NLP 南京大学
自然语言处理研究组
Natural Language Processing Group

南京大學
NANJING UNIVERSITY

神经机器翻译的扩展研究方向

黄书剑

神经网络机器翻译的研究热点

- 网络结构变化
- 提升解码效率

→ 提高训练解码效率 →

- 无监督/低资源翻译
- 领域自适应
- 多模态翻译

→ 扩大适用范围 ↑

- 可解释性、可视化、分析
- 鲁棒性、对抗样本

→ 可理解性 ↑

- 引入句法结构信息
- 引入统计机器翻译的经验
- 记忆网络、注意力改进

→ 提高翻译质量 ↘

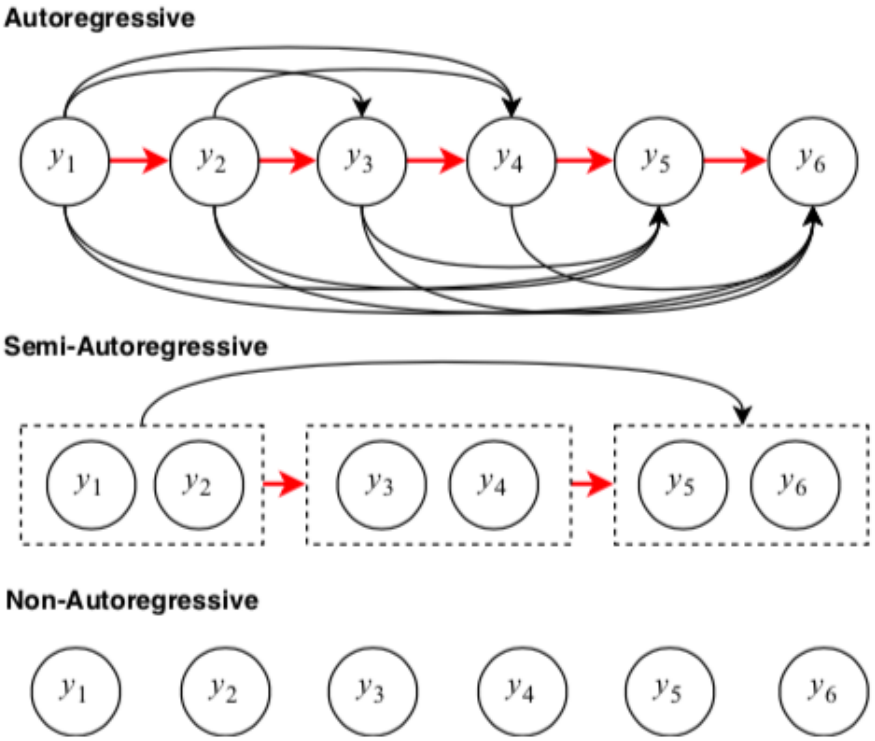
- ……

*下文列出了部分相关方向的论文作为参考

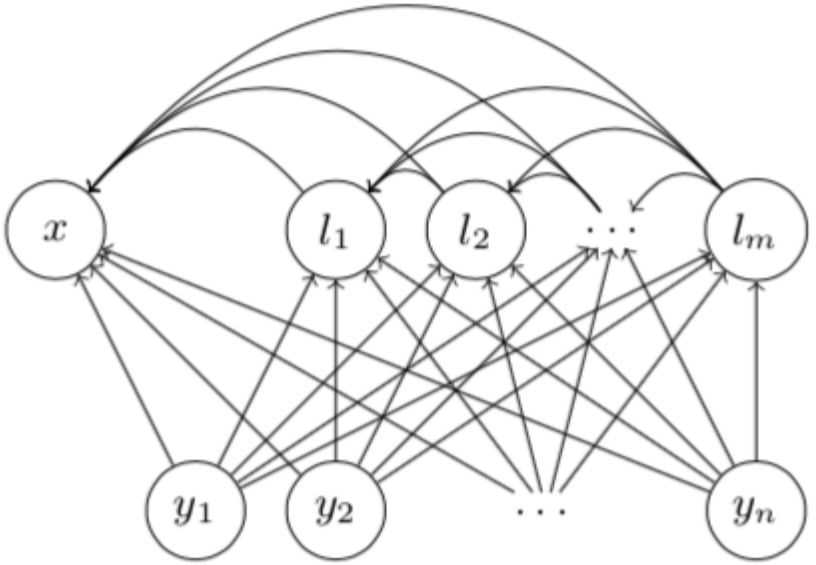
网络结构变化

- 序列处理v.s. 并行处理
- ACL17
  - A Convolutional Encoder Model for Neural Machine Translation (Convolutional Sequence to Sequence Learning)
- NIPS17
  - Attention Is All You Need.
- ICLR2018
  - Non-Autoregressive Neural Machine Translation
- ACL2018
  - The Best of Both Worlds: Combining Recent Advances in Neural Machine Translation.
- EMNLP2018
  - Semi-Autoregressive Neural Machine Translation.

- 必须从左到右生成一个句子(单词生成依赖前序)
  - 并行化程度低



Semi-Autoregressive Neural Machine Translation. Wang et al. 2018

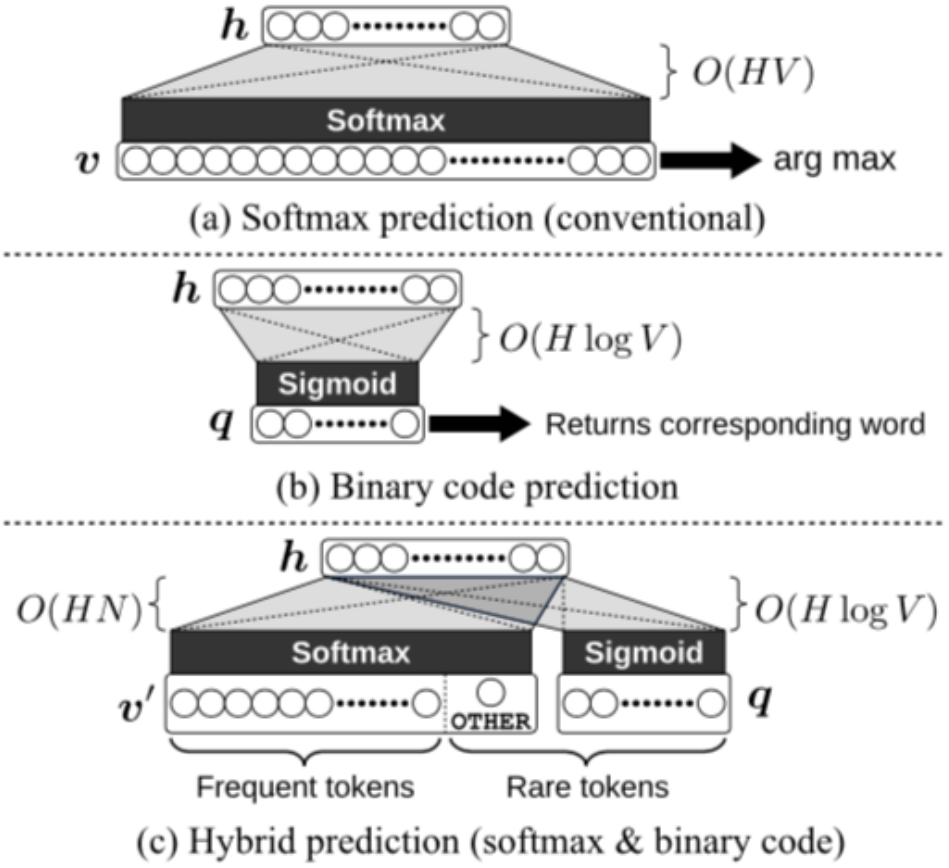


Fast Decoding in Sequence Models Using Discrete Latent Variables. Kaiser et al. 2018

提升解码效率

- 通过缩小词表、蒸馏模型、单独训练解码过程等方法提高解码效率
- ACL17
  - Neural Machine Translation via Binary Code Prediction
  - Speeding up Neural Machine Translation Decoding by Shrinking Run-time Vocabulary (short paper)
- EMNLP17
  - Trainable Greedy Decoding for Neural Machine Translation
  - Sharp Models on Dull Hardware: Fast and Accurate Neural Machine Translation Decoding on the CPU(short)
- ……

- 通过编码减少预测代价，提高预测效率



Neural Machine Translation via Binary Code Prediction. Oda et al. 2017

- 通过缩小词汇表，提高预测效率

Sub-module	Full vocab	WA50	Speedup
Total	1002.78 s	481.52 s	2.08
– Beam expansion	174.28 s	76.52 s	2.28
– Source-side	83.67 s	83.44 s	1
– Target-side	743.25 s	354.52 s	2.1
– – Softmax	402.77 s	20.68 s	19.48
– – Attention	123.05 s	123.12 s	1
– – 2nd layer	64.72 s	64.76 s	1
– – 1st layer	88.02 s	87.96 s	1
Shrink vocab	-	0.39 s	-
BLEU	25.16	25.13	-

Speeding Up Neural Machine Translation Decoding by Shrinking Run-time Vocabulary. Shi and Knight. 2017

细粒度编解码单元

- ACL2018
  - Subword Regularization: Improving Neural Network Translation Models with Multiple Subword Candidates
- NAACL2018
  - Improving Character-based Decoding Using Target-Side Morphological Information for Neural Machine Translation
  - Combining Character and Word Information in Neural Machine Translation Using a Multi-Level Attention
- EMNLP2018
  - Revisiting Character-Based Neural Machine Translation with Capacity and Compression

- **仍存在大量新造单词**
  - 通过字、词联合的方式处理

Source	[...] 将 **东西方 冷战** 的 象征 柏林 墙 的 三 块 墙体 赠送 到 了 联合国
Reference	[...] presented the united nations with three pieces of the berlin wall , a symbol of *the cold war between the east and the west* .
NMT	[...] sent the three pieces of UNK UNK to the un to the un
CNN-Char	[...] sent three pieces of UNK to the united nations, which was *the cold war in eastern china* .
Ours	[...] presented the un on the 4th of the three wall UNK of *the eastern and western cold war* .

Combining Character and Word Information in Neural Machine Translation Using a Multi-Level Attention. Chen et al. 2018

- 存在一些语言具有复杂的形态变换

Word	Translation
terbiye	good manners
terbiye.siz	rude
terbiye.siz**.**lik	rudeness
terbiye.siz**.**lik**.**leri	their rudeness
terbiye.siz**.**lik**.**leri**.**nden	from their rudeness

Improving Character-based Decoding Using Target-Side Morphological Information for Neural Machine Translation. Passban et al. 2018

鲁棒的翻译系统学习

- ACL2018
  - Towards Robust Neural Machine Translation
- AAAI2018
  - Neural Machine Translation with Gumbel-Greedy Decoding
- NAACL2018
  - Improving Neural Machine Translation with Conditional Sequence Generative Adversarial Nets
- COLING2018
  - On Adversarial Examples for Character-Level Neural Machine Translation

机器翻译容易受到输入噪音的影响

Input	tamen *bupa* kunnan zuochu weiqi AI.
Output	They are not afraid of difficulties to make Go AI.

他们不怕困难做出围棋AI

Input	tamen *buwei* kunnan zuochu weiqi AI.
Output	They are not afraid to make Go AI.

他们不畏困难做出围棋AI

中国电子银行业务管理新规将于三月一日起实行

zhongguo dianzi yinhang yewu guanli xingui jiangyu sanyue yiri qi shixing
china's electronic bank rules to be implemented on march 1

中方电子银行业务管理新规将于三月一日起实行

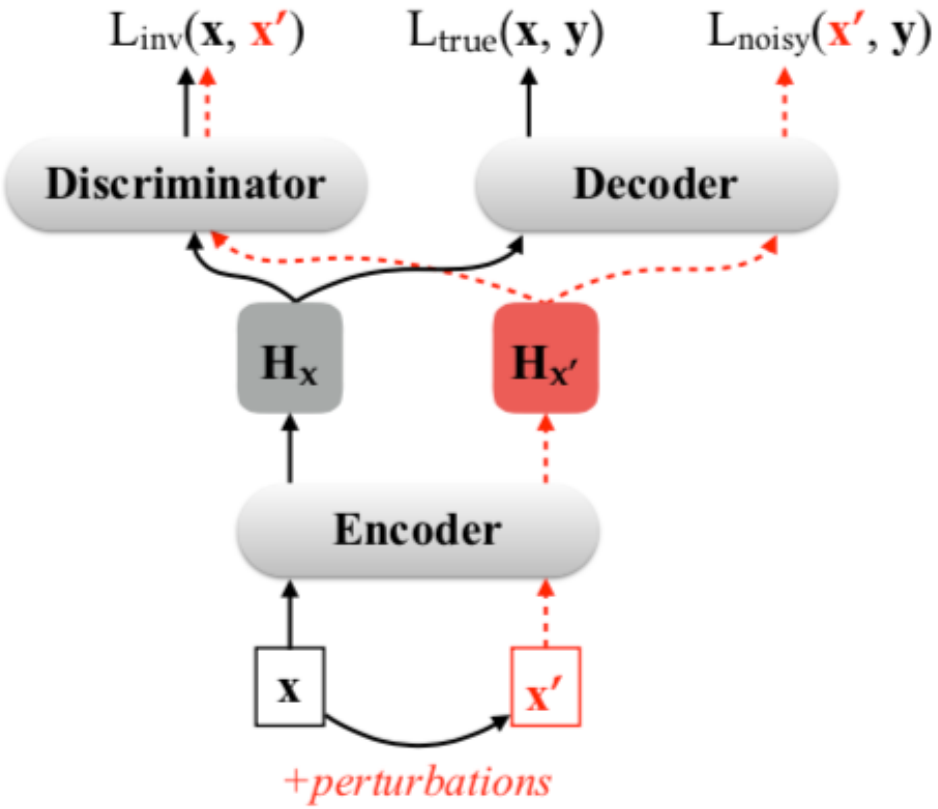
zhongfang dianzi yinhang yewu guanli xingui jiangyu sanyue yiri qi shixing
china to implement new regulations on business management

Towards Robust Neural Machine Translation. Cheng et al. 2018

1901 wurde eine Frau namens Auguste in eine medizinische Anstalt in Frankfurt gebracht.
1901 wurde eine Frau namens **Afuiguste** in eine medizinische Anstalt in Frankfurt gebracht.
In 1931, a woman named **Augustine** was brought into a medical institution in France.
In 1931, a woman named Rutgers was brought into a medical institution in France.
Das ist Dr. Bob Childs – er ist Geigenbauer und Psychotherapeut.
Das ist Dr. Bob Childs – er ist Geigenbauer und **Psy6hothearpeiut**.
This is Dr. Bob Childs – he's a wizard maker and a **therapist**'s **therapist**.
This is Dr. Bob Childs – he's a brick maker and a **psychopath**.

On Adversarial Examples for Character-Level Neural Machine Translation.
Ebrahimi et al. 2018

- 人工制造噪音，加强模型抗干扰能力



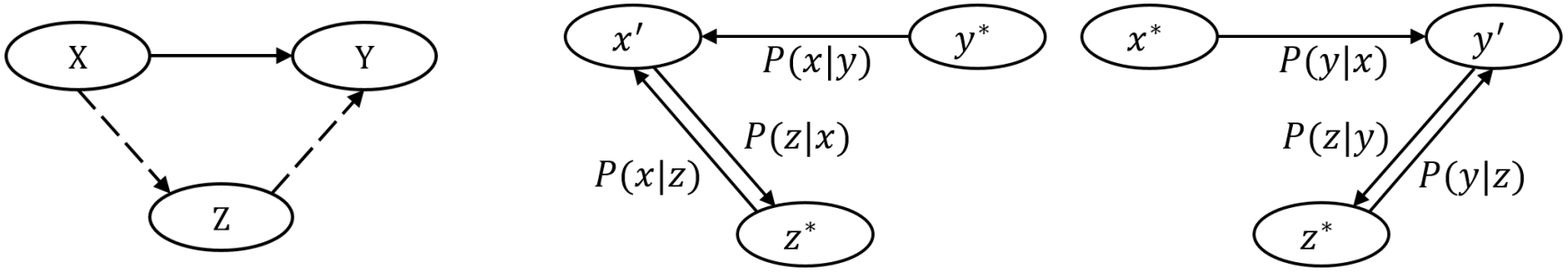
Towards Robust Neural Machine Translation. Cheng et al. 2018

无监督/低资源翻译

- 尝试在少量甚至无平行数据的情况下学习机器翻译
- ACL17
  - Data Augmentation for Low-Resource Neural Machine Translation (short paper)
- ICLR18
  - Word Translation Without Parallel Data
  - Unsupervised Machine Translation Using Monolingual Corpora Only
  - Unsupervised Neural Machine Translation
- ACL18
  - Unsupervised Neural Machine Translation with Weight Sharing
  - Adaptive Knowledge Sharing in Multi-Task Learning: Improving Low-Resource Neural Machine Translation (short paper)
- ……

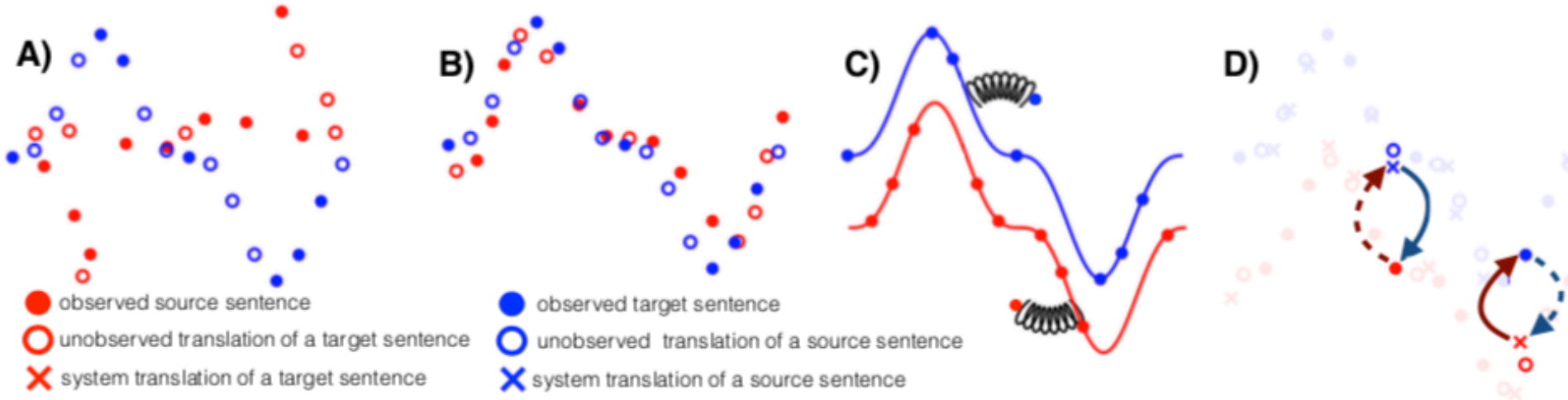
低资源翻译

- 利用中间语言



Triangular Architecture for Rare Language Translation. Ren et al. 2018

无监督翻译学习过程



- Monolingual
- Initialization
- Language Modeling
- Back Translation

多模态翻译

- 利用图片中包含的信息帮助翻译结果生成
- ACL17
  - Doubly-Attentive Decoder for Multi-modal Neural Machine Translation
- EMNLP17
  - Incorporating Global Visual Features into Attention-based Neural Machine Translation
  - An empirical study of the effectiveness of images on Multi-modal Neural Machine Translation
- ACL18
  - Learning Translations via Images: A Large Multilingual Dataset and Comprehensive Study
- ……

src.	eine Gruppe junger Menschen trinkt Shots in einem Mexikanischen Setting .
ref.	a group of young people take shots in a Mexican setting .
NMT	a group of young people are **having fun** in an auditorium .
PBSMT	a group of young people drinking at a Shots Mexikanischen Setting .
IMG_{2W}	a group of young people having drinks in a **Mexican restaurant** .
IMG_{E}	a group of young people drinking apples in a **Mexican restaurant** .
IMG_{D}	a group of young people drinking food in a **Mexican restaurant** .
IMG_{2W+D}	a group of young people **having fun** in a Mexican room .
IMG_{E+D}	a group of young people drinking dishes in a **Mexican restaurant** .

die grauen mauern und grünen terrassen einer ruine auf einem berg , mit einem sehr markanten berg dahinter und einer bergkette im hintergrund .

PRE.: a ruin with grey walls and green terraces in the foreground .

JOINT: the grey walls and green terraces of ruins on top of a mountain , with a very distinctive mountain behind them and a wooded mountain range in the background .

Incorporating Global Visual Features into Attention-Based Neural Machine Translation. Calixto and Liu 2017

Zero-Resource Neural Machine Translation with Multi-Agent Communication Game Chen et al. 2018

引入句法结构信息

- 以句法信息融入编解码器为主，增强翻译中的结构信息
- ACL17
  - Improved Neural Machine Translation with a Syntax-Aware Encoder and Decoder
  - Modeling Source Syntax for Neural Machine Translation
  - Sequence-to-Dependency Neural Machine Translation
  - Chunk-based Decoder for Neural Machine Translation
  - Chunk-Based Bi-Scale Decoder for Neural Machine Translation(short paper)
  - Learning to Parse and Translate Improves Neural Machine Translation(short paper)
  - Towards String-To-Tree Neural Machine Translation(short paper)

引入句法结构信息

- EMNLP17
  - Graph Convolutional Encoders for Syntax-aware Neural Machine Translation
  - Neural Machine Translation with Source-Side Latent Graph Parsing
  - Neural Machine Translation with Source Dependency Representation (short paper)
- ACL18
  - Forest-Based Neural Machine Translation
  - Practical Target Syntax for Neural Machine Translation (short paper)
- ……

引入统计机器翻译的经验

- 包括尝试引入SMT的方法、模型（短语表、调序模型）和结果等
- ACL17
  - Incorporating Word Reordering Knowledge into Attention-based Neural Machine Translation
  - Prior Knowledge Integration for Neural Machine Translation using Posterior Regularization
  - Neural system combination for machine translation
- EMNLP17
  - Neural Machine Translation Leveraging Phrase-based Models in a Hybrid Search
  - Translating Phrases in Neural Machine Translation
- ICLR18
  - Towards Neural Phrase-based Machine Translation
- ……