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Technical Review
CS 410 - Text Information Systems
University of Illinois – UC

Gensim in Python – Features & Applications to the MIR Field

1. Introduction

The human language is the only known form of communication that uses composition, the use of nouns, verbs, and adjectives to express different meanings. If we were to construct a sentence consisting of a subject, verb, and object, with twenty-five different words for each, there would be over fifteen thousand different sentence possibilities. (2) For computers, this level of complexity creates a challenge. This field is referred to as natural language processing (NLP). NLP can be divided into several subtasks: part-of-speech tagging, syntactic parsing, semantic parsing, word sense disambiguation, summarization, sentiment analysis, and more.

2. Music Information Retrieval (MIR)

The field of music information retrieval deals with extracting information from music related databases. The many tasks covered under this term can be categorized under two branches, audio and text. This review will focus on natural language processing of text in MIR. NLP can be used to process music related text such as lyrics, artist biographies, social media, blogs, forums, and encyclopedias. Databases such as MusicBrainz, Discogs, Grove Music as well as the many websites hosting music related content are available for text music information retrieval. Although there are many tools available for NLP tasks that can be applied to the MIR field, we will discuss the Gensim library available through Python.

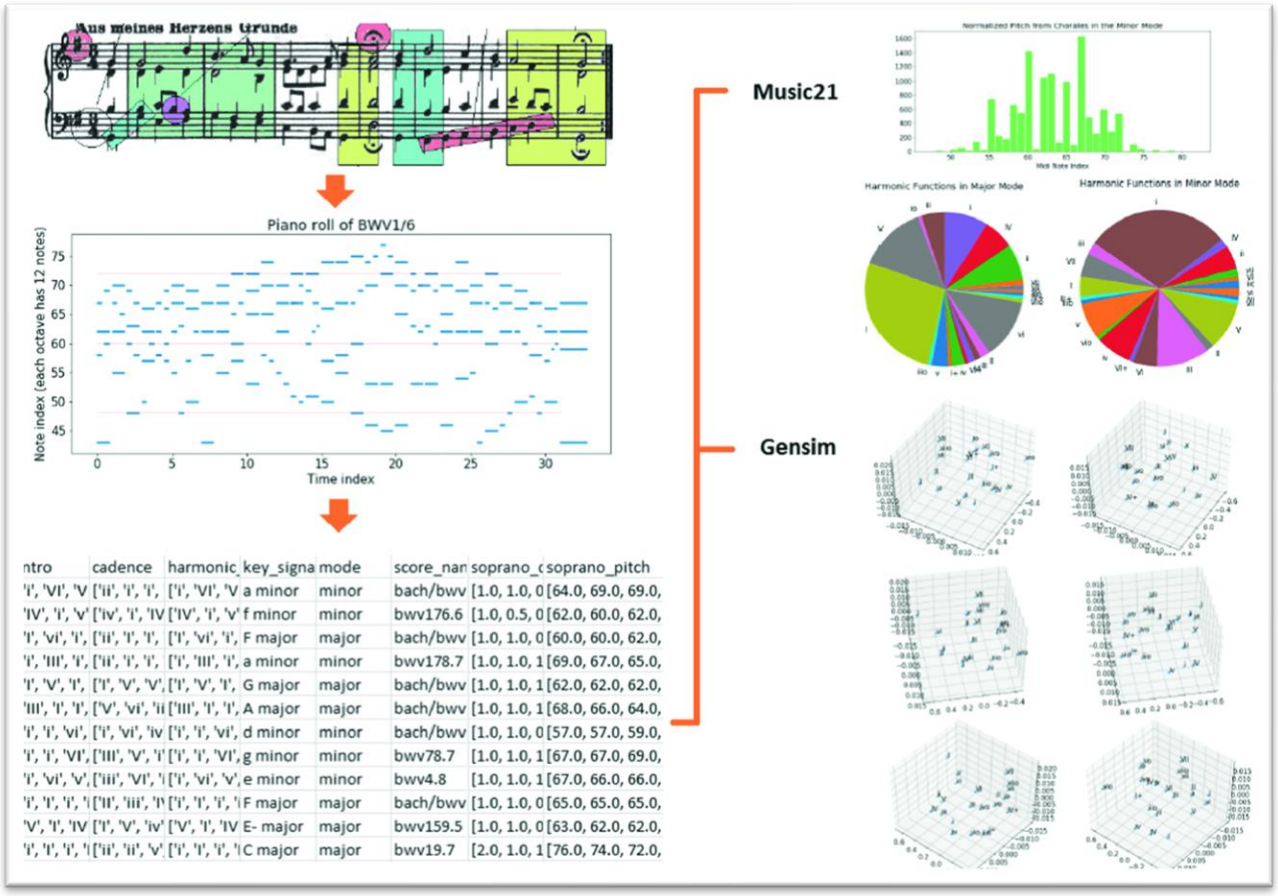
3. Gensim Library – Features

There are four core concepts that make up the Gensim toolkit: Document, Corpus, Vector, and Model. The corpus is a collection of documents, which are made up of text, or strings of characters. The models available in Gensim are well known vector space algorithms that have been proven to work in industry applications. These models can be trained by a corpus through data streaming. This provides a space efficient solution to large corpora for training and semantic analysis. Before this can occur, the text documents must be preprocessed. Gensim includes the built in tool *simple_preprocess(doc, deaccent, min_length, max_length)* for such purposes. Vectors can then be generated to represent each document mathematically so that the model can produce meaningful results. The key feature in these models is that they run unsupervised and as such do not require time consuming labeling of documents. The following table outlines built in models included in the Gensim toolkit and their brief explanations. (1)

Model Used in Gensim	Mechanism
Term Frequency/Inverse Document Frequency (Tf-Idf)	Utilizes the document's term frequency in a bag-of-words vector representation to adjust values based on very rare or very common frequencies (IDF). `models.TfidfModel(bow_corpus)`
Latent Semantic Indexing (LSI/LSA)	Begins with either a bag-of-words or TF-IDF representation and reduces the dimensionality by grouping words that commonly occur together. This uncovers meanings to words in a phrase which tend to have less ambiguity than if they were to be analyzed individually. `models.LsiModel(tfidf_corpus, id2word=dictionary, num_topics=300)`
Random Projections (RP)	Introduces randomness to the approximation of similarity between vectors representing documents. Due to its simplicity, this model is memory and CPU efficient in reducing dimensionality while preserving the approximate distance between vectors. `models.RpModel(tfidf_corpus, num_topics=500)`
Latent Dirichlet Allocation (LDA)	Used to discover topics covered in documents. Similar to LSA, LDA reduces the dimension of bag-of-words vectors and employs statistical methods to derive word and topic probabilities. `models.LdaModel(corpus, id2word=dictionary, num_topics=100)`
Hierarchical Dirichlet Process (HDP)	Clusters groups of words (lower dimensions) without the need for parameters. `models.HdpModel(corpus, id2word=dictionary)`
Custom Model Provided by user	Gensim AI allows the use of custom vector space model solutions, such as different weighting schemes.

4. Applications of Gensim in MIR

Music information is typically thought of as audio files, with corresponding lyrics, or artist information. This is certainly relevant to the field of MIR, however there is undiscovered information available through other sources. One example is the comments section of a music video hosted on YouTube. This can contain not only information on the receptiveness of a song, but also the user's response to that artist's appearance, fashion, dance style, and even recent public appearances or news. A web scraper can be used to collect the text from these sources, with a crawler updating the database as necessary. With Gensim, meaningful semantic analysis can be made to that person's overall popularity and be used in the management of the artist's public relations. Another use in the MIR field is for a musically relevant search engine. Dance moves popularized by a certain artist can be found through similar vector distances, such as the moon walk to Michael Jackson, and the superman to Soulja Boy. Songs with similar lyrical meanings or moods can be suggested to a user in a recommender system, as an add-on to a streaming service. Audio data can also be converted to a text form to utilize this tool as outlined in this image from *Exploring Music21 and Gensim for Music Data Analysis and Visualization*. (3)



ntro	cadence	harmonic	key_signa	mode	score_nan	soprano_(	soprano_pitch
'i', 'VI', 'V	['ii', 'i', 'i',	['i', 'VI', 'V	a minor	minor	bach/bwv	[1.0, 1.0, 0	[64.0, 69.0, 69.0,
'IV', 'i', 'v'	['iv', 'i', 'IV	['IV', 'i', 'v'	f minor	minor	bwv176.6	[1.0, 0.5, 0	[62.0, 60.0, 62.0,
'i', 'vi', 'i',	['ii', 'i', 'i',	['i', 'vi', 'i',	F major	major	bach/bwv	[1.0, 1.0, 0	[60.0, 60.0, 62.0,
'i', 'III', 'i',	['ii', 'i', 'i',	['i', 'III', 'i',	a minor	minor	bwv178.7	[1.0, 1.0, 1	[69.0, 67.0, 65.0,
'i', 'V', 'i',	['i', 'V', 'V',	['i', 'V', 'i',	G major	major	bach/bwv	[1.0, 1.0, 1	[62.0, 62.0, 62.0,
'III', 'i', 'i',	['V', 'vi', 'ii	['III', 'i', 'i',	A major	major	bach/bwv	[1.0, 1.0, 1	[68.0, 66.0, 64.0,
'i', 'i', 'vi',	['i', 'vi', 'iv	['i', 'i', 'vi',	d minor	minor	bach/bwv	[1.0, 1.0, 0	[57.0, 57.0, 59.0,
'i', 'i', 'VI',	['III', 'V', 'i'	['i', 'i', 'VI',	g minor	minor	bwv78.7	[1.0, 1.0, 1	[67.0, 67.0, 69.0,
'i', 'vi', 'v',	['iii', 'VI', 'i	['i', 'vi', 'v',	e minor	minor	bwv4.8	[1.0, 1.0, 1	[67.0, 66.0, 66.0,
'i', 'i', 'i', 'i	['II', 'iii', 'I	['i', 'i', 'i', 'i	F major	major	bach/bwv	[1.0, 1.0, 0	[65.0, 65.0, 65.0,
'V', 'i', 'IV	['i', 'V', 'iv'	['V', 'i', 'IV	E- major	major	bwv159.5	[1.0, 1.0, 0	[63.0, 62.0, 62.0,
'i', 'i', 'i', 'i	['ii', 'ii', 'v'	['i', 'i', 'i', 'i	C major	major	bwv19.7	[2.0, 1.0, 1	[76.0, 74.0, 72.0,

5. Conclusion

There have been many advances in the field of natural language processing and semantic analysis. Some advances are the development of algorithms that utilize the vector space model representation of documents. Such algorithms can be powerful tools to extract meaningful data from not only text, but particularly lyrics, artist biographies, music webpages, and social media accounts of users participating in music related discussions. The Gensim Python library provides a simple channel to train these preloaded algorithms to process MIR specific data in a memory and CPU efficient way, while still allowing for customization.

References

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