SEMANTIC PROCESSING OF (REAL-LIFE) QUESTIONS AND ANSWERS

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A₁ Charlie is a unicorn.

A₁ Charlie is a unicorn.

➜ Semantics: *compositionality*

A₁ Charlie is a unicorn.

B₂ **She** prefers coffee or tea?

➔ Semantics: *compositionality*

A₁ Charlie is a unicorn.

B₂ She prefers coffee or tea?

➔ Semantics: compositionality

➔ Context: dynamicity

A_1 Charlie is a unicorn.

B_2 **She** prefers coffee or tea?

A_3 **Yes.**

➔ Semantics: **compositionality**

➔ Context: **dynamicity**

A_1 Charlie is a unicorn.

B_2 **She** prefers coffee or tea?

A_3 **Yes.**

➜ Semantics: **compositionality**

➜ Context: **dynamicity**

➜ Comprehension: **logic**

A_1 When will you guys get off?

B_2 My last exam is like…I don't know, maybe on Monday or on Tuesday…

Saarbrücken Corpus of Spoken English

A_1 When will you guys get off?

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Saarbrücken Corpus of Spoken English

We want:

- A formal model for semantics of dialogue (**logical, compositional, dynamic**)
- For this model to behave well on non-controlled data (**lexicality, flexibility**)

Semantic processing

Real-life settings

Building bridges

SEMANTIC PROCESSING
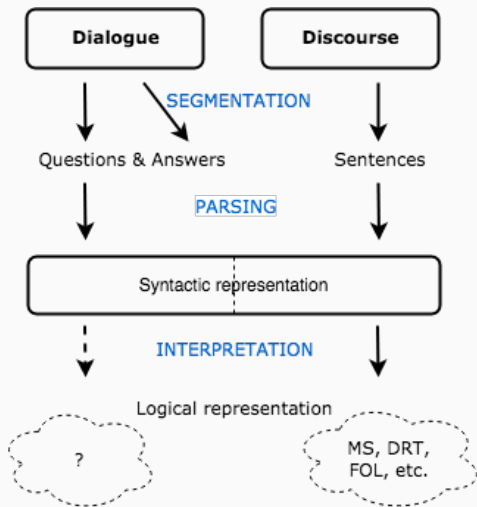
FIGURE – The big picture.

Montague Semantics

Montague Semantics   Dynamicity?

Montague Semantics   Dynamicity?

DRT

Montague Semantics   Dynamicity?

DRT   Computability?

Montague Semantics   Dynamicity?

DRT   Computability?

KoS

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

Montague Semantics   Dynamicity?

    DRT   Computability?

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    ML, NN

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

ML, NN   Data?

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

ML, NN   Data?

Inquisitive Semantics

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

ML, NN   Data?

Inquisitive Semantics   Linguistic interpretation?

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

ML, NN   Data?

Inquisitive Semantics   Linguistic interpretation?

Event Semantics

Montague Semantics   Dynamicity?

DRT   Computability?

KoS   Lexicality?

ML, NN   Data?

Inquisitive Semantics   Linguistic interpretation?

Event Semantics   Why not?
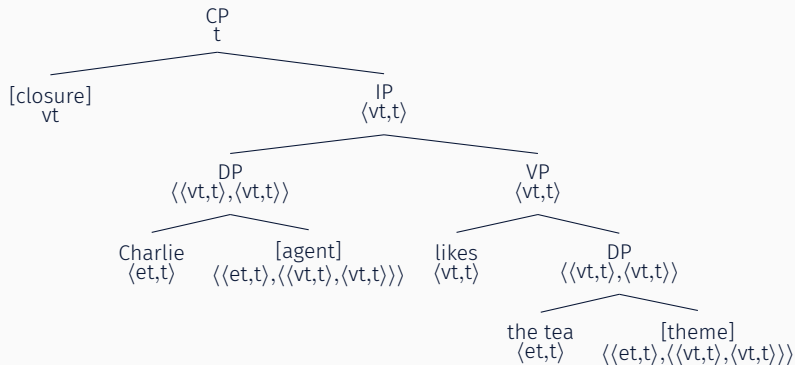
FIGURE – "Charlie likes the tea"

$[\![\text{Charlie likes the tea}]\!]$

$= \left(\left([\![[\text{agent}]]\!] \, [\![\text{Charlie}]\!] \right) \left(\left([\![[\text{theme}]]\!] \left([\![\text{the}]\!] \, [\![\text{tea}]\!] \right) \right) [\![\text{likes}]\!] \right) \right) [\![[\text{closure}]]\!]$

$= \exists x \, \big[\textbf{tea}(x) \wedge \exists e \, [\textbf{like}(e) \wedge \text{agent}(e) = \textbf{charlie} \wedge \text{theme}(e) = x] \big]$

Intuition: require to fill in missing information

Wh-words: what, when, where, who, whom, which, whose, why, how

WH-WORD	SEMANTIC ROLE
Who	`Agent`
Whom	`Theme`
Whose	`Owner`
Where	`Location`
Why	`Reason`
When	`Temporality`
What + focus phrase	`role`(focus phrase)
Which + focus phrase	`role`(focus phrase)
How	`Characteristic`

⟦Charlie likes the tea⟧

$= \exists x \, [\text{tea}(x) \wedge \exists e \, [\text{like}(e) \wedge \text{agent}(e) = \text{charlie} \wedge \text{theme}(e) = x]]$

⟦Charlie likes the tea⟧

$= \exists x \, [\textbf{tea}(x) \wedge \exists e \, [\textbf{like}(e) \wedge \text{agent}(e) = \textbf{charlie} \wedge \text{theme}(e) = x]]$

⟦Who likes tea?⟧

$= \lambda w. \, \exists x \, [\textbf{tea}(x) \wedge \exists e \, [\textbf{like}(e) \wedge \text{agent}(e) = w \wedge \text{theme}(e) = x]]$

⟦Charlie likes the tea⟧

$= \exists x \ \big[\textbf{tea}(x) \land \exists e \ [\textbf{like}(e) \land \text{agent}(e) = \textbf{charlie} \land \text{theme}(e) = x]\big]$

⟦Who likes tea?⟧

$= \lambda w. \ \exists x \ \big[\textbf{tea}(x) \land \exists e \ [\textbf{like}(e) \land \text{agent}(e) = w \land \text{theme}(e) = x]\big]$

⟦Where does Charlie live?⟧

$= \lambda w. \ \exists e \ [\textbf{live}(e) \land \text{agent}(e) = \textbf{Charlie} \land \text{location}(e) = w]$

A_1 Does Charlie like the tea?
B_2 Yes

A_1 Does Charlie like the tea?
B_2' No

A$_1$ Does Charlie like the tea?
B$_2$ Yes

A$_1$ Does Charlie like the tea?
B$_2'$ No

$$\llbracket B_2 \rrbracket \, \llbracket \text{decl}(A_1) \rrbracket$$

$$= \llbracket B_2 \rrbracket \, \llbracket \text{Charlie likes the tea} \rrbracket$$

$$= (\lambda P.P) \, \llbracket \text{Charlie likes the tea} \rrbracket$$

$$= \llbracket \text{Charlie likes the tea} \rrbracket$$

A$_1$ Does Charlie like the tea?
B$_2$ Yes

A$_1$ Does Charlie like the tea?
B$_2'$ No

$\llbracket B_2 \rrbracket \llbracket decl(A_1) \rrbracket$

$= \llbracket B_2 \rrbracket \llbracket$ Charlie likes the tea $\rrbracket$

$= (\lambda P.P) \llbracket$ Charlie likes the tea $\rrbracket$

$= \llbracket$ Charlie likes the tea $\rrbracket$

$\llbracket B_2' \rrbracket \llbracket decl(A_1) \rrbracket$

$= \llbracket B_2 \rrbracket \llbracket$ Charlie likes the tea $\rrbracket$

$= (\lambda P.\ not\ P) \llbracket$ Charlie likes the tea $\rrbracket$

$= \llbracket$ Charlie doesn't like tea $\rrbracket$

Types:

individual/entity	ι
proposition	o
context	γ

Types:

individual/entity	ι
proposition	o
context	γ

Jane loves Mary.

$\lambda ek.\text{love } j \ m \wedge k(m :: j :: e)$

e	γ
k	$\gamma \rightarrow o$
j,m	ι
love	$\iota \rightarrow \iota \rightarrow o$

```
SYNT SEM realize
    like (the tea) Charlie : S;

In ABS:
   like (the tea) Charlie : S
Interpreted by SYNT in S_FORM as:
   Charlie + (like + (the + tea)) : string

Interpreted by SEM in L_FORM as:
   Lambda e k. Ex x. k (x @ (c @ e)) ((tea x) &
   (like c x)) : g => ((g => (o => o)) => o)
```

REAL-LIFE SETTINGS

English Saarbrücken Corpus of Spoken English (SCoSE)
Spanish CallFriend corpus
Dutch Spoken Dutch Corpus (CGN)
French Traitement de Corpus Oraux en Français (TCOF)
Italian Corpus del parlato italiano (API)
Chinese PolyU Corpus of Spoken Chinese

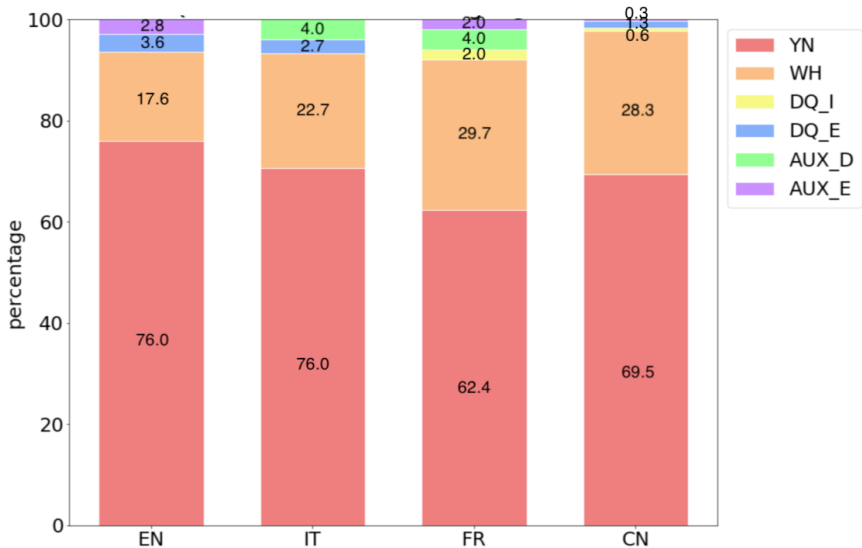|	QUESTIONS	ANSWERS
Form	Yes/No, Wh, Disjunctive-Inclusive, Disjunctive-Exclusive, Auxiliary-Deontic, Auxiliary-Epistemic	Yes/No, Wh, Uncertain, Unknown
Function	Completion Suggestion, Phatic, Ask_Confirmation, Ask_Feature, Ask_Performance, Reported Speech (RS)	Refuse, Accept, Phatic, Give_Confirmation, Give_Uncertainty, Give_Unknown, Reported Speech (RS), Give_Feature, Perform, NONE

	QUESTIONS	ANSWERS
Form	Yes/No, Wh, **Disjunctive-Inclusive**, **Disjunctive-Exclusive**, **Auxiliary-Deontic**, **Auxiliary-Epistemic**	Yes/No, Wh, Uncertain, Unknown
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Figure – Question forms distribution

A₁ Why are you crying?

B₂ Because I hurt myself.

➜ A₁ is of `Wh` form, `Ask_Feature` function

➜ B₂ is of `Wh` form, `Give_Feature` function

A$_1$ so- wh- where can you move to?

B$_2$ Well…you know…I don't even know where I'm living next year.

Saarbrücken Corpus of Spoken English

→ A$_1$ is of Wh form, Ask_Feature function
→ B$_2$ is of Uncertain form, Give_Uncertainty function

1. Asymmetry of form/function

2. The form/function of the given answer doesn't fall under one of the forms/functions accepted by the question

➔ Mismatch of form/function

➔ Logical incoherence

	Questions	Expected Answers
Forms	Yes/No	{Yes/No, Uncertain, Unknown}
	Wh	{Wh, Uncertain, Unknown}
	Disjunctive-Inclusive	{Yes/No, Uncertain, Unknown}
	Disjunctive-Exclusive	{Wh, Uncertain, Unknown}
	Auxiliary-Deontic	{Yes/No, NONE, Performance}
	Auxiliary-Epistemic	{Yes/No, Uncertain, Unknown}
Functions	Completion Suggestion	{Refuse, Accept, Phatic, Give_Confirmation}
	Phatic	{Refuse, Phatic, Give_Confirmation, Report, NONE}
	Ask_Confirmation	{Refuse, Accept, Give_Uncertainty, Give_Unknown, Give_Confirmation}
	Ask_Feature,	{Give_Feature, Give_Uncertainty, Give_Unknown}
	Ask_Performance	{Perform, NONE, Give_Unknown, Give_Uncertainty, Accept}
	Reported Speech	{Phatic, Reported, NONE}

BUILDING BRIDGES

SANDERS Well, I think we got one that's coming out tomorrow.

BLITZER Which one?

SANDERS Last year's.

BLITZER 2014?

SANDERS Yes.

BLITZER What about 2013, all the other ones?

SANDERS You'll get them, yes. […] Unfortunately — unfortunately, I remain one of the poorer members of the United States Senate. And that's what that will show. [applause]

BLITZER So, Senator, just to be clear, tomorrow you will release the 2014 tax returns from you and your family?

SANDERS Yes.

BLITZER And what about the earlier ones? What's the problem…

SANDERS Yes.

BLITZER What's taking so long? Because you just have to go to the filing cabinet, make a copy, and release them. [applause]

<div align="center">

Democratic Candidates Debate in Brooklyn, New York, April 14, 2016

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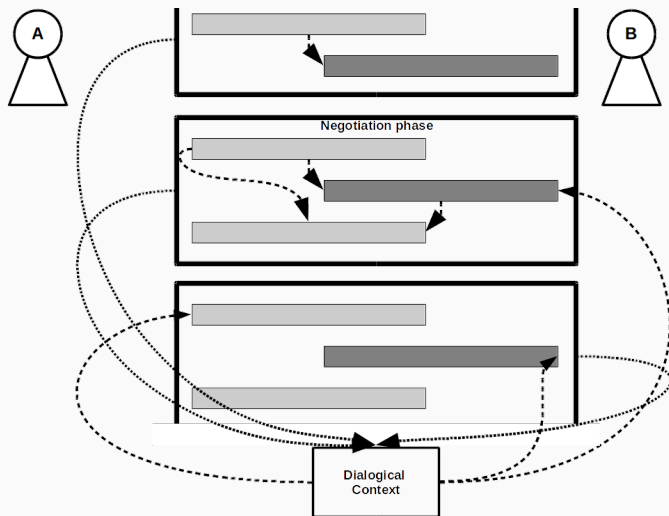
FIGURE – Subdivision of a dialogue in negotiation phases.

Wh-words: what, when, where, who, whom, which, whose, why, how

WH-WORD	FRENCH EQUIVALENTS
Who	qui, quel, quelle, quels, quelles
	lequel, laquelle, lesquels, lesquelles

TABLE – French equivalents of English wh-words – the case of "Who".

Minimal negotiation phases

Question Where is the unicorn ?

Answer The unicorn is at home.

Question Où est la licorne ?

Answer La licorne est à la maison.

★ The unicorn will grow soon

★ The unicorn is blue   VS   Charlie is a blue
  unicorn

★ What coulour is Charlie?

Figure – Gameboard during a game.

A₁ Est-ce que quelqu'un a de l'argile ?

B₂ Oui

A₃ Contre du bois ?

B₄ Non

A₁ Does anyone have clay?

B₂ Yes

A₃ To trade for wood?

B₄ No

Dialogues in Games (DinG)

A_1 Does anyone have clay?

B_2 Yes

A_3 To trade for wood?

B_4 No

A_1 Does anyone have clay?

B_2 Yes

A_3 To trade for wood?

B_4 No

$$[\![B_2]\!] \, [\![decl(A_1)]\!]$$

$$= (\lambda P.\ P)\ [\![\text{Someone has clay}]\!]$$

$$= \exists x\ [clay(x) \wedge \exists e\ [have(e) \wedge ag(e) = someone \wedge th(e) = x]]$$

A_1 Does anyone have clay?

B_2 Yes

A_3 To trade for wood?

B_4 No

$$[\![B_4]\!] \, [\![A_3]\!] = [\![B_4]\!] \, [\![\text{Does anyone have clay to trade for wood?}]\!]$$

$$= (\lambda P. \text{ not } P) \, [\![\text{Someone has clay to trade for wood}]\!]$$

$$= \text{not } (\exists x \, \exists y \, [\text{clay}(x) \wedge \text{wood}(y) \wedge$$
$$\exists e \, [\text{have}(e) \wedge \text{ag}(e) = \text{someone} \wedge \text{th}(e) = x \wedge$$
$$\exists f \, [\text{trade}(f, x, y)]]])$$

Conclusion

We have:

- A minimal (logical, compositional, dynamic) theoretical model of questions and answers
- A minimal implementation for builiding representations (UniC)
- A cross-lingual typology of questions and answers (annotation scheme)
- A corpus of simplified real-life interactions (DinG)

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To-do:

- Make it all work together (automatically)

RÉFÉRENCES
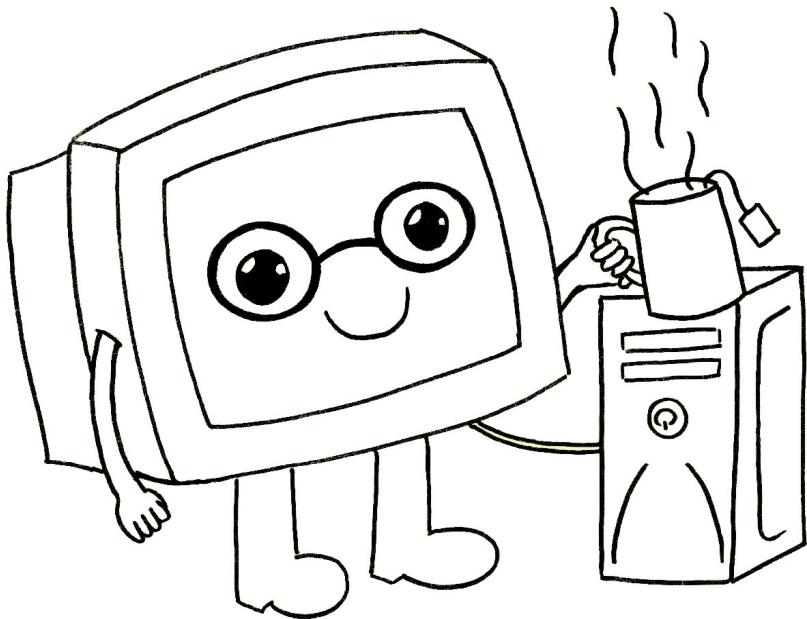
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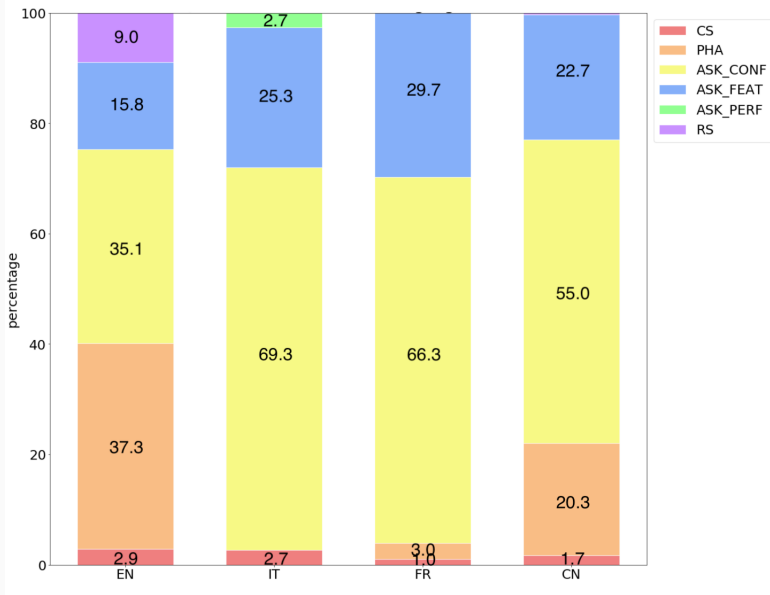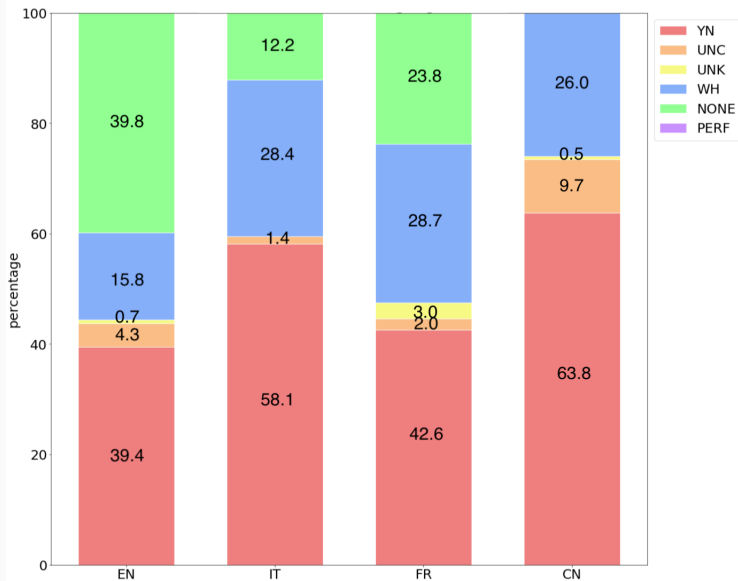
FIGURE – Question functions distribution

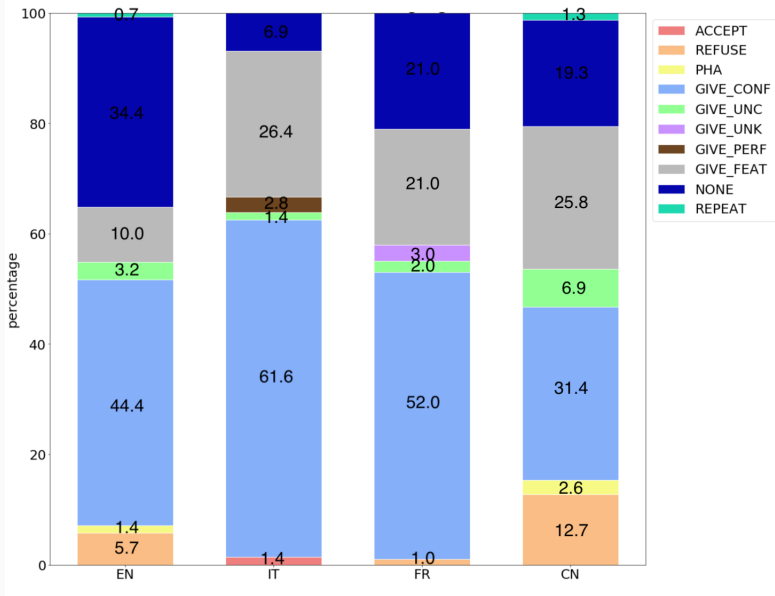FIGURE – Answer forms distribution

FIGURE – Answer functions distribution