# Automated Essay Scoring 2.0 with BERT

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Kaggle | Learning Agency Lab | Automated Essay Scoring

# Automated Essay Scoring 2.0 *with BERT

## FINAL GOAL

IMPROVE UPON ESSAY SCORING ALGORITHMS
TO IMPROVE STUDENT LEARNING OUTCOMES

## OUR GOAL

TRAINING A SCORING MODEL
FOR STUDENT ESSAYS

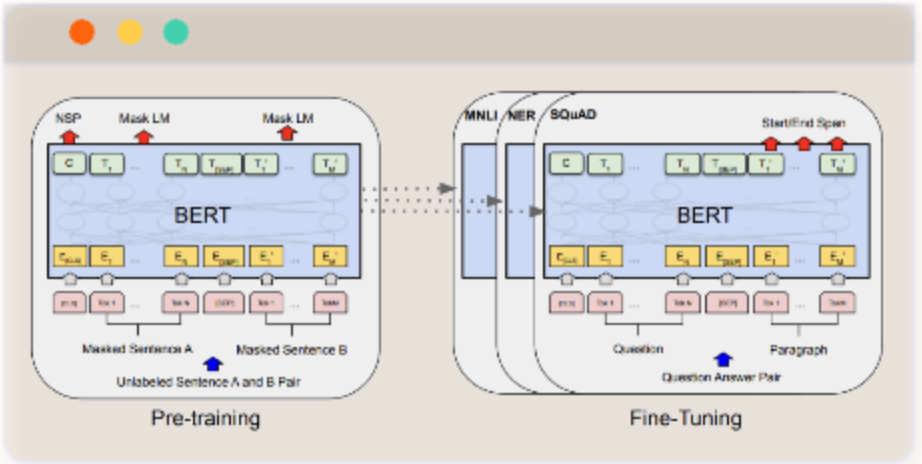
| | essay_id | full_text | score |
|---|---|---|---|
| 14982 | dc77aca | I am against that the technology doesn't have ... | 1 |
| 8928 | 83d10b5 | Mona Lisa, when you hear her name you think of... | 1 |
| 6175 | 5c752fb | Venus is the planet closest to Earth. Also the... | 1 |
| 7961 | 773c30a | The author explains his idea very well by sayi... | 2 |

about 24,000 data

essay_id : the unique ID of the essay
full_text : the fully essay response
score : holistic score of the essay on a 1–6 scale

# BERT

## Bidirectional Encoder Representations from Transformers




what is a BERT?.ipynb

PRO+ 파일 수정 보기 삽입 런타임 도구 도움말

댓글 공유

```
[ ] an open-source model developed by Google in 2018
```

```
bidirectional representations from unlabeled text
```

```
[ ] Masked LM + Next Sentence Prediction
```

```
### fine-tuned with just one additional output layer (downstream task)
```

fine-tuned with just one additional output layer (downstream task)

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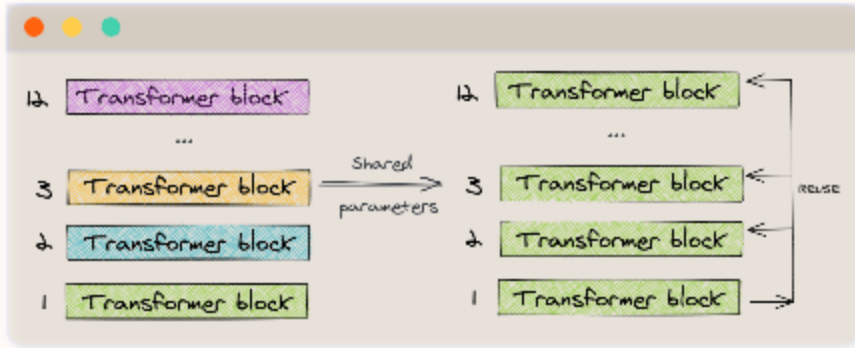
ALBert

ELECTRA

DeBERTa

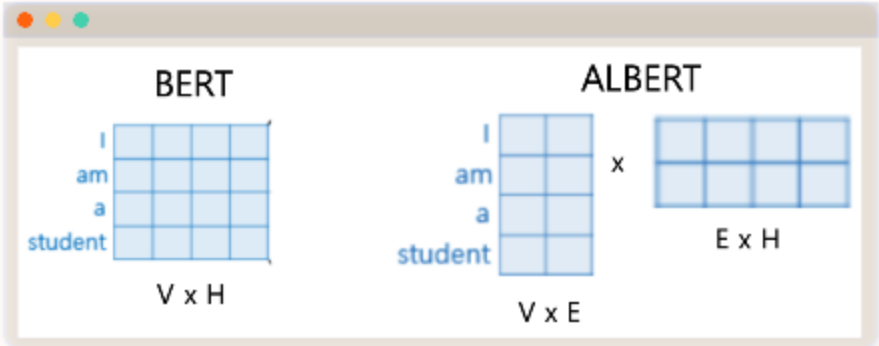
maintian similar perfromance to BERT
while requiring fewer resources

cross – layer parameter sharing




reducing the matrix size
increasing memory efficiency

factorized embedding layer parameterization



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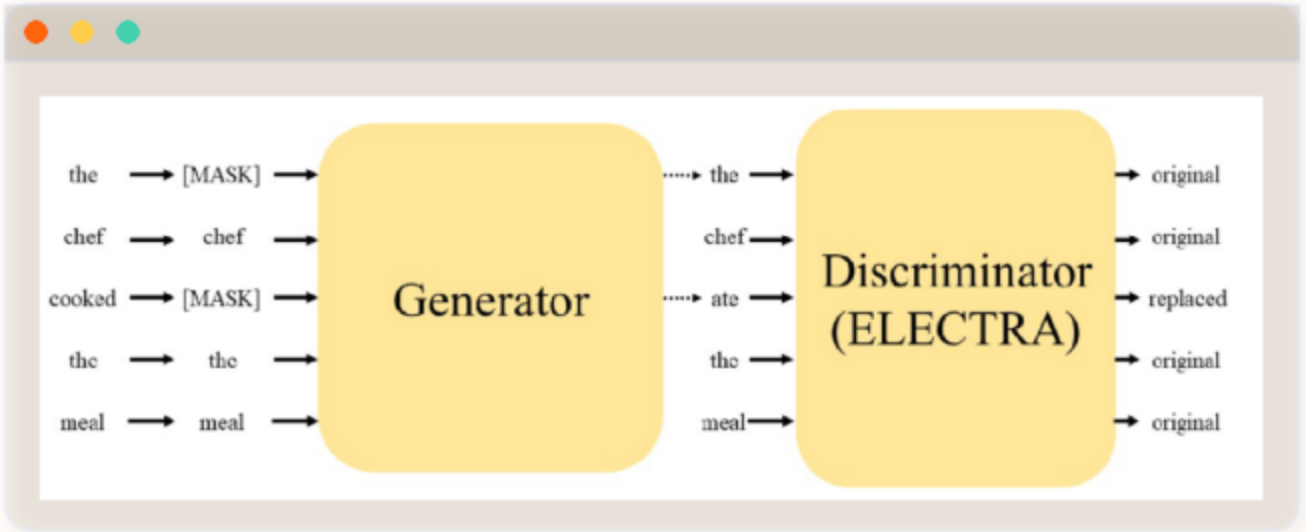
AlBert

ELECTRA

DeBERTa

a model replacing BERT's pre-learning method
with alternative token detection




earing for all tokens

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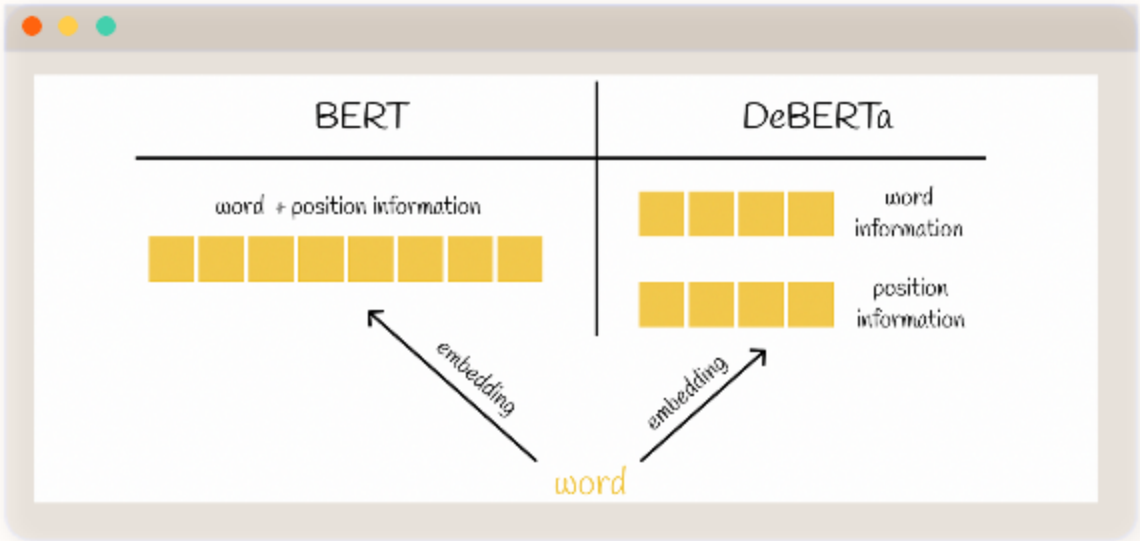
ALBert

ELECTRA

DeBERTa

- disentangled attention mechanism
- enhanced positional encodings
- improved parameter efficiency



# Quadratic Weighted Kappa

How to measure agreement on measurement category values among observers

actual score $i$

predicted score $j$

[ n x n histogram matrix **O** representing the number of i and j ]

[ weighted matrix **W** $w_{i,j} = \frac{(i-j)^2}{(N-1)^2}$ ]

- Normalized so that the sum of the prediction results (E and O) is the same
- Calculate evaluation index qwk with three matrices W, O, E

$$\kappa = 1 - \frac{\sum_{i,j} w_{i,j} O_{i,j}}{\sum_{i,j} w_{i,j} E_{i,j}}.$$

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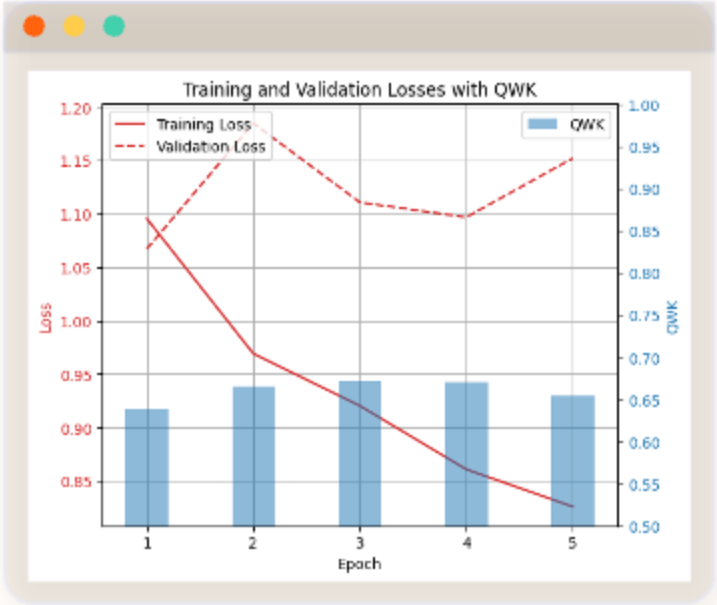
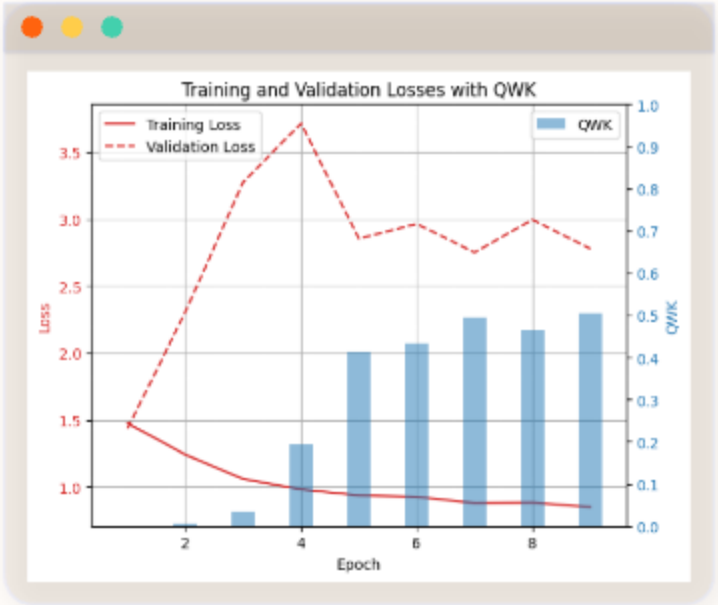
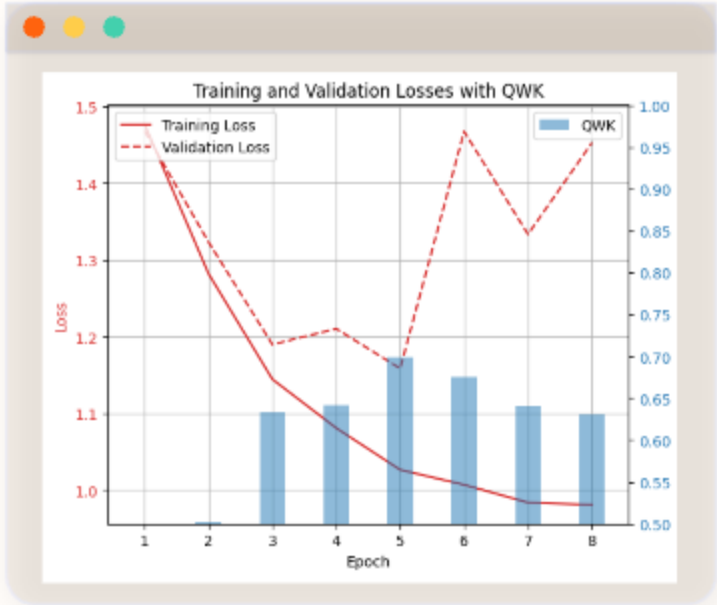



ALBert
best qwk：0.698652

ELECTRA
best qwk：0.505179




DeBERTa
best qwk：0.730117

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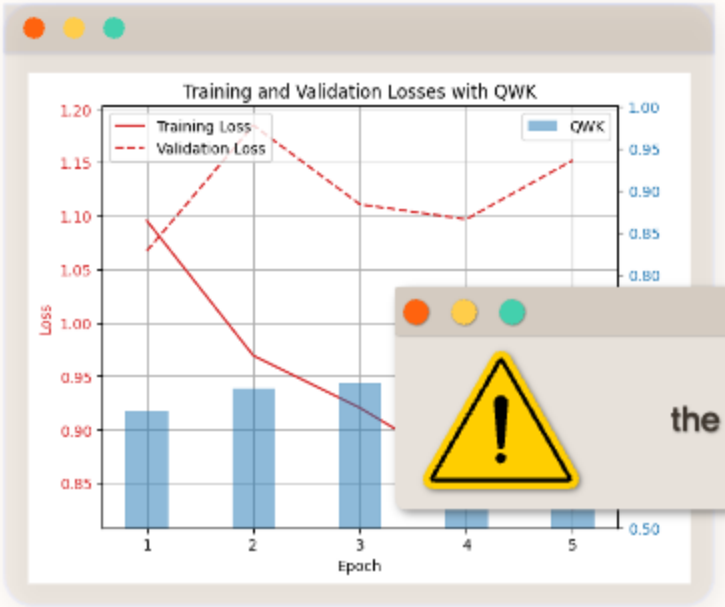


ALBert
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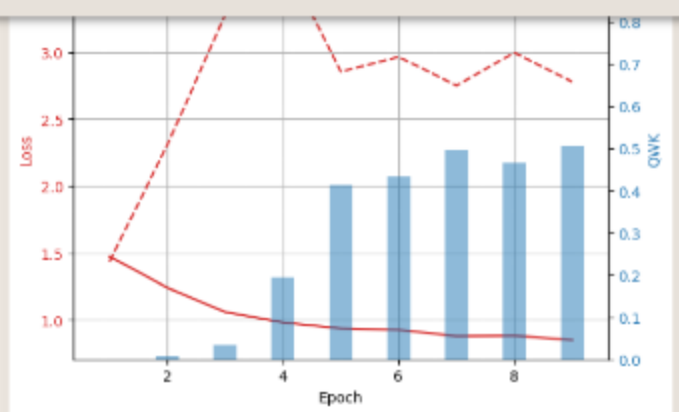


the performance of the classification model was not satisfactory!


DeBERTa
best qwk：0.730117

# How to solve the problem?

## classification ⟷ regressor

- score is an integer in the range of 1 to 6 points
- number of labels = 6
- loss : cross entropy

- score is an order scale
- number of labels = 1
- loss : MSE
- dropout part

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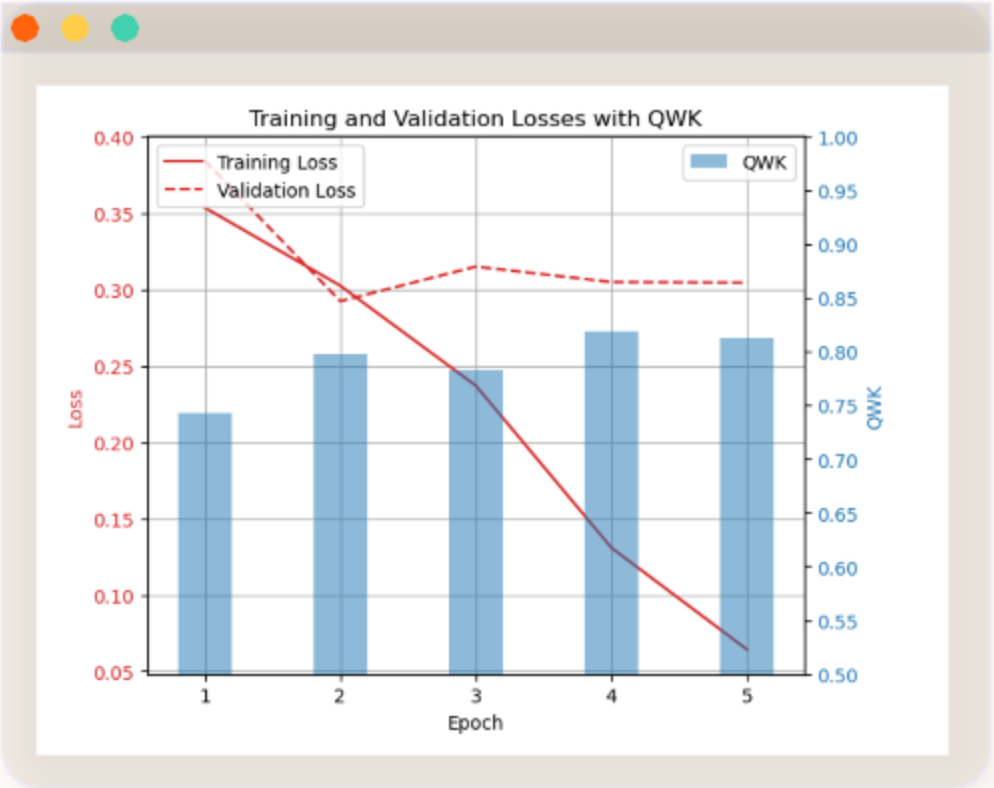


Regressor

| Model | Best Training Loss | Best Validation Loss | Best QWK |
|---|---|---|---|
| ALBert | 0.018100 | 0.349295 | 0.788330 |
| ELECTRA | 0.196400 | 0.341242 | 0.782262 |
| DeBERTa | 0.017700 | 0.297137 | 0.818309 |

# INTERMEDIATE RESULTS

verify that the regression model has higher performance

among the three BERT model, DeBERTa has the highest performance

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| | essay_id | full_text | score |
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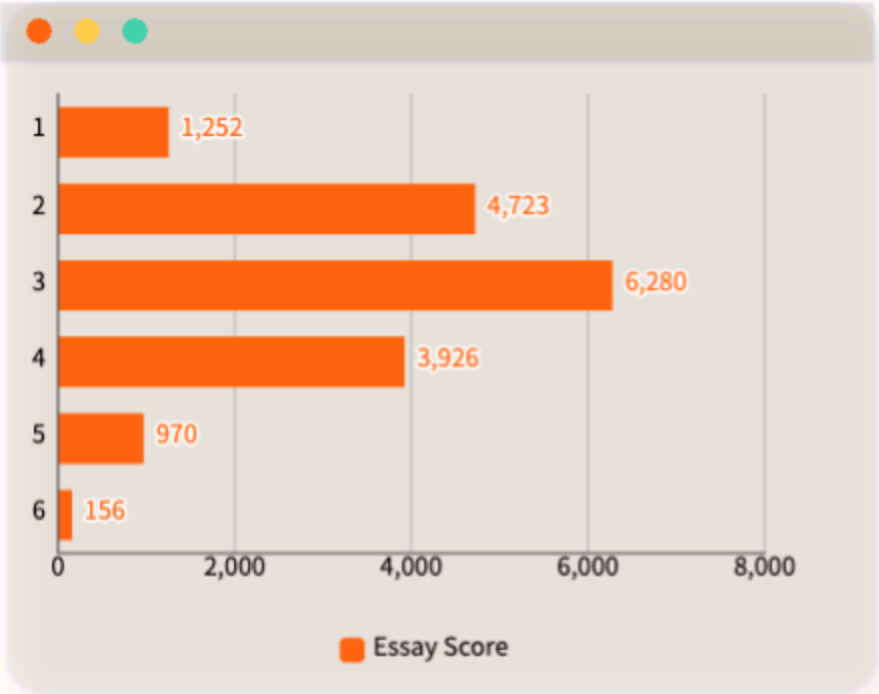


~~im~~ balanced data

↓

text data augmentation

# TEXT DATA AUGMENTATION

## Random Deletion

~~야호~~ 종강이다~

## Synonym Replacement

야호~ 방학이다~

## Random Swap

종강이다~ 야호~

## Random Insertion

대박~

야호~ 종강이다~

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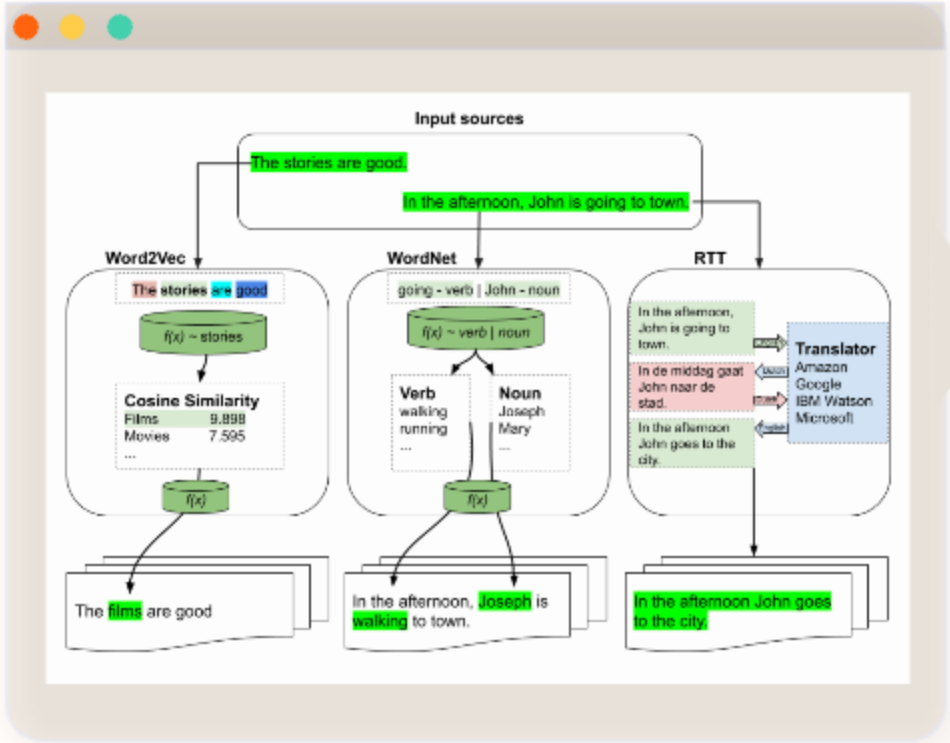
# TEXT DATA AUGMENTATION

Original Sentence : This is an example sentence for random insertion.
Augmented Sentence : This is an example sentence for random sentences insertion.

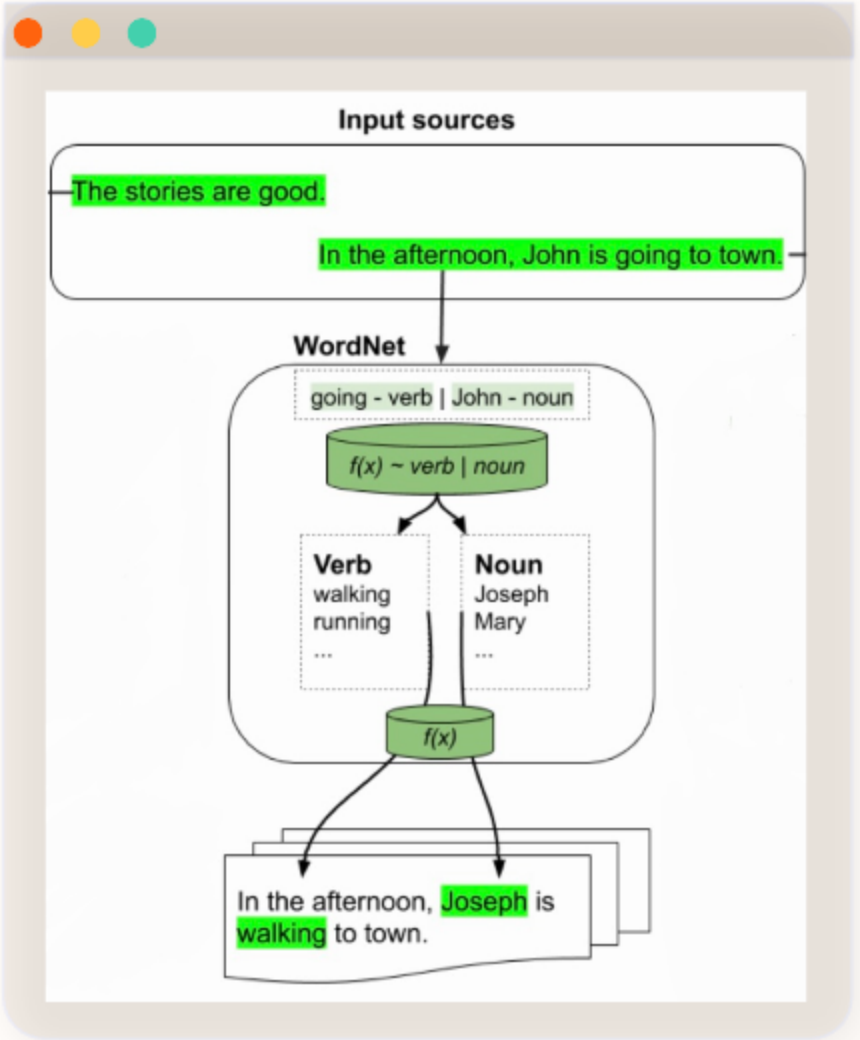
Random Insertion

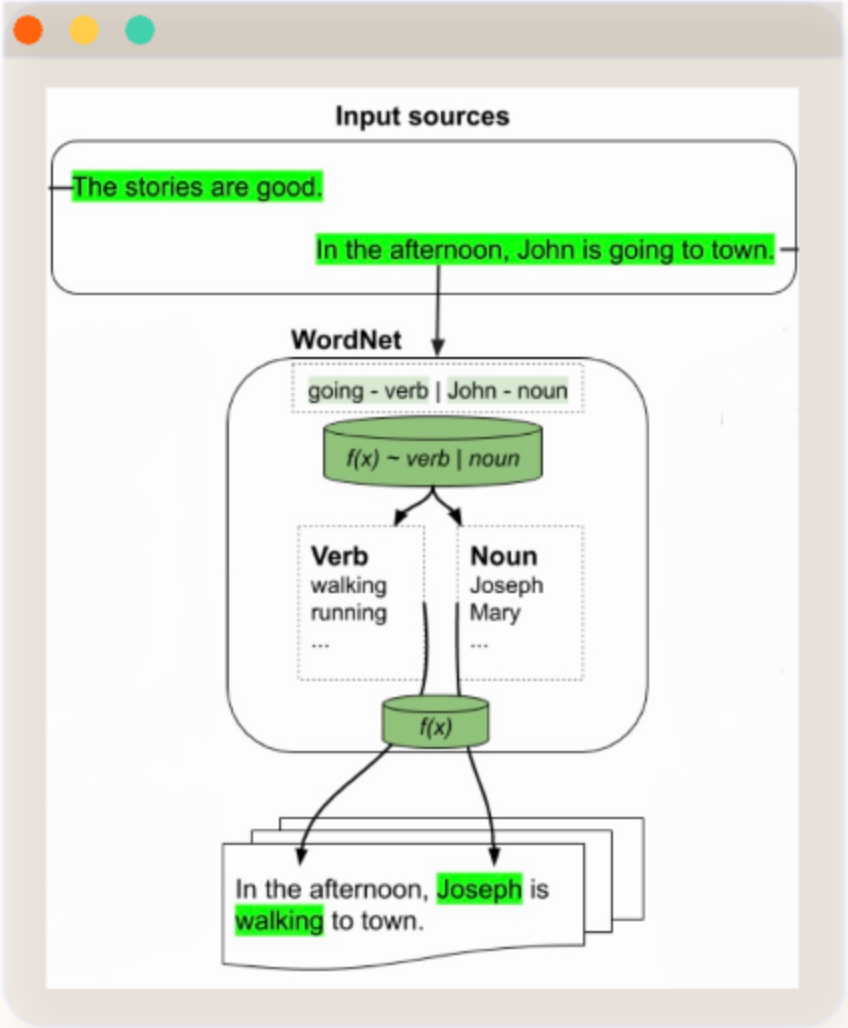
Original Sentence : This is an example sentence for random insertion.
Augmented Sentence : example This is an example random sentence for random sentences insertion insertion.

problem : affect the score




# Wordnet-Based Synonym Augmentation






# Wordnet-Based Synonym Augmentation

- SELECT REPLACEABLE WORDS
  like verbs, nouns, and the combination of them
- The new sentence is constructed by
  replacing the selected verb or noun with THEIR SYNONYMS
- The algorithm has options to choose to augment using either verbs or nouns or even a combination

# Round-Trip Translation

## ORIGNIAL LANGUAGE

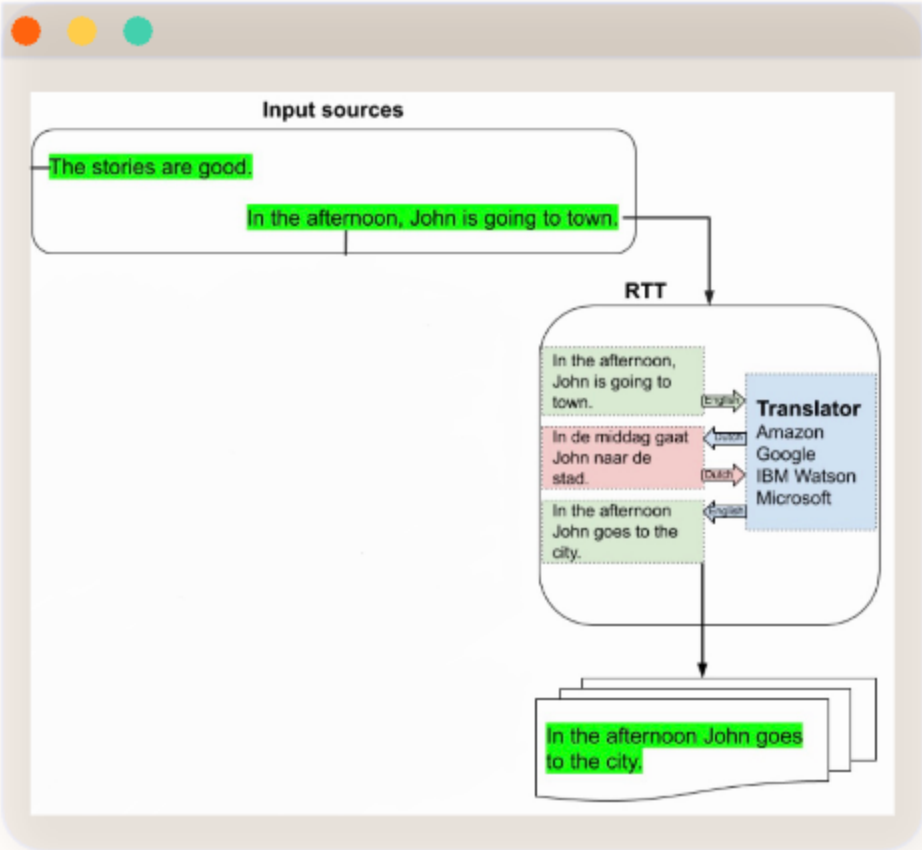
야호~ 종강이다~

## FORWARD TRANSLATION

Yay~ It's the end of the semester~

## BACK TRANSLATION

이야~ 이제 학기말이다~



# TEXT DATA AUGMENTATION RESULT

```python
class Augmenter:
    def __init__(self, method='wordnet', **kwargs):
        """
        Augmenter 클래스 초기화
        method: 사용할 증강 기법 ('wordnet', 'word2vec', 'translate')
        kwargs: 각 증강 기법의 인스턴스 생성 시 필요한 추가 매개변수
        """
        self.method = method.lower()
        if self.method == 'wordnet':
            self.augmenter = Wordnet(v=kwargs.get('v', True),
                                     n=kwargs.get('n', False),
                                     runs=kwargs.get('runs', 1),
                                     p=kwargs.get('p', 0.5))

        elif self.method == 'translate':
            self.augmenter = Translate(src=kwargs.get('src', 'en'),
                                       to=kwargs.get('to', 'fr'))

        else:
            raise ValueError("지원하지 않는 증강 기법입니다. 'wordnet', 'translate' 중 하나를 선택하세요.")

    def augment_text(self, text, **kwargs):
        """
        주어진 텍스트를 증강하는 메소드
        text: 증강할 원본 텍스트
        kwargs: 증강 시 필요한 추가 매개변수
        """
        if self.method == 'wordnet':
            top_n = kwargs.get('top_n', 10)
            augmented_text = self.augmenter.augment(text, top_n=top_n)
        elif self.method == 'translate':
            augmented_text = self.augmenter.augment(text)
        else:
            raise ValueError("지원하지 않는 증강 기법입니다. 'wordnet', 'translate' 중 하나를 선택하세요.")

        # 개행 문자 제거
        augmented_text = re.sub(r'\n', ' ', augmented_text)
        return augmented_text
```

## Wordnet

I am a scientist at nasa that is discussing the "face" on mars,
iodine will comprise explaining how the "face" is a ground form.

Original Sentence : I am a scientist at NASA that is discussing the "face" on mars,
I will be explaining how the "face" is a land form.

## Translate

i am scientist from nasa who discusses the "face" no mars,
i will explain how the "face" is a terrestrial form.

# TEXT DATA AUGMENTATION RESULT

```
essay.data['score'].value_counts()

score
3    6280
2    4723
4    3926
1    1252
5     970
6     156
Name: count, dtype: int64
```

3X MORE DATA

```
essay.data['score'].value_counts()

score
3    6280
2    4723
4    3926
1    3756
5    2910
6     468
Name: count, dtype: int64
```

# FINAL RESULTS

[17650/17650 4:33:57, Epoch 10/10]

| Epoch | Training Loss | Validation Loss | Qwk |
|---|---|---|---|
| 1 | 0.328100 | 0.295461 | 0.892667 |
| 2 | 0.265100 | 0.298933 | 0.900289 |
| 3 | 0.193900 | 0.251835 | 0.907659 |
| 4 | 0.110500 | 0.258230 | 0.907451 |
| 5 | 0.058500 | 0.275791 | 0.905832 |
| 6 | 0.030600 | 0.244650 | 0.912932 |
| 7 | 0.016200 | 0.244928 | 0.911339 |
| 8 | 0.010100 | 0.242523 | 0.914721 |
| 9 | 0.004300 | 0.244368 | 0.911536 |
| 10 | 0.002100 | 0.242474 | 0.912705 |

| MODEL - DEBERTA | BEST TRAINING LOSS | BEST VALIDATION LOSS | BEST QWK |
|---|---|---|---|
| NOT AUGMENTED | 0.018100 | 0.349295 | 0.788330 |
| AUGMENTED | 0.010100 | 0.242523 | 0.914721 |

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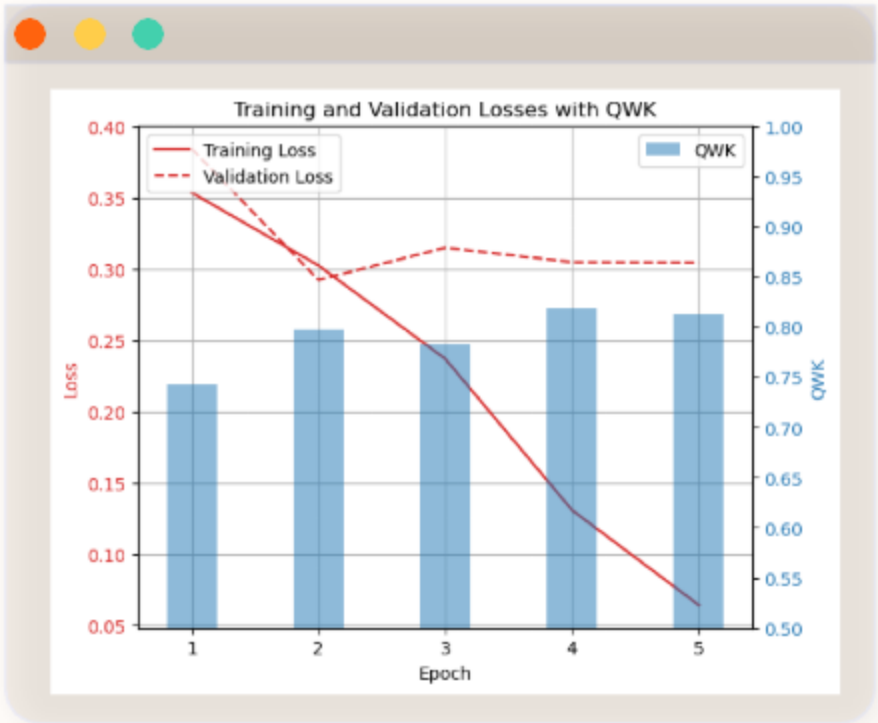


REGRESSOR DEBERTA MODEL

+

ORIGINAL DATA


REGRESSOR DEBERTA MODEL

+

AUGMNETED DATA

PROBLEM 1

Poor performance of classification model

→ Using regressor model

PROBLEM 2

Data imbalance

→ Text augmentation

COMPLEMENT

→ Add word2vec
for text data augmentation

→ Use other LLM models

THANK {

→ •• YOU

[ ] ^_^ ^u^ ∩u∩ *

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