tf-idf_function

March 15, 2025

[1]:
```
# Libraries
%matplotlib inline
import pandas as pd
from collections import Counter
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.decomposition import LatentDirichletAllocation
from sklearn.decomposition import NMF
from sklearn.decomposition import TruncatedSVD
from sklearn.decomposition import PCA
from tqdm import tqdm
tqdm.pandas()
pd.options.display.max_colwidth = 150 ###
import numpy as np
import re
import sys
import os
import matplotlib.pyplot as plt
# Add the directory containing visualization_utils.py to path
sys.path.append("/Users/debr/English-Homer/")
import visualization_utils as viz
import seaborn as sns
sns.set_style("whitegrid")
# palette astroblue   orange   genoa      carrot    tawny     neptune     ␣
↪SELAGO    mako   black
color = ['#003D59',␣
↪'#FD6626','#177070','#FB871D','#641B5E','#86C3BC','#F5E1FD','#414A4F','k']
danB_plotstyle = {'figure.figsize': (12, 7),
               'axes.labelsize': 'large', # fontsize for x and y labels (was␣
↪large)
               'axes.titlesize': 'large', # fontsize for title
               'axes.titleweight': 'bold', # font type for title
               'xtick.labelsize': 'large', # fontsize for x
               'ytick.labelsize':'small', # fontsize fory ticks
               'grid.color': 'k', # grid color
                'grid.linestyle': ':', # grid line style
                'grid.linewidth': 0.2, # grid line width
```

```python
                 'font.family': 'Times New Roman', # font family
                 'grid.alpha': 0.5, # transparency of grid
                'figure.dpi': 300, # figure display resolution
                'savefig.bbox': 'tight', # tight bounding box
                'savefig.pad_inches': 0.4, # padding to use when saving
                'axes.titlepad': 15, # title padding
                'axes.labelpad': 8, # label padding
                'legend.borderpad': .6, # legend border padding
                'axes.prop_cycle': plt.cycler(
                 color=color) # color cycle for plot lines
                }

# adjust matplotlib defaults
plt.rcParams.update(danB_plotstyle)
```

[2]:
```python
# Load CSVs
filepath_Wilson = "/Users/debr/odysseys_en/Odyssey_dfs/Odyssey_Wilson_eda_END.
 ↪csv"
filepath_Green = "/Users/debr/odysseys_en/Odyssey_dfs/Odyssey_Green_eda_END.csv"

df_W = pd.read_csv(filepath_Wilson)
df_G = pd.read_csv(filepath_Green)

# Add translation label
df_W["translation"] = "Wilson"
df_G["translation"] = "Green"

# merging "book_num" with "translation" to create a unique identifier
df_W["book_id"] = df_W["book_num"].astype(str) + "_W"
df_W = df_W.drop(columns=["book_num"])
df_G["book_id"] = df_G["book_num"].astype(str) + "_G"
df_G = df_G.drop(columns=["book_num"])

# Keep only necessary columns: book number & tokens
df_W = df_W[["book_id", "tokens"]]
df_G = df_G[["book_id", "tokens"]]

# Combine both into one DataFrame
df = pd.concat([df_W, df_G], ignore_index=True)

# Ensure tokens are stored as lists (if stored as strings, convert them)
df["tokens"] = df["tokens"].apply(lambda x: eval(x) if isinstance(x, str) else␣
 ↪x)
```

[3]:
```python
import pandas as pd
import numpy as np
from collections import Counter
```

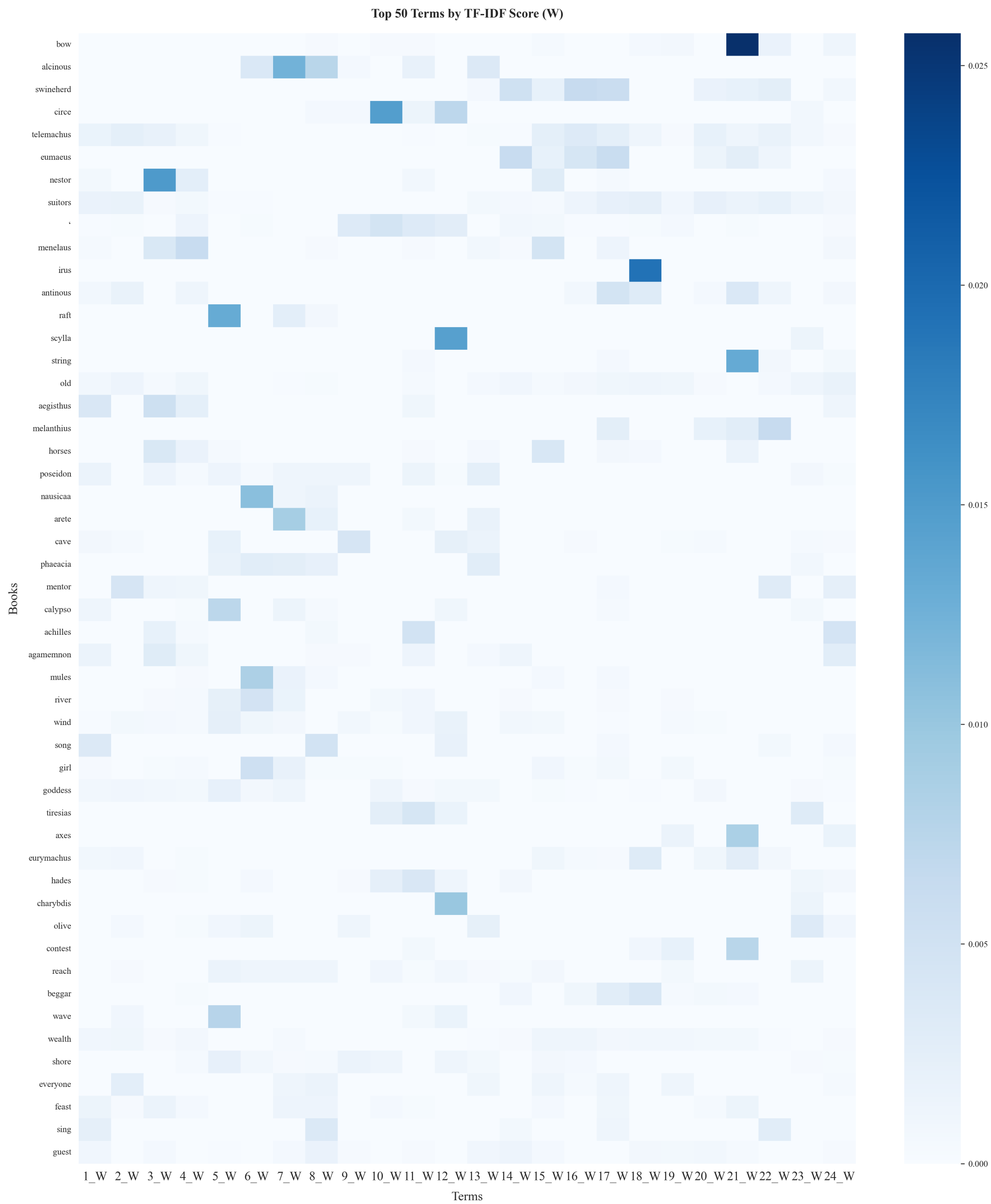
```python
def calculate_tfidf(df):
    """
    Calculate TF-IDF scores for a DataFrame with book_id and tokens columns.

    Parameters:
    -----------
    df : pandas DataFrame
        A DataFrame with 'book_id' and 'tokens' columns.
        The 'tokens' column should contain lists of tokens (as strings or␣
↪actual lists).

    Returns:
    --------
    pandas DataFrame
        The original DataFrame with additional columns:
        - term_freq: Dictionary of term frequencies for each token
        - term_counts: Dictionary of raw counts for each token
        - idf: Dictionary of IDF scores for each token
        - tf_idf: Dictionary of TF-IDF scores for each token
    """
    # Create a copy of the DataFrame to avoid modifying the original
    result_df = df.copy()

    # Function to compute term frequency and term counts
    def term_freq_by_doc(list_of_tokens):
        # Handle both string representation of list and actual list
        if isinstance(list_of_tokens, str):
            token_list = eval(list_of_tokens)  # Convert string representation␣
↪to list
        else:
            token_list = list_of_tokens  # Use as is if already a list

        # Count occurrences of each term
        term_counts = Counter(token_list)

        # Total number of terms in the document
        total_terms = len(token_list)

        # Compute TF: term frequency for each token
        term_freq = {term: count / total_terms for term, count in term_counts.
↪items()}

        return term_freq, term_counts

    # Apply function to compute TF for each book
```

```
    result_df["term_freq"], result_df["term_counts"] = zip(*result_df["tokens"].
↪apply(term_freq_by_doc))

    # Get total number of documents (books)
    N = len(result_df)

    # Count how many documents contain each term
    doc_containing_term = Counter()
    for term_counts in result_df["term_freq"]:
        doc_containing_term.update(term_counts.keys())  # Count unique terms in␣
↪each document

    # Compute IDF for each term
    idf_scores = {term: np.log(N / (1 + doc_count)) for term, doc_count in␣
↪doc_containing_term.items()}  # Adding 1 to avoid division by zero

    # Add IDF column to df
    result_df["idf"] = result_df["term_freq"].apply(lambda term_freq: {term:␣
↪idf_scores[term] for term in term_freq})

    # Compute TF-IDF by multiplying TF and IDF for each term in each document
    result_df["tf_idf"] = result_df.apply(lambda row: {term:␣
↪row["term_freq"][term] * row["idf"][term] for term in row["term_freq"]},␣
↪axis=1)

    return result_df

# Example usage:
df_tfidf_W = calculate_tfidf(df_W)
df_tfidf_G = calculate_tfidf(df_G)
```

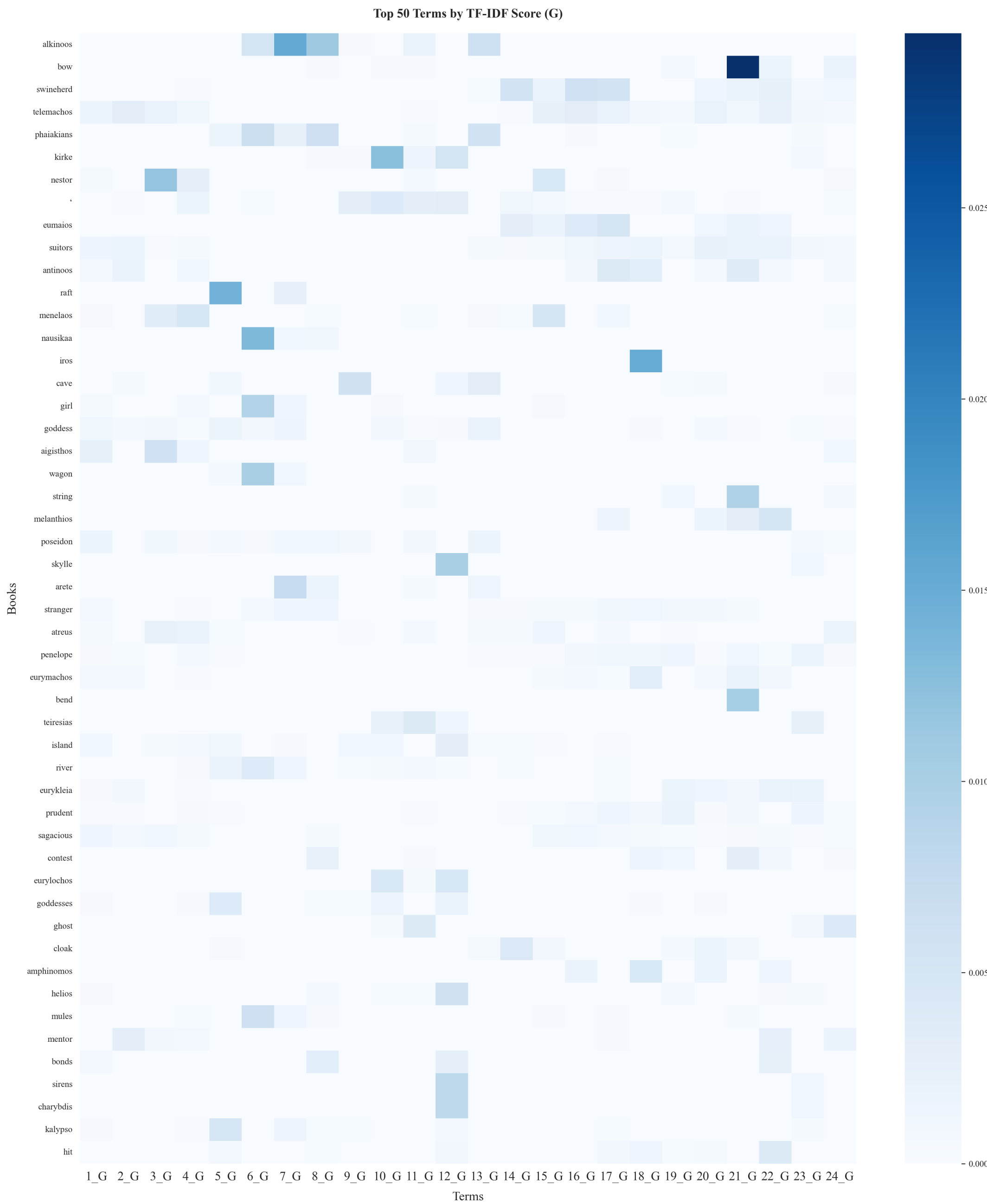
[4]:
```
# Top terms for each book and heatmap plot

def extract_top_terms(df, n=50):
    """
    Extract the top N most important terms from the tf_idf column

    Parameters:
    -----------
    df : pandas DataFrame
        DataFrame with 'book_id' and 'tf_idf' columns
    n : int
        Number of top terms to extract (default: 50)

    Returns:
    --------
    tuple
```

```
        (top_terms_per_book, top_terms_overall)
        - top_terms_per_book: DataFrame with top terms for each book
        - top_terms_overall: DataFrame with top terms across all books
    """
    # Extract top terms per book
    top_terms_per_book = {}

    for _, row in df.iterrows():
        book_id = row['book_id']
        tf_idf_dict = row['tf_idf']

        # Sort terms by tf-idf score (descending) and take top N
        sorted_terms = sorted(tf_idf_dict.items(), key=lambda x: x[1],␣
↪reverse=True)[:n]
        top_terms_per_book[book_id] = {term: score for term, score in␣
↪sorted_terms}

    # Convert to DataFrame for easier analysis
    top_terms_df = pd.DataFrame.from_dict(top_terms_per_book, orient='index')

    # Extract top terms overall
    all_terms = {}
    for tf_idf_dict in df['tf_idf']:
        for term, score in tf_idf_dict.items():
            if term in all_terms:
                all_terms[term] += score
            else:
                all_terms[term] = score

    # Sort terms by total tf-idf score (descending) and take top N
    top_terms_overall = sorted(all_terms.items(), key=lambda x: x[1],␣
↪reverse=True)[:n]

    # Convert to DataFrame
    top_terms_overall_df = pd.DataFrame(top_terms_overall, columns=['term',␣
↪'total_score'])

    return top_terms_df, top_terms_overall_df

def create_tfidf_heatmap(df, top_n=50):
    """
    Create a heatmap of the top N terms across all books

    Parameters:
    -----------
    df : pandas DataFrame
        DataFrame with 'book_id' and 'tf_idf' columns
```

```python
    top_n : int
        Number of top terms to include in the heatmap (default: 50)
    """
    # Extract top terms overall
    _, top_terms = extract_top_terms(df, n=top_n)
    top_terms_list = top_terms['term'].tolist()

    # Create a matrix of book_id x top_terms
    heatmap_data = []
    book_ids = []

    for _, row in df.iterrows():
        book_id = row['book_id']
        book_ids.append(book_id)

        tf_idf_dict = row['tf_idf']

        # Extract scores for top terms
        scores = [tf_idf_dict.get(term, 0) for term in top_terms_list]
        heatmap_data.append(scores)

    # Convert to numpy array
    heatmap_array = np.array(heatmap_data).T

    # Create heatmap
    plt.figure(figsize=(14, 16))
    sns.heatmap(heatmap_array, cmap='Blues', xticklabels=book_ids, yticklabels=top_terms_list)
    plt.title(f'Top {top_n} Terms by TF-IDF Score ({df["book_id"].iloc[0][2:]})')
    plt.xlabel('Terms')
    plt.ylabel('Books')
    plt.xticks(rotation=0)
    plt.tight_layout()
    plt.savefig(f"/Users/debr/English-Homer/MVP_Green-Wilson/plots/tfidf_heatmap({df['book_id'].iloc[0][2:]}).png")
    plt.show()

    return heatmap_array

# Example usage
top_terms_per_book_W, top_terms_overall_W = extract_top_terms(df_tfidf_W)
heatmap_array = create_tfidf_heatmap(df_tfidf_W)
```



[5]:
```
top_terms_per_book_G, top_terms_overall_G = extract_top_terms(df_tfidf_G)
heatmap_array = create_tfidf_heatmap(df_tfidf_G)
```



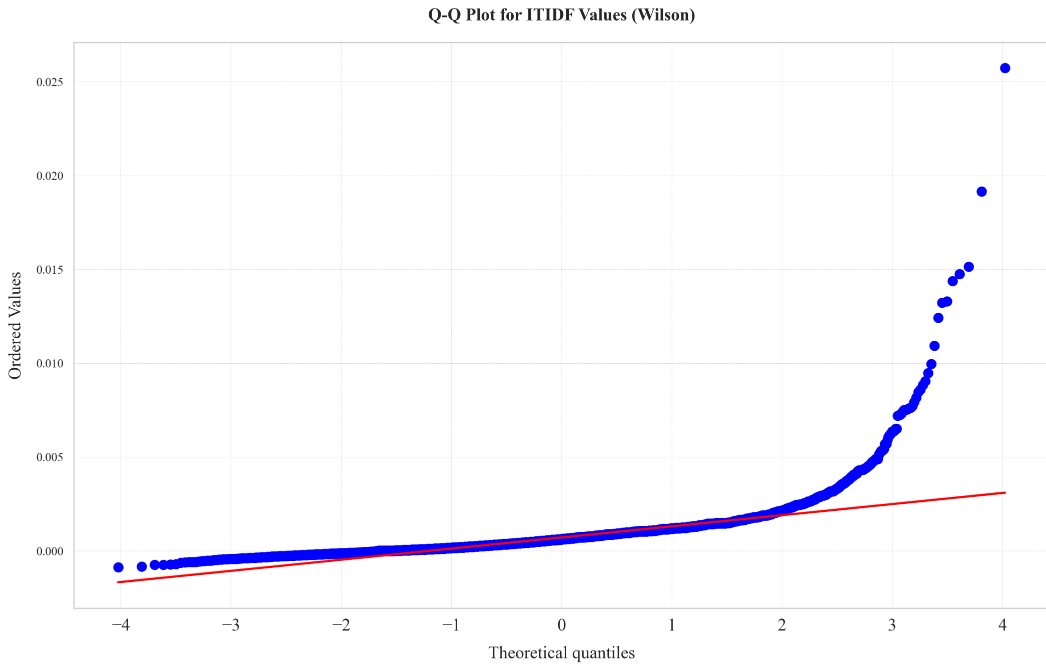
[6]:
```python
# Getting the 30 top terms for each translation
tt_W = top_terms_overall_W['term'][:30]
tt_G = top_terms_overall_G['term'][:30]
# New df with the top terms from both for comparison
top_terms_overall = pd.DataFrame({'Wilson': tt_W, 'Green': tt_G})
top_terms_overall
```

[6]:

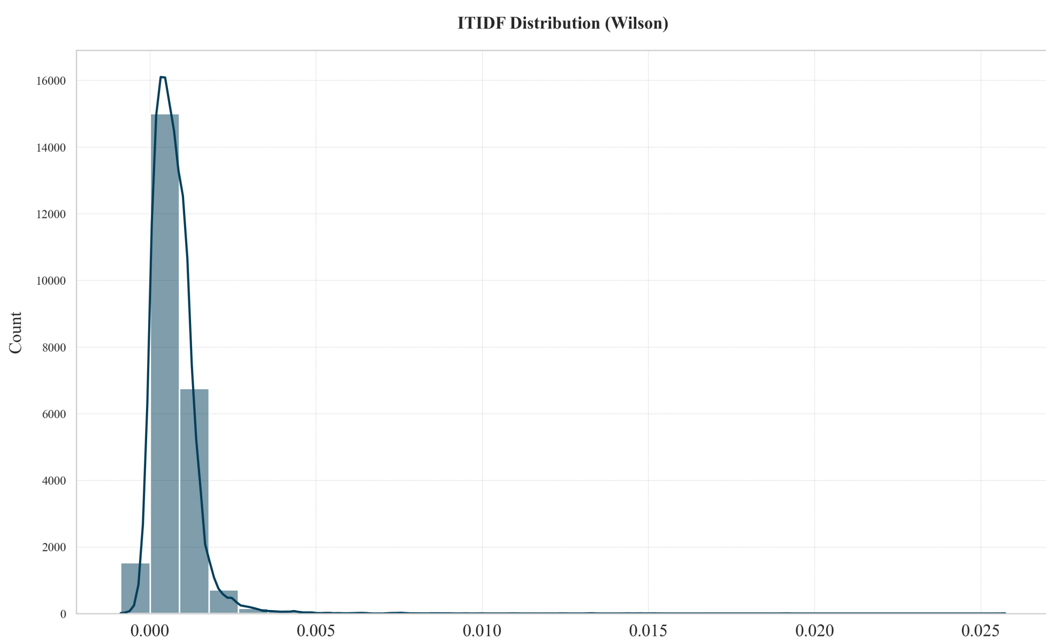
	Wilson	Green
0	bow	alkinoos
1	alcinous	bow
2	swineherd	swineherd
3	circe	telemachos
4	telemachus	phaiakians
5	eumaeus	kirke
6	nestor	nestor
7	suitors	‘
8	‘	eumaios
9	menelaus	suitors
10	irus	antinoos
11	antinous	raft
12	raft	menelaos
13	scylla	nausikaa
14	string	iros
15	old	cave
16	aegisthus	girl
17	melanthius	goddess
18	horses	aigisthos
19	poseidon	wagon
20	nausicaa	string
21	arete	melanthios
22	cave	poseidon
23	phaeacia	skylle
24	mentor	arete
25	calypso	stranger
26	achilles	atreus
27	agamemnon	penelope
28	mules	eurymachos
29	river	bend

[7]:
```
itidf_W = df_tfidf_W["tf_idf"].apply(lambda x: list(x.values())).sum()
itidf_G = df_tfidf_G["tf_idf"].apply(lambda x: list(x.values())).sum()
```

[8]:
```
import scipy.stats as stats
# Q-Q plot for ITIDF values
stats.probplot(itidf_W, dist="norm", plot=plt)
plt.title("Q-Q Plot for ITIDF Values (Wilson)")
plt.savefig(f"/Users/debr/English-Homer/MVP_Green-Wilson/plots/Q-Q_Plot_Wilson.
↪png")
plt.show()
sns.histplot(itidf_W, bins=30, kde=True)  # KDE adds a smoothed curve
plt.title("ITIDF Distribution (Wilson)")
plt.savefig(f"/Users/debr/English-Homer/MVP_Green-Wilson/plots/
↪ITIDF_Distribution_Wilson.png")
plt.show()
```



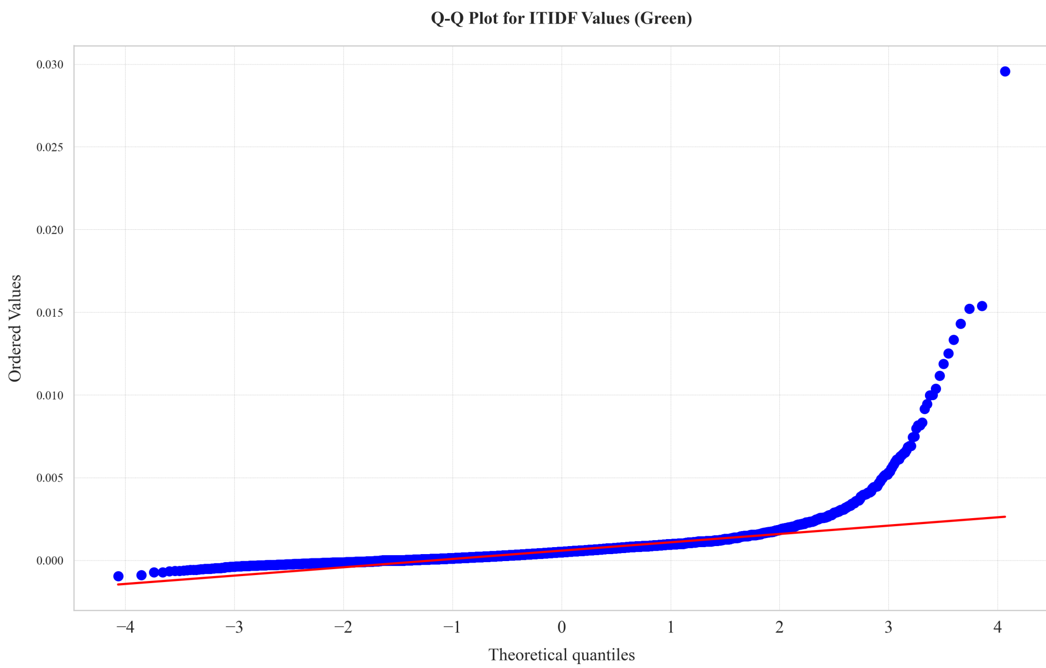
Q-Q Plot for ITIDF Values (Wilson)
Ordered Values
0.025
0.020
0.015
0.010
0.005
0.000
−4
−3
−2
−1
0
1
2
3
4
Theoretical quantiles

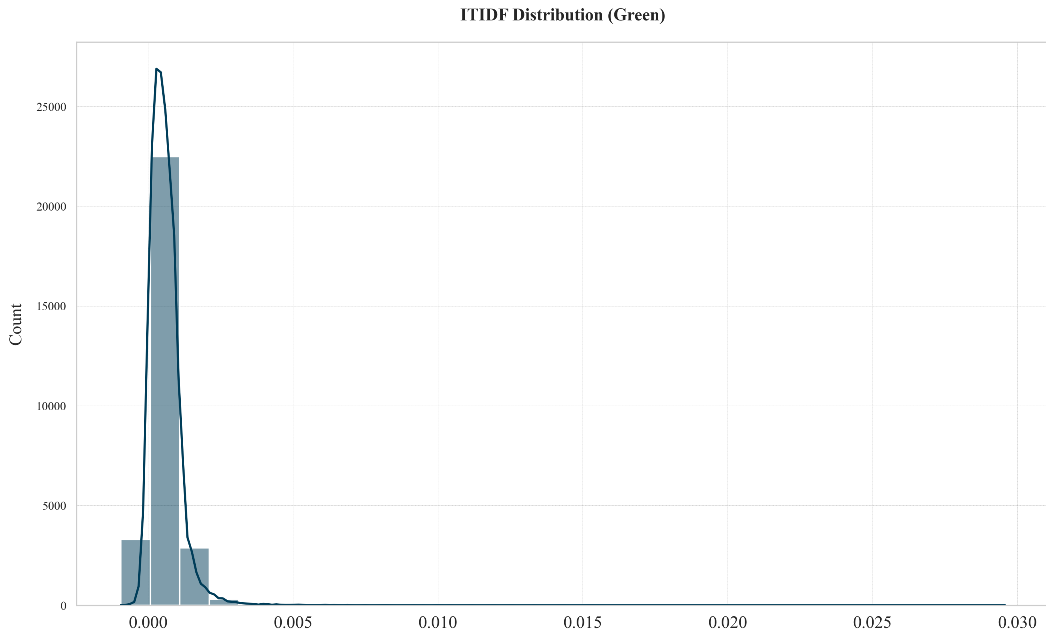


ITIDF Distribution (Wilson)
Count
16000
14000
12000
10000
8000
6000
4000
2000
0
0.000
0.005
0.010
0.015
0.020
0.025

[9]:

```
import scipy.stats as stats
# Q-Q plot for ITIDF values
stats.probplot(itidf_G, dist="norm", plot=plt)
plt.title("Q-Q Plot for ITIDF Values (Green)")
plt.savefig(f"/Users/debr/English-Homer/MVP_Green-Wilson/plots/Q-Q_Plot_Green.
↪png")
plt.show()
sns.histplot(itidf_G, bins=30, kde=True)  # KDE adds a smoothed curve
plt.title("ITIDF Distribution (Green)")
plt.savefig(f"/Users/debr/English-Homer/MVP_Green-Wilson/plots/
↪ITIDF_Distribution_Green.png")
plt.show()
```





[10]:
```python
from scipy.stats import shapiro
# Shapiro test for normality
def shapiro_test(data):
    """
    Perform the Shapiro-Wilk test for normality from scipy.stats and print the␣
 ↪results.

    Parameters:
    -----------
    data : list or array
        The data to be tested for normality.

    Returns: shapiro statistic and p-value

    """
    stat, p = shapiro(data)
    print(f"Shapiro-Wilk Test: p-value = {p}")

    if p > 0.05:
        print("Data appears to be normally distributed (fail to reject H0).")
    else:
        print("Data is not normally distributed (reject H0).")
    return stat, p
```

```python
# Shapiro-Wilk test for normality
print("Wilson")
shapiro_test(itidf_W)
print("\n")
print("Green")
shapiro_test(itidf_G)
```

```
Wilson
Shapiro-Wilk Test: p-value = 1.8664746605407613e-105
Data is not normally distributed (reject H0).


Green
Shapiro-Wilk Test: p-value = 1.5165217224910905e-113
Data is not normally distributed (reject H0).
```

[10]:
```
(np.float64(0.6884581528049329), np.float64(1.5165217224910905e-113))
```

[11]:
```python
# Mannwhitney U test for comparing ITIDF values
from scipy.stats import mannwhitneyu  # Import the actual function

def mannwhitneyu_test(x, y, alternative='two-sided'):
    """
    Perform the Mann-Whitney U test for comparing two independent samples.
    """
    stat, p = mannwhitneyu(x, y, alternative=alternative)  # Use SciPy's␣
 ↪function
    print(f"Mann-Whitney U test statistic: {stat}, p-value: {p}")

    if p < 0.05:
        print("Reject H : The distributions of the translations are␣
 ↪significantly different.")
    else:
        print("Fail to reject H : No significant difference between the␣
 ↪translations.")

# Run the test
mannwhitneyu_test(itidf_W, itidf_G, alternative='two-sided')
```

```
Mann-Whitney U test statistic: 398708946.5, p-value: 4.071216635611771e-145
Reject H : The distributions of the translations are significantly different.
```