Low-Resource Neural Machine Translation

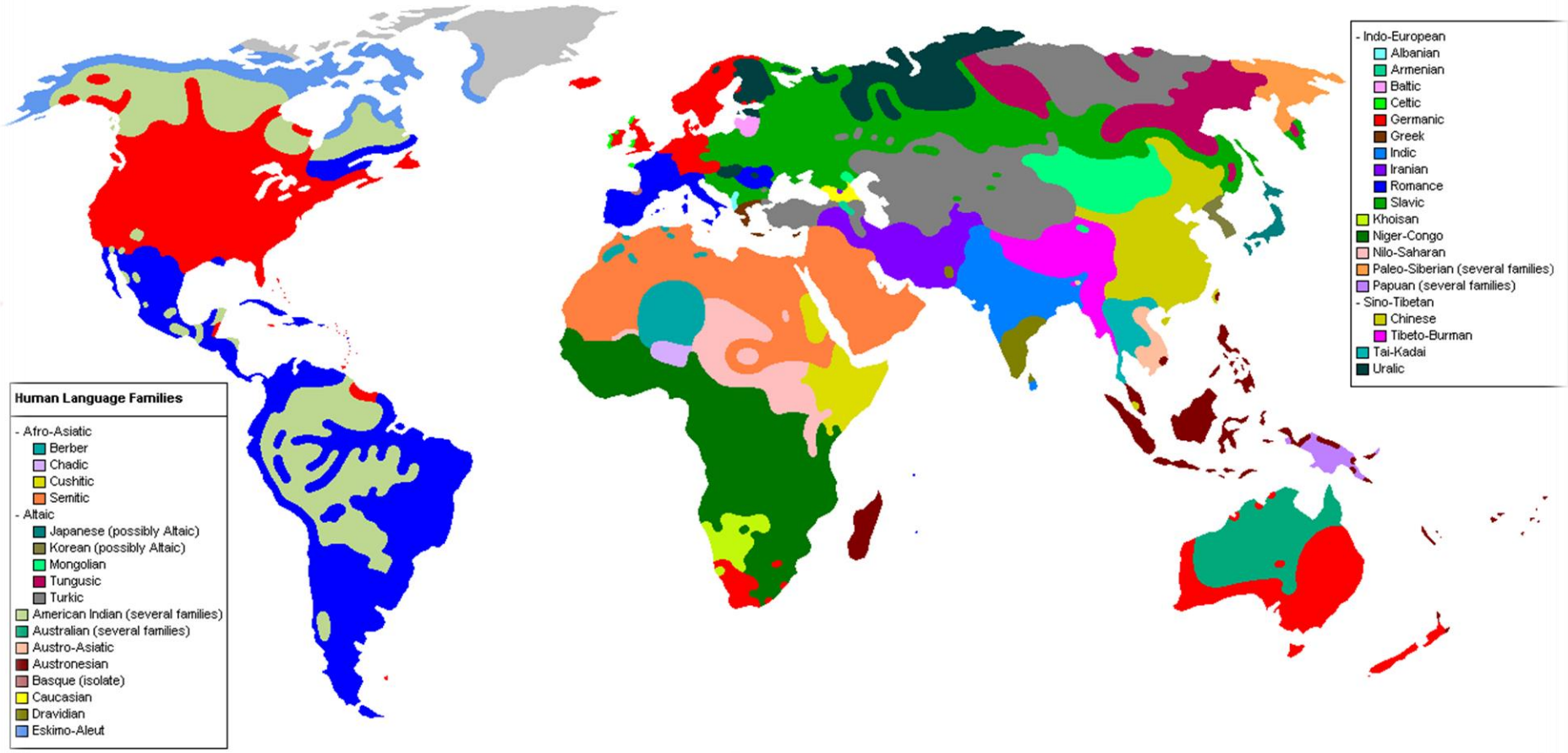
Mieradilijiang Maimaiti

2019.11.12, Beijing (Minzu University of China)

Outline

- Machine Translation
- Related Work and Current State for LRLs NMT
- Motivation
- Our works
- Projects
- Copyrights && Patents
- Conclusions

Cross Lingual Environment

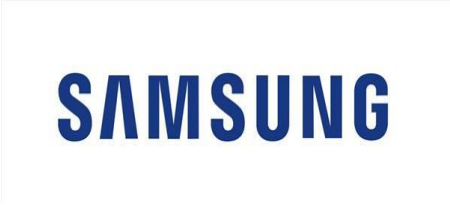


Machine Translation (MT)

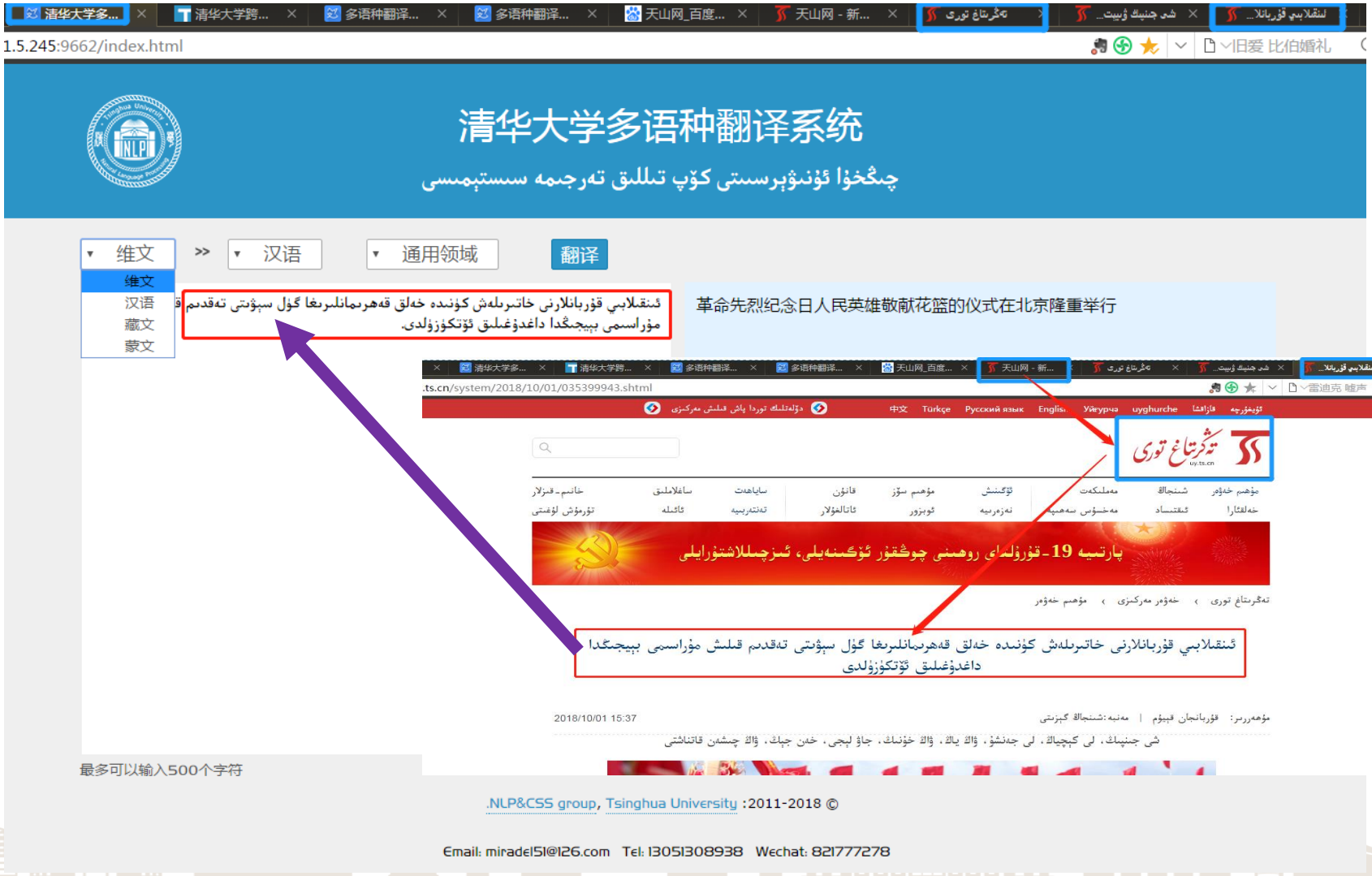
- Machine Translation: let the computer translate the human language, as well as it is a technique that uses a computer to automatically convert one natural language (Source language) to another natural language (target language).

Typical MT Systems

Current State of MT Community



Demo (SMT)


清华大学多语种翻译系统
چېڭخۇا ئۇنىۋېرسىتى كۆپ تىللىق تەرجىمە سىستېمىسى
维文
汉语
通用领域
翻译
革命先烈纪念日人民英雄敬献花篮的仪式在北京隆重举行
最多可以输入500个字符
NLP&CSS group, Tsinghua University :2011-2018 ©
Email: miradel51@126.com Tel: 13051308938 Wechat: 821777278

Demo (NMT)


多语种翻译系统
كۆپ تىللىق تەرجىمە سىستېمىسى
维吾尔语
>>
汉语
通用领域
翻译
群众组成方队，面对的是中共中央。,全国人民代表大会常务委员会,国务院；,全国政协：,中央军事委员会；,各民主党派,全国工商联及无党派爱国人士,各人民团体和各界群众,老战士,老同志和革命先烈的家属。,以中国少先队命名的九个大型花束排列。
最多可以输入500个字符

MT Parallel Corpus

他 喜欢 北京 。

He likes Beijing .

他 在 东京 居住 。

He lives in Tokyo .

日本 的 首都 是 东京 。

The capital of Japan is Tokyo .

北京 是 中国 的 首都 。

Beijing is the capital of China .

… …

他 来自 日本 。

He is from Japan .

日本 临近 中国 。

Japan is near China .

中国 是 亚洲 国家 。

China is an Asian Country .

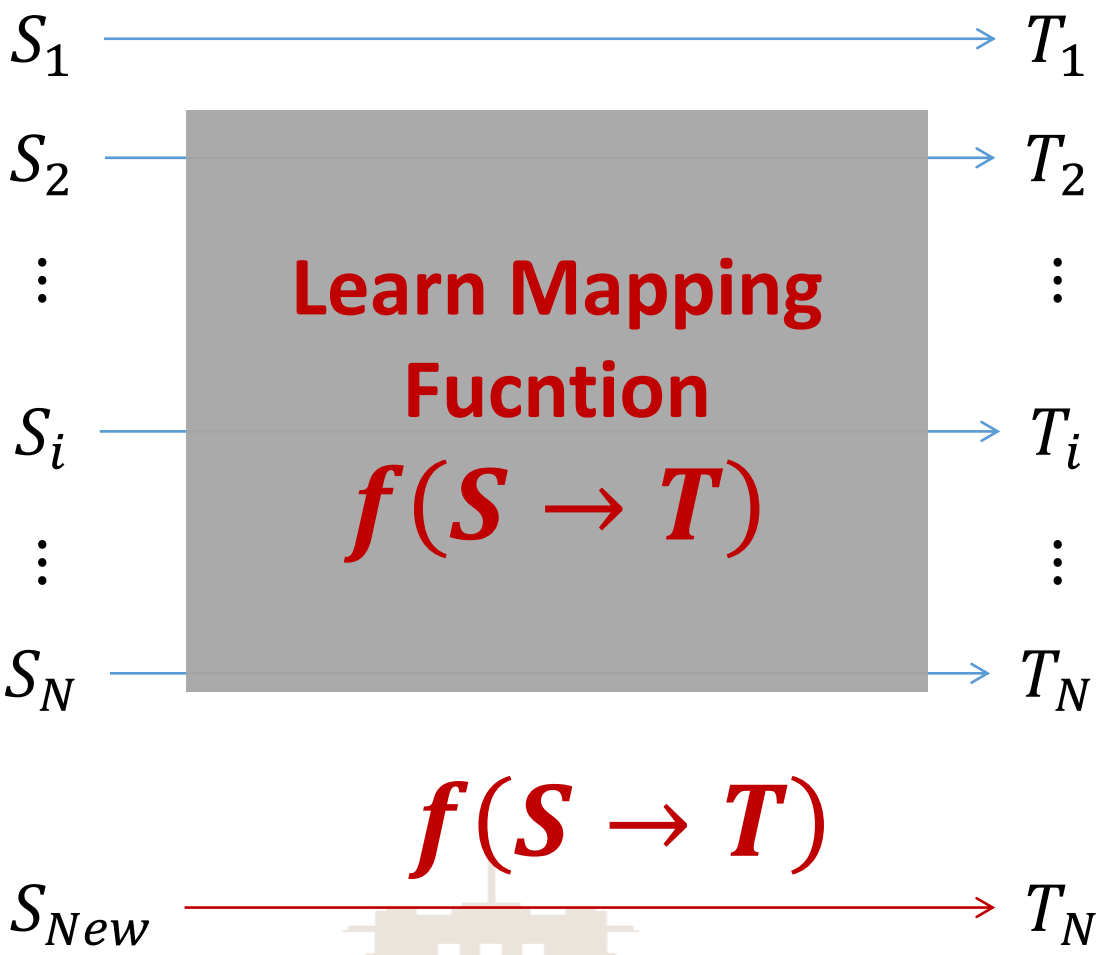
北京 位于 中国 的 北方 。

Beijing is located in the North of China .

… …

(Jiajun Zhang, CCL2018)

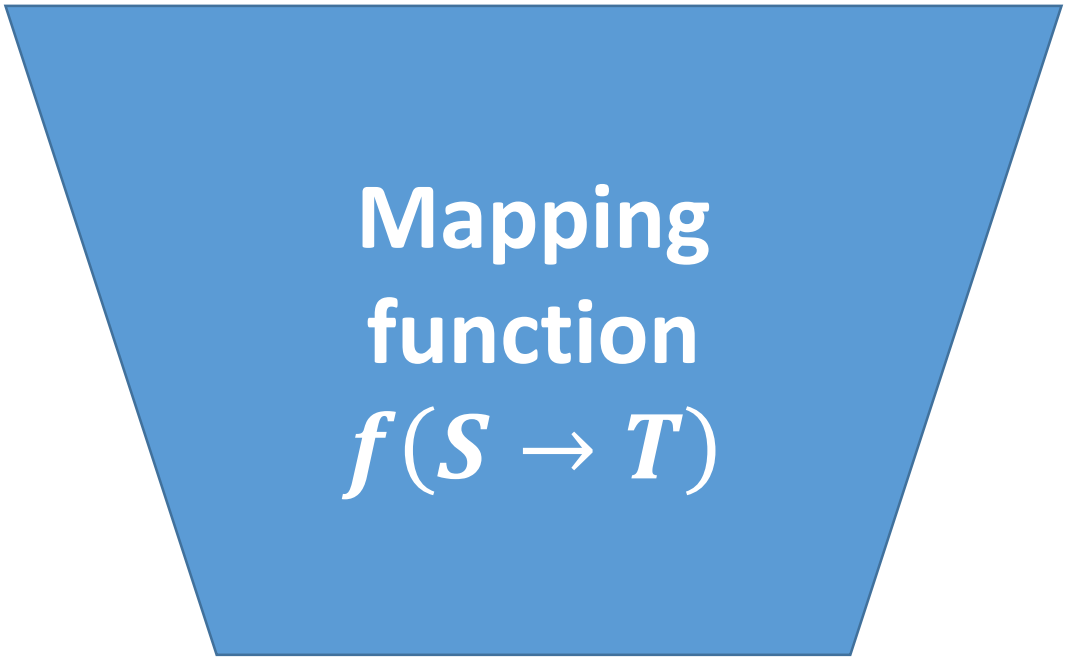
Mapping function from source to target language



(Jiajun Zhang, CCL2018)

Mapping function from source to target language

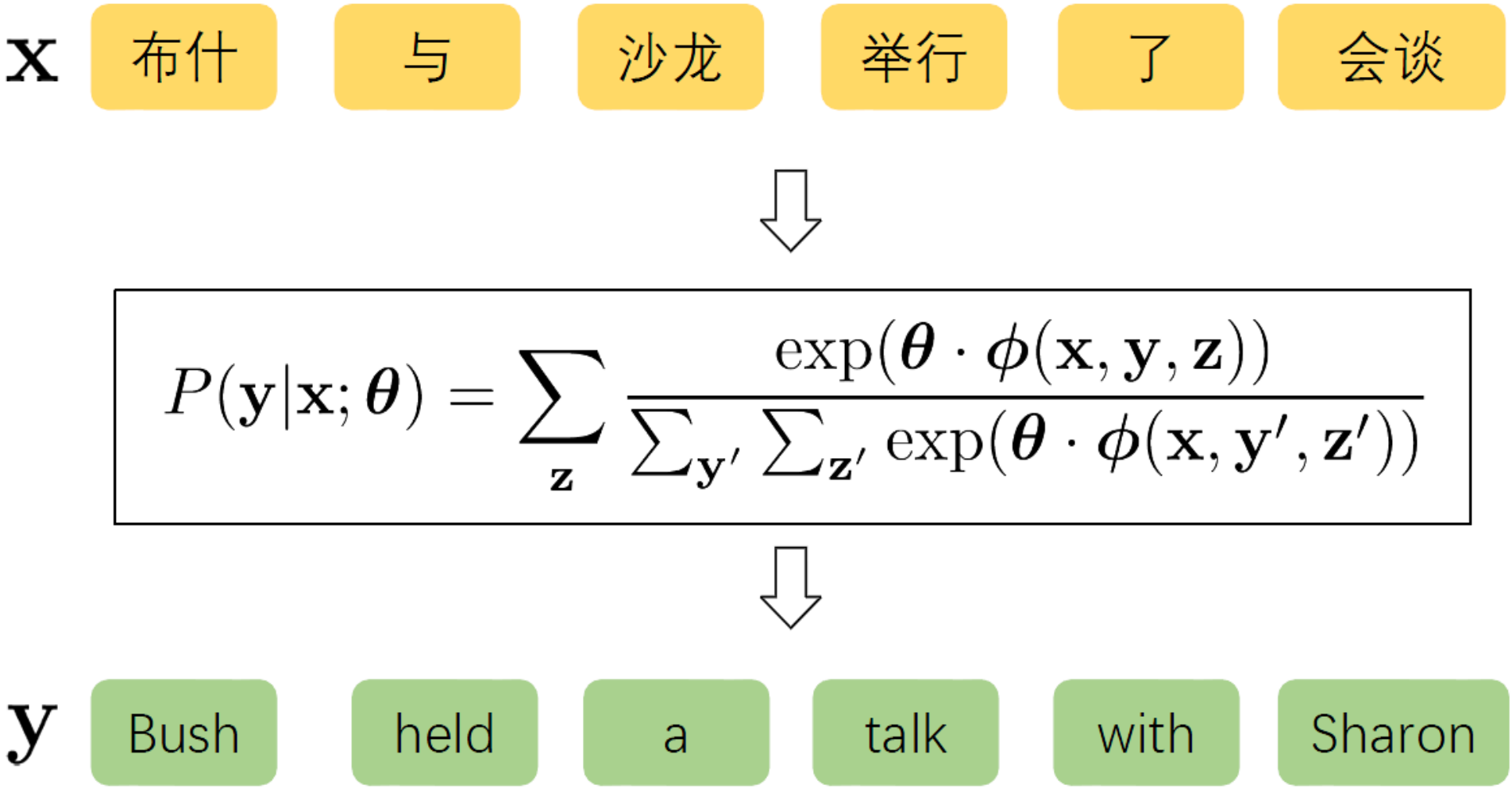
Chinese: 我 在 三星 做了 报告



English: I gave a talk in Samsung

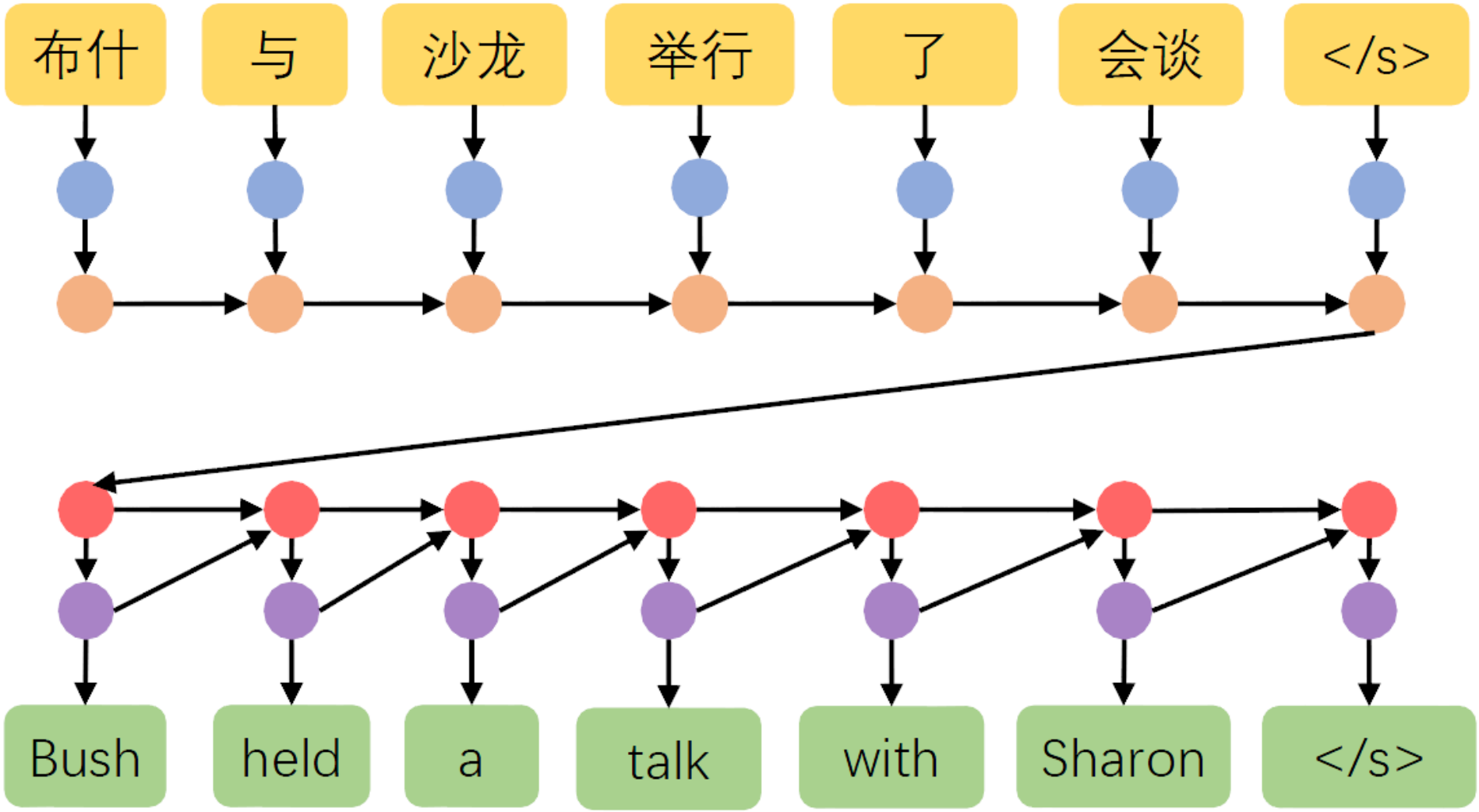
(Jiajun Zhang, CCL2018)

SMT



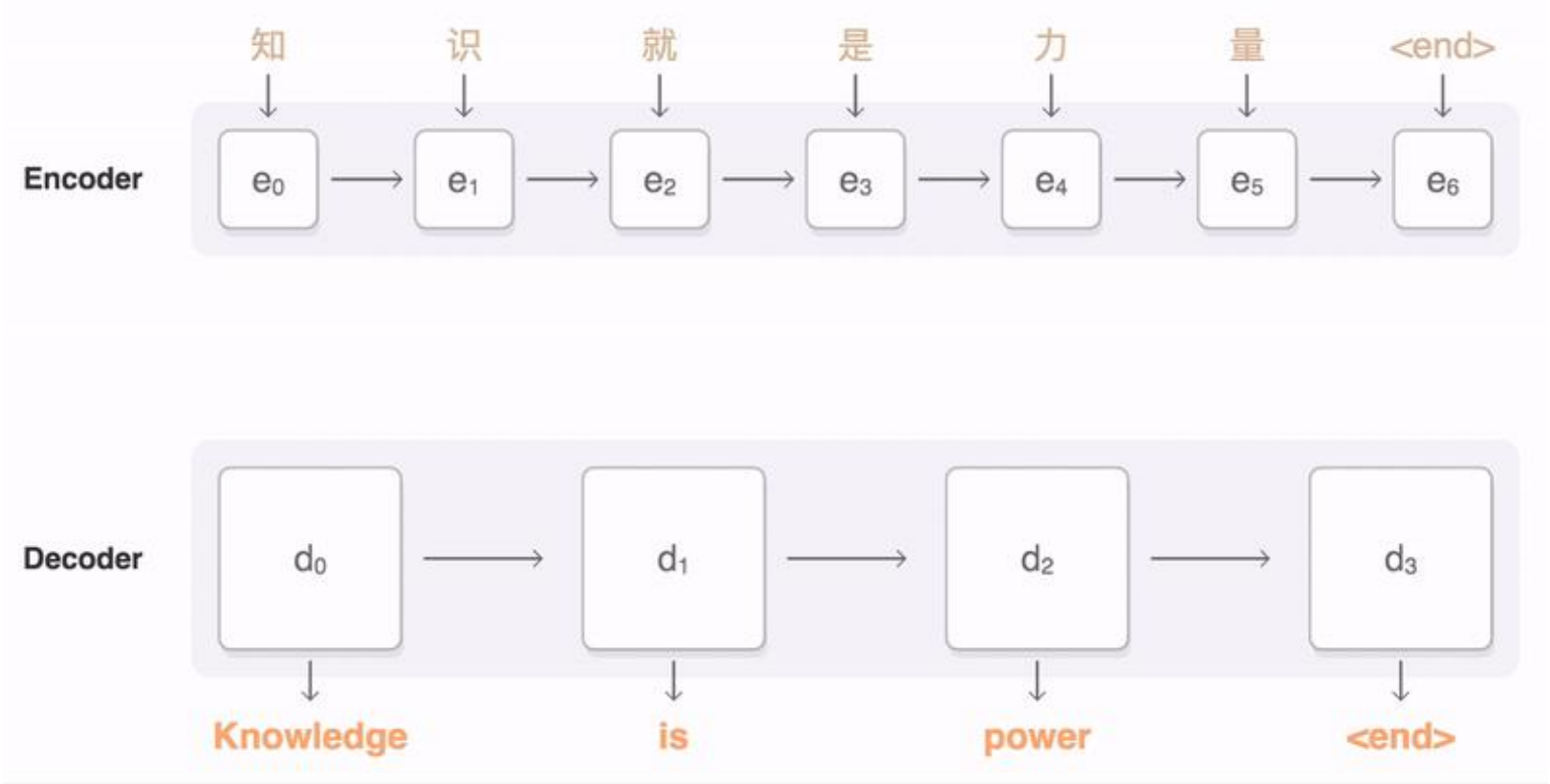
(Och and Ney., 2002)

NMT



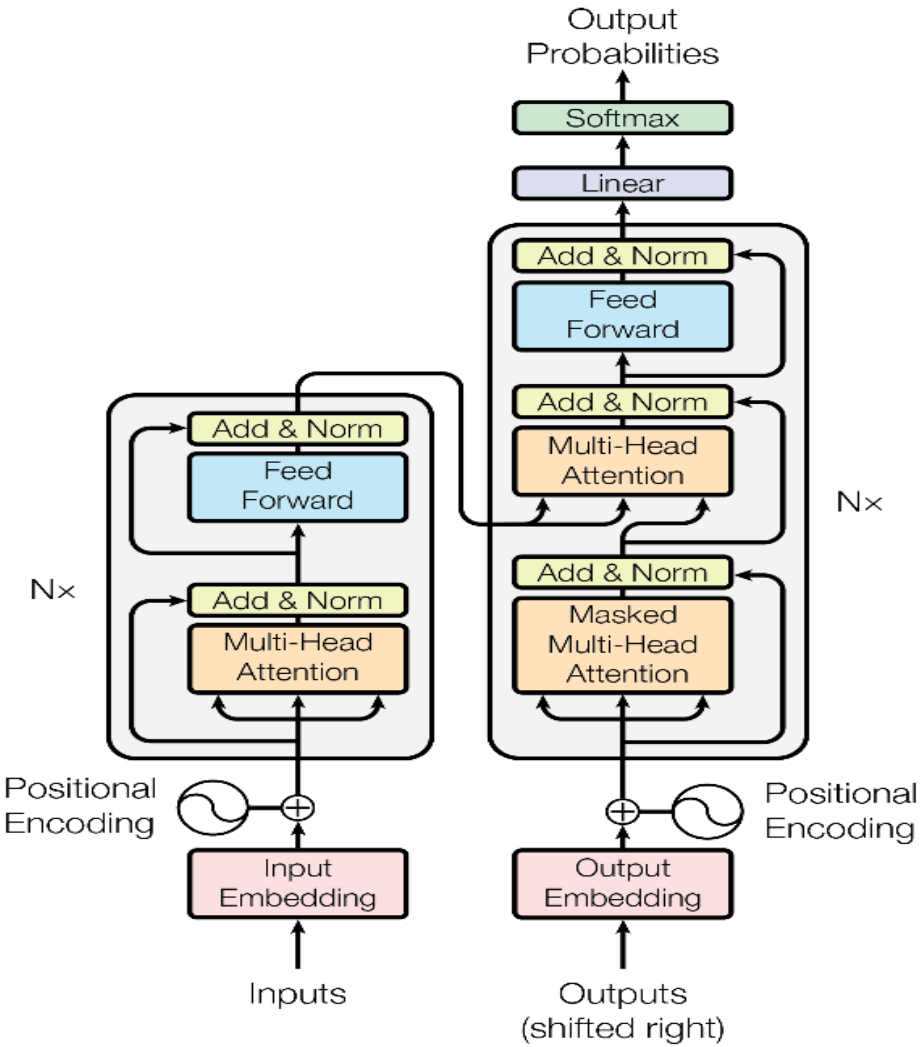
(Sutskever et al., 2014)

NMT - Attention



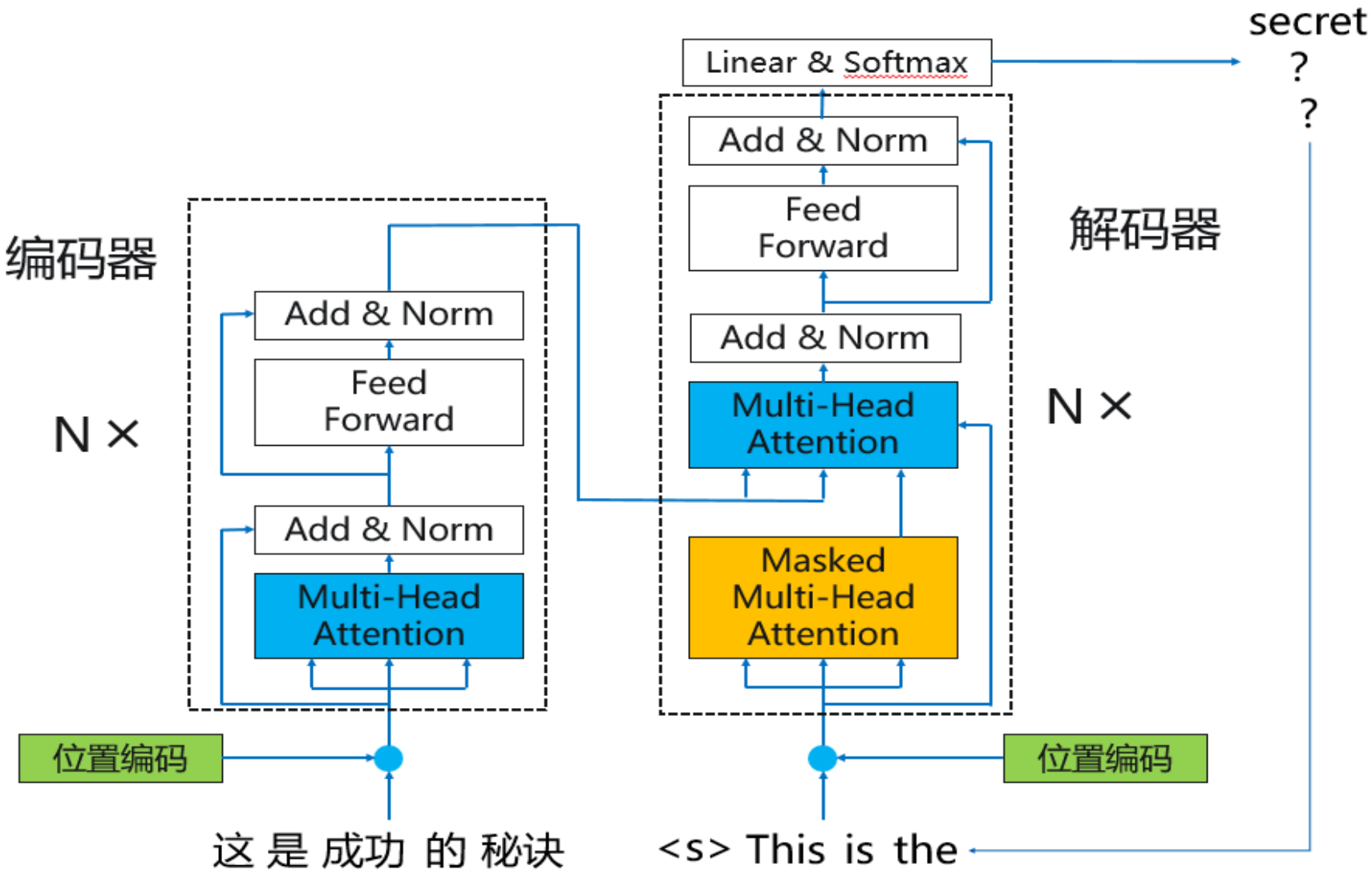
(Wu,et al. 2016)

NMT - Transformer



(Vaswani,et **al. 2017)**

NMT - Transformer



(Guoping Huang, Qcon2018)

Outline

✓Machine Translation

- Related Work and Current State for LRLs NMT
- Motivation
- Our works
- Projects
- Copyrights && Patents
- Conclusions

MT Everywhere

MT Everywhere

MT Everywhere

Some Issues


通用领域
翻译
英文
中文简体
阿拉伯语
土耳其语
维语
天山网讯 10月7日19时15分许
TianShan Network News October 07 19: 15 Split
7 تشرين الأول/ أكتوبر الجلسة 51/ 91
“新闻”翻译成“会议”
“月份”重翻译
Tianshan Network Haber Ekimde 07: 15: 15
日期漏了，时间也不对
تەڭرىتاغ تورى خەۋىرى 8-نىيۇل سائەت 91 دىن 51 مىنۇت ئۆتكەندە باشلاندى
7月8日

Significance of Low Resource MT Research

- Academic value
  - Machine translation is a data-driven task, and it relies heavily on parallel corpora. Therefore, the performance is really good on high resource language pairs, but inferior accuracy on low-resource language pairs.

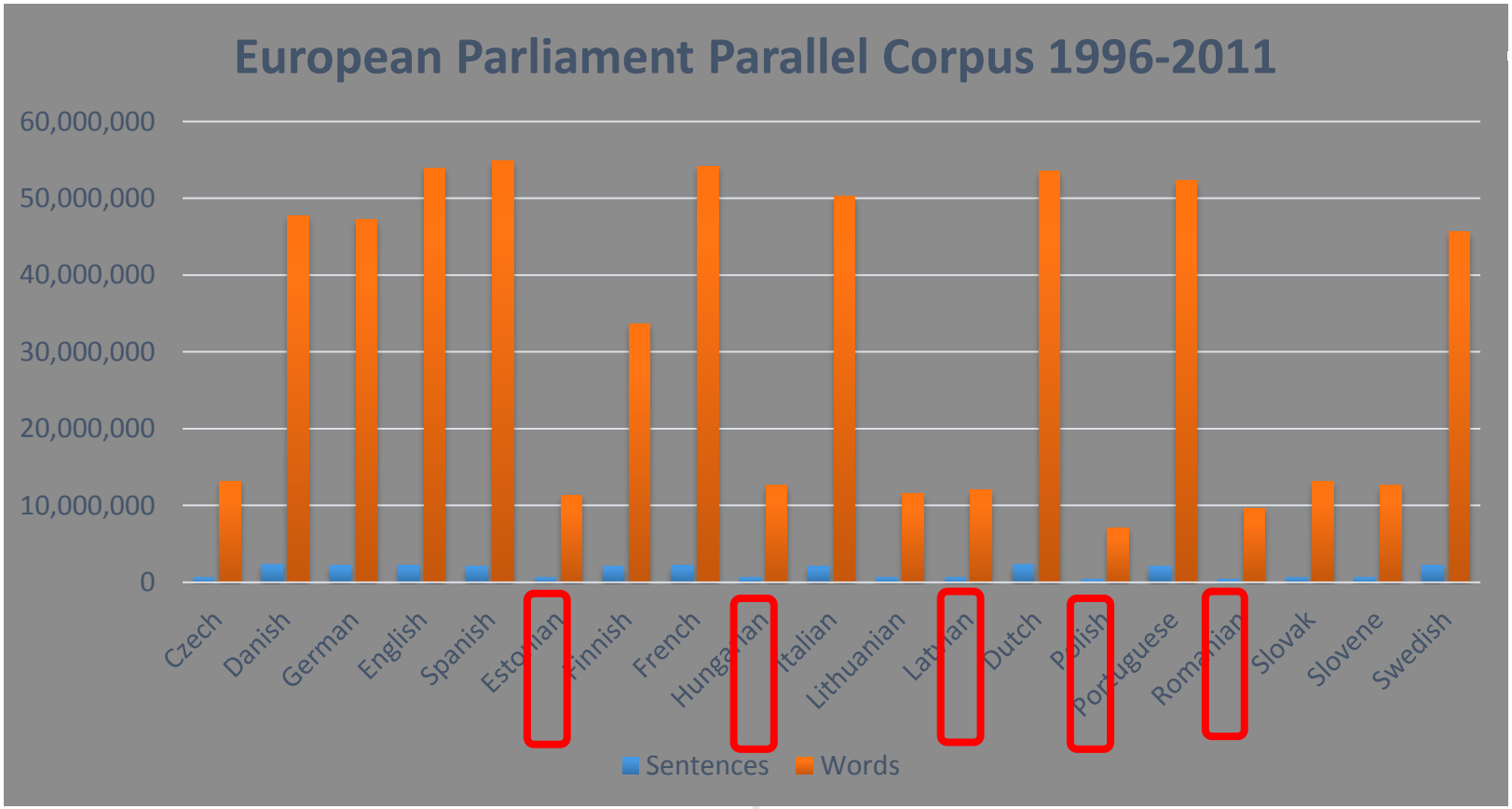
- Application value
  - In the “One Belt One Road” work, there is an urgent need for policy communication, smooth trade, financial access, facility connectivity, shared citizenship and cultural exchanges between 65 countries along the route, especially in Central/East/Western Asia.

Significance of Low Resource MT Research

- Hot topics concerned by academia and industry
- The national languages of many countries are almost morphologically rich low-resource languages.

From: http://www.mrcjcn.com/n/224527.html

Low-Resource Languages (LRLs)



(Koehn, 2005)

Related Work and Current State

- High-resource Languages
- Domain Adaptation
- Morphology Analyzer
- Data Augmentation
- Transfer Learning
- Zero-Shot Learning
- ……

High-resource Languages

- Attention Based Multilingual Encoder

  (Marton *et al.*, 2009; Nakov, *et al.*, 2012; Dong *et al.*, 2015; Zoph and Knight *et al.*, 2016; Thanh-Le *et al.*, 2016 ; Schwenk *et al.*, 2017 ; Johnson *et al.*, 2016 ; G*et al.*, 2018)

- Transfer Learning

  (Wang, *et al.*, 2012; Zoph *et al.*, 2016 ; Zoph *et al.*, 2017b ; Nguyen *et al.*, 2017 ; Chu *et al.*, 2017 ; Passban *et al.*, 2017 ; Dabre *et al.*, 2017; Wang *al.*, 2018)

Domain Adaptation

- Data Selection

  (Foster *et al.*, 2007 ; Zhao *et al.*, 2007; Lü *et al.*, 2007 ; Moore *et al.*, 2010 Axelrod *et al.*, 2011; Lewis *et al.*, 2011; Duh *et al.*, 2013; Chen *et al.*, 2016 ; Ruder *et al.*, 2017)

- Context Information

  (Tiedemann *et al.*, 2010; Gong *et al.*, 2011; Carpuat1 *et al.*, 2013)

- Topic Information

  (Tam *et al.*, 2007 ; Xiao *et al.*, 2012 ; Su *et al.*, 2012 ; Eidelman *et al.*, 2012; Hewavitharana, *et al.*, 2013; Zhang *et al.*, 2014 ; Zhang *et al.*, 2016)

Morphology Analyzer

- Rule Based

  (Maddox *et al.*, 2003; Daybelge *et al.*, 2007; Lignos *et al.*, 2009; Hatem, *et al.*, 2011; Kessikbayeva *et al.*, 2015)

- Traditional Statistical Method

  (Kudo *et al.*, 2004; Creutz *et al.*, 2006; Virpioja *et al.*, 2013; Stig-Arne *et al.*, 2014 ; Kohonen *et al.*, 2010 ; Ruokolainen *et al.*, 2014; Sennrich *et al.*, 2016a)

- Neural Network Method

  (Stuskever *et al.*, 2014; Bahdanau *et al.*, 2015; Wu *et al.*, 2016; Vaswani *et al.*, 2017; Belinkov *et al.*, 2017; Vania *et al.*, 2017; Rajana *et al.*, 2017)

Data Augmentation

- Monolingual Based

  (Koehn *et al.*, 2002; Quirk *et al.*, 2004; Ueffing, *et al.*, 2006; Marta, *et al.*, 2006; Wubben *et al.*, 2012; Gulchere *et al.*, 2015; Sennrich *et al.*, 2016b ; Cheng *et al.*, 2016b ; Zhang *et al.*, 2018)

- Word Level Replacement

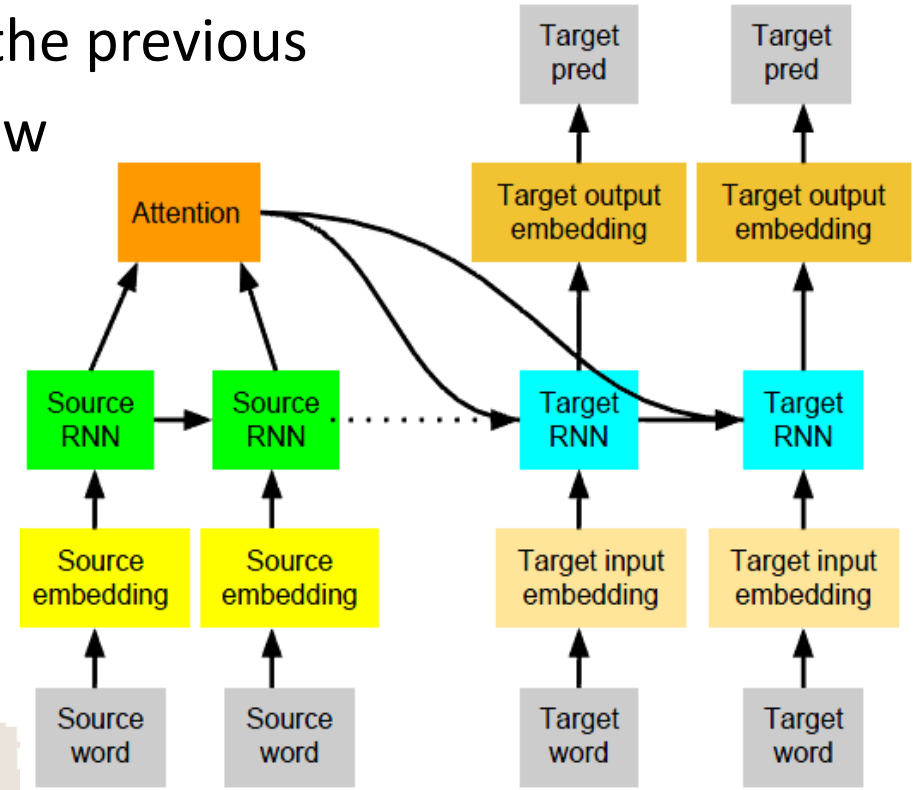
  (Francis *et al.*, 2009; Fadaee *et al.*, 2017 ; Huang *et al.*, 2016; Sennrich *et al.*, 2016c; Ribeiro *et al.*, 2018; Wang *et al.*, 2018)

Challenges for LRLs MT

- Challenges
  - Unable to make efficient use of high resource language issue
  - Specific domain adaptive problem
  - Unable to analyze morphological problems efficiently
  - Syntactic and Semantic error problem after data augmentation

Challenge1-Using High-resource Languages

- (Zoph *et al.*, 2016) exploited the transfer learning on high-resource languages to help LRLs.
- (Passban *et al.*, 2017) based on the previous Idea, by using of one HRLs from tow Different domains.



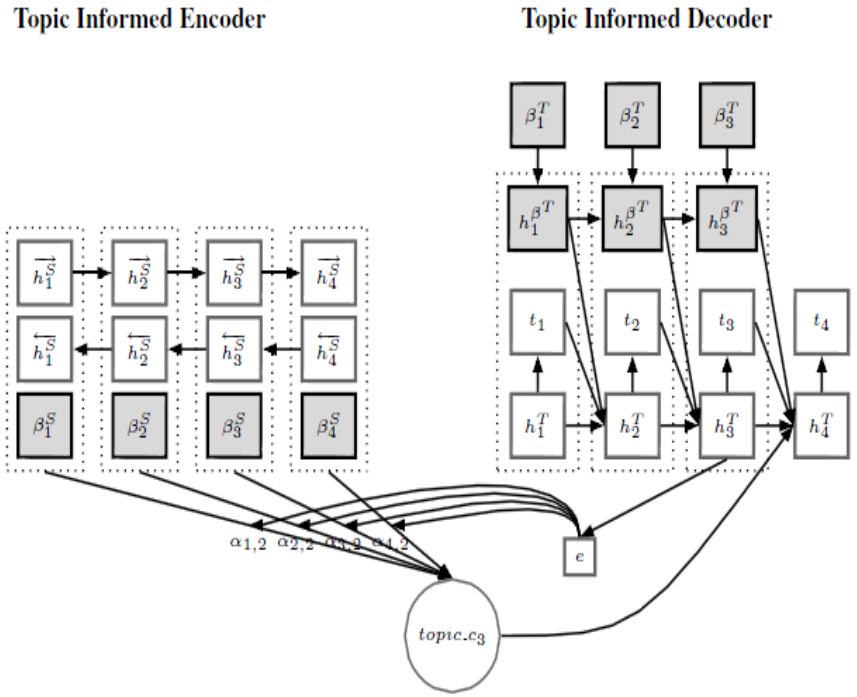
- Issue：
  - Both of them unable to use efficiently multiple HRLs.
  - Ignored character level similarity.

Challenge2-Specific Domain Adaptive issue

- (Zhang *et al.*, 2016) we can regard their idea was fully-supervised method, first learn the topic

Information by using LDA, then

feed them into NMT.



- Issue：
  - Unable to jointly train the topic

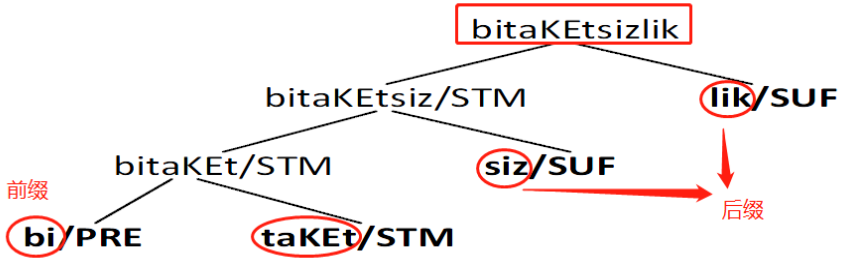
    Information and NMT.
  - Dependently train the topic model

    and time consuming.
  - Hard to set the topic number, heuristically set the topic number both on

    encoder and decoder of NMT.

Challenge3-Inferior Accuracy of Morphological Analyzer

- (Virpioja *et al.*, 2013) exploit the semi-supervised method to segment, and proposed language independent lexicon analyzer Morfessor2.0
- (Sennrich *et al.*, 2016a) used the greedy algorithm to compute the state of each characters to be connected with others, and proposed the BPE.



“bitaKetsizlik”(不耐心的)

- Issue :
  - Unable to coverage the language knowledge
  - Still exist over /imperfect /non segmentation

r · → r·
l o → lo
lo w → low
e r· → er·

{‘low’, ‘lowest’, ‘newer’, ‘wider’}

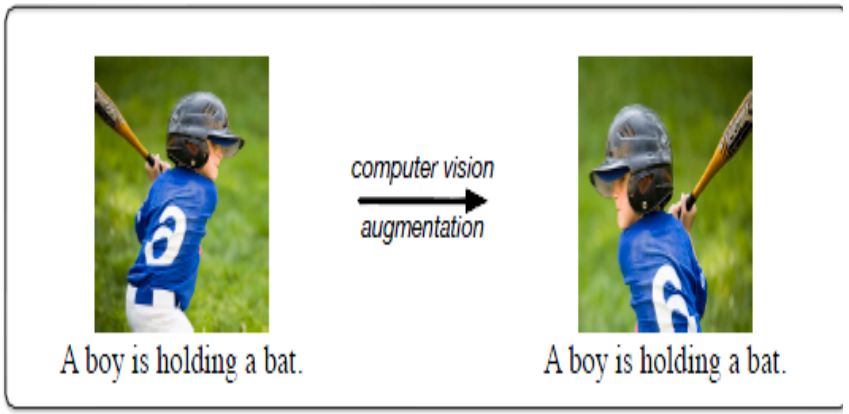
Challenge4-Syntactic and Semantic Errors

- (Fadaee *et al.*, 2017) exploited the very common augmentation method used in CV, namely data augmentation.
- (Cheng *et al.*, 2016b) expand the corpus size via back translation on monolingual data.

Semantics: John waters the [**Plant**/**Bike**]

Syntax: I have three [**bags**/**pencil**]

- Issue:
  - Relied on existed translation model.
  - Unable to address the syntactic and semantic errors efficiently after data augmentation.



original pair

$S : s_1, ..., s_i, ..., s_n$

$T : t_1, ..., t_j, ..., t_m$

augmented pair

$S' : s_1, ..., s'_i, ..., s_n$

$T' : t_1, ..., t'_j, ..., t_m$

Outline

✓Machine Translation

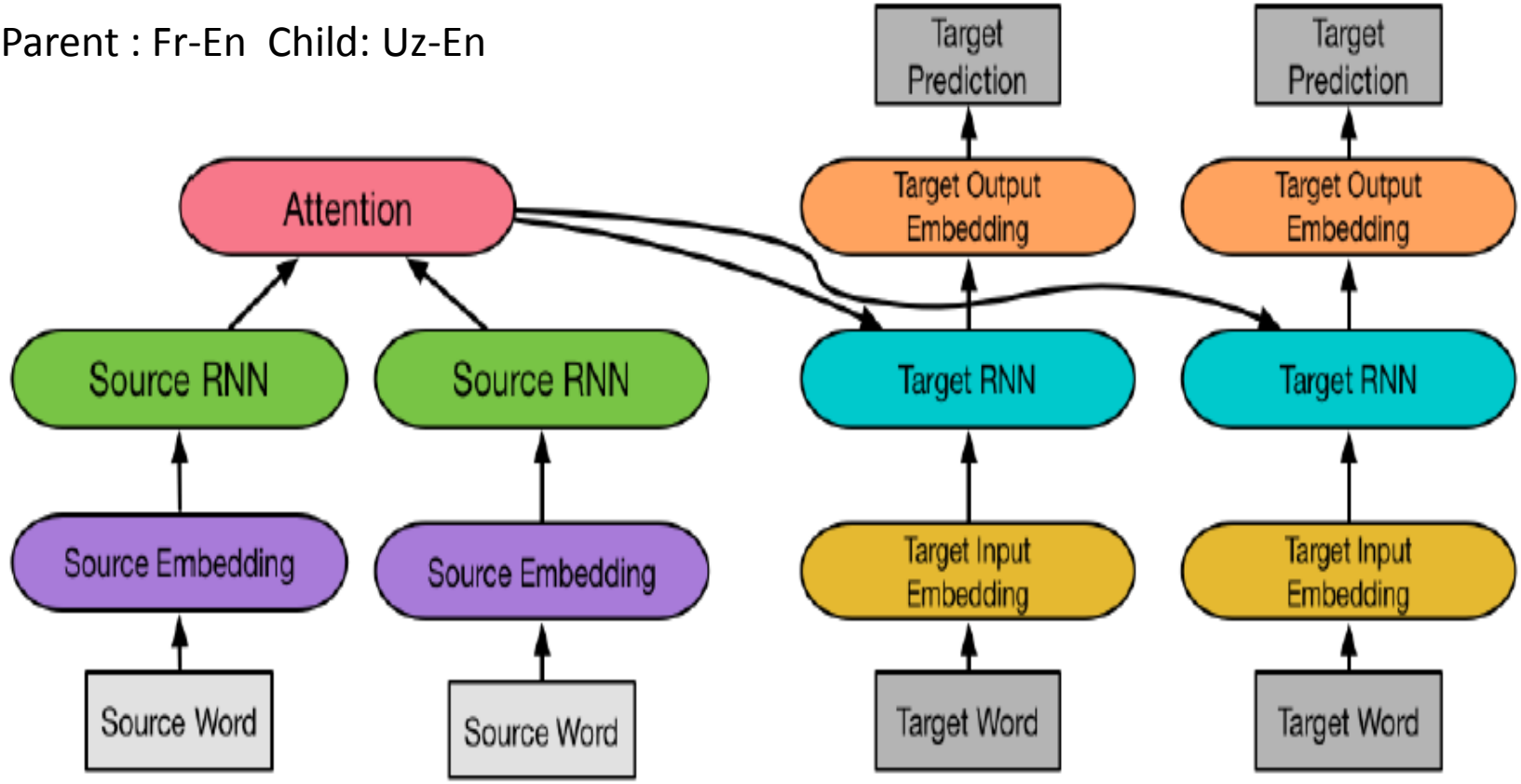
✓Related Work and Current State for LRLs NMT

- Motivation
- Our works
- Projects
- Copyrights && Patents
- Conclusions

Motivation – Transfer Learning

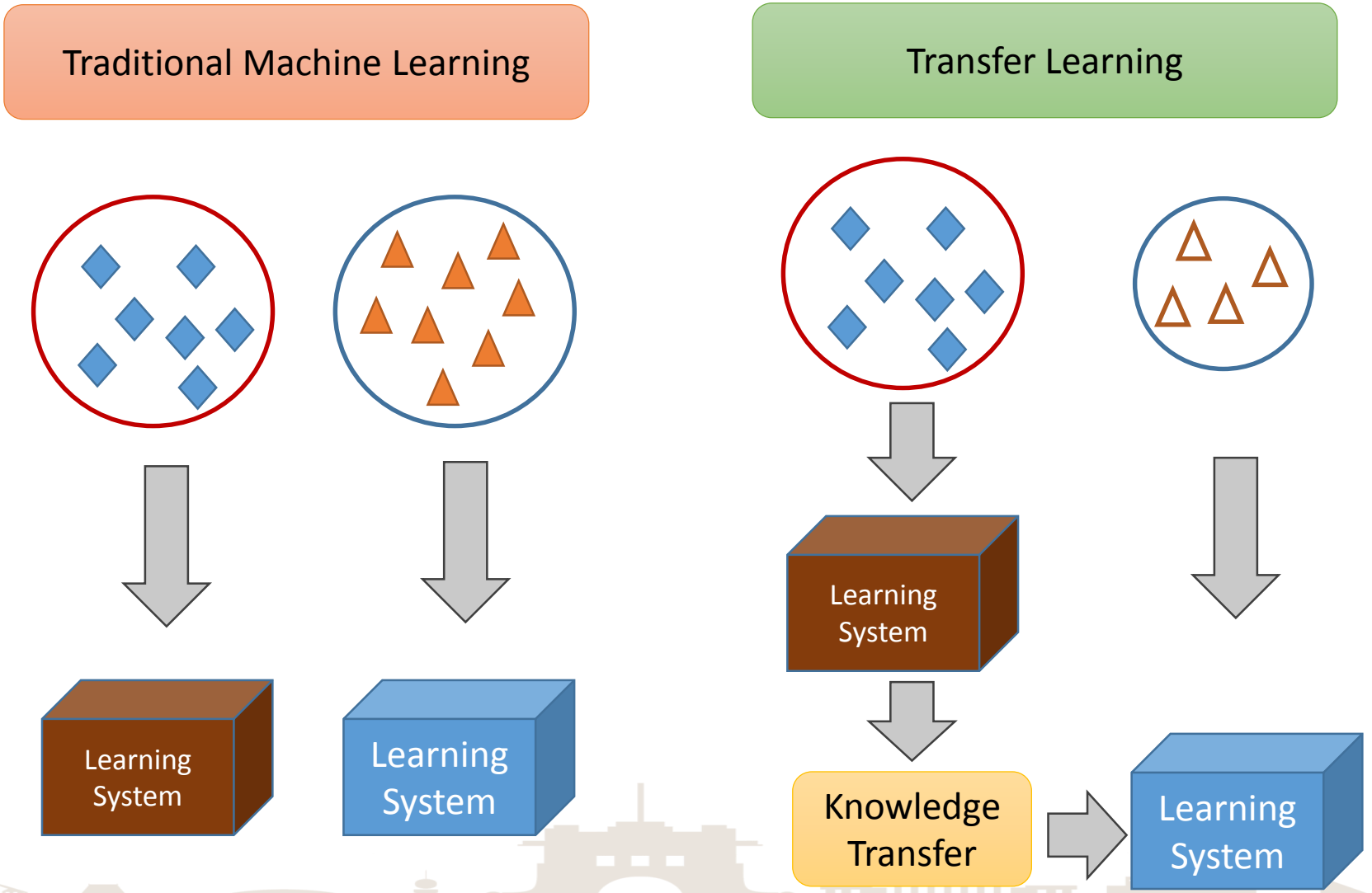
Optimal setting for transferring from **parent** model to **child** model.

Parent : Fr-En Child: Uz-En



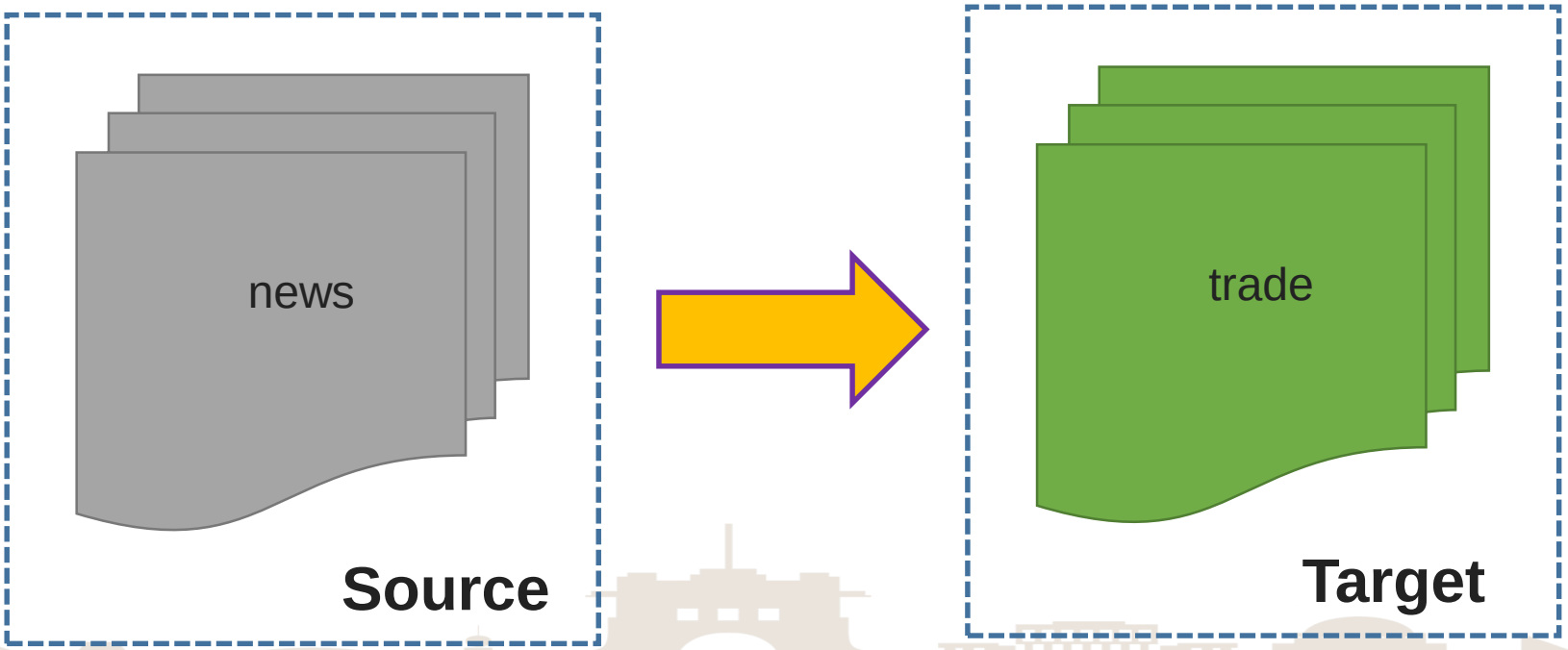
[Barret Zoph et al., 2016]

Transfer Learning && Machine Learning



Transfer Learning – domain adaptation

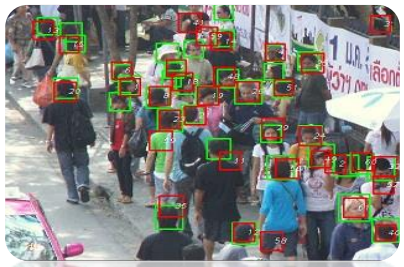
This scenario arises when we aim at learning from a source data distribution a well performing model on a different (but related) target data distribution.



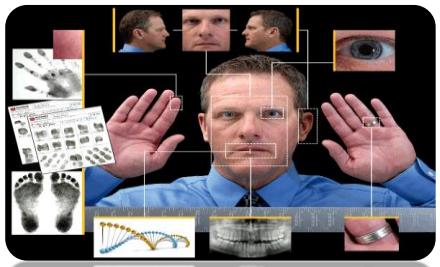
Transfer Learning – domain adaptation

In Natural Language Processing (NLP), train a system on some language data, retune && apply it to specific different task.

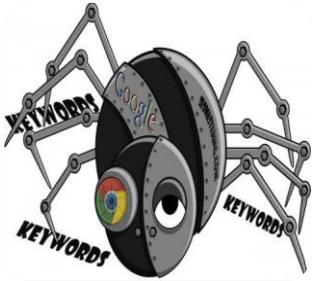
Build speech recognition system using recorded phone calls, then tune it to use as an airline reservation hotline.



CV



ER



IR

ASR

Outline

- ✓Machine Translation
- ✓Related Work and Current State for LRLs NMT
- ✓Motivation
- Our works
- Projects
- Copyrights && Patents
- Conclusions

Multi-Round Transfer Learning for Low-Resource NMT Using Multiple High-Resource Languages

Mieradilijiang Maimaiti[1], Yang Liu[1], Huanbo Luan[1] , Maosong Sun[1]
[1]Department of Computer Science and Technology, Tsinghua University, Beijing, China

Accepted by ACM Transactions on Asian and Low-Resource Language Information Processing (TALLIP), 2019.

Methodology - NMT

- X, Y;Raw source and target sentences.
- Given source sentences $X = x_1, \cdots, x_i, \cdots, x_I$ and target sentence Y= $y_1, \cdots, y_i, \cdots, y_I$
- Standard NMT models usually factorize the sentence-level translation probability as a product of word-level probabilities：
- $P(y|x;\theta) = \prod_{j=1}^{J} P(y_i|x, y_{<j};\theta)$
- θ is model parameters, $y_{<j}$ is partial translation.

Methodology – Transfer Learning

- We take the $L_3 \rightarrow L_2$ as parent and $L_1 \rightarrow L_2$ as child language pair. L_3 and L_1 are source languages of parent and child ,respectively, $L_2$is the target language for both.

- $\theta_{L_3 \rightarrow L_2} = \{< e_{L_3}, W, e_{L_2} >\}$ while e_{L_3} and e_{L_3}source and target embedding of parent model, W is parameters.

- $\hat{\theta}_{L_3 \rightarrow L_2} = \underset{\theta_{L_3 \rightarrow L_2}}{\operatorname{argmax}}\{L(D_{L_3}, \theta_{L_3 \rightarrow L_2})\}$ train the parent model $M_{L_3 \rightarrow L_2}$

- Then fine-tune the child model $M_{L_1 \rightarrow L_2}$ with parent model $M_{L_3 \rightarrow L_2}$:

- $\theta_{L_1 \rightarrow L_2} = f(\hat{\theta}_{L_3 \rightarrow L_2})$, while f is initialization function.

Main Idea

- we aim to deal with the problem of how to make full use of these corpora of highly related multiple languages, to increase the translation quality of the child model.
- Increase the similar even identical words between parent and child language by using unified transliteration method.

Original Transfer Learning

- The original TL transfers parameters of parent model into child model.

$$\theta_{L_3} = \{\langle e_{L_3}, W, e_{L_3} \rangle\}$$

$$\hat{\theta}_{L_3 \to L_2} = \underset{\theta_{L_3 \to L_2}}{\operatorname{argmax}} \{L(D_{L_3 \to L_2}, \theta_{L_3 \to L_2})\}$$

$$\theta_{L_1 \to L_2} = f(\hat{\theta}_{L_3 \to L_2})$$

[Barret Zoph et al., 2016]

Modified Transfer Learning

- The modified TL transfers parameters of parent model into child model from one parent with different domains.

$$\theta_{L_3^{`}\rightarrow L_2} = f(\hat{\theta}_{L_3\rightarrow L_2})$$

$$\hat{\theta}_{L_3^{`}\rightarrow L_2} = \underset{L_3^{`}\rightarrow L_2}{\operatorname{argmax}}\left\{L(D_{L_3^{`}\rightarrow L_2}, \theta_{L_3^{`}\rightarrow L_2})\right\}$$

$$\theta_{L_1\rightarrow L_2} = f(\hat{\theta}_{L_3^{`}\rightarrow L_2})$$

[Passban *et al.*, 2017]

Multi-round Transfer Learning

- The central idea of our proposed MRTL is to encourage the child model receive more information from different parent models.

$$\theta_{L_4 \to L_2} = f(\hat{\theta}_{L_3 \to L_2})$$

$$\hat{\theta}_{L_4 \to L_2} = \underset{\theta_{L_4 \to L_2}}{\operatorname{argmax}} \{L(D_{L_4 \to L_2}, \theta_{L_4 \to L_2})\}$$

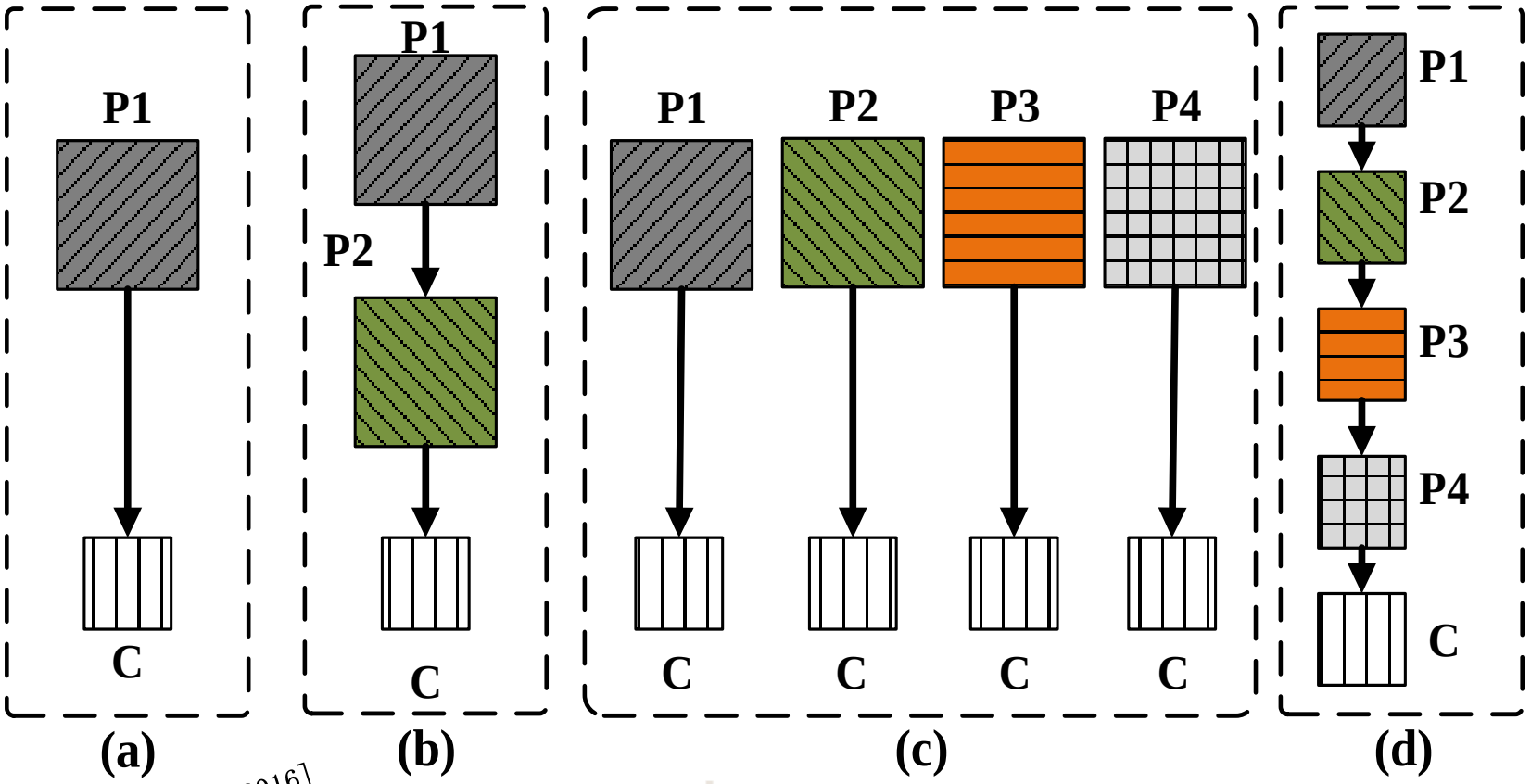
$$\vdots \quad = \quad \vdots$$

$$\theta_{L_{k+1} \to L_2} = f(\hat{\theta}_{L_k \to L_2})$$

$$\hat{\theta}_{L_{k+1} \to L_2} = \underset{\theta_{L_{k+1} \to L_2}}{\operatorname{argmax}} \{L(D_{L_{k+1} \to L_2}, \theta_{L_{k+1} \to L_2})\}$$

$$\theta_{L_1 \to L_2} = f(\hat{\theta}_{L_{k+1} \to L_2})$$

Multi-round Transfer Learning



[Barret Zoph et al., 2016]

[Passban et al., 2017]

This work

Language pairs

Language features of all languages used in our experiments

Language		Family	Group	Branch	Order	Unit	Inflection
Arabic	(Ar)	Hamito-Semitic	Semitic	South	VSO	Word	High
Farsi	(Fa)	Indo-European	Indic	West	SOV	Word	Moderate
Urdu	(Ur)		Iranian	Iranian	SOV	Word	Moderate
Finnish	(Fi)	Uralic	Finno-Ugric	Finnish	SVO	Word	Moderate
Hungarian	(Hu)			Ugric	SVO	Word	Moderate
Turkish	(Tr)	Altaic	Turkic	Oghuz	SOV	Word	Moderate
Uyghur	(Uy)			Qarluq	SOV	Word	Moderate
Chinese	(Ch)	Sino-Tibetan	Chinese	Sinitic	SVO	Character	Light

Corpora

Characteristics of all languages parallel corpora.

Languages	Train	Dev	Test	Source		Target	
				Vocab.	# Word	Vocab.	# Word
Ar → Ch	5.1M	2.0K	2.0K	1.0M	32.2M	0.5M	37.4M
Fa → Ch	1.4M	2.0K	1.0K	0.2M	10.4M	0.2M	10.0M
Ur → Ch	78.0K	1.0K	1.0K	17.6K	2.6M	12.7K	2.4M
Fi → Ch	2.8M	2.0K	1.0K	0.7M	18.4M	0.3M	23.1M
Hu → Ch	4.1M	2.0K	1.0K	1.0M	30.4M	0.5M	32.5M
Tr → Ch	4.4M	2.0K	1.0K	0.7M	30.6M	0.5M	35.9M
Uy → Ch	46.3K	1.0K	1.0K	73.5K	1.1M	42.1K	11.2M

The "Vocab." and "# Word" represent vocabulary (word type) and word token, respectively

Shared words

The shared words between each languages

	Ar	Fa	Ur	Fi	Hu	Tr	Uy
Ar		11.49%	8.31%	0.52%	0.45%	0.73%	0.77%
Fa	2.34%		8.29%	0.27%	0.30%	0.32%	0.57%
Ur	0.15%	0.75%		0.01%	0.01%	0.03%	0.11%
Fi	0.36%	0.94%	0.53%		2.74%	3.80%	0.50%
Hu	0.45%	1.46%	0.70%	3.85%		5.07%	0.75%
Tr	0.57%	1.22%	1.14%	4.22%	4.01%		2.47%
Uy	0.06%	0.21%	0.47%	0.05%	0.06%	0.24%	

The Ar, Fa, Ur, and Uy are converted with proposed unified transliteration method. Besides, shared word rate calculated as the division of shared word numbers to word type counts of the language in each column.

Methodology – Unified Transliteration

The shared words between each languages

Language	Original	Latin	Chinese	English	Unified
Ar	مدرسة	maktab	学校	School	mektep
Uy	مەكتەپ	mektep			
Tr	okul	mektep			
Fa	باغ وحش	bağça	果园	Orchard	bağça
Uy	باغچا	bağça			
Tr	bahçesi	bahçe			
Ar	غرفة القراءة	qiraaaatxana	阅览室	Reading room	qiraetxana
Fa	اتاق مطالعه	qiraaaat xana			
Tr	Okuma odası	kıraathane			
Uy	قىرائەتخانا	qiraetxana			

The second column “Original" represents prototype scripts of corresponding languages. Besides, the last column “Unified" stands for the converted format with unified transliteration method.

Methodology – Unified Transliteration

Algorithm 1: Unified Transliteration Method

Input: the source side monolingual sentences $D_{sm} = \{x_{sm}^{m}\}_{m=1}^{M}$ of parent (child).
Output: the transliterated word sequence in current sentences D'_{sm}.
/* Initialize the variables. */
$Current_l \leftarrow$ the word sequence in current line among D_{sm};
$Output_c \leftarrow$ the transliterated word sequence in current line among D'_{sm};
Read the source side monolingual sentences D_{sm} of parent (child);
for *each line in* D_{sm} **do**
  /* the current line should be decoded as ''utf-8''. */
  $Current_l \leftarrow$ each line.decode('utf-8');
  /* split the current line with white space and save them as a list. */
  $Current_l \leftarrow Current_l$.strip().split();
  for *each word in* $Current_l$ **do**
    for *each char in each word* **do**
      /* check each char from the manually prepared mapping table. */
      each $char_{latin} \leftarrow$ each char;
    end
    /* check the each word if contains same repeated char continually. */
    if *Is Contain repeated char in each* $char_{latin}$ **then**
      compare the length of $Current_l$ and the length of Latinized $Current_l$;
      remove repeated each $char_{latin}$ from each word;
    end
    convert them into unified form sequentially;
    each word $\leftarrow$ sums of unified chars after removing repeated chars;
    final word $\leftarrow$ each word ; /* reserve the final word. */
  end
  $Output_c \leftarrow$ the joint sequence of final words with white-space
end

Experiment

- System : THUMT
- Parameters：
  - Dropout 0.1
  - Word Embedding 620
  - Hidden State 1000
  - Vocabulary **: source 3w, target 29k**
- Other parameter we use the default parameters of THUMT
- Preprocess
  - Clear data use NiuTrans , Chinese segmenter use THULAC
  - Some processing tools designed by us

Experiment

- GPU: 4
- GPU type: NVIDIA TITAN X (Pascal)
- Training time : less than 3-4 days (include fine-tuning)
- Corpus :
  - Parent : Open Subtitle2016 and Tanzil corpora
  - Child : Chinese-LDC (CLDC) corpus
- UNK replace : NO
- BPE : Yes

Experiment

The Effect of unified transliteration method for MRTL.

Method	Round	Parent	Child	BLEU
TRANSFORMER	R=0	N/A		28.28
MRTL (Original)	R=1	Ur → Ch	Uy → Ch	10.29
		Fa → Ch		28.83
		Ar → Ch		30.64^{++}
MRTL (Unified)		Ur → Ch		10.93^{*}
		Fa → Ch		29.96^{++**}
		Ar → Ch		31.64^{++*}

Experiment

The Effect of corpus size to child model in single fine-tuning.

Method	Parent	Child	BLEU
TRANSFORMER	N/A		28.28
MRTL (R=1)	Tr → Ch (0.5M)	Uy → Ch	29.89^{++}
	Tr → Ch (2.4M)		$30.88^{++\flat}$
	Tr → Ch (4.4M)		$32.74^{++\natural}$

The effect of parent language pairs to

Method	Parent	Child	BLEU
TRANSFORMER	N/A		28.28
MRTL (R=1)	*Ur* → *Ch*	Uy → Ch	10.93
	Fa → *Ch*		29.96^{++}
	Fi → *Ch*		30.85^{++}
	Tr → Ch (2.4M)		$30.88^{++\star}$
	Ar → *Ch*		$31.64^{++\star}$
	Hu → *Ch*		$32.41^{++\circ}$
	Tr → Ch (4.4M)		$32.74^{++\dagger}$

Experiment

Parent Language Selection

Different language **family**

MRTL	Parent	Family	Domain	Size	Child	BLEU
R=0	N/A	Altaic	CLDC	46.3K	Uy → Ch	28.28
R=1	Hu → Ch	Uralic	Open Subtile	4.1M		32.41^{++}
	Tr → Ch	Altaic				32.58^{++}

Different **domain**

MRTL	Parent	Family	Domain	Size	Child	BLEU
R=0	N/A	Altaic	CLDC	46.3K	Uy → Ch	28.28
R=1	Ur → Ch	Indo-European	Tanzil	78.0K		10.93
	Fa → Ch		Open Subtitle			24.27

Different **corpus size**

MRTL	Parent	Family	Domain	Size	Child	BLEU
R=0	N/A	Altaic	CLDC	46.3K	Uy → Ch	28.28
R=1	Fi → Ch	Uralic	Open Subtile	2.8M		30.85^{++}
	Hu → Ch			4.1M		32.41^{++}

Experiment

The Effect of MRTL.

Method	Round	Parent	Child	BLEU
TRANSFORMER	R=0	N/A	Uy → Ch	28.28
MANY-to-ONE				32.43^{++}
MRTL	R=1	Tr (4.4M) → Ch		32.03^{++}
	R=2	Tr (4.4M), (2.4M) → Ch		32.54^{++}
	R=3	Tr (4.4M), (2.4M), Fi → Ch		$33.54^{++‡*}$
		Tr (4.4M), (2.4M), Fi, Hu → Ch		33.66^{++**}
	R=4	Ar (Unified), Tr (4.4M), Hu, Fi → Ch		33.73^{++**}
		Tr (4.4M), Ar (Unified), Hu, Fi → Ch		33.91^{++**}

Conclusions

- We address the **drawbacks of TL**, which exploits only one parent to optimize the child model at a time.
- We mitigate the gap between parent and child language pairs at the **character** level.
- We achieve **transparency** in network architectures, as well as in our method for neural network architecture.
- We observe meaningful discovery **by sharing both** source side and target side embeddings of parent models.

Discussion on Bilingual Cognition in International Exchange Activities

Mieradilijiang Maimaiti[1] and Xiaohui Zou[1]
[1]Department of Computer Science and Technology, Tsinghua University, Beijing, China
[2] Sino-American Saerle Research Center, Beijing, China

ICIS2018, Beijing

How to Understand: Three Types of Bilingual Information Processing?

Mieradilijiang Maimaiti[1] ,Shunpeng Zou[2],Xiaoqun Wang[3] and Xiaohui Zou[234]
[1]Department of Computer Science and Technology, Tsinghua University, Beijing, China
[2] China University of Geosciences (Beijing) 29 Xueyuan Road, 100083, China
[3] Audio-Visual Building, Room 415, Peking University, 100871 Beijing, China
[4]Sino-American Searle Research Center, UC Berkeley 94720-3840, USA

ICCSIP2018, Beijing

Motivation: human-machine translation

Source sentence:

At the meeting on UN Operational Activities for Development, Wang also stressed that developed countries should bear the primary responsibility for financing for development.

Machine translation:

联合国发展业务活动的一次会议上，王汉斌还强调，发达国家应发展筹资问题负有主要责任。

Quality Estimation ⇩ Editing

Final translation:

在联合国发展业务活动的会议上，王还强调，发达国家在发展筹资问题上应负主要责任。

(Guoping Huang, Qcon2018)

Motivation: human-machine translation

Source sentence:

At the meeting on UN Operational Activities for Development, Wang also stressed that developed countries should bear the primary responsibility for financing for development.

Human partial input:

在联合国发展业务活动的

Human-machine interact translation:

在联合国发展业务活动的一次会议上，王汉斌还强调，发达国家应发展筹资问题负有主要责任。

Repeated interaction

Final translation:

在联合国发展业务活动的会议上，王还强调，发达国家在发展筹资问题上应负主要责任。

(Guoping Huang, Qcon2018)

Methodology – three types of bilingualism

- Narrow bilingualism
  - Chinese – English
- Alternative bilingualism
  - Terminologies and popular sayings
- Generalized bilingualism
  - Mathematical language of arithmetic numbers and natural language of Chinese characters

Methodology

- Replacing
- Switching
- Dropping
- Editing
- Adding

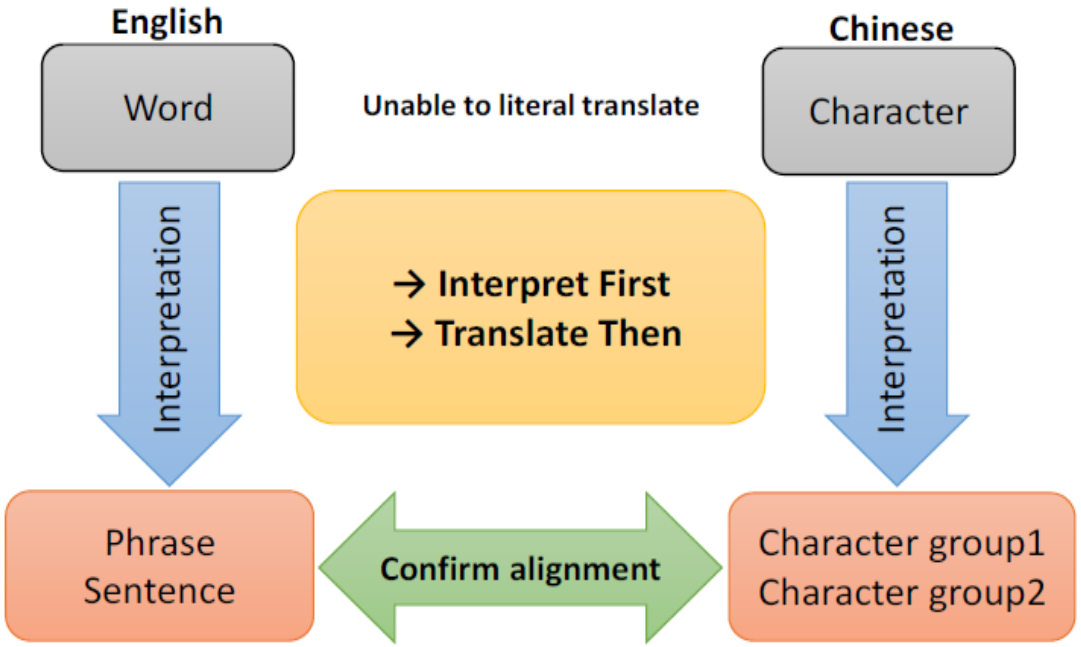


Fig. 1. The sketching graph for narrow bilingual information processing model.

Methodology

Algorithm 1 Bilingual Information Processing.

Input: Given bilingual corpus L, $L = \{\langle \mathbf{x}^{(n)}, \mathbf{y}^{(n)} \rangle\}_{n=1}^{N}$

Output: translation result y

1: **for** $t = 1, 2, 3, 4, 5, ..., N do$ **do**
2: Generate "Phrase Set" and modify sentence structures
3: Select some words and modify its position among sentence S
4: Remove the original input from the testset
5: Feed the revised sentence $S^{'}$ to the testset
6: Translate final input
7: **end for**

Our work (Word segmentation)

[This slide intentionally left blank]

Not good as we expected

Our work (Data Augmentation)

[This slide intentionally left blank]

We have been doing corresponding experiments…

Outline

✓Machine Translation

✓Related Work and Current State for LRLs NMT

✓Motivation

✓Our works

●Projects

●Copyrights && Patents

●Conclusions

Projects

- Project1: “少数民族网络舆情综合分析与云服务关键技术研究及应用示范”
- Project2: “跨语言社会舆情分析基础理论与关键技术
- Project3: “面向三元空间的互联网中文信息处理理论与方法”
- Project4: “基于深度学习的维汉机器翻译”

1.5.245:9662/index.html

清华大学多语种翻译系统

چىڭخۇا ئۇنىۋېرسىتى كۆپ تىللىق تەرجىمە سىستېمىسى

维文 >> 汉语 通用领域 翻译

维文
汉语
藏文
蒙文

ئىنقلابىي قۇربانلارنى خاتىرىلەش كۈنىدە خەلق قەھرىمانلىرىغا گۈل سېۋېتى تەقدىم قىلىش مۇراسىمى بېيجىڭدا داغدۇغىلىق ئۆتكۈزۈلدى.

革命先烈纪念日人民英雄敬献花篮的仪式在北京隆重举行

最多可以输入500个字符

Email: miradel51@126.com Tel: 13051308938 Wechat: 821777278

清华大学跨语言信息检索系统

查询语言

◉ 中文

文档语言

◉ 维吾尔语 ○ 藏语 ○ 蒙古语

请输入关键词...

点击率	日期	标题	编号
ئاۋاتلىقى: 261	2018-07-26	شى جىنپىڭ كېسەك ئالتۇن دۆلەتلىرى سودا-سانائەت مۇنبىرىگە قاتناشتى ھەم مۇھەم سۆز قىلدى	1
ئاۋاتلىقى: 229	2018-07-26	شى جىنپىڭ راماپوسا زۇڭتۇڭ ئۆتكۈزگەن قارشى ئېلىش ۋە جۇڭگو - جەنۇبىي ئافرىقا دىپلوماتىك...	2
ئاۋاتلىقى: 173	2018-07-26	سىرتىمپوسلىق كىچىك قىزى خۇشمۇ بوللۇدىقا كىرشى مۇمكىن	3
ئاۋاتلىقى: 149	2018-07-26	داۋالىنىش سۇغۇرتىسى مالىيە ياردەم يۇلى ئۆلچىمى كىشى بېشىغا يىلىغان 40 يۈەن قوشۇلدى	4
ئاۋاتلىقى: 123	2018-07-26	گوۋۇيۈەن تەكشۈرۈش گۇرۇپپىسى جىلىن ئۆلكىسىدە بىرىپ دىلۇنى تەكشۈرۈپ بىر تەرەپ قىلىش خىزمىتىنى ...	5

Email: miradel51@126.com Tel: 13051308938 Wechat: 821777278

清华大学多语... | 清华大学跨语... | 多语种翻译系统 | 多语种翻译系统 | 天山网_百度搜... | 天山网 - 新疆... | ئۇيغۇر تورى | ئىش ئورنىدا چىك تۇ...

.196:9666/index.html

多语种翻译系统

كۆپ تىللىق تەرجىمە سىستېمىسى

维吾尔语 >> 汉语 通用领域 翻译

ئاممۋى تۈزگەن چاسا ئەترەت ئالدىغا جۈڭگو كوممۇنىستىك پارتىيەسى مەركىزي كومىتېتى، مەملىكەتلىك خەلق قۇرۇلتىيى دائىمي كومىتېتى، گوۋۇيۈەن، مەملىكەتلىك سىياسي كېڭەش، مەركىزي ھەربي كومىتېت، ھەرقايسى دېموكراتىك پارتىيە–گۇرۇھلار، مەملىكەتلىك سودا–سانائەتچىلەر بىرلەشمىسى ۋە پارتىيە–گۇرۇھسىز ۋەتەنپەرۋەر زاتلار، ھەرقايسى خەلق تەشكىلاتلىرى ۋە ھەر ساھە ئاممىسى، پىشقەدەم جەڭچىلەر، پىشقەدەم يولداشلار ۋە ئىنقلابىي قۇربانلارنىڭ ئائىلە تاۋابئاتلىرى، جۈڭگو پىيونېرلار ئەترىتىنىڭ ناممدا تەقدىم قىلىنغان چوڭ تېپتىكى توققۇز گۈل سېۋىتى قاتار تىزىلغاندى.

群众组成方队，面对的是中共中央。,全国人民代表大会常务委员会,国务院；,全国政协：,中央军事委员会；,各民主党派,全国工商联及无党派爱国人士,各人民团体和各界群众,老战士,老同志和革命先烈的家属。,以中国少先队命名的九个大型花束排列。

最多可以输入500个字符

灵云
Alcloud.com

中文 ⇌ 维文

10月6日晚，“我爱你中国”主题灯光秀把夜色中的乌鲁木齐装点得分外绚丽。各族市民和众多来疆游客观灯赏景，欢声笑语，为中华人民共和国69周年华诞送上衷心的祝福。

10 - ئاينىڭ 6 - كۈنى كەچتە ، « سىزنى سۆيىمەن » دېگەن تېمىدىكى چىراق نۇرى كېچىدىكى ئۈرۈمچى شەھىرىدە نومۇر ئېلىپ ، گۈزەل تۈسكە كىردى .ھەر مىللەت شەھەر ئاھالىلىرى ۋە شىنجاڭغا كەلگەن نۇرغۇن ساياھەتچىلەرنىڭ ياۋۇس سەيلىسى ، كۆلكە سادالىرى جۈڭخۇا خەلق جۇمھۇرىيىتى قۇرۇلغانلىقىنىڭ 69 يىللىقىنى قىزغىن تەبرىكلىدى .

Outline

- ✓Machine Translation
- ✓Related Work and Current State for LRLs NMT
- ✓Motivation
- ✓Our works
- ✓Projects
- ●Copyrights && Patents
- ●Conclusions

Copyrights

- 已发布
  - **米尔阿迪力江·麦麦提**，“维吾尔语人工词性标注及语料库构建系统”[简称：维吾尔语人工词性标注平台]，登记号：2016SR031180
  - **米尔阿迪力江·麦麦提**，“维吾尔语自动词性标注系统”[简称：维语词性标注平台]，登记号：2016SR052763
  - **米尔阿迪力江·麦麦提**，“维吾尔语自动词干提取与词性标注系统”[简称：维吾尔语形态分析器]，登记号：2016SR379408
  - 孙茂松，**米尔阿迪力江·麦麦提**，刘洋，栾焕博，“基于Python的多语种多文种编码转换工具软件(1.0)”[简称：维蒙藏-汉(小语种)在线翻译系统]，登记号：2019SR0110291
  - 孙茂松，**米尔阿迪力江·麦麦提**，刘洋，栾焕博，“面向低资源语言的多语种在线机器翻译系统(1.0)”[简称：小语种在线翻译系统]，登记号：2019SR0108620
  - 孙茂松，**米尔阿迪力江·麦麦提**，刘洋，栾焕博，“跨语言社会舆情分析在线信息检索系统”[简称：小语种跨语言信息检索系统]，**在申请**

Patents

- 已授权
  - **米尔阿迪力江·麦麦提**，刘洋，栾焕博，孙茂松，“一种基于无监督领域自适应的神经网络机器翻译方法”，申请日：2017年03月09日，申请号：201710139214.0，授权公布日：2017年08月11日，授权号：CN 107038159 A
- 在审
  - 孙茂松，**米尔阿迪力江·麦麦提**，刘洋，栾焕博，“神经网络机器翻译模型的训练方法和装置”，申请日：2018年07月27日，申请号：201810845896.1

Outline

- ✓Machine Translation
- ✓Related Work and Current State for LRLs NMT
- ✓Motivation
- ✓Our works
- ✓Projects
- ✓Copyrights && Patents
- ●Conclusions

Conclusions

- Semi-supervised Learning
- Unsupervised Learning
- Pivot-based Methods
- Data Augmentation
- Data Selection
- Transfer Learning
- Meta Learning
- Morphological analyses
- Pos-tagging
- NER

شكرا لك

köszönöm

شكريا

谢 谢！

ཐཀུརྩེ ཅ།

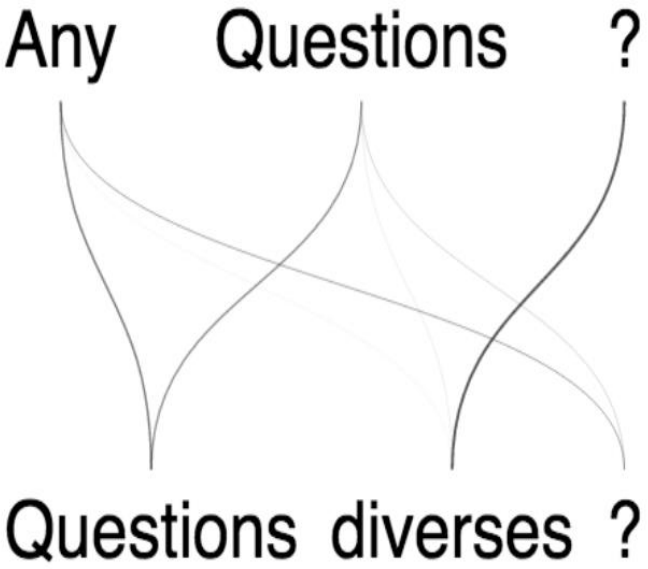
བཀའ་དྲིན་ཆེ།

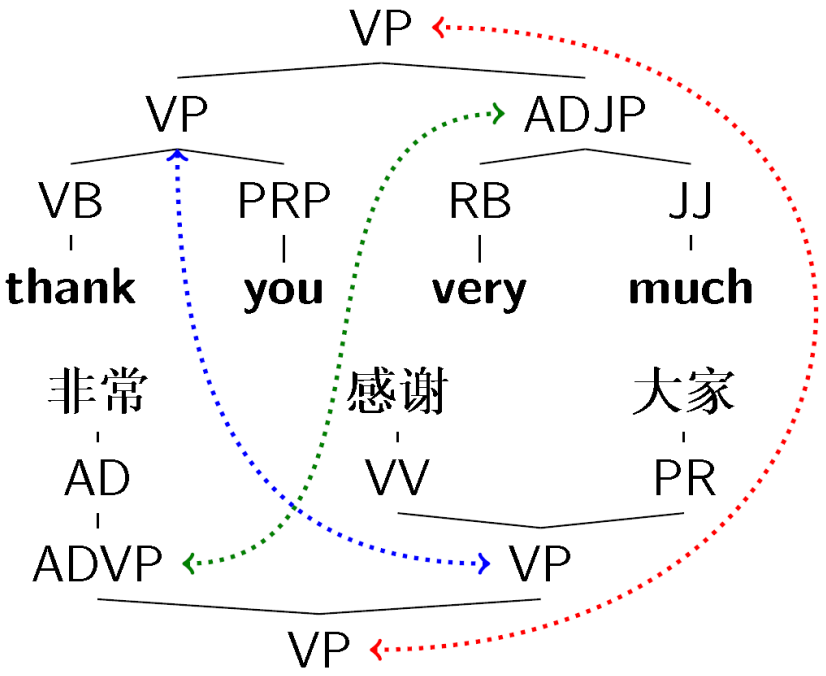
ره خمه ت!

הדות

Teşekkür

Kiitos





This inspiration comes from Dzmitry Bahdanau @ *ICLR2014* .