Do Context-Aware Translation Models Pay the Right Attention?

Kayo Yin[1], Patrick Fernandes[1,2], Danish Pruthi[1], Aditi Chaudhary[1]
André F.T. Martins[2,3], Graham Neubig[1]

1 Carnegie Mellon University Language Technologies Institute

2 TÉCNICO LISBOA

3 Unbabel

Why is Context Important for Translation?

We'll have to get rid of that mole.

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Things could start to get dangerous if the ministers find out.
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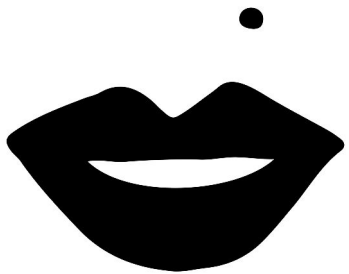

Why is Context Important for Translation?

English:
Things could start to get dangerous if the ministers find out.
We'll have to get rid of that mole.

French:
Les choses pourraient commencer à devenir dangereuses si les ministres le découvraient.
Nous devrons nous débarrasser de cette taupe.

Why is Context Important for Translation?

English:
Could it be anything serious, Doctor?
We'll have to get rid of that mole.

French:
Serait-ce quelque chose de grave, docteur ?
Nous devrons nous débarrasser de ~~cette taupe~~.
cet grain de beauté

Why is Context Important for Translation?

English:
So you see how bad the implications are.
Yes, they are quite devastating.

French:
Vous voyez donc à quel point les implications sont mauvaises.
Oui, ils sont assez dévastateurs.

Why is Context Important for Translation?

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So you see how bad the implications are.
Yes, they are quite devastating.

French:
Vous voyez donc à quel point les implications sont mauvaises.
Oui, ~~ils~~ sont assez ~~dévastateurs.~~

elles dévastatrices

Context-Aware NMT

Source input	Have we got her report? Yes, it's in the infirmary already.
Context-aware NMT output	On dispose de son rapport? Oui, elle est déjà à l'infirmerie.

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Context-Aware NMT

Source input

~~Have we got her report~~?
Yes, it's in the infirmary already.

Context-aware NMT output

~~On dispose de son rapport~~?
Oui, elle est déjà à l'infirmerie.

Outline

1. What context is useful during ambiguous translations?

2. Are models paying attention to this context or not?

3. If not, can we encourage them to do so?

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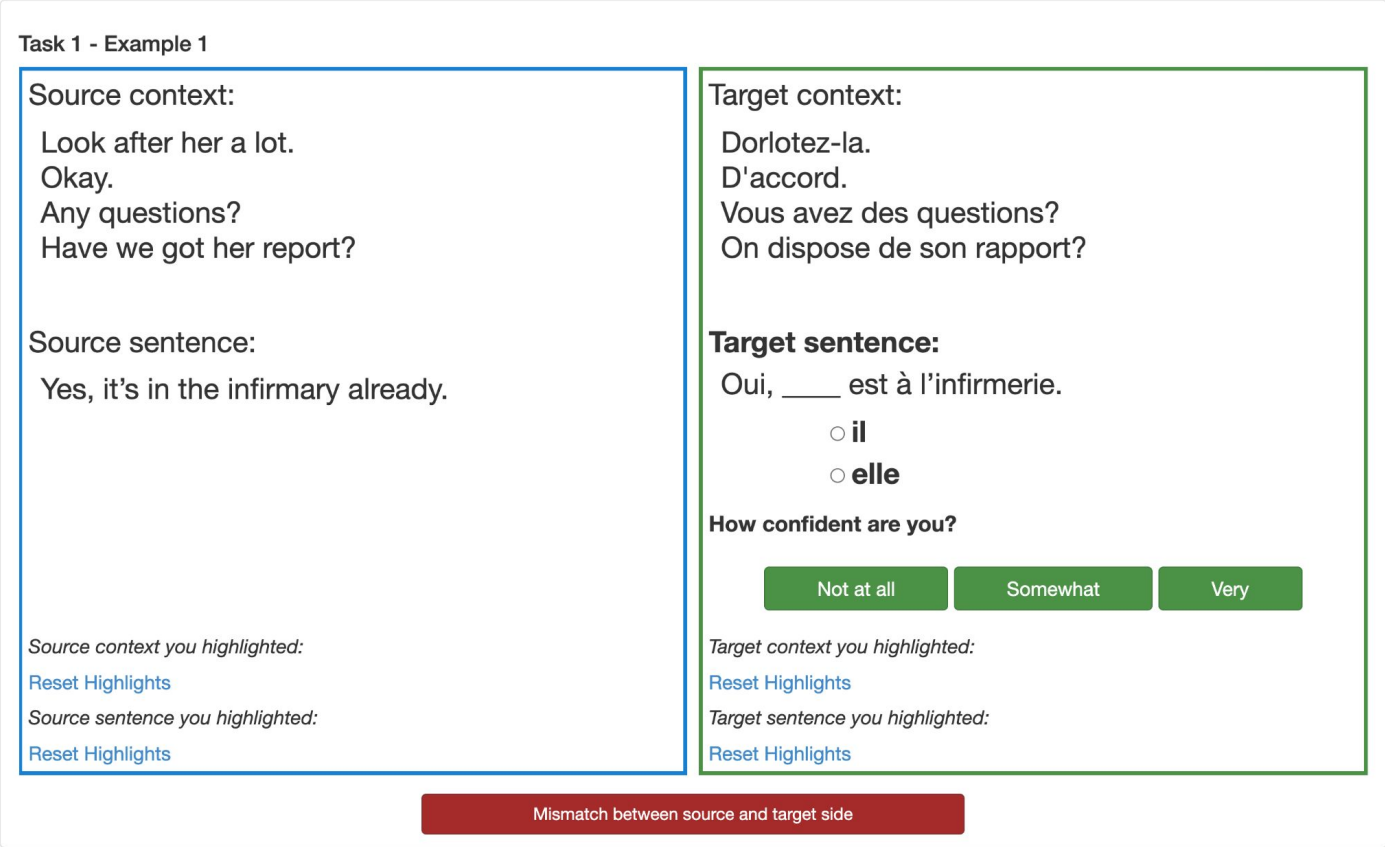
User Study


Task 1 - Example 1
Source context:
Look after her a lot.
Okay.
Any questions?
Have we got her report?
Source sentence:
Yes, it's in the infirmary already.
Source context you highlighted:
Reset Highlights
Source sentence you highlighted:
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Target context:
Dorlotez-la.
D'accord.
Vous avez des questions?
On dispose de son rapport?
Target sentence:
Oui, ____ est à l'infirmerie.
il
elle
How confident are you?
Not at all
Somewhat
Very
Target context you highlighted:
Reset Highlights
Target sentence you highlighted:
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Mismatch between source and target side

User Study

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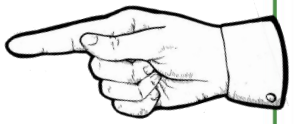

Target sentence:

Oui, ____ est à l'infirmerie.

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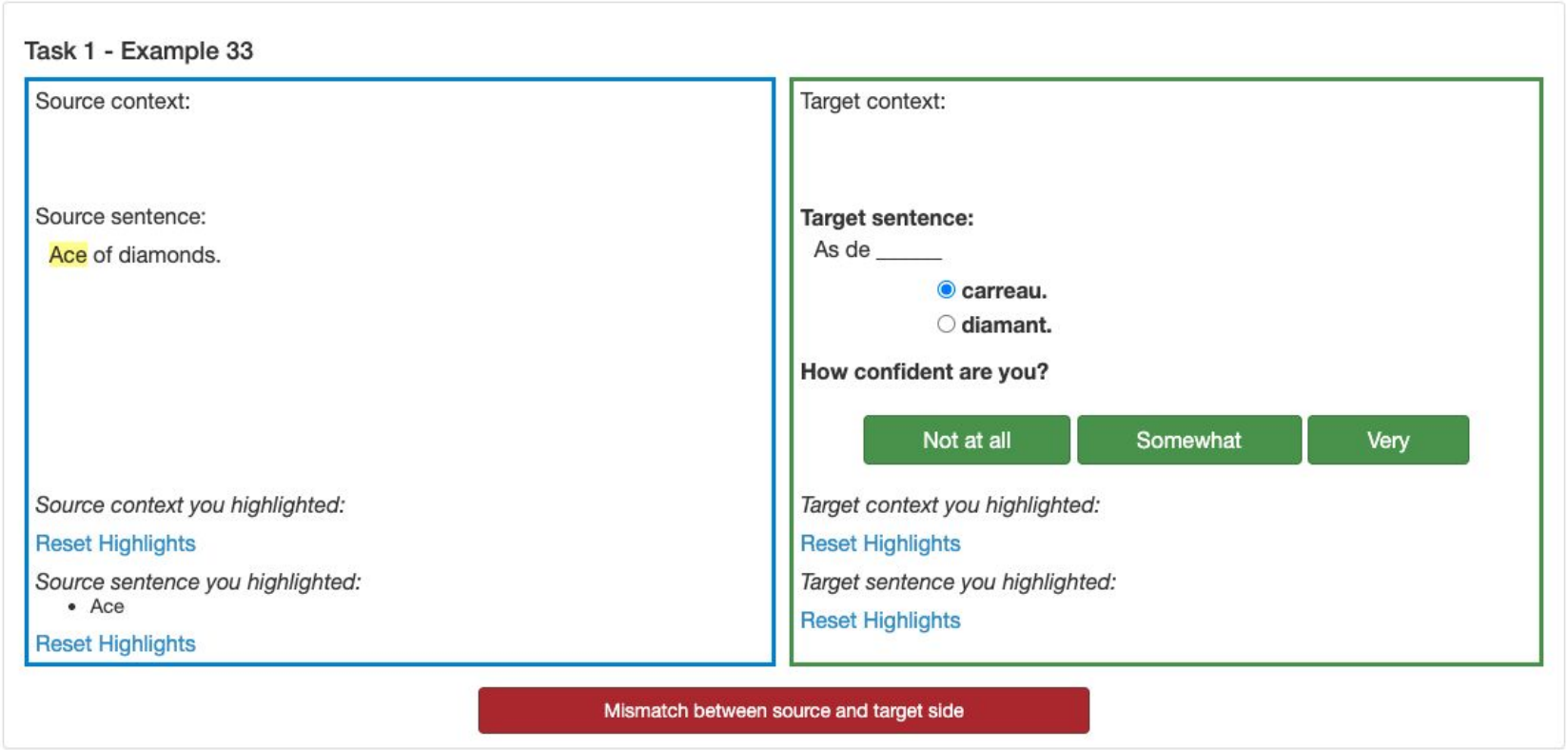
Task 1 - Example 33
Source context:
Source sentence:
Ace of diamonds.
Source context you highlighted:
Reset Highlights
Source sentence you highlighted:
Ace
Reset Highlights
Target context:
Target sentence:
As de _____
carreau.
diamant.
How confident are you?
Not at all
Somewhat
Very
Target context you highlighted:
Reset Highlights
Target sentence you highlighted:
Reset Highlights
Mismatch between source and target side

What Context do Human Translators Use?

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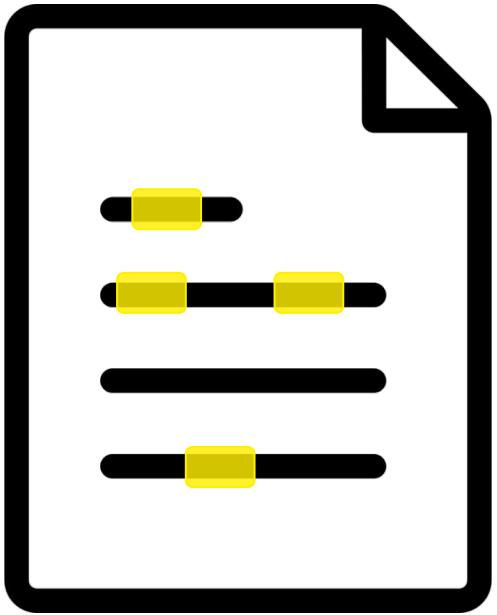

What Context do Human Translators Use? (Pronoun Anaphora Resolution)

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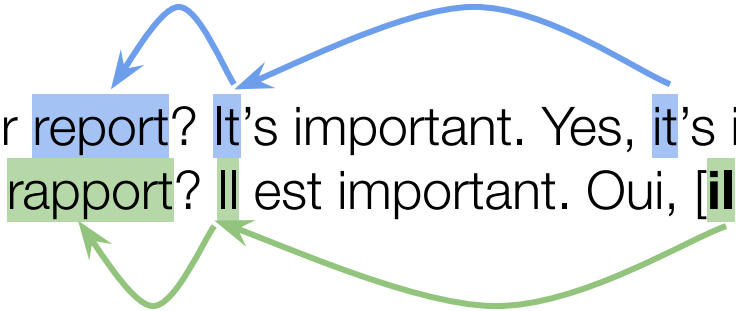

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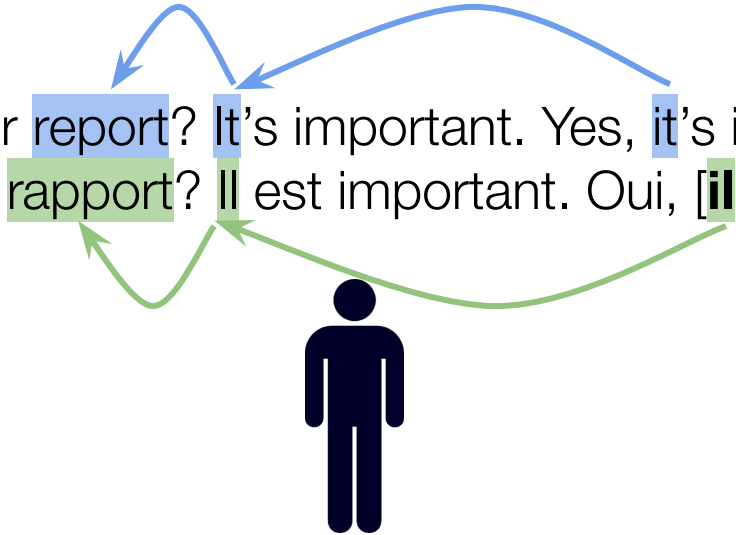

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What Context do Human Translators Use? (Word Sense Disambiguation)

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Your charm is only exceeded by your frankness.

Ton [**charme** / ~~portebonheur~~] n’a d’égal que ta franchise.

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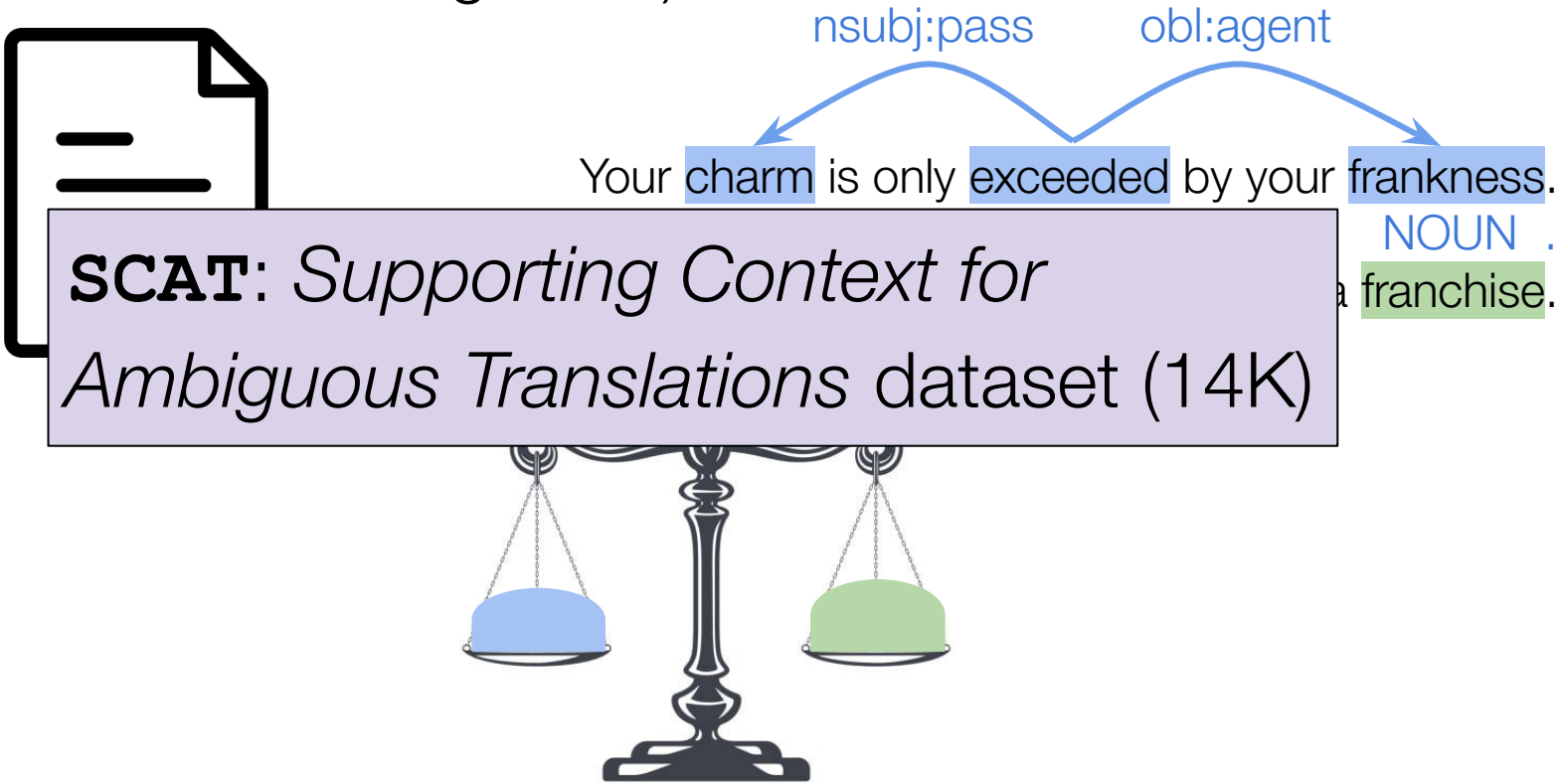
What Context do Human Translators Use? (Word Sense Disambiguation)

nsubj:pass obl:agent

Your charm is only exceeded by your frankness.
VERB NOUN .

Ton [**charme** / ~~portebonheur~~] n'a d'égal que ta franchise.

What Context do Human Translators Use? (Word Sense Disambiguation)



Outline

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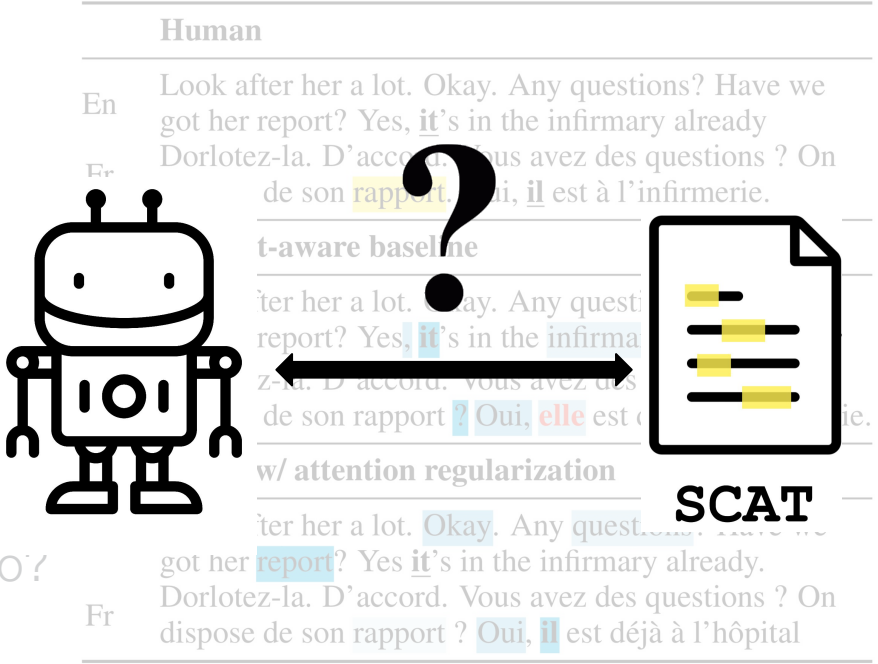
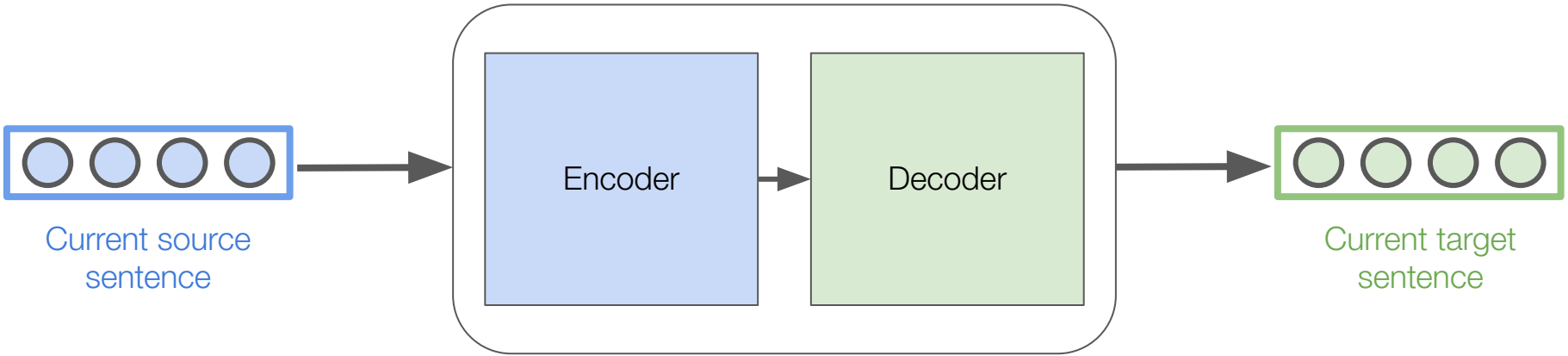
2. Are models paying attention to this context or not?

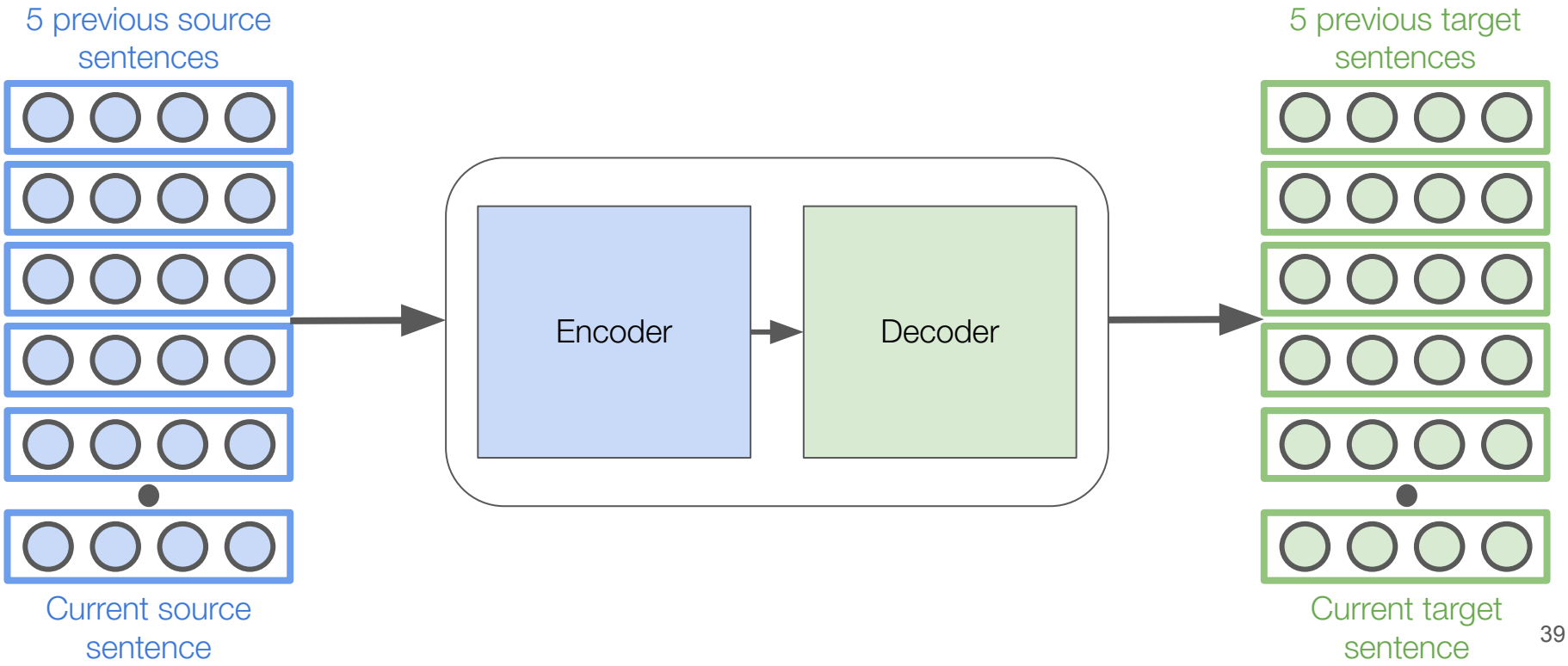
3. If not, can we encourage them to do so?



Model

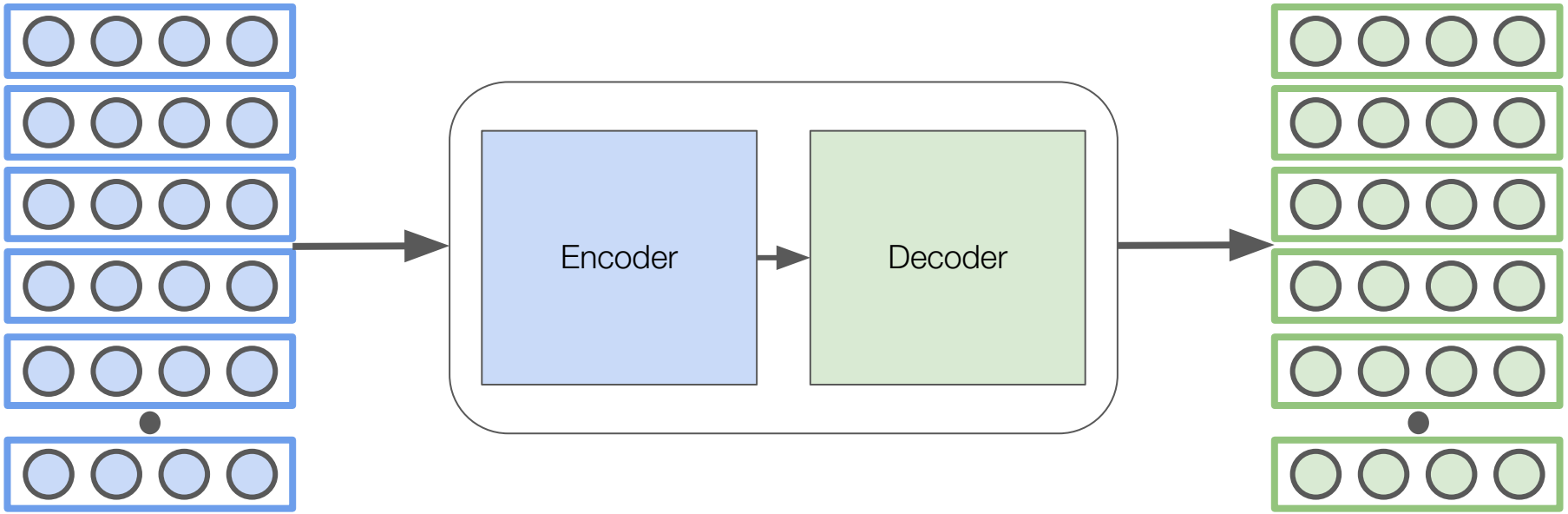

Encoder
Decoder
Current source sentence
Current target sentence

Model


5 previous source sentences
Encoder
Decoder
5 previous target sentences
Current source sentence
Current target sentence

Model

Open Subtitles



Quantifying Human-Model Alignment with **SCAT**

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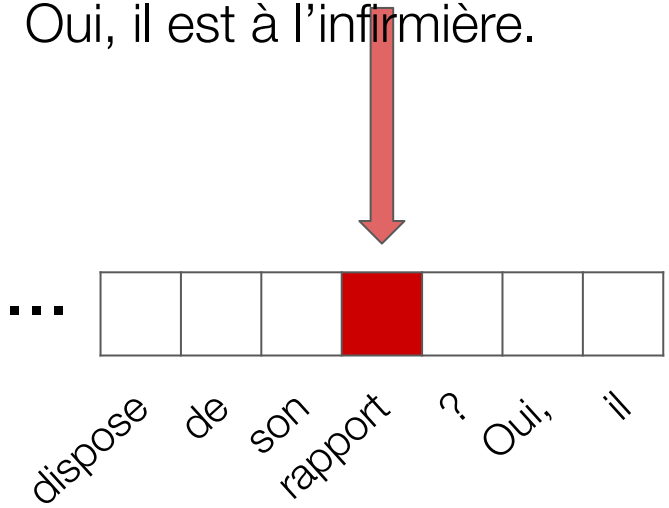

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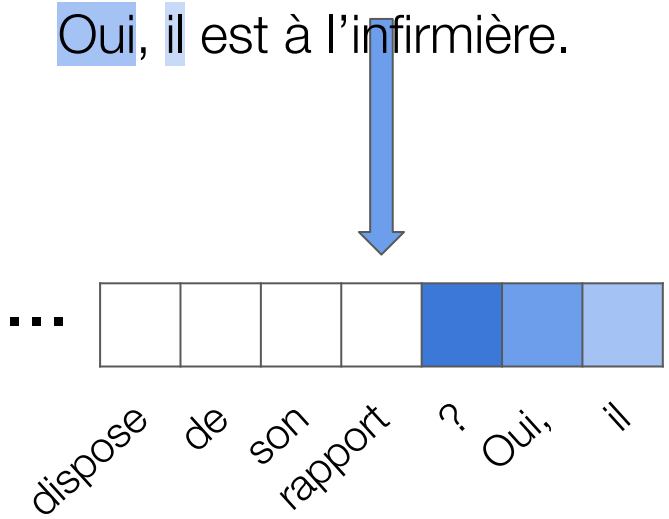

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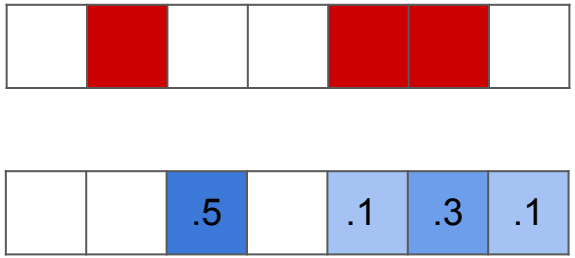

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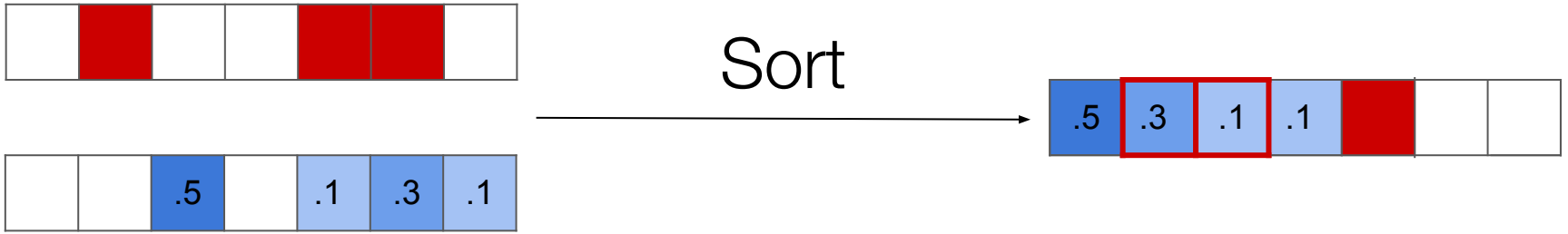

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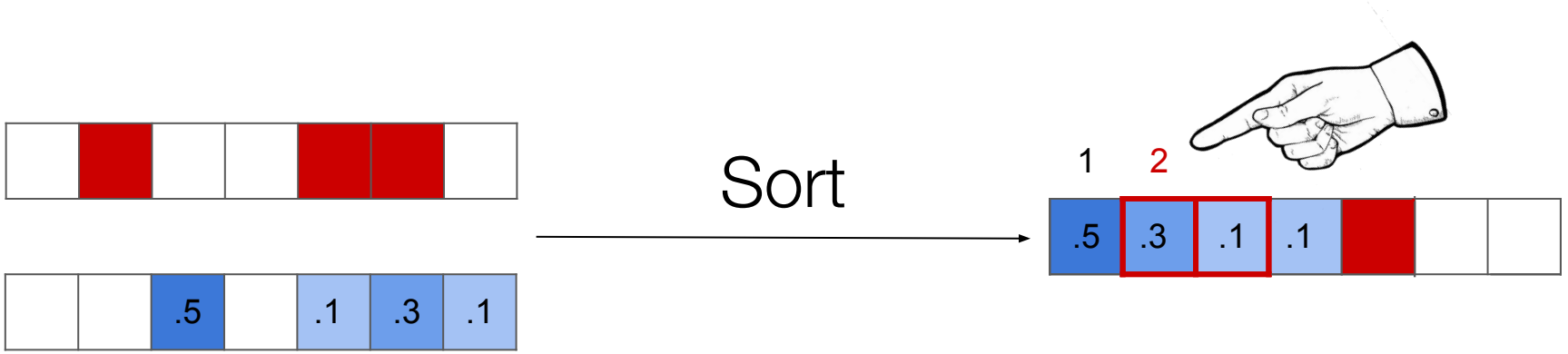
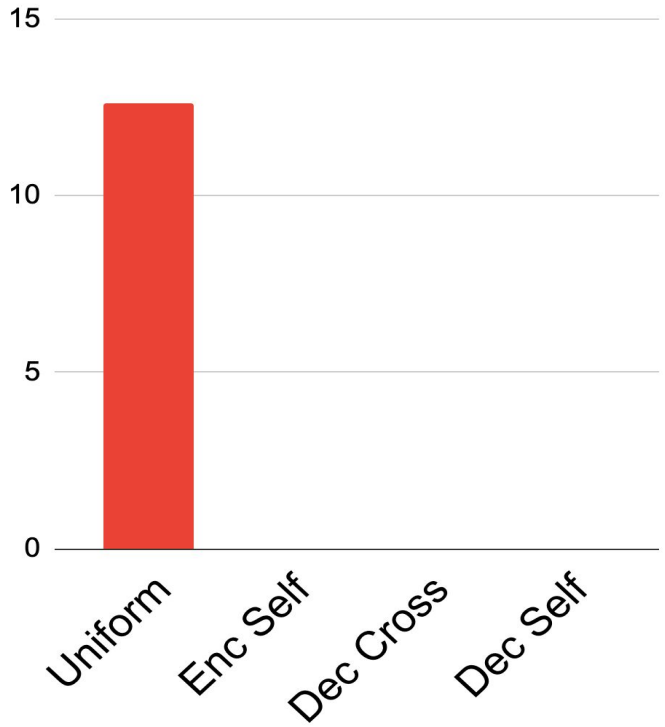


Alignment Results



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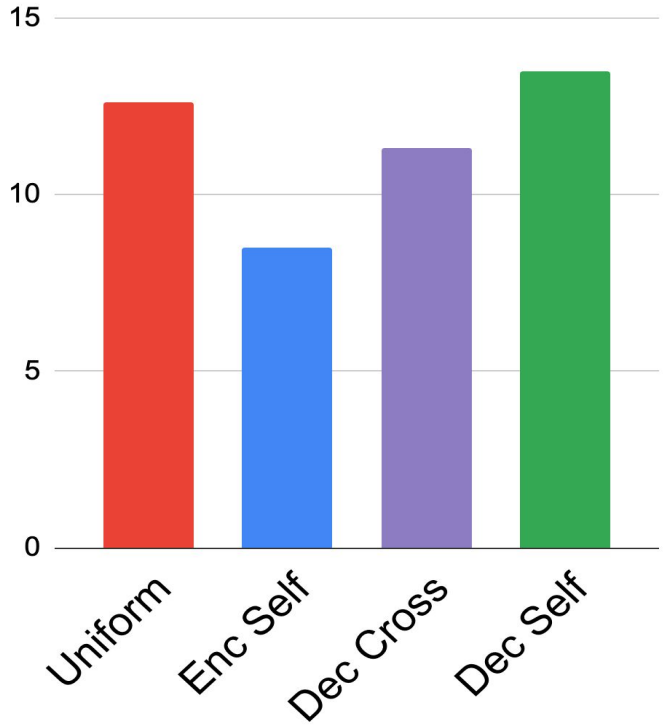

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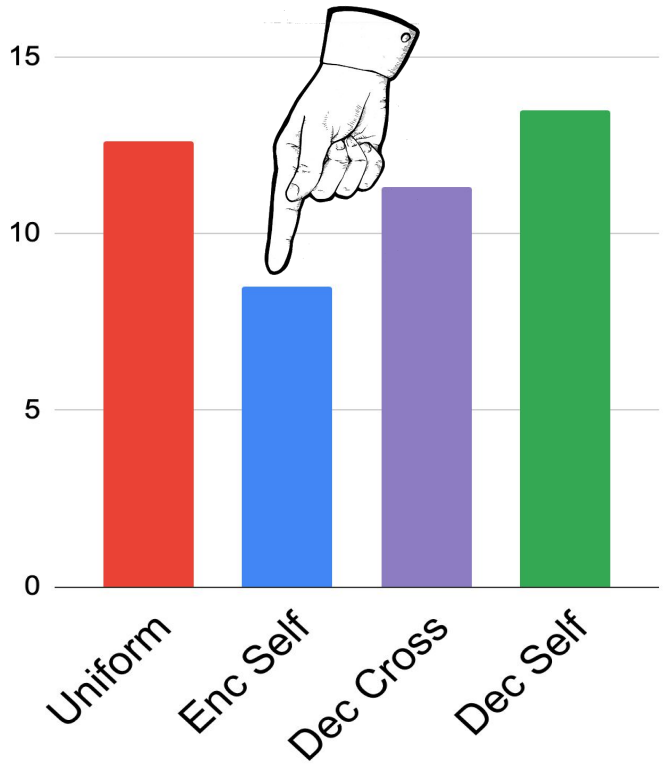

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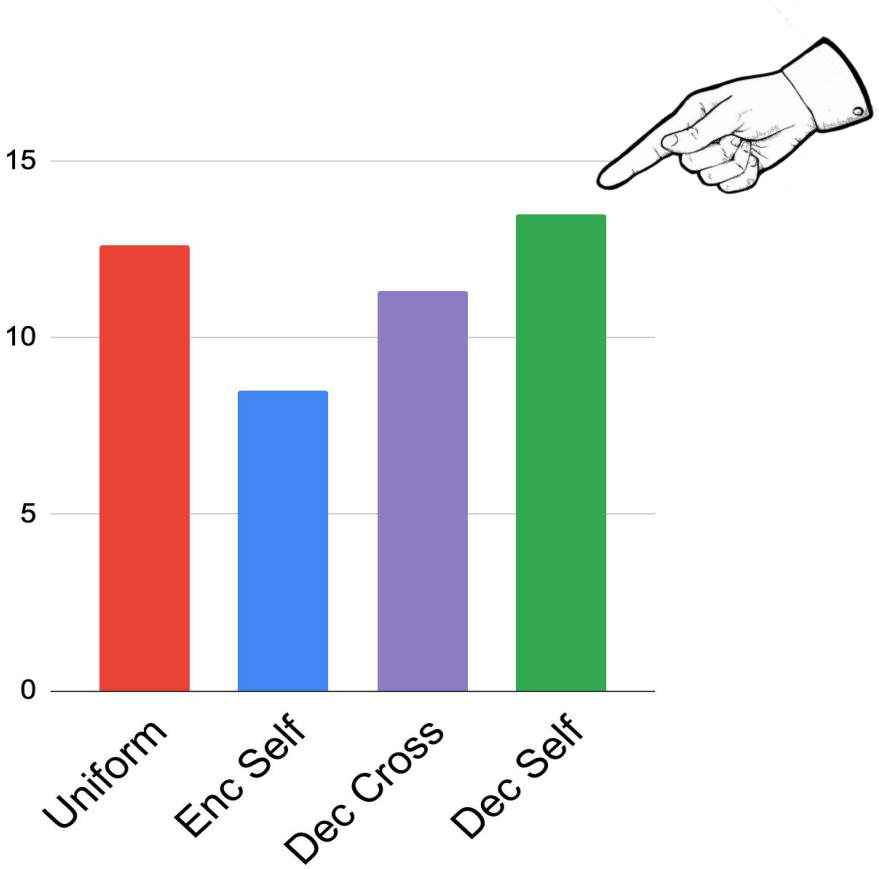

Outline

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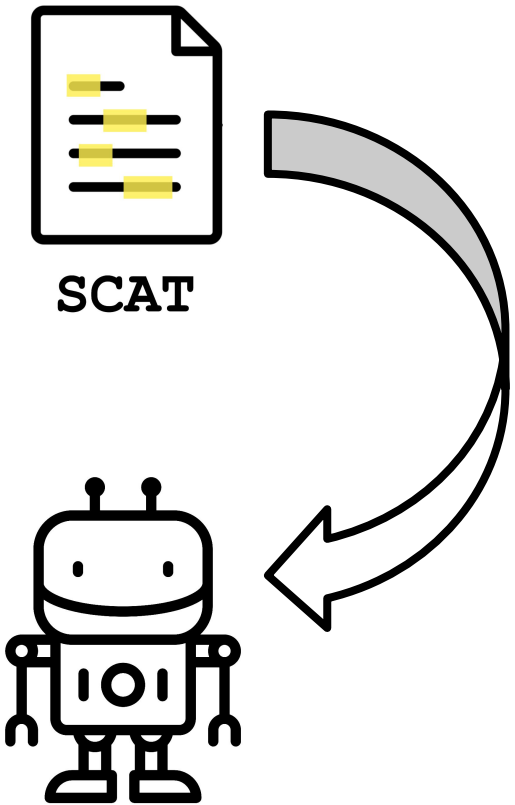

Attention Regularization

$$\mathcal{L}_{NLL}(\theta) = -\sum_{j=1}^{m} \log p_\theta(y_j | x, y_{i<j})$$

OpenSubtitles18

Context-aware MT Model

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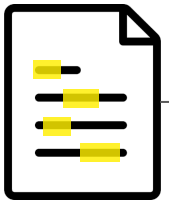
Context-aware MT Model



SCAT

$$\mathcal{R}(\theta) = -\lambda \mathrm{KL}(\alpha_{\text{human-norm}} || \alpha_{\text{model}}(\theta))$$

Evaluation

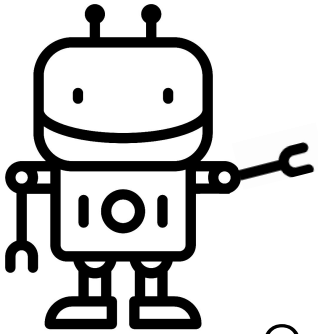
- BLEU
- COMET

Evaluation

- BLEU
- COMET
- Pronouns F-measure

Evaluation

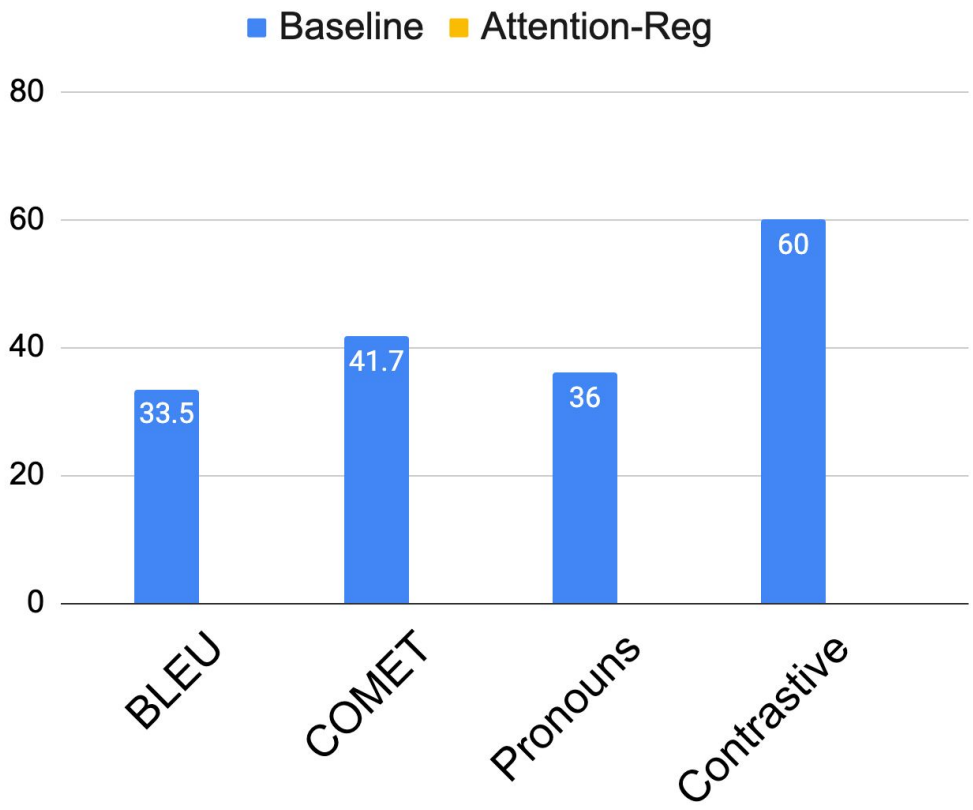
- BLEU
- COMET
- Pronouns F-measure
- Contrastive Evaluation



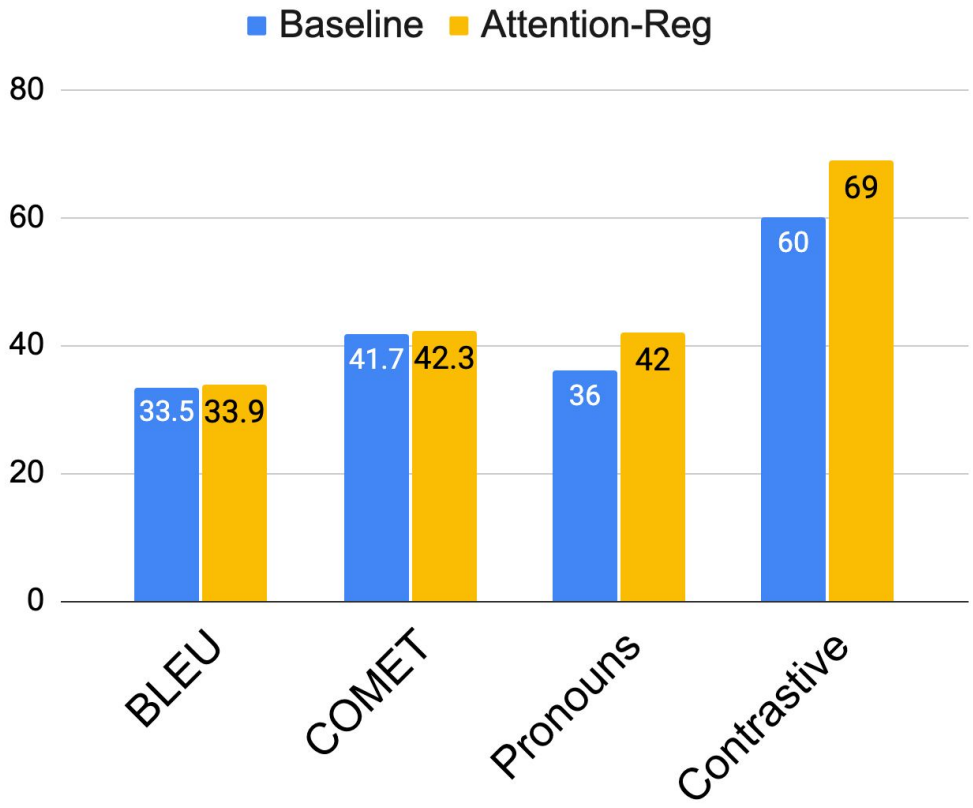
Oui, **il** est déjà à l'infirmerie.

Oui, **elle** est déjà à l'infirmerie.

Results


Baseline
Attention-Reg
80
60
40
20
0
33.5
41.7
36
60
BLEU
COMET
Pronouns
Contrastive

Results


Baseline
Attention-Reg
80
60
40
20
0
33.5
33.9
41.7
42.3
36
42
60
69
BLEU
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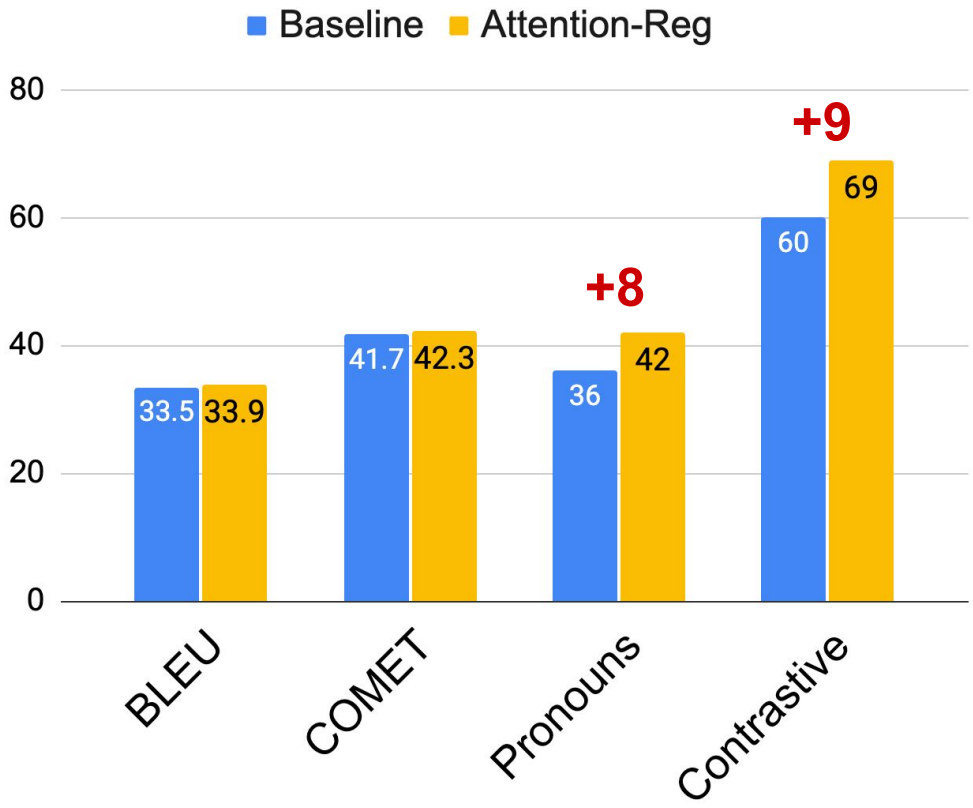
Results


Baseline
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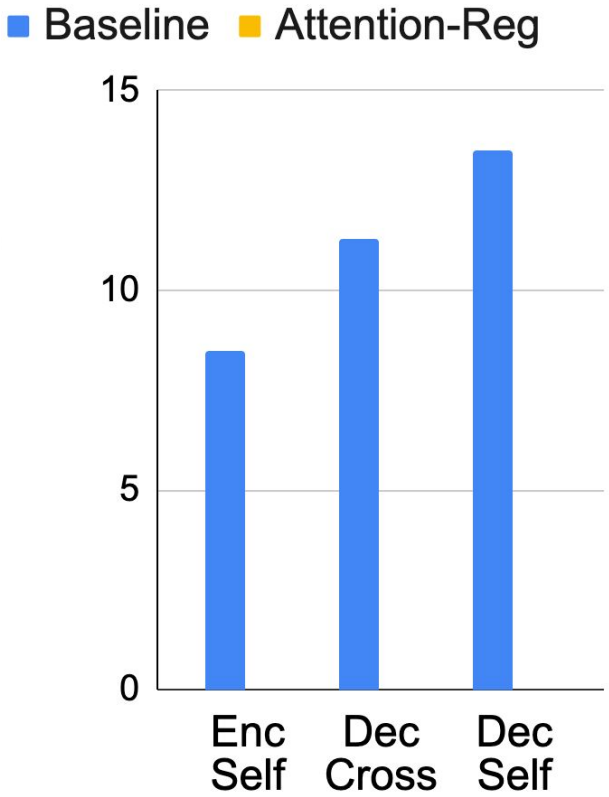

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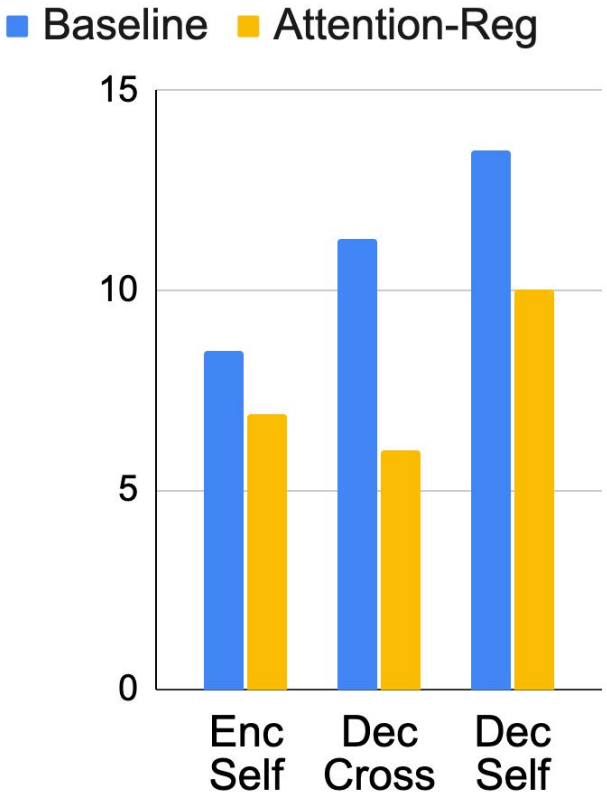
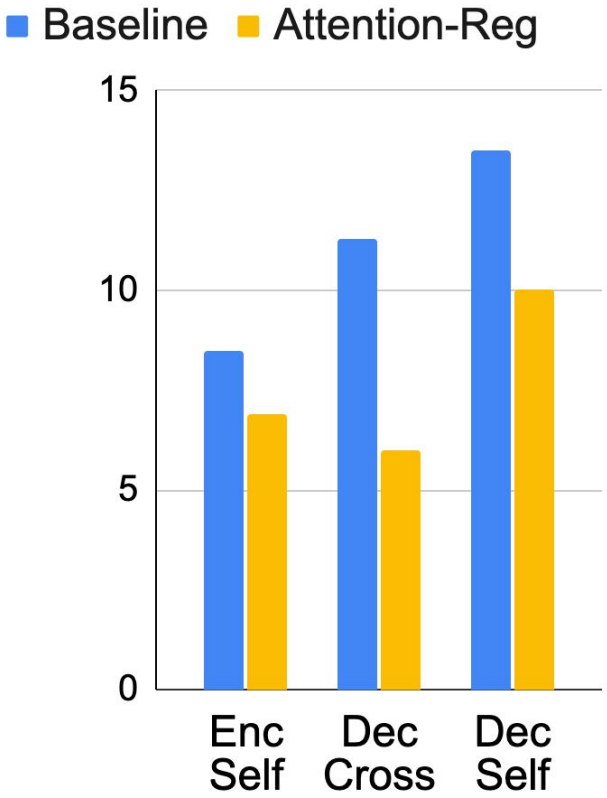


Results



Have we got her report?
Yes, it's in the infirmary already.

Baseline

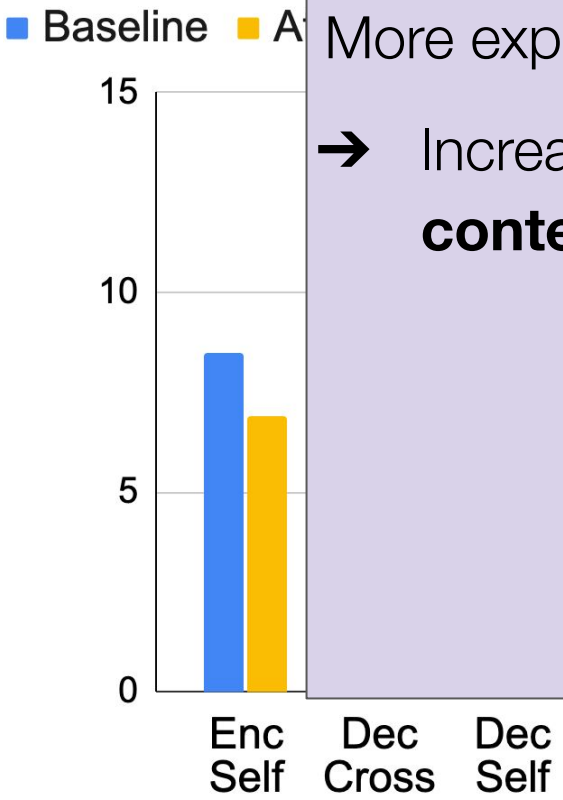
On dispose de son rapport?
Oui, **elle** est déjà à l'infirmerie.

Have we got her report?
Yes, it's in the infirmary already.

Attention-Reg

On dispose de son rapport?
Oui, **il** est déjà à l'infirmerie.

Results

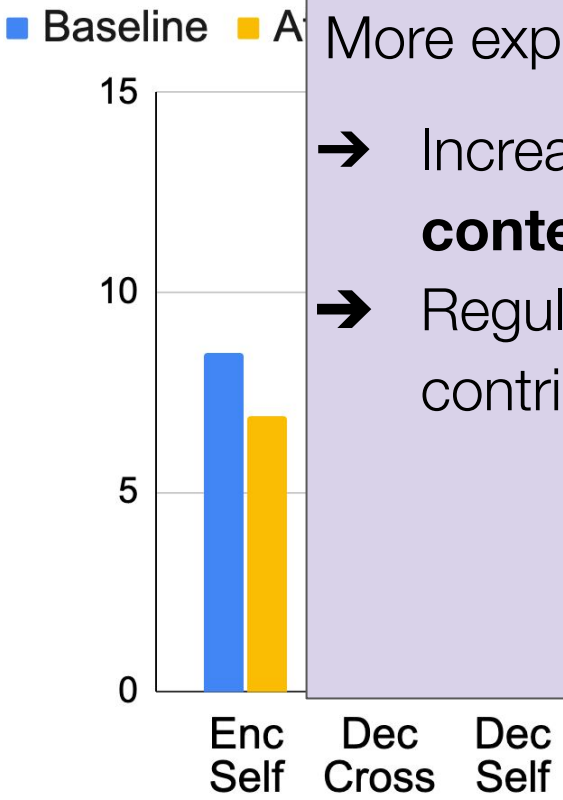


More experiments & results in paper:

➔ Increased usage of **supporting context**

Have we got her report?
mary already.
son rapport?
à l'infirmerie.
ot her report?
rmary already.
de son rapport?
Oui, il est déjà à l'infirmerie.

Results



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➔ Increased usage of **supporting context**

➔ Regularizing **encoder self-attention** contributes the most

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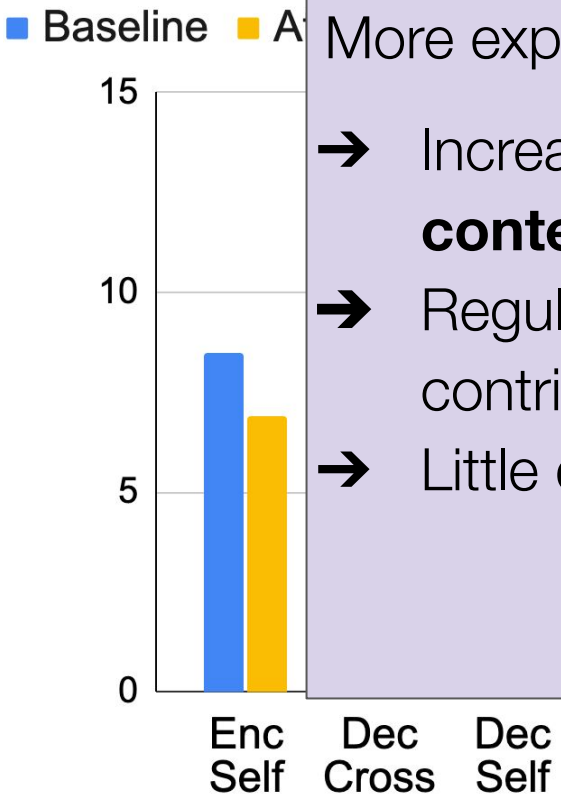
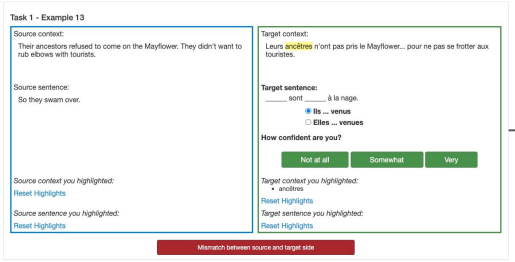


More experiments & results in paper:

- ➔ Increased usage of **supporting context**
- ➔ Regularizing **encoder self-attention** contributes the most
- ➔ Little difference in **WSD** performance

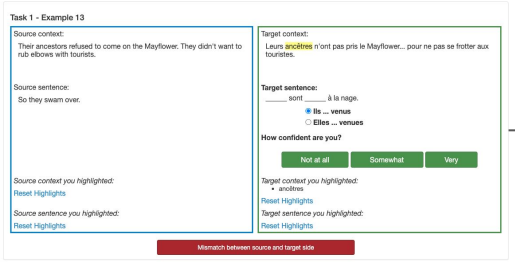
Have we got her report?
mary already.
son rapport?
à l'infirmerie.
ot her report?
rmary already.
de son rapport?
Oui, il est déjà à l'infirmerie.

Summary



14k SCAT

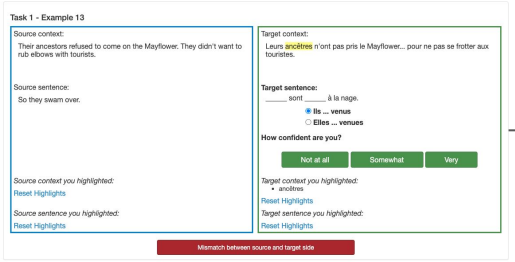
Summary



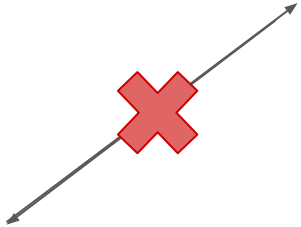
14k SCAT

Baseline Model

Summary

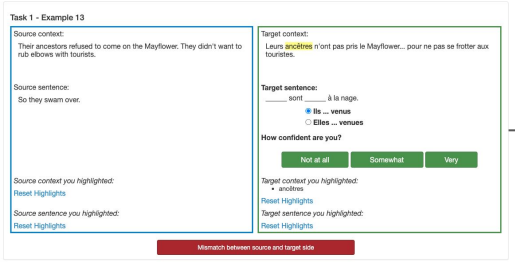


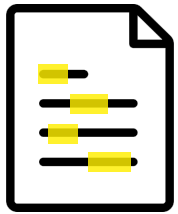
14k SCAT



Baseline Model

Summary





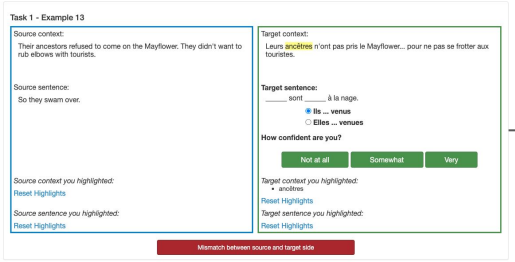
14k SCAT

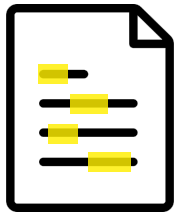
$$\mathcal{R}(\theta)$$

Regularized Model

Baseline Model

Summary





14k SCAT

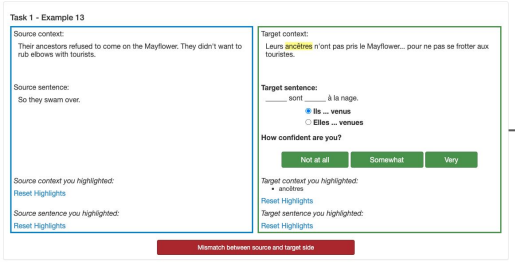
$\mathcal{R}(\theta)$

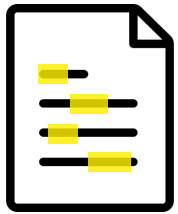
Regularized Model

Baseline Model

➔ Better alignment, context usage, translation performance

Summary





14k SCAT

$\mathcal{R}(\theta)$

Regularized Model

Baseline Model

- ➔ Better alignment, context usage, translation performance
- ➔ Code & Data: **github.com/neulab/contextual-mt**