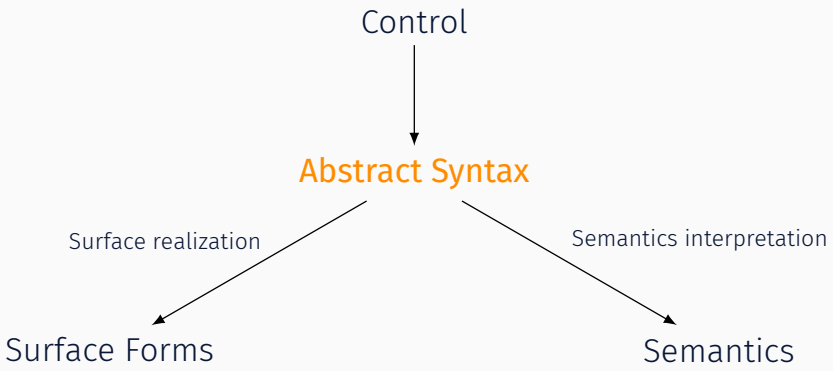


Excerpts from the grammar



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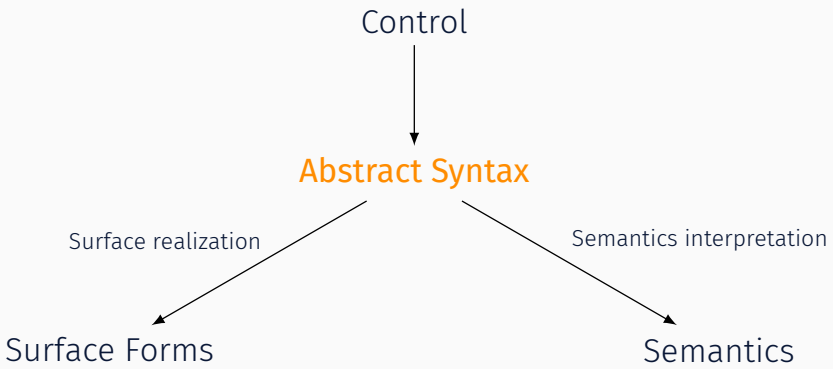
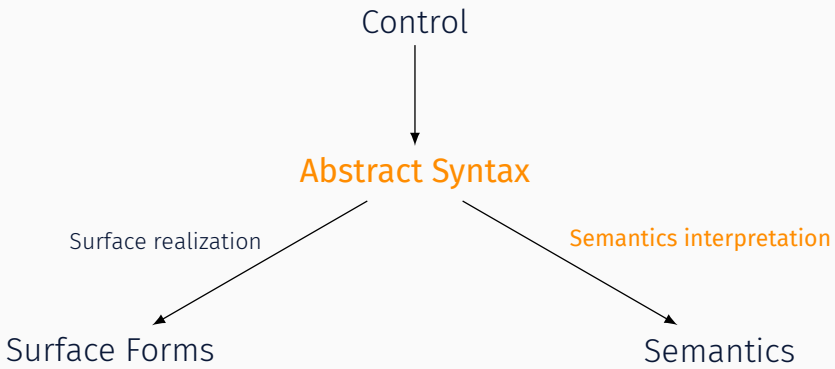


Abstract Syntax
$\textsc{some} : n \to (np \to s) \to s$
$\textsc{which} : n \to (np \to s) \to s$

Excerpts from the grammar



Abstract Syntax
$\textsc{some} : n \to (np \to s) \to s$
$\textsc{which} : n \to (np \to s) \to s$

Semantic Interpretation
$\textsc{some} := \lambda pq.\, !(\exists x.\, (p\, x) \wedge (q\, x))$
$\textsc{which} := \lambda pq.\, \exists x.\, (p\, x) \wedge (q\, x)$

Parsing and over-generation

where did every farmer feed a donkey ✓

Parsing and over-generation

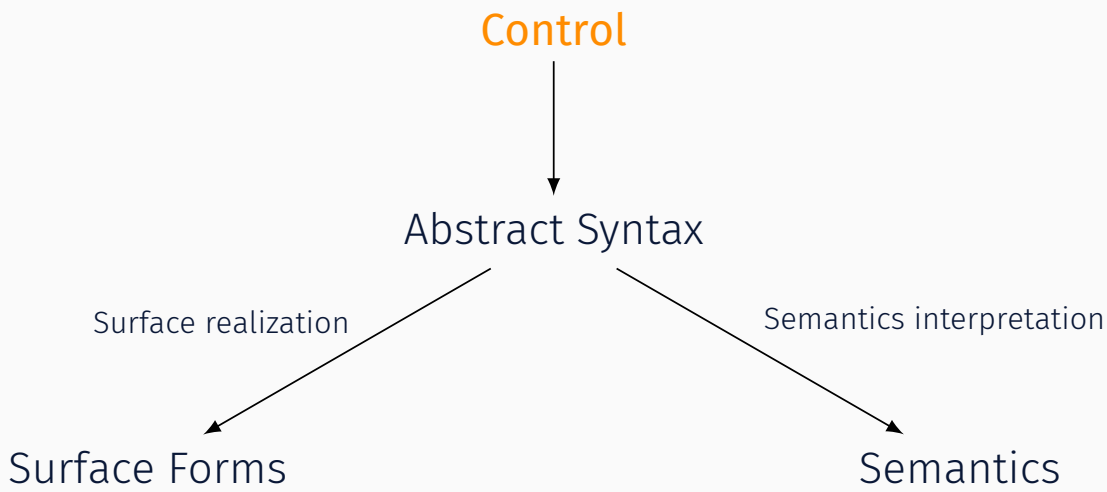
where did every farmer feed a donkey ✓

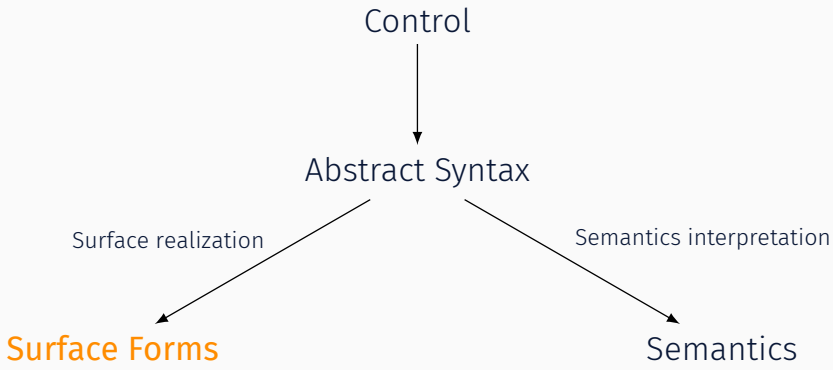
where did every farmer feed which donkey ✗

Parsing and over-generation

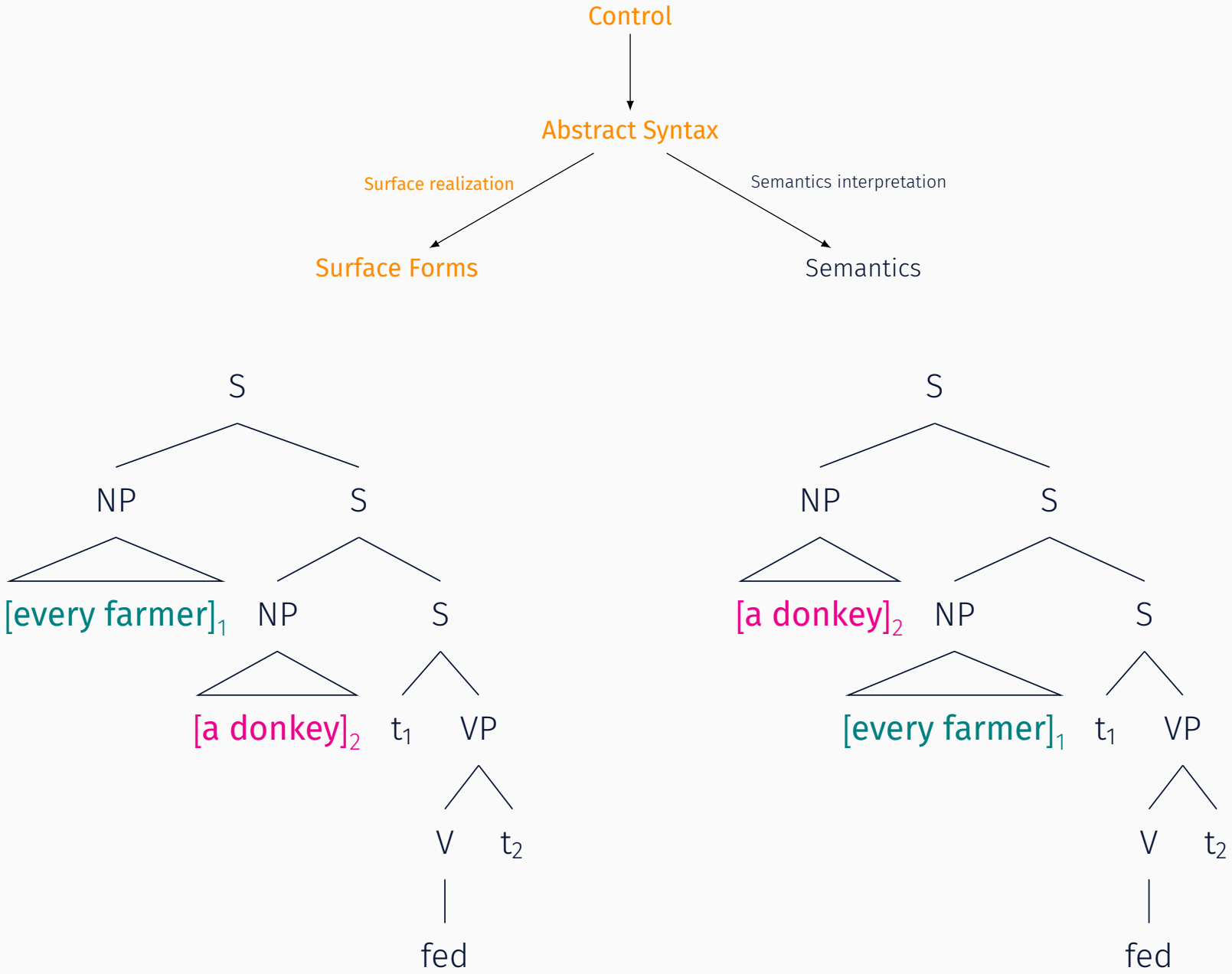
where did every farmer feed a donkey ✓

where did every farmer feed which donkey ✗



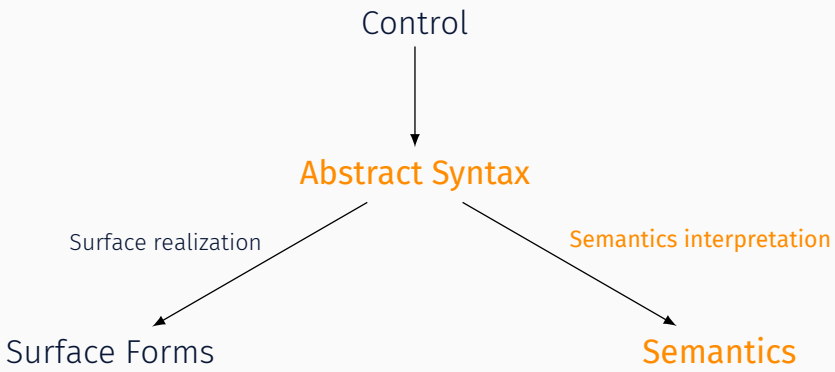


Every farmer fed a donkey

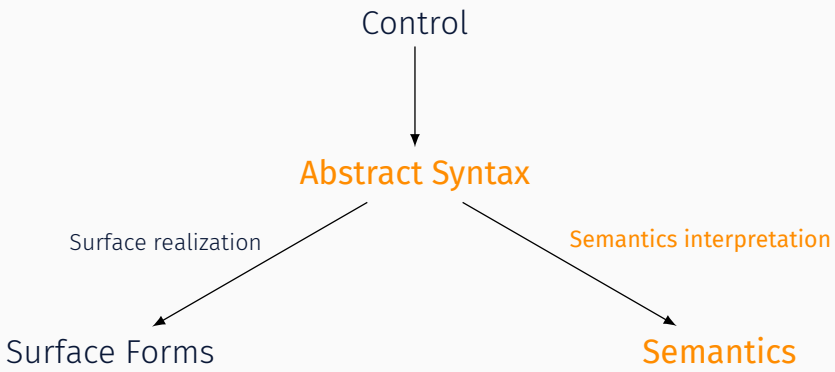


Every farmer fed a donkey

Where did every farmer feed a donkey?



Where did every farmer feed a donkey?



$$\text{Q}\,(\text{WHERE}\,(\lambda f.\ \textbf{EVERY FARMER}\,(\lambda x.\ \textbf{A DONKEY}\,(\lambda y.\ \text{E-CLOS}\,(f\,(\text{DID-FEED}\,y\,x)))))) \quad (1)$$

$$\text{Q}\,(\text{WHERE}\,(\lambda f.\ \textbf{A DONKEY}\ \ (\lambda x.\ \textbf{EVERY FARMER}\,(\lambda y.\ \text{E-CLOS}\,(f\,(\text{DID-FEED}\,x\,y)))))) \quad (2)$$

$$?\exists x.\forall y.(\text{farmer}\ y) \rightarrow !((\exists z.(\text{donkey}\ z) \wedge !((\exists e.(\text{fed}\ e) \wedge (\text{patient}\ e\ z) \wedge (\text{agent}\ e\ y) \wedge (\text{location}\ e\ x))))) \quad (1)$$

$$?\exists x.!(\exists y.(\text{donkey}\ y) \wedge (\forall z.(\text{farmer}\ z) \rightarrow !((\exists e.(\text{fed}\ e) \wedge (\text{patient}\ e\ y) \wedge (\text{agent}\ e\ z) \wedge (\text{location}\ e\ x))))) \quad (2)$$

DIALOGUES AND REASONING

Enthymemes [Breitholtz, 2020]

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have?

A_3 Earl Grey

B_4 I think Charlie would rather have coffee

Enthymemes [Breitholtz, 2020]

A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have? `tea > coffee`

A_3 Earl Grey

B_4 I think Charlie would rather have coffee

Enthymemes [Breitholtz, 2020]

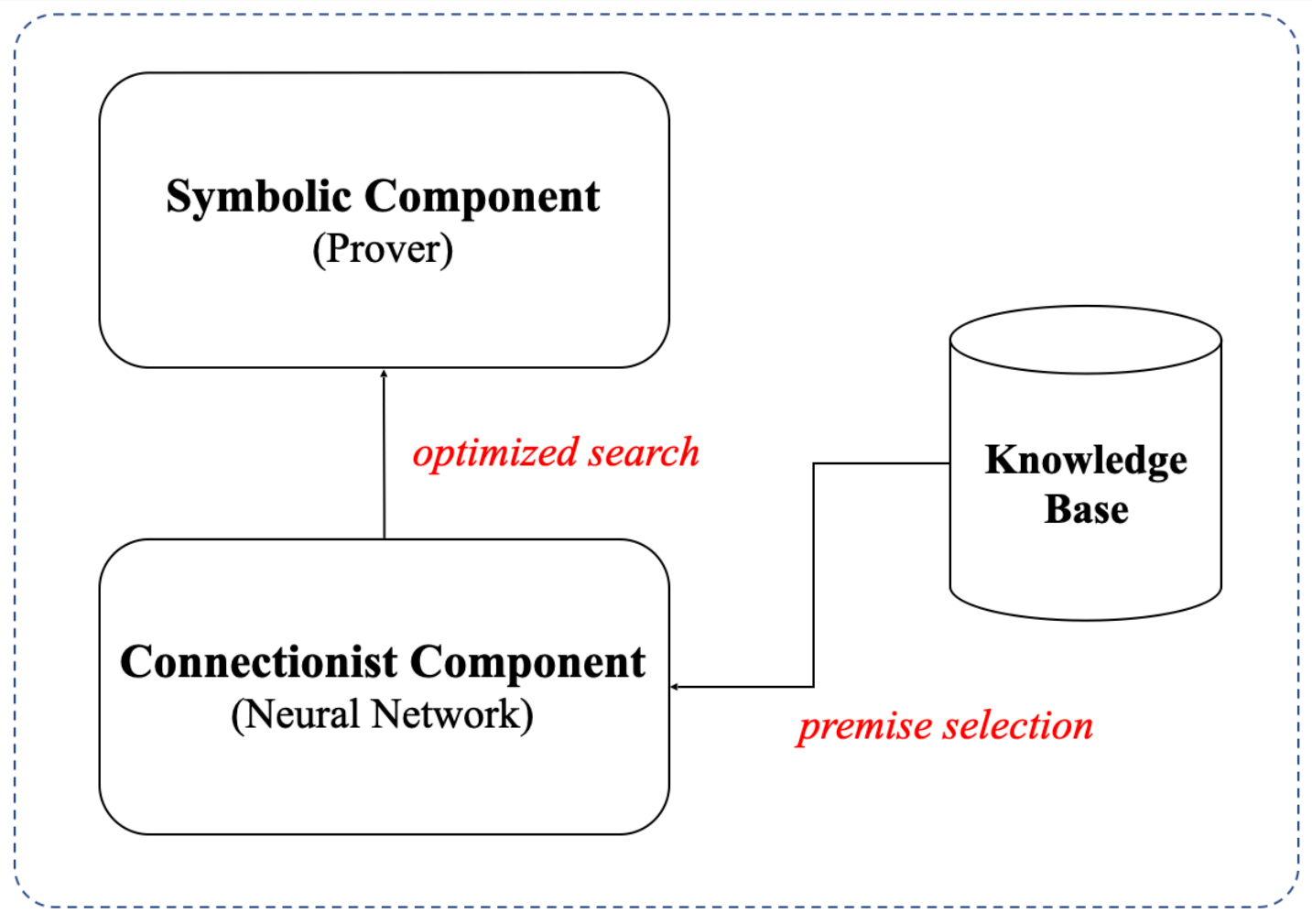
A_1 Does Charlie want tea or coffee?

B_2 What kind of tea do you have? `tea > coffee`

A_3 Earl Grey

B_4 I think Charlie would rather have coffee `coffee > Earl Grey`

Hybrid model for logical reasoning



Hybrid model for logical reasoning

Compositionality in a simple corpus, Manuel Vargas Guzmán, Maria Boritchev, Jakub Szymanik, Maciej Malicki, JJ des GdR LIFT & TAL, 2022.

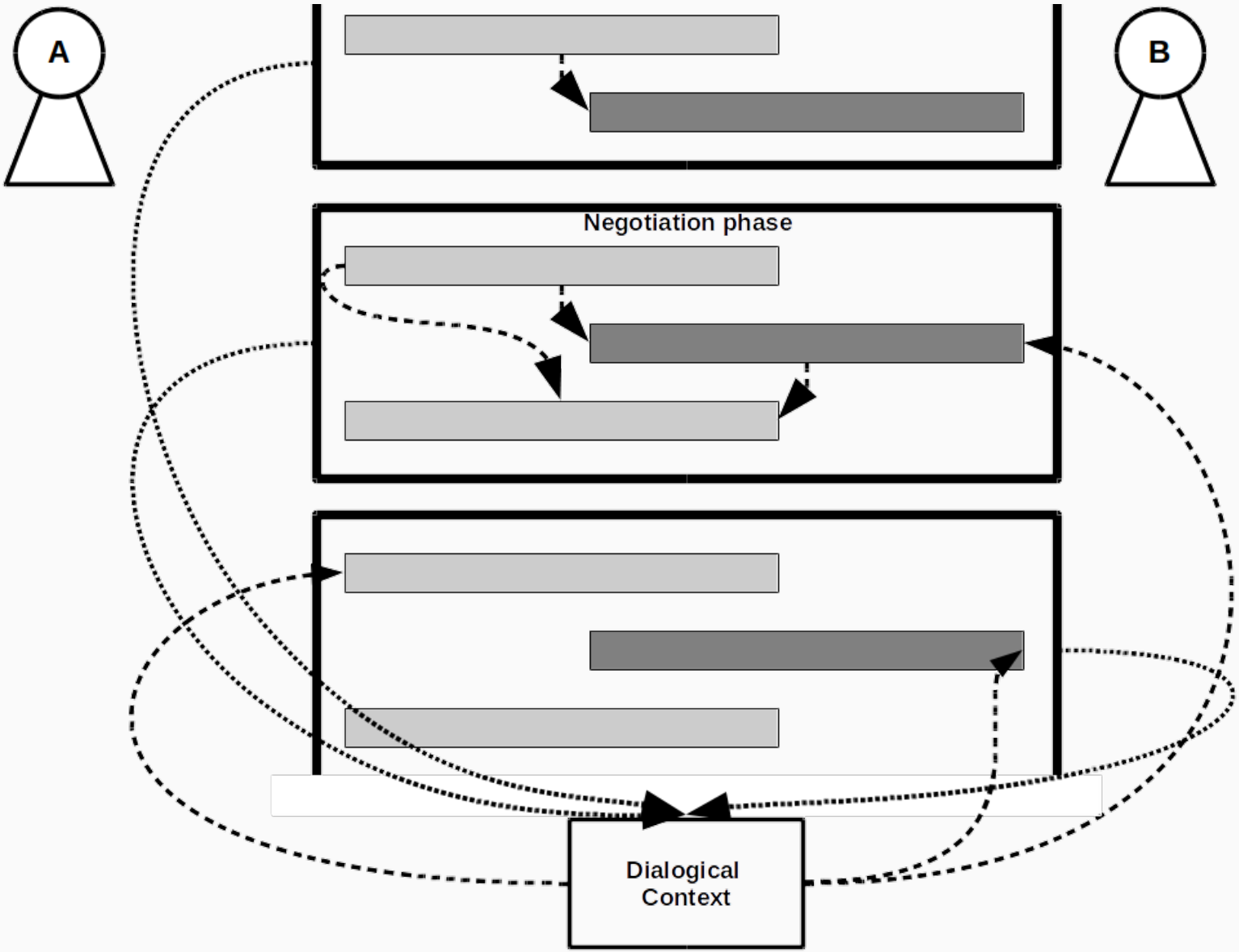
➔ NNs pick up some **structure** from data:

- some **generalization** in the variations in proof length compositionality tests;
- sub-proofs play a role in learning.

➔ **Limited** generalization:

- unseen length experiment;
- high sensitivity to the order of constants, $\gg$ overall structure of the $\mathcal{KB}$.

Conclusion



Thank you for your attention!

Questions?

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