# Q1: Data processing

## Tokenizer

我使用的bert tokenizer是wordpiece，它會將資料集裡句子的每個字斷開，然後不斷地將unit合併在一起來最大提升跟train data的likelihood

兩種model的tokenizer都會將每個字都視為一個token，並且將原本為同一個字詞的字前面加上##，來表示這個字和前面的字為同一個詞

## Answer Span

**a.**

先把所有的句子切成token，如果切完的長度大於max_seq_length，則將其切割成不同的span跟在最後一個span做padding，並且將每個token在原文的起始和終點位置存到offset_mapping，之後一個一個掃過offset_mapping，把answer在原文的起始和終點位置轉成對應的offset index，也就是第幾個token，存到start_positions跟end_positions中。

**b.**

因為把所有token對應的文本位置存在offset_mapping裡，只要將model output中機率最大的一組start_positions跟end_positions轉換成offset_mapping中第start_positions個開頭跟第end_positions個結尾就可以得到answer text在文本的起始和終點位置

# Q2: Modeling with BERTs and their variants

## Main pretrained model

- **MC:** chinese-roberta-wwm-ext-large
  - **Loss function:** CrossEntropyLoss
  - **Optimization:** AdamW
  - **Learning Rate:** 3e-5
  - **Batch Size:** 2 (per_gpu_train_batch_size 1 * gradient_accumulation_steps 2)
- **QA:** chinese-roberta-wwm-ext-large
  - **Loss function:** CrossEntropyLoss
  - **Optimization:** AdamW
  - **Learning Rate:** 3e-5
  - **Batch Size:** 2 (per_gpu_train_batch_size 1 * gradient_accumulation_steps 2)

## Other Pretrained model

除了bert-base-chinese跟chinese-roberta-wwm-ext-large之外，我也試了chinese-macbert-large在MC跟QA上

- **MC:** chinese-macbert-large
  - **Loss function:** Cross Entropy Loss
  - **Optimization:** AdamW
  - **Learning Rate:** 3e-5
  - **Batch Size:** 2 (per_gpu_train_batch_size 1 * gradient_accumulation_steps 2)
- **QA:** chinese-macbert-large
  - **Loss function:** Cross Entropy Loss
  - **Optimization:** AdamW
  - **Learning Rate:** 3e-5
  - **Batch Size:** 2 (per_gpu_train_batch_size 1 * gradient_accumulation_steps 2)

| Model | BERT | Train Loss | Val Loss | Val EM |
|---|---|---|---|---|
| MC | chinese-roberta-wwm-ext-large | 0.32971993838378144 | 0.4042188227176666 | 0.9378530979156494 |
| MC | chinese-macbert-large | 0.562534138676957 | 0.385102778673172 | 0.9185776114463806 |
| QA | chinese-roberta-wwm-ext-large | 0.9830446687250011 | 0.9042038917541504 | 0.8321701561980724 |
| QA | chinese-macbert-large | 0.8147450521009988 | 0.6574541330337524 | 0.8295114656031905 |

| MC BERT | QA BERT | Public score |
|---|---|---|
| chinese-roberta-wwm-ext | chinese-macbert-large | 0.76943 |
| chinese-macbert-large | chinese-macbert-large | 0.76130 |
| chinese-roberta-wwm-ext | chinese-roberta-wwm-ext | 0.73779 |
| chinese-roberta-wwm-ext-large | chinese-roberta-wwm-ext-large | 0.78390 |

MacBert和一般Bert不同的是將原本需要被Mask的字詞用word2vec找出相似的同義字或用隨機詞彙取代

roberta-wwm-ext和一般roberta不同的則是當一個字被Mask掉時會連同將整個詞都Mask掉

# Configs:

## MC

### chinese-roberta-wwm-ext-large


```
{
  "_name_or_path": "./chinese-roberta-wwm-ext-large",
  "architectures": [
    "BertForMultipleChoice"
  ],
  "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": 1024,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 16,
  "num_hidden_layers": 24,
  "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
}
```

## chinese-macbert-large


```
{
  "_name_or_path": "./chinese-macbert-large",
  "architectures": [
    "BertForMultipleChoice"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 1024,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 16,
  "num_hidden_layers": 24,
  "pad_token_id": 0,
  "pooler_fc_size": 768,
  "pooler_num_attention_heads": 12,
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  "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
}
```

# QA

## chinese-roberta-wwm-ext-large


```
{
  "_name_or_path": "./chinese-roberta-wwm-ext-large",
  "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": 1024,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 16,
  "num_hidden_layers": 24,
  "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
}
```

## chinese-macbert-large


```
{
  "_name_or_path": "./chinese-macbert-large",
  "architectures": [
    "BertForQuestionAnswering"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 1024,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 16,
  "num_hidden_layers": 24,
  "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
}
```

# Q3: Curves

## chinese-roberta-wwm-ext-large

## chinese-macbert-large

這邊validation loss的算法是用model output兩個分別代表對start跟end的預測的array跟和train一樣求出start_positions跟end_positions各自轉成的one-hot vector算兩者cross entropy loss的平均

# Q4: Pretrained vs Not Pretrained

- **Task**: Multiple Choice
- **Pretrained Model**: chinese-macbert-large

from scratch Train的方法就跟之前的一樣，只不過把原本的

```
model = AutoModelForMultipleChoice.from_pretrained()
```

改成

```
model = AutoModelForMultipleChoice.from_config(config)
```

讓model不load pretrained weights

| Model | Train Loss | Val Loss | Val Acc |
| --- | --- | --- | --- |
| With Pretrained Weights | 0.562534138676957 | 0.385102778673172 | 0.9185776114463806 |
| Without Pretrained Weights | 0.9815234939422003 | 1.0061808824539185 | 0.5257560610771179 |

# Configs

## chinese-macbert-large


```
{
  "_name_or_path": "./chinese-macbert-large",
  "architectures": [
    "BertForMultipleChoice"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 1024,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 16,
  "num_hidden_layers": 24,
  "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
}
```

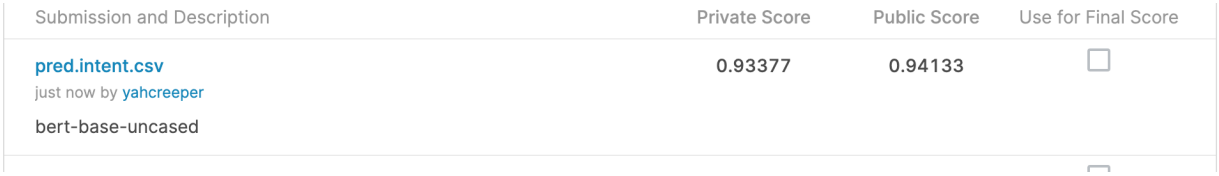
### without pretrained weights


```
{
  "_name_or_path": "./chinese-macbert-large",
  "architectures": [
    "BertForMultipleChoice"
  ],
  "attention_probs_dropout_prob": 0.1,
  "classifier_dropout": null,
  "directionality": "bidi",
  "gradient_checkpointing": false,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 384,
  "initializer_range": 0.02,
  "intermediate_size": 4096,
  "layer_norm_eps": 1e-12,
  "max_position_embeddings": 512,
  "model_type": "bert",
  "num_attention_heads": 8,
  "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
}
```

# Q5: Bonus: HW1 with BERTs

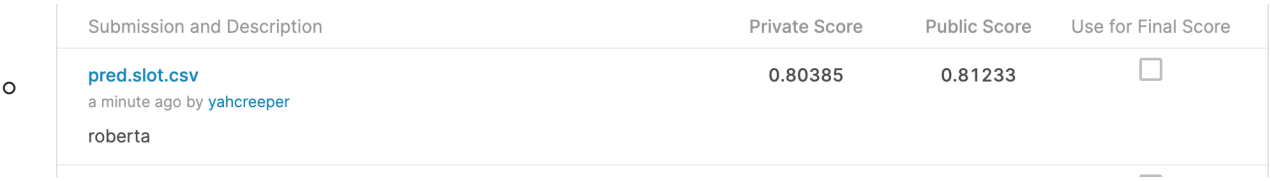
## Intent Classification

Code我參考網路上的script[https://www.xiuweihan.cn/2021/04/14/2021-04-14-bert%E4%B9%8B%E6%96%87%E6%9C%AC%E5%88%86%E7%B1%BB/]

- **Bert:** bert-base-uncased
- **Performance**
  - 
    
- **Loss function**: CrossEntropyError
- **Optimization:** AdamW
- **Learning Rate:** 2e-5
- **Batch Size:** 4
- **Epoch:** 1

## Slot Tagging

Code我參考huggingface的script[https://github.com/huggingface/transformers/blob/main/examples/pytorch/token-classification/run_ner.py]

- **Bert:** roberta-base
- **Performance**
  - 
    
- **Loss function**: CrossEntropyError
- **Optimization:** AdamW
- **Learning Rate:** 3e-5
- **Batch Size:** 2
- **Epoch:** 1

| Model | Task | Val Acc | Val loss | Public score | Private score |
|---|---|---|---|---|---|
| RNN | Intent Classification | 0.9343 | 0.455507 | 0.92133 | 0.92044 |
| BERT | Intent Classification | 0.9423 | 1.1190784533818563 | 0.94133 | 0.93377 |
| RNN | Slot Tagging | (Joint)0.791 | 1.648562 | 0.78498 | 0.78188 |
| BERT | Slot Tagging | 0.9670468948035488 | 0.12472361326217651 | 0.81233 | 0.80385 |

# Configs

## Intent Classification


```
{
  "_name_or_path": "./bert-base-uncased/pytorch_model.bin",
  "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": {
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  "intermediate_size": 3072,
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  "pad_token_id": 0,
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  "problem_type": "single_label_classification",
  "torch_dtype": "float32",
  "transformers_version": "4.17.0",
  "type_vocab_size": 2,
  "use_cache": true,
  "vocab_size": 30522
}
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## Slot Tagging


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  "bos_token_id": 0,
  "classifier_dropout": null,
  "eos_token_id": 2,
  "finetuning_task": "ner",
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.1,
  "hidden_size": 768,
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    "1": "B-first_name",
    "2": "B-last_name",
    "3": "B-people",
    "4": "B-time",
    "5": "I-date",
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    "7": "I-time",
    "8": "O"
  },
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "label2id": {
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    "B-first_name": 1,
    "B-last_name": 2,
    "B-people": 3,
    "B-time": 4,
    "I-date": 5,
    "I-people": 6,
    "I-time": 7,
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