Translation of Patent Sentences with a Large Vocabulary of Technical Terms Using Neural Machine Translation

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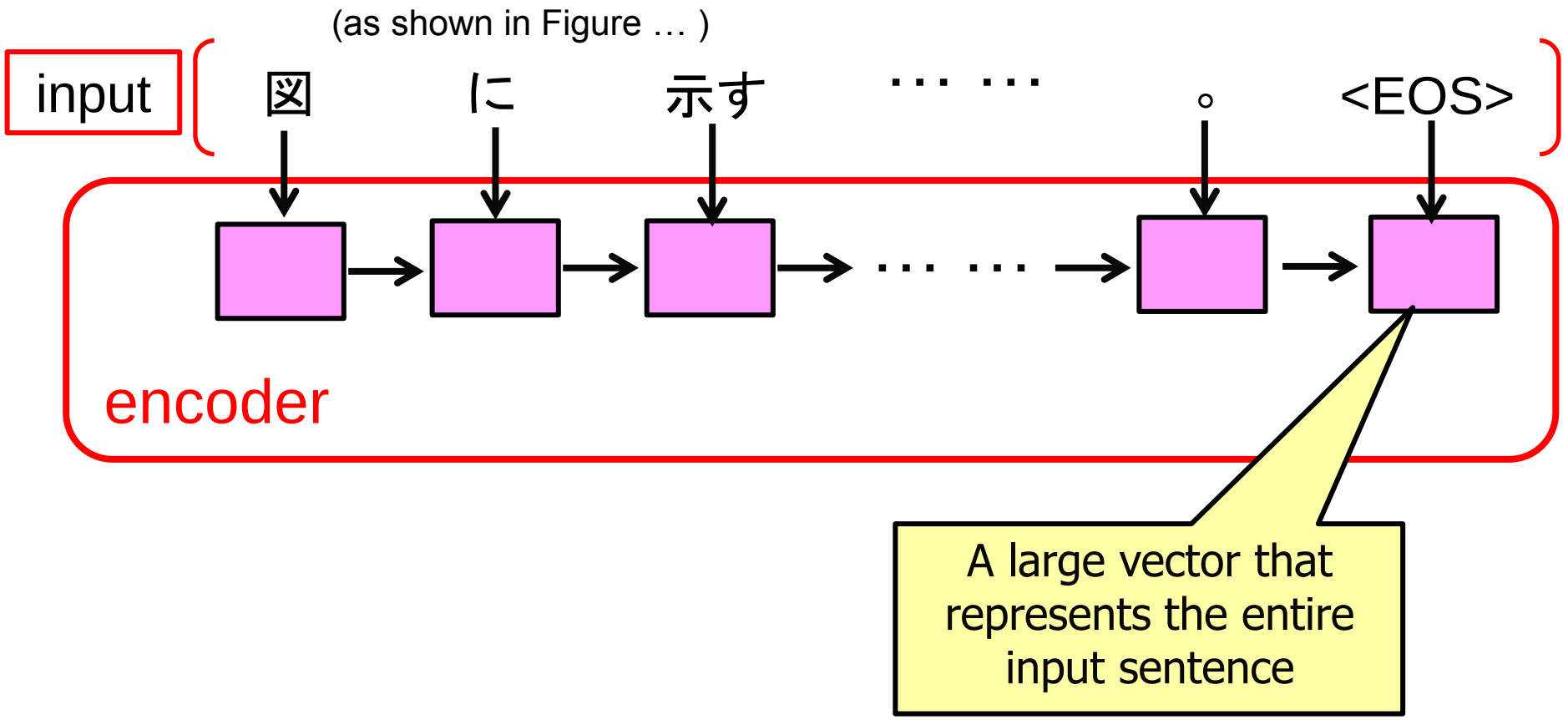
Neural Machine Translation (encoder-decoder Model and attention mechanism)

Vinyals et al. Grammar as a foreign language. In Proc. NIPS, 2015



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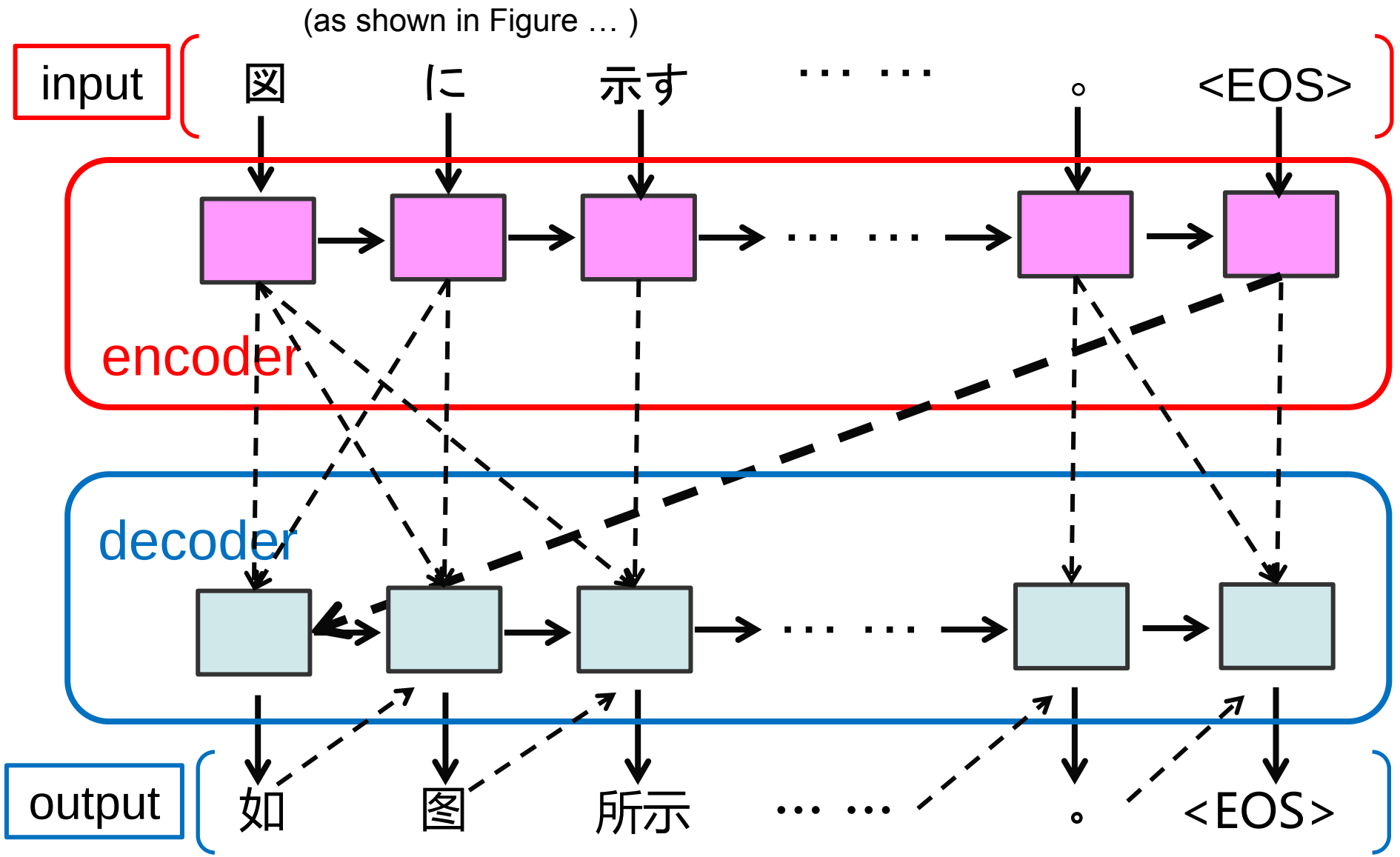
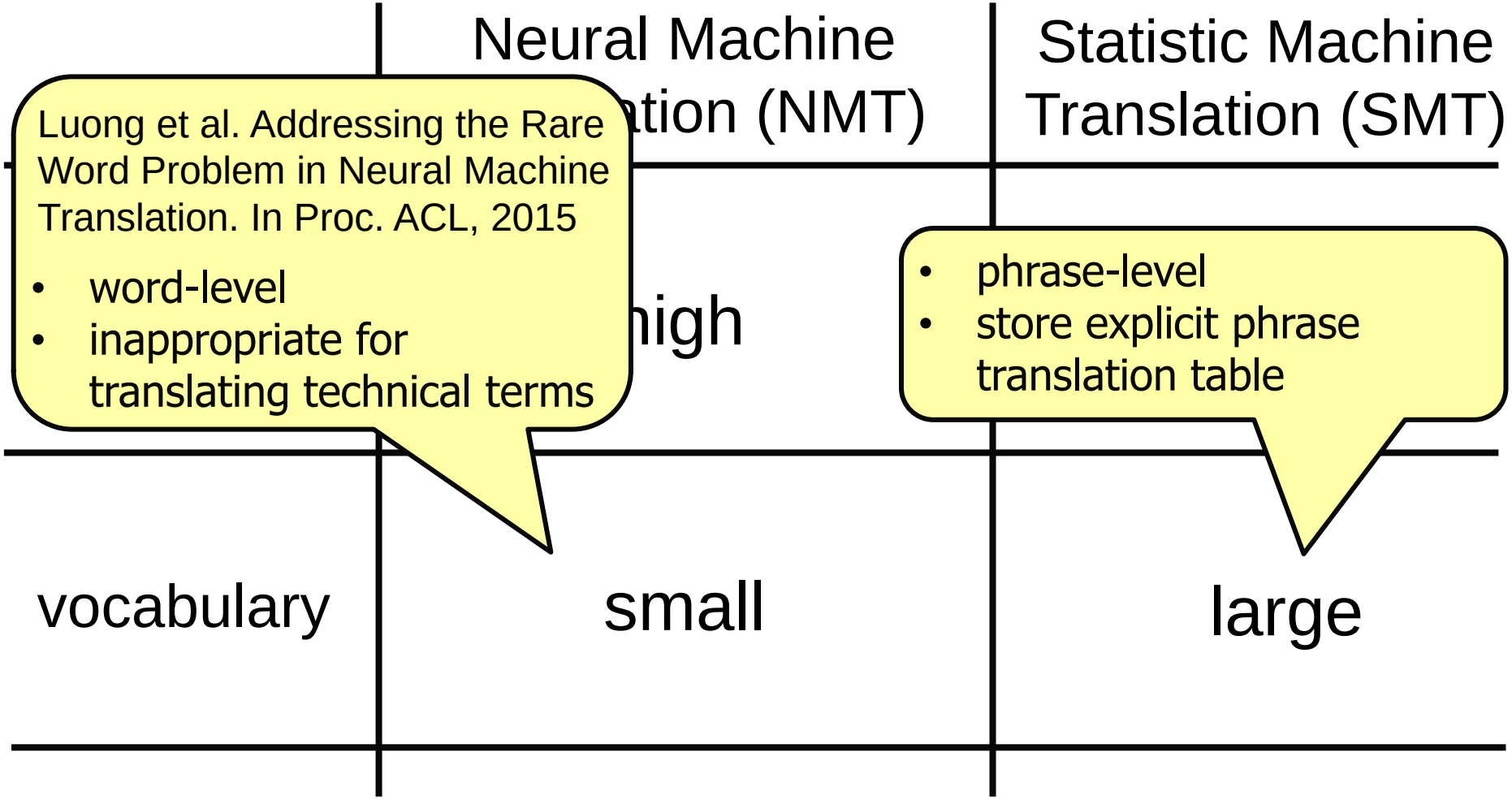


Neural Machine Translation VS Statistic Machine Translation

	Neural Machine Translation (NMT)	Statistic Machine Translation (SMT)
fluency	high	low
vocabulary	small	large

Neural Machine Translation VS Statistic Machine Translation



NMT with a Large Vocabulary of Technical Terms

- Step 1. training NMT model with technical term tokens
- Step 2. applying NMT model with technical term tokens
  - Approach 1. NMT decoding and SMT technical term translation
  - Approach 2. NMT rescoring of 1,000-best SMT translations (not as fluent as Approach 1)

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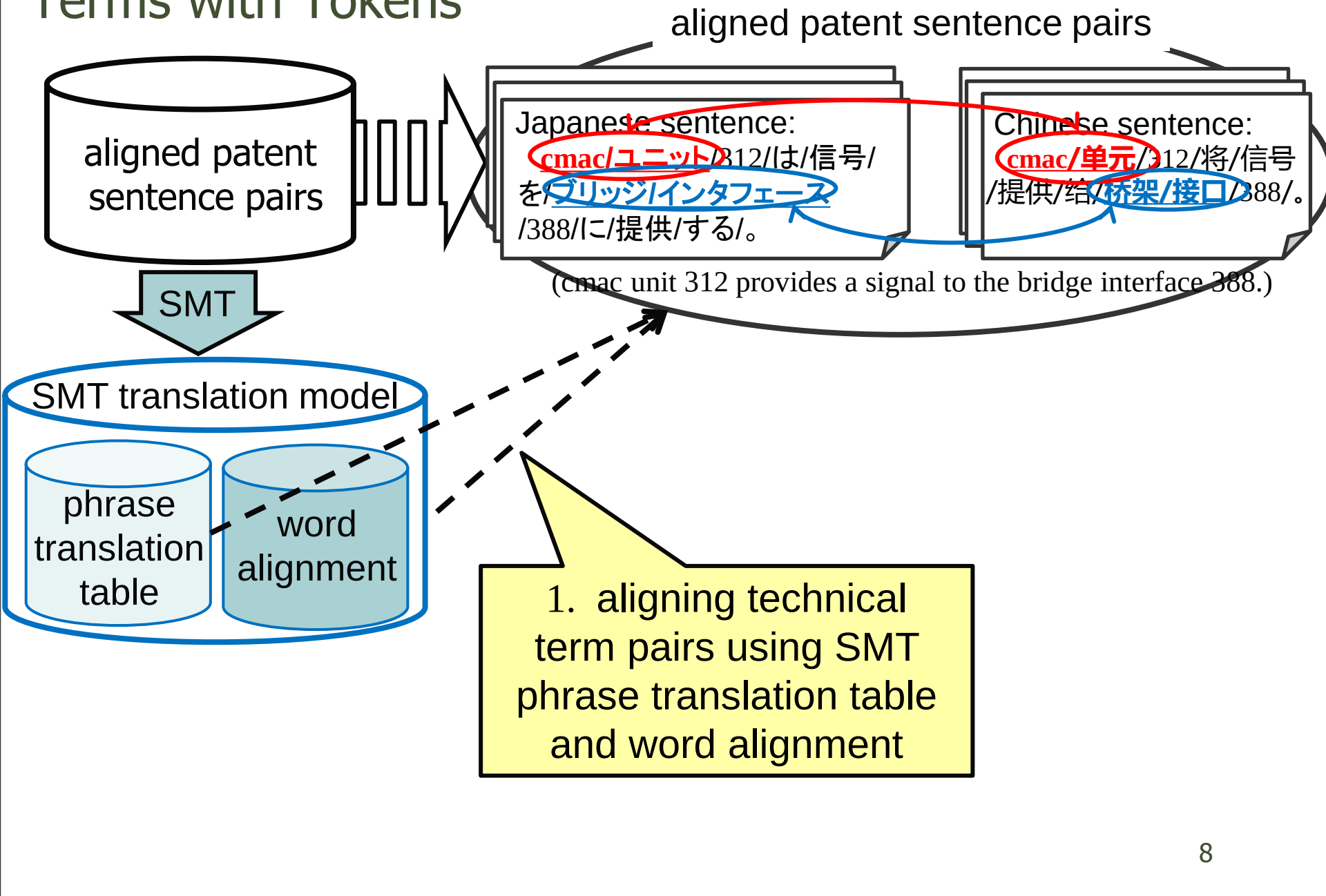
NMT training after replacing Technical Terms with Tokens



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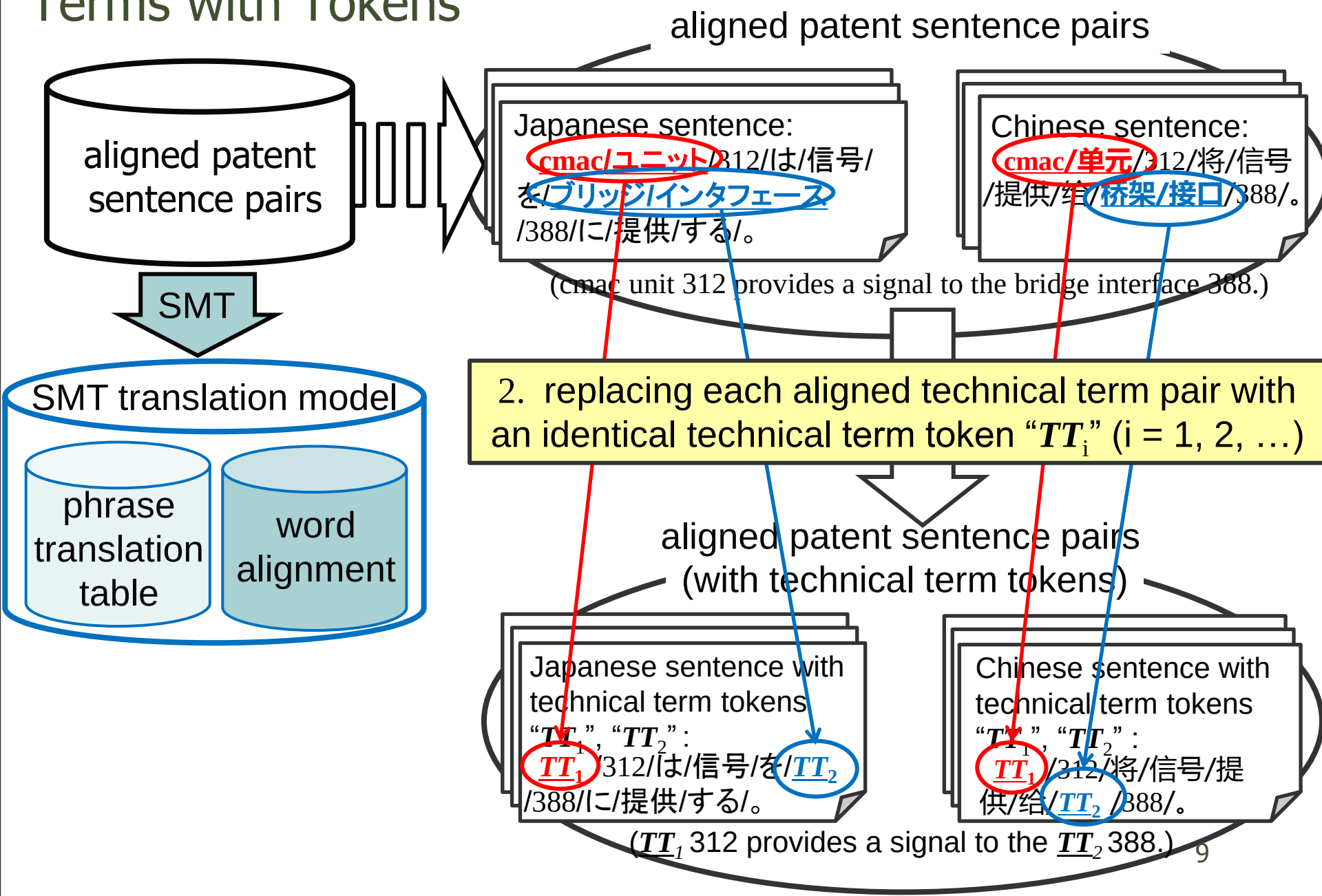

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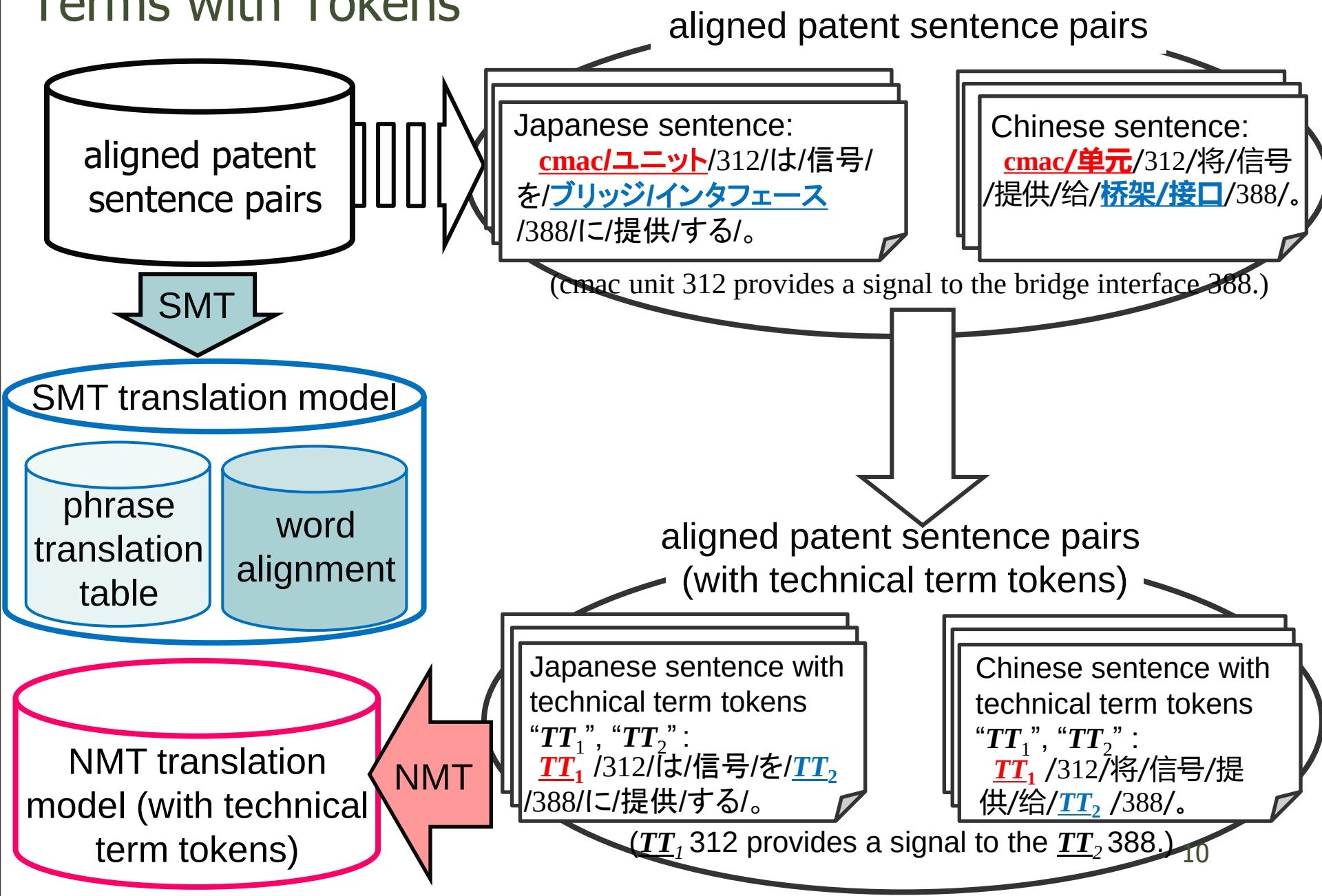

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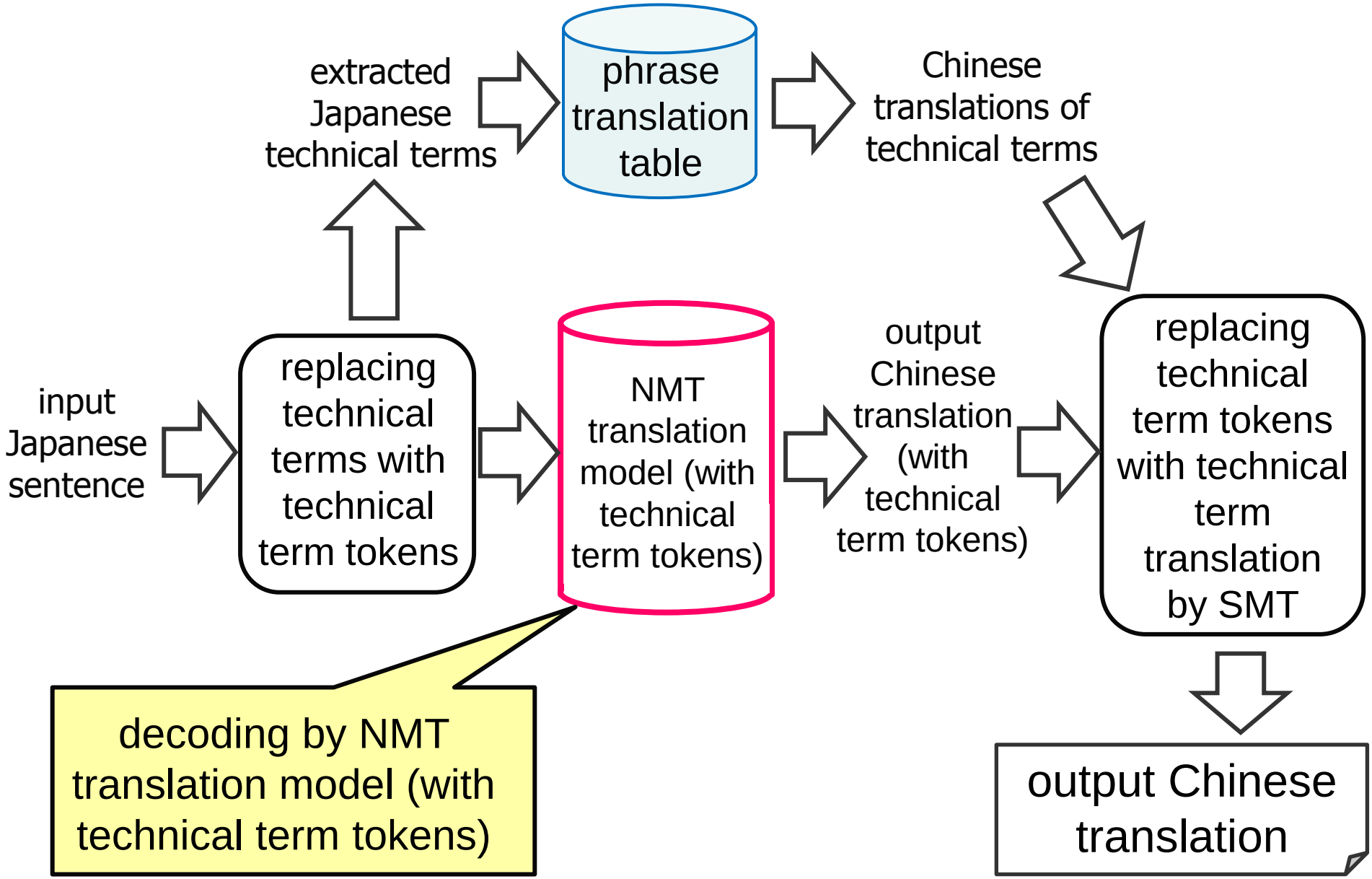
NMT Decoding and SMT technical Term Translation



Training and Test Sets

- 2.8M parallel sentences extracted from Japanese-Chinese patent families
  - Randomly selected 1,000 sentence pairs as the test set

pair 1:
J: ･･･冷蔵庫および**冷蔵庫扉閉鎖装置**･･･
C: ･･･电冰箱及**电冰箱门锁闭装置**･･･。
(closing appliance of Refrigerator's door)

pair 2:
J: ･･･**真空断熱材**及びその製造方法･･･.
C: ･･･**真空绝热材料**及其制作方法･･･。
(vacuum thermal insulation)

⋮

pair *n*:
J: ･･･運動に関する3次元**デカルト座標系**を定める。
C: ･･･以限定用于描述运动的三维**笛卡尔坐标系**･･･。
(Cartesian coordinate system)

Experiments Settings

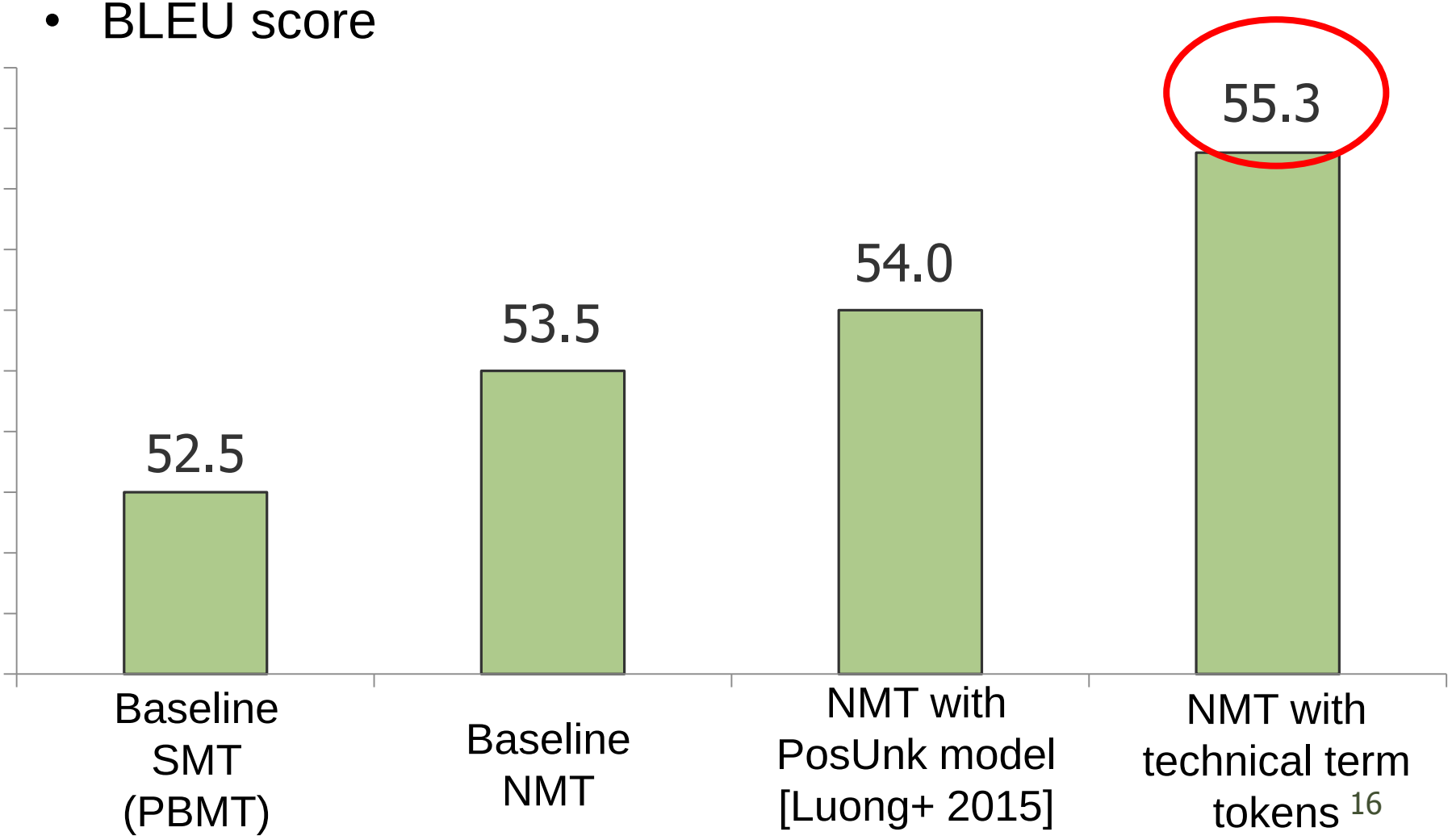
- Baseline SMT (PBMT)
  - phrase-based SMT model trained with the same training set using Moses.
- Baseline NMT
  - uni-direction model with attention mechanism
  - 3 layer deep LSTMs with 512 cells in each layer and a 512-dimensional word embedding.
  - limit both the Japanese vocabulary and the Chinese vocabulary to 40,000 most frequently used word
  - more training details.

Experiments Settings

- NMT with PosUnk model [Luong+ 2015]
  - same training parameters with the baseline NMT
  - training NMT model with PosUnk model
- NMT with technical term tokens
  - same training parameters with the baseline NMT
  - training NMT model after replacing technical terms with tokens.

Evaluation Results (automatic evaluation - BLEU)

- BLEU score



Evaluation Results (automatic evaluation - RIBES)

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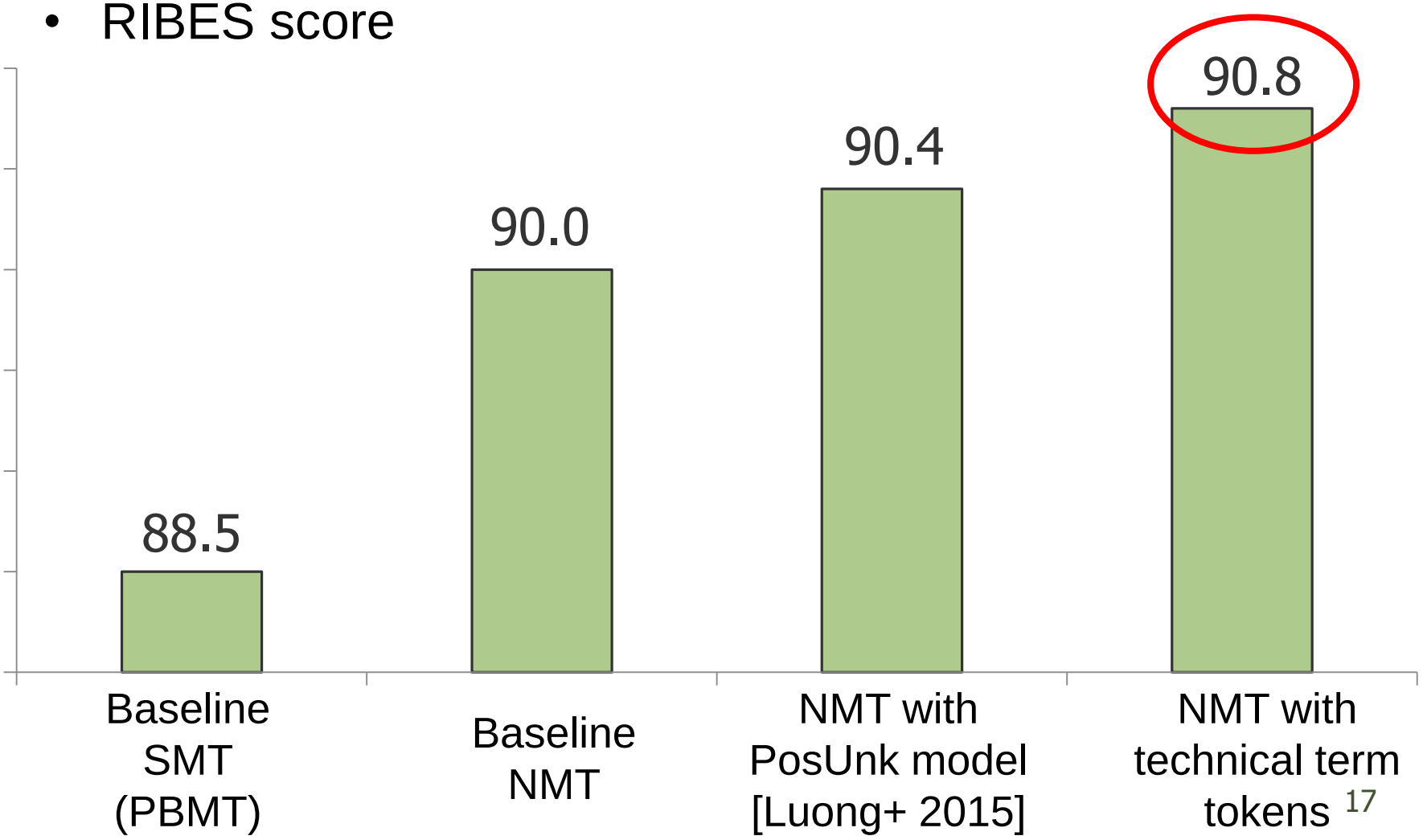
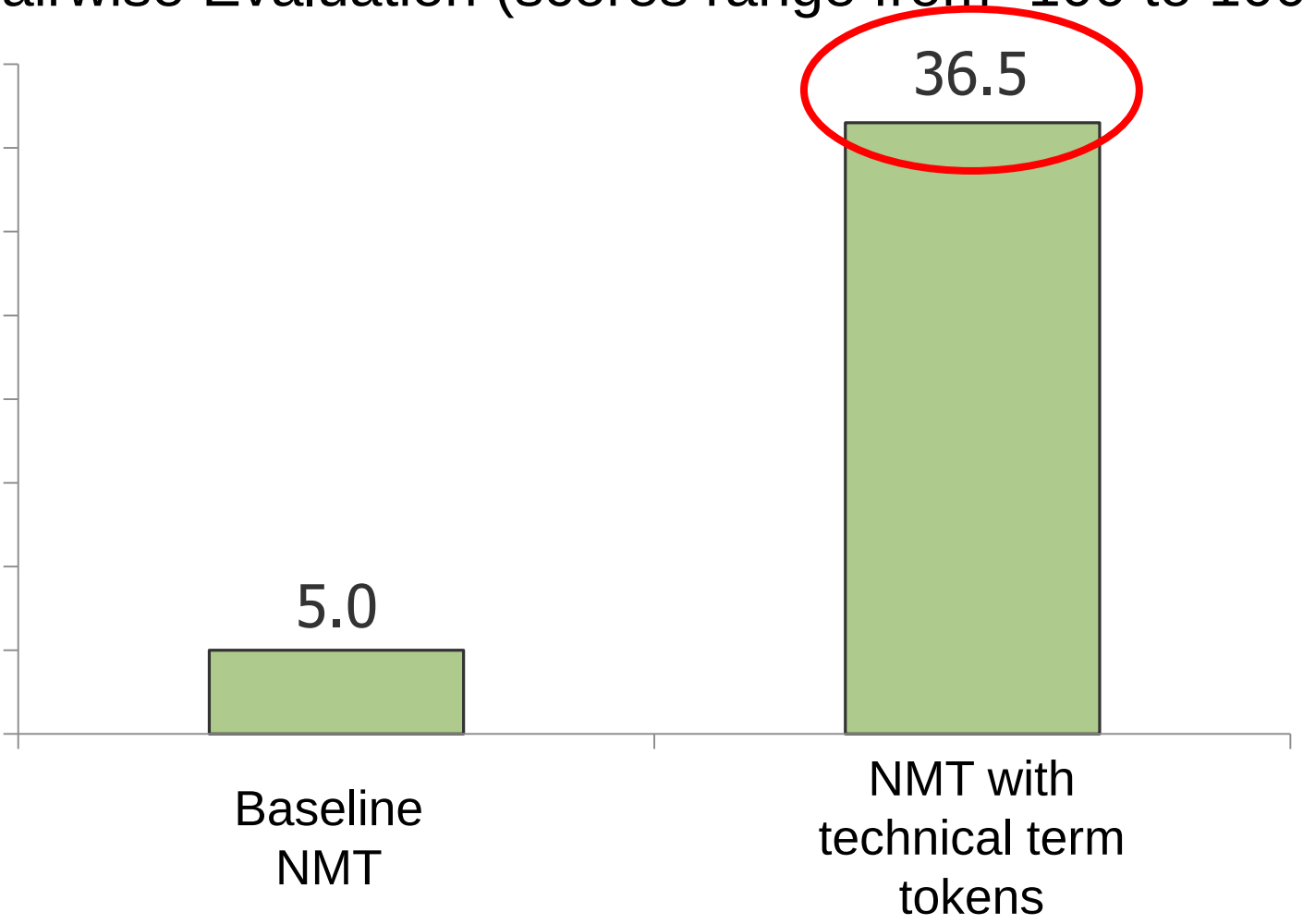


Evaluation Results
(human evaluation – pairwise evaluation)

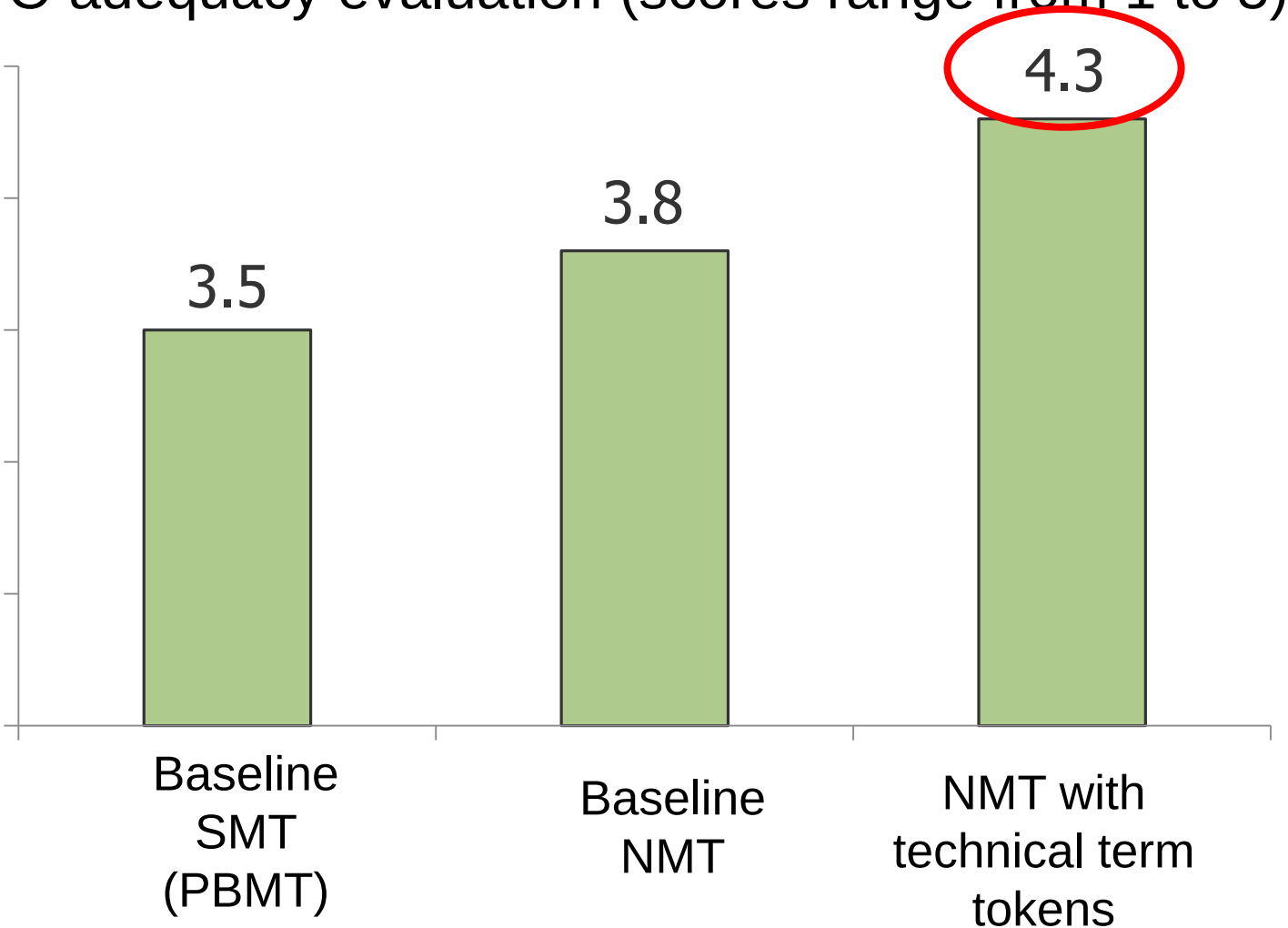
- Pairwise Evaluation (scores range from -100 to 100)



Evaluation Results

(human evaluation – JPO adequacy evaluation)

- JPO adequacy evaluation (scores range from 1 to 5)



Example of correct translations produced by NMT decoding

Japanese sentence

次に、酸化膜をhf洗浄により除去した後、**貼り合わせウェーハ**の剥離面から酸素イオンを注入した。

(Next, after removing an oxide film by hf washing, we inject oxygen ions from the peeled surface of the **laminated wafer**.)

NMT decoding
by the **PROPOSED** NMT

接着，通过hf洗涤除去氧化膜后，从**贴合晶片**的剥离面注入氧离子。

(TRANSLATION: Subsequently, after the oxide film was removed by washing with hf, and oxygen ions were injected from the peeled surface of the **laminated wafer**.)

Correct!

NMT decoding
by the **BASELINE** NMT

接着，通过hf清洗除去氧化膜后，从**贴合的UNK**的剥离面注入氧气。

(TRANSLATION: Then, after the oxide film was removed by hf cleaning, oxygen was injected from the peeled surface of the **laminated UNK**.)

Incorrect!

The Chinese word “晶片”(wafer) is out of the vocabulary

Example of correct translations produced by NMT decoding

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次に、酸化膜をhf洗浄により除去した後、**貼り合わせウェーハ**の剥離面から酸素イオンを注入した。

(Next, after removing an oxide film by hf washing, we inject oxygen ions from the peeled surface of the **laminated wafer**.)

Japanese technical term “**貼り合わせウェーハ**”(laminated wafer) is translated as Chinese technical term “贴合晶片” by SMT

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(TRANSLATION: Subsequently, after the oxide film was removed by washing with hf, and oxygen ions were injected from the peeled surface of the **laminated wafer**.)

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(TRANSLATION: Then, after the oxide film was removed by hf cleaning, oxygen was injected from the peeled surface of the **bonded UNK**.)

Incorrect!

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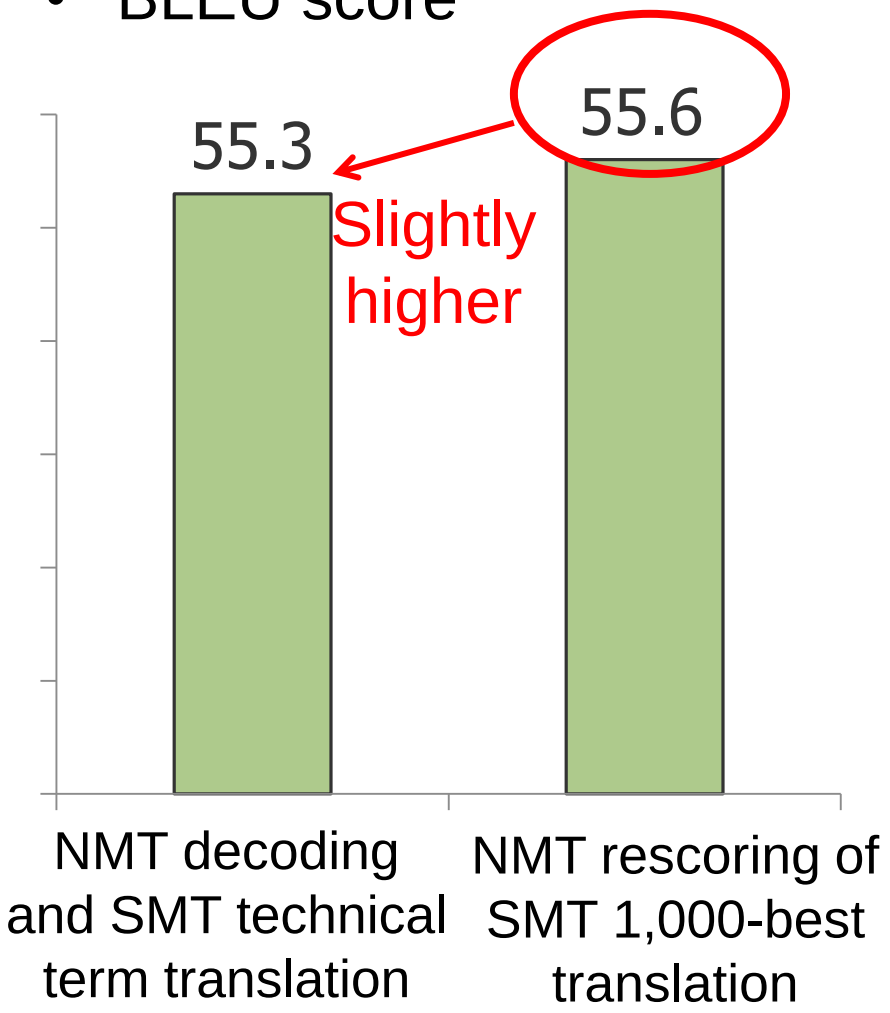
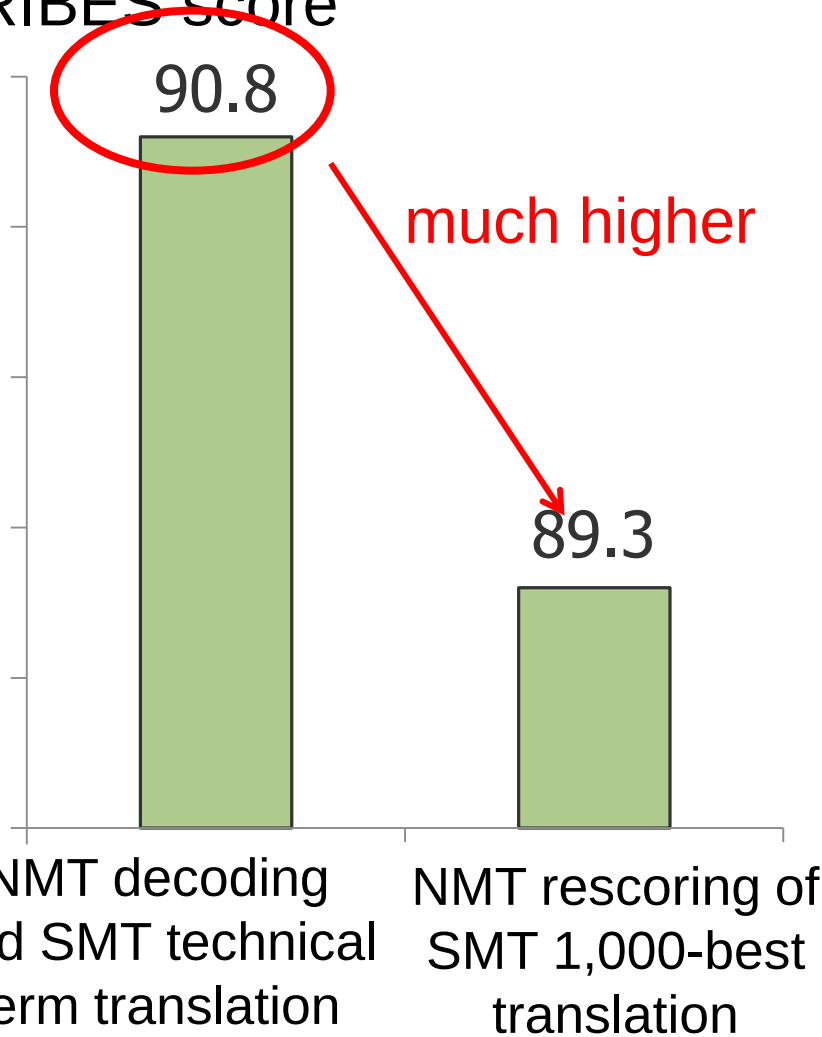


- RIBES score



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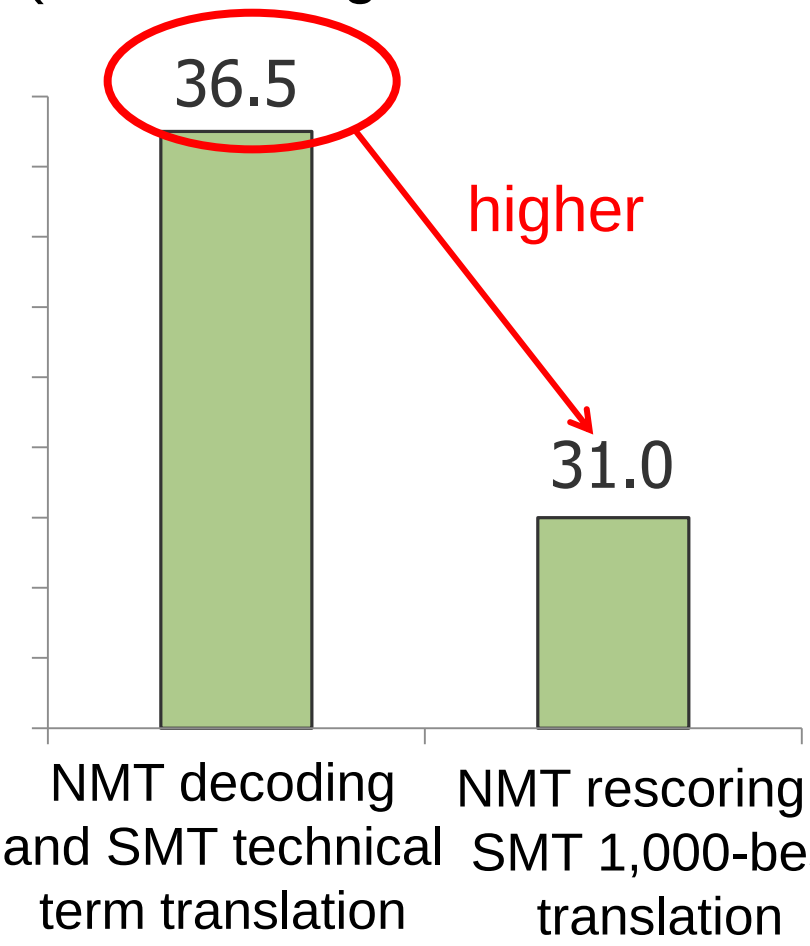

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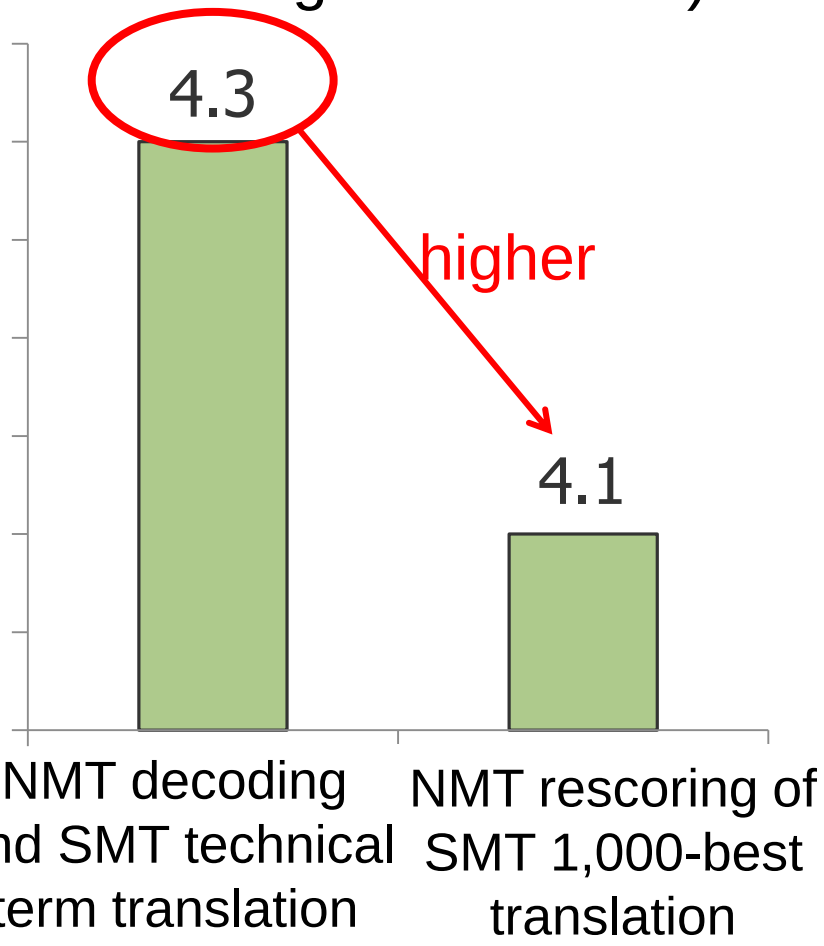

Conclusion and Future Work

- Translating patent sentences with a large vocabulary of technical terms by training an NMT system on a bilingual corpus, wherein technical terms are replaced with tokens
- Evaluation experiments on Japanese-Chinese patent sentences proved the effectiveness of the proposed method
- Future Work:
  - Evaluate the proposed method with a bidirection NMT system (Bahdanau et al. 2015)
  - Rescore 1,000-best NMT translations by using SMT system

Thank you for your attention!