# 实验五——多模态融合

**Github仓库:**

https://github.com/volcano26/Multimodal

## 实验环境：Autodl

CPU： 16 核心
内存：120 GB
GPU： NVIDIA GeForce RTX 4090, 1

## 1.代码介绍

### 1）数据预处理

```
def read_and_process_data(txt_filepath, output_csv_filepath):
    df_txt = pd.read_csv(txt_filepath, header=None, names=['guid', 'tag'],
dtype={'guid': str, 'tag': str})

    df_result = pd.DataFrame(columns=['guid', 'text', 'tag'])

    for index, row in df_txt.iterrows():
        guid = row['guid']
        txt_filename = f"{guid}.txt"
        txt_filepath = os.path.join('data', txt_filename)

        if os.path.exists(txt_filepath):

            with open(txt_filepath, 'rb') as txt_file:
                raw_data = txt_file.read()
                result = chardet.detect(raw_data)
                encoding = result['encoding']

            with open(txt_filepath, 'r', encoding=encoding, errors='replace') as
txt_file:
                text = txt_file.read().strip(",")

            df_result = df_result.append({'guid': guid, 'text': text, 'tag':
row['tag']}, ignore_index=True)
        else:
            print(f"Warning: Text file not found for guid {guid}")

    df_result['img_path'] = df_result['guid'].apply(lambda guid:
f'data/{guid}.jpg')

    df_result.to_csv(output_csv_filepath, index=False)
```

```
train_txt_filepath = 'train.txt'
train_csv_filepath = 'train.csv'
read_and_process_data(train_txt_filepath, train_csv_filepath)

train_df = pd.read_csv(train_csv_filepath)
```

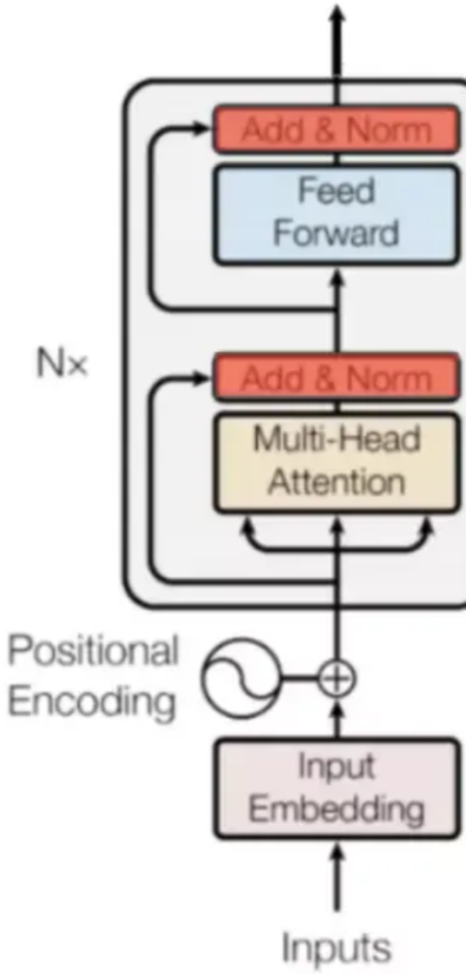
```
train_set, val_set = train_test_split(train_df, test_size=0.2, random_state=42)

print(f'Training set shape: {train_set.shape}')
print(f'Validation set shape: {val_set.shape}')


train_train_csv_filepath = 'train_train.csv'
train_val_csv_filepath = 'train_val.csv'
train_set.to_csv(train_train_csv_filepath, index=False)
val_set.to_csv(train_val_csv_filepath, index=False)

test_txt_filepath = 'test_without_label.txt'
test_csv_filepath = 'test.csv'
read_and_process_data(test_txt_filepath, test_csv_filepath, is_test=True)
```

这里我将txt文件进行数据的预处理，将其修改为csv文件的同时，在每个csv文件中添加**guid，其对应的text文本，其对应的img路径以及其tag标签**，以方便我后续对于其信息的处理效率（不需要每次寻找调用txt文件）

| guid | text | tag | img_path |
|---|---|---|---|
| 1 | How I feel to... | positive | data/1.jpg |
| 2 | grattis min g... | positive | data/2.jpg |
| 3 | RT @polynm... | positive | data/3.jpg |
| 4 | #escort We... | positive | data/4.jpg |
| 6 | RT @babesh... | positive | data/6.jpg |
| 7 | RT @deepik... | positive | data/7.jpg |
| 9 | Look at their... | positive | data/9.jpg |
| 10 | @ArrivaTW a... | negative | data/10.jpg |
| 11 | RT @Dthom... | positive | data/11.jpg |
| 12 | RT @cosy_co... | positive | data/12.jpg |
| 14 | RT @Chester... | positive | data/14.jpg |
| 15 | Awesome rec... | positive | data/15.jpg |
| 16 | RT @VenusC... | positive | data/16.jpg |
| 17 | Love to party... | positive | data/17.jpg |
| 18 | RT @JoeyXcv... | positive | data/18.jpg |
| 19 | #depressed... | negative | data/19.jpg |
| 21 | Thank you t... | positive | data/21.jpg |
| 22 | Enraged by t... | negative | data/22.jpg |
| 23 | I am enthusi... | positive | data/23.jpg |
| 24 | Looking for... | neutral | data/24.jpg |
| 25 | RT @curiosit... | neutral | data/25.jpg |
| 26 | Waxwing tril... | neutral | data/26.jpg |
| 27 | RT @Poshbi... | neutral | data/27.jpg |
| 28 | RT @Beltrew... | positive | data/28.jpg |

而后以**20%验证集，80%训练集**的比例进行划分，形成train_train.csv,train_val.csv两个文件存储

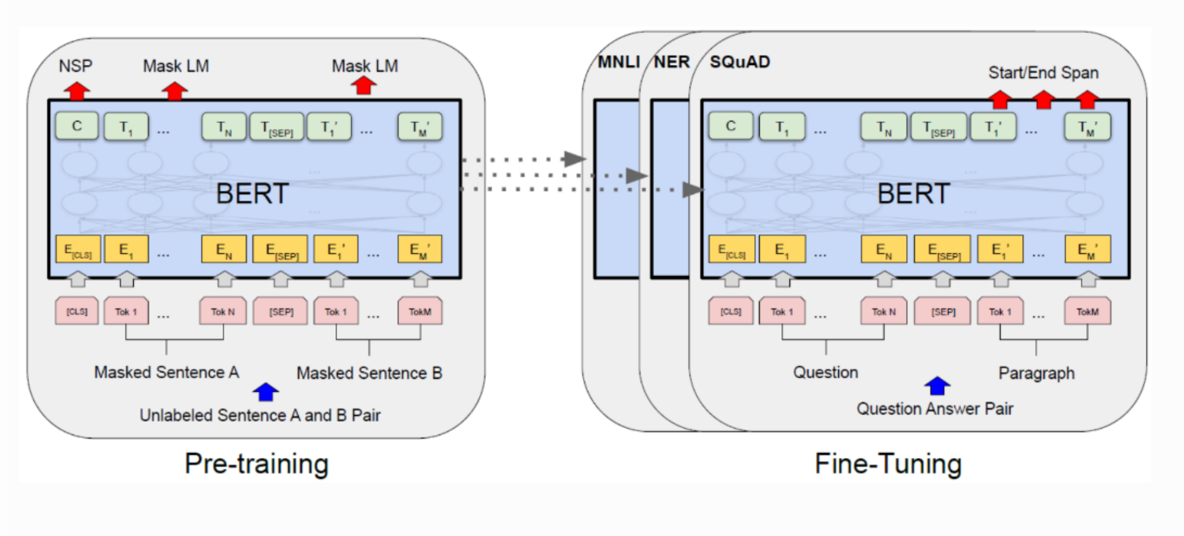
**2）bert模型介绍**



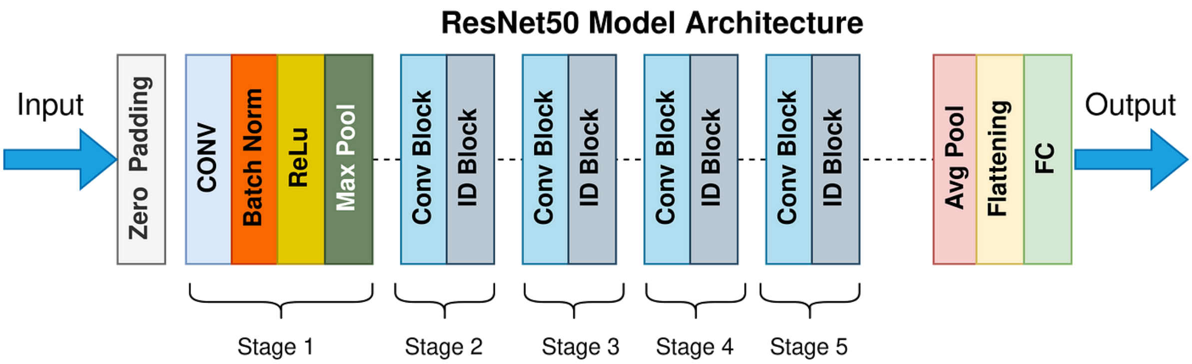

```
class BertModel(nn.Module):
    def __init__(self, num_labels, text_pretrained='./bert-base-uncased'):
        super().__init__()
        self.num_labels = num_labels
        self.text_encoder = AutoModel.from_pretrained(text_pretrained)
        self.classifier = nn.Linear(self.text_encoder.config.hidden_size,
num_labels)

    def forward(self, text):
        output = self.text_encoder(text.input_ids,
attention_mask=text.attention_mask, return_dict=True)
        logits = self.classifier(output.last_hidden_state[:, 0, :])
        return logits
```

其中`logits = self.classifier(output.last_hidden_state[:, 0, :])`这一行代码我使用的是CLS embedding；因为`[CLS]`所对应的Embedding被使用来代表句义的原理，所以比较适合于在进行text文本（特别是单句话的情况使用）

我这里使用的预训练模型是`bert-base-uncased`(这里很多遇到的问题会在后面讲)




3）resnet模型

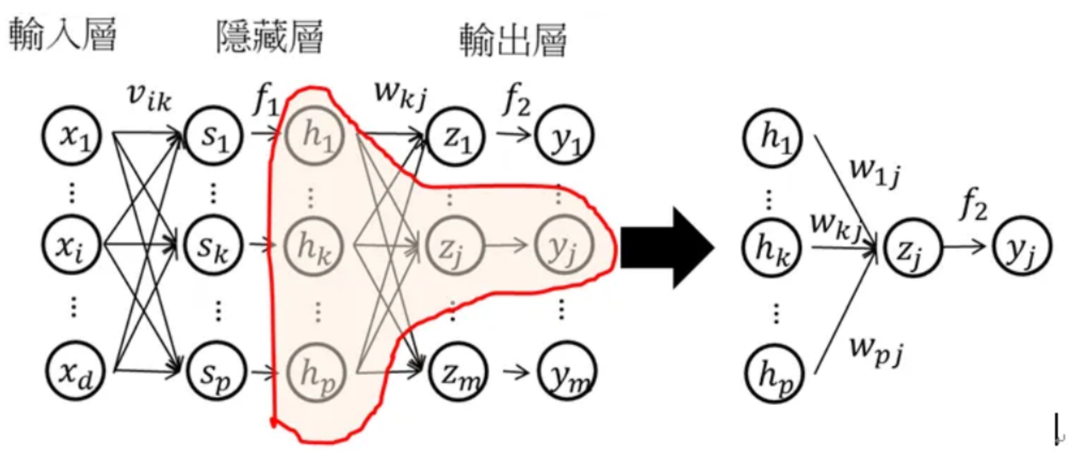



```
class ResNetDataset(Dataset):
    def __init__(self, df, label_to_id, train=False, text_field="text",
label_field="tag", image_path_field="img_path"):
        self.df = df.reset_index(drop=True)
        self.label_to_id = label_to_id
        self.train = train
        self.text_field = text_field
        self.label_field = label_field
        self.image_path_field = image_path_field

        # ResNet-50 settings
        self.img_size = 224
        self.mean, self.std = (
            0.48145466, 0.4578275, 0.40821073), (0.26862954, 0.26130258,
0.27577711)


        self.train_transform_func = transforms.Compose(
                [transforms.RandomResizedCrop(self.img_size, scale=(0.5, 1.0)),
                    transforms.RandomHorizontalFlip(),
                    transforms.ToTensor(),
                    transforms.Normalize(self.mean, self.std)
                    ])

        self.eval_transform_func = transforms.Compose(
                [transforms.Resize(256),
                    transforms.CenterCrop(self.img_size),
```

```
                    transforms.ToTensor(),
                    transforms.Normalize(self.mean, self.std)
                    ])


    def __getitem__(self, index):
        text = str(self.df.at[index, self.text_field])
        label = self.label_to_id.get(self.df.at[index, self.label_field], -1)
        # self.label_to_id[self.df.at[index, self.label_field]]
        img_path = self.df.at[index, self.image_path_field]


        image = Image.open(IMG_FOLDER + '/' + img_path)
        if self.train:
          img = self.train_transform_func(image)
        else:
          img = self.eval_transform_func(image)

        return text, label, img

    def __len__(self):
        return self.df.shape[0]
```

使用的是resnet-50模型;使用残差块来更好的进行图像的识别

**4）模型融合**




```
class MML(nn.Module):
    def __init__(self, input_size1, input_size2, hidden_size, output_size):
        super().__init__()
        self.fc1 = nn.Linear(input_size1 + input_size2, hidden_size)
        self.relu = nn.ReLU()
        self.fc2 = nn.Linear(hidden_size, output_size)

    def forward(self, x1, x2):
        x = torch.cat((x1, x2), dim=1)
        x = self.fc1(x)
        x = self.relu(x)
        x = self.fc2(x)
        return x
```

```
class MMLmodel(nn.Module):
    def __init__(self, num_labels, text_pretrained='./bert-base-uncased',
hidden_size=512):
        super().__init__()
        self.text_encoder = AutoModel.from_pretrained(text_pretrained)
        self.visual_encoder = FeatureModel(output_layer='avgpool')
        self.image_hidden_size = 2048
        self.mlp_text = nn.Linear(self.text_encoder.config.hidden_size,
num_labels)
        self.mlp_image = nn.Linear(self.image_hidden_size, num_labels)
        self.mlp_both = MML(self.text_encoder.config.hidden_size,
self.image_hidden_size, hidden_size, num_labels)

    def forward(self, text, image, mode='both'):
        text_output = self.text_encoder(**text)
        text_feature = text_output.last_hidden_state[:, 0, :]
        img_feature = self.visual_encoder(image)

        if mode == 'text':
            logits = self.mlp_text(text_feature)
        elif mode == 'image':
            logits = self.mlp_image(img_feature)
        else:  # 'both'
            logits = self.mlp_both(text_feature, img_feature)

        return logits
```

使用MLP，多层感知机进行模块的融合；多层感知机是一种**前向传递类神经网路**，利用到倒传递的技术达到监督式学习，将文本和图像的bert和resnet50两个模型相互交叉融合（这里一定要保证其输出的层数维度一致，不然矩阵乘法会报错）

## 2.遇到的问题

### 1）bert预训练模型下载

遇到直接使用代码超时

```
OSError: We couldn't connect to 'https://huggingface.co' to load this file,
couldn't find it in the cached files and it looks like bert-base-uncased is not
the path to a directory containing a file named config.json.
```

**解决方案1：** 登入官网下载其所需要的文件（pytorch或者tensorflow），而后将代码中的预训练模型改为本地链接

```
def __init__(self, num_labels, text_pretrained='./bert-base-uncased')
```

这样子操作我能够在本地电脑中运行，但是因为文件太大上传至服务器会有所丢失导致其bin文件不完整

```
OSError: Unable to load weights from pytorch checkpoint file for 'bert-base-
uncased' at ... If you tried to load a PyTorch model from a TF 2.0 checkpoint,
please set from_tf=True.
```

**解决方案2：**

安装依赖

```
pip install -U huggingface_hubCopy
```

输入命令

```
export HF_ENDPOINT=https://hf-mirror.comCopy
huggingface-cli download --resume-download --local-dir-use-symlinks False bert-base-uncased --local-dir bert-base-uncased
```

直接在云服务器上面下载

**2）读取txt文件数据时候报错**

我代码先对于txt文件进行预处理，保存为csv文件，但其文本格式一直报错

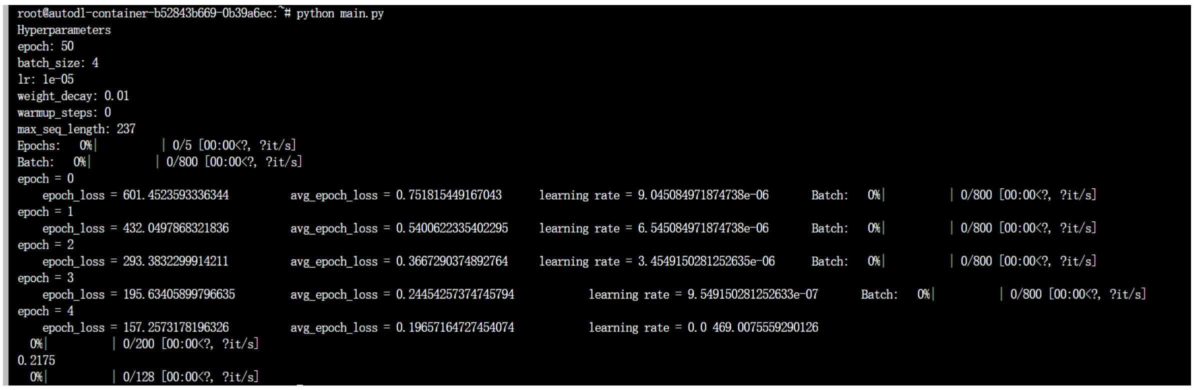
使用`chardet`包先对于文本进行格式的判断，而后添加`errors='replace'`阻止其报错（只会有warning出现）

```
            with open(txt_filepath, 'rb') as txt_file:
                raw_data = txt_file.read()
                result = chardet.detect(raw_data)
                encoding = result['encoding']

            with open(txt_filepath, 'r', encoding=encoding, errors='replace') as txt_file:
                text = txt_file.read().strip(",")
```

## 3.结果分析

### 1)只使用文本

可以看到只使用文本在验证集的准确率仅有0.2175



```
root@autodl-container-b52843b669-0b39a6ec:~# python main.py
Hyperparameters
epoch: 50
batch_size: 4
lr: 1e-05
weight_decay: 0.01
warmup_steps: 0
max_seq_length: 237
Epochs:   0%|          | 0/5 [00:00<?, ?it/s]
Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 0
    epoch_loss = 601.4523593336344        avg_epoch_loss = 0.751815449167043      learning rate = 9.045084971874738e-06       Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 1
    epoch_loss = 432.0497868321836        avg_epoch_loss = 0.5400622335402295     learning rate = 6.545084971874738e-06       Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 2
    epoch_loss = 293.3832299914211        avg_epoch_loss = 0.3667290374892764     learning rate = 3.4549150281252635e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 3
    epoch_loss = 195.63405899796635       avg_epoch_loss = 0.24454257374745794          learning rate = 9.549150281252633e-07       Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 4
    epoch_loss = 157.2573178196326        avg_epoch_loss = 0.19657164727454074          learning rate = 0.0 469.0075559290126
  0%|          | 0/200 [00:00<?, ?it/s]
0.2175
  0%|          | 0/128 [00:00<?, ?it/s]
```

### 2）只使用图像

验证集准确率为0.71375

```
root@autodl-container-b52843b669-0b39a6ec:~# python main.py
Hyperparameters
epoch: 50
batch_size: 4
lr: 1e-05
weight_decay: 0.01
warmup_steps: 0
max_seq_length: 237
Epochs:   0%|          | 0/5 [00:00<?, ?it/s]
Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 0
    epoch_loss = 607.885859683156        avg_epoch_loss = 0.7598573246039451     learning rate = 9.045084971874738e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 1
    epoch_loss = 438.6919890344143       avg_epoch_loss = 0.5483649862930179     learning rate = 6.545084971874738e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 2
    epoch_loss = 292.11121618561447      avg_epoch_loss = 0.3651390202320181     learning rate = 3.4549150281252635e-06     Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 3
    epoch_loss = 195.7560373879969       avg_epoch_loss = 0.24469504673499615          learning rate = 9.549150281252633e-07      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 4
    epoch_loss = 155.85070120729506      avg_epoch_loss = 0.1948133765091188     learning rate = 0.0 464.2953635309823
  0%|          | 0/200 [00:00<?, ?it/s]
0.71375
  0%|          | 0/128 [00:00<?, ?it/s]
root@autodl-container-b52843b669-0b39a6ec:~#
```

### 3）文本图像相互结合

验证集准确率为0.69875

```
root@autodl-container-b52843b669-0b39a6ec:~# python main.py
Hyperparameters
epoch: 50
batch_size: 4
lr: 1e-05
weight_decay: 0.01
warmup_steps: 0
max_seq_length: 237
Epochs:   0%|          | 0/10 [00:00<?, ?it/s]
Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 0
    epoch_loss = 607.7502309828997       avg_epoch_loss = 0.7596877887286246     learning rate = 9.755282581475769e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 1
    epoch_loss = 429.7851064391434       avg_epoch_loss = 0.5372313830489293     learning rate = 9.045084971874738e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 2
    epoch_loss = 277.62029856815934      avg_epoch_loss = 0.34702537321019916          learning rate = 7.938926261462366e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 3
    epoch_loss = 155.37706632027403      avg_epoch_loss = 0.19422133290034252          learning rate = 6.545084971874738e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 4
    epoch_loss = 87.99552065017633       avg_epoch_loss = 0.10999440081272041          learning rate = 5e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 5
    epoch_loss = 60.12018438533414       avg_epoch_loss = 0.07515023048166768          learning rate = 3.4549150281252635e-06     Batch:   0%|          | 0/800 [00:00<?, ?it/s]
 epoch = 6
    epoch_loss = 41.44392206822522       avg_epoch_loss = 0.051804902585281525         learning rate = 2.061073738537635e-06      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 7
    epoch_loss = 31.22713000647491       avg_epoch_loss = 0.039033912508093634         learning rate = 9.549150281252633e-07      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 8
    epoch_loss = 24.504319305648096      avg_epoch_loss = 0.03063039913206012          learning rate = 2.447174185242324e-07      Batch:   0%|          | 0/800 [00:00<?, ?it/s]
epoch = 9
    epoch_loss = 23.67398760310607       avg_epoch_loss = 0.029592484503882587         learning rate = 0.0 913.8805663757958
  0%|          | 0/200 [00:00<?, ?it/s]
0.69875
  0%|          | 0/128 [00:00<?, ?it/s]
root@autodl-container-b52843b669-0b39a6ec:~#
```


可以看到其损失值已经趋近于平滑，基本上达到拟合状态

**疑问点：**为什么使用多模态融合的结果反而不如单使用图像识别的准确率（个人猜测是因为单使用文本的准确率过低所以拉低了融合预测的准确率）