

External Knowledge in Machine Translation: Case Studies of Multimodal Machine Translation and Automatic Post-Editing

Julia Ive

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Outline

- multimodal machine translation
 - translate-and-refine approach with Deliberation nets
 - investigation on the need for visual context
- automatic post-editing
 - CopyCat networks
 - terminology copy or correct

Multimodal Machine Translation (MMT)



Model

Un canard sur la berge de la rivière.

A duck on the bank of a river.

Human Translation Study - 2k sentences

(Frank et al., 2018)

Step 1



Step 2



- 14% of sentences post-edited

Multimodal translation – humans

ambiguous words

- Three children in **football** uniforms are playing **football**.
- Drei Kinder in **Fußballtrikots** spielen **Fußball**.

Multimodal translation – humans

ambiguous words

- Three children in **football** uniforms are playing **football**.
- Drei Kinder in **Fußballtrikots** spielen **Fußball**.
- Drei Kinder in **Footballtrikots** spielen **Football**.



Multimodal translation – humans

gender-neutral words

- **A baseball player** in a black shirt just tagged **a player** in a white shirt.
- **Ein Baseballspieler** in einem schwarzen Shirt fängt **einen Spieler** in einem weißen Shirt.

Multimodal translation – humans

gender-neutral words

- **A baseball player** in a black shirt just tagged **a player** in a white shirt.
- **Ein Baseballspieler** in einem schwarzen Shirt fängt **einen Spieler** in einem weißen Shirt.
- **Eine Baseballspielerin** in einem schwarzen Shirt fängt **eine Spielerin** in einem weißen Shirt.



Multimodal translation – humans

noise

- A woman wearing a white **shirt** works on an elliptical machine.
- Eine Frau in einem weißen **Shirt** trainiert auf einem Crosstrainer.

Multimodal translation – humans

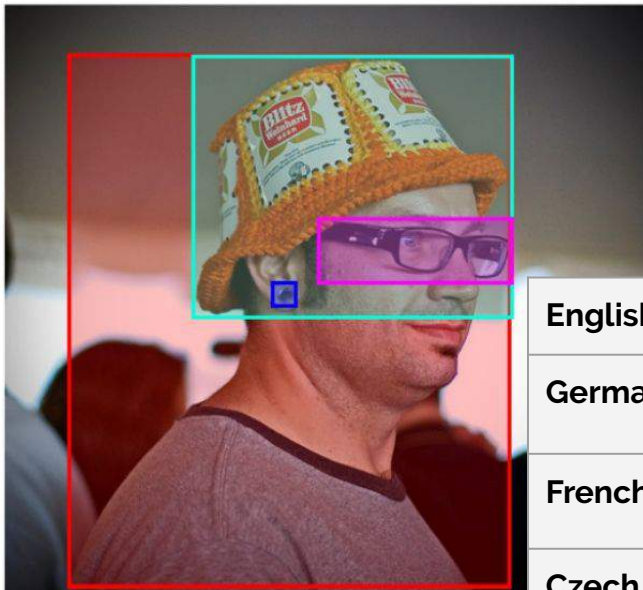
noise

- A woman wearing a white **shirt** works on an elliptical machine.
- Eine Frau in einem weißen **Shirt** trainiert auf einem Crosstrainer.
- Eine Frau in einem weißen **Pullover** trainiert auf einem Crosstrainer.



Multi30K dataset

(Elliott et al., 2016)



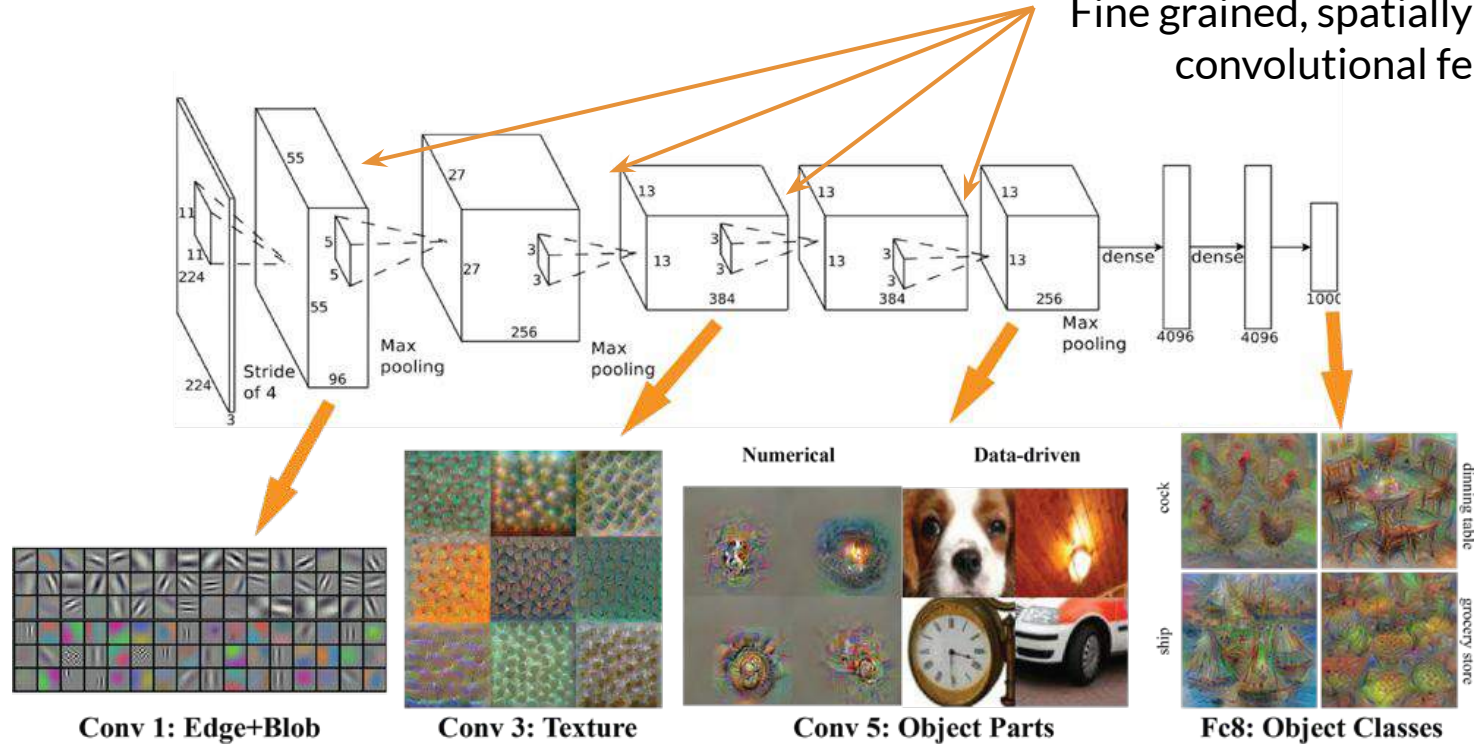
30K (image, sentence) pairs per language

English	A man in an orange hat staring at something.
German	Ein Mann mit einem orangefarbenen Hut, der etwas anstarrt.
French	Un homme avec un chapeau orange regardant quelque chose.
Czech	Muž v oranžovém klobouku na něco zírá.

Representing images: CNN image networks

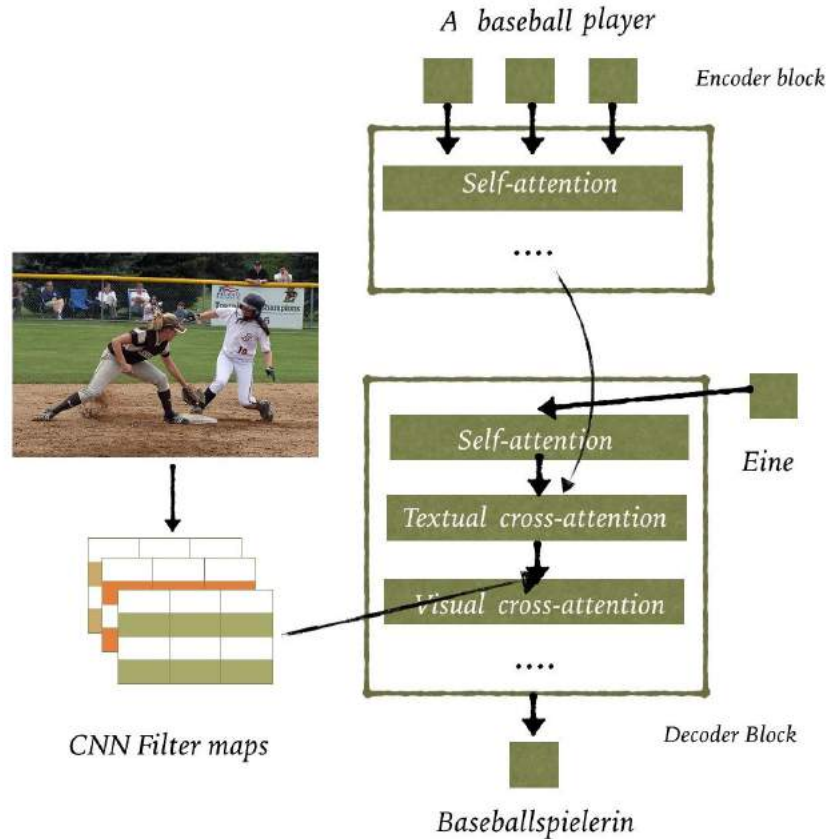
ImageNet classification task (1,000 object classes):

Fine grained, spatially informative convolutional features



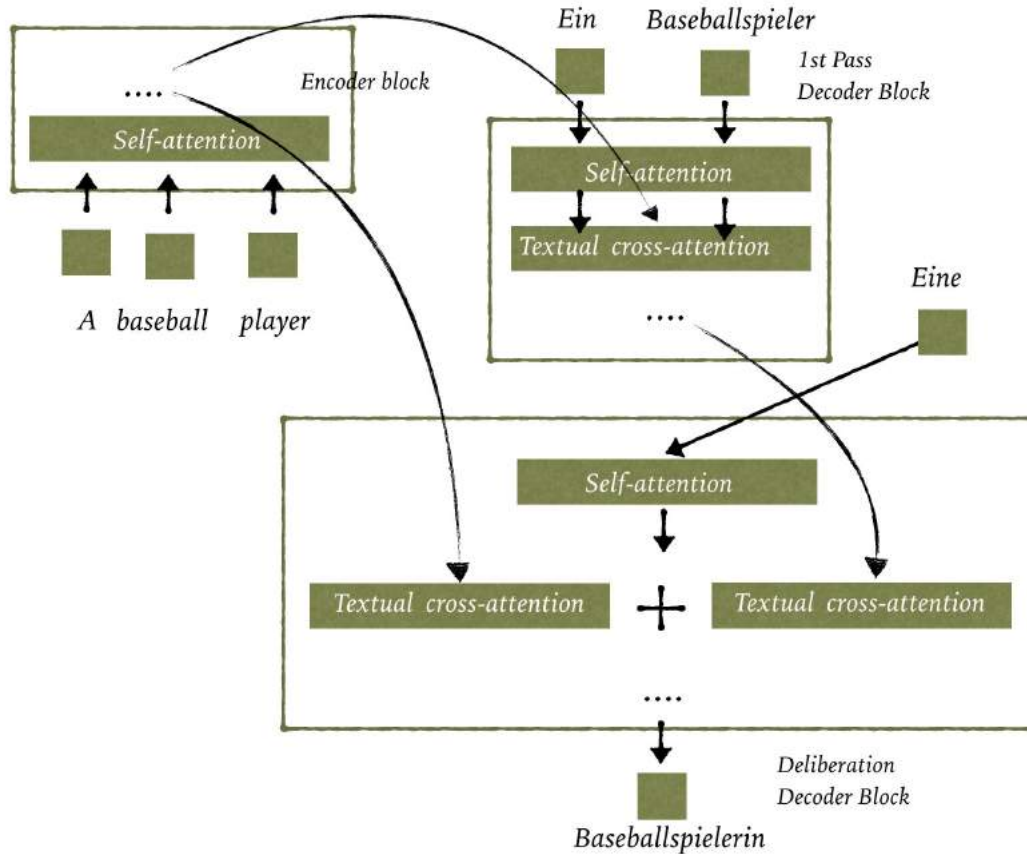
State-of-the-Art

(Helcl et al., 2018)



Deliberation Nets

(Hassan et al., 2018;
Xia et al., 2017)



Textual Context

We went to the ?

Textual Context

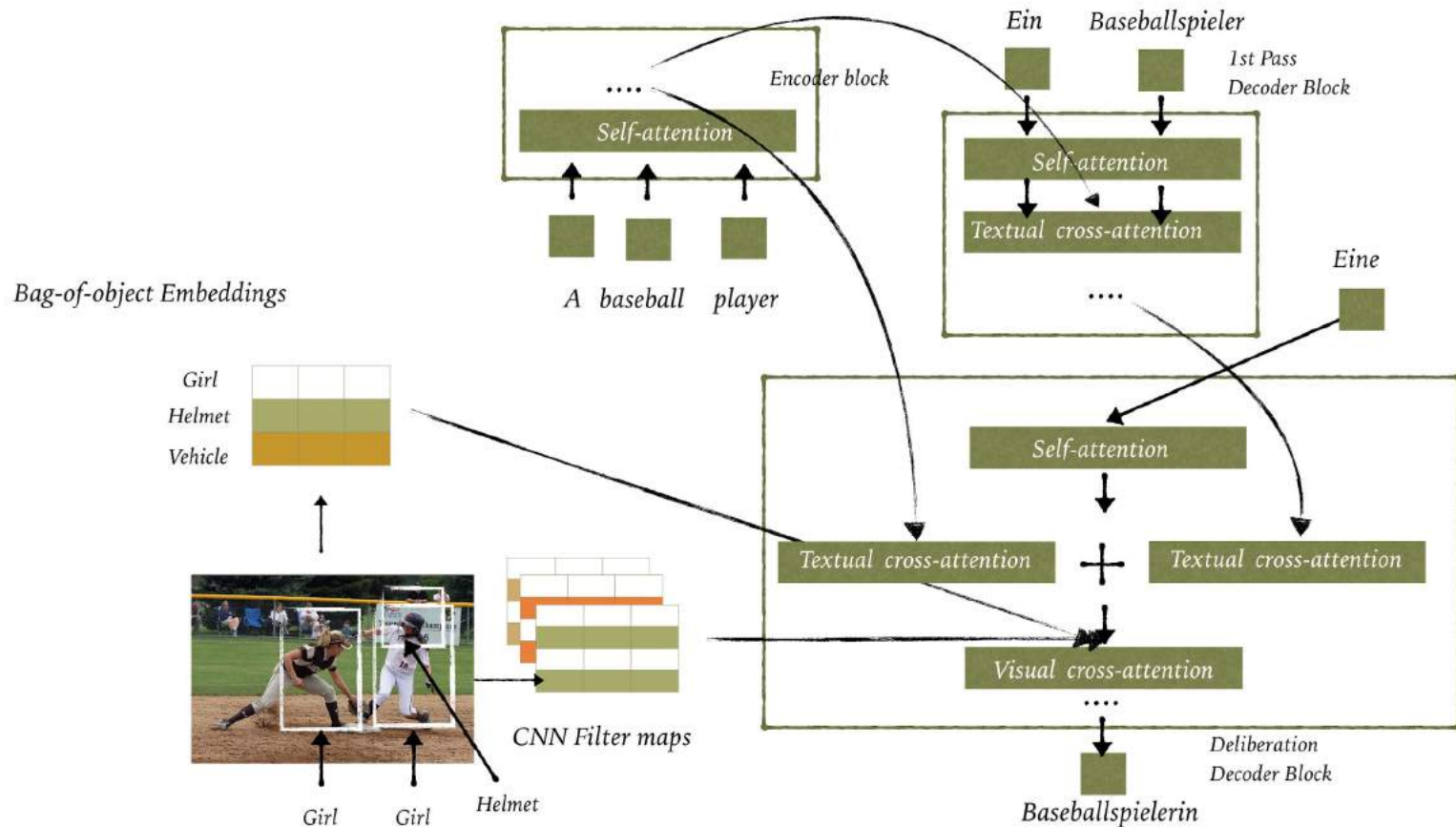
We went to the ? but the movie was boring.

Textual Context

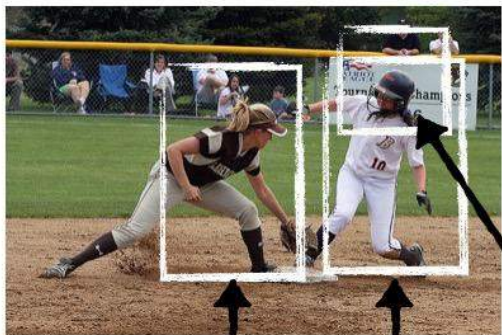
cinema

We went to the ? but the movie was boring.

Our Architecture



Object-based Features



Girl

Girl

Helmet

Object vector

<i>Girl</i>	2
<i>Helmet</i>	1
<i>Vehicle</i>	0

Bag-of-object Embeddings

<i>Girl</i>			
<i>Helmet</i>			
<i>Vehicle</i>			

Results

METEOR	EN-DE		EN-FR	
	Test 2016	Test 2018	Test 2016	Test 2018
text only	54.5	45.0	73.7	56.4
SOTA	53.1	-	75.0	-
our SOTA	54.5	45.3	73.5	56.1
delib	55.5	46.3	74.6	57.2
delib + CNN	55.1	46.1	73.7	56.3
delib + obj	55.6	46.5	74.4	57.0

red marks statistically significant improvements over text only baseline

Human Analysis

- 2 annotators
- 50 samples per language pair

SRC	MT1	MT2	MT3	Rank MT1	Rank MT1	Rank MT3	Interesting
<p><s> a man jumps and poses for photographers lying on the ground . </s></p> 	<p><s> un homme saute et pose pour des photographes par terre . </s></p>	<p><s> un homme saute et pose pour des photographes allongés par terre . </s></p>	<p><s> un homme saute et pose pour des photographes allongé par terre . </s></p>	2	1	1	

Results

	our SOTA	delib	delib+obj
FR	0.35	0.62	0.59
DE	0.41	0.60	0.67

Degradation Experiments

an indian man is talking to children as they cut a cake .

Degradation Experiments

Random Content Words

an indian man is  to children as they cut a cake .

Degradation Experiments

Ambiguous Words (Lala et al., 2018)

an indian man is talking to children as they  a cake .

Degradation Experiments

Person Words (Plummer et al., 2017)

an  is talking to  as they cut a cake .

Results

METEOR	EN-DE			EN-FR		
	RND	AMB	PERS	RND	AMB	PERS
text only	45.6	48.4	47.0	59.3	66.4	63.9
delib	44.6	47.7	47.5	61.0	67.3	64.5
delib + obj	46.5	49.8	48.1	61.3	67.7	65.0

red marks statistically significant improvements over text only baseline

Human Evaluation

EN-DE

	text only	delib	delib+obj	gold
RND	22	23	24	79
AMB	29	25	33	88
PERS	43	46	51	84

Examples

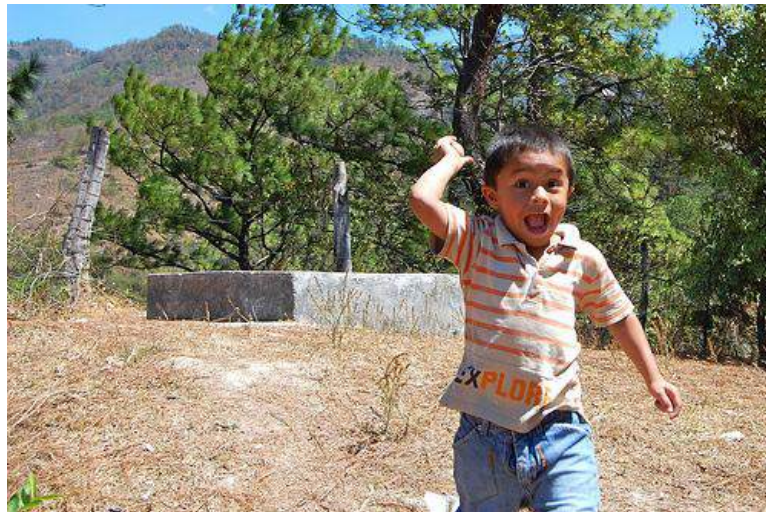
- The boy is outside enjoying a summer day.



Objects: clothing, face, tree, boy, jeans

Examples

- The is outside enjoying a summer day.
- **Text-only:** **L'homme** profite d'une journée d'été.
- **Delib:** **La femme** profite d'une journée d'été.
- **Delib+ obj:** **L'enfant** profite d'une journée d'été.



Objects: clothing, face, tree, boy, jeans

Examples

- A bride and groom kiss under the bride's veil.



Objects: face, woman, dress

Examples

- A and kiss under the bride's veil.
- **Text-only:** Ein **Mann** und eine **Frau** küssen sich unter den Blicken der Frau.
- **Delib:** Ein **Mann** und eine **Frau** küssen sich unter dem Brautschleier.
- **Delib+ obj:** Ein **Mann** und eine **Frau** küssen sich unter den hin.



Objects: face, woman, dress

Examples

- A guy give a kiss to a guy also.



objects: clothing, man, face

Examples

- A give a kiss to a also.
- **Text-only:** Ein **Mann**, der sich vor, um eine **Frau** zu küssen.
- **Delib:** Ein **Mann**, der sich vor, um eine **Frau** zu küssen.
- **Delib+obj:** Ein **Mann**, der einem Kuss küsst, um eine **Frau** zu küssen.



objects: clothing, man, face

Automatic Post-Editing (APE)

- automatic correction errors of MT errors

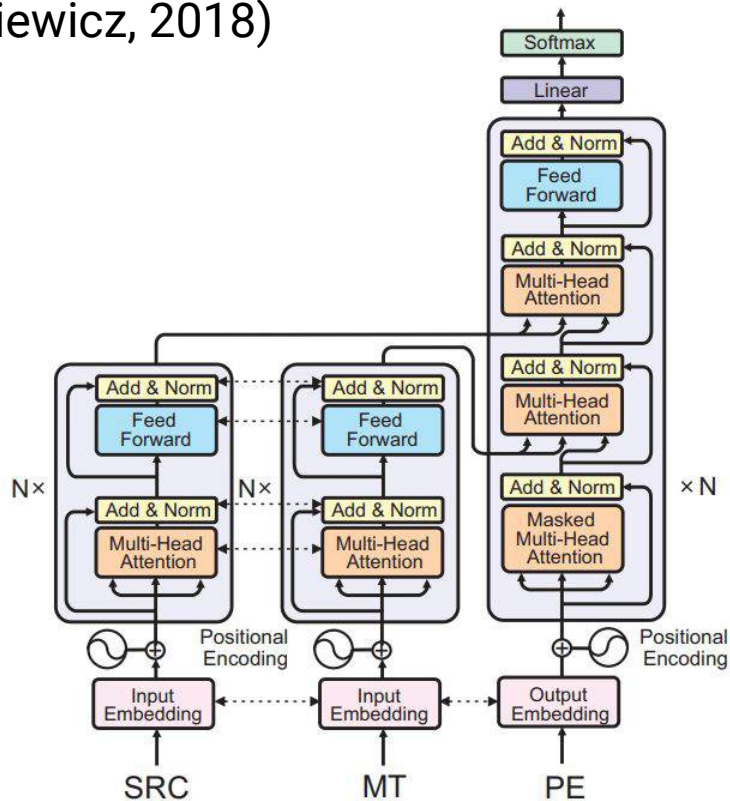
Source	Ça va?
MT	It will?
Post-edit	How are you?

APE

Source	Each flag can be accessed as a property of the regular expression object.
MT	Wählen Sie im Entwurf das zu rotierende Bild aus.
Post-edit	Wählen Sie im Entwurf das zu drehende Bild aus.

Multi-source Architecture

(Dowmunt and Grundkiewicz, 2018)

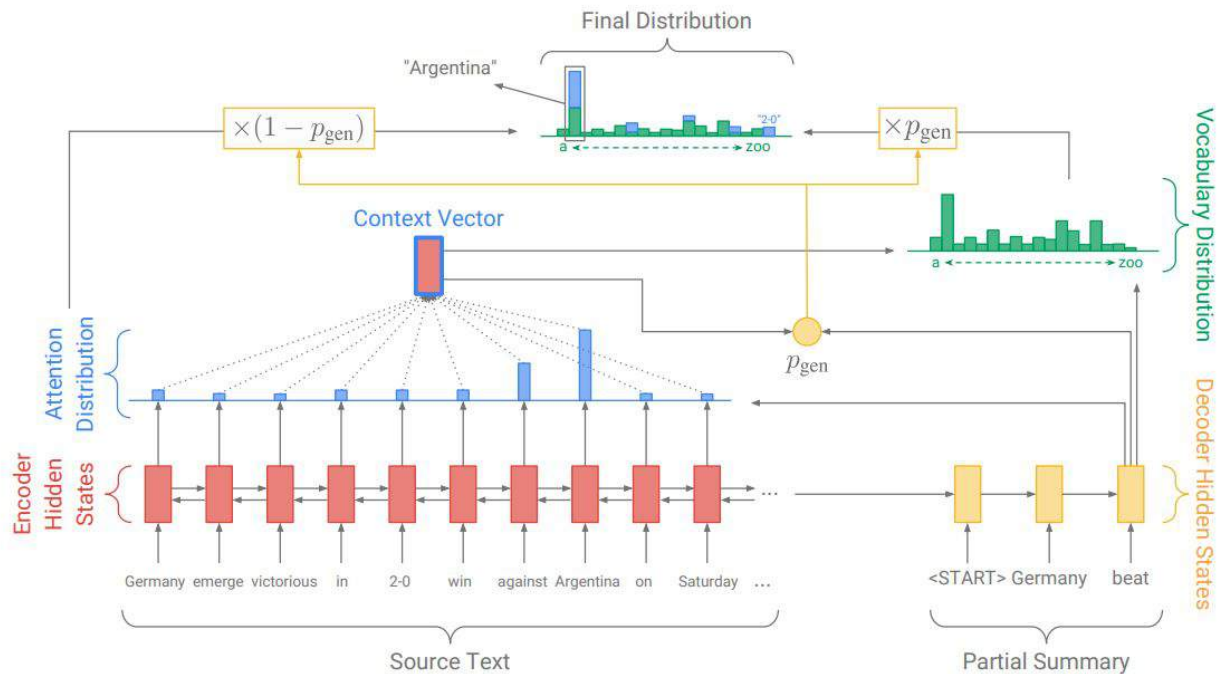


APE with DelibNets

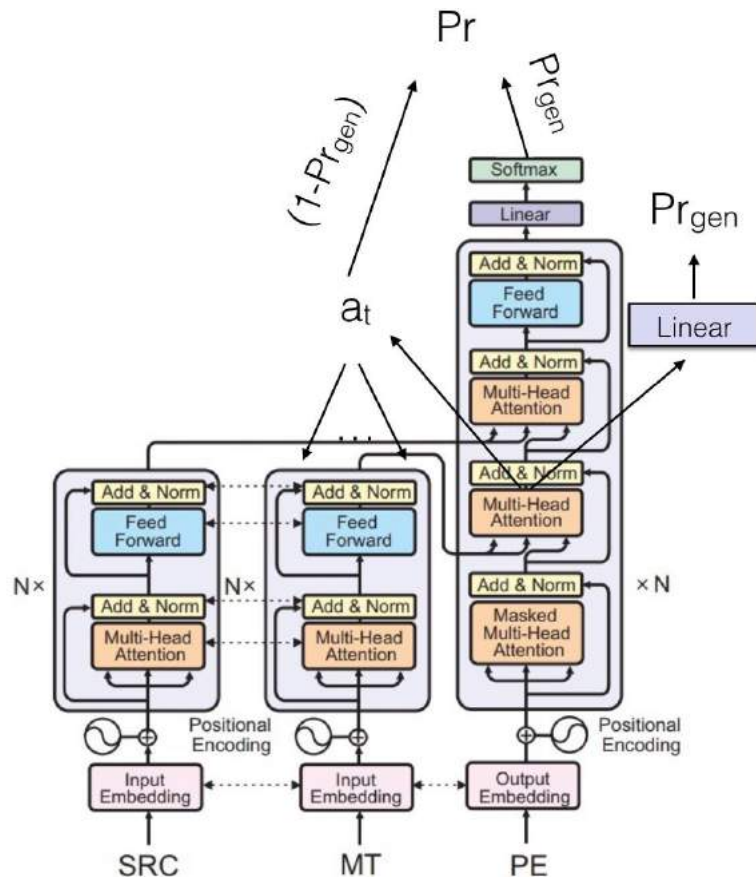
Source	Each flag can be accessed as a property of the regular expression object.
MT	Wählen Sie im Entwurf das zu rotierende Bild aus.
DelibNet	Wählen Sie im Entwurf das Bild aus, das Sie drehen möchten.
Post-edit	Wählen Sie im Entwurf das zu drehende Bild aus.

Pointer-Generator Network

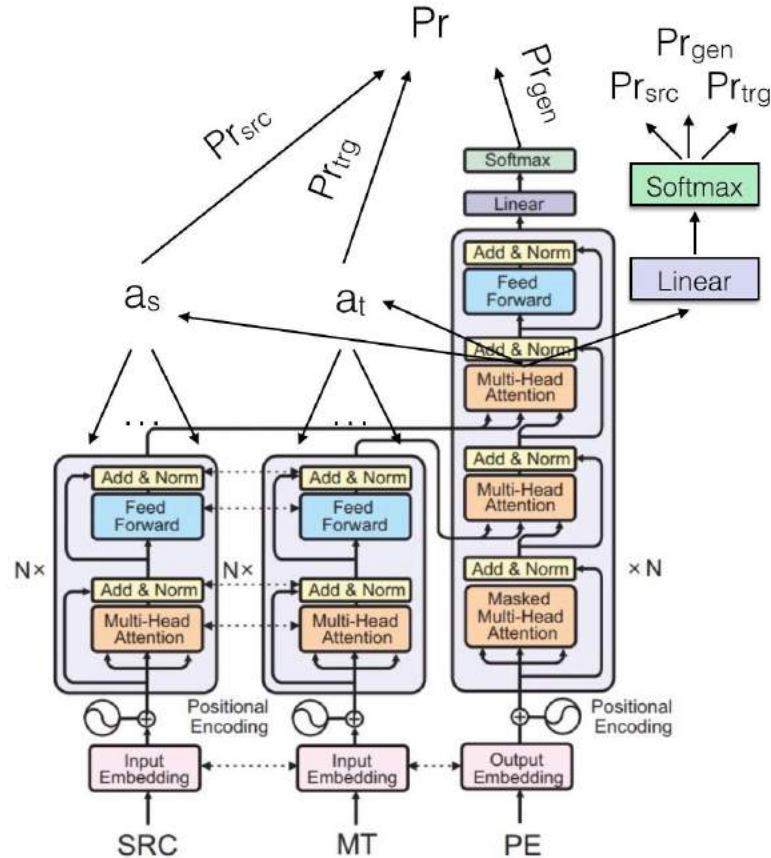
(See et al., 2017)



CopyCat Network



CopyCat Network Double-Attention



APE CopyCat Training

- pre-training with data with random noise mimicking target HTER
- attempts to mimic MT errors
- fine-tuning on actual APE data

Results

	Do Nothing		No Pointer		CopyCat		Dual-Attention CopyCat	
	HTER	BLEU	HTER	BLEU	HTER	BLEU	HTER	BLEU
LV	30.0	59.5	62.5	23.3	29.0	59.8	28.6	59.9
DE	17.8	72.3	18.5	71.2	17.9	72.3	17.8	72.4

Results

- adjusting amount of corrections: 5% of sentences for DE; 22% - for LV
- DE: 60% are positive
- punctual corrections to punctuation, grammar and terminology

Examples

Source	Photomerge has fewer steps.
MT	Die Photomerge hat weniger Schritte.
Copycat	Photomerge hat weniger Schritte.
Post-edit	Photomerge hat weniger Schritte.

Examples

Source	For more information, see Using regular expressions.
MT	Weitere Informationen finden Sie unter Verwenden regulärer Ausdrücke.
Copycat	Weitere Informationen finden Sie unter "Verwenden regulärer Ausdrücke ."
Post-edit	Weitere Informationen finden Sie unter "Verwenden regulärer Ausdrücke ."

Examples

Source	Glivec is also a treatment for children with CML.
MT	Glivec ir arī paredzēts lietošanai bērniem ar HML .
CopyCat	Glivec ir arī paredzēts lietošanai bērniem ar CML .
Post-edit	Glivec lieto arī CML ārstēšanai bērniem.

Experiments with Terminology

- bilingual terminology
- replace good translations in the reference from a lexical translation table
- CopyCat almost restores the reference

Examples

Source	Is it possible to enforce a mediation agreement?
MT	Est-il possible de faire appliquer un avenant de médiation?
Copycat	Est-il possible de faire appliquer un accord de médiation?
Post-edit	Est-il possible de faire appliquer un accord de médiation?

Take-home Message

- translate-and-refine approach with Deliberation nets
- only refine approach with CopyCat nets
- careful choice of architecture depending on the actual need