Abstractive Text Summarization Transformer Model

Project Objective

The objective of this project is to build an abstractive text summarization model using a Transformer architecture. Abstractive summarization aims to generate a concise and fluent summary that may include words or phrases not present in the original text, while capturing the most important information. We will use a prtrained model for this task.

Install Modules

```
In [18]:  !pip install transformers==2.8.0
          !pip install torch
```

```
Collecting transformers==2.8.0
  Using cached transformers-2.8.0-py3-none-any.whl.metadata (43 kB)
Requirement already satisfied: numpy in /usr/local/lib/python3.12/dist-packages
(from transformers==2.8.0) (2.0.2)
Collecting tokenizers==0.5.2 (from transformers==2.8.0)
  Using cached tokenizers-0.5.2.tar.gz (64 kB)
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
Collecting boto3 (from transformers==2.8.0)
  Using cached boto3-1.40.64-py3-none-any.whl.metadata (6.6 kB)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packa
ges (from transformers==2.8.0) (3.20.0)
Requirement already satisfied: requests in /usr/local/lib/python3.12/dist-packa
ges (from transformers==2.8.0) (2.32.4)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.12/dist-pac
kages (from transformers==2.8.0) (4.67.1)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.12/d
ist-packages (from transformers==2.8.0) (2024.11.6)
Requirement already satisfied: sentencepiece in /usr/local/lib/python3.12/dist-
packages (from transformers==2.8.0) (0.2.1)
Collecting sacremoses (from transformers==2.8.0)
  Using cached sacremoses-0.1.1-py3-none-any.whl.metadata (8.3 kB)
Collecting botocore<1.41.0,>=1.40.64 (from boto3->transformers==2.8.0)
  Using cached botocore-1.40.64-py3-none-any.whl.metadata (5.7 kB)
Collecting jmespath<2.0.0,>=0.7.1 (from boto3->transformers==2.8.0)
  Using cached jmespath-1.0.1-py3-none-any.whl.metadata (7.6 kB)
Collecting s3transfer<0.15.0,>=0.14.0 (from boto3->transformers==2.8.0)
  Using cached s3transfer-0.14.0-py3-none-any.whl.metadata (1.7 kB)
Requirement already satisfied: charset_normalizer<4,>=2 in /usr/local/lib/pytho
n3.12/dist-packages (from requests->transformers==2.8.0) (3.4.4)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.12/dist-p
ackages (from requests->transformers==2.8.0) (3.11)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/
dist-packages (from requests->transformers==2.8.0) (2.5.0)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.12/
dist-packages (from requests->transformers==2.8.0) (2025.10.5)
Requirement already satisfied: click in /usr/local/lib/python3.12/dist-packages
(from sacremoses->transformers==2.8.0) (8.3.0)
Requirement already satisfied: joblib in /usr/local/lib/python3.12/dist-package
s (from sacremoses->transformers==2.8.0) (1.5.2)
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/py
thon3.12/dist-packages (from botocore<1.41.0,>=1.40.64->boto3->transformer
s==2.8.0) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-packa
ges (from python-dateutil<3.0.0,>=2.1->botocore<1.41.0,>=1.40.64->boto3->transf
ormers==2.8.0) (1.17.0)
Using cached transformers-2.8.0-py3-none-any.whl (563 kB)
Using cached boto3-1.40.64-py3-none-any.whl (139 kB)
Using cached sacremoses-0.1.1-py3-none-any.whl (897 kB)
Using cached botocore-1.40.64-py3-none-any.whl (14.1 MB)
Using cached jmespath-1.0.1-py3-none-any.whl (20 kB)
Using cached s3transfer-0.14.0-py3-none-any.whl (85 kB)
Building wheels for collected packages: tokenizers
```

error: **subprocess-exited-with-error**

× Building wheel for tokenizers **(pyproject.toml)** did not run successfully.
│ exit code: **1**
╰─> See above for output.

note: This error originates from a subprocess, and is likely not a problem with pip.
Building wheel for tokenizers (pyproject.toml) ... error
ERROR: Failed building wheel for tokenizers
Failed to build tokenizers
ERROR: ERROR: Failed to build installable wheels for some pyproject.toml based projects (tokenizers)
Requirement already satisfied: torch in /usr/local/lib/python3.12/dist-packages (2.8.0+cu126)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from torch) (3.20.0)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.12/dist-packages (from torch) (4.15.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from torch) (75.2.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch) (1.13.3)
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (from torch) (3.5)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from torch) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.12/dist-packages (from torch) (2025.3.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.80)
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch) (9.10.2.21)
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.4.1)
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.12/dist-packages (from torch) (11.3.0.4)
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python3.12/dist-packages (from torch) (10.3.7.77)
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch) (11.7.1.2)
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/python3.12/dist-packages (from torch) (12.5.4.2)
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python3.12/dist-packages (from torch) (0.7.1)
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/dist-packages (from torch) (2.27.3)
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/li

```
b/python3.12/dist-packages (from torch) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/p
ython3.12/dist-packages (from torch) (1.11.1.6)
Requirement already satisfied: triton==3.4.0 in /usr/local/lib/python3.12/dist-
packages (from torch) (3.4.0)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/
dist-packages (from sympy>=1.13.3->torch) (1.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dis
t-packages (from jinja2->torch) (3.0.3)
```

Import Libraries

In [19]:
```python
import torch
from transformers import T5Tokenizer, T5ForConditionalGeneration
```

Model Implementation

Initialize the T5 model and tokenizer.

In [20]:
```python
#initialize the pretrained model
model = T5ForConditionalGeneration.from_pretrained('t5-small')
tokenizer = T5Tokenizer.from_pretrained('t5-small')
device = torch.device('cpu')
```

In [21]:
```python
#input text

text = """
Artificial Intelligence (AI) is rapidly transforming how the world works, crea
With breakthroughs in generative AI, machine learning, and natural language pr
Businesses are using AI to automate processes, enhance customer experiences, a
This technological shift is leading to massive growth opportunities, helping c
However, AI's rise also brings a shift in the job market – while repetitive ta
The future workforce will need strong analytical and creative skills to work a
For employees and organizations alike, upskilling in AI technologies will beco
In the coming years, AI will become more ethical, personalized, and embedded i
The future belongs to those who can combine human intelligence with machine in
"""
```

Data Preprocessing

Data preprocessing involves preparing the text data for input into the Transformer model. This includes tokenization, handling special characters, and formatting the data as required by the model.

In [22]:
```python
#preprocess the input text
preprocessed_text = text.strip().replace('\n', '')
t5_input_text = 'summarize: ' + preprocessed_text
```

```
In [23]:  t5_input_text
```

Out[23]: 'summarize: Artificial Intelligence (AI) is rapidly transforming how the worl
          d works, creating a new era of innovation across industries. With breakthroug
          hs in generative AI, machine learning, and natural language processing, machi
          nes are now capable of analyzing, learning, and even creating like humans. Bu
          sinesses are using AI to automate processes, enhance customer experiences, an
          d make data-driven decisions faster than ever before.This technological shift
          is leading to massive growth opportunities, helping companies boost efficienc
          y and gain a competitive edge.However, AI's rise also brings a shift in the j
          ob market — while repetitive tasks are being automated, new roles in data sci
          ence, AI ethics, and prompt engineering are emerging. The future workforce wi
          ll need strong analytical and creative skills to work alongside intelligent s
          ystems.For employees and organizations alike, upskilling in AI technologies w
          ill become essential.In the coming years, AI will become more ethical, person
          alized, and embedded in daily life — from healthcare and education to finance
          and entertainment. Rather than replacing humans, AI will empower them to focu
          s on strategy, empathy, and innovation. The future belongs to those who can c
          ombine human intelligence with machine intelligence to drive progress.'

```
In [24]:  len(t5_input_text.split())
```

Out[24]: 186

```
In [25]:  tokenized_text = tokenizer.encode(t5_input_text, return_tensors = 'pt', max_le
```

Summary

```
In [26]:  summary_ids = model.generate(tokenized_text, min_length = 30, max_length = 120
          summary = tokenizer.decode(summary_ids[0], skip_special_tokens= True)
```

```
In [27]:  summary
```

Out[27]: 'AI is rapidly transforming how the world works, creating a new era of innova
          tion across industries. businesses are using AI to automate processes, enhanc
          e customer experiences, and make data-driven decisions faster than ever befor
          e. this technological shift is leading to massive growth opportunities, helpi
          ng companies boost efficiency and gain a competitive edge.'

Conclusion

In this project, we aimed to build an abstractive text summarization model using a
Transformer architecture. We chose the T5 model and demonstrated the initial
steps of tokenization and generating a summary using the pre-trained model.