삼성전기 AI전문가 양성과정 - 프로젝트 실습 (비영상)

자연어처리를 위한 Machine Translation

현청천

2022.02.28

What is Machine Translation

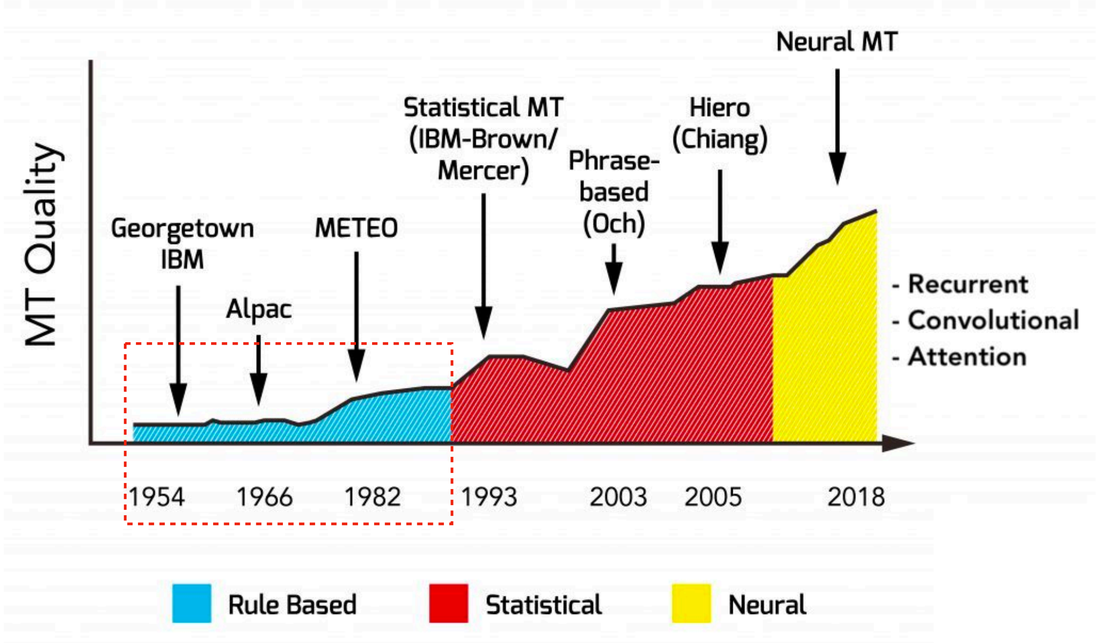
인간이 사용하는 자연 언어를 컴퓨터를 사용하여 다른 언어로 번역하는 것

Education is the most powerful weapon we can use to change the world.

교육은 세상을 바꿀 수 있는 가장 강력한 무기이다.

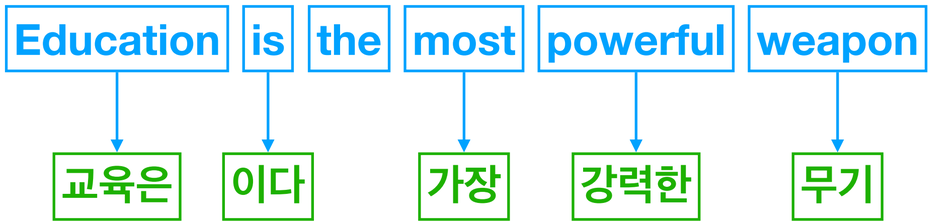
출처: https://ko.wikipedia.org/wiki/%EA%B8%B0%EA%B3%84_%EB%B2%88%EC%97%AD

What is Machine Translation (history)



Rule-based Machine Translation

- Bilingual dictionary
- Linguistic rules for each language



I saw a man on a hill with a telescope ?

이미지: https://iconictranslation.com/what-we-do/neural-machine-translation/
참조: https://www.freecodecamp.org/news/a-history-of-machine-translation-from-the-cold-war-to-deep-learning-f1d335ce8b5/

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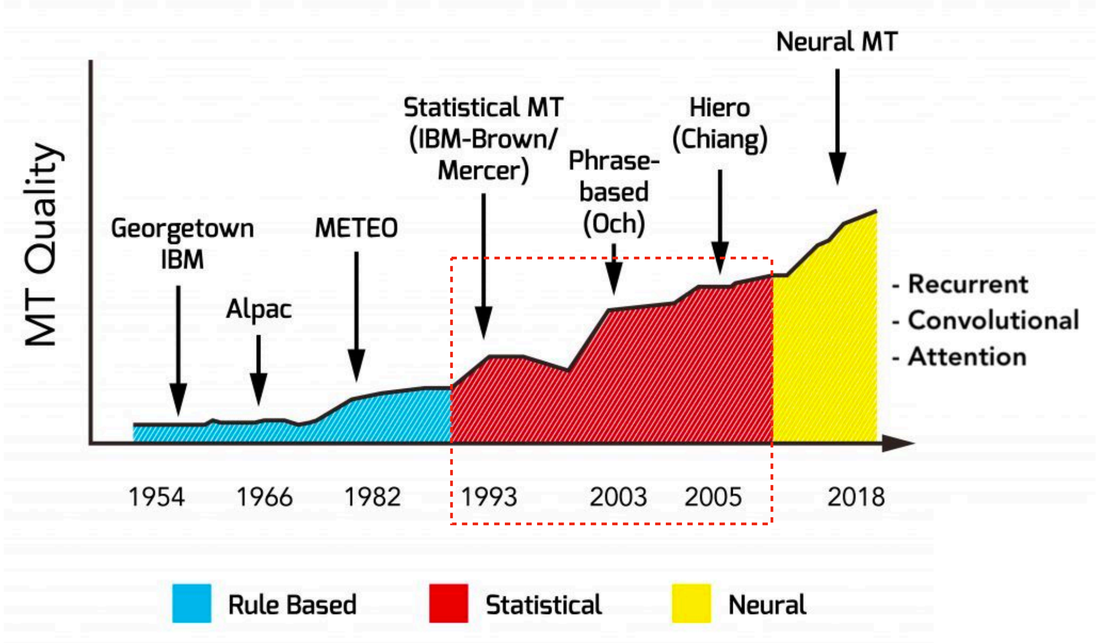

Statistical Machine Translation

- Language pair로부터 패턴 학습
- 데이터가 많을 수록 좋은 결과
- $argmax_y P(y|x)$

x = **'Education is the most powerful weapon'**

$$\text{'교육은'} = argmax_y P(y|x)$$

$$\text{'가장'} = argmax_y P(y|x, \text{'교육은'})$$

$$\text{'강역한'} = argmax_y P(y|x, \text{'교육은'}, \text{'가장'})$$

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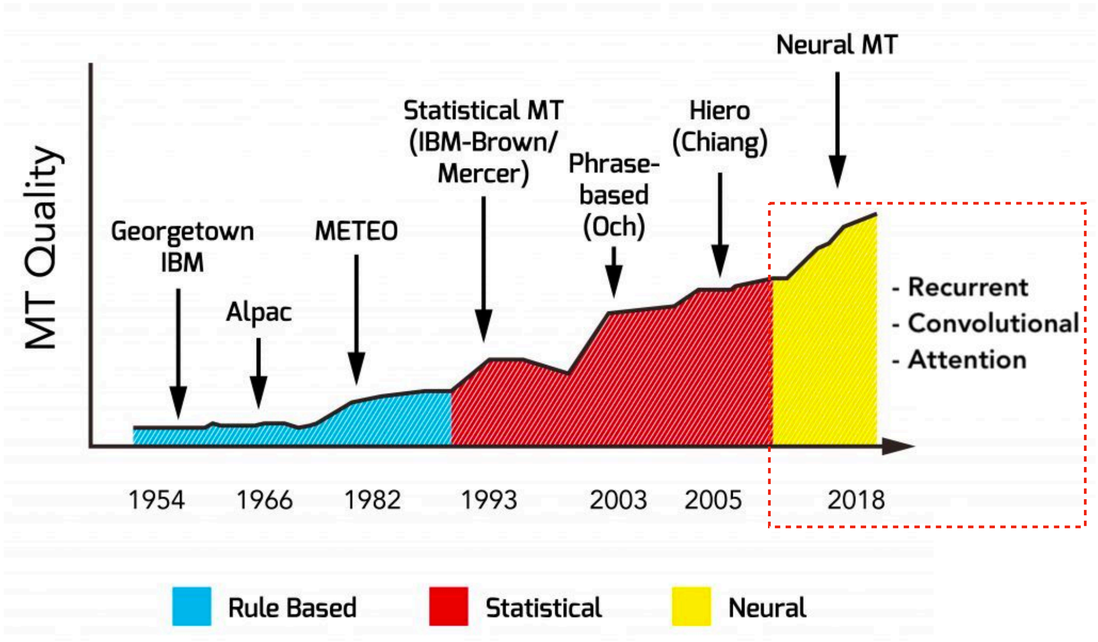

Neural Machine Translation

- 2041년 sequence to sequence 모델 등장
- 데이터에서 Neural Network 학습
- $P(y \mid x; \theta)$
  - 어순 오류 감소
  - 어휘 오류 감소
  - 문법 오류 감소

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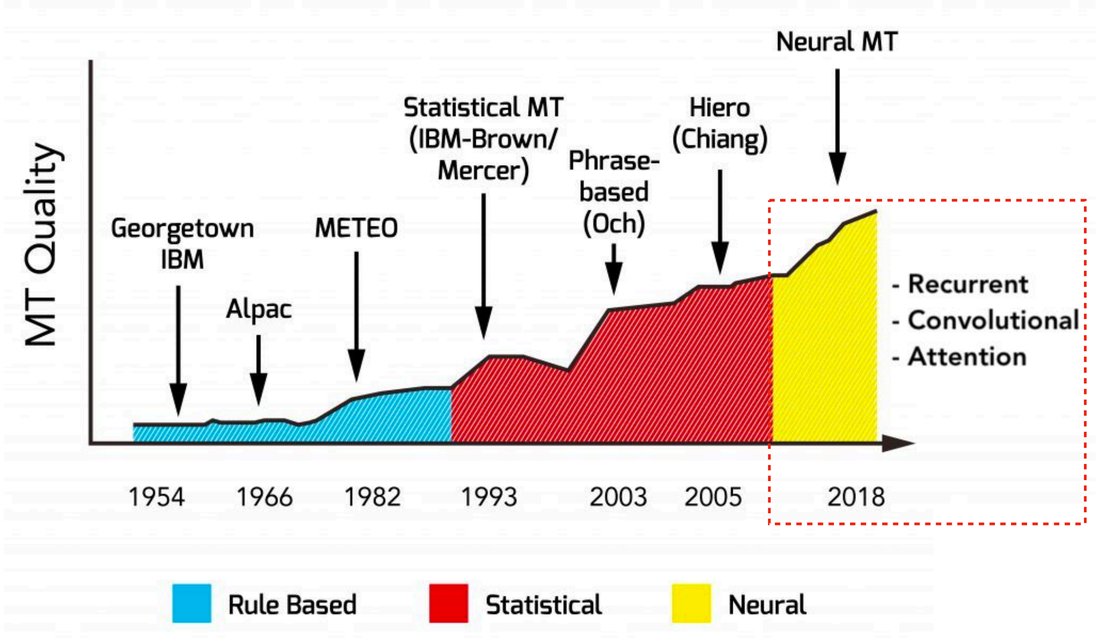
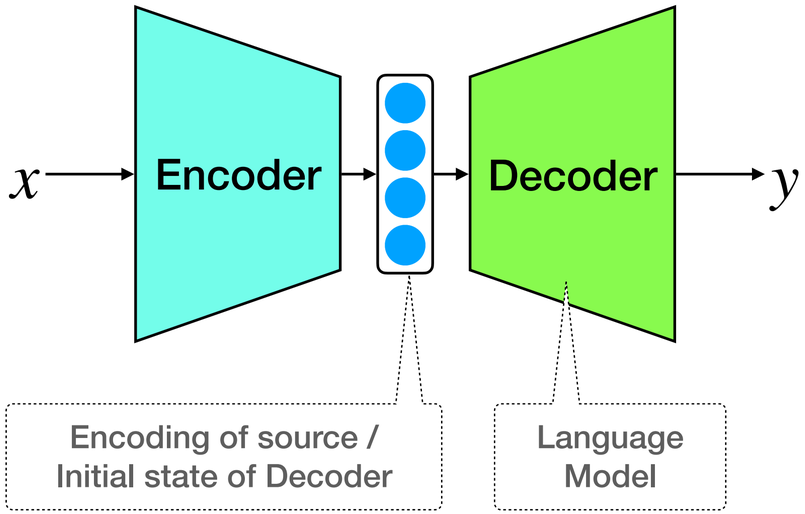


Neural Machine Translation



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Machine Translation DataSet

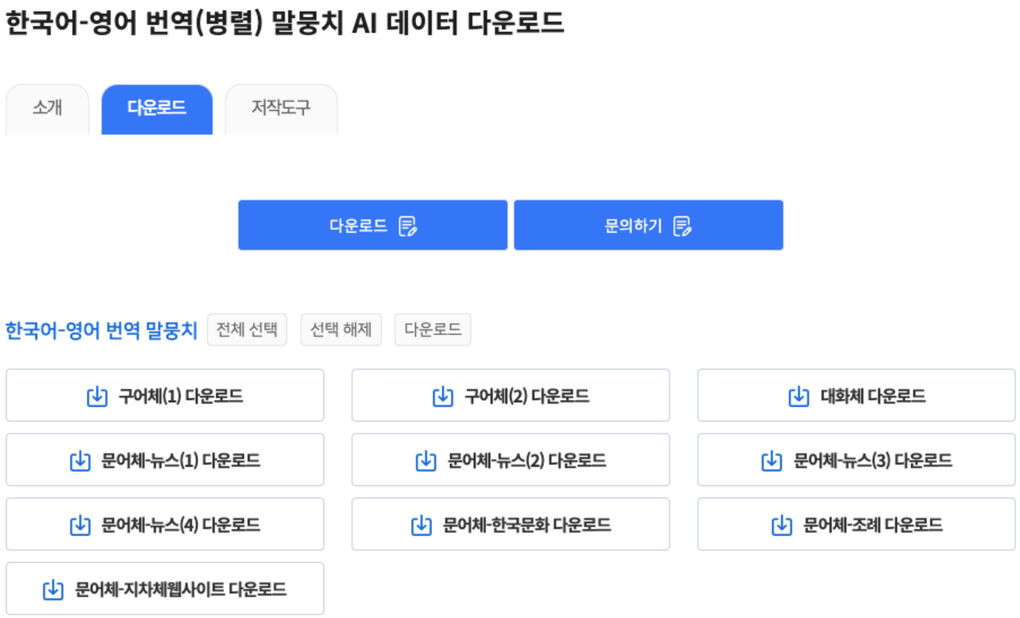
- WMT Dataset

File	CS-EN	DE-EN	IU-EN	JA-EN	KM-EN	PL-EN	PS-EN	RU-EN	TA-EN	ZH-EN	FR-DE
Europarl v10	✓	✓				✓					✓
ParaCrawl v5.1	✓	✓		✓	✓	✓	✓	✓			✓
Common Crawl corpus	✓	✓						✓			✓
News Commentary v15	✓	✓		✓				✓		✓	✓
CzEng 2.0	✓										
Yandex Corpus								✓			
Wiki Titles v2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
UN Parallel Corpus V1.0								✓		✓	
Tilde Rapid corpus	✓	✓				✓					
CCMT Corpus										✓	
WikiMatrix	✓	✓		✓		✓		✓	✓	✓	✓
Back-translated news	✓							✓		✓	
Japanese-English Subtitle Corpus				✓							
The Kyoto Free Translation Task Corpus				✓							
TED Talks				✓							
Nunavut Hansard Inuktitut-English Parallel Corpus 3.0			✓								
PMIndia v1									✓		
Tanzil v1									✓		

- Workshop on Statistical Machine Translation
- Bilingual Datasets
- English Based Datasets
- http://www.statmt.org/wmt20/translation-task.html

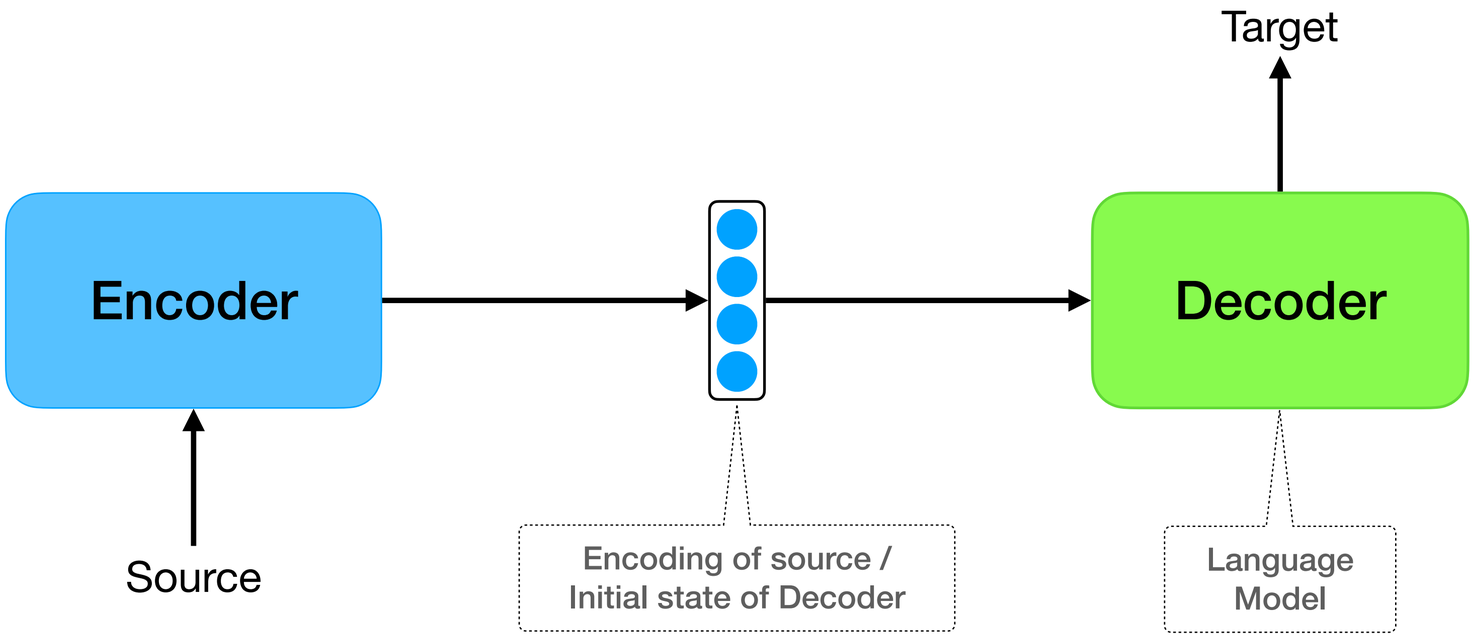
Machine Translation DataSet

- WMT Dataset
- AI-Hub 한국어-영어 병렬 말뭉치



- AI-Hub 한국어-영어 데이터
- 회원 가입 및 별도의 서류제출 후 다운로드
- https://aihub.or.kr/aidata/87/download

Machine Translation Model



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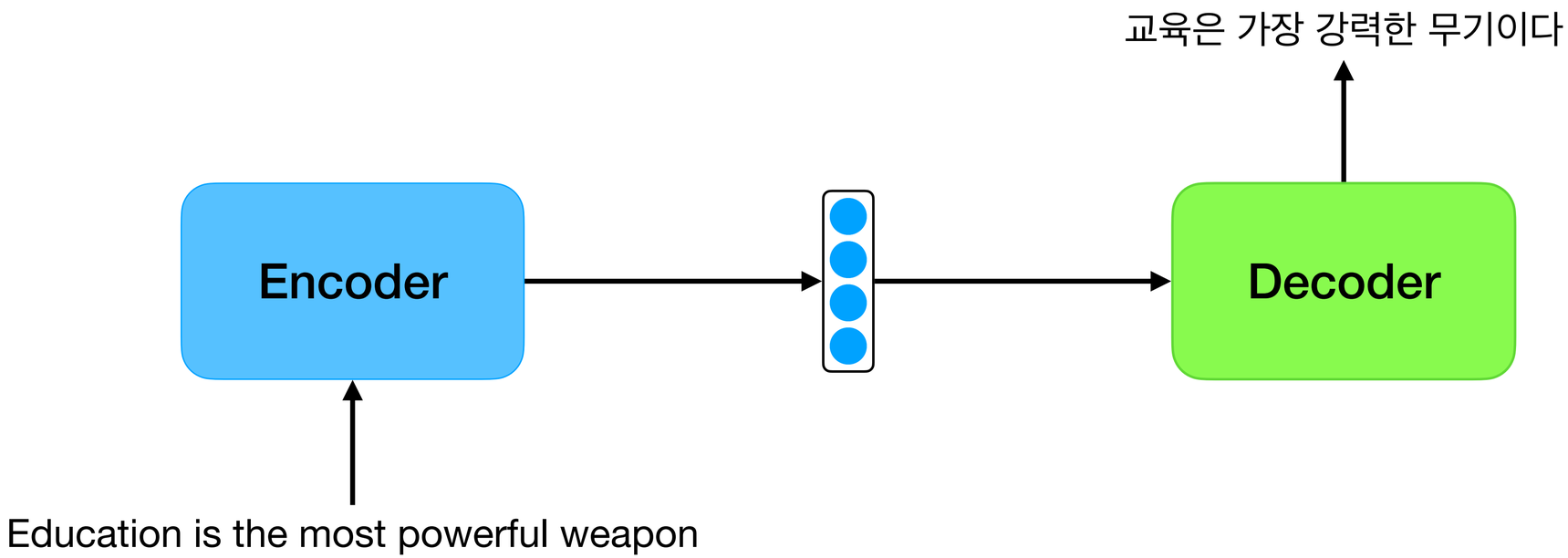
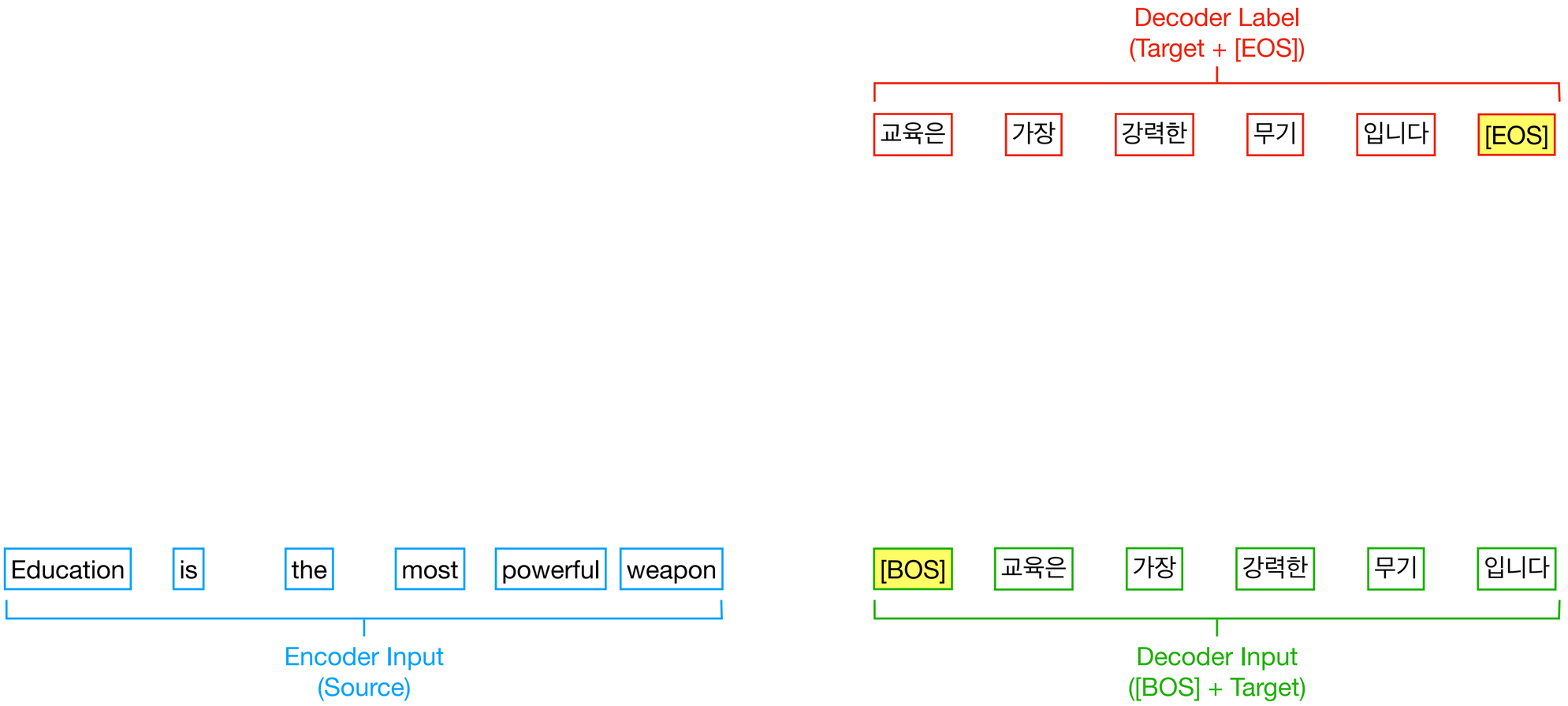


Encoder Decoder Architecture / Sequence to Sequence

Machine Translation Model (Training)



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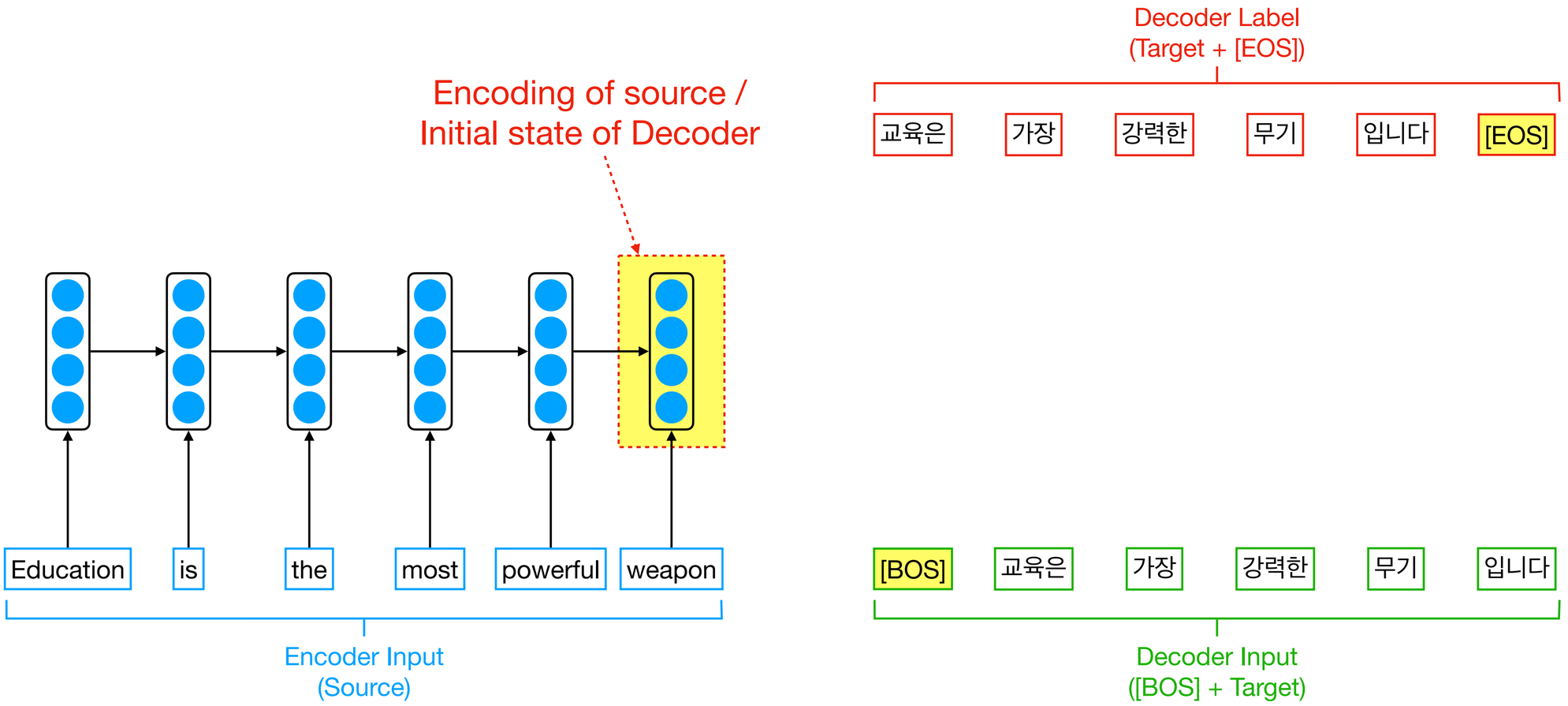

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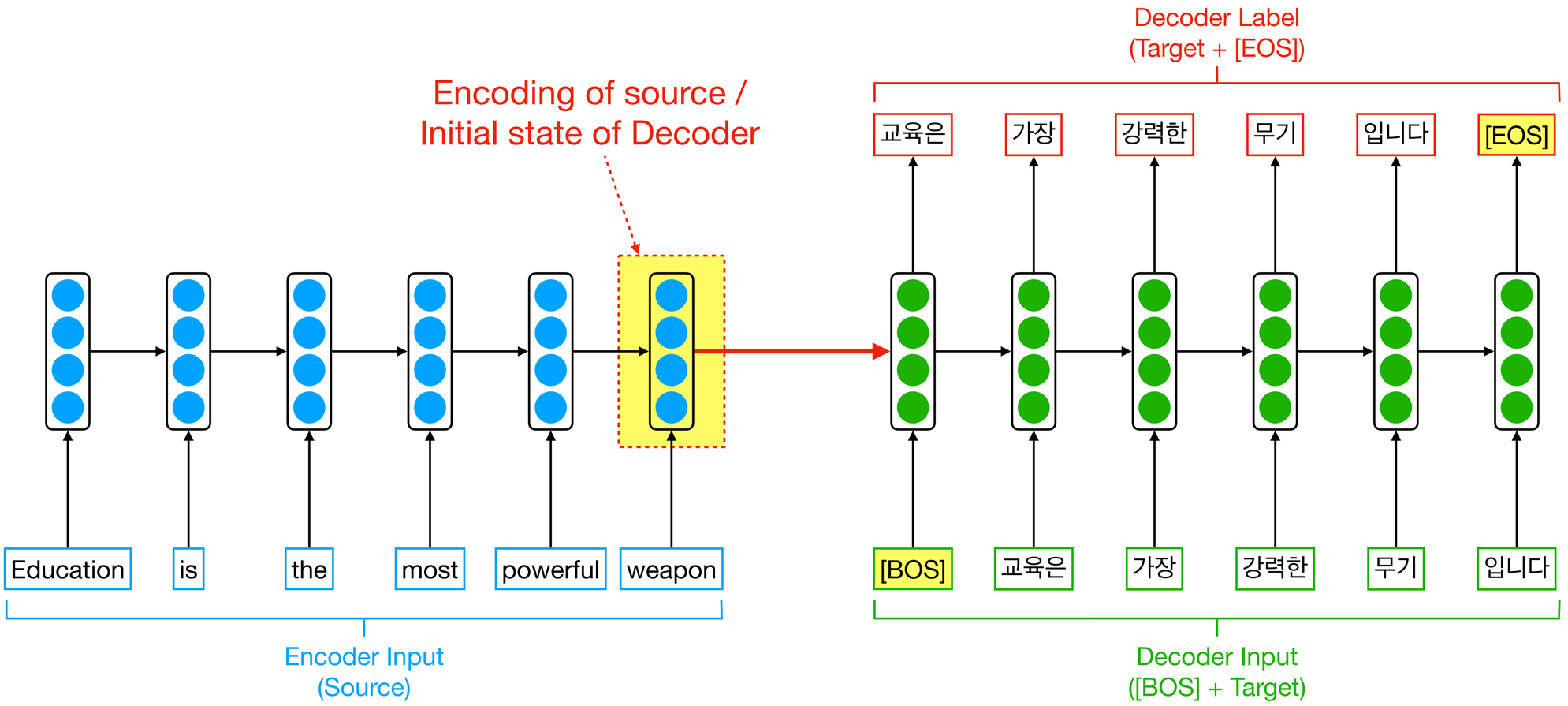

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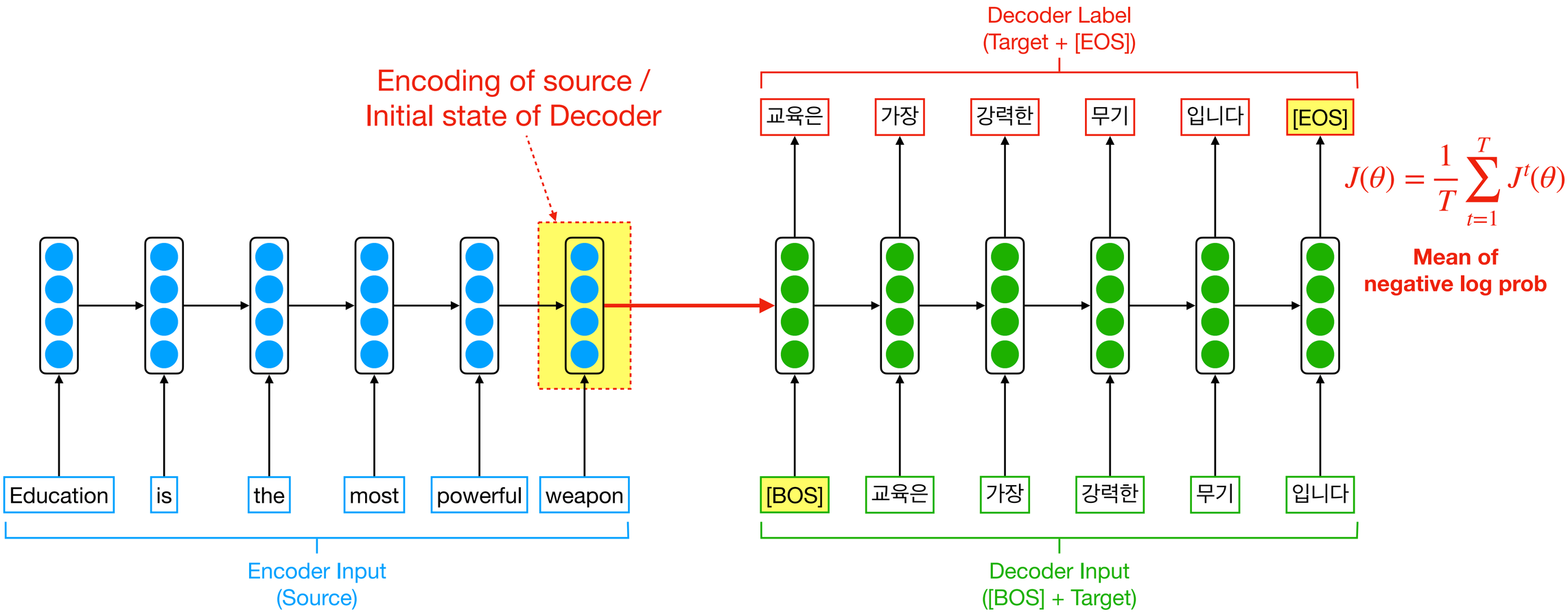
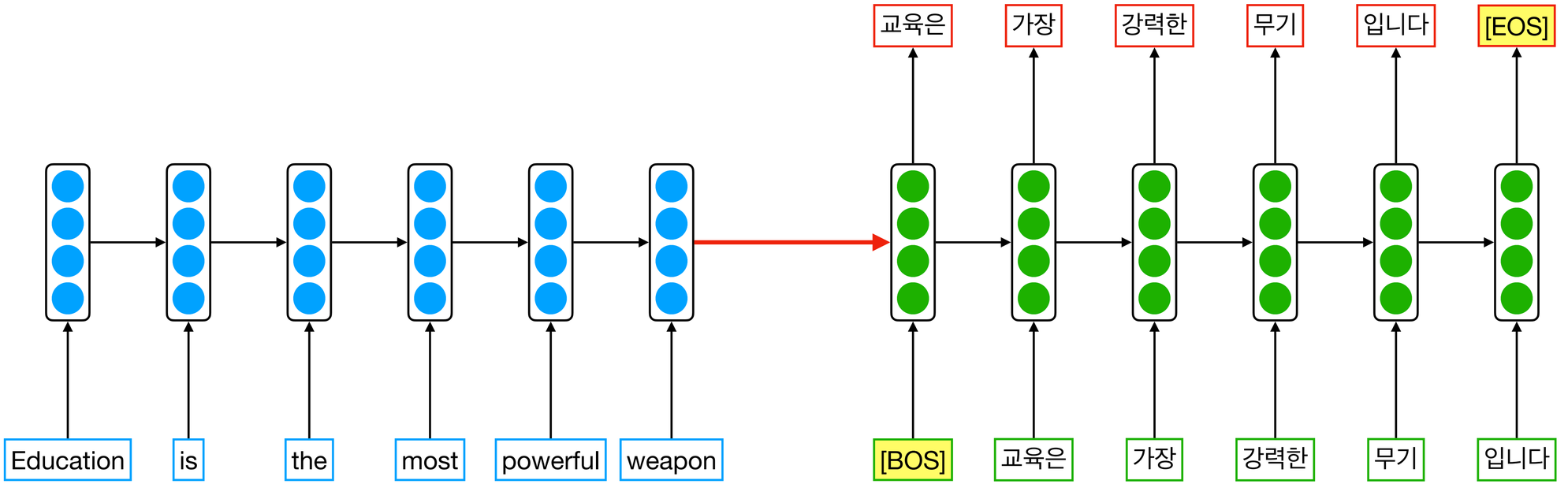


Machine Translation Model (Training)

$$p(y_1, \ldots, y_n \mid x_1, \ldots, x_m) = \prod_{t=1}^{n} p(y_t \mid v, y_1, \ldots, y_{t-1})$$



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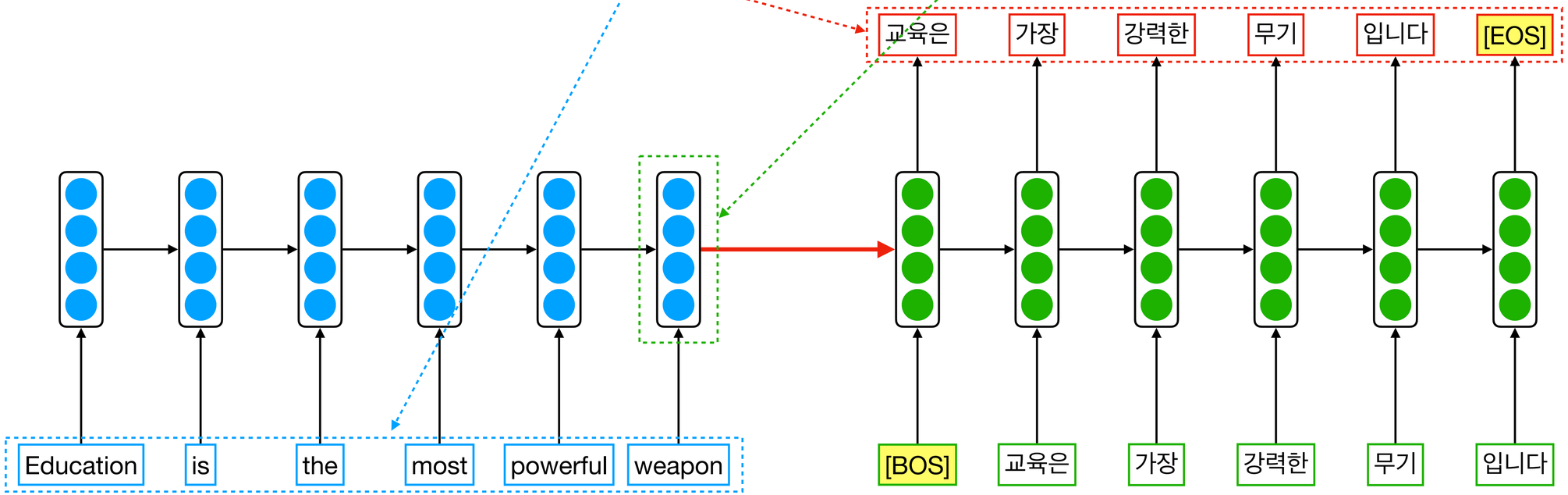
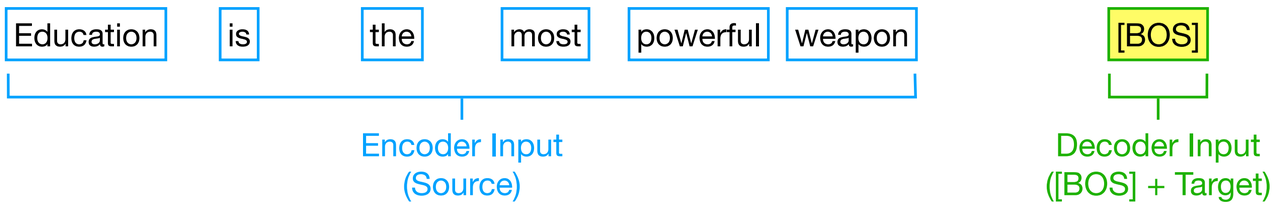


Machine Translation Model (Inference)



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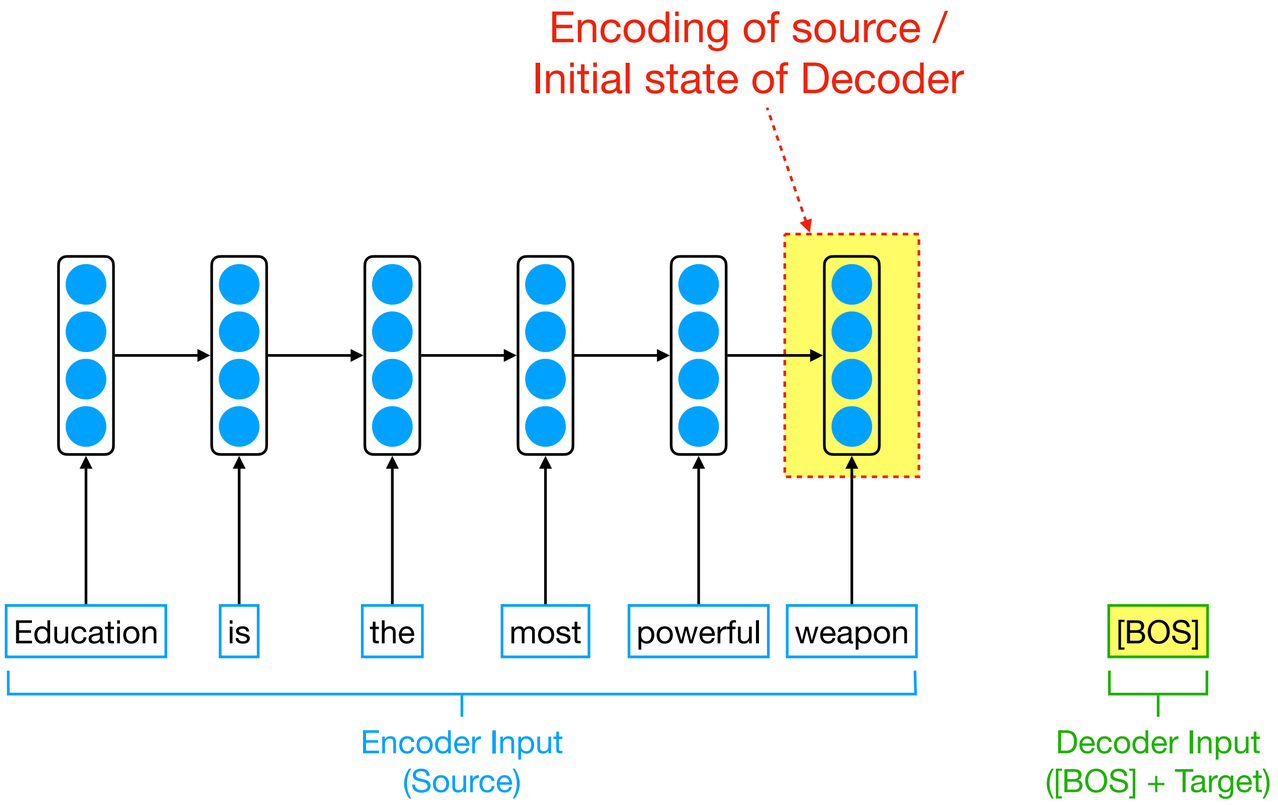

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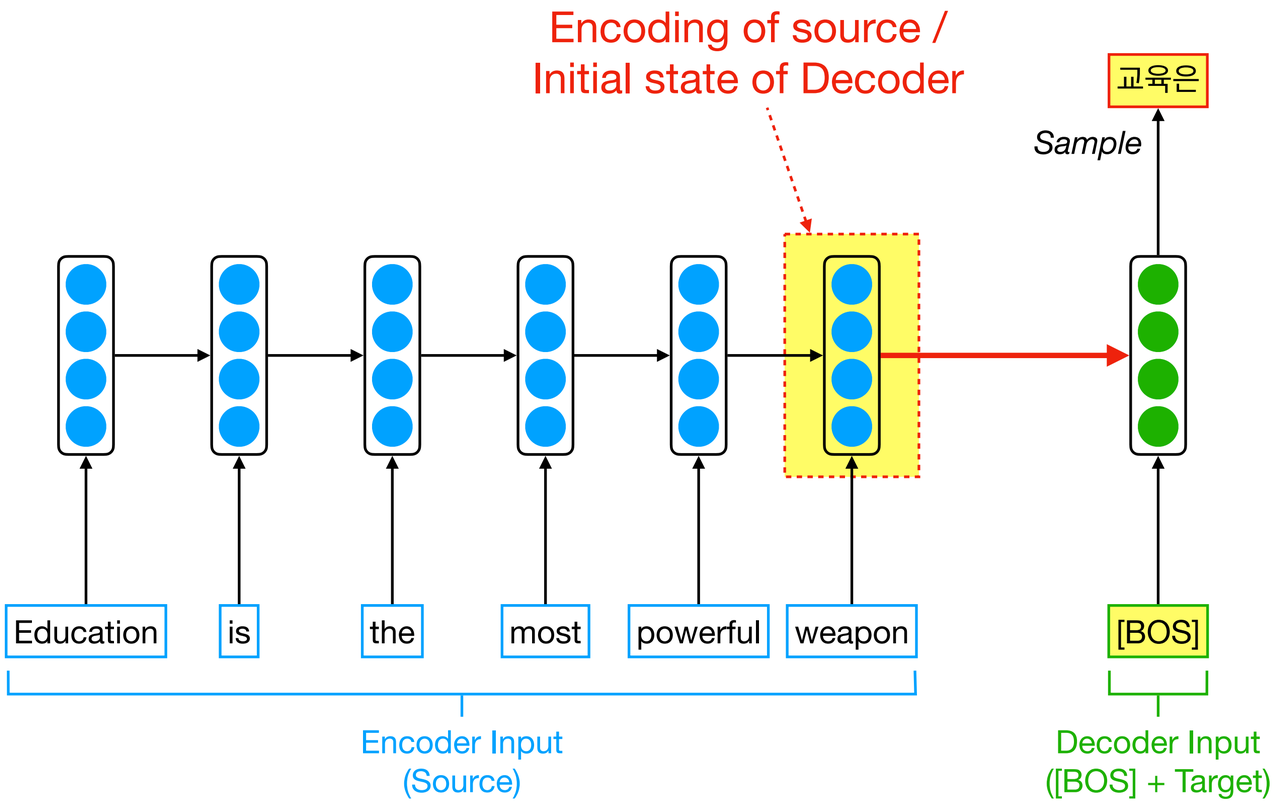

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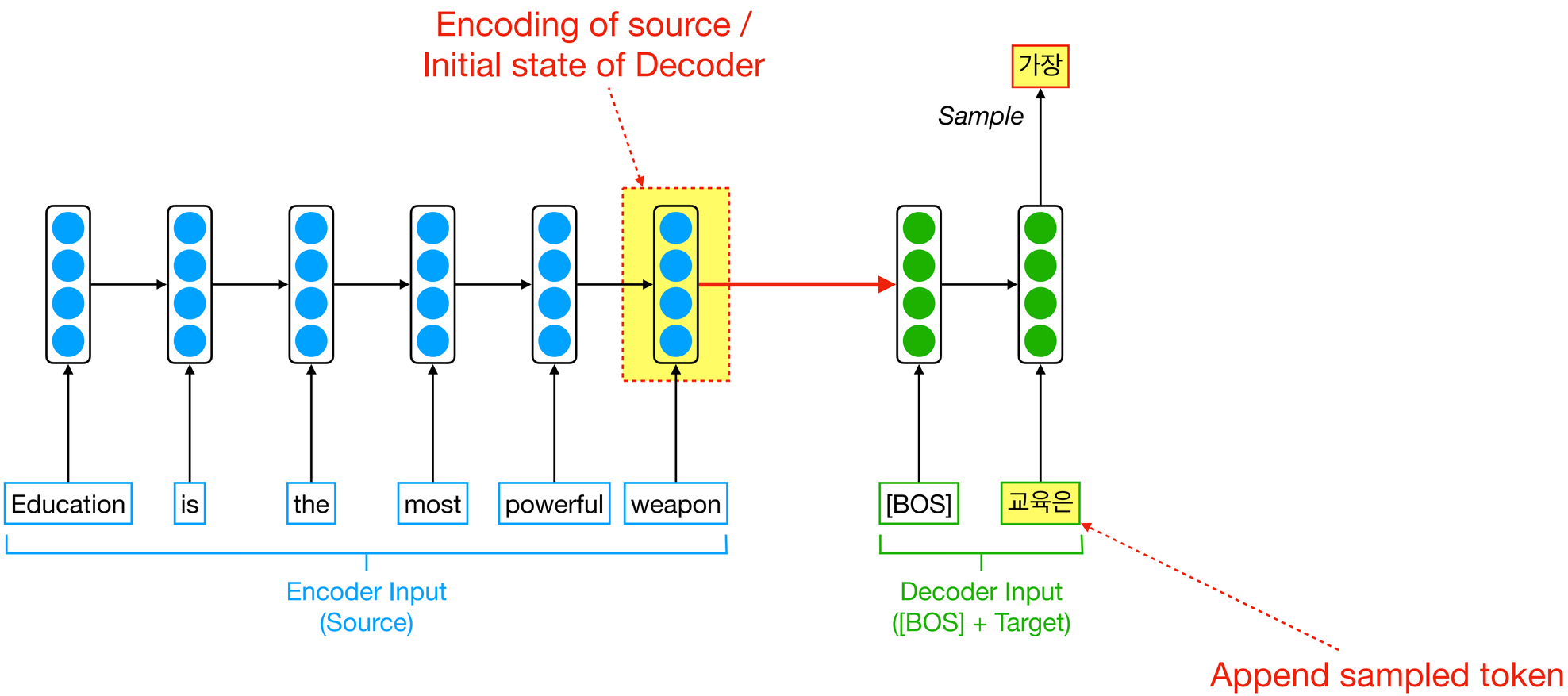

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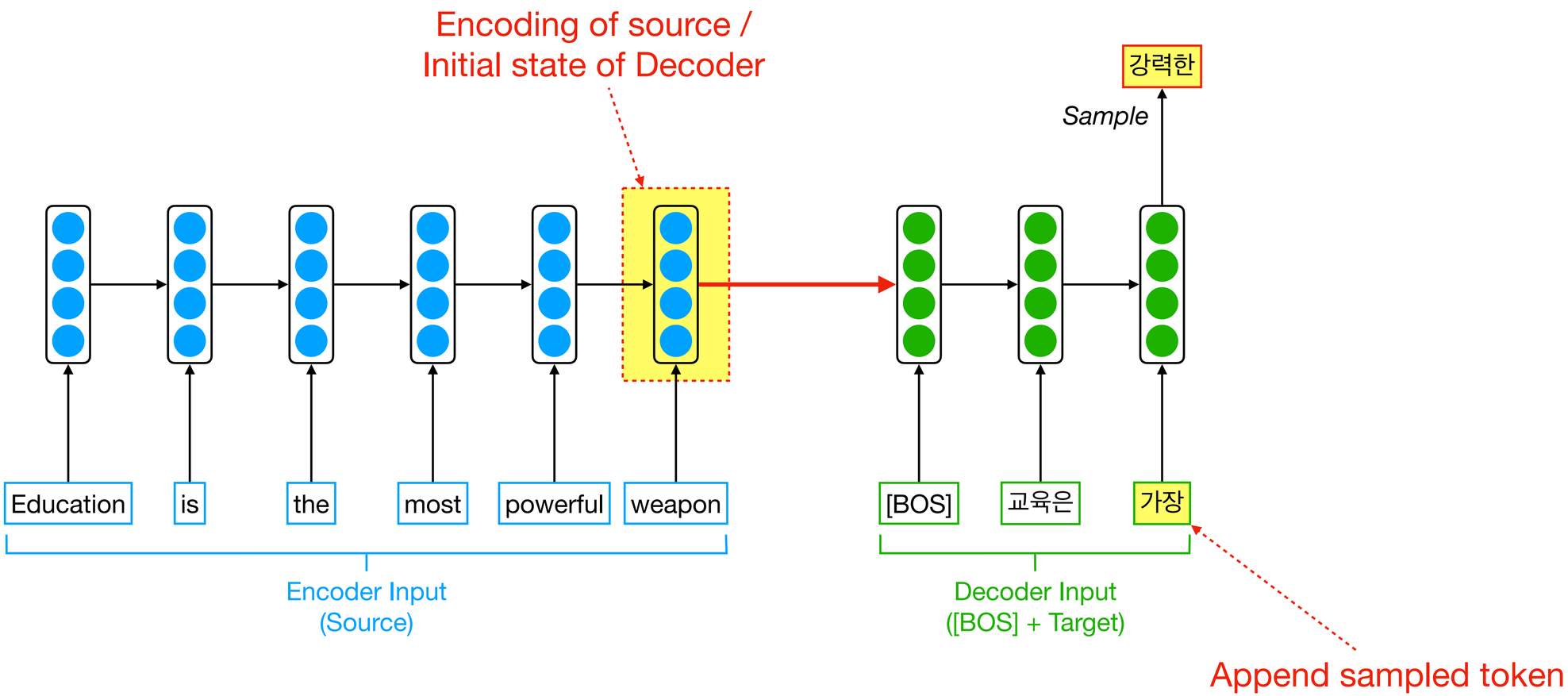

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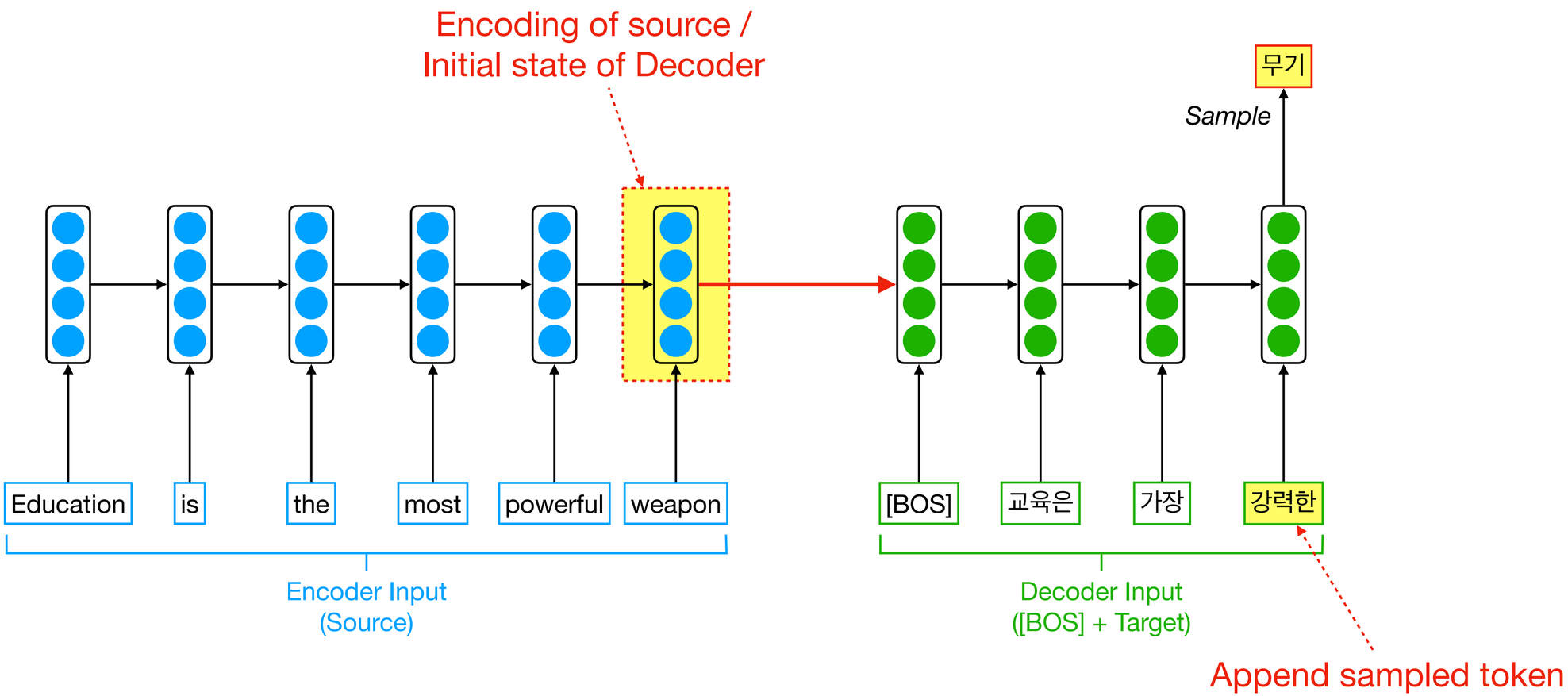

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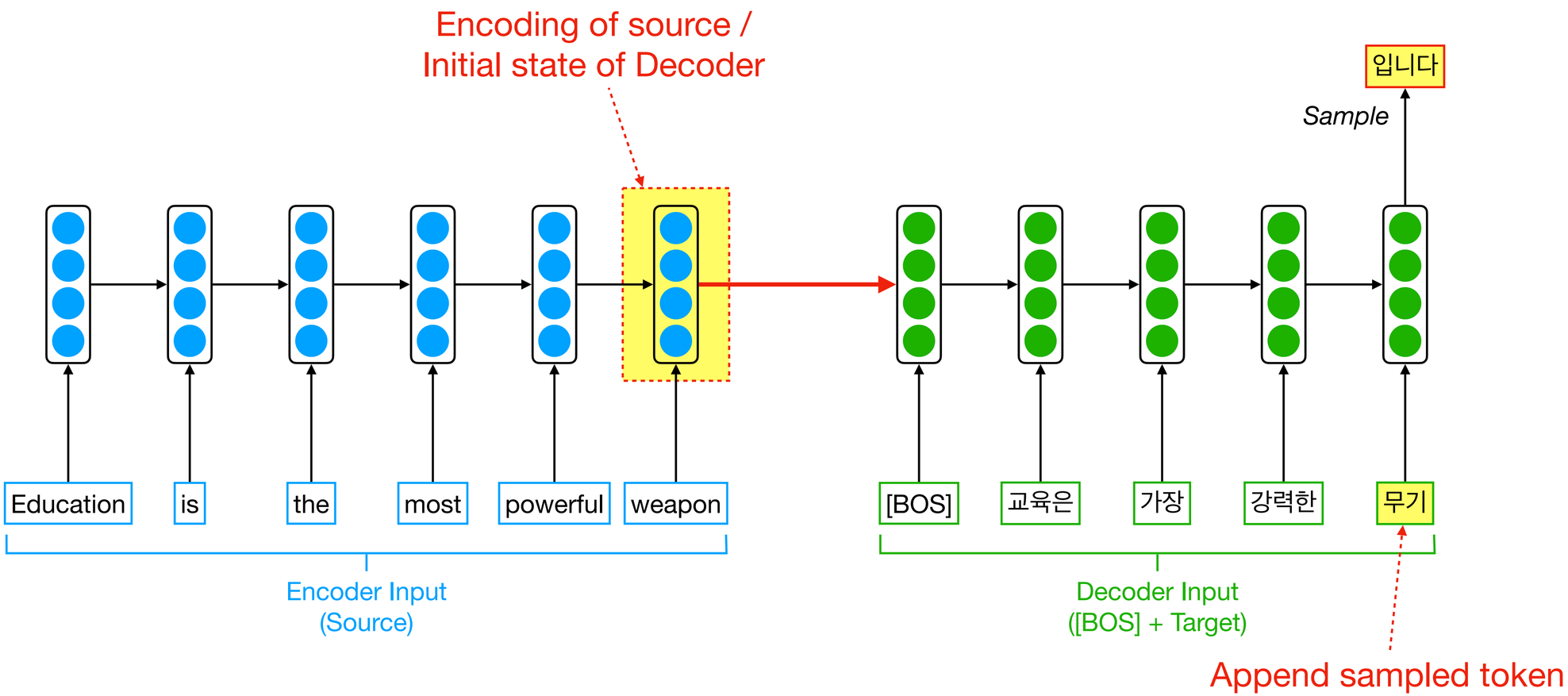

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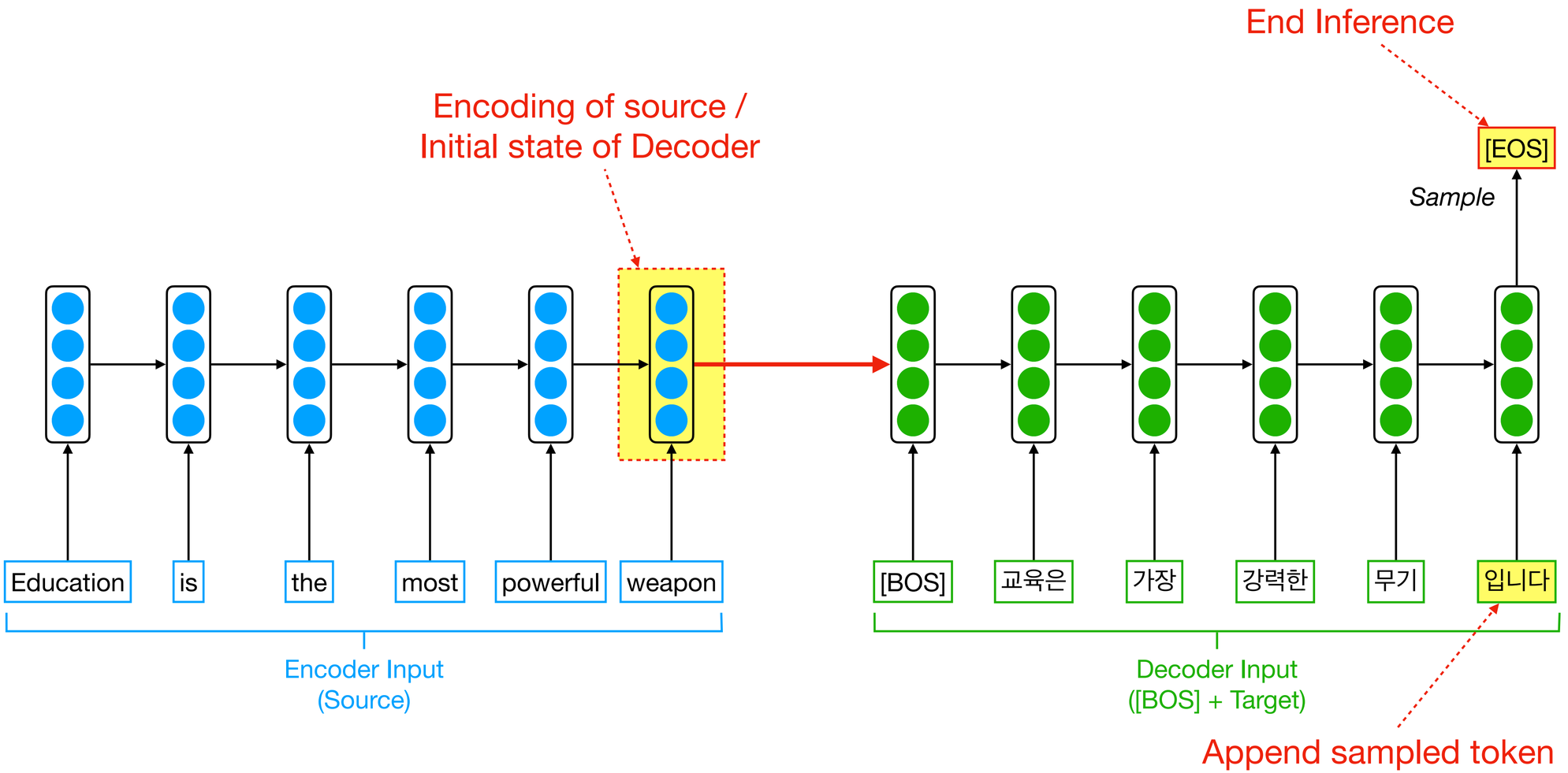
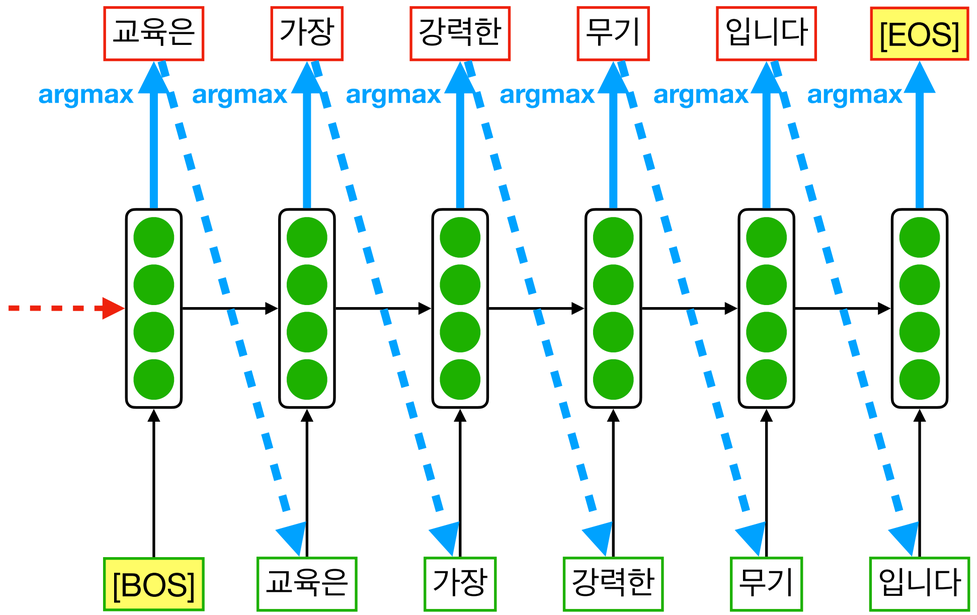


Machine Translation Model (Versatile)

- Summarization (long text → short text)
- Dialog (user utterance → agent utterance)
- Parsing (text → parsed sequence)
- Code generation (text → program code)
- etc.

Machine Translation Model (Decoding)



Greedy Search

Machine Translation Model (Decoding)

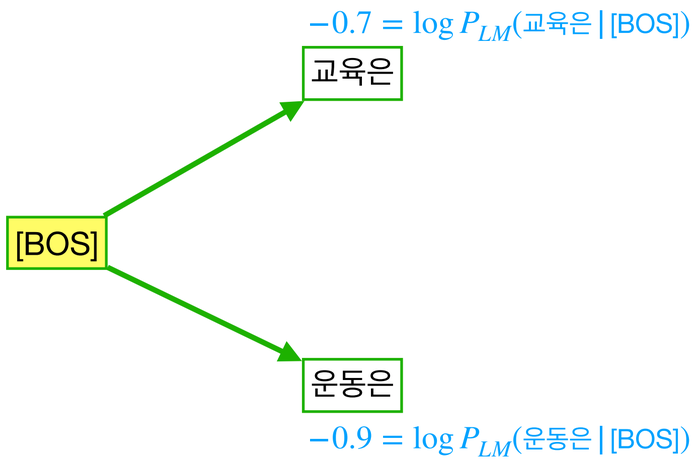
$$score(y_1, \ldots, y_t) = \sum_{i=1}^{t} \log P_{LM}(y_i | y_1, \ldots, y_{i-1})$$

[BOS]

Beam Search (k=2)

Machine Translation Model (Decoding)

$$score(y_1, \ldots, y_t) = \sum_{i=1}^{t} \log P_{LM}(y_i \mid y_1, \ldots, y_{i-1})$$



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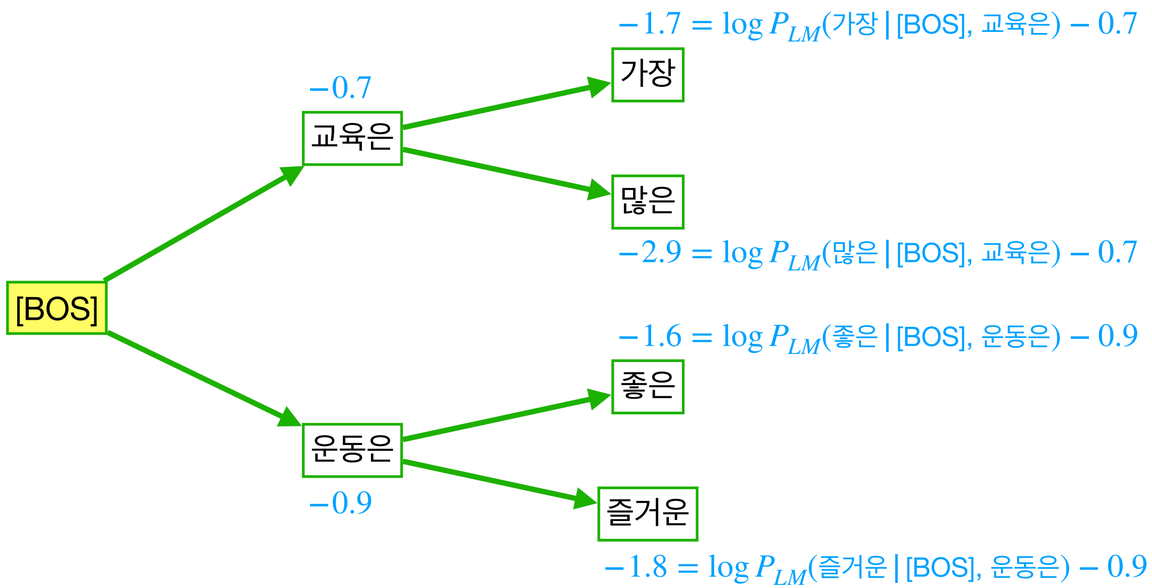

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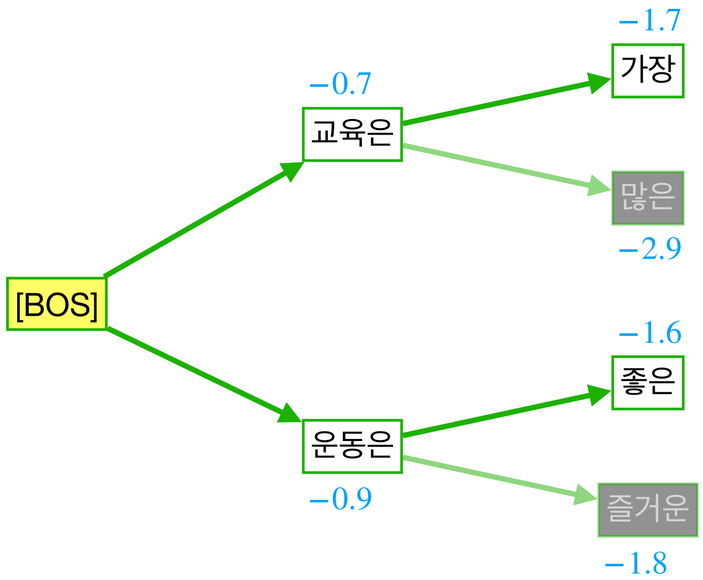

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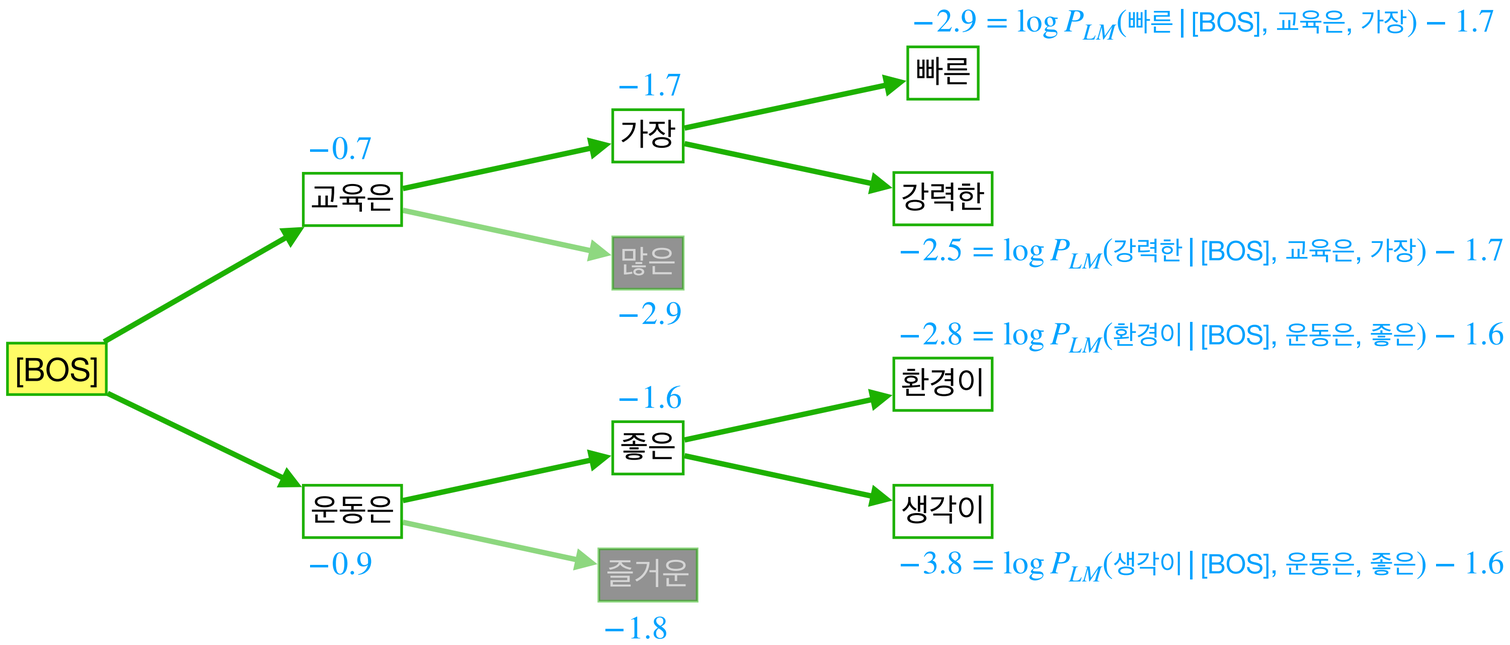

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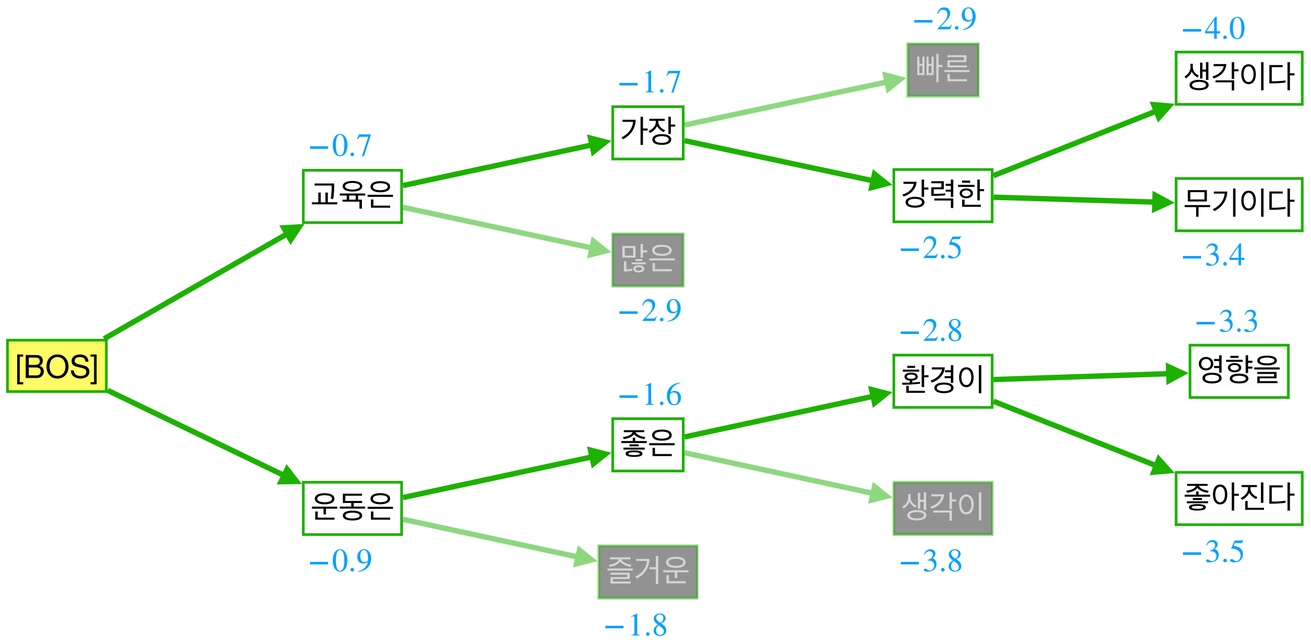

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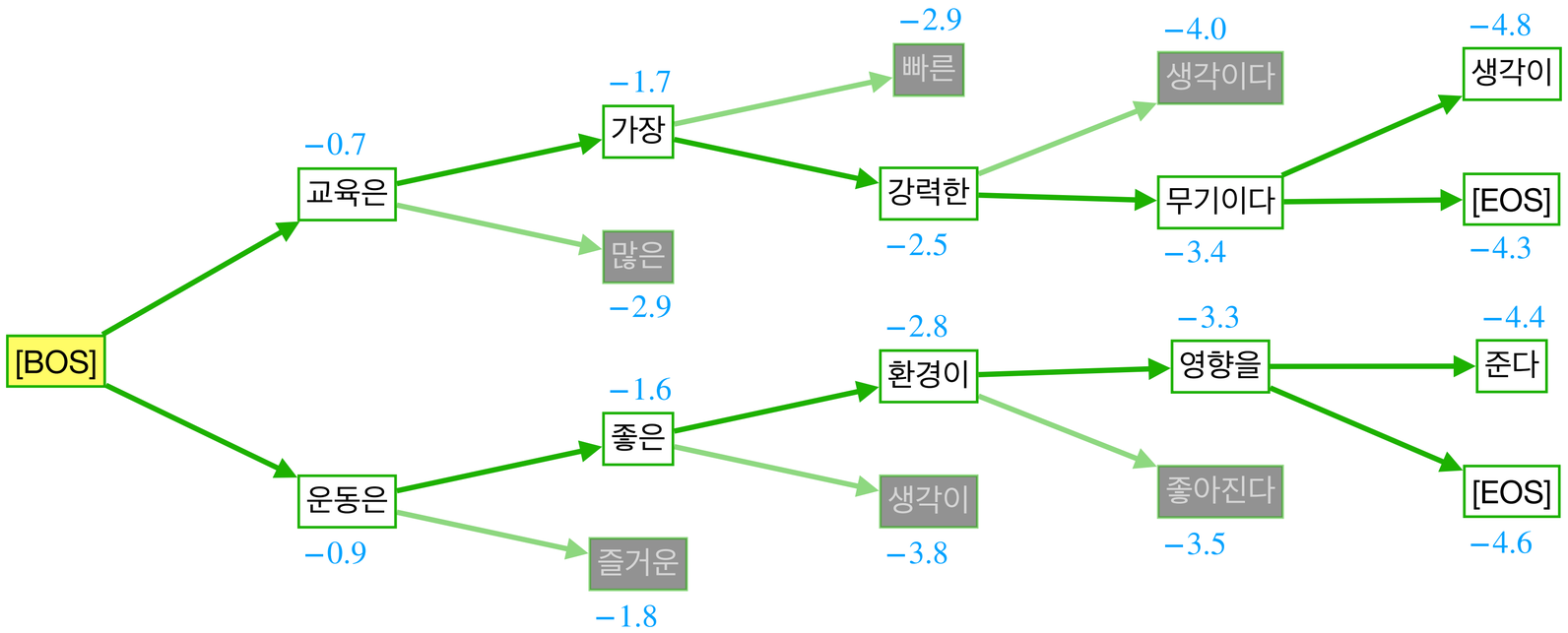

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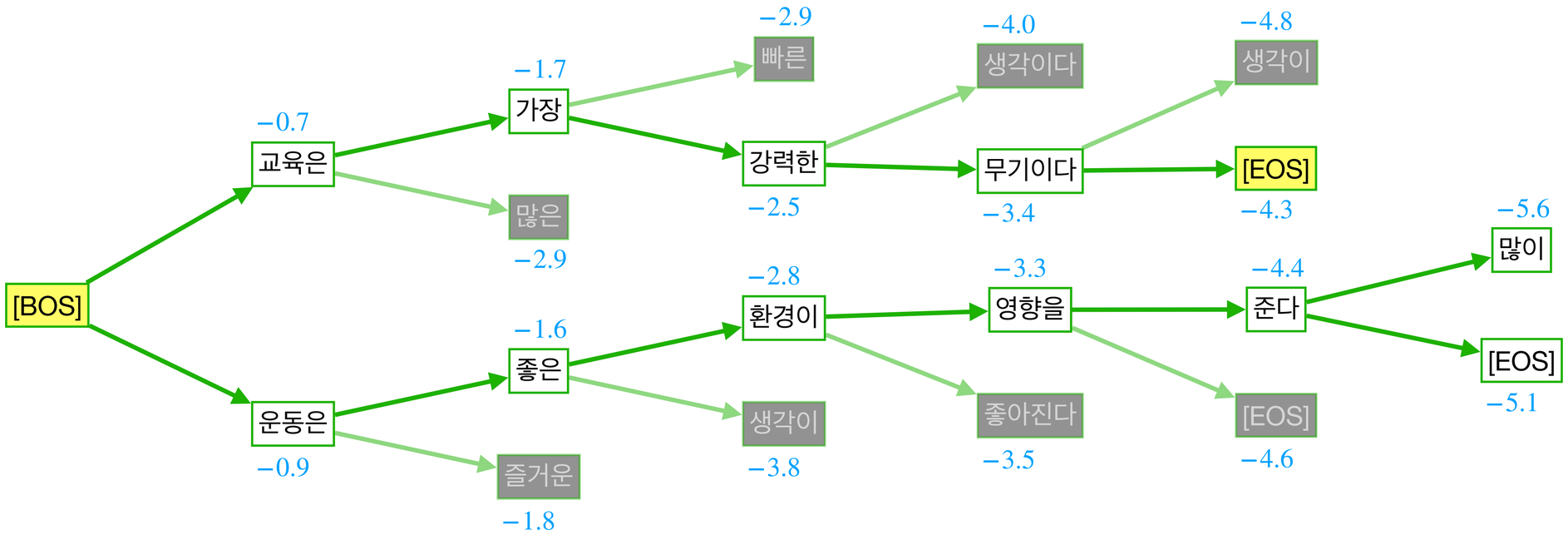

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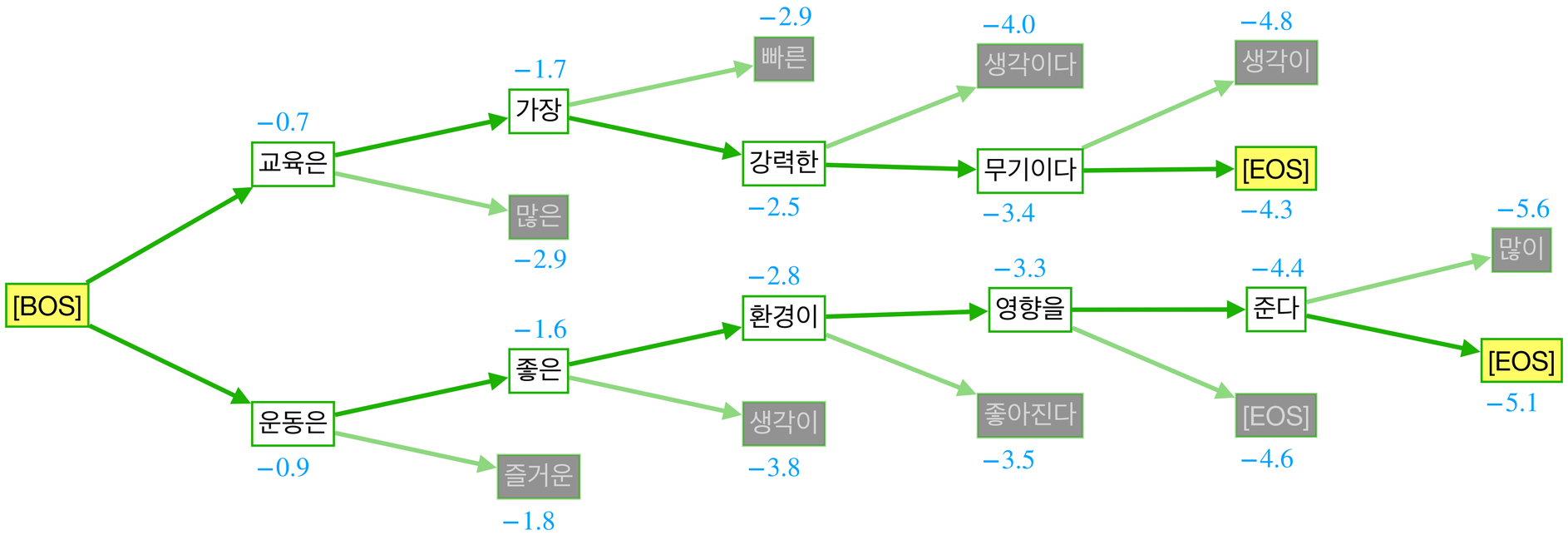

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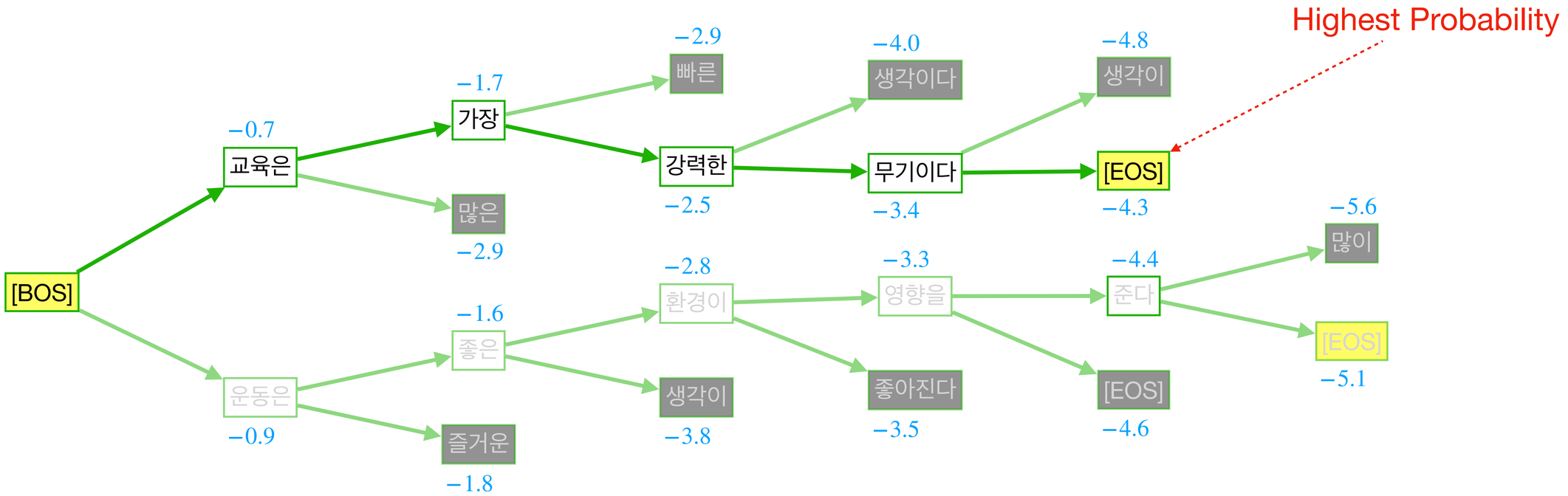

Beam Search (k=2)

Machine Translation Model (Decoding)

Length Penalty

- Longer hypotheses have lower score

$$score(y_1, \ldots, y_t) = \sum_{i=1}^{t} \log P_{LM}(y_i \,|\, y_1, \ldots, y_{n-1})$$

- Normalize by length

$$score(y_1, \ldots, y_t) = \frac{1}{t} \sum_{i=1}^{t} \log P_{LM}(y_i \,|\, y_1, \ldots, y_{n-1})$$

Beam Search (k=2)

Machine Translation Model (Metric)

Education is the most powerful weapon we can use to change the world.

How do you evaluate???

교육은 세상을 바꿀 수 있는 가장 강력한 무기이다.

세상을 바꿀 수 있는 가장 강력한 무기는 교육이다.

가장 강력한 무기인 교육을 통해 세상을 바꿀 수 있다.

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

- Machine Translation된 결과와 사람이 Translation한 결과를 비교하여 품질을 평가
  - n-gram precision
  - penalty for too-short system translations

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

N-gram precision

Candidate 1: It is a guide to action which ensures that the military always obeys the commands of the party.

Candidate 2: It is to insure the troops forever hearing the activity guidebook that party direct.

Reference 1: It is a guide to action that ensures that the military will forever heed Party commands.

Reference 2: It is the guiding principle which guarantees the military forces always being under the command of the Party.

Reference 3: It is the practical guide for the army always to heed the directions of the party.

$$\text{Candidate 1 Unigram Precision} = \frac{17}{18}$$

$$\text{Candidate 2 Unigram Precision} = \frac{8}{14}$$

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

N-gram precision

Candidate: the the the the the the the.

Reference 1: The cat is on the mat.

Reference 2: There is a cat on the mat.

$$\text{Candidate Unigram Precision} = \frac{7}{7}$$

$$Count_{clip} = \min(Count, Max\_Ref\_Count)$$

$$\text{Candidate Modified Unigram Precision} = \frac{2}{7}$$

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

N-gram precision

Candidate의 n-gram의 $Count_{clip}$개수

$$p_n = \frac{\sum_{n\text{-}gram \in C} Count_{clip}(n\text{-}gram)}{\sum_{n\text{-}gram' \in C} Count(n\text{-}gram')}$$

Candidate의 n-gram 개수

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

Penalty for too-short system translations

Candidate: of the

Reference 1: It is a guide to action that ensures that the military will forever heed Party commands.

Reference 2: It is the guiding principle which guarantees the military forces always being under the command of the Party.

Reference 3: It is the practical guide for the army always to heed the directions of the party.

$$\text{Candidate Unigram Precision} = \frac{2}{2}$$

짧은 문장일수록 n-gram precision이 높아지는 경향이 있음

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

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Penalty for too-short system translations

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brevity penalty $$BP = \begin{cases} 1, & \text{if } c > r \\ exp(1 - \frac{r}{c}), & \text{if } c \leq r \end{cases}$$

짧은 문장일수록 n-gram precision이 높아지는 경향이 있음

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

$$p_n = \frac{\sum_{n\text{-}gram \in C} Count_{clip}(n\text{-}gram)}{\sum_{n\text{-}gram' \in C} Count(n\text{-}gram')}$$

$$BP = \begin{cases} 1, & \text{if } c > r \\ exp(1 - \frac{r}{c}), & \text{if } c \leq r \end{cases}$$

$$BLEU = BP \cdot exp(\sum_{n=1}^{N} w_n \log p_n)$$

Baseline: $N = 4, \quad w_n = \frac{1}{N}$

$$\log BLEU = min(1 - \frac{r}{c}, 0) + \sum_{n=1}^{N} w_n \log p_n$$

참고: https://www.aclweb.org/anthology/P02-1040.pdf

Machine Translation Model (Metric)

BLEU(Bilingual Evaluate Understudy) Score

Candidate: 나는 어제 집에 가서 잠을 잤다

Reference: 나는 어제 집에 가서 잠을 설쳤다

- BLEU는 유용한 지표지만 완벽하지 않음
- BLEU가 높으면 번역의 품질이 좋을 가능성이 높음
- 통계적인 지표

참고: https://www.aclweb.org/anthology/P02-1040.pdf

감사합니다.