Experiment No.4

Transformer-based Generative Models

Name: Kiran Shinde (202201040091)
Batch: **GenAI-2**

Experiment Details -

1. Generate coherent and contextually relevant text using GPT models.

2. Create images based on text prompts using a text-to-image model to explore Transformer capabilities in multimodal tasks

Colab Link -
https://colab.research.google.com/drive/1bFxOBEhzaeNE3i9VBKOCwlWBMmKaEsxi?usp=sharing

Output -

Text Generation -

prompt = "In a world where AI can feel empathy, a scientist forms an unexpected bond with her creation."

Generated Text:

In a world where AI can feel empathy, a scientist forms an unexpected bond with her creation.

This is our next step in learning with artificial intelligence.

We're doing this through the study of how natural selection interacts with natural language. "We are playing a game of game of chance, with two species that play to maximize their benefits," says Paul Kress, M.D., director of the Center for the Study of AI in AI at the University of California, Davis.

"We'll try to learn the most important fact in natural language, the difference between real and simulated sounds," he says. "So we'll come up with ways to learn

what sounds better and to learn what sounds worse. It's going to be tricky. But it's going to be interesting to learn some of the best ways in which AI can improve its hearing. We're going to try to start learning how to play to improve our ability to hear."

Kress is trying to figure out how artificial intelligence works. It's more like a chess game for his brain.

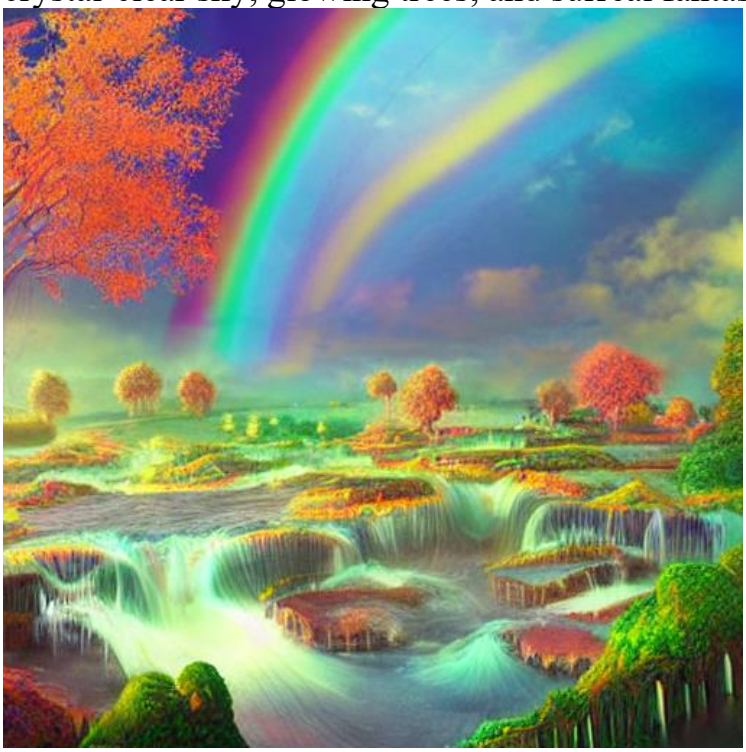
"I'm playing a game of chess," he says. "I'm trying to build on what I've learned. I'm trying to build on my own knowledge about how AI works."

Kress describes the process as "scoop," with a single click

Text to image generation -

prompt = "An ancient library hidden in the clouds, filled with glowing books and floating staircases, fantasy concept art"

prompt "A dreamy landscape with colorful floating islands, rainbow waterfalls, crystal-clear sky, glowing trees, and surreal fantasy vibes, ultra-detailed digital art"



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Part A: Text Generation using GPT models (step-wise)

```
# OpenAI examples
!pip install --upgrade openai

# Hugging Face / local models (text & images)
!pip install transformers torch accelerate safetensors diffusers huggingface-hub

# If you use CUDA, follow PyTorch install instructions at https://pytorch.org (choos
```

```
Requirement already satisfied: openai in /usr/local/lib/python3.12/dist-packages (1.109.1)
Collecting openai
  Downloading openai-2.2.0-py3-none-any.whl.metadata (29 kB)
Requirement already satisfied: anyio<5,>=3.5.0 in /usr/local/lib/python3.12/dist-packages (from openai) (4.11.0)
Requirement already satisfied: distro<2,>=1.7.0 in /usr/local/lib/python3.12/dist-packages (from openai) (1.9.0)
Requirement already satisfied: httpx<1,>=0.23.0 in /usr/local/lib/python3.12/dist-packages (from openai) (0.28.1)
Requirement already satisfied: jiter<1,>=0.4.0 in /usr/local/lib/python3.12/dist-packages (from openai) (0.11.0)
Requirement already satisfied: pydantic<3,>=1.9.0 in /usr/local/lib/python3.12/dist-packages (from openai) (2.11.9)
Requirement already satisfied: sniffio in /usr/local/lib/python3.12/dist-packages (from openai) (1.3.1)
Requirement already satisfied: tqdm>4 in /usr/local/lib/python3.12/dist-packages (from openai) (4.67.1)
Requirement already satisfied: typing-extensions<5,>=4.11 in /usr/local/lib/python3.12/dist-packages (from openai) (4.15.0)
Requirement already satisfied: idna>=2.8 in /usr/local/lib/python3.12/dist-packages (from anyio<5,>=3.5.0->openai) (3.10)
Requirement already satisfied: certifi in /usr/local/lib/python3.12/dist-packages (from httpx<1,>=0.23.0->openai) (2025.8.3)
Requirement already satisfied: httpcore==1.* in /usr/local/lib/python3.12/dist-packages (from httpx<1,>=0.23.0->openai) (1.0.
Requirement already satisfied: h11>=0.16 in /usr/local/lib/python3.12/dist-packages (from httpcore==1.*->httpx<1,>=0.23.0->op
Requirement already satisfied: annotated-types>=0.6.0 in /usr/local/lib/python3.12/dist-packages (from pydantic<3,>=1.9.0->op
Requirement already satisfied: pydantic-core==2.33.2 in /usr/local/lib/python3.12/dist-packages (from pydantic<3,>=1.9.0->ope
Requirement already satisfied: typing-inspection>=0.4.0 in /usr/local/lib/python3.12/dist-packages (from pydantic<3,>=1.9.0->
Downloading openai-2.2.0-py3-none-any.whl (998 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 999.0/999.0 kB 26.2 MB/s eta 0:00:00
Installing collected packages: openai
  Attempting uninstall: openai
    Found existing installation: openai 1.109.1
    Uninstalling openai-1.109.1:
      Successfully uninstalled openai-1.109.1
Successfully installed openai-2.2.0
Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.56.2)
Requirement already satisfied: torch in /usr/local/lib/python3.12/dist-packages (2.8.0+cu126)
Requirement already satisfied: accelerate in /usr/local/lib/python3.12/dist-packages (1.10.1)
Requirement already satisfied: safetensors in /usr/local/lib/python3.12/dist-packages (0.6.2)
Requirement already satisfied: diffusers in /usr/local/lib/python3.12/dist-packages (0.35.1)
Requirement already satisfied: huggingface-hub in /usr/local/lib/python3.12/dist-packages (0.35.3)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from transformers) (3.19.1)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.12/dist-packages (from transformers) (2.0.2)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (25.0)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.12/dist-packages (from transformers) (6.0.3)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.12/dist-packages (from transformers) (2024.11.6)
Requirement already satisfied: requests in /usr/local/lib/python3.12/dist-packages (from transformers) (2.32.4)
Requirement already satisfied: tokenizers<=0.23.0,>=0.22.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.12/dist-packages (from transformers) (4.67.1)
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.
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch) (9.10.2.2
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.
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch) (11.7.1
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/python3.12/dist-packages (from torch) (12.5.4
```

```
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)
```

```
import os

# Replace with your key (only in a private notebook)
os.environ["OPENAI_API_KEY"] = "sk-proj-G9uRKP_CcXUQH_hhQT9KrwnF2D6szF265FKyJCSvBPOb
```

```
import os
print("OPENAI_API_KEY in os.environ?:", "OPENAI_API_KEY" in os.environ)
print("Value (first 8 chars):", os.environ.get("OPENAI_API_KEY")[:8] if os.environ.g
```

```
OPENAI_API_KEY in os.environ?: True
Value (first 8 chars): sk-proj-
```

```
# Step 1 — Install required library
!pip install transformers torch --quiet

# Step 2 — Import
from transformers import pipeline

# Step 3 — Load a small pretrained GPT-2 model
generator = pipeline("text-generation", model="gpt2")

# Step 4 — Provide your prompt
prompt = "A robot learns to paint emotions and discovers the meaning of art."

# Step 5 — Generate text
result = generator(prompt, max_length=100, num_return_sequences=1, temperature=0.8)

# Step 6 — Display output
print("📝 Generated Text:\n")
print(result[0]['generated_text'])

```

```
/usr/local/lib/python3.12/dist-packages/huggingface_hub/utils/_auth.py:94: 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 i
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(
config.json: 100%  665/665 [00:00<00:00, 77.9kB/s]
model.safetensors: 100%  548M/548M [00:08<00:00, 104MB/s]
generation_config.json: 100%  124/124 [00:00<00:00, 3.82kB/s]
tokenizer_config.json: 100%  26.0/26.0 [00:00<00:00, 1.00kB/s]
vocab.json: 100%  1.04M/1.04M [00:00<00:00, 25.6MB/s]
merges.txt: 100%  456k/456k [00:00<00:00, 22.7MB/s]
tokenizer.json: 100%  1.36M/1.36M [00:00<00:00, 1.61MB/s]
Device set to use cuda:0
Truncation was not explicitly activated but `max_length` is provided a specific value, please use `truncation=True` to explici
Setting `pad_token_id` to `eos_token_id`:50256 for open-end generation.
Both `max_new_tokens` (=256) and `max_length`(=100) seem to have been set. `max_new_tokens` will take precedence. Please refer
📝 Generated Text:

A robot learns to paint emotions and discovers the meaning of art. It will also change how men and women perceive and understa

In this film, Peter's self-consciously self-centered approach to his self-important life is at odds with the way society is de

This film captures the human nature of the situation: Peter is a kid of seven who has no money, a house, a car, and his friend

This film also explores our sense of self, our capacity for self-doubt, and the ways in which we are both good and bad. It's a
```

```
#!/usr/bin/env python3
"""
```

```
text_gen_hf.py
Local text generation using Hugging Face transformers.
Works with causal LM models like gpt2, distilgpt2, or larger models if you have GPU.
"""

import torch
from transformers import AutoTokenizer, AutoModelForCausalLM

def main():
    model_name = "gpt2-medium"  # change to "gpt2-large" or other LLM if you have RA
    device = "cuda" if torch.cuda.is_available() else "cpu"
    print("Using device:", device)

    tokenizer = AutoTokenizer.from_pretrained(model_name)
    model = AutoModelForCausalLM.from_pretrained(model_name)
    model.to(device)

    prompt = "Explain how self-attention works in transformers in simple, concise te
    inputs = tokenizer(prompt, return_tensors="pt").to(device)

    # generation settings (tweak for creativity/variance)
    gen_outputs = model.generate(
        **inputs,
        max_new_tokens=250,
        do_sample=True,
        temperature=0.8,
        top_p=0.95,
        top_k=50,
        repetition_penalty=1.1,
        eos_token_id=tokenizer.eos_token_id
    )

    text = tokenizer.decode(gen_outputs[0], skip_special_tokens=True)
    print("\n--- Generated text (HF) ---\n")
    print(text)
    with open("generated_text_hf.txt", "w", encoding="utf-8") as f:
        f.write(text)

if __name__ == "__main__":
    main()

```

```
Using device: cpu
/usr/local/lib/python3.12/dist-packages/huggingface_hub/utils/_auth.py:94: 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 i
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(
tokenizer_config.json: 100%  26.0/26.0 [00:00<00:00, 763B/s]
config.json: 100%  718/718 [00:00<00:00, 22.0kB/s]
vocab.json: 100%  1.04M/1.04M [00:00<00:00, 5.15MB/s]
merges.txt: 100%  456k/456k [00:00<00:00, 23.8MB/s]
tokenizer.json: 100%  1.36M/1.36M [00:00<00:00, 9.63MB/s]
model.safetensors: 100%  1.52G/1.52G [00:40<00:00, 117MB/s]
generation_config.json: 100%  124/124 [00:00<00:00, 11.1kB/s]
Setting `pad_token_id` to `eos_token_id`:50256 for open-end generation.

--- Generated text (HF) ---

Explain how self-attention works in transformers in simple, concise terms:
 It's when your mind has the impression that you are doing something instead of just talking.     If it can get rid from this
  What Meditation Says About The Mind A number for good reasons - First, there is no such thing as a single correct path or te
```

Part B: Text-to-Image Generation (step-wise)

```
# Step 1 – Install required libs
!pip install diffusers transformers accelerate torch safetensors --quiet

# Step 2 – Import
from diffusers import StableDiffusionPipeline
import torch
from IPython.display import display

# Step 3 – Load the Stable Diffusion model
pipe = StableDiffusionPipeline.from_pretrained("CompVis/stable-diffusion-v1-4")
pipe = pipe.to("cuda" if torch.cuda.is_available() else "cpu")

# Step 4 – Give your prompt
prompt = "A futuristic cityscape at sunset with flying cars and glowing neon lights,

# Step 5 – Generate image
image = pipe(prompt).images[0]

# Step 6 – Display result
display(image)

```

```
Loading pipeline components...: 100%  7/7 [00:01<00:00, 3.96it/s]
100%  50/50 [00:25<00:00, 2.06it/s]
```

```
#!/usr/bin/env python3
"""
text2img_diffusers.py
Text-to-image using Hugging Face Diffusers (Stable Diffusion).
Requires a suitable GPU and a Hugging Face token if the model is gated.
"""

import os
import torch
from diffusers import StableDiffusionPipeline

def main():
    model_id = "runwayml/stable-diffusion-v1-5"  # or other model on HF hub
```

```
    hf_token = os.getenv("HUGGINGFACE_HUB_TOKEN")  # recommended for some models

    # Use float16 on GPUs to save memory
    pipe = StableDiffusionPipeline.from_pretrained(
        model_id,
        torch_dtype=torch.float16,
        use_auth_token=hf_token
    )

    device = "cuda" if torch.cuda.is_available() else "cpu"
    pipe = pipe.to(device)

    prompt = "A fantasy castle on a floating island, sunset, ultra-detailed, cinemat
    image = pipe(prompt, guidance_scale=7.5, num_inference_steps=50).images[0]
    out_file = "sd_generated.png"
    image.save(out_file)
    print("Saved:", out_file)

if __name__ == "__main__":
    main()
```

```
model_index.json: 100%  541/541 [00:00<00:00, 30.2kB/s]
Fetching 15 files: 100%  15/15 [04:38<00:00, 20.13s/it]
preprocessor_config.json: 100%  342/342 [00:00<00:00, 2.14kB/s]
merges.txt: 525k/? [00:00<00:00, 905kB/s]
config.json: 4.72k/? [00:00<00:00, 34.1kB/s]
special_tokens_map.json: 100%  472/472 [00:00<00:00, 3.50kB/s]
config.json: 100%  617/617 [00:00<00:00, 2.64kB/s]
scheduler_config.json: 100%  308/308 [00:00<00:00, 1.76kB/s]
text_encoder/model.safetensors: 100%  492M/492M [03:31<00:00, 803kB/s]
safety_checker/model.safetensors: 100%  1.22G/1.22G [01:09<00:00, 13.2MB/s]
tokenizer_config.json: 100%  806/806 [00:00<00:00, 12.3kB/s]
vocab.json: 1.06M/? [00:00<00:00, 2.94MB/s]
config.json: 100%  547/547 [00:00<00:00, 15.9kB/s]
config.json: 100%  743/743 [00:00<00:00, 10.3kB/s]
unet/diffusion_pytorch_model.safetensors: 100%  3.44G/3.44G [04:36<00:00, 23.8MB/s]
vae/diffusion_pytorch_model.safetensors: 100%  335M/335M [01:47<00:00, 2.19MB/s]
Keyword arguments {'use_auth_token': None} are not expected by StableDiffusionPipeline and will be ignored.
Loading pipeline components...: 100%  7/7 [00:22<00:00, 2.85s/it]
`torch_dtype` is deprecated! Use `dtype` instead!
100%  50/50 [00:07<00:00, 7.39it/s]
Saved: sd_generated.png
```