In [3]:
```
import pandas as pd
import io

# Read the uploaded Excel file into a DataFrame
# Read the CSV file back into a DataFrame. It is Cleaned Dataset
grouped_new_read = pd.read_csv('Grouped_Subject_Description.csv')

# Display the DataFrame
grouped_new_read.head(20)
```

Out[3]:

	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses
0	2020	AAP	Architecture, Art, and Plannin	EmptyString	1
1	2021	AAP	Architecture, Art, and Plannin	EmptyString	1
2	2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2
3	2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4
4	2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13
5	2016	AAS	Asian American Studies	course examine historical contemporary issue a...	14
6	2017	AAS	Asian American Studies	course examine historical contemporary issue a...	9
7	2018	AAS	Asian American Studies	course introduce student historical contempora...	10
8	2019	AAS	Asian American Studies	interdisciplinary course offer introduction st...	15
9	2020	AAS	Asian American Studies	interdisciplinary course offer introduction st...	12
10	2021	AAS	Asian American Studies	interdisciplinary course offer introduction st...	9
11	2022	AAS	Asian American Studies	interdisciplinary course offer introduction st...	19
12	2023	AAS	Asian American Studies	course introduce variety writing asian north a...	13
13	2024	AAS	Asian American Studies	interdisciplinary course offer introduction st...	9
14	2014	AEM	Applied Economics & Management	like subsistence farmer develop world choice c...	75
15	2015	AEM	Applied Economics & Management	introduction cost accounting emphasize applica...	163
16	2016	AEM	Applied Economics & Management	course develop data drive model base approach ...	205
17	2017	AEM	Applied Economics & Management	course develop data drive model base approach ...	199
18	2018	AEM	Applied Economics & Management	course develop data drive model base approach ...	218
19	2019	AEM	Applied Economics & Management	course develop data drive model base approach ...	229

In [5]:
```
# Function to count occurrences of business-related words
#This is the BruteForce approach

business_keywords = {'business', 'startup', 'entrepreneurship', 'entrepreneur', 'venture', 'market', 'inve

def count_business_words(description):
    """
    This function returns the count of business related words

    Args: text to be analysed

    Returns: Returns count of business related words
        type: int
    """
    # Tokenize the description into words
    words = description.split()
    count = len(words)
    # Count how many words are in the business_keywords set
    business_related_words = sum(word.lower() in business_keywords for word in words)
    percentageOfBusinessWords = (business_related_words/count)*100
    return count, business_related_words, round(percentageOfBusinessWords,2)
```

In [6]:
```
data = grouped_new_read['Grouped_Subject_Description'].apply(count_business_words)

totalCount = [item[0] for item in data]
businessCount = [item[1] for item in data]
percentageOfBusiness = [item[2] for item in data]

# Assign the cleaned texts and word counts to their respective columns
grouped_new_read['TotalWords'] = totalCount
grouped_new_read['businessCount'] = businessCount
grouped_new_read['%OfBusinessWords'] = percentageOfBusiness

grouped_new_read.head(20)
```

Out[6]:

	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords
0	2020	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.00
1	2021	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.00
2	2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2	17	0	0.00
3	2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4	162	0	0.00
4	2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13	605	0	0.00
5	2016	AAS	Asian American Studies	course examine historical contemporary issue a...	14	666	1	0.15
6	2017	AAS	Asian American Studies	course examine historical contemporary issue a...	9	539	0	0.00
7	2018	AAS	Asian American Studies	course introduce student historical contempora...	10	491	0	0.00
8	2019	AAS	Asian American Studies	interdisciplinary course offer introduction st...	15	874	0	0.00
9	2020	AAS	Asian American Studies	interdisciplinary course offer introduction st...	12	662	0	0.00
10	2021	AAS	Asian American Studies	interdisciplinary course offer introduction st...	9	545	1	0.18
11	2022	AAS	Asian American Studies	interdisciplinary course offer introduction st...	19	1088	1	0.09
12	2023	AAS	Asian American Studies	course introduce variety writing asian north a...	13	557	0	0.00
13	2024	AAS	Asian American Studies	interdisciplinary course offer introduction st...	9	399	1	0.25
14	2014	AEM	Applied Economics & Management	like subsistence farmer develop world choice c...	75	2410	67	2.78
15	2015	AEM	Applied Economics & Management	introduction cost accounting emphasize applica...	163	6182	157	2.54
16	2016	AEM	Applied Economics & Management	course develop data drive model base approach ...	205	8337	203	2.43
17	2017	AEM	Applied Economics & Management	course develop data drive model base approach ...	199	8133	202	2.48
18	2018	AEM	Applied Economics & Management	course develop data drive model base approach ...	218	9064	238	2.63
19	2019	AEM	Applied Economics & Management	course develop data drive model base approach ...	229	9482	244	2.57

In [7]:
```
!pip install keybert
```

```
Requirement already satisfied: keybert in c:\programdata\anaconda3\lib\site-packages (0.8.3)
Requirement already satisfied: scikit-learn>=0.22.2 in c:\programdata\anaconda3\lib\site-packages (from k
eybert) (1.3.0)
Requirement already satisfied: numpy>=1.18.5 in c:\programdata\anaconda3\lib\site-packages (from keybert)
(1.24.3)
Requirement already satisfied: rich>=10.4.0 in c:\programdata\anaconda3\lib\site-packages (from keybert)
(13.7.0)
Requirement already satisfied: sentence-transformers>=0.3.8 in c:\programdata\anaconda3\lib\site-packages
(from keybert) (2.2.2)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\programdata\anaconda3\lib\site-packages (fro
m rich>=10.4.0->keybert) (2.15.1)
Requirement already satisfied: typing-extensions<5.0,>=4.0.0 in c:\programdata\anaconda3\lib\site-package
s (from rich>=10.4.0->keybert) (4.8.0)
Requirement already satisfied: markdown-it-py>=2.2.0 in c:\programdata\anaconda3\lib\site-packages (from
rich>=10.4.0->keybert) (3.0.0)
Requirement already satisfied: mdurl~=0.1 in c:\programdata\anaconda3\lib\site-packages (from markdown-it
-py>=2.2.0->rich>=10.4.0->keybert) (0.1.2)
Requirement already satisfied: scipy>=1.5.0 in c:\programdata\anaconda3\lib\site-packages (from scikit-le
arn>=0.22.2->keybert) (1.10.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anaconda3\lib\site-packages (from s
cikit-learn>=0.22.2->keybert) (2.2.0)
Requirement already satisfied: joblib>=1.1.1 in c:\programdata\anaconda3\lib\site-packages (from scikit-l
earn>=0.22.2->keybert) (1.2.0)
Requirement already satisfied: tqdm in c:\programdata\anaconda3\lib\site-packages (from sentence-transfor
mers>=0.3.8->keybert) (4.65.0)
Requirement already satisfied: transformers<5.0.0,>=4.6.0 in c:\programdata\anaconda3\lib\site-packages
(from sentence-transformers>=0.3.8->keybert) (4.32.1)
Requirement already satisfied: torch>=1.6.0 in c:\programdata\anaconda3\lib\site-packages (from sentence-
transformers>=0.3.8->keybert) (2.1.1)
Requirement already satisfied: huggingface-hub>=0.4.0 in c:\programdata\anaconda3\lib\site-packages (from
sentence-transformers>=0.3.8->keybert) (0.15.1)
Requirement already satisfied: sentencepiece in c:\programdata\anaconda3\lib\site-packages (from sentence
-transformers>=0.3.8->keybert) (0.1.99)
Requirement already satisfied: nltk in c:\programdata\anaconda3\lib\site-packages (from sentence-transfor
mers>=0.3.8->keybert) (3.8.1)
Requirement already satisfied: torchvision in c:\programdata\anaconda3\lib\site-packages (from sentence-t
ransformers>=0.3.8->keybert) (0.16.1)
Requirement already satisfied: filelock in c:\programdata\anaconda3\lib\site-packages (from huggingface-h
ub>=0.4.0->sentence-transformers>=0.3.8->keybert) (3.9.0)
Requirement already satisfied: fsspec in c:\programdata\anaconda3\lib\site-packages (from huggingface-hub
>=0.4.0->sentence-transformers>=0.3.8->keybert) (2023.4.0)
Requirement already satisfied: pyyaml>=5.1 in c:\programdata\anaconda3\lib\site-packages (from huggingfac
e-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (6.0)
Requirement already satisfied: packaging>=20.9 in c:\programdata\anaconda3\lib\site-packages (from huggin
gface-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (23.1)
Requirement already satisfied: requests in c:\programdata\anaconda3\lib\site-packages (from huggingface-h
ub>=0.4.0->sentence-transformers>=0.3.8->keybert) (2.31.0)
Requirement already satisfied: jinja2 in c:\programdata\anaconda3\lib\site-packages (from torch>=1.6.0->s
entence-transformers>=0.3.8->keybert) (3.1.2)
Requirement already satisfied: sympy in c:\programdata\anaconda3\lib\site-packages (from torch>=1.6.0->se
ntence-transformers>=0.3.8->keybert) (1.11.1)
Requirement already satisfied: networkx in c:\programdata\anaconda3\lib\site-packages (from torch>=1.6.0-
>sentence-transformers>=0.3.8->keybert) (3.1)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-packages (from tqdm->sentenc
e-transformers>=0.3.8->keybert) (0.4.6)
Requirement already satisfied: safetensors>=0.3.1 in c:\programdata\anaconda3\lib\site-packages (from tra
nsformers<5.0.0,>=4.6.0->sentence-transformers>=0.3.8->keybert) (0.3.2)
Requirement already satisfied: tokenizers!=0.11.3,<0.14,>=0.11.1 in c:\programdata\anaconda3\lib\site-pac
kages (from transformers<5.0.0,>=4.6.0->sentence-transformers>=0.3.8->keybert) (0.13.2)
Requirement already satisfied: regex!=2019.12.17 in c:\programdata\anaconda3\lib\site-packages (from tran
sformers<5.0.0,>=4.6.0->sentence-transformers>=0.3.8->keybert) (2022.7.9)
Requirement already satisfied: MarkupSafe>=2.0 in c:\programdata\anaconda3\lib\site-packages (from jinja2
->torch>=1.6.0->sentence-transformers>=0.3.8->keybert) (2.1.1)
Requirement already satisfied: click in c:\programdata\anaconda3\lib\site-packages (from nltk->sentence-t
ransformers>=0.3.8->keybert) (8.1.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\programdata\anaconda3\lib\site-packages (from req
uests->huggingface-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (1.26.16)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\programdata\anaconda3\lib\site-packages (fr
om requests->huggingface-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\programdata\anaconda3\lib\site-packages (from requests-
>huggingface-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (3.4)
Requirement already satisfied: certifi>=2017.4.17 in c:\programdata\anaconda3\lib\site-packages (from req
uests->huggingface-hub>=0.4.0->sentence-transformers>=0.3.8->keybert) (2023.7.22)
Requirement already satisfied: mpmath>=0.19 in c:\programdata\anaconda3\lib\site-packages (from sympy->to
rch>=1.6.0->sentence-transformers>=0.3.8->keybert) (1.3.0)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in c:\programdata\anaconda3\lib\site-packages (from
torchvision->sentence-transformers>=0.3.8->keybert) (9.4.0)
```

```
WARNING: Ignoring invalid distribution -mpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -umpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -sspec (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mportlib-metadata (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution - (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -umpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -sspec (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mportlib-metadata (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution - (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -umpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -sspec (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mportlib-metadata (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution - (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -umpy (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -sspec (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -mportlib-metadata (c:\programdata\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution - (c:\programdata\anaconda3\lib\site-packages)
WARNING: You are using pip version 21.1.2; however, version 23.3.1 is available.
You should consider upgrading via the 'C:\ProgramData\Anaconda3\python.exe -m pip install --upgrade pip' command.
```

In [6]:

```
# We can also use the model paraphrase-MiniLM-L6-v2

from keybert import KeyBERT
from sentence_transformers import SentenceTransformer
sentence_model = SentenceTransformer('all-MiniLM-L6-v2')  # This is the default model used by KeyBERT
kw_model = KeyBERT(model=sentence_model)    #Sentence transformer is based on Hugging face transformer
```

In [7]:

```
# Extract keywords using BERT model
def extract_keywords_and_update_count(text):
    """
    Function to extract keywords using KeyBERT model

    Args: text to the model

    Returns: Keywords along with cosine similarity wrt document
        type: list of tuples
    """
    keywords = kw_model.extract_keywords(text, keyphrase_ngram_range=(1, 2), stop_words='english',top_n=50
    return keywords
```

In [8]:

```
candidate_keywords = [
    "marketing", "finance", "investment", "startup",
    "entrepreneurship", "management", "corporate", "economics",
    "venture capital", "market analysis", "business development",
    "commercialization", "innovation", "strategic planning"
]
```

```
['marketing', 'finance', 'investment', 'startup', 'entrepreneurship', 'management', 'corporate', 'economi
cs', 'venture capital', 'market analysis', 'business development', 'commercialization', 'innovation', 'st
rategic planning']
<class 'list'>
```

In [9]:

```
from transformers import BertModel, BertTokenizer
import torch
```

In [10]:

```
tokenizer = BertTokenizer.from_pretrained('bert-base-uncased')
model = BertModel.from_pretrained('bert-base-uncased')
```

In [11]:
```
Function to get words embeddings intensor format
def get_word_embedding(word, tokenizer, model):
    """
    Function to get word embedding using a specified tokenizer and model

    Args:
    word (str): The word for which the embedding is to be obtained.
    tokenizer: The tokenizer to be used for tokenizing the input word. This should be compatible with the mo
    model: The pre-trained model to be used for obtaining the word embeddings. This model should be compatib

    Returns:
    torch.Tensor: The mean of the last hidden state of the model's output, representing the word embedding.
    """
    inputs = tokenizer(word, return_tensors='pt')
    with torch.no_grad():
        outputs = model(**inputs)
    return outputs.last_hidden_state.mean(dim=1).squeeze()
```

In [12]:
```
#Function to return the word embeddings for candidate keywords
def get_batch_embeddings(words, tokenizer, model, batch_size=32):
    """
    Function to return word embeddings for a list of candidate keywords in batches

    Args:
    words (list of str): A list of words or phrases for which embeddings are to be obtained.
    tokenizer: The tokenizer to be used for tokenizing the input words.
    model: The pre-trained model to be used for obtaining word embeddings.
    batch_size (int, optional): The size of each batch for processing the words. Defaults to 32.

    Returns:
    list of torch.Tensor: A list containing the embeddings for each word or phrase in the input list.
    """
    # Process words in batches
    embeddings = []
    for i in range(0, len(words), batch_size):
        batch = words[i:i+batch_size]
        inputs = tokenizer(batch, padding=True, truncation=True, return_tensors='pt', max_length=512)
        with torch.no_grad():
            outputs = model(**inputs)
        batch_embeddings = outputs.last_hidden_state.mean(dim=1)
        embeddings.extend(batch_embeddings)
    return embeddings
```

In [13]:
```
# Precompute embeddings for candidate keywords
candidate_embeddings = get_batch_embeddings(candidate_keywords, tokenizer, model)
```

In [14]:
```
from scipy.spatial.distance import cosine

def cosine_similarity(vec1, vec2):
    """
    Function to calculate the cosine similarity between two vectors

    Args:
    vec1 (array-like): The first vector. It can be a list, numpy array, or any array-like structure that re
    vec2 (array-like): The second vector. It should be of the same length as vec1.

    Returns:
    float: The cosine similarity between vec1 and vec2.

    """
    return 1 - cosine(vec1, vec2)
```

In [15]:
```
#Function calculates similarity usign Cosine similarity
def calculate_similarity(keywords):
    """
    Function to calculate the number of keywords that have a high similarity with a set of candidate embed

    Args:
    keywords (list of tuples): A list where each tuple contains a keyword (str).


    Returns:
    int: The count of keywords whose embeddings have a cosine similarity of 0.85 or higher.

    """
    count=0
    for keyword in keywords:
        keyword_vec = get_word_embedding(keyword[0], tokenizer, model)
        for business_word_vec in candidate_embeddings:
            similarity = cosine_similarity(keyword_vec, business_word_vec)
            if similarity>=0.85:
                count+=1
    return count
```

In [16]:
```
def get_business_related_words_keyBERT(text):
    """
    Function to extract business-related keywords from a given text using the KeyBERT model

    Args:
    text (str): The text from which business-related keywords are to be extracted.

    Global Dependencies:
    extract_keywords_and_update_count: A globally accessible function that takes a text string as input an

    Returns:
    list: A list of extracted keywords from the given text.

    """
    keywords = extract_keywords_and_update_count(text)
    return keywords
```

In [27]:
```
data = grouped_new_read['Grouped_Subject_Description'].apply(get_business_related_words_keyBERT)
grouped_new_read['KeyBERTCount'] = data
grouped_new_read.to_csv('filename2.csv', index=False)
```

In [28]:
```
import pandas as pd
import io
import ast  # Import the ast module

# Read the CSV file back into a DataFrame. It is Cleaned Dataset
final_df = pd.read_csv('filename2.csv')

# Display the DataFrame
final_df.head(20)
# Convert the 'KeyBERTCount' column from string to list of tuples
final_df['KeyBERTCount'] = final_df['KeyBERTCount'].apply(ast.literal_eval)

# Now the 'KeyBERTCount' column should contain lists of tuples
```

In [30]:
```
final_df.head()
```

Out[30]:

	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords	Ke
0	2020	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
1	2021	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
2	2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2	17	0	0.0	(c
3	2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4	162	0	0.0	
4	2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13	605	0	0.0	[(a

In [42]:
```
def process_element(keywords):
    count = calculate_similarity(keywords)
    return count
```

In [43]:
```
countOfWords = final_df['KeyBERTCount'].apply(calculate_similarity)
```

In [45]:
```
final_df['KeyBERTBusiness'] = countOfWords
```

In [46]:
```
final_df.tail()
```

Out[46]:

Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords	KeyBER
2020	ZULU	Zulu	isizulu widely speak language southern african...	6	223	0	0.0	[(zul 0.532 s
2021	ZULU	Zulu	isizulu widely speak language southern african...	6	230	0	0.0	[(zul 0.579 la (
2022	ZULU	Zulu	development communication skill dialogue role ...	6	171	0	0.0	[(conve isizulu, (zul
2023	ZULU	Zulu	development communication skill dialogue role ...	6	171	0	0.0	[(conve isizulu, (zul
2024	ZULU	Zulu	development communication skill dialogue role ...	3	79	0	0.0	[((deve

In [47]:
```
# Save it to .csv file for future use
final_df.to_csv('FinalBusiness.csv', index=False)
```

In [48]:
```
final_df.head()
```

Out[48]:

Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords	KeyBEF
2020	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	[(emp
2021	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	[(emp
2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2	17	0	0.0	col (colonia
2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4	162	0	0.0	[(ex asian, (asian
2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13	605	0	0.0	[(asian 0.508 asian

Analysis for Business related words

In [49]:
```
final_df.drop(columns=['KeyBERTCount'], inplace=True)
```

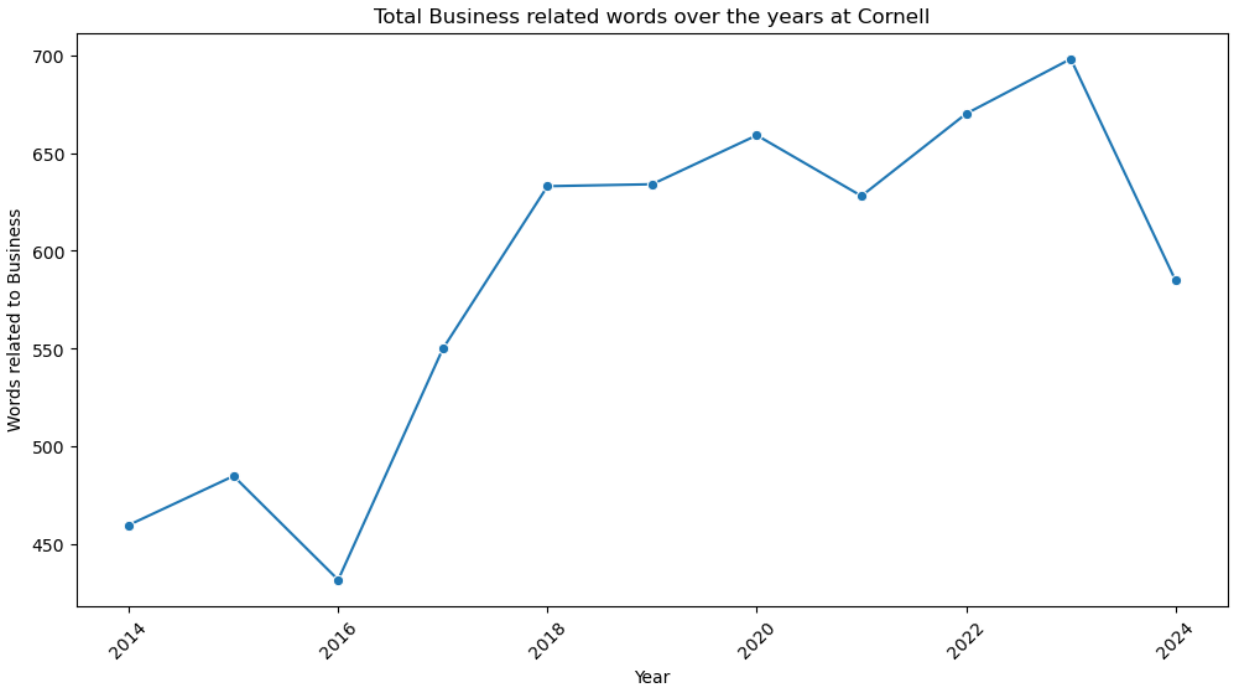
In [31]:
```
import matplotlib.pyplot as plt
import seaborn as sns

final_df_analyis_business = pd.read_csv('FinalBusiness.csv')
```

Line Chart for Business related word count over time at Cornell:

In [34]:
```
# Group data by Year and calculate the total KeyBERTCountFinal
total_counts_over_time = final_df_analyis_business.groupby('Year')['KeyBERTBusiness'].sum().reset_index()

# Create a line chart
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTBusiness', data=total_counts_over_time, marker='o')
plt.title('Total Business related words over the years at Cornell')
plt.xlabel('Year')
plt.ylabel('Words related to Business')
plt.xticks(rotation=45)
plt.show()
```

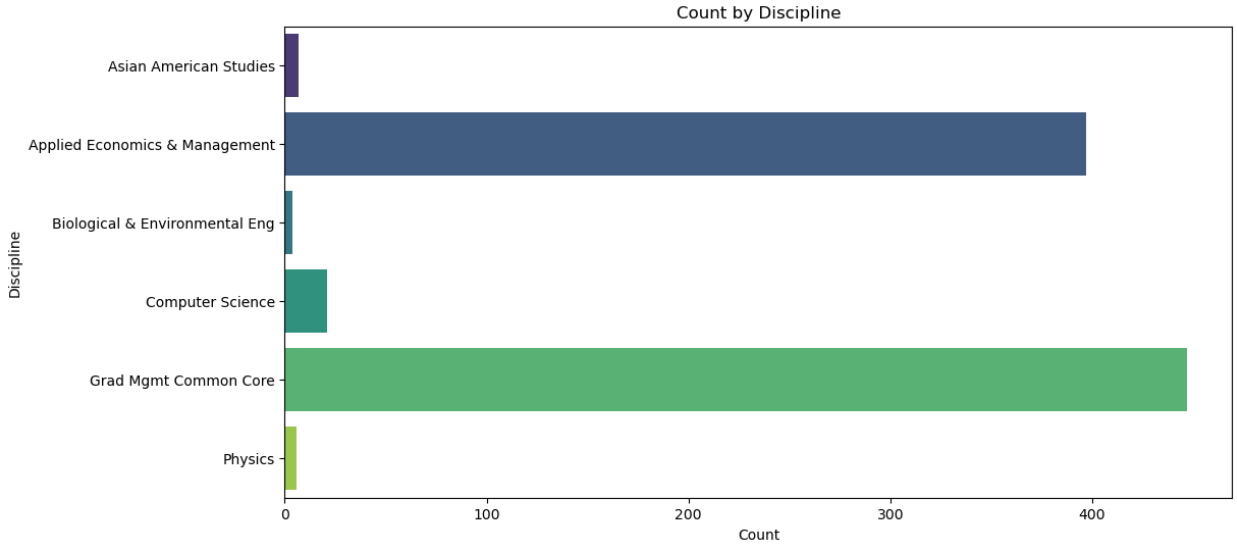


Total count of words by Descipline

In [55]:
```
# Define custom aggregation functions for the columns you want to include
agg_funcs = {
    'SubjectLongForm': 'first',  # Keep the first value of SubjectLongForm
    'Grouped_Subject_Description': 'first',  # Keep the first value of Grouped_Subject_Description
    'TotalWords': 'sum',  # Sum the TotalWords for each group
    'businessCount': 'sum',  # Sum the businessCount for each group
    '%OfBusinessWords': 'mean',  # Calculate the mean of %OfBusinessWords for each group
    'KeyBERTBusiness': 'sum',  # Sum the KeyBERTCountFinal for each group
}
# Group data by Subject and apply custom aggregation functions
grouped_data = final_df_analyis_business.groupby('Subject').agg(agg_funcs).reset_index()
# List of disciplines you want to include in the graph
selected_disciplines = ['AEM', 'AAS', 'BEE', 'CS', 'NCC', 'PHYS']

# Filter the DataFrame to include only selected disciplines
filtered_data = grouped_data[grouped_data['Subject'].isin(selected_disciplines)]

# Create a bar chart
plt.figure(figsize=(12, 6))
sns.barplot(x='KeyBERTBusiness', y='SubjectLongForm', data=filtered_data, palette='viridis')
plt.title('Count by Discipline')
plt.xlabel('Count')
plt.ylabel('Discipline')
plt.show()
```



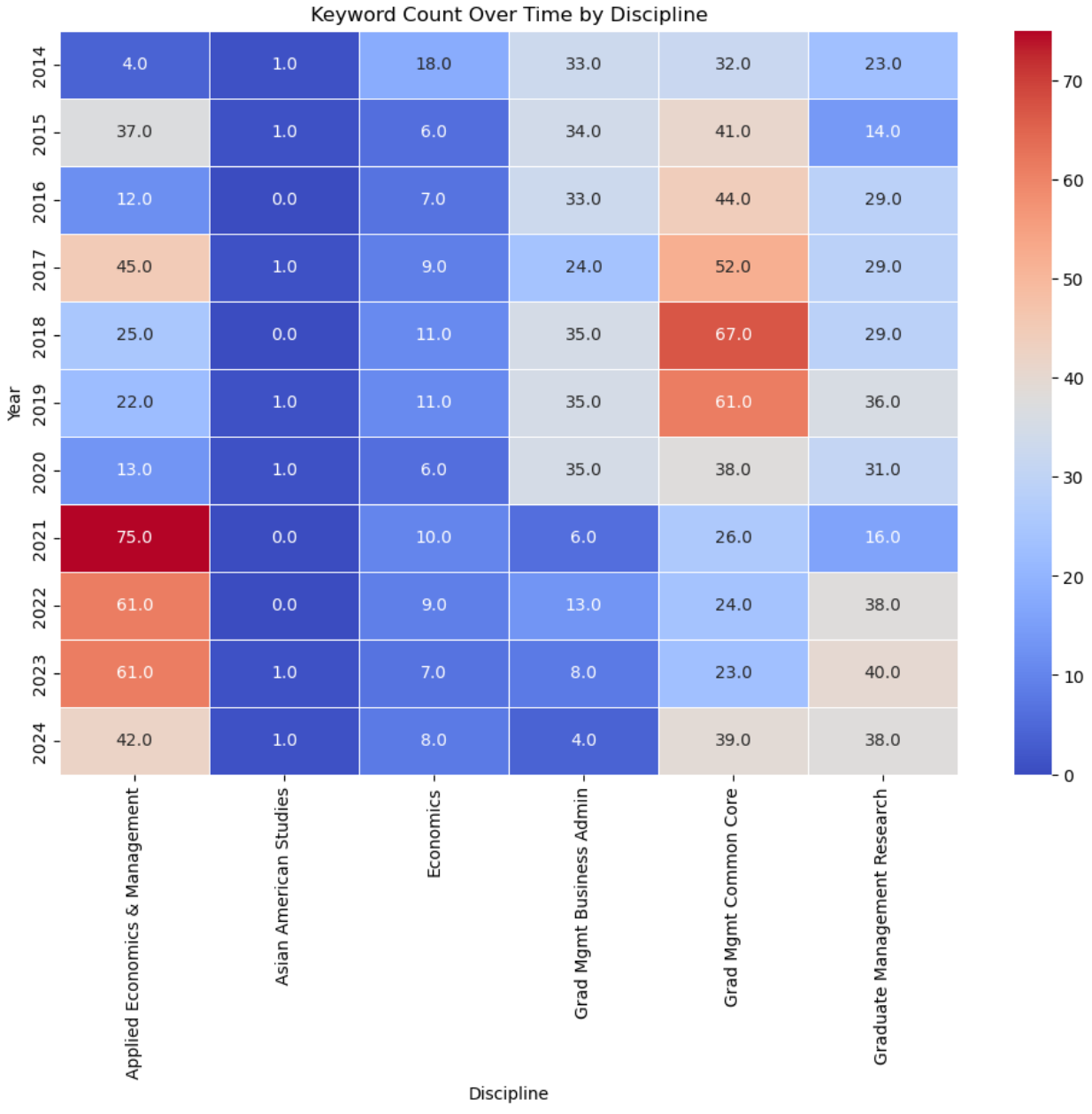
Heatmap for Keyword Count Over Time by Business Discipline

In [36]:

```
selected_subjects = ['AEM', 'ECON', 'NCC', 'NBA','NRE','AAS']

# Filter the DataFrame to include only selected disciplines
filtered_df = final_df_analyis_business[final_df_analyis_business['Subject'].isin(selected_subjects)]
# Pivot the filtered data to create a heatmap
heatmap_data = filtered_df.pivot_table(index='Year', columns='SubjectLongForm', values='KeyBERTBusiness',

# Create a heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(heatmap_data, cmap='coolwarm', annot=True, fmt='.1f', linewidths=0.5)
plt.title('Keyword Count Over Time by Discipline')
plt.xlabel('Discipline')
plt.ylabel('Year')
plt.show()
```

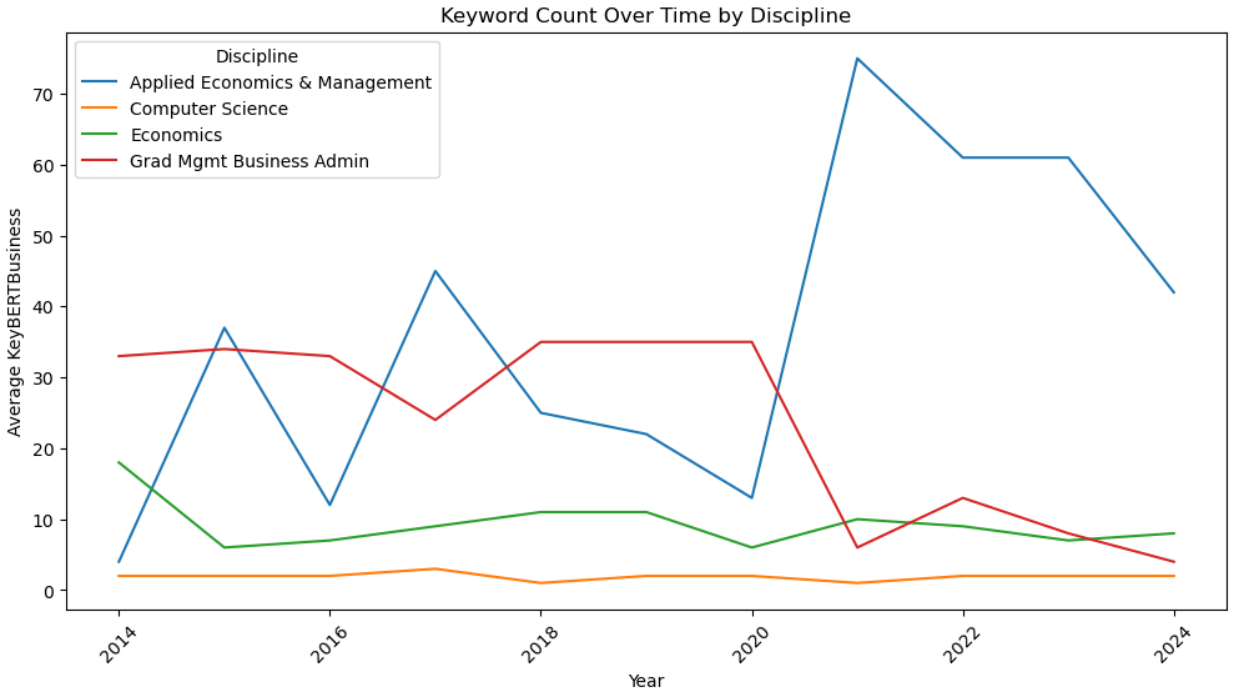


Line Graph for Business keywords count for Descipline over time

In [94]:
```
# List of specific disciplines you want to include
selected_disciplines = ['Computer Science','Applied Economics & Management','Economics','Grad Mgmt Busines

# Filter the DataFrame to include only specific disciplines
avg_counts_by_discipline = final_df_analyis_business[final_df_analyis_business['SubjectLongForm'].isin(sel

#Create a line graph
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTBusiness', hue='SubjectLongForm', data=avg_counts_by_discipline)
plt.title('Keyword Count Over Time by Discipline')
plt.xlabel('Year')
plt.ylabel('Average KeyBERTBusiness')
plt.xticks(rotation=45)
plt.legend(title='Discipline')
plt.show()
```



Line Graph for Business keywords count for Descipline over time (Added the NoOfClasses to get the actual analysis)

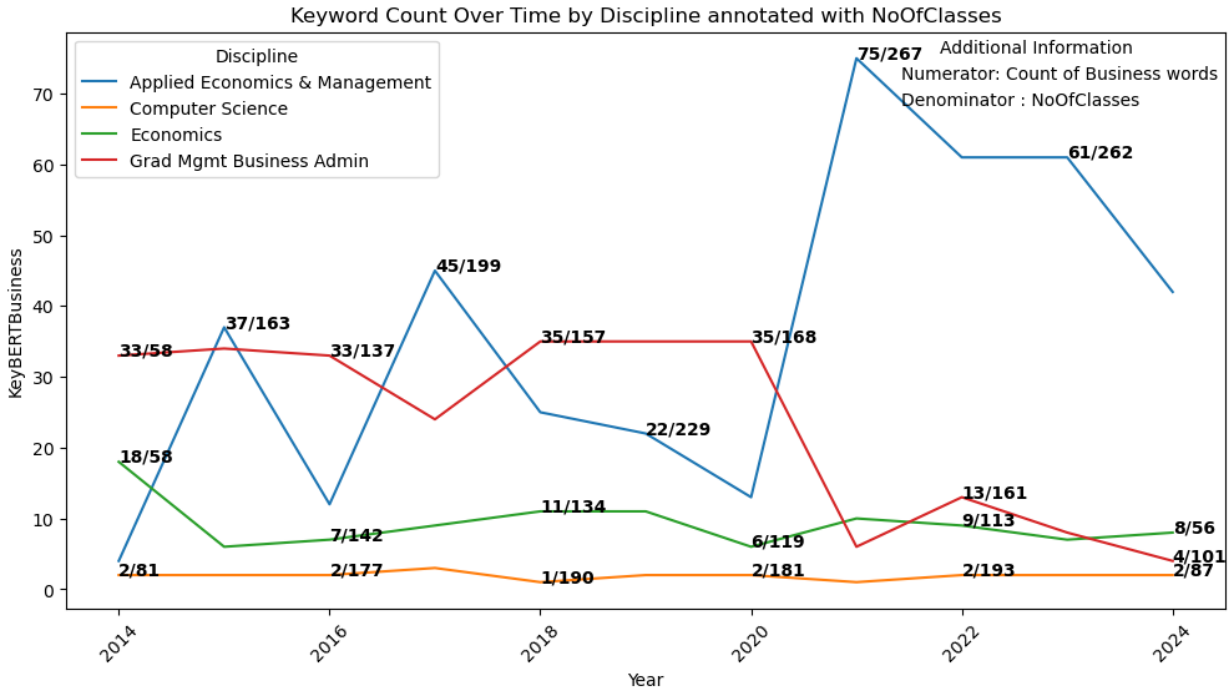
In [110]:
```
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTBusiness', hue='SubjectLongForm', data=avg_counts_by_discipline)

# Annotate points
for i, row in avg_counts_by_discipline.iterrows():
    if i%2==1:
        plt.text(row['Year'], row['KeyBERTBusiness'], f"{row['KeyBERTBusiness']}/{row['NoOfClasses']}", ho

plt.title('Keyword Count Over Time by Discipline annotated with NoOfClasses')
plt.xlabel('Year')
plt.ylabel('KeyBERTBusiness')
plt.xticks(rotation=45)
original_legend  = plt.legend(title='Discipline',loc='upper left')
# Create custom legend entries
custom_entry1 = mpatches.Patch(color='none', label='Numerator: Count of Business words')
custom_entry2 = mpatches.Patch(color='none', label='Denominator : NoOfClasses')

# Create custom legend
custom_legend = plt.legend(handles=[custom_entry1, custom_entry2],
                           loc='upper right',
                           title='Additional Information',
                           borderaxespad=0,
                           frameon=False)

# Add the custom legend to the plot
plt.gca().add_artist(original_legend)
plt.show()
```



Bubble Chart to analysize the 3 dimensions of Data

Dimension 1 : Group by Subject & Year

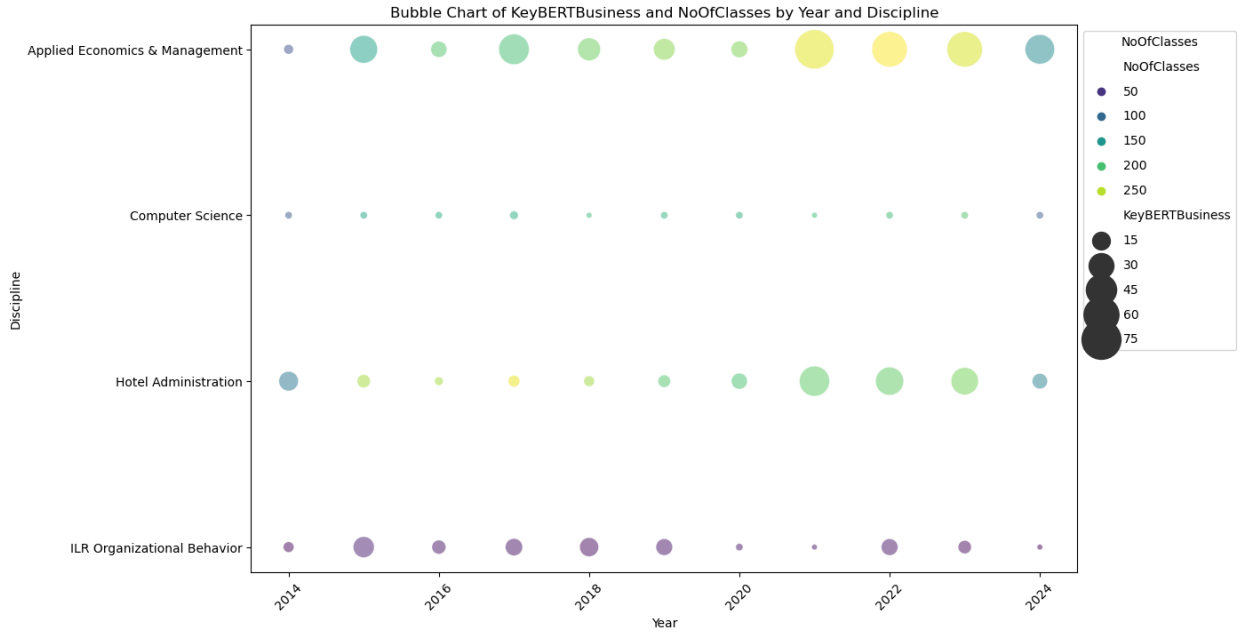
Dimension 2 : Count of Business related words (Size of Bubble)

Dimension 3 : No of Classes (Color of Bubble)

In [133]:
```
# Grouping and aggregating the data
bubble_data = avg_counts_by_discipline.groupby(['Year', 'SubjectLongForm']).agg({'KeyBERTBusiness': 'sum',

# Creating the bubble chart
plt.figure(figsize=(12, 8))
bubble_plot = sns.scatterplot(data=bubble_data, x='Year', y='SubjectLongForm', size='KeyBERTBusiness', hue

# Adding titles and labels
plt.title('Bubble Chart of KeyBERTBusiness and NoOfClasses by Year and Discipline')
plt.xlabel('Year')
plt.ylabel('Discipline')
plt.xticks(rotation=45)
bubble_plot.legend(title='NoOfClasses', labelspacing=1, bbox_to_anchor=(1, 1))
plt.show()
```



In [134]:
```
import pandas as pd
import ast
```

In [135]:
```
ethics_df = pd.read_csv('FinalBusiness.csv')
ethics_df['KeyBERTCount'] = ethics_df['KeyBERTCount'].apply(ast.literal_eval)
```

In [136]:
```
ethics_df.head()
```

Out[136]:

	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords	K
0	2020	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
1	2021	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
2	2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2	17	0	0.0	(
3	2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4	162	0	0.0	
4	2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13	605	0	0.0	[(

In [137]:
```
ethics_candidate_keywords = [
    "Ethical Sustainable Design", "Safety Risk Management", "Professional Responsibility",
    "Animal Research Ethics","Human Movement Analysis Ethics", "Robotics Ethics", "Prosthetics Ethics",
    "Research Data Management", "Research supervision", "Intellectual Property Rights", "Ethical Dilemma D
    "Doctor-Patient Relationship", "Clinical Trial Ethics", "Bioethics","Biomedicine","Patient Consent", "
    "Legal Professional Ethics", "Justice and Fairness in Law", "Client Confidentiality"
]
```

In [138]:
```
ethics_candidate_embeddings = get_batch_embeddings(ethics_candidate_keywords, tokenizer, model)
```

In [139]:
```
#Function calculates similarity usign Cosine similarity
def calculate_similarity_ethics(keywords):
    """
    Function to calculate the number of keywords that have a high similarity with a set of candidate embedd

    Args:
    keywords (list of tuples): A list where each tuple contains a keyword (str).


    Returns:
    int: The count of keywords whose embeddings have a cosine similarity of 0.85 or higher.

    """
    count=0
    for keyword in keywords:
        keyword_vec = get_word_embedding(keyword[0], tokenizer, model)
        for ethics_word_vec in ethics_candidate_embeddings:
            similarity = cosine_similarity(keyword_vec, ethics_word_vec)
            if similarity>=0.8:
                count+=1
    return count
```

In [140]:
```
countOfWordsEthics = ethics_df['KeyBERTCount'].apply(calculate_similarity_ethics)
```

In [142]:
```
ethics_df['KeyBERTEthics'] = countOfWordsEthics
```

In [143]:
```
ethics_df.to_csv('FinalEthics.csv', index=False)
```

Analysis for Ethics related words

In [154]:
```
final_df_analyis_ethics = pd.read_csv('FinalEthics.csv')
```

In [155]:
```
#Check whetherimported properly
final_df_analyis_ethics.head()
```

Out[155]:

	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords	K
0	2020	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
1	2021	AAP	Architecture, Art, and Plannin	EmptyString	1	1	0	0.0	
2	2023	AAP	Architecture, Art, and Plannin	topics tba create justice worlds examine struc...	2	17	0	0.0	
3	2014	AAS	Asian American Studies	introductory history chinese japanese asian in...	4	162	0	0.0	a ('a
4	2015	AAS	Asian American Studies	course examine historical contemporary issue a...	13	605	0	0.0	(

In [156]:
```
top5_keybert_ethics = final_df_analyis_ethics.sort_values('KeyBERTEthics', ascending=False).head(5)
```

In [157]:
```
top5_keybert_ethics.head()
```

Out[157]:

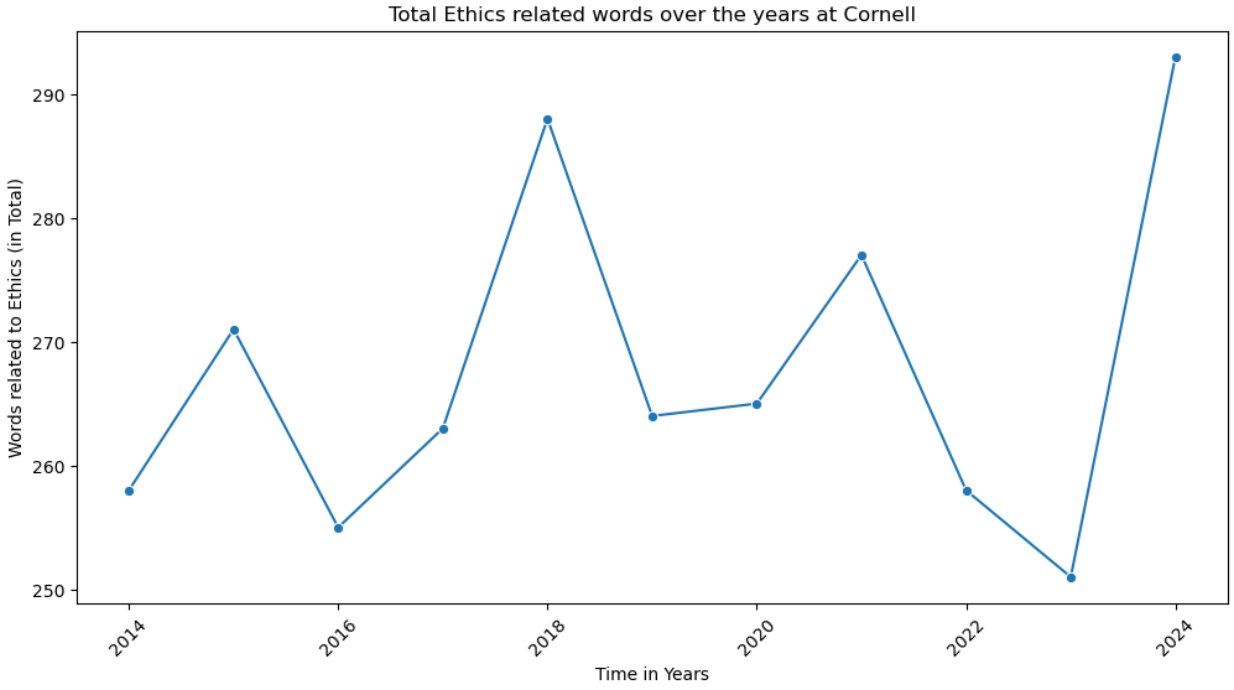
	Year	Subject	SubjectLongForm	Grouped_Subject_Description	NoOfClasses	TotalWords	businessCount	%OfBusinessWords
358	2016	BSOC	Biology & Society	today rapidly change world health medicine com...	27	1804	2	0.11
1731	2016	STS	Science & Technology Studies	woman minority student drop stem science techn...	63	3365	4	0.12
960	2015	ILROB	ILR Organizational Behavior	introductory survey course theory research ind...	29	1313	6	0.46
1730	2015	STS	Science & Technology Studies	woman minority student drop stem science techn...	66	3606	7	0.19
1309	2016	NCC	Grad Mgmt Common Core	introductory accounting course examine subject...	9	413	7	1.69

Line Chart: Total Ethics related words over the years at Cornell

In [158]:
```
# Group data by Year and calculate the total KeyBERTCountFinal
total_counts_over_time = final_df_analyis_ethics.groupby('Year')['KeyBERTEthics'].sum().reset_index()

# Create a line chart
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTEthics', data=total_counts_over_time, marker='o')
plt.title('Total Ethics related words over the years at Cornell')
plt.xlabel('Time in Years')

plt.ylabel('Words related to Ethics (in Total)')
plt.xticks(rotation=45)
plt.show()
```

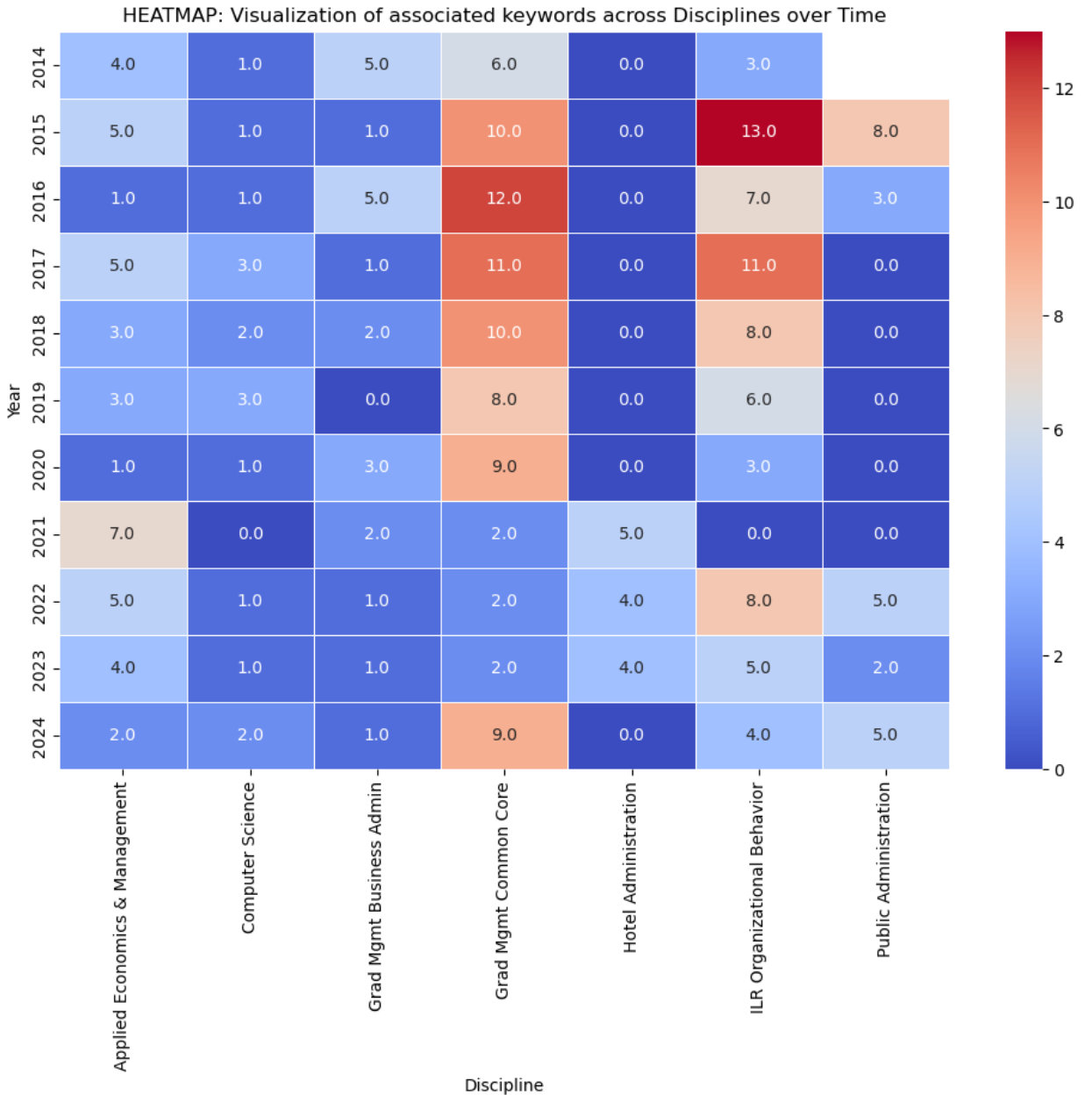


Visualization of associated keywords across Disciplines over Time

In [159]:
```
selected_subjects = ['AEM', 'NBA','NCC', 'HADM', 'PADM','ILROB','CS']

# Filter the DataFrame to include only selected disciplines
filtered_df = final_df_analyis_ethics[final_df_analyis_ethics['Subject'].isin(selected_subjects)]
# Pivot the filtered data to create a heatmap
heatmap_data = filtered_df.pivot_table(index='Year', columns='SubjectLongForm', values='KeyBERTEthics', ag

# Create a heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(heatmap_data, cmap='coolwarm', annot=True, fmt='.1f', linewidths=0.5)
plt.title('HEATMAP: Visualization of associated keywords across Disciplines over Time')
plt.xlabel('Discipline')
plt.ylabel('Year')
plt.show()
```

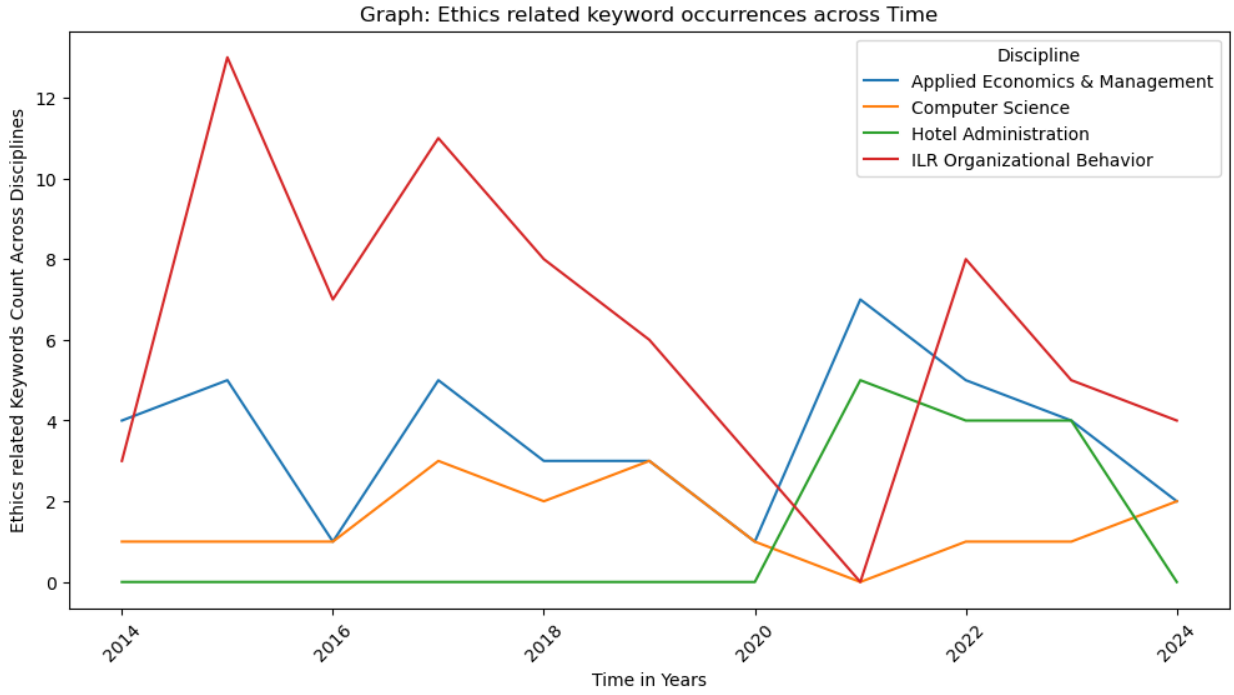


Line Graph for Ethics keywords count for Descipline over time

In [160]:
```
# List of specific disciplines you want to include
selected_disciplines = ['Hotel Administration',
                        'Applied Economics & Management','ILR Organizational Behavior',
                        'Computer Science']

# Filter the DataFrame to include only specific disciplines
avg_counts_by_discipline = final_df_analyis_ethics[final_df_analyis_ethics['SubjectLongForm'].isin(selecte

# Create a line graph
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTEthics', hue='SubjectLongForm', data=avg_counts_by_discipline)
plt.title('Graph: Ethics related keyword occurrences across Time')
plt.xlabel('Time in Years')
plt.ylabel('Ethics related Keywords Count Across Disciplines')
plt.xticks(rotation=45)
plt.legend(title='Discipline')
plt.show()
```



Line Graph for Ethics keywords count for Descipline over time (Added the NoOfClasses to get the actual analysis)

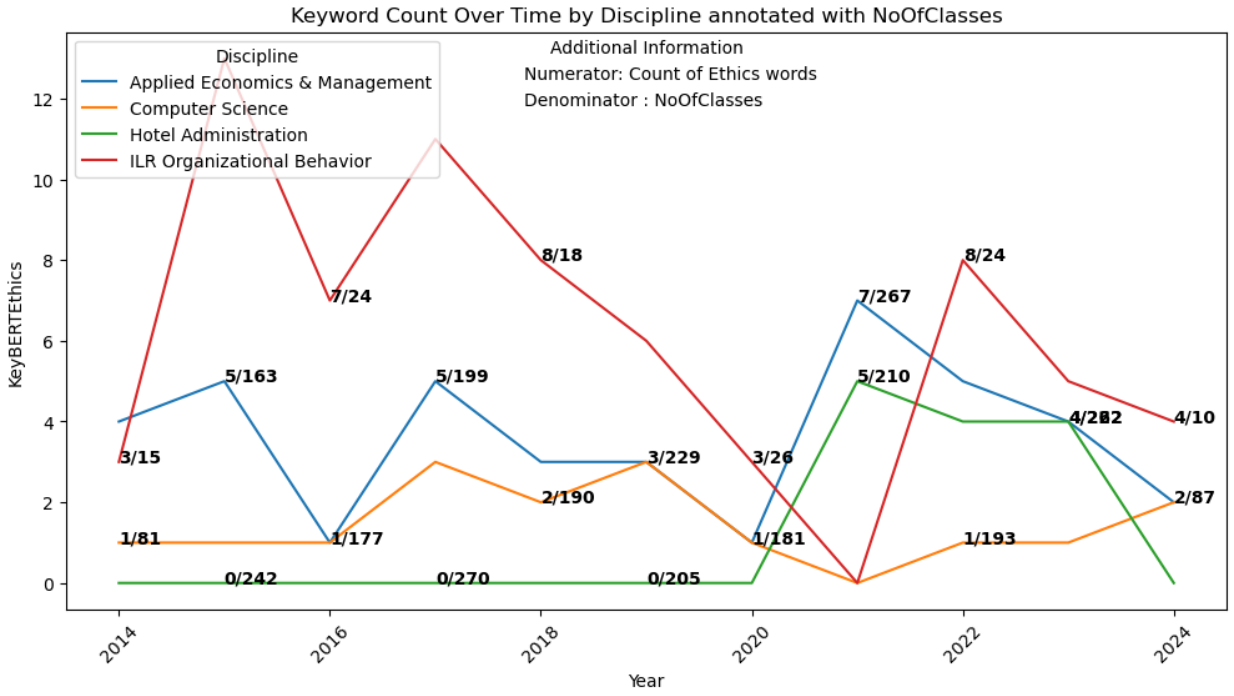
In [161]:
```
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
plt.figure(figsize=(12, 6))
sns.lineplot(x='Year', y='KeyBERTEthics', hue='SubjectLongForm', data=avg_counts_by_discipline)

# Annotate points
for i, row in avg_counts_by_discipline.iterrows():
    if i%2==1:
        plt.text(row['Year'], row['KeyBERTEthics'], f"{row['KeyBERTEthics']}/{row['NoOfClasses']}", horizo

plt.title('Keyword Count Over Time by Discipline annotated with NoOfClasses')
plt.xlabel('Year')
plt.ylabel('KeyBERTEthics')
plt.xticks(rotation=45)
original_legend  = plt.legend(title='Discipline',loc='upper left')
# Create custom legend entries
custom_entry1 = mpatches.Patch(color='none', label='Numerator: Count of Ethics words')
custom_entry2 = mpatches.Patch(color='none', label='Denominator : NoOfClasses')

# Create custom legend
custom_legend = plt.legend(handles=[custom_entry1, custom_entry2],
                           loc='upper center',
                           title='Additional Information',
                           borderaxespad=0,
                           frameon=False)

# Add the custom legend to the plot
plt.gca().add_artist(original_legend)
plt.show()
```



Bubble Chart to analysize the 3 dimensions of Data

Dimension 1 : Group by Subject & Year

Dimension 2 : Count of Ethics related words (Size of Bubble)

Dimension 3 : No of Classes (Color of Bubble)

In [162]:
```
# Grouping and aggregating the data
bubble_data = avg_counts_by_discipline.groupby(['Year', 'SubjectLongForm']).agg({'KeyBERTEthics': 'sum', '

# Creating the bubble chart
plt.figure(figsize=(12, 8))
bubble_plot = sns.scatterplot(data=bubble_data, x='Year', y='SubjectLongForm', size='KeyBERTEthics', hue='

# Adding titles and labels
plt.title('Bubble Chart of KeyBERTEthics and NoOfClasses by Year and Discipline')
plt.xlabel('Year')
plt.ylabel('Discipline')
plt.xticks(rotation=45)
bubble_plot.legend(title='NoOfClasses', labelspacing=1, bbox_to_anchor=(1, 1))
plt.show()
```

In [ ]: