

# Report

## Dataset :

[https://drive.google.com/drive/folders/1zJ7k\\_m4LvaS4\\_E17j--8vmQXG\\_2pSUFQ?usp=sharing](https://drive.google.com/drive/folders/1zJ7k_m4LvaS4_E17j--8vmQXG_2pSUFQ?usp=sharing)

## Objective :

The main objective of the Task is to generate summaries of product reviews obtained from the Amazon Fine Food Reviews dataset. We'd fine-tuned the GPT-2 model on the review data and evaluate its performance in generating to the point summaries.

## 1. Data Preprocessing :

First we take out the two columns "Text" and "Summary" from the original Amazon Fine Food Review dataset and then applied text preprocessing by the method `preprocess_text()` to both the columns "Text" and "Summary" and converted them into a new dataset called ``preprocessed_data``. And after that we kept only 10% of "preprocessed\_data" data called `trimmed_data` and used it for further steps(Training, Evaluation, Generating Summaries) because of time and space constraints.

▶

```
# Trim the DataFrame to its 10% of original size
trimmed_data = data.sample(n=new_size, random_state=42)
trimmed_data
```

[22]:

	Text	Summary
41432	actually tasty pure potatoes great texture nas...	like
209473	realize taste matter personal preference food ...	good subjectively 5 star
247296	one favorite cup soup choices never carried st...	lipton cup soup spring vegetable4 oz
80087	like classic taste good margarita likely youll...	suited purpose quite goal
218571	willing give chance even reading scathing revi...	tastes artificial
...	...	...
518527	bought thing curiosity tackle roach problem en...	impressed
492179	ive used xplod drink mixes like past always en...	energy without stomach aches
299310	im training first marathon order package heari...	great keeping energy
101940	even think baby food tastes good 9 month old a...	great baby food buy somewhere else

## 2. Model Training :

We initialized a GPT-2 tokenizer and model from HuggingFace and divided the trimmed\_data into train and test set in the ratio(75:25).

A custom dataset class was created to prepare the data for training where each input consisted of the review text concatenated with a special token “<BOS>” and summary text.

```
[33]: # Step-4 : Training

num_epochs = 10
for epoch in range(num_epochs):
    model.train()
    for batch in train_loader:
        input_ids, labels = batch
        input_ids = input_ids.to(device)
        labels = labels.to(device)

        optimizer.zero_grad()

        outputs = model(input_ids=input_ids, labels=labels)
        loss = outputs.loss
        loss.backward()

    optimizer.step()

    print(f"Epoch {epoch+1}/{num_epochs}, Loss: {loss.item()}")
```

```
Epoch 1/10, Loss: 0.2209586352109909
Epoch 2/10, Loss: 0.18844905495643616
Epoch 3/10, Loss: 0.35137054324150085
Epoch 4/10, Loss: 0.0789911076426506
Epoch 5/10, Loss: 0.08545723557472229
Epoch 6/10, Loss: 0.0809001624584198
Epoch 7/10, Loss: 0.06948107481002808
Epoch 8/10, Loss: 0.07574597001075745
Epoch 9/10, Loss: 0.05396013334393501
Epoch 10/10, Loss: 0.09450507909059525
```

### 3. Fine-tuning the Model:

The GPT-2 model was fine-tuned on the review data using a training set. We did some experiments with different hyperparameters such as learning rate, batch size and number of epochs to optimize the model to get best performance.

While training, we chose the AdamW optimizer and back-propagated loss to the model.

```
[30]: train_loader = DataLoader(train_dataset, batch_size=8, shuffle=True)
      test_loader = DataLoader(test_dataset, batch_size=8, shuffle=False)
```

```
[32]: optimizer = torch.optim.AdamW(model.parameters(), lr=1e-4)
```

### 4. Evaluation :

After fine-tuning the model, we evaluated the model on the test dataset to calculate the model performance in generating summaries.

We determined ROUGE scores (Recall-Oriented Understudy for Gisting Evaluation) to measure the overlap between the generated summaries and the actual summaries in terms of n-gram overlap, recall, precision, and F1 score.

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num of batches: 889

Average Loss on Test Set: 0.21930818596626428

```
[41]: # Print ROUGE scores
      print("ROUGE Scores:")
      print("ROUGE-1: Precision: {:.2f}, Recall: {:.2f}, F1-Score: {:.2f}".format(scores['rouge-1']['p'], scores['rouge-1']['r'], scores['rouge-1']['f1']))
      print("ROUGE-2: Precision: {:.2f}, Recall: {:.2f}, F1-Score: {:.2f}".format(scores['rouge-2']['p'], scores['rouge-2']['r'], scores['rouge-2']['f1']))
      print("ROUGE-L: Precision: {:.2f}, Recall: {:.2f}, F1-Score: {:.2f}".format(scores['rouge-l']['p'], scores['rouge-l']['r'], scores['rouge-l']['f1']))

      ROUGE Scores:
      ROUGE-1: Precision: 0.01, Recall: 0.06, F1-Score: 0.01
      ROUGE-2: Precision: 0.00, Recall: 0.00, F1-Score: 0.00
      ROUGE-L: Precision: 0.01, Recall: 0.06, F1-Score: 0.01
```

### Hyper Parameter tuning (using 1% of original data)

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Epoch 1/3, Loss: 0.10763468950336859

Epoch 2/3, Loss: 0.10264296125704475

Epoch 3/3, Loss: 0.09768123026259286

Hyperparameters: LR=1e-05, Batch Size=2, Epochs=3, Average Loss on Test Set:  
0.17511065624413275

Epoch 1/5, Loss: 0.09353177442248582

Epoch 2/5, Loss: 0.08884868070773264

Epoch 3/5, Loss: 0.08446727622314365

Epoch 4/5, Loss: 0.07997531429156801

Epoch 5/5, Loss: 0.07599304376631333

Hyperparameters: LR=1e-05, Batch Size=2, Epochs=5, Average Loss on Test Set:  
0.21473581127497549

Epoch 1/8, Loss: 0.07280005656329541

Epoch 2/8, Loss: 0.06836133787764925

Epoch 3/8, Loss: 0.06503848290144279

Epoch 4/8, Loss: 0.061898817195544825

Epoch 5/8, Loss: 0.05885151964323997

Epoch 6/8, Loss: 0.056171942233172636

Epoch 7/8, Loss: 0.05348305890859082

Epoch 8/8, Loss: 0.051170274920195456

Hyperparameters: LR=1e-05, Batch Size=2, Epochs=8, Average Loss on Test Set:  
0.2743694307400456

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Epoch 1/3, Loss: 0.04858995489007313

Epoch 2/3, Loss: 0.04696351165165094

Epoch 3/3, Loss: 0.04541790510194051

Hyperparameters: LR=1e-05, Batch Size=4, Epochs=3, Average Loss on Test Set:  
0.28949261961107176

Epoch 1/5, Loss: 0.044589667830888816

Epoch 2/5, Loss: 0.04347351418832565

Epoch 3/5, Loss: 0.04234540036147352

Epoch 4/5, Loss: 0.04173196038129909

Epoch 5/5, Loss: 0.040652127632448416

Hyperparameters: LR=1e-05, Batch Size=4, Epochs=5, Average Loss on Test Set:  
0.3070501001614533

Epoch 1/8, Loss: 0.040381700041621754

Epoch 2/8, Loss: 0.03945687493417713

Epoch 3/8, Loss: 0.03892290752772486

Epoch 4/8, Loss: 0.038349220405138794

Epoch 5/8, Loss: 0.03760478530764077

Epoch 6/8, Loss: 0.03709731797126819

Epoch 7/8, Loss: 0.036642360488760094

Epoch 8/8, Loss: 0.03630341311451921  
Hyperparameters: LR=1e-05, Batch Size=4, Epochs=8, Average Loss on Test Set:  
0.3266136610273565

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Epoch 1/3, Loss: 0.03570236867436996  
Epoch 2/3, Loss: 0.034856723911543055  
Epoch 3/3, Loss: 0.03487640853069625

Hyperparameters: LR=1e-05, Batch Size=8, Epochs=3, Average Loss on Test Set:  
0.33421916531377965

Epoch 1/5, Loss: 0.034779092415775856  
Epoch 2/5, Loss: 0.03433776617497485  
Epoch 3/5, Loss: 0.03417712970729393  
Epoch 4/5, Loss: 0.03356366385452408  
Epoch 5/5, Loss: 0.033599912798762545

Hyperparameters: LR=1e-05, Batch Size=8, Epochs=5, Average Loss on Test Set:  
0.3486149608251754

Epoch 1/8, Loss: 0.03349210304779474  
Epoch 2/8, Loss: 0.03314433281447941  
Epoch 3/8, Loss: 0.03295854468590547  
Epoch 4/8, Loss: 0.03288785447881996  
Epoch 5/8, Loss: 0.03240311210433381  
Epoch 6/8, Loss: 0.032486338804407815  
Epoch 7/8, Loss: 0.032367967596840234  
Epoch 8/8, Loss: 0.03207327238166981

Hyperparameters: LR=1e-05, Batch Size=8, Epochs=8, Average Loss on Test Set:  
0.3564302914598015

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Epoch 1/3, Loss: 0.04644670335123382  
Epoch 2/3, Loss: 0.04616730562917972  
Epoch 3/3, Loss: 0.04346038064505297

Hyperparameters: LR=5e-05, Batch Size=2, Epochs=3, Average Loss on Test Set:  
0.2611521486475875

Epoch 1/5, Loss: 0.04271872591325143  
Epoch 2/5, Loss: 0.03887979833690509  
Epoch 3/5, Loss: 0.036991499493241056  
Epoch 4/5, Loss: 0.0355270800008622  
Epoch 5/5, Loss: 0.03407640685523925

Hyperparameters: LR=5e-05, Batch Size=2, Epochs=5, Average Loss on Test Set:  
0.29631856020995834

Epoch 1/8, Loss: 0.03378680743225527

Epoch 2/8, Loss: 0.03189574879324186  
Epoch 3/8, Loss: 0.03054238436197579  
Epoch 4/8, Loss: 0.029168894763325653  
Epoch 5/8, Loss: 0.028377244904068146  
Epoch 6/8, Loss: 0.027680464527794896  
Epoch 7/8, Loss: 0.026649384099042644  
Epoch 8/8, Loss: 0.02575026346156749  
Hyperparameters: LR=5e-05, Batch Size=2, Epochs=8, Average Loss on Test Set:  
0.2938796127458665

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Epoch 1/3, Loss: 0.024623924197531243  
Epoch 2/3, Loss: 0.02325929330109739  
Epoch 3/3, Loss: 0.022892354583711926  
Hyperparameters: LR=5e-05, Batch Size=4, Epochs=3, Average Loss on Test Set:  
0.326121072065127

Epoch 1/5, Loss: 0.023132231835656804  
Epoch 2/5, Loss: 0.022790469415256524  
Epoch 3/5, Loss: 0.0222262707455905  
Epoch 4/5, Loss: 0.021792218390953556  
Epoch 5/5, Loss: 0.021838182929857838  
Hyperparameters: LR=5e-05, Batch Size=4, Epochs=5, Average Loss on Test Set:  
0.31441768223231426

Epoch 1/8, Loss: 0.022010583654185845  
Epoch 2/8, Loss: 0.021582246462746365  
Epoch 3/8, Loss: 0.02095900726566654  
Epoch 4/8, Loss: 0.021129785271363218  
Epoch 5/8, Loss: 0.02046058248253679  
Epoch 6/8, Loss: 0.020195405327017798  
Epoch 7/8, Loss: 0.02036487774162376  
Epoch 8/8, Loss: 0.020015041738762528  
Hyperparameters: LR=5e-05, Batch Size=4, Epochs=8, Average Loss on Test Set:  
0.3233362851099352

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Epoch 1/3, Loss: 0.019490315264359983  
Epoch 2/3, Loss: 0.018948607178191752  
Epoch 3/3, Loss: 0.018783769916260778  
Hyperparameters: LR=5e-05, Batch Size=8, Epochs=3, Average Loss on Test Set:  
0.34032257939322613

Epoch 1/5, Loss: 0.019084679431109  
Epoch 2/5, Loss: 0.01891258012636182

Epoch 3/5, Loss: 0.01847564858012251

Epoch 4/5, Loss: 0.01841368572174888

Epoch 5/5, Loss: 0.018388857741754566

Hyperparameters: LR=5e-05, Batch Size=8, Epochs=5, Average Loss on Test Set:  
0.34681457682941735

Epoch 1/8, Loss: 0.01868669847882655

Epoch 2/8, Loss: 0.018472766895965442

Epoch 3/8, Loss: 0.018259748617295478

Epoch 4/8, Loss: 0.018180884582499012

Epoch 5/8, Loss: 0.01834815284272212

Epoch 6/8, Loss: 0.01792970732008203

Epoch 7/8, Loss: 0.0179684556335714

Epoch 8/8, Loss: 0.01788071472299116

Hyperparameters: LR=5e-05, Batch Size=8, Epochs=8, Average Loss on Test Set:  
0.3437500244446015

0.0001 2

Epoch 1/3, Loss: 0.02649111281207843

Epoch 2/3, Loss: 0.025692680213002705

Epoch 3/3, Loss: 0.025332192645181772

Hyperparameters: LR=0.0001, Batch Size=2, Epochs=3, Average Loss on Test Set:  
0.2604559545265052

Epoch 1/5, Loss: 0.026409062564894593

Epoch 2/5, Loss: 0.024649096487200865

Epoch 3/5, Loss: 0.02443895482195639

Epoch 4/5, Loss: 0.024012225008624315