RESEARCH SUBJECT

PREDICTION PROJECT

A part of Intro to DS/DE course 2024

10 Dec 2024

WHAT WE DO

Input

organizations, classifications, affiliations, auth-keywords, reference, or publish name

Subject Prediction

using our trained model

Return the most compatible subject

along with total views and rating for the book in the same subject

A part of Intro to DS/DE course 2024

10 Dec 2024

ABOUT OUR

DATA USED

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RAW-DATA

- 2018
- 2019
- 2020
- 2021
- 2022
- 2023

SOURCE DATA : สำนักงานวิทยทรัพยากร OFFICE OF ACADEMIC RESOURCES Chulalongkorn University | Scopus ELSEVIER

20,216 FILES

ABOUT OUR

DATA PREPARATION

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FILE SCHEMA

- abstracts-retrieval-response
  - classification
    - name
  - affiliation
    - affilname
  - coredata
    - prism:publicationName
    - dc:title
  - authkeywords
  - subject-areas (Object)
    - subject-area

} INPUT VARIABLES

} OUTPUT VARIABLES

DATA-PREPARATION

GET FEATURES

- File
- Organizations
- Classifications
- Affiliations
- Auth-keywords
- Authors
- Reference
- Title
- Publish_name
- Subjects

```python
def extract_features(json_file):
    with open(json_file, 'r', encoding='utf-8') as f:
        data = json.load(f)

    abs_resp = data.get('abstracts-retrieval-response', {})

    # Special handling for organizations
    def get_organizations(data):
        orgs = []
        author_groups = data.get('item', {}).get('bibrecord', {}).get('head', {}).get('author-group', [])

        if isinstance(author_groups, dict):
            author_groups = [author_groups]

        for group in author_groups:
            if isinstance(group, dict):
                affiliation = group.get('affiliation', {})
                if isinstance(affiliation, dict):
                    org = affiliation.get('organization', [])
                    if isinstance(org, dict):
                        org = [org]
                    if isinstance(org, list):
                        for o in org:
                            if isinstance(o, dict):
                                orgs.append(o.get('$', None))
                            else:
                                orgs.append(o)

        return orgs if orgs else [None]

    features = {
        'organizations': {
            'custom': get_organizations
        },
        'classifications': {
            'path': ['item', 'bibrecord', 'head', 'enhancement',
                     'classificationgroup', 'classifications'],
            'key': '@type'
        },
        'affiliations': {
            'path': ['affiliation'],
            'key': 'affilname'
        },
        'auth-keywords': {
            'path': ['authkeywords', 'author-keyword'],
            'key': '$'
        },
        'subjects': {
            'path': ['subject-areas', 'subject-area'],
            'key': '$'
        },
        'authors': {
            'path': ['authors', 'author'],
            'key': 'ce:indexed-name'
        }
    }

    record = {'file': Path(json_file).name}

    for feature_name, config in features.items():
        if 'custom' in config:
            # Use custom extraction function for organizations
            record[feature_name] = config['custom'](abs_resp)
        elif 'subpath' in config:
            values = []
            main_array = get_array_or_dict_values(abs_resp, config['path'], None)
            for item in main_array:
                if isinstance(item, dict):
                    sub_values = get_array_or_dict_values(item, config['subpath'], config['key'])
                    values.extend(sub_values)
            record[feature_name] = values
        else:
            record[feature_name] = get_array_or_dict_values(abs_resp, config['path'], config['key'])

    return record
```

```python
def extract_features(json_file):
    with open(json_file, 'r', encoding='utf-8') as f:
        data = json.load(f)

    abs_resp = data.get('abstracts-retrieval-response', {})

    # Special handling for organizations
    def get_organizations(data):
        orgs = []
        author_groups = data.get('item', {}).get('bibrecord', {}).get('head', {}).get('author-group', [])

        if isinstance(author_groups, dict):
            author_groups = [author_groups]

        for group in author_groups:
            if isinstance(group, dict):
                affiliation = group.get('affiliation', {})
                if isinstance(affiliation, dict):
                    org = affiliation.get('organization', [])
                    if isinstance(org, dict):
                        org = [org]
                    if isinstance(org, list):
                        for o in org:
                            if isinstance(o, dict):
                                orgs.append(o.get('$', None))
                            else:
                                orgs.append(o)

        return orgs if orgs else [None]

    features = {
        'organizations': {
            'custom': get_organizations
        },
        'classifications': {
            'path': ['item', 'bibrecord', 'head', 'enhancement',
                     'classificationgroup', 'classifications'],
            'key': '@type'
        },
        'affiliations': {
            'path': ['affiliation'],
            'key': 'affilname'
        },
        'auth-keywords': {
            'path': ['authkeywords', 'author-keyword'],
            'key': '$'
        },
        'subjects': {
            'path': ['subject-areas', 'subject-area'],
            'key': '$'
        },
        'authors': {
            'path': ['authors', 'author'],
            'key': 'ce:indexed-name'
        }
    }

    record = {'file': Path(json_file).name}

    for feature_name, config in features.items():
        if 'custom' in config:
            # Use custom extraction function for organizations
            record[feature_name] = config['custom'](abs_resp)
        elif 'subpath' in config:
            values = []
            main_array = get_array_or_dict_values(abs_resp, config['path'], None)
            for item in main_array:
                if isinstance(item, dict):
                    sub_values = get_array_or_dict_values(item, config['subpath'], config['key'])
                    values.extend(sub_values)
            record[feature_name] = values
        else:
            record[feature_name] = get_array_or_dict_values(abs_resp, config['path'], config['key'])

    return record
```

```python
def get_array_or_dict_values(data, path, key):
    """Extract values from deeply nested arrays/dictionaries."""
    try:
        value = data
        for p in path:
            if isinstance(value, dict):
                value = value.get(p, None)
            elif isinstance(value, list):
                # Handle list of dicts or list of lists
                temp_values = []
                for item in value:
                    if isinstance(item, dict):
                        item_value = item.get(p, None)
                        if isinstance(item_value, list):
                            temp_values.extend(item_value)
                        elif item_value is not None:
                            temp_values.append(item_value)
                    elif isinstance(item, list):
                        temp_values.extend(item)
                value = temp_values if temp_values else None
            else:
                return [None]

        # Handle final value
        if value is None:
            return [None]
        elif isinstance(value, dict):
            # Handle dictionary case
            if key in value:
                return [value[key]]
            elif '$' in value:  # Special case for $ key
                return [value['$']]
            return [None]
        elif isinstance(value, list):
            # Handle list case
            results = []
            for item in value:
                if isinstance(item, dict):
                    if key in item:
                        results.append(item[key])
                    elif '$' in item:  # Special case for $ key
                        results.append(item['$'])
                    else:
                        results.append(None)
                else:
                    results.append(item if item is not None else None)
            return results
        else:
            return [value]
    except Exception as e:
        print(f"Error extracting from path {path}: {e}")
        return [None]
```

DATA-PREPARATION

See information

```
df_data_file = pd.read_csv("data/features_summation.csv", encoding='utf-8')
df_data_file.info()
df_data_file.describe(include='all')
df_data_file.shape
df_data_file.head(5)
```

Drop column and null

```
df_data_file.drop(columns=['file', 'authors', 'reference','title'], inplace=True)
df_data_file_null_out = df_data_file_null_out.applymap(lambda x: None if x == '[None]' or x == '[]' or x == 'None' else x)
df_data_file_null_out.dropna(inplace=True)
df_data_file_null_out.drop_duplicates(inplace=True)
```

DATA-PREPARATION

Drop column value that has count < 1 % and > 99 %

```
# Calculate the 1st and 99th percentiles
lower_percentile = df_data_file_cutoff['auth-keywords'].value_counts().quantile(0.01)
upper_percentile = df_data_file_cutoff['auth-keywords'].value_counts().quantile(0.99)

# Filter the DataFrame to keep only the rows with 'auth-keywords' within the desired range
df_data_file_cutoff = df_data_file_cutoff[
  df_data_file_cutoff['auth-keywords'].map(df_data_file_cutoff['auth-keywords'].value_counts()).between(lower_percentile, upper_percentile)
]

# Display the shape of the new DataFrame
df_data_file_cutoff.shape
```

DATA-PREPARATION

DATA PREPARATION

- Preparing each input variable
  - Organizations
  - Classifications
  - Affiliations
  - Auth-keywords
  - Publish_name
  - Subjects

```python
df_data_file_subject = pd.read_csv('data_pandas/1_features_drop_null.csv', encoding='utf-8')
df_data_file_subject.shape
df_data_file_subject.describe(include='all')

# Ensure the subjects column contains valid string representations of lists
def safe_literal_eval(val):
    try:
        return ast.literal_eval(val)
    except (ValueError, SyntaxError):
        return []

# Split the subjects column into multiple rows
df_data_file_subject['subjects'] = df_data_file_subject['subjects'].apply(safe_literal_eval)

df_data_file_subject = df_data_file_subject.explode('subjects').reset_index(drop=True)

# Clean subject values
df_data_file_subject['subject'] = (
    df_data_file_subject['subjects']
    .str.replace(r"[\[\]\"\']", '', regex=True)  # Remove unwanted characters
    .str.strip()                                 # Trim whitespace
    .str.replace(r'\(.*?\)', '', regex=True)     # Remove parentheses and their contents
    .str.lower()                                 # Convert to lowercase
)

def is_valid_utf8(text):
    try:
        text.encode('utf-8')
        return True
    except UnicodeEncodeError:
        return False

# Filter rows with only valid UTF-8 characters
df_data_file_subject['subject'] = df_data_file_subject['subject'].apply(lambda x: x if is_valid_utf8(x) else np.nan)

# Drop the original subjects column (if required)
df_data_file_subject.drop(columns=['subjects'], inplace=True)

df_data_file_subject.dropna(inplace=True)
df_data_file_subject.drop_duplicate(inplace=True)

import json
with open('clustering_subject.json', encoding='utf-8') as file:
  mapping_subjects = json.load(file)

import nltk
from nltk.stem import PorterStemmer
from fuzzywuzzy import fuzz

subject_cluster_mapping = {cluster_data['Cluster']: set(cluster_data['Subjects']) for cluster_data in mapping_subjects}
stemmer = PorterStemmer()

def map_subjects(subject):
    subject = subject.lower()
    tokens = subject.split()
    stemmed_tokens = [stemmer.stem(token) for token in tokens]

    for cluster, subjects in subject_cluster_mapping.items():
        for cluster_subject in subjects:
            cluster_tokens = cluster_subject.lower().split()
            stemmed_cluster_tokens = [stemmer.stem(token) for token in cluster_tokens]

            # Exact match
            if set(stemmed_tokens) == set(stemmed_cluster_tokens):
                return cluster

            # Fuzzy matching based on token similarity
            fuzzy_ratio = fuzz.token_sort_ratio(subject, cluster_subject)
            if fuzzy_ratio > 80:
                return cluster

    return 'Other'

df_data_file_subject_clustering['subject-cluster'] = df_data_file_subject_clustering['subject'].apply(lambda x: map_subjects(x.strip()))

df_data_file_subject_clustering.drop(columns=['subject'], inplace=True)
```

ABOUT OUR

WEB SCRAPING

A part of Intro to DS/DE course 2024

10 Dec 2024

WEB SCRAPING

GET FEATURES

- Title
- Author
- Keyword
- Reading log count
- Rating
- Link

```
def searchbook(keyword):
  filename = keyword + '_data.csv'
  data_file = open(filename, 'w', newline='')
  csv_writer = csv.writer(data_file)
  headers = ['title','author_name', 'subject_key', 'readinglog_count',
             'ratings_avg','ratings_count','href']
  csv_writer.writerow(headers)
  for i in range(1,3):
    url = "https://openlibrary.org/search.json?q=" + keyword + "&page=" + str(i)
    response = requests.get(url)
    jdata = json.loads(response.content)
    data_d = jdata['docs']
    for book in data_d:
        if 'ratings_average' not in book:
            book['ratings_average'] = 0
        if 'subject_key' not in book:
            book['subject_key'] = []
        if 'title' not in book:
            book['title'] = ""
        if 'readinglog_count' not in book:
            book['readinglog_count'] = 0
        if 'ratings_count' not in book:
            book['ratings_count'] = 0
        if 'key' not in book:
            book['key'] = ''
        if 'author_name' not in book:
            book['author_name'] = []
        book['key'] = "https://openlibrary.org" + book['key']
        csv_writer.writerow([book['title'], book['author_name'],
                             book['subject_key'],book['readinglog_count'],
                             book['ratings_average'], book['ratings_count'],
                             book['key']])
  data_file.close()
```

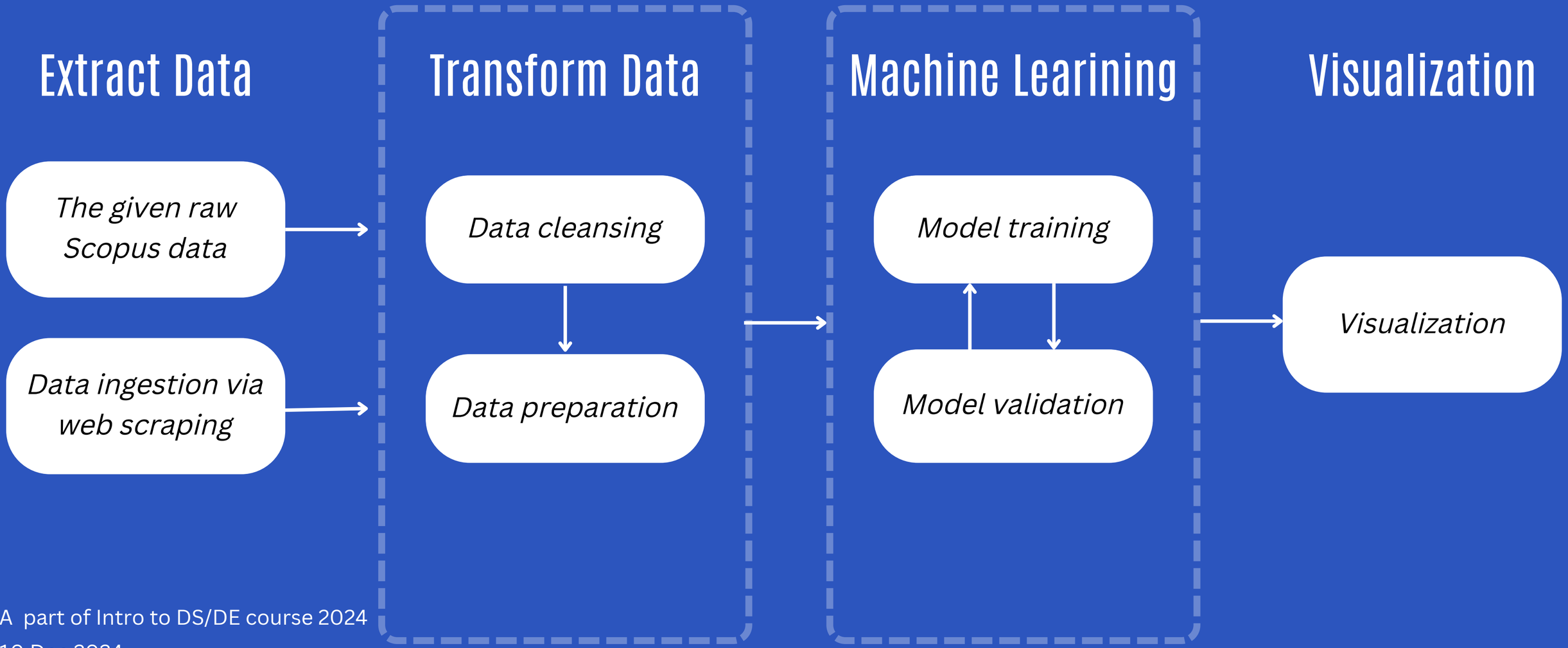
WEB SCRAPING

	title	author_name	subject_key	readinglog_count	ratings_avg	ratings_count	href
0	NASA/DoD aerospace knowledge diffusion researc...	['Thomas E. Pinelli']	['aeronautical_engineering', 'aeronautics', 'a...	168.0	4.000000	5.0	https://openlibrary.org/works/OL8894965W
1	Engineering mechanics	['R. C. Hibbeler', 'R.C. Hibbeler', 'S.C. Fan']	['applied_mechanics', 'dynamics', 'dynamik', '...	365.0	4.500000	10.0	https://openlibrary.org/works/OL1865037W
2	The Soul of a New Machine	['Tracy Kidder']	['architecture_des_ordinateurs', 'computer_eng...	173.0	4.133333	15.0	https://openlibrary.org/works/OL98218W
3	[William Wheeler Hubbell, authorized to apply ...	['United States. Congress. Senate. Committee o...	['administration_of_justice', 'agricultural_ma...	224.0	3.250000	12.0	https://openlibrary.org/works/OL7574091W
4	Pride and Prejudice	['Jane Austen']	['adaptations', 'amours', 'austen_jane_1775-18...	4737.0	4.131488	289.0	https://openlibrary.org/works/OL66554W
...	...	...	...	...	...	...	...
1795	On the origin of species by means of natural s...	['Charles Darwin']	['biological_evolution', 'classic_literature',...	448.0	4.238095	21.0	https://openlibrary.org/works/OL515051W
1796	De rerum natura	['Titus Lucretius Carus']	['ancient_philosophy', 'anthologies', 'atomic_...	344.0	3.769231	13.0	https://openlibrary.org/works/OL1548597W
1797	Biology	['Cecie Starr', 'Christine Evers', 'Lisa Starr']	['biologie', 'biology', 'biology_social_aspect...	296.0	3.818182	11.0	https://openlibrary.org/works/OL1975314W
1798	Biology	['Sylvia S. Mader']	['biologie', 'biology', 'biology_textbooks', '...	136.0	5.000000	1.0	https://openlibrary.org/works/OL2657847W
1799	Physics	['Aristotle']	['08.21', '18.43', '500', 'ancient_science', '...	420.0	3.705882	17.0	https://openlibrary.org/works/OL151632W

1800 rows × 7 columns

1,800 ROWS

DATA PIPLINE



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DE COMPONENT

Web scraping to recommeded books

- BeautifulSoup
- SpringerLink
- OPEN LIBRARY

```
import requests, csv, json
from bs4 import BeautifulSoup

def searchbook(bookname):
  titlename = bookname.replace(' ','+')
  url = "https://link.springer.com/search?new-search=true&query=" + titlename +
  "&content-type=book&dateFrom=&dateTo=&sortBy=relevance"
  return url

def recomend(book,isbnlist, b):
  response2 = requests.get(book)
  soup2 = BeautifulSoup(response2.content, "html.parser")
  titles2 = [title for title in soup2.find_all('a',
   {'class': 'c-article-recommendations-card__link'})]
  a1 = soup2.find('h1').get_text().strip()
  a2 = soup2.find('p', {'data-test': 'bibliographic-information__pisbn'})
  a3 = soup2.find('p', {'class': 'app-article-metrics-bar__count'})
  if(a2):
    b2 = a2.find_all('span')
    a2 = b2[1].get_text().replace('-','')
  else:
    a2 =  book[-17:].replace('-','')
  isbnlist.append([a1,a2,a3.get_text().strip()[:-8],book])
  for title in titles2:
    b.append([title.get_text().strip(),title.get_attribute_list('href')[0]])
  return 0

def rating(isbn,i,isbnlist):
  url3 = "https://openlibrary.org/search.json?isbn="+ isbn + "&fields=rating*"
  response3 = requests.get(url3)
  jdata = json.loads(response3.content)
  data2 = jdata['docs']
  if(len(data2)>0 and len(data2[0]) > 0):
    data3 = data2[0]
    isbnlist[i].extend([data3['ratings_average'], data3['ratings_sortable'],
                        data3['ratings_count_1'],data3['ratings_count_2'],
                        data3['ratings_count_3'],data3['ratings_count_4'],
                        data3['ratings_count_5'],data3['ratings_count']])
  else:
    isbnlist[i].extend([0,0,0,0,0,0,0,0])

def searchrelatebook(bookname):
  url = searchbook(bookname)
  response = requests.get(url)
  soup = BeautifulSoup(response.content, "html.parser")
  titles = [title for title in soup.find_all("h3")]
  a = titles[0].find('a')['href']
  b = [[titles[0].get_text(),"https://link.springer.com" + a]]
  isbnlist = []
  for i in range(6):
    recomend(b[i][1], isbnlist, b)
  for i in range(6):
    rating(isbnlist[i][1], i, isbnlist)

  file = open('export_data.csv', 'a', newline='', encoding='utf-8')
  writer = csv.writer(file)
  headers = ['title', 'isbn', 'access', 'link', 'ratings_avg',
             'ratings_sortable','ratings_count_1','ratings_count_2'
            ,'ratings_count_3','ratings_count_4','ratings_count_5'
            ,'ratings_count']
  writer.writerow(headers)
  for title in isbnlist:
    headers = (title)
    writer.writerow(headers)
  file.close()

searchrelatebook("Radiology in Global Health")
```

AI/ML COMPONENT

```python
import pandas as pd
import re
import string
import numpy as np
import tensorflow as tf
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from tensorflow.keras.utils import to_categorical


df["combined_text"] = df["organizations"] + " classifications: " + df["classifications"] + \
                      " publish_name: " + df["publish_name"] + " auth-keywords: " + df["auth-keywords"] \
                       + " affiliations: "+ df['affiliations']


def clean_text(text):
    text = re.sub(r"[\[\]']", "", str(text))
    text = re.sub(r"\s+", " ", text)
    return text.strip()

df["combined_text"] = df["combined_text"].apply(clean_text)


def normalize_text(text):
    text = text.lower()
    # Remove punctuation
    text = text.translate(str.maketrans("", "", string.punctuation))
    return text

df["combined_text"] = df["combined_text"].apply(normalize_text)


label_encoder = LabelEncoder()
df["group_subjectEncoded"] = label_encoder.fit_transform(df["grouped_subject"])
num_classes = len(label_encoder.classes_)


X = df["combined_text"]
y = to_categorical(df["group_subjectEncoded"], num_classes=num_classes)
```

AI/ML COMPONENT

```
X_train = X_train.to_numpy()
X_test = X_test.to_numpy()

vectorizer = tf.keras.layers.TextVectorization(max_tokens=1000, output_sequence_length=100)
vectorizer.adapt(X_train)

X_train_vec = vectorizer(X_train)
X_test_vec = vectorizer(X_test)

X_train_vec = np.array(X_train_vec)
X_test_vec = np.array(X_test_vec)
```

AI/ML COMPONENT

```
model = Sequential([
    Dense(256, activation='relu', input_shape=(X_train_vec.shape[1],)),
    BatchNormalization(),
    Dropout(0.4),

    Dense(128, activation='relu'),
    BatchNormalization(),
    Dropout(0.3),

    Dense(64, activation='relu'),
    Dropout(0.3),

    Dense(num_classes, activation='softmax')
])


model.compile(
    optimizer='adamax',
    loss='categorical_crossentropy',
    metrics=['accuracy']
)


early_stopping = EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True)
reduce_lr = ReduceLROnPlateau(monitor='val_loss', factor=0.5, patience=3, min_lr=1e-5)


history = model.fit(
    X_train_vec, y_train,
    validation_data=(X_test_vec, y_test),
    epochs=20,
    batch_size=32,
    callbacks=[early_stopping, reduce_lr]
)

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

history = model.fit(X_train_vec, y_train, validation_data=(X_test_vec, y_test), epochs=1, batch_size=32)
```

VIZ COMPONENT

```python
import streamlit as st
import pandas as pd
import matplotlib.pyplot as plt
import tensorflow as tf
import numpy as np
from tensorflow.keras.models import load_model
from tensorflow.keras.layers import TextVectorization
from sklearn.preprocessing import LabelEncoder
import re
import string
import pickle
```

```python
def preprocess_input(book_info):
    def clean_text(text):
        text = re.sub(r"[\[\]']", "", str(text))
        text = re.sub(r"\s+", " ", text)
        return text.strip()

    book_info = clean_text(book_info)

    def normalize_text(text):
        text = text.lower()
        # Remove punctuation
        text = text.translate(str.maketrans("", "", string.punctuation))
        return text

    book_info = normalize_text(book_info)

    # Preprocess the book information (e.g., title, abstract)
    vectorizer = tf.keras.layers.TextVectorization(max_tokens=1000, output_sequence_length=100)
    vectorizer.adapt(np.array([book_info]))
    new_input_vectorized = vectorizer(np.array([book_info]))  # Wrap in np.array to match expected input format

    return np.array(new_input_vectorized)
```

VIZ COMPONENT

```python
# Function to predict the subject
def predict_subject(publich_name, organizations, classifications, auth_keywords):
    feature_string = organizations + " classifications: " + classifications + \
                     " publish_name: " + publich_name + " auth-keywords: " + auth_keywords

    # Preprocess the book information
    processed_input = preprocess_input(feature_string)

    # Predict the probabilities for each subject
    predictions = model.predict(processed_input)

    # Get the index of the highest probability
    best_subject_index = np.argmax(predictions)

    # Map index to class name (your subject labels)
    predicted_subject = label_encoder.inverse_transform([best_subject_index])[0]

    return predicted_subject
```

VIZ COMPONENT

```
# Load the model
model = load_model('my_dnn_model.keras')

# Load the LabelEncoder
with open('label_encoder.pkl', 'rb') as file:
    label_encoder = pickle.load(file)


#-----------------------------------streamlit things-----------------------------------
# Streamlit Layout
st.title("Research Subject Prediction & Book Recommendation Dashboard")

# Input Section
st.sidebar.header("Input for Prediction")
book_publich_name = st.sidebar.text_input("Enter Publish Name")
book_organizations = st.sidebar.text_input("Enter Organizations")
book_classifications = st.sidebar.text_input("Enter Classifications (you can input more than 1 classification)")
auth_keywords = st.sidebar.text_input("Enter Author Keywords (you can input more than 1 keyword)")
```

VIZ COMPONENT

```python
if st.sidebar.button("Predict Subject"):
    if not (book_publich_name or book_organizations or book_classifications or auth_keywords):
        st.sidebar.error("Please fill at least one field before prediction.")
        predicted_subject = None
    else:
        predicted_subject = predict_subject(book_publich_name, book_organizations, book_classifications, auth_keywords)
        if predicted_subject:
            st.sidebar.success(f"Predicted Subject: {predicted_subject}")
else:
    predicted_subject = None

# Visualization Section
if predicted_subject:
    st.header(f"Books recommended for Subject: {predicted_subject}")
```

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```
try:
    books_df = pd.read_csv(f'{predicted_subject}.csv')

    total_books = len(books_df)
    st.write(f"Displaying {total_books} books for subject: {predicted_subject}")

    # Table with book details
    st.dataframe(books_df[['title', 'author_name', 'href', 'ratings_avg', 'ratings_count', 'readinglog_count']])

    # Chart avg rating
    st.subheader("Book Ratings Distribution")
    fig, ax = plt.subplots(figsize=(10, 6))
    ax.hist(books_df['ratings_avg'], bins=20, color='skyblue', edgecolor='black')
    ax.set_title("Distribution of Average Ratings", fontsize=16, fontweight='bold', color='darkblue')
    ax.set_xlabel("Average Rating", fontsize=12, fontweight='bold', color='darkgreen')
    ax.set_ylabel("Number of Books", fontsize=12, fontweight='bold', color='darkgreen')
    ax.grid(True, axis='y', linestyle='--', alpha=0.7)
    ax.set_xticks(np.arange(1, 6, 0.5))
    ax.tick_params(axis='both', labelsize=10)
    st.pyplot(fig)
```

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```
    # Chart total views
    st.subheader("Book Views Distribution")
    fig, ax = plt.subplots(figsize=(10, 6))
    ax.hist(books_df['readinglog_count'], bins=20, color='lightgreen', edgecolor='black')
    ax.set_title("Distribution of Book Views", fontsize=16, fontweight='bold', color='darkblue')
    ax.set_xlabel("Number of Views")
    ax.set_ylabel("Number of Books")
    ax.grid(True, axis='y', linestyle='--', alpha=0.7)
    ax.set_xticks(np.arange(0, 2000, 100))
    ax.tick_params(axis='both', labelsize=10)
    st.pyplot(fig)

except FileNotFoundError:
    st.error(f"No CSV file found for subject: {predicted_subject}")
```

DEMO TIME