LAB ACTIVITY 10

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Forgetting Cursive Writing – A Google Ngram Based Analysis

Task : Fetch Google Books Ngram JSON, save as CSV, plot, generate word cloud and prepare a prompt for an LLM to produce a human summary.

In [10]:
```
# Install necessary packages
!pip install requests
```

```
Requirement already satisfied: requests in c:\users\sonal\appdata\roaming\python\python312\site-packages (2.32.3)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from
requests) (3.4.1)
Requirement already satisfied: idna<4,>=2.5 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from requests)
(3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from reques
ts) (2.3.0)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from reques
ts) (2025.1.31)
WARNING: Ignoring invalid distribution ~umpy (C:\Users\sonal\AppData\Roaming\Python\Python312\site-packages)
WARNING: Ignoring invalid distribution ~umpy (C:\Users\sonal\AppData\Roaming\Python\Python312\site-packages)

[notice] A new release of pip is available: 24.3.1 -> 25.2
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [14]:
```
!pip install wordcloud
```

```
Collecting wordcloud
  Downloading wordcloud-1.9.4-cp312-cp312-win_amd64.whl.metadata (3.5 kB)
Requirement already satisfied: numpy>=1.6.1 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from wordcloud)
(1.26.4)
Requirement already satisfied: pillow in c:\users\sonal\appdata\roaming\python\python312\site-packages (from wordcloud) (11.1.
0)
Requirement already satisfied: matplotlib in c:\users\sonal\appdata\roaming\python\python312\site-packages (from wordcloud) (3.
9.2)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplotl
ib->wordcloud) (1.3.1)
Requirement already satisfied: cycler>=0.10 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplotlib->
wordcloud) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplot
lib->wordcloud) (4.55.8)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplot
lib->wordcloud) (1.4.8)
Requirement already satisfied: packaging>=20.0 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplotli
b->wordcloud) (24.2)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matplotl
ib->wordcloud) (3.2.1)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from matp
lotlib->wordcloud) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in c:\users\sonal\appdata\roaming\python\python312\site-packages (from python-dateutil>
=2.7->matplotlib->wordcloud) (1.16.0)
Downloading wordcloud-1.9.4-cp312-cp312-win_amd64.whl (301 kB)
Installing collected packages: wordcloud
Successfully installed wordcloud-1.9.4
WARNING: Ignoring invalid distribution ~umpy (C:\Users\sonal\AppData\Roaming\Python\Python312\site-packages)
WARNING: Ignoring invalid distribution ~umpy (C:\Users\sonal\AppData\Roaming\Python\Python312\site-packages)

[notice] A new release of pip is available: 24.3.1 -> 25.2
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [19]:

```python
# import necessary packages
import requests
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from wordcloud import WordCloud
```

```
import json
import sys
```

In [23]:
```
# List of search terms (trends to analyze in Google Books Ngram Viewer)
TERMS = ["cursive", "penmanship", "handwriting"]   # Example: missing trends in millennials/Gen Z lifestyles

# Start year of analysis (earliest year to include in results)
YEAR_START = 1800

# End year of analysis (latest year to include in results)
YEAR_END = 2025

# Google Books Ngram corpus ID (15 = English, modern standard corpus)
# Other IDs correspond to different languages/corpora (check Ngram Viewer UI for details)
CORPUS = 15

# Smoothing factor (0 = no smoothing, higher numbers smooth out yearly fluctuations)
SMOOTHING = 0

# HTTP User-Agent header (used to mimic a browser request when fetching data)
USER_AGENT = "Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100 Safari/537.36"

# Filepath for saving extracted Ngram data in CSV format
OUTPUT_CSV = "ngrams_output.csv"

# Filepath for saving the generated trend plot as a PNG image
PLOT_PNG = "ngrams_plot.png"

# Filepath for saving the generated word cloud of terms as a PNG image
WORDCLOUD_PNG = "ngrams_wordcloud.png"
```

In [27]:
```
def fetch_ngram_json(terms, year_start=YEAR_START, year_end=YEAR_END, corpus=CORPUS, smoothing=SMOOTHING):
    """
    Uses the Google Ngram JSON endpoint:
    https://books.google.com/ngrams/json?content=...&year_start=...&year_end=...&corpus=...&smoothing=...
    Returns parsed JSON (list of dicts) on success, raises on failure.
    """
    url = "https://books.google.com/ngrams/json?content=cursive,penmanship,handwriting&year_start=1800&year_end=2025&corpus=15
    params = {
        "content": ",".join(terms),
```

```
        "year_start": year_start,
        "year_end": year_end,
        "corpus": corpus,
        "smoothing": smoothing,
    }
    headers = {"User-Agent": USER_AGENT}
    r = requests.get(url, params=params, headers=headers, timeout=30)
    r.raise_for_status()
    # The endpoint returns JSON that pandas.read_json can also parse; here we return Python list/dict
    return r.json()
```

In [29]:
```
def json_to_dataframe(ngram_json, year_start=YEAR_START, year_end=YEAR_END):
    """
    Convert the JSON returned by the endpoint into a tidy pandas DataFrame:
    columns = ['year', 'ngram', 'freq']
    """
    years = list(range(year_start, year_end + 1))
    rows = []
    for series in ngram_json:
        ngram = series.get("ngram")
        timeseries = series.get("timeseries", [])
        if len(timeseries) != len(years):
            # fill/truncate defensively
            timeseries = (timeseries + [0] * len(years))[:len(years)]
        for y, v in zip(years, timeseries):
            rows.append({"year": y, "ngram": ngram, "freq": float(v)})
    df = pd.DataFrame(rows)
    return df
```

In [31]:
```
def pivot_timeseries(df):
    """Return a wide DataFrame indexed by year with each ngram as a column (frequencies)."""
    pivot = df.pivot(index="year", columns="ngram", values="freq").fillna(0)
    return pivot
```

In [33]:
```
def save_csv(pivot_df, filename=OUTPUT_CSV):
    """
    Save the given pivoted DataFrame (trend data) to a CSV file.
    Parameters:
    pivot_df : pandas.DataFrame
        The pivoted DataFrame containing Google Ngram data.
```

```
        Typically, rows = years and columns = search terms.
    """

    # Save DataFrame as CSV (include index = years)
    pivot_df.to_csv(filename, index=True)

    # Print confirmation for user
    print(f"[+] Saved CSV to {filename}")
```

In [35]:
```
def plot_timeseries(pivot_df, filename=PLOT_PNG):
    plt.figure(figsize=(12,6))
    ax = plt.gca()
    pivot_df.plot(ax=ax, linewidth=2)
    ax.set_xlabel("Year")
    ax.set_ylabel("Relative frequency (%)")
    ax.set_title("Google Books Ngram time series")
    ax.grid(axis="y", alpha=0.3)
    plt.legend(title="ngram", loc="upper right")
    plt.tight_layout()
    plt.savefig(filename, dpi=150)
    plt.close()
    print(f"[+] Saved time-series plot to {filename}")
```

In [37]:
```
def generate_wordcloud(pivot_df, filename=WORDCLOUD_PNG):
    """
    Create a simple word cloud where word sizes are proportional to the overall mean frequency
    across years for each ngram.
    """
    means = pivot_df.mean(axis=0).to_dict()
    # WordCloud expects a text or a frequency dict; we feed frequency dict
    wc = WordCloud(width=800, height=400, background_color="white")
    wc.generate_from_frequencies(means)
    wc.to_file(filename)
    print(f"[+] Saved word cloud to {filename}")
```

In [39]:
```
def compute_summary_stats(pivot_df):
    """Return a dict of helpful summary statistics for each ngram."""
    stats = {}
    for col in pivot_df.columns:
        series = pivot_df[col]
```

```
        stats[col] = {
            "mean": float(np.mean(series)),
            "median": float(np.median(series)),
            "std": float(np.std(series, ddof=0)),
            "max_value": float(series.max()),
            "max_year": int(series.idxmax()),
            "min_year": int(series.idxmin())
        }
    return stats
```

In [41]:

```
def prepare_llm_prompt(summary_stats, pivot_df, top_n_years=5):
    """
    Prepare a textual prompt to send to an LLM along with the CSV or summary.
    The prompt asks the LLM for an interpretive summary and recommended
    human-readable labels for the produced word cloud.
    """
    short_table = pivot_df.mean(axis=0).sort_values(ascending=False).head(top_n_years).to_dict()
    prompt = {
        "instruction": "You are given frequency time-series data (Google Ngram) for several terms. "
                       "Please produce a concise (3-6 sentence) summary about the trends, "
                       "mentioning which term rose or fell and notable years, and suggest 10 short keywords "
                       "suitable for a word cloud. Use the summary statistics and CSV data below.",
        "summary_stats": summary_stats,
        "top_mean_terms": short_table,
        "note": "CSV file attached separately (ngrams_output.csv). Provide the textual summary and a 10-word list for the clou
    }
    return json.dumps(prompt, indent=2)
```

In [49]:

```
# Inform the user which terms are being fetched
print("[*] Fetching Ngram JSON for:", TERMS)

try:
    # Attempt to fetch JSON data from Google Ngram Viewer
    ngram_json = fetch_ngram_json(TERMS)

    # (Optional) confirm successful fetch
    print(f"[+] Successfully fetched Ngram data for {len(TERMS)} terms.")

except Exception as e:
    # Handle any errors (network issues, invalid response, etc.)
```

```
    print("[!] Error fetching Ngram JSON:", e)

    # Exit the script safely with error code 1
    sys.exit(1)
```

```
[*] Fetching Ngram JSON for: ['cursive', 'penmanship', 'handwriting']
[+] Successfully fetched Ngram data for 3 terms.
```

In [51]:
```
# Convert the fetched Ngram JSON into a long-format DataFrame
# (columns: year, term, frequency) for easier analysis/plotting
df_long = json_to_dataframe(ngram_json)
```

In [53]:
```
# Pivot the long DataFrame into wide format (rows = years, columns = terms, values = frequencies)
pivot_df = pivot_timeseries(df_long)
```

In [55]:
```
# Save the pivoted DataFrame to a CSV file for later use
save_csv(pivot_df)
```

```
[+] Saved CSV to ngrams_output.csv
```

In [57]:
```
# Generate and display a time series plot of term frequencies from the pivoted DataFrame
plot_timeseries(pivot_df)
```

```
[+] Saved time-series plot to ngrams_plot.png
```

In [59]:
```
# Generate and save a word cloud image from the pivoted DataFrame
generate_wordcloud(pivot_df)
```

```
[+] Saved word cloud to ngrams_wordcloud.png
```

In [61]:
```
# Compute summary statistics (e.g., mean, max, trends) for each term
stats = compute_summary_stats(pivot_df)
```

In [63]:
```
# Print per-term summary statistics in a readable JSON format
print("\n[Summary statistics (per-term)]:")
print(json.dumps(stats, indent=2))
```

```
[Summary statistics (per-term)]:
{
  "cursive": {
    "mean": 2.643547123937414e-07,
    "median": 2.1630468438615935e-07,
    "std": 2.322693166755568e-07,
    "max_value": 1.4496442872768966e-06,
    "max_year": 1912,
    "min_year": 1802
  },
  "handwriting": {
    "mean": 3.752254315510571e-06,
    "median": 4.140479859415791e-06,
    "std": 1.8684784324154998e-06,
    "max_value": 8.120618986140471e-06,
    "max_year": 1924,
    "min_year": 2009
  },
  "penmanship": {
    "mean": 4.4027313086529734e-07,
    "median": 3.8897559306860785e-07,
    "std": 2.760173390825902e-07,
    "max_value": 1.460775820305571e-06,
    "max_year": 1925,
    "min_year": 2009
  }
}
```

In [65]:
```python
# Prepare an LLM-friendly JSON prompt based on stats and data
prompt = prepare_llm_prompt(stats, pivot_df)
```

In [67]:
```python
# Print the generated LLM prompt for use in downstream tasks
print("\n[LLM prompt you can send (JSON):]\n")
print(prompt)
```

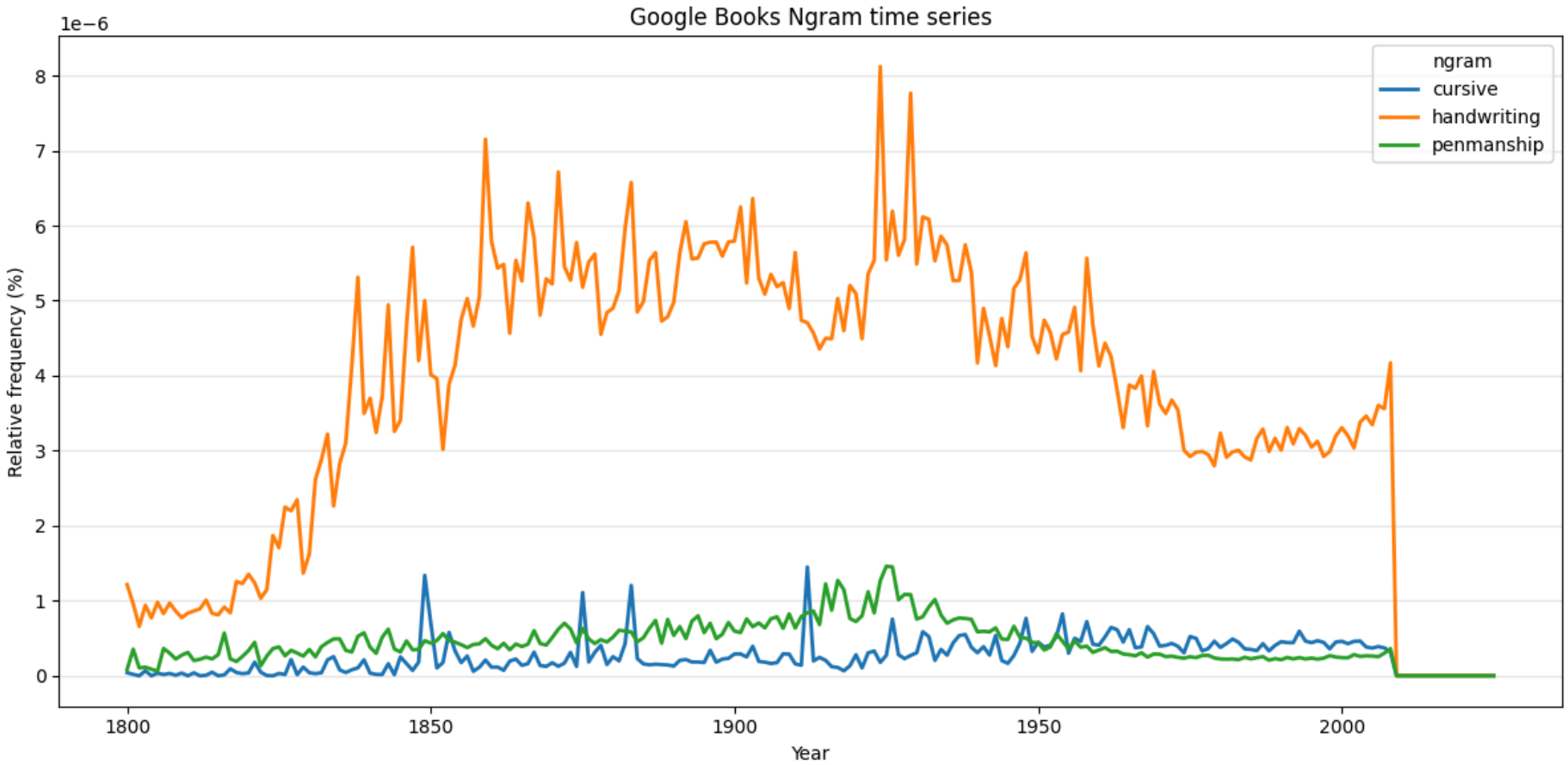
[LLM prompt you can send (JSON):]


```
{
  "instruction": "You are given frequency time-series data (Google Ngram) for several terms. Please produce a concise (3-6 sent
ence) summary about the trends, mentioning which term rose or fell and notable years, and suggest 10 short keywords suitable fo
r a word cloud. Use the summary statistics and CSV data below.",
  "summary_stats": {
    "cursive": {
      "mean": 2.643547123937414e-07,
      "median": 2.1630468438615935e-07,
      "std": 2.322693166755568e-07,
      "max_value": 1.4496442872768966e-06,
      "max_year": 1912,
      "min_year": 1802
    },
    "handwriting": {
      "mean": 3.752254315510571e-06,
      "median": 4.140479859415791e-06,
      "std": 1.8684784324154998e-06,
      "max_value": 8.120618986140471e-06,
      "max_year": 1924,
      "min_year": 2009
    },
    "penmanship": {
      "mean": 4.4027313086529734e-07,
      "median": 3.8897559306860785e-07,
      "std": 2.760173390825902e-07,
      "max_value": 1.460775820305571e-06,
      "max_year": 1925,
      "min_year": 2009
    }
  },
  "top_mean_terms": {
    "handwriting": 3.752254315510571e-06,
    "penmanship": 4.4027313086529734e-07,
    "cursive": 2.643547123937414e-07
  },
  "note": "CSV file attached separately (ngrams_output.csv). Provide the textual summary and a 10-word list for the cloud."
}
```

In [69]:
```
# Final confirmation with names of all saved output files
print("\n[Done] Files: ", OUTPUT_CSV, PLOT_PNG, WORDCLOUD_PNG)
```

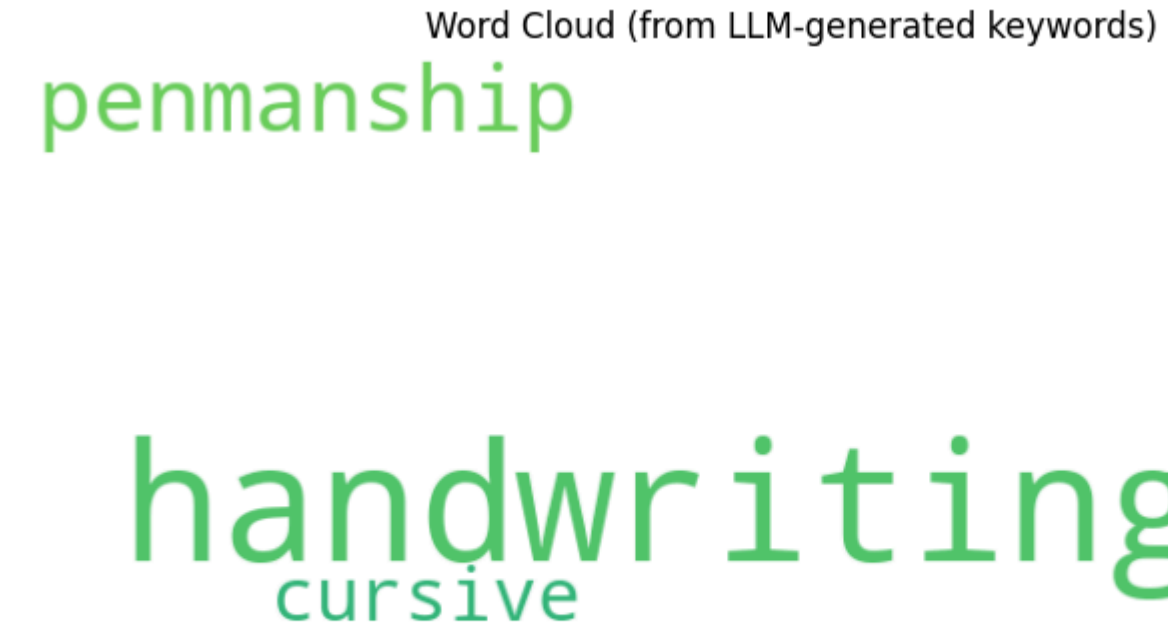
```
[Done] Files:  ngrams_output.csv ngrams_plot.png ngrams_wordcloud.png
```

In [135…
```
# Visualization of time series plot of term frequencies from the pivoted DataFrame
plt.figure(figsize=(12,6))
ax = plt.gca()
pivot_df.plot(ax=ax, linewidth=2)
ax.set_xlabel("Year")
ax.set_ylabel("Relative frequency (%)")
ax.set_title("Google Books Ngram time series")
ax.grid(axis="y", alpha=0.3)
plt.legend(title="ngram", loc="upper right")
plt.tight_layout()
```



In [139…

```
# word cloud from the pivoted DataFrame
means = pivot_df.mean(axis=0).to_dict()
# WordCloud expects a text or a frequency dict; we feed frequency dict
wc = WordCloud(width=800, height=400, background_color="white")
wc.generate_from_frequencies(means)
plt.figure(figsize=(10,5))
plt.imshow(wc, interpolation="bilinear")
plt.axis("off")
plt.title("Word Cloud (from LLM-generated keywords)")
plt.show()
```



In [71]:
```
# Load CSV dataset
df = pd.read_csv("ngrams_output.csv")
# Expecting columns like: ["year", "cursive", "handwriting", "penmanship"]
```

In [141…
```
# display the dataset
print(df)
```

```
     year       cursive   handwriting    penmanship
0    1800  4.238222e-08  1.214957e-06  8.476443e-08
1    1801  1.864104e-08  9.600137e-07  3.541798e-07
2    1802  0.000000e+00  6.580872e-07  1.044583e-07
3    1803  6.719577e-08  9.407408e-07  1.151927e-07
4    1804  0.000000e+00  7.715785e-07  8.767937e-08
..    ...           ...           ...           ...
221  2021  0.000000e+00  0.000000e+00  0.000000e+00
222  2022  0.000000e+00  0.000000e+00  0.000000e+00
223  2023  0.000000e+00  0.000000e+00  0.000000e+00
224  2024  0.000000e+00  0.000000e+00  0.000000e+00
225  2025  0.000000e+00  0.000000e+00  0.000000e+00

[226 rows x 4 columns]
```

In [73]:
```python
# Compute summary statistics
summary_stats = {}
for col in df.columns[1:]:  # skip 'year'
    values = df[col].dropna()
    summary_stats[col] = {
        "mean": float(np.mean(values)),
        "median": float(np.median(values)),
        "std": float(np.std(values)),
        "max_value": float(np.max(values)),
        "max_year": int(df.loc[values.idxmax(), "year"]),
        "min_year": int(df.loc[values.idxmin(), "year"])
    }
```

In [75]:
```python
# Rank terms by mean frequency
top_mean_terms = {col: summary_stats[col]["mean"] for col in df.columns[1:]}
top_mean_terms = dict(sorted(top_mean_terms.items(), key=lambda x: x[1], reverse=True))
```

In [77]:
```python
# Prepare JSON prompt for LLM

prompt_payload = {
    "instruction": (
        "You are given frequency time-series data (Google Ngram) for several terms. "
        "Please produce a concise (3-6 sentence) summary about the trends, mentioning "
        "which term rose or fell and notable years, and suggest 10 short keywords "
        "suitable for a word cloud. Use the summary statistics and CSV data below."
```

```
    ),
    "summary_stats": summary_stats,
    "top_mean_terms": top_mean_terms,
    "note": "CSV file attached separately (ngrams_output.csv). Provide the textual summary and a 10-word list for the cloud."
}
```

In [87]:
```
# Call LLM API

API_KEY = "api-key"   # 🔑 Replace with your API key
API_URL = "https://openrouter.ai/api/v1/chat/completions"  # Example for OpenAI GPT

headers = {
    "Content-Type": "application/json",
    "Authorization": f"Bearer {API_KEY}"
}
```

In [89]:
```
data = {
    "model": "gpt-4o-mini",  # you can change model if needed
    "messages": [
        {"role": "system", "content": "You are a data analysis assistant."},
        {"role": "user", "content": json.dumps(prompt_payload)}
    ],
    "temperature": 0.3
}
```

In [91]:
```
# getting summary response from LLM
response = requests.post(API_URL, headers=headers, json=data)
```

In [92]:
```
if response.status_code == 200:
    result = response.json()
    summary = result["choices"][0]["message"]["content"]
    print("\n=== LLM Generated Summary & Keywords ===\n")
    print(summary)
else:
    print("Error:", response.status_code, response.text)
```

```
=== LLM Generated Summary & Keywords ===

The analysis of the frequency time-series data reveals that "handwriting" has consistently been the most prominent term, peakin
g in 1924. In contrast, "cursive" and "penmanship" have shown lower overall frequencies, with "cursive" reaching its maximum in
1912 and "penmanship" peaking in 1925. Notably, both "cursive" and "penmanship" have seen a decline in usage since their peak y
ears, while "handwriting" has maintained a more stable presence, particularly in recent years. The data suggests a shift in foc
us away from traditional writing styles towards more modern forms of communication.

**Keywords for Word Cloud:**
1. Handwriting
2. Cursive
3. Penmanship
4. Trends
5. Peaks
6. Decline
7. Communication
8. 1924
9. 1912
10. 1925
```

In [117…

```python
def extract_keywords(summary_text):
    # 1) Try to grab numbered list items (most reliable)
    numbered = re.findall(r'^\s*\d+\.\s*(.+?)\s*$', summary_text, flags=re.MULTILINE)
    if numbered:
        return numbered

    # 2) Try to find a "Keywords" header and then comma-separated tokens
    m = re.search(r'(?i)keywords(?:\s*for\s*word\s*cloud)?\s*[:\-]\s*(.+)', summary_text, flags=re.S)
    if m:
        tail = m.group(1).strip()
        # if comma separated on same line
        if ',' in tail:
            parts = [p.strip() for p in tail.split(',') if p.strip()]
            if parts:
                return parts
        # otherwise split on newlines and pick tokens
        lines = [ln.strip() for ln in tail.splitlines() if ln.strip()]
        parts = []
        for ln in lines:
            # if starts with number
            if re.match(r'^\d+\.', ln):
```

```
                parts.append(re.sub(r'^\d+\.\s*', '', ln).strip())
            else:
                # try splitting by spaces/commas
                parts.extend([p.strip() for p in re.split(r'[,;]\s*|\s{2,}', ln) if p.strip()])
        if parts:
            return parts

    # 3) Fallback: extract quoted words (e.g., "cursive")
    quoted = re.findall(r'"([^"]+)"', summary_text)
    if quoted:
        return quoted

    return []
```

In [119…

```
def clean_keyword(k):
    # remove surrounding quotes and leading/trailing punctuation
    k = k.strip().strip('\'"')
    # strip any leading/trailing punctuation except keep digits (years)
    k = re.sub(r'^[^\w\d]+|[^\w\d]+$', '', k)
    return k
```

In [121…

```
# Extract + clean
raw_keywords = extract_keywords(summary)
cleaned = [clean_keyword(k) for k in raw_keywords if clean_keyword(k)]
# preserve order and remove duplicates (case-insensitive)
seen = set()
keywords = []
for k in cleaned:
    key = k.lower()
    if key not in seen:
        seen.add(key)
        keywords.append(k)

print("Extracted keywords:", keywords)
```

```
Extracted keywords: ['Handwriting', 'Cursive', 'Penmanship', 'Trends', 'Peaks', 'Decline', 'Communication', '1924', '1912', '19
25']
```

In [127…

```
# Build a simple weighted frequency dict (higher weight for earlier items)
import os
```

```
freqs = {}
n = len(keywords)
for i, k in enumerate(keywords):
    freqs[k] = n - i  # e.g., first item gets highest weight

# Find a font for WordCloud (helps avoid "Only supported for TrueType fonts" error)
possible_fonts = [
    "/usr/share/fonts/truetype/dejavu/DejaVuSans.ttf",         # common on Linux
    "/usr/share/fonts/truetype/liberation/LiberationSans-Regular.ttf",
    "/Library/Fonts/Arial.ttf",                                # macOS
    "C:\\Windows\\Fonts\\Arial.ttf"                            # Windows
]
font_path = None
for p in possible_fonts:
    if os.path.exists(p):
        font_path = p
        break
wc_kwargs = dict(width=800, height=400, background_color="white", collocations=False)
if font_path:
    wc_kwargs['font_path'] = font_path
```

In [129…

```
# Generate word cloud
wc = WordCloud(**wc_kwargs).generate_from_frequencies(freqs)
```

In [131…

```
# Save and show
output_file = "wordcloud_handwriting.png"
wc.to_file(output_file)
plt.figure(figsize=(10,5))
plt.imshow(wc, interpolation="bilinear")
plt.axis("off")
plt.title("Word Cloud (from LLM-generated keywords)")
plt.show()
```

In [133…
```
print(f"Word cloud saved to: {os.path.abspath(output_file)}")
```

```
Word cloud saved to: C:\Users\sonal\Downloads\CSI3007 - Advanced Python Programming\wordcloud_handwriting.png
```

In [ ]: