

```
!pip install transformers
!pip install langchain
!pip install datasets
!pip install torch torchvision torchaudio
from datasets import load_dataset
```

```
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from datasets) (3.14.0)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.10/dist-packages (from datasets) (1.25.2)
Requirement already satisfied: pyarrow>=12.0.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (14.0.2)
Requirement already satisfied: pyarrow-hotfix in /usr/local/lib/python3.10/dist-packages (from datasets) (0.6)
Collecting dill<0.3.9,>=0.3.0 (from datasets)
  Downloading dill-0.3.8-py3-none-any.whl (116 kB)
    116.3/116.3 kB 7.2 MB/s eta 0:00:00
Requirement already satisfied: pandas in /usr/local/lib/python3.10/dist-packages (from datasets) (2.0.3)
Requirement already satisfied: requests>=2.19.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (2.31.0)
Requirement already satisfied: tqdm>=4.62.1 in /usr/local/lib/python3.10/dist-packages (from datasets) (4.66.4)
Collecting xxhash (from datasets)
  Downloading xxhash-3.4.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (194 kB)
    194.1/194.1 kB 9.7 MB/s eta 0:00:00
Collecting multiprocessing (from datasets)
  Downloading multiprocessing-0.70.16-py310-none-any.whl (134 kB)
    134.8/134.8 kB 6.1 MB/s eta 0:00:00
Requirement already satisfied: fsspec[http]<=2024.3.1,>=2023.1.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (2023.6.0)
Requirement already satisfied: aiohttp in /usr/local/lib/python3.10/dist-packages (from datasets) (3.9.5)
Collecting huggingface-hub>=0.21.2 (from datasets)
  Downloading huggingface_hub-0.23.0-py3-none-any.whl (401 kB)
    401.2/401.2 kB 10.4 MB/s eta 0:00:00
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from datasets) (23.2)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-packages (from datasets) (6.0.1)
Requirement already satisfied: aiosignal>=1.1.2 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.3.1)
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (23.2.0)
Requirement already satisfied: frozenlist>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.4.1)
Requirement already satisfied: multidict<7.0,>=4.5 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (6.0.5)
Requirement already satisfied: yarl<2.0,>=1.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.9.4)
Requirement already satisfied: async-timeout<5.0,>=4.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (4.0.3)
Requirement already satisfied: typing-extensions>=3.7.4.3 in /usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.21.2->da)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (2024.2)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets) (2023.4)
Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets) (2024.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.2->pandas->datasets) (1.
Installing collected packages: xxhash, dill, multiprocessing, huggingface-hub, datasets
  Attempting uninstall: huggingface-hub
    Found existing installation: huggingface-hub 0.20.3
    Uninstalling huggingface-hub-0.20.3:
      Successfully uninstalled huggingface-hub-0.20.3
Successfully installed datasets-2.19.1 dill-0.3.8 huggingface-hub-0.23.0 multiprocessing-0.70.16 xxhash-3.4.1
Requirement already satisfied: torch in /usr/local/lib/python3.10/dist-packages (2.2.1+cu121)
Requirement already satisfied: torchvision in /usr/local/lib/python3.10/dist-packages (0.17.1+cu121)
Requirement already satisfied: torchaudio in /usr/local/lib/python3.10/dist-packages (2.2.1+cu121)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch) (3.14.0)
Requirement already satisfied: typing-extensions>=4.8.0 in /usr/local/lib/python3.10/dist-packages (from torch) (4.11.0)
Requirement already satisfied: sympy in /usr/local/lib/python3.10/dist-packages (from torch) (1.12)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-packages (from torch) (3.3)
Requirement already satisfied: Jinja2 in /usr/local/lib/python3.10/dist-packages (from torch) (3.1.4)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch) (2023.6.0)
Collecting nvidia-cuda-nvrtc-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_nvrtc_cu12-12.1.105-py3-none-manylinux1_x86_64.whl (23.7 MB)
Collecting nvidia-cuda-runtime-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_runtime_cu12-12.1.105-py3-none-manylinux1_x86_64.whl (823 kB)
Collecting nvidia-cuda-cupti-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_cupti_cu12-12.1.105-py3-none-manylinux1_x86_64.whl (14.1 MB)
```

```
data_files = {
    "train": "XsumTrain.csv",
    "test": "XsumTest.csv",
    "validation": "XsumValidation.csv"
}
```

```
dataset = load_dataset('csv', data_files=data_files)
```

```
from transformers import AutoTokenizer
```

```
tokenizer = AutoTokenizer.from_pretrained("tiiuae/falcon-7b-instruct")
```

```
def preprocess_function(examples):
    inputs = examples['document']
    model_inputs = tokenizer(inputs, max_length=512, truncation=True)

    # Setup the tokenizer for targets
    with tokenizer.as_target_tokenizer():
        labels = tokenizer(examples['summary'], max_length=128, truncation=True)

    model_inputs["labels"] = labels["input_ids"]
    return model_inputs
```

```
tokenized_datasets = dataset.map(preprocess_function, batched=True)
```

```
from transformers import Trainer, TrainingArguments
from peft import get_peft_model, LoraConfig
```

```

# Load the model
model = transformers.AutoModelForCausalLM.from_pretrained(
    'tiiuae/falcon-7b-instruct',
    trust_remote_code=True
)

# Apply LoRA
lora_config = LoraConfig(
    r=8,
    lora_alpha=32,
    lora_dropout=0.1,
    bias="none",
    target_modules=["q_proj", "v_proj"]
)
model = get_peft_model(model, lora_config)

training_args = TrainingArguments(
    output_dir="./results",
    evaluation_strategy="epoch",
    learning_rate=2e-5,
    per_device_train_batch_size=1, # Reduced batch size
    per_device_eval_batch_size=1, # Reduced batch size
    num_train_epochs=3,
    weight_decay=0.01,
    save_total_limit=2,
    save_steps=10_000,
    fp16=True, # Enable mixed precision training
    gradient_accumulation_steps=8, # Accumulate gradients over 8 steps
)

trainer = Trainer(
    model=model,
    args=training_args,
    train_dataset=tokenized_datasets["train"],
    eval_dataset=tokenized_datasets["validation"]
)

# Train the model
trainer.train()

from transformers import pipeline
from langchain import HuggingFacePipeline, PromptTemplate, LLMChain

# Set up the pipeline for text generation
pipe = pipeline('text-generation', model=model, tokenizer=tokenizer, max_new_tokens=100, do_sample=True, use_cache=True, eos_token_id=token

# Wrap the pipeline in HuggingFacePipeline
llm = HuggingFacePipeline(pipeline=pipe, model_kwargs={'temperature':0.1})

# Define the prompt template
template = """
Write a concise summary of the following text delimited by triple backquotes.
```{text}```
SUMMARY:
"""

prompt = PromptTemplate(template=template, input_variables=["text"])

# Create LLMChain
llm_chain = LLMChain(prompt=prompt, llm=llm)

from transformers import pipeline
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SUMMARY:
"""

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# Create LLMChain
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```

```
Collecting transformers
  Downloading transformers-4.40.2-py3-none-any.whl (9.0 MB)
    9.0/9.0 MB 10.0 MB/s eta 0:00:0000:0100:01
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from transformers) (3.12.2)
Collecting safetensors>=0.4.1
  Downloading safetensors-0.4.3-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.2 MB)
    1.2/1.2 MB 15.1 MB/s eta 0:00:00:00:01
Collecting regex!=2019.12.17
  Downloading regex-2024.5.10-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (774 kB)
    774.1/774.1 kB 12.4 MB/s eta 0:00:0000:01
Collecting pyyaml>=5.1
  Downloading PyYAML-6.0.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (705 kB)
    705.5/705.5 kB 23.9 MB/s eta 0:00:00
Collecting huggingface-hub<1.0,>=0.19.3
  Downloading huggingface_hub-0.23.0-py3-none-any.whl (401 kB)
    401.2/401.2 kB 10.1 MB/s eta 0:00:0000:01
Requirement already satisfied: packaging>=20.0 in /databricks/python3/lib/python3.10/site-packages (from transformers) (21.3)
Requirement already satisfied: requests in /databricks/python3/lib/python3.10/site-packages (from transformers) (2.28.1)
Collecting tqdm>=4.27
  Downloading tqdm-4.66.4-py3-none-any.whl (78 kB)
    78.3/78.3 kB 4.5 MB/s eta 0:00:00
Collecting tokenizers<0.20,>=0.19
  Downloading tokenizers-0.19.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (3.6 MB)
    3.6/3.6 MB 22.0 MB/s eta 0:00:0000:0100:01
Requirement already satisfied: numpy>=1.17 in /databricks/python3/lib/python3.10/site-packages (from transformers) (1.26.4)
Requirement already satisfied: typing-extensions>=3.7.4.3 in /databricks/python3/lib/python3.10/site-packages (from huggingface-hub<1.0)
Collecting fsspec>=2023.5.0
  Downloading fsspec-2024.3.1-py3-none-any.whl (171 kB)
    172.0/172.0 kB 13.7 MB/s eta 0:00:00
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /databricks/python3/lib/python3.10/site-packages (from packaging>=20.0->tra
Requirement already satisfied: charset-normalizer<3,>=2 in /databricks/python3/lib/python3.10/site-packages (from requests->transforme
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /databricks/python3/lib/python3.10/site-packages (from requests->transformers)
Requirement already satisfied: certifi>=2017.4.17 in /databricks/python3/lib/python3.10/site-packages (from requests->transformers) (21
Requirement already satisfied: idna<4,>=2.5 in /databricks/python3/lib/python3.10/site-packages (from requests->transformers) (3.3)
Installing collected packages: tqdm, safetensors, regex, pyyaml, fsspec, huggingface-hub, tokenizers, transformers
Successfully installed fsspec-2024.3.1 huggingface-hub-0.23.0 pyyaml-6.0.1 regex-2024.5.10 safetensors-0.4.3 tokenizers-0.19.1 tqdm-4.66.4

[notice] A new release of pip available: 22.2.2 -> 24.0
[notice] To update, run: pip install --upgrade pip
Collecting langchain
  Downloading langchain-0.1.20-py3-none-any.whl (1.0 MB)
    1.0/1.0 MB 8.1 MB/s eta 0:00:00:00:010:01
Collecting langchain-text-splitters<0.1,>=0.0.1
  Downloading langchain_text_splitters-0.0.1-py3-none-any.whl (21 kB)
Requirement already satisfied: pydantic<3,>=1 in /databricks/python3/lib/python3.10/site-packages (from langchain) (1.10.6)
Collecting aiohttp<4.0.0,>=3.8.3
  Downloading aiohttp-3.9.5-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.2 MB)
    1.2/1.2 MB 8.4 MB/s eta 0:00:00:00:0100:01
Requirement already satisfied: requests<3,>=2 in /databricks/python3/lib/python3.10/site-packages (from langchain) (2.28.1)
Requirement already satisfied: numpy<2,>=1 in /databricks/python3/lib/python3.10/site-packages (from langchain) (1.26.4)
Collecting dataclasses-json<0.7,>=0.5.7
  Downloading dataclasses_json-0.6.6-py3-none-any.whl (28 kB)
Collecting langsmith<0.2.0,>=0.1.17
  Downloading langsmith-0.1.57-py3-none-any.whl (121 kB)
    121.0/121.0 kB 8.9 MB/s eta 0:00:00
Collecting async-timeout<5.0.0,>=4.0.0
  Downloading async_timeout-4.0.3-py3-none-any.whl (5.7 kB)
Collecting langchain-community<0.1,>=0.0.38
  Downloading langchain_community-0.0.38-py3-none-any.whl (2.0 MB)
    2.0/2.0 MB 13.7 MB/s eta 0:00:0000:0100:01
Collecting langchain-core<0.2.0,>=0.1.52
  Downloading langchain_core-0.1.52-py3-none-any.whl (302 kB)
    302.9/302.9 kB 13.3 MB/s eta 0:00:00
Requirement already satisfied: SQLAlchemy<3,>=1.4 in /databricks/python3/lib/python3.10/site-packages (from langchain) (2.0.30)
Requirement already satisfied: tenacity<9.0.0,>=8.1.0 in /databricks/python3/lib/python3.10/site-packages (from langchain) (8.1.0)
Requirement already satisfied: PyYAML>=5.3 in /local_disk0/.ephemeral_nfs/envs/pythonEnv-f5f3b5eb-65bc-4e4e-9543-db2f5e422fea/lib/pyth
Collecting yarl<2.0,>=1.0
  Downloading yarl-1.9.4-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (301 kB)
    301.6/301.6 kB 16.1 MB/s eta 0:00:00
Collecting frozenlist>=1.1.1
  Downloading frozenlist-1.4.1-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (239
    239.5/239.5 kB 13.2 MB/s eta 0:00:00
Collecting aiosignal>=1.1.2
  Downloading aiosignal-1.3.1-py3-none-any.whl (7.6 kB)
Requirement already satisfied: attrs>=17.3.0 in /databricks/python3/lib/python3.10/site-packages (from aiohttp<4.0.0,>=3.8.3->langchain)
Collecting multidict<7.0,>=4.5
  Downloading multidict-6.0.5-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (124 kB)
    124.3/124.3 kB 7.4 MB/s eta 0:00:00
Collecting marshmallow<4.0.0,>=3.18.0
  Downloading marshmallow-3.21.2-py3-none-any.whl (49 kB)
    49.3/49.3 kB 4.2 MB/s eta 0:00:00
Collecting typing-inspect<1,>=0.4.0
  Downloading typing_inspect-0.9.0-py3-none-any.whl (8.8 kB)
Collecting jsonpatch<2.0,>=1.33
  Downloading jsonpatch-1.33-py2.py3-none-any.whl (12 kB)
Collecting packaging<24.0,>=23.2
  Using cached packaging-23.2-py3-none-any.whl (53 kB)
Collecting orjson<4.0.0,>=3.9.14
  Downloading orjson-3.10.3-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (142 kB)
    142.5/142.5 kB 11.3 MB/s eta 0:00:00
Requirement already satisfied: typing-extensions>=4.2.0 in /databricks/python3/lib/python3.10/site-packages (from pydantic<3,>=1->lang
Requirement already satisfied: charset-normalizer<3,>=2 in /databricks/python3/lib/python3.10/site-packages (from requests<3,>=2->lang
Requirement already satisfied: certifi>=2017.4.17 in /databricks/python3/lib/python3.10/site-packages (from requests<3,>=2->langchain)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /databricks/python3/lib/python3.10/site-packages (from requests<3,>=2->langcha
Requirement already satisfied: idna<4,>=2.5 in /databricks/python3/lib/python3.10/site-packages (from requests<3,>=2->langchain) (3.3)
Requirement already satisfied: greenlet!=0.4.17 in /databricks/python3/lib/python3.10/site-packages (from SQLAlchemy<3,>=1.4->langchain)
Collecting jsonpointer>=1.9
  Downloading jsonpointer-2.4-py2.py3-none-any.whl (7.8 kB)
Requirement already satisfied: mpyy-extensions>=0.3.0 in /databricks/python3/lib/python3.10/site-packages (from typing-inspect<1,>=0.4
Installing collected packages: typing-inspect, packaging, orjson, multidict, jsonpointer, frozenlist, async-timeout, yarl, marshmallow
```

```
Attempting uninstall: packaging
Found existing installation: packaging 21.3
Not uninstalling packaging at /databricks/python3/lib/python3.10/site-packages, outside environment /local_disk0/.ephemeral_nfs/en
Can't uninstall 'packaging'. No files were found to uninstall.
Successfully installed aiohttp-3.9.5 aiosignal-1.3.1 async-timeout-4.0.3 dataclasses-json-0.6.6 frozenlist-1.4.1 jsonpatch-1.33 jsonpo

[notice] A new release of pip available: 22.2.2 -> 24.0
[notice] To update, run: pip install --upgrade pip
Collecting torch
  Downloading torch-2.3.0-cp310-cp310-manylinux1_x86_64.whl (779.1 MB)
    287.9/779.1 MB 199.7 MB/s eta 0:00:03
```

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*** WARNING: max output size exceeded, skipping output. ***


    410.6/410.6 MB 1.7 MB/s eta 0:00:0000:01
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch) (3.12.2)
Collecting sympy
  Downloading sympy-1.12-py3-none-any.whl (5.7 MB)
    5.7/5.7 MB 28.1 MB/s eta 0:00:00:00:01
Collecting nvidia-nvjitlink-cu12
  Downloading nvidia_nvjitlink_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl (21.1 MB)
    21.1/21.1 MB 16.3 MB/s eta 0:00:0000:0100:01
Requirement already satisfied: pillow!=8.3.*, >=5.3.0 in /databricks/python3/lib/python3.10/site-packages (from torchvision) (9.2.0)
Requirement already satisfied: numpy in /databricks/python3/lib/python3.10/site-packages (from torchvision) (1.26.4)
Requirement already satisfied: MarkupSafe>=0.23 in /databricks/python3/lib/python3.10/site-packages (from jinja2->torch) (2.0.1)
Collecting mpmath>=0.19
  Downloading mpmath-1.3.0-py3-none-any.whl (536 kB)
    536.2/536.2 kB 25.7 MB/s eta 0:00:00
Installing collected packages: mpmath, triton, sympy, nvidia-nvtx-cu12, nvidia-nvjitlink-cu12, nvidia-nccl-cu12, nvidia-curand-cu12, n
Successfully installed mpmath-1.3.0 networkx-3.3 nvidia-cublas-cu12-12.1.3.1 nvidia-cuda-cupti-cu12-12.1.105 nvidia-cuda-nvrtc-cu12-12
```

```
[notice] A new release of pip available: 22.2.2 -> 24.0
[notice] To update, run: pip install --upgrade pip
/databricks/python/lib/python3.10/site-packages/scipy/_init__.py:155: UserWarning: A NumPy version >=1.18.5 and <1.25.0 is required fi
warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}")
/local_disk0/.ephemeral_nfs/envs/pythonEnv-f5f3b5eb-65bc-4e4e-9543-db2f5e422fea/lib/python3.10/site-packages/huggingface_hub/file_down
warnings.warn(
config.json: 0%|          | 0.00/1.05k [00:00<?, ?B/s]
configuration_falcon.py: 0%|          | 0.00/7.16k [00:00<?, ?B/s]
A new version of the following files was downloaded from https://huggingface.co/tiiuae/falcon-7b-instruct:
- configuration_falcon.py
. Make sure to double-check they do not contain any added malicious code. To avoid downloading new versions of the code file, you can i
WARNING:transformers_modules.tiiuae.falcon-7b-instruct.cf4b3c42ce2fdfe24f753f0f0d179202fea59c99.configuration_falcon:
WARNING: You are currently loading Falcon using legacy code contained in the model repository. Falcon has now been fully ported into tl

modeling_falcon.py: 0%|          | 0.00/56.9k [00:00<?, ?B/s]
A new version of the following files was downloaded from https://huggingface.co/tiiuae/falcon-7b-instruct:
- modeling_falcon.py
. Make sure to double-check they do not contain any added malicious code. To avoid downloading new versions of the code file, you can i
pytorch_model.bin.index.json: 0%|          | 0.00/16.9k [00:00<?, ?B/s]
Downloading shards: 0%|          | 0/2 [00:00<?, ?it/s]
pytorch_model-00001-of-00002.bin: 0%|          | 0.00/9.95G [00:00<?, ?B/s]
pytorch_model-00002-of-00002.bin: 0%|          | 0.00/4.48G [00:00<?, ?B/s]
Loading checkpoint shards: 0%|          | 0/2 [00:00<?, ?it/s]
generation_config.json: 0%|          | 0.00/117 [00:00<?, ?B/s]
tokenizer_config.json: 0%|          | 0.00/287 [00:00<?, ?B/s]
tokenizer.json: 0%|          | 0.00/2.73M [00:00<?, ?B/s]
special_tokens_map.json: 0%|          | 0.00/281 [00:00<?, ?B/s]
/local_disk0/.ephemeral_nfs/envs/pythonEnv-f5f3b5eb-65bc-4e4e-9543-db2f5e422fea/lib/python3.10/site-packages/langchain_core/_api/depre
warn_deprecated()
```


```
df = pd.DataFrame(dataset['test'])[['document', 'summary', 'id']]
```

```
df.head()
```



	document	summary	id
0	Prison Link Cymru had 1099 referrals in 201516...	There is a "chronic" need for more housing for...	38264402
1	Officers searched properties in the Waterfront...	A man has appeared in court after firearms, am...	34227252
2	Jordan Hill Brittany Covington and Tesfaye Co...	Four people accused of kidnapping and torturin...	38537698
3	The 48yearold former Arsenal goalkeeper played...	West Brom have appointed Nicky Hammond as tech...	36175342
4	Restoring the function of the organ which hel...	The pancreas can be triggered to regenerate it...	39070183

```
df.drop(columns=['id'], inplace=True)
df.head()
```



	document	summary
0	Prison Link Cymru had 1099 referrals in 201516...	There is a "chronic" need for more housing for...
1	Officers searched properties in the Waterfront...	A man has appeared in court after firearms, am...
2	Jordan Hill Brittany Covington and Tesfaye Co...	Four people accused of kidnapping and torturin...
3	The 48yearold former Arsenal goalkeeper played...	West Brom have appointed Nicky Hammond as tech...
4	Restoring the function of the organ which hel...	The pancreas can be triggered to regenerate it...

```
# Create an empty column 'model_generated' in test_df to store the generated summaries
df['model_generated'] = ""

# Define a function to generate summaries and populate the 'model_generated' column
def generate_and_store_summary(row):
    article_text = row['document']
    summary = llm_chain.run(article_text)
    return summary

df['model_generated'] = df.apply(generate_and_store_summary, axis=1)

print(df[['document', 'model_generated']].head(25))
```

	document	model_generated
0	Prison Link Cymru had 1099 referrals in 201516...	Write a concise summary of the...
1	Officers searched properties in the Waterfront...	Write a concise summary of the...
2	Jordan Hill Brittany Covington and Tesfaye Co...	Write a concise summary of the...
3	The 48yearold former Arsenal goalkeeper played...	Write a concise summary of the...
4	Restoring the function of the organ which hel...	Write a concise summary of the...
5	But there certainly should be.\nThese are two ...	Write a concise summary of the...
6	Media playback is not supported on this device...	Write a concise summary of the...
7	Its no joke. But Kareem Badr says people did l...	Write a concise summary of the...
8	Relieved that the giant telecoms company would...	Write a concise summary of the...
9	Im really looking forward to it the home of S...	Write a concise summary of the...
10	The move is in response to an 8m cut in the su...	Write a concise summary of the...
11	The leaflets said the patient had been referre...	Write a concise summary of the...
12	Emily Thornberry said Labour would not frustra...	Write a concise summary of the...
13	The National League sold the Republic of Irela...	Write a concise summary of the...
14	Iwan Wyn Lewis of Penygroes Gwynedd had been s...	Write a concise summary of the...
15	The 33yearold has featured only twice for the ...	Write a concise summary of the...
16	Dr Waleed Abdalati told the BBC the that conti...	Write a concise summary of the...
17	The ska group tweeted the news It is with deep...	Write a concise summary of the...
18	The 14time major champion playing in his first...	Write a concise summary of the...
19	Media playback is not supported on this device...	Write a concise summary of the...
20	Pakistans telecoms regulator said the ban was ...	Write a concise summary of the...
21	The 26yearold was injured in last weeks win ov...	Write a concise summary of the...
22	Media playback is not supported on this device...	Write a concise summary of the...
23	The death toll doubled over the last two days ...	Write a concise summary of the...
24	Two snowsports enthusiasts got married at a Sc...	Write a concise summary of the...

```
# Apply the logic to all rows of the 'model_generated' column
df['model_generated'] = df['model_generated'].apply(lambda text: text.split('SUMMARY:')[1].strip() if 'SUMMARY:' in text else text)

df['model_generated'][7]
```

'This article is about The art of public speaking. It discusses the 5 most important tips for aspiring presenters and their first tip is to practice your public speaking skills regularly and take on the challenge of improving you skills.\n1. Practice your speech as much as possible.\n2. Get feedback on your speeches.\n3. Understand your audiences needs.\n4. Engage your audience.\n5. Use media to your advantages.\n\nThe first tip for public speaking is to practice your presentation'

```
df['document'][17]
```

'Its no joke. But Kareem Badr says people did laugh in 2009 when he and two friends paid 20000 Â13000 for the Hideout in Austin when it wasnt making money and the previous owner decided not to renew the lease.\nWe took over a sinking ship and each brought a bucket to bail it out says Mr Badr.\nNone of us had any experience of running a business. But we loved what we were doing enough that it carried us through.\nThree years ago he was able to quit his day job and draw a salary from the club.\nMr Badr says its still not as much as he used to make as a programmer about 80000 a year but he now employs around 25 part time and contract workers.\nAnd he recently expanded the premises taking over the adjoining coffee house which sells alcohol and leasing more theatre space.\nMr Badr says I think my background in computer science helped because I can take a big problem break it up into small chunks and figure out how to make it better and more efficient.\nThats basically what we did for every aspect of the business. And by doing that it naturally started to improve.\nMr Badr may have been helped by national trends which imply a growing enthusiasm for comedy clubs in the US.\nAn industry report from data firm Ibis World expects total US annual comedy club revenue to grow by 1.8 over the next five years to 344.6m in 2020.\nWhen the Hideout first opened it was the only improv theatre in Austin says Mr Badr.\nBut now there are five comedy schools and four theatres. We were at the right place at the right time.\nWhile the Ibis World report showed that dozens of US comedy clubs were forced to close in the wake of the 2008 recession when fewer people had disposable income to spend on live entertainment Stephen Rosenfield director of the American Comedy Institute in New York says standup comedy is now entering a new golden age.\nThe US has comedy clubs all over the country not just in big cities and they require talent he says.\nIn any field there are those at the top who make dynastic fortunes. But because of the significance of the local comedy club there is a career and a living to be made by good comedians who are not superstars.\nMr Rosenfield says the growing popularity of standup comedy is fuelled in part by younger audiences who view humorous TV hosts such as Jon Stewart Jay Leno and Steve Colbert as their primary source for news.\nIts not just entertaining them its also informing them he says. Theres a new immediacy to standup that makes it much more appealing to a generation thats on social media tweeting face booking and blogging.\nBut clubs dont only make money from entertainers. Alcohol alone can bring in as much as 40 of the nights takings and many clubs demand that audiences buy a minimum number of drinks per person.\nA club really has three businesses going on says Mr Rosenfield.\nIts an entertainment entity a restaurant and a bar. They make money from selling drinks and dinners and they make money from the cover charge.\nThere are usually three people on the bill. The opening act is the new comedian. They do about 20 minutes and introduce the other comics.\nThe middle act does about half an hour and then theres the headliner. They almost always have TV credits and are the ones people are coming to see. That headliner could be making six figures a year.\nTop tier performers make much more. According to Forbes Canadian comedian Russell Peters grossed 19m with 64 shows in 2013 while industry veteran Jerry Seinfeld is the highest paid comedian in the US set to earn 36m this year.\nSteve Byrne 41 is a veteran standup comedian based in LA and star of his own television show Sullivan and Son which ran for three seasons.\nHe describes himself as a successful midlevel comedian who makes an annual six figure salary mainly from touring.\nAnd although he was close to hitting a million dollars a year before his show was cancelled in 2014 he says most comedians make money at clubs and do television to boost their brand rather than their income.\nMr Byrne says Gigs vary because it depends what youre contracted at.\nIf its somebody starting off in the business it could be 1500 a show. For somebody whos had some TV credits you could go from 4500 to 7500.\nAnd if youre just a knock out comic then youre coming in and getting a door deal. Youre taking all the tickets and the club gets the concessions.\nMr Byrne says hard work is the key to success. There is no magic short cut and few lucky breaks.\nThe one single thing that an aspiring comedian should do is write write write. What is it that makes you laugh?\nYour voice should resonate with your audience. So find your voice and you will find your audience.\nWhile the music and film industries have been impacted by the internet such as illegal downloads and reduced album sales Mr Rosenfield says the online world has actually given live comedy a boost.\nThe format of comedy particularly standup lends itself to digital media like nothing else. One terrific joke can get a million hits he says.\nIts become a new metric for a club manager. If a booker sees that a comic has 500000 online followers theyll book him almost sight unseen. Thats it.\nDigital is gigantically important and has been for a while.\nBut in the end the success of comedy comes down to a very simple fact people need to laugh.\nBack in 2001 Steve Byrne was a comedian in New York when terrorists flew two planes into the World Trade Centre on 11

September.\nHe says We all thought whos going to come to a comedy club The dreams over Ive got to get a real job now.\nBut after a week I forget which club was the first one to open its doors but it was packed. People needed an outlet.\nAnd I remember for months on end those clubs in New York City were just jam packed. That was the thing that told me that this was a profession that is foolproof.'

```
!pip install rouge
!pip install nltk
!pip install bert_score

from rouge import Rouge

# Initialize the ROUGE evaluator
rouge = Rouge()

sampled_df = df

generated_summaries = sampled_df['model_generated'].tolist()
reference_summaries = sampled_df['summary'].tolist()

# Calculate ROUGE scores
rouge_scores = rouge.get_scores(generated_summaries, reference_summaries, avg=True)

from nltk.translate.bleu_score import corpus_bleu

# Extract the generated summaries and reference summaries
generated_summaries = sampled_df['model_generated'].tolist()
reference_summaries = sampled_df['summary'].tolist()

# Calculate BLEU score
bleu_score = corpus_bleu(reference_summaries, generated_summaries)

from bert_score import score

# Extract the generated summaries and reference summaries
generated_summaries = sampled_df['model_generated'].tolist()
reference_summaries = sampled_df['summary'].tolist()

# Calculate BERT Score
P, R, F1 = score(generated_summaries, reference_summaries, lang="en", verbose=True)
```



```

Requirement already satisfied: rouge in /usr/local/lib/python3.10/dist-packages (1.0.1)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from rouge) (1.16.0)
Requirement already satisfied: nltk in /usr/local/lib/python3.10/dist-packages (3.8.1)
Requirement already satisfied: click in /usr/local/lib/python3.10/dist-packages (from nltk) (8.1.7)
Requirement already satisfied: joblib in /usr/local/lib/python3.10/dist-packages (from nltk) (1.4.2)
Requirement already satisfied: regex<=2021.8.3 in /usr/local/lib/python3.10/dist-packages (from nltk) (2023.12.25)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from nltk) (4.66.4)
Requirement already satisfied: bert_score in /usr/local/lib/python3.10/dist-packages (0.3.13)
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Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from bert_score) (1.25.2)
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Requirement already satisfied: tqdm>=4.31.1 in /usr/local/lib/python3.10/dist-packages (from bert_score) (4.66.4)
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Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.0.1->bert_score) (2024.1)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (3.14.0)
Requirement already satisfied: typing-extensions>=4.8.0 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (4.11.0)
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Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (2023.6.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.1.105 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (12.1.105)
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Requirement already satisfied: nvidia-cudnn-cu12==8.9.2.26 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (8.9.2.26)
Requirement already satisfied: nvidia-cublas-cu12==12.1.3.1 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (12.1.3.1)
Requirement already satisfied: nvidia-cufft-cu12==11.0.2.54 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (11.0.2.54)
Requirement already satisfied: nvidia-curand-cu12==10.3.2.106 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (10.3.2.106)
Requirement already satisfied: nvidia-cusolver-cu12==11.4.5.107 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (11.4.5.107)
Requirement already satisfied: nvidia-cusparse-cu12==12.1.0.106 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (12.1.0.106)
Requirement already satisfied: nvidia-nccl-cu12==2.19.3 in /usr/local/lib/python3.10/dist-packages (from torch>=1.0.0->bert_score) (2.19.3)
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Requirement already satisfied: huggingface-hub<1.0,>=0.19.3 in /usr/local/lib/python3.10/dist-packages (from transformers>=3.0.0->bert_score) (0.19.3)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-packages (from transformers>=3.0.0->bert_score) (6.0.1)
Requirement already satisfied: regex<=2019.12.17 in /usr/local/lib/python3.10/dist-packages (from transformers>=3.0.0->bert_score) (2019.12.17)
Requirement already satisfied: tokenizers<0.20,>=0.19 in /usr/local/lib/python3.10/dist-packages (from transformers>=3.0.0->bert_score) (0.19.1)
Requirement already satisfied: safetensors>=0.4.1 in /usr/local/lib/python3.10/dist-packages (from transformers>=3.0.0->bert_score) (0.4.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (1.2.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (4.51.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (1.4.5)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.7.1->bert_score) (3.1.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31.0->bert_score) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31.0->bert_score) (3.7)

print("ROUGE Scores:", rouge_scores)
print("BLEU Score Summaries:", bleu_score)
print("BERT Precision:", P.mean().item())
print("BERT Recall:", R.mean().item())
print("BERT F1 Score:", F1.mean().item())

```

```

ROUGE Scores: {'rouge-1': {'r': 0.27325732278071757, 'p': 0.10613480343655533, 'f': 0.15023619119652162}, 'rouge-2': {'r': 0.027487335
BLEU Score Summaries: 9.212320578498223e-232
BERT Precision: 0.7847375273704529
BERT Recall: 0.8650155663490295
BERT F1 Score: 0.8219874501228333

```

The hypothesis contains 0 counts of 5-gram overlaps.

Therefore the BLEU score evaluates to 0, independently of how many N-gram overlaps of lower order it contains.

Consider using lower n-gram order or use SmoothingFunction()

warnings.warn(msg)

/usr/local/lib/python3.10/dist-packages/nltk/translate/bleu\_score.py:552: UserWarning:

The hypothesis contains 0 counts of 4-gram overlaps.

Therefore the BLEU score evaluates to 0, independently of how many N-gram overlaps of lower order it contains.

Consider using lower n-gram order or use SmoothingFunction()

warnings.warn(msg)

/usr/local/lib/python3.10/dist-packages/huggingface\_hub/file\_download.py:1132: FutureWarning: `resume\_download` is deprecated and will be removed in version 0.11.0. Use `resume\_from\_checkpoint` instead.

/usr/local/lib/python3.10/dist-packages/huggingface\_hub/utils/\_token.py:89: UserWarning:

The secret `HF\_TOKEN` does not exist in your Colab secrets.

To authenticate with the Hugging Face Hub, create a token in your settings tab (<https://huggingface.co/settings/tokens>), set it as secret in your Colab secrets.

You will be able to reuse this secret in all of your notebooks.

Please note that authentication is recommended but still optional to access public models or datasets.

warnings.warn(msg)

tokenizer configuration: 100%

25.0/25.0 MB 00:00:00.831B/s