1. Install required libraries and load the spaCy English model

✦ Gemini

```
pip install spacy pandas matplotlib seaborn emoji
python -m spacy download en_core_web_sm
!pip install spacy pandas matplotlib seaborn emoji
!python -m spacy download en_core_web_sm
```

```
ownloading emoji-2.15.0-py3-none-any.whl.metadata (5.7 kB)
irement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in /usr/local/lib/pyt
irement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in /usr/local/lib/pyt
irement already satisfied: murmurhash<1.1.0,>=0.28.0 in /usr/local/lib/pytho
irement already satisfied: cymem<2.1.0,>=2.0.2 in /usr/local/lib/python3.12/
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irement already satisfied: thinc<8.4.0,>=8.3.4 in /usr/local/lib/python3.12/
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irement already satisfied: weasel<0.5.0,>=0.4.2 in /usr/local/lib/python3.12
irement already satisfied: typer-slim<1.0.0,>=0.3.0 in /usr/local/lib/python
irement already satisfied: tqdm<5.0.0,>=4.38.0 in /usr/local/lib/python3.12/
irement already satisfied: numpy>=1.19.0 in /usr/local/lib/python3.12/dist-p
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irement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages
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irement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.12/dist-pa
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irement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.12/di
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irement already satisfied: pydantic-core==2.41.4 in /usr/local/lib/python3.1
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irement already satisfied: typing-inspection>=0.4.2 in /usr/local/lib/python
irement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-packag
irement already satisfied: charset_normalizer<4,>=2 in /usr/local/lib/python
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irement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/d
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irement already satisfied: blis<1.4.0,>=1.3.0 in /usr/local/lib/python3.12/d
irement already satisfied: confection<1.0.0,>=0.0.1 in /usr/local/lib/python
irement already satisfied: click>=8.0.0 in /usr/local/lib/python3.12/dist-pa
irement already satisfied: cloudpathlib<1.0.0,>=0.7.0 in /usr/local/lib/pyth
irement already satisfied: smart-open<8.0.0,>=5.2.1 in /usr/local/lib/python
```

```
.ecting en-core-web-sm==3.8.0
ownloading https://github.com/explosion/spacy-models/releases/download/en_cor
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ownload and installation successful
 can now load the package via spacy.load('en_core_web_sm')
estart to reload dependencies
ou are in a Jupyter or Colab notebook, you may need to restart Python in
er to load all the package's dependencies. You can do this by selecting the
start kernel' or 'Restart runtime' option.
```

```
import re
import pandas as pd
import spacy
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter
import emoji
```

2. Load the Twitter US Airline Sentiment dataset

```
df = pd.read_csv("Tweets.csv")
df.head()
```

tweet_id	airline_sentiment	airline_sentiment_confidence	negat
570306133677760513	neutral	1.0000	
570301130888122368	positive	0.3486	
570301083672813571	neutral	0.6837	
570301031407624196	negative	1.0000	
570300817074462722	negative	1.0000	

Next steps: Generate code with df New interactive sheet

3. Select tweet text and sentiment columns and remove missing values

```
df = df[['text', 'airline_sentiment']]
df.dropna(inplace=True)

df.shape
```

```
(14640, 2)
```

4. Clean tweets

```
def clean_tweet(text):
    text = text.lower()
    text = re.sub(r"http\S+|www\S+", "", text)     # remove URLs
    text = re.sub(r"@\w+", "", text)               # remove mentions
    text = re.sub(r"#", "", text)                  # remove hashtag symbol
    text = emoji.replace_emoji(text, replace="")  # remove emojis
    text = re.sub(r"[^a-z\s]", "", text)           # remove special characte
    text = re.sub(r"\s+", " ", text).strip()
    return text
```

```
df['clean_text'] = df['text'].apply(clean_tweet)
df.head()
```

	text	airline_sentiment	clean_text
0	@VirginAmerica What @dhepburn said.	neutral	what said
1	@VirginAmerica plus you've added commercials t...	positive	plus youve added commercials to the experience...
2	@VirginAmerica I didn't today... Must mean I n...	neutral	i didnt today must mean i need to take another...
3	@VirginAmerica it's really aggressive to blast...	negative	its really aggressive to blast obnoxious enter...
4	@VirginAmerica and it's a really big bad thing...	negative	and its a really big bad thing about it

Next steps: Generate code with df New interactive sheet

5. Create a cleaned tweet corpus

```
corpus = df['clean_text'].tolist()
corpus[:5]
```

```
['what said',
 'plus youve added commercials to the experience tacky',
 'i didnt today must mean i need to take another trip',
 'its really aggressive to blast obnoxious entertainment in your guests
faces amp they have little recourse',
 'and its a really big bad thing about it']
```

6. Initialize the spaCy NLP pipeline

```
nlp = spacy.load("en_core_web_sm")
```

7. Create and add a custom spaCy pipeline component to detect hashtags

```
from spacy.language import Language

@Language.component("hashtag_detector")
def hashtag_detector(doc):
    hashtags = re.findall(r"#\w+", doc.text)
    doc._.hashtags = hashtags
    return doc
```

```
from spacy.tokens import Doc

Doc.set_extension("hashtags", default=[])

nlp.add_pipe("hashtag_detector", last=True)

nlp.pipe_names
```

```
['tok2vec',
 'tagger',
 'parser',
 'attribute_ruler',
 'lemmatizer',
 'ner',
 'hashtag_detector']
```

8. Process the cleaned tweets using the customized spaCy pipeline

```
docs = list(nlp.pipe(corpus))
```

9. Extract lemmas and part-of-speech tags

```
lemmatized_pos = []

for doc in docs:
    tokens = [(token.lemma_, token.pos_)
              for token in doc
              if not token.is_stop and token.is_alpha]
    lemmatized_pos.append(tokens)

lemmatized_pos[:2]
```

```
[[('say', 'VERB')],
 [('plus', 'CCONJ'),
  ('ve', 'AUX'),
  ('add', 'VERB'),
  ('commercial', 'NOUN'),
  ('experience', 'NOUN'),
  ('tacky', 'ADV')]]
```

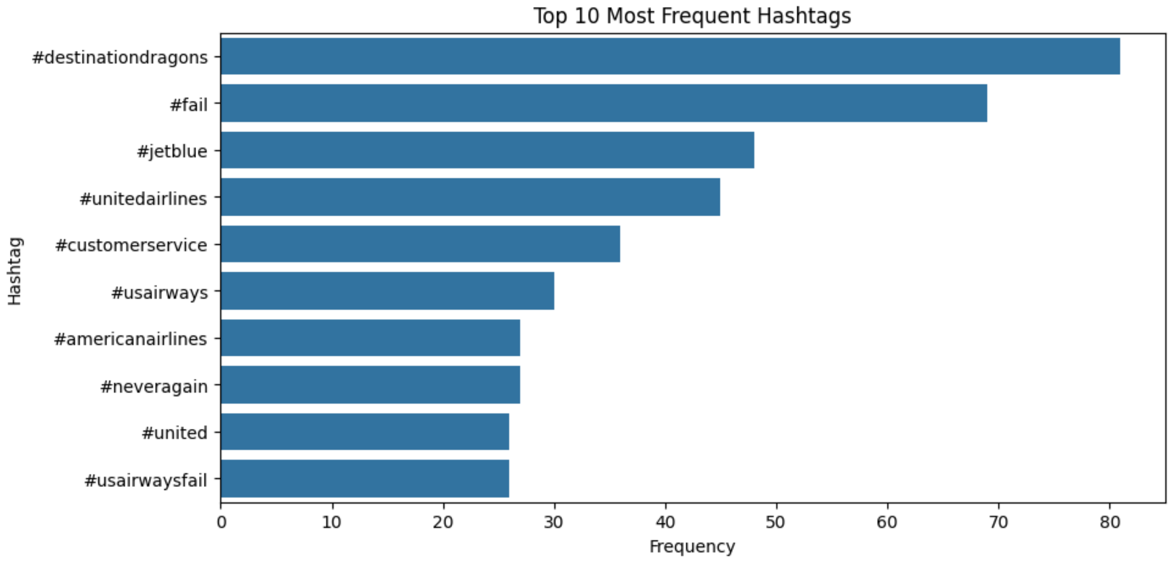
10. Extract hashtags from original tweets and compute frequencies

```
hashtag_counter = Counter()

for text in df['text']:
    hashtags = re.findall(r"#\w+", text.lower())
    hashtag_counter.update(hashtags)

hashtag_counter.most_common(10)
```

```
[('#destinationdragons', 81),
 ('#fail', 69),
 ('#jetblue', 48),
 ('#unitedairlines', 45),
 ('#customerservice', 36),
 ('#usairways', 30),
 ('#americanairlines', 27),
 ('#neveragain', 27),
 ('#united', 26),
 ('#usairwaysfail', 26)]
```

11. Visualize the most frequent hashtags

```
top_hashtags = hashtag_counter.most_common(10)
hashtags, counts = zip(*top_hashtags)

plt.figure(figsize=(10,5))
sns.barplot(x=list(counts), y=list(hashtags))
plt.title("Top 10 Most Frequent Hashtags")
plt.xlabel("Frequency")
plt.ylabel("Hashtag")
plt.show()
```



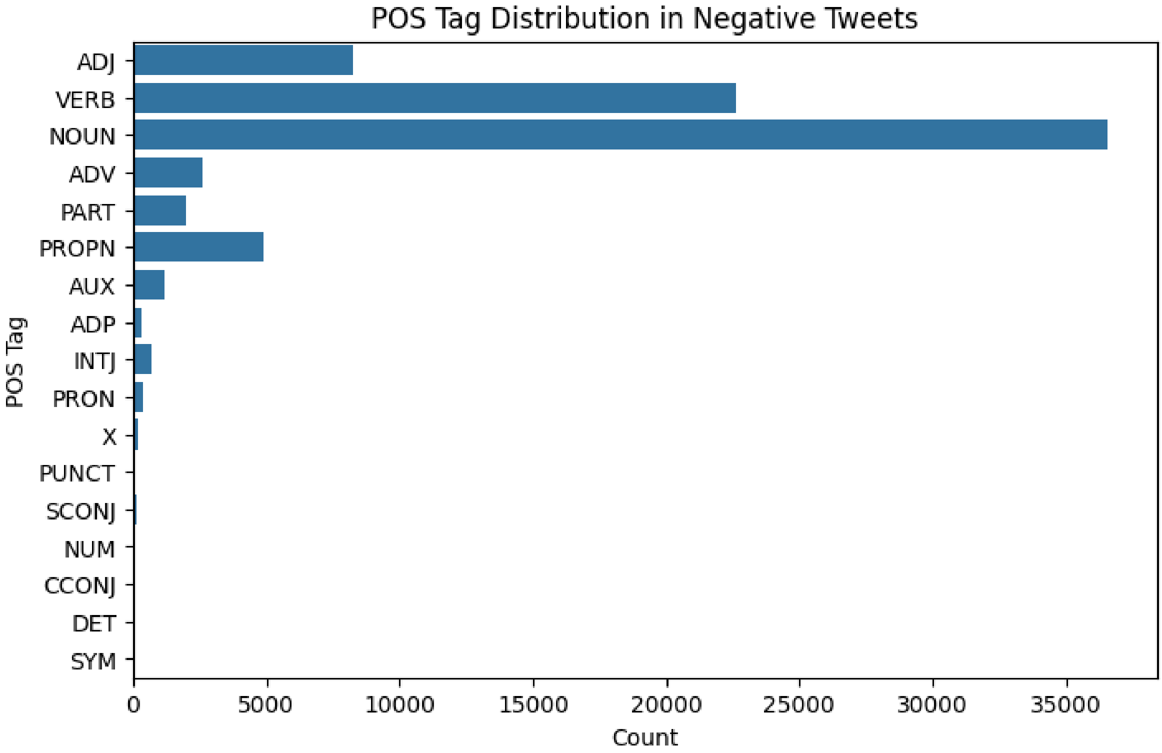
12. Filter negative tweets and visualize their POS tag distribution

```
negative_df = df[df['airline_sentiment'] == 'negative']
negative_docs = list(nlp.pipe(negative_df['clean_text']))

pos_counter = Counter()

for doc in negative_docs:
    for token in doc:
        if token.is_alpha and not token.is_stop:
            pos_counter[token.pos_] += 1

pos_counter
```

```
Counter({'ADJ': 8272,
         'VERB': 22633,
         'NOUN': 36596,
         'ADV': 2633,
         'PART': 1974,
         'PROPN': 4918,
         'AUX': 1185,
         'ADP': 344,
         'INTJ': 676,
         'PRON': 347,
         'X': 165,
         'PUNCT': 22,
         'SCONJ': 125,
         'NUM': 58,
         'CCONJ': 53,
         'DET': 60,
         'SYM': 2})
```

```
plt.figure(figsize=(8,5))
sns.barplot(
    x=list(pos_counter.values()),
    y=list(pos_counter.keys())
)
```

```
plt.title("POS Tag Distribution in Negative Tweets")
plt.xlabel("Count")
plt.ylabel("POS Tag")
plt.show()
```


POS Tag Distribution in Negative Tweets
POS Tag
ADJ
VERB
NOUN
ADV
PART
PROPN
AUX
ADP
INTJ
PRON
X
PUNCT
SCONJ
NUM
CCONJ
DET
SYM
Count