

# Experiment No.4 Transformer-based Generative Models

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Colab Link: <https://colab.research.google.com/drive/1DeHP3e0faPYSr9DrKu2IdKiEkXz3VL9?usp=sharing>

## Part 1. Generate text using an GPT model.

### Identifying a suitable open-source gpt model

Research and choose an open-source GPT model that meets your requirements (e.g., model size, performance, license). Popular options include models from Hugging Face's Transformers library.

```
1 chosen_model_name = "gpt2"
2 print(f"Chosen open-source GPT model: {chosen_model_name}")
```

Chosen open-source GPT model: gpt2

### Set up the environment

Install necessary libraries like transformers , torch or tensorflow , and potentially accelerate for better performance.

```
1 %pip install transformers torch accelerate
```

```
Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.56.1)
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: filelock in /usr/local/lib/python3.12/dist-packages (from transformers) (3.19.1)
Requirement already satisfied: huggingface-hub<1.0,>=0.34.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.35.0)
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) (6.0.2)
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) (0.22.0)
Requirement already satisfied: safetensors>=0.4.3 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.6.2)
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) (12.6.77)
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-cusparselt-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/lib/python3.12/dist-packages (from torch) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/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: psutil in /usr/local/lib/python3.12/dist-packages (from accelerate) (5.9.5)
Requirement already satisfied: hf-xet<2.0.0,>=1.1.3 in /usr/local/lib/python3.12/dist-packages (from huggingface-hub<1.0,>=0.34.0->transformers) (1.3.0)
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/dist-packages (from jinja2->torch) (3.0.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.12/dist-packages (from requests->transformers) (3)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.12/dist-packages (from requests->transformers) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/dist-packages (from requests->transformers) (2.5.0)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.12/dist-packages (from requests->transformers) (2025.8.3)
```

## Load the model and tokenizer

Load the chosen model and its corresponding tokenizer from the Hugging Face Hub or a local path.

```
1 from transformers import AutoModelForCausalLM, AutoTokenizer
2
3 tokenizer = AutoTokenizer.from_pretrained("gpt2")
4 model = AutoModelForCausalLM.from_pretrained("gpt2")
```

```
/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 it as
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, 642B/s]
config.json: 100%                   665/665 [00:00<00:00, 19.5kB/s]
vocab.json: 100%                   1.04M/1.04M [00:00<00:00, 11.7MB/s]
merges.txt: 100%                   456k/456k [00:00<00:00, 6.57MB/s]
tokenizer.json: 100%               1.36M/1.36M [00:00<00:00, 12.7MB/s]
model.safetensors: 100%            548M/548M [00:06<00:00, 113MB/s]
generation_config.json: 100%       124/124 [00:00<00:00, 5.84kB/s]
```

## Generate text

Use the loaded model and tokenizer to generate text based on a given prompt.

```
1 prompt = "What is Machine Learning?"
2 inputs = tokenizer(prompt, return_tensors="pt")
3 generated_ids = model.generate(inputs.input_ids, max_length=100, num_return_sequences=1, no_repeat_ngram_size=2, do_sample=True)
4 generated_text = tokenizer.decode(generated_ids[0], skip_special_tokens=True)
5
```

The attention mask and the pad token id were not set. As a consequence, you may observe unexpected behavior. Please pass your input Setting `pad\_token\_id` to `eos\_token\_id`:50256 for open-end generation.

```
1 print("Output:")
2 print(generated_text)
```

Output:  
What is Machine Learning?

Machine learning is a way to build new models and algorithms on top of existing methods. As we saw before, a large number of model

## Part 2: Generate images based on text prompts using an open-source text-to-image model.

### Set up the environment for text-to-image generation

Install necessary libraries for text-to-image models, such as `diffusers`, `transformers`, and `accelerate`.

```
1 %pip install diffusers transformers accelerate
```

```
Requirement already satisfied: diffusers in /usr/local/lib/python3.12/dist-packages (0.35.1)
Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.56.1)
Requirement already satisfied: accelerate in /usr/local/lib/python3.12/dist-packages (1.10.1)
Requirement already satisfied: importlib_metadata in /usr/local/lib/python3.12/dist-packages (from diffusers) (8.7.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from diffusers) (3.19.1)
Requirement already satisfied: huggingface-hub>=0.34.0 in /usr/local/lib/python3.12/dist-packages (from diffusers) (0.35.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.12/dist-packages (from diffusers) (2.0.2)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.12/dist-packages (from diffusers) (2024.11.6)
Requirement already satisfied: requests in /usr/local/lib/python3.12/dist-packages (from diffusers) (2.32.4)
Requirement already satisfied: safetensors>=0.3.1 in /usr/local/lib/python3.12/dist-packages (from diffusers) (0.6.2)
```

```
Requirement already satisfied: Pillow in /usr/local/lib/python3.12/dist-packages (from diffusers) (11.3.0)
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) (6.0.2)
Requirement already satisfied: tokenizers<=0.23.0,>=0.22.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.22.0)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.12/dist-packages (from transformers) (4.67.1)
Requirement already satisfied: psutil in /usr/local/lib/python3.12/dist-packages (from accelerate) (5.9.5)
Requirement already satisfied: torch>=2.0.0 in /usr/local/lib/python3.12/dist-packages (from accelerate) (2.8.0+cu126)
Requirement already satisfied: fsspec>=2023.5.0 in /usr/local/lib/python3.12/dist-packages (from huggingface-hub>=0.34.0->diffusers)
Requirement already satisfied: typing-extensions>=3.7.4.3 in /usr/local/lib/python3.12/dist-packages (from huggingface-hub>=0.34.0->diffusers)
Requirement already satisfied: hf-xet<2.0.0,>=1.1.3 in /usr/local/lib/python3.12/dist-packages (from huggingface-hub>=0.34.0->diffusers)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate) (75.2.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate) (1.13.3)
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate) (3.5)
Requirement already satisfied: Jinja2 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate) (3.1.6)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate)
Requirement already satisfied: triton==3.4.0 in /usr/local/lib/python3.12/dist-packages (from torch>=2.0.0->accelerate) (3.4.0)
Requirement already satisfied: zipp>=3.20 in /usr/local/lib/python3.12/dist-packages (from importlib-metadata->diffusers) (3.23.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (3.4)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (2.5.0)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (2025.8.3)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-packages (from sympy>=1.13.3->torch>=2.0.0->accelerate)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from Jinja2->torch>=2.0.0->accelerate) (3.0.2)
```

## Load a text-to-image model

Choose and load a suitable open-source text-to-image model (e.g., from the Diffusers library) and its corresponding tokenizer.

```
1 import torch
2 from diffusers import StableDiffusionPipeline
3
4 model_id = "runwayml/stable-diffusion-v1-5"
5 pipe = StableDiffusionPipeline.from_pretrained(model_id)
```

Loading pipeline components...: 100%

7/7 [00:00<00:00, 10.55it/s]

## Generate an image from a text prompt

Use the loaded model to generate an image based on a given text prompt.

```
1 if torch.cuda.is_available():
2     pipe = pipe.to("cuda")
3 prompt = "A photo of an astronaut riding a horse on the moon."
4 image = pipe(prompt).images[0]
```

100%

50/50 [00:24<00:00, 1.98it/s]

```
1 display(image)
```

