# ADL HW2 Report

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## Q1 (Data processing)

### Tokenizer

**Multiple Choice**

在前處理時，會將 question 與 4 個候選的 context 同時做 tokenize，tokenizer 會根據 max_seq_length 將原始句子做斷詞、編碼，其中 tokenizer 加入的 special token 也可能隨著選用的 pretrained model 不同而有所改變，最終會處理成 [(tokenized_question, $tokenizedcontext_1$),...,(tokenized_question, $tokenizedcontext_4$)] 的集合

**Question Answering**

在前處理時，為了避免 question 中有過多空白字元，會先將其移除；接著將處理後的 question 與 context 交給 tokenizer 處理。 Tokenizer 會根據 max_seq_length 做 truncation & padding，透過 overflow_to_sample_mapping 能夠將得到的 sequence feature mapping 回去 sequence，透過 offset_mapping 能夠幫助我們 mapping token 所對應到原句子中的 position。

### Answer Span

**How did you convert the answer span start/end position on characters to position on tokens after BERT tokenization?**

Answer Span 階段會將 tokenized 後的 tokenized_examples 逐筆做處理。 先取出 input_ids 以此可以得到 CLS_token 所在的 postion，也能得到 tokenized sequence length 以利後續尋找 end postion。 接著先確認此筆 tokenized_example 有沒有給定 answer start 的位置，如果沒有則將 start/end position 都設為 CLS_token 的位置，如果有則將 start postion 設為給定的位置，而 end position 則為 start postion + anwser length，後續再將目前的 start/end position 透過 offset_mapping mapping 回去原句子中的 position。

**After your model predicts the probability of answer span start/end position, what rules did you apply to determine the final start/end position?**

在 post_processing_function 的步驟，會將模型輸出的 (start_logits, end_logits) 組合，排除所有 start/end position 可能發生的不合理情況，如 end position 比 start postion 前面、start position 超過 sequence length ...等，最後排序剩餘組合的分數，取 N 個最高分的 start/end position 儲存在 nbest_predictions.json，最佳的也會直接 mapping 回原句，將答案儲存在 predictions.json。

# Q2 (Modeling with BERTs and their variants)

## Describe

- configuration of the transformer model

  **Multiple Choice**

```
{
  "_name_or_path": "bert-base-chinese",
  "architectures": [
    "BertForMultipleChoice"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "pad_token_id": 0,
  "pooler_fc_size": 768,
  "pooler_num_attention_heads": 12,
  "pooler_num_fc_layers": 3,
  "pooler_size_per_head": 128,
  "pooler_type": "first_token_transform",
  "position_embedding_type": "absolute",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 21128
}
```

  **Question Answering**

```
{
  "_name_or_path": "bert-base-chinese",
  "architectures": [
    "BertForQuestionAnswering"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "pad_token_id": 0,
  "pooler_fc_size": 768,
  "pooler_num_attention_heads": 12,
  "pooler_num_fc_layers": 3,
  "pooler_size_per_head": 128,
  "pooler_type": "first_token_transform",
  "position_embedding_type": "absolute",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 21128
}
```

- performance

**Multiple Choice**

```
# Validation Set
Accuracy: 0.9937
```

**Question Answering**

```
# Test Set
EM: 0.7749 (Kaggle)

# Validation Set
EM: 0.9351
```

- loss function

  **Multiple Choice**

  ```
  CrossEntropyLoss
  ```

  **Question Answering**

  ```
  CrossEntropyLoss
  ```

- The following hyperparameters were used during training:

  **Multiple Choice**

  ```
  learning_rate: 3e-05
  train_batch_size: 1
  eval_batch_size: 8
  seed: 42
  gradient_accumulation_steps: 2
  total_train_batch_size: 2
  optimizer: Adam with betas=(0.9,0.999) and epsilon=1e-08
  lr_scheduler_type: linear
  num_epochs: 2.0
  ```

  **Question Answering**

  ```
  learning_rate: 3e-05
  train_batch_size: 4
  eval_batch_size: 8
  seed: 42
  gradient_accumulation_steps: 2
  total_train_batch_size: 8
  optimizer: Adam with betas=(0.9,0.999) and epsilon=1e-08
  lr_scheduler_type: linear
  num_epochs: 2.0
  ```

## Try another type of pretrained model and describe

### Question Answering (Use the same Multiple Choice model)

- configuration of the transformer model

```
{
  "_name_or_path": "hfl/chinese-roberta-wwm-ext",
  "architectures": [
    "BertForQuestionAnswering"
  ],
  "attention_probs_dropout_prob": 0.1,
  "bos_token_id": 0,
  "classifier_dropout": null,
  "directionality": "bidi",
  "eos_token_id": 2,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "output_past": true,
  "pad_token_id": 0,
  "pooler_fc_size": 768,
  "pooler_num_attention_heads": 12,
  "pooler_num_fc_layers": 3,
  "pooler_size_per_head": 128,
  "pooler_type": "first_token_transform",
  "position_embedding_type": "absolute",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 21128
}
```

- performance

```
# Test Set
EM: 0.7966 (Kaggle)

# Validation Set
EM: 0.9461
```

- difference

### architecture

| | bert-base-chinese | chinese-roberta-wwm-ext |
|---|---|---|
| Masking | WordPiece | WWM[1] |
| Type | base | base |
| Data Source | wiki | wiki+ext[2] |
| Training Tokens # | 0.4B | 5.4B |
| Device | TPU Pod v2 | TPU v3 |
| Optimizer | AdamW | AdamW |
| Vocabulary | 21,128 | ~bert-base-chinese |
| Init Checkpoint | Random Init | ~bert-base-chinese |

[1] WWM: Whole Word Masking [2] ext: extended data

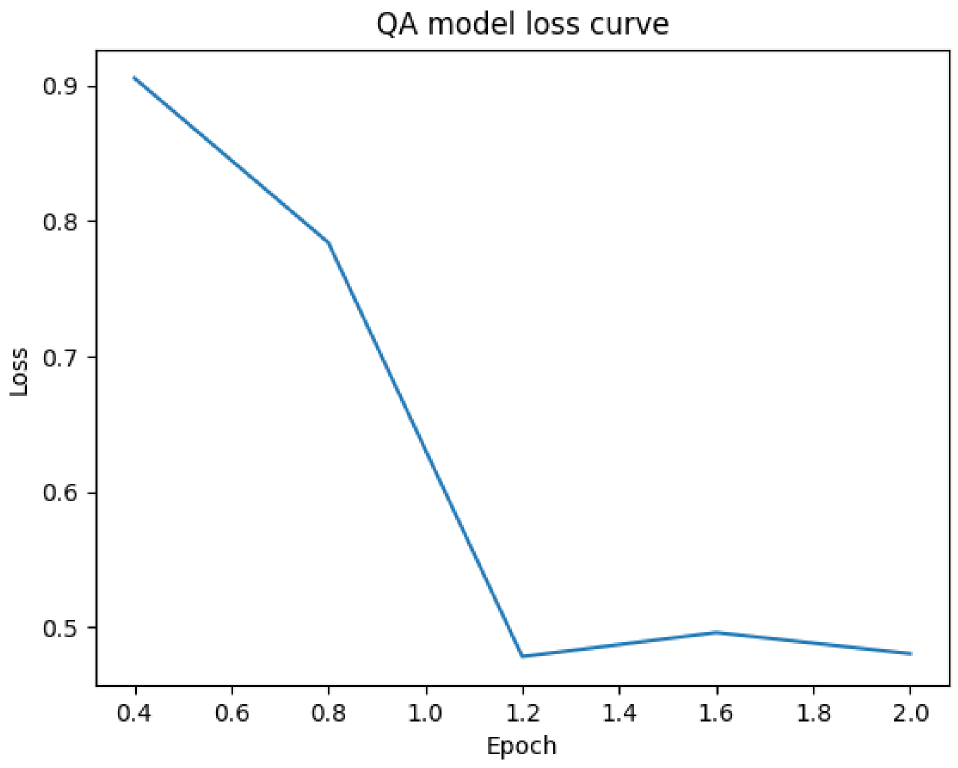
RoBERTa 與 BERT 不同在於，RoBERTa 取消了 BERT 原有的 Next SentencePrediction(NSP) 任務，並將原本靜態 Masking 的方法改成動態的 Masking。

### pretraining loss

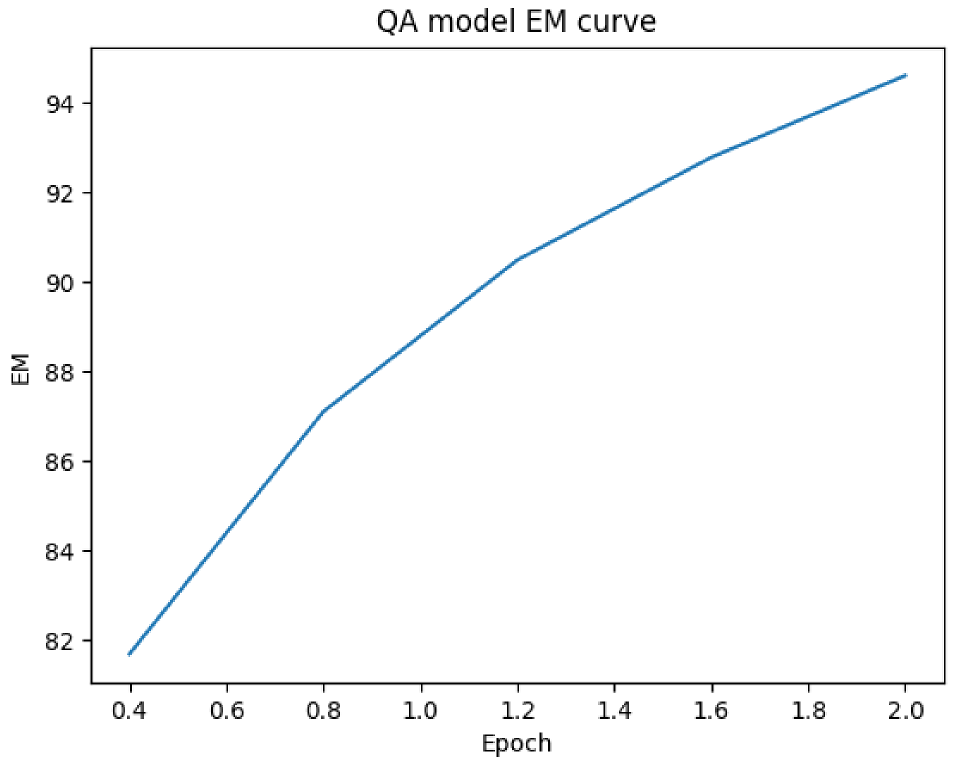
```
# bert-base-chinese
"train_loss": 0.7986815468019802
# chinese-roberta-wwm-ext
"train_loss": 0.7193350367217894
```

# Q3 (Curves)

Learning curve of loss



Learning curve of EM



# Q4 (Pretrained vs Not Pretrained)

## Configuration of the model and how do you train this model

- config

```
{
  "_name_or_path": "tmp/qa_chinese_roberta_wwm_ext/",
  "architectures": [
    "BertForQuestionAnswering"
  ],
  "attention_probs_dropout_prob": 0.1,
  "bos_token_id": 0,
  "classifier_dropout": null,
  "directionality": "bidi",
  "eos_token_id": 2,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "output_past": true,
  "pad_token_id": 0,
  "pooler_fc_size": 768,
  "pooler_num_attention_heads": 12,
  "pooler_num_fc_layers": 3,
  "pooler_size_per_head": 128,
  "pooler_type": "first_token_transform",
  "position_embedding_type": "absolute",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 21128
}
```

- how to train

```
將
    model = AutoModelForQuestionAnswering.from_pretrained()
替換成:
    config = AutoConfig.from_pretrained(model_config_path)
    model = AutoModelForQuestionAnswering.from_config(config)

從相同模型設定的資料夾讀取 config, AutoModel 中的 from_pretrained 會 load
weight,
而 from_config 則不會，其餘的 training script 不變，即可 training from scratch
```

## Performance of this model v.s. BERT

```
# Evaluate on valid set

(Without pretrained weight)
{
    "eval_exact_match": 6.945829179129279,
    "eval_f1": 6.945829179129279,
}

(With pretrained weight)
{
    "eval_exact_match": 94.6161515453639,
    "eval_f1": 94.6161515453639,
}
```

# Q5 (Bonus: HW1 with BERTs)

## model

**intent**

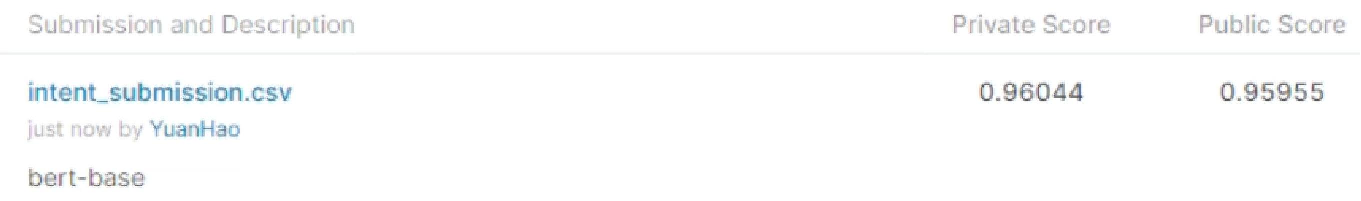
```
{
  "_name_or_path": "bert-base-cased",
  "architectures": [
    "BertForSequenceClassification"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "id2label": {
    "0": "accept_reservations",
    "1": "account_blocked",
    "2": "alarm",
    .
    {太冗長，故省略}
    .
    "147": "who_do_you_work_for",
    "148": "who_made_you",
    "149": "yes"
  },
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "label2id": {
    "accept_reservations": 0,
    "account_blocked": 1,
    "alarm": 2,
    .
    {太冗長，故省略}
    .
    "who_do_you_work_for": 147,
    "who_made_you": 148,
    "yes": 149
  },
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "pad_token_id": 0,
  "position_embedding_type": "absolute",
  "problem_type": "single_label_classification",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 28996
}
```

#### slot tagging

```
{
  "_name_or_path": "bert-base-cased",
  "architectures": [
    "BertForTokenClassification"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "finetuning_task": "ner",
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
  "id2label": {
    "0": "B-date",
    "1": "B-first_name",
    "2": "B-last_name",
    "3": "B-people",
    "4": "B-time",
    "5": "I-date",
    "6": "I-people",
    "7": "I-time",
    "8": "O"
  },
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "label2id": {
    "B-date": 0,
    "B-first_name": 1,
    "B-last_name": 2,
    "B-people": 3,
    "B-time": 4,
    "I-date": 5,
    "I-people": 6,
    "I-time": 7,
    "O": 8
  },
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 12,
  "num_hidden_layers": 12,
  "pad_token_id": 0,
  "position_embedding_type": "absolute",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 28996
}
```

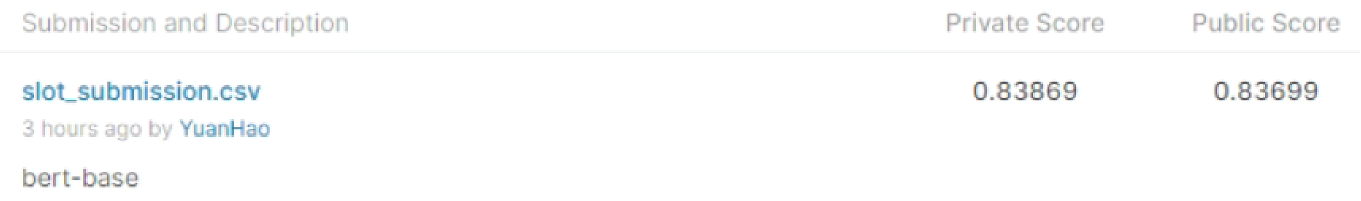
## performance

### intent classification



| Submission and Description | Private Score | Public Score |
|---|---|---|
| intent_submission.csv<br>just now by YuanHao<br>bert-base | 0.96044 | 0.95955 |

### slot tagging



| Submission and Description | Private Score | Public Score |
|---|---|---|
| slot_submission.csv<br>3 hours ago by YuanHao<br>bert-base | 0.83869 | 0.83699 |

## Loss function

### intent classification & slot tagging

```
CrossEntropyLoss
```

## The optimization algorithm (e.g. Adam), learning rate and batch size.

### intent classification & slot tagging

```
learning_rate: 5e-05
train_batch_size: 8
eval_batch_size: 8
seed: 42
optimizer: Adam with betas=(0.9,0.999) and epsilon=1e-08
lr_scheduler_type: linear
num_epochs: 3.0
```