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# Step 1 — Dataset Preparation for Generative AI Assignment
# ------------------------------------------------------------

# Import required libraries
import tensorflow as tf
import numpy as np
import requests
import re
import matplotlib.pyplot as plt
from collections import Counter
import random

# Set random seeds for reproducibility
random.seed(42)
np.random.seed(42)
tf.random.set_seed(42)

print("Libraries imported successfully.")


# Step 1A — Load a publicly available text dataset (Project Gutenberg)
url = "https://www.gutenberg.org/cache/epub/1342/pg1342.txt"  # Pride and Prejudice
response = requests.get(url)
raw_text = response.text

print("Characters in raw text:", len(raw_text))
print("\nSample of raw text:\n")
print(raw_text[:800])


# Step 1B — Clean and preprocess the text
def clean_text(text):
    # Remove Project Gutenberg header/footer
    start_idx = text.find("*** START OF")
    end_idx = text.find("*** END OF")
    if start_idx != -1 and end_idx != -1:
        text = text[start_idx:end_idx]
    # Keep letters, digits, punctuation, and whitespace only
    text = re.sub(r'[^A-Za-z0-9.,;:!?\'"()\-\s\n]', ' ', text)
    text = re.sub(r'\s+', ' ', text).strip()
    return text

cleaned_text = clean_text(raw_text)

print("\nCharacters after cleaning:", len(cleaned_text))
print("\nCleaned text sample:\n")
print(cleaned_text[:800])


# Step 1C — Basic statistics
num_chars = len(cleaned_text)
num_words = len(cleaned_text.split())
unique_chars = sorted(list(set(cleaned_text)))

print(f"\nTotal characters: {num_chars}")
print(f"Total words: {num_words}")
print(f"Unique characters: {len(unique_chars)}")
print(f"Unique character set:\n{unique_chars}")


# Step 1D — Character frequency visualization
char_counts = Counter(cleaned_text)

plt.figure(figsize=(10, 4))
plt.bar(list(char_counts.keys())[:50], list(char_counts.values())[:50])
plt.title("Character Frequency Distribution (Top 50)")
plt.xlabel("Character")
plt.ylabel("Frequency")
plt.show()


# Step 1 Summary
print("\n✅ Step 1 Complete: Dataset loaded, cleaned, and analyzed.")
print("Ready for Step 2 — Tokenization and Sequence Preparation.")
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```
Libraries imported successfully.
Characters in raw text: 763043

Sample of raw text:

The Project Gutenberg eBook of Pride and Prejudice

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most other parts of the world at no cost and with almost no restrictions
whatsoever. You may copy it, give it away or re-use it under the terms
of the Project Gutenberg License included with this ebook or online
at www.gutenberg.org. If you are not located in the United States,
you will have to check the laws of the country where you are located
before using this eBook.

Title: Pride and Prejudice

Author: Jane Austen

Release date: June 1, 1998 [eBook #1342]
               Most recently updated: September 22, 2025

Language: English

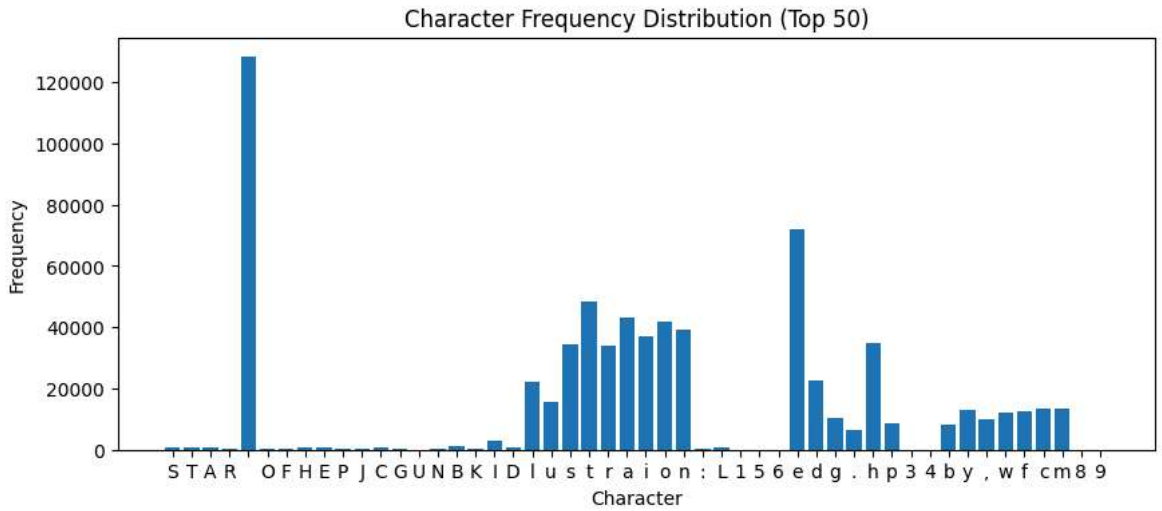
Credits: Chuck Greif and the Online Distributed Proofreading Team at http://www.pgdp.net (This file was produced

Characters after cleaning: 713166

Cleaned text sample:

START OF THE PROJECT GUTENBERG EBOOK PRIDE AND PREJUDICE Illustration: GEORGE ALLEN PUBLISHER 156 CHARING CROSS ROAD LONDON RUSK

Total characters: 713166
Total words: 128160
Unique characters: 71
Unique character set:
[' ', '!', '(', ')', ',', '-', '.', '0', '1', '2', '3', '4', '5', '6', '7', '8', '9', ':', ';', '?', 'A', 'B', 'C', 'D', 'E', 'F
```

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✅ Step 1 Complete: Dataset loaded, cleaned, and analyzed.
Ready for Step 2 — Tokenization and Sequence Preparation.
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# Step 2 — Exploring Generative Pre-trained Transformers (GPTs)
# ---------------------------------------------------------------
"""
Model Architecture (Summary)
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GPTs are decoder-only Transformer models built from:
1. Token + Positional Embeddings
2. Multi-Head Self-Attention layers (causal)
3. Feed-Forward networks
4. Residual connections + Layer Normalization
5. Output projection predicting the next token probability

GPTs generate text autoregressively:
Given a seed, the model predicts P(next_token | previous_tokens),
samples a token, appends it, and repeats to form coherent text.

Below is a simplified autoregressive text generator using an LSTM
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to demonstrate the same concept of next-token prediction.
"""

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
import numpy as np

# ------------------------------
# Use small subset of text for speed
# ------------------------------
try:
    cleaned_text
except NameError:
    cleaned_text = (
        "This is a fallback example text for a simple generative model demonstration."
    )

cleaned_text = cleaned_text[:20000]  # limit for faster training

# ------------------------------
# Character-level tokenization
# ------------------------------
vocab = sorted(list(set(cleaned_text)))
char_to_idx = {ch: i for i, ch in enumerate(vocab)}
idx_to_char = {i: ch for ch, i in char_to_idx.items()}
vocab_size = len(vocab)

SEQ_LEN = 60
STEP = 3

# Encode text
encoded = [char_to_idx[c] for c in cleaned_text if c in char_to_idx]

# Prepare training sequences
sequences, next_chars = [], []
for i in range(0, len(encoded) - SEQ_LEN, STEP):
    sequences.append(encoded[i:i+SEQ_LEN])
    next_chars.append(encoded[i+SEQ_LEN])

X = np.zeros((len(sequences), SEQ_LEN, vocab_size), dtype=np.bool_)
y = np.zeros((len(sequences), vocab_size), dtype=np.bool_)
for i, seq in enumerate(sequences):
    for t, idx in enumerate(seq):
        X[i, t, idx] = 1
    y[i, next_chars[i]] = 1

print(f"Prepared {len(sequences)} sequences. Vocabulary size: {vocab_size}")

# ------------------------------
# Build a small LSTM text generator
# ------------------------------
model = keras.Sequential([
    layers.LSTM(128, input_shape=(SEQ_LEN, vocab_size)),
    layers.Dense(vocab_size, activation="softmax")
])

model.compile(optimizer="adam", loss="categorical_crossentropy")

# ------------------------------
# Train quickly (3 epochs)
# ------------------------------
EPOCHS = 3
history = model.fit(X, y, batch_size=128, epochs=EPOCHS, verbose=2)

# ------------------------------
# Text generation function
# ------------------------------
def generate_text(model, seed_text, length=300, temperature=1.0):
    generated = seed_text
    sentence = seed_text[-SEQ_LEN:]
    for _ in range(length):
        x_pred = np.zeros((1, SEQ_LEN, vocab_size))
        for t, ch in enumerate(sentence):
            if ch in char_to_idx:
                x_pred[0, t, char_to_idx[ch]] = 1.0
        preds = model.predict(x_pred, verbose=0)[0]
        preds = np.log(preds + 1e-8) / temperature
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            preds = np.log(preds + 1e-8) / temperature
            exp_preds = np.exp(preds)
            preds = exp_preds / np.sum(exp_preds)
            next_idx = np.random.choice(range(vocab_size), p=preds)
            next_char = idx_to_char[next_idx]
            generated += next_char
            sentence = (sentence + next_char)[-SEQ_LEN:]
        return generated

# ----------------------------
# Generate sample text
# ----------------------------
seed = "Chapter 1. "
print("\n--- Generated Text ---\n")
print(generate_text(model, seed, length=300, temperature=0.8))
```

```
Prepared 6647 sequences. Vocabulary size: 65
Epoch 1/3
52/52 - 11s - 208ms/step - loss: 3.3013
Epoch 2/3
52/52 - 8s - 155ms/step - loss: 3.0437
Epoch 3/3
52/52 - 9s - 180ms/step - loss: 3.0163

--- Generated Text ---

Chapter 1. etni   sin ur-  cheai beeo,hi i  turc ne f tamchh uotsit a eeasdNh r wo, rnno e sie daolse nohoghe   mdetaeoa d trisr
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# Step 3 — Application Demonstration
# ----------------------------------
"""
Objective:
Demonstrate a simple real-world use of a generative text model for
content creation. The model trained in Step 2 will be used to automatically
generate creative text such as story paragraphs or short article content.
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# Example 1: Automated Story/Creative Writing Generator
seed_text = "Once upon a time in a small village, "
generated_story = generate_text(model, seed_text, length=400, temperature=0.7)
```