

BACHELOR THESIS

Application of sentiment analysis on music recommendation

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Motivation

Artists, Genres...

Experimental
Avant-garde Alternative post-rock
Classical World Math rock
House Punk Country Metal Shoegaze
Grime Indie Folk Hip-hop R&B
Dubstep Blues Rock Jazz Latin
Post-punk Reggae Pop Rap Soul Dream pop
K-pop Electronic Funk New Age
Emo Reggaeton Gospel Techno
Trance Ambient
Drum and Bass



Emotions



Introduction: Recommender systems

General

- Collaborative filtering
- Content-based
- Non-personalized

Context-aware

- Context (time, location...)
- Content-based

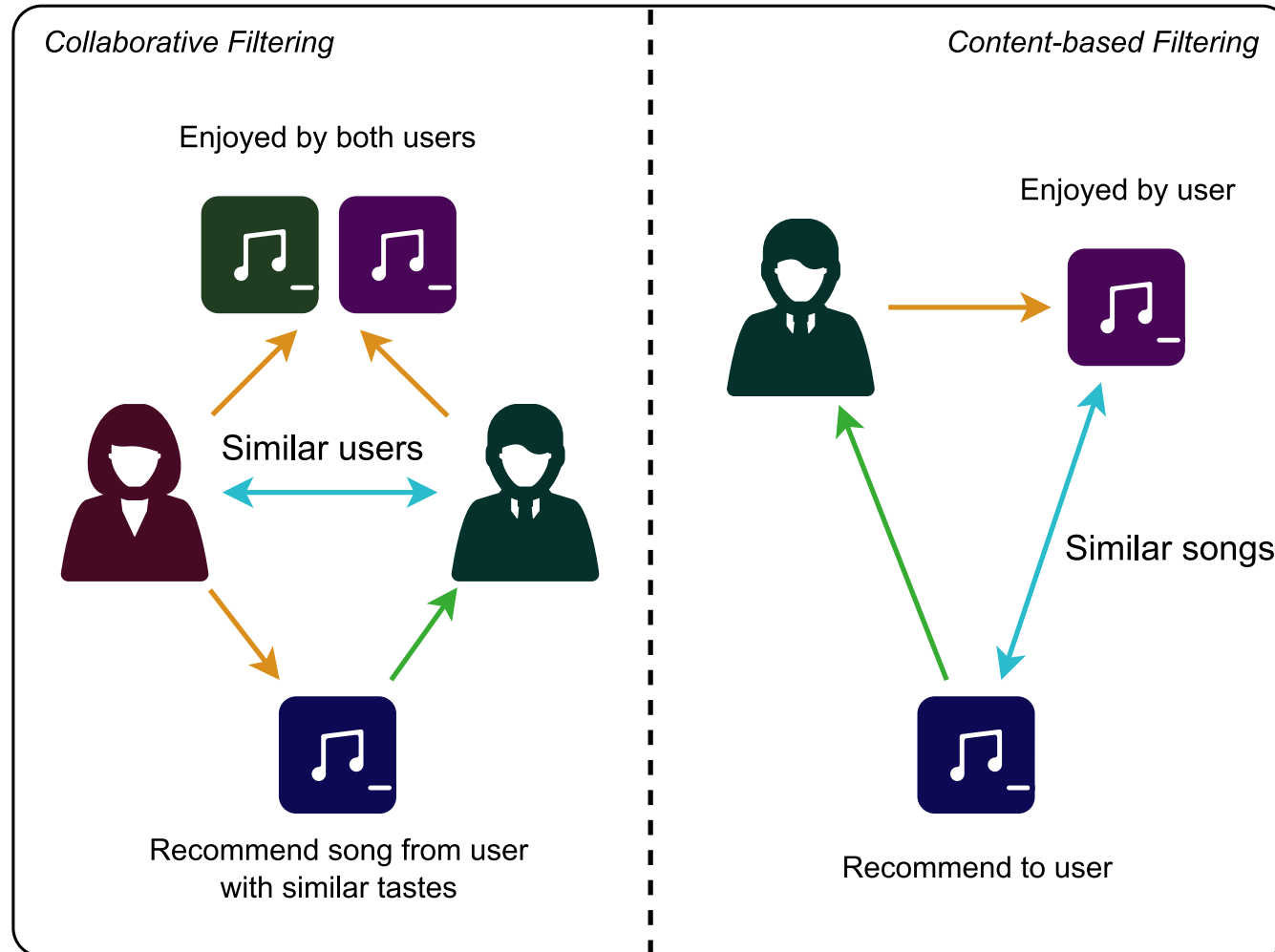
Sequential

- Temporal order of actions
- Next-item recommendation

Knowledge-based

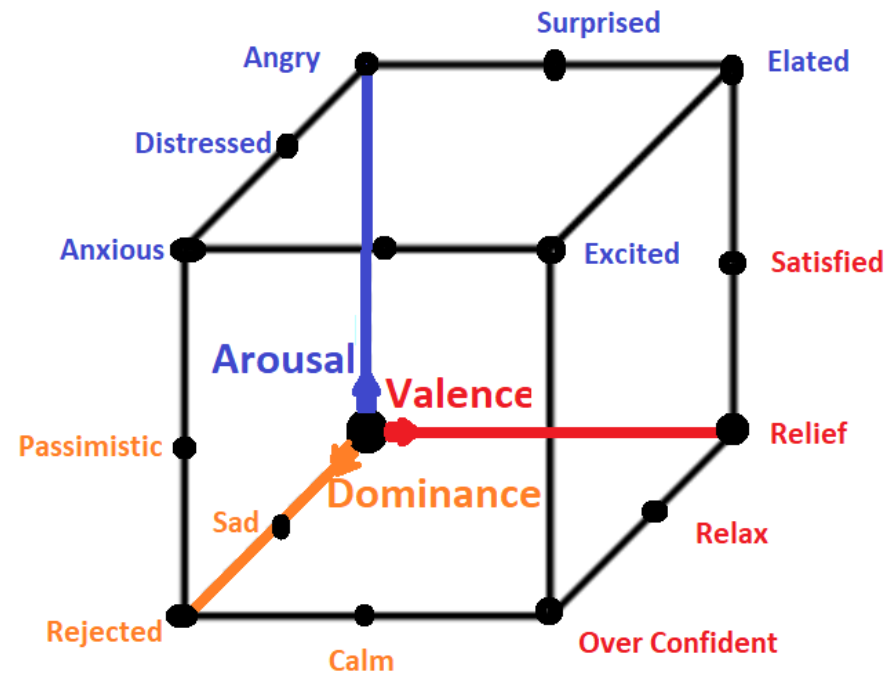
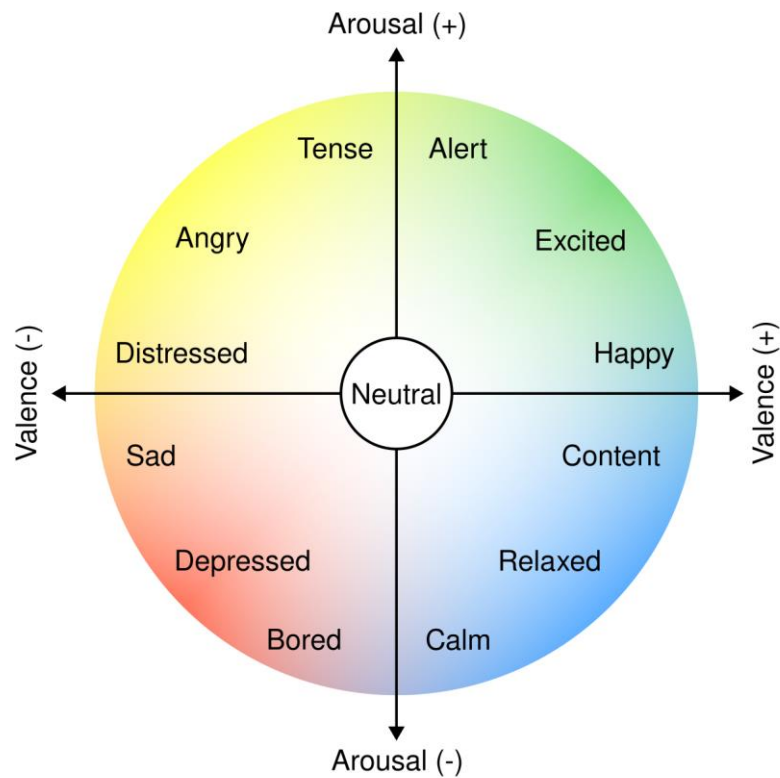
- Knowledge graphs
- Semantic networks

Introduction: Music recommendation

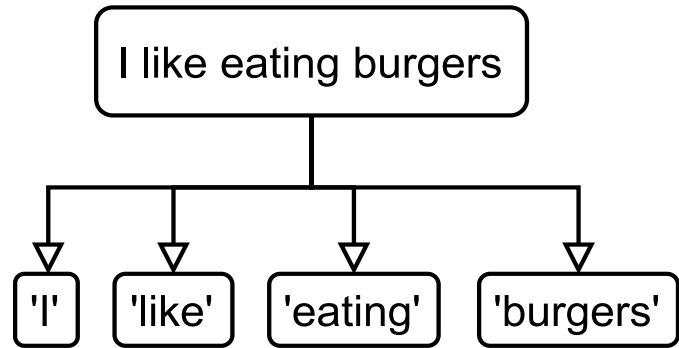


Introduction: Sentiment analysis

- Models based on Valence / Arousal / Dominance.



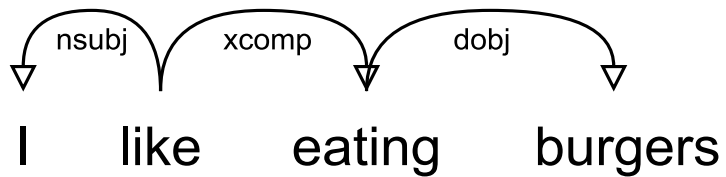
Introduction: Text processing



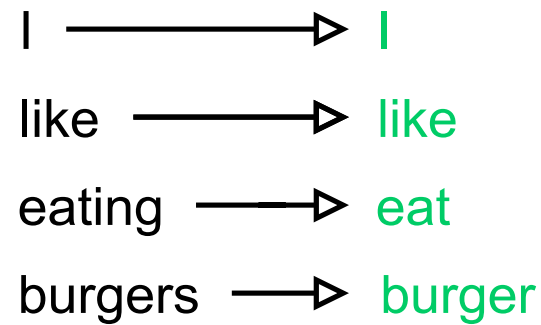
Tokenization



Part-of-speech Tagging

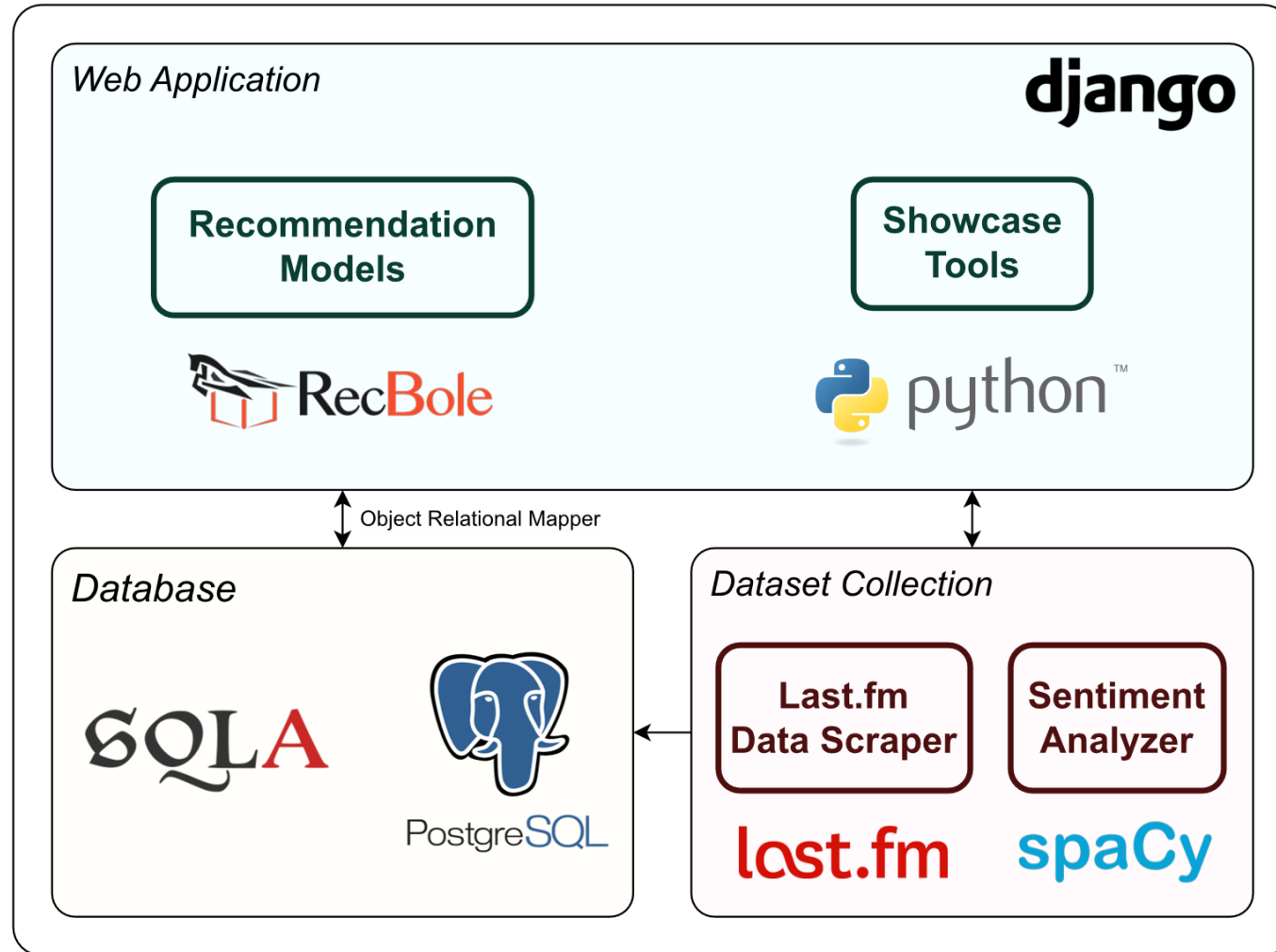


Dependency Parsing

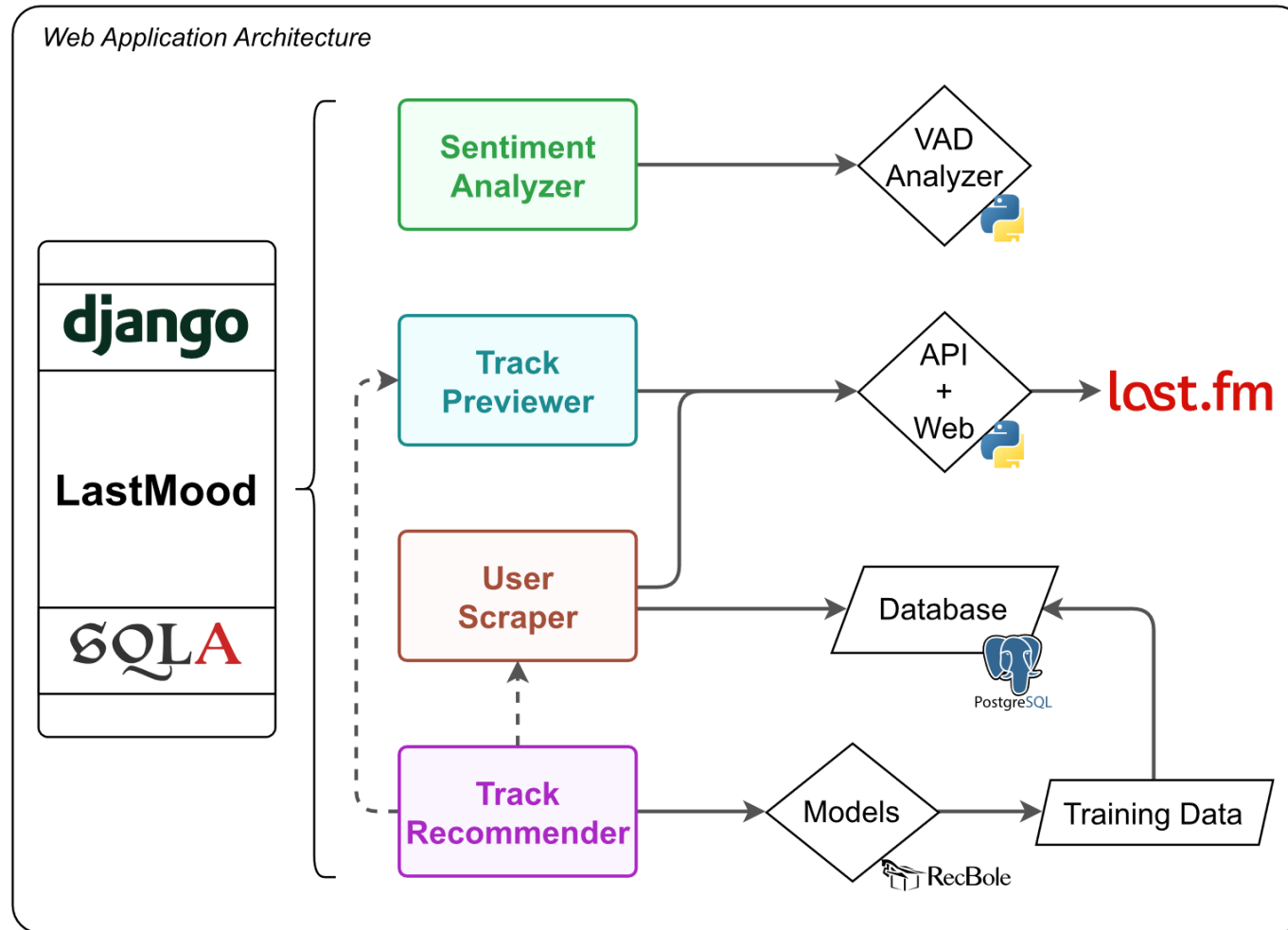


Lemmatization

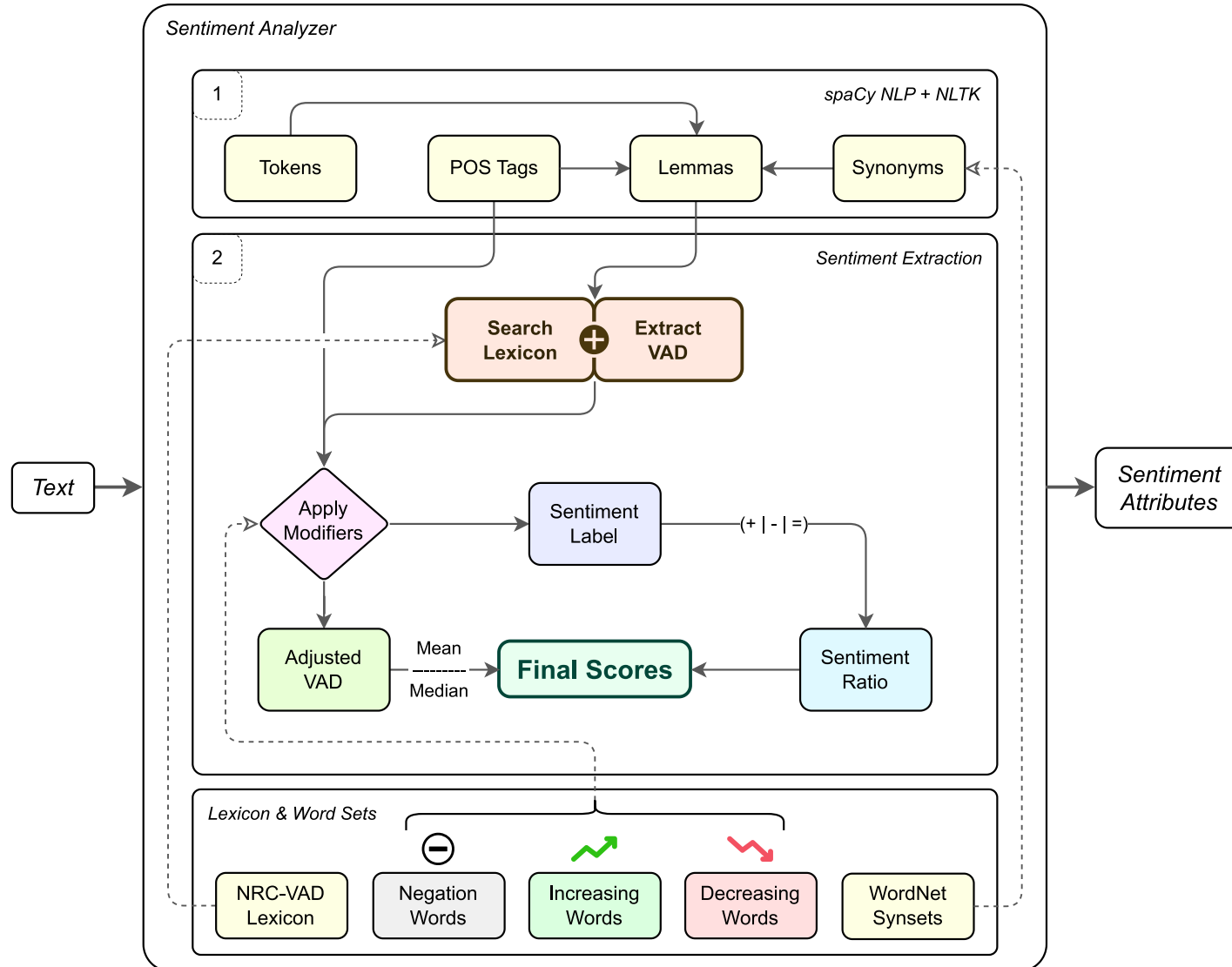
Project structure



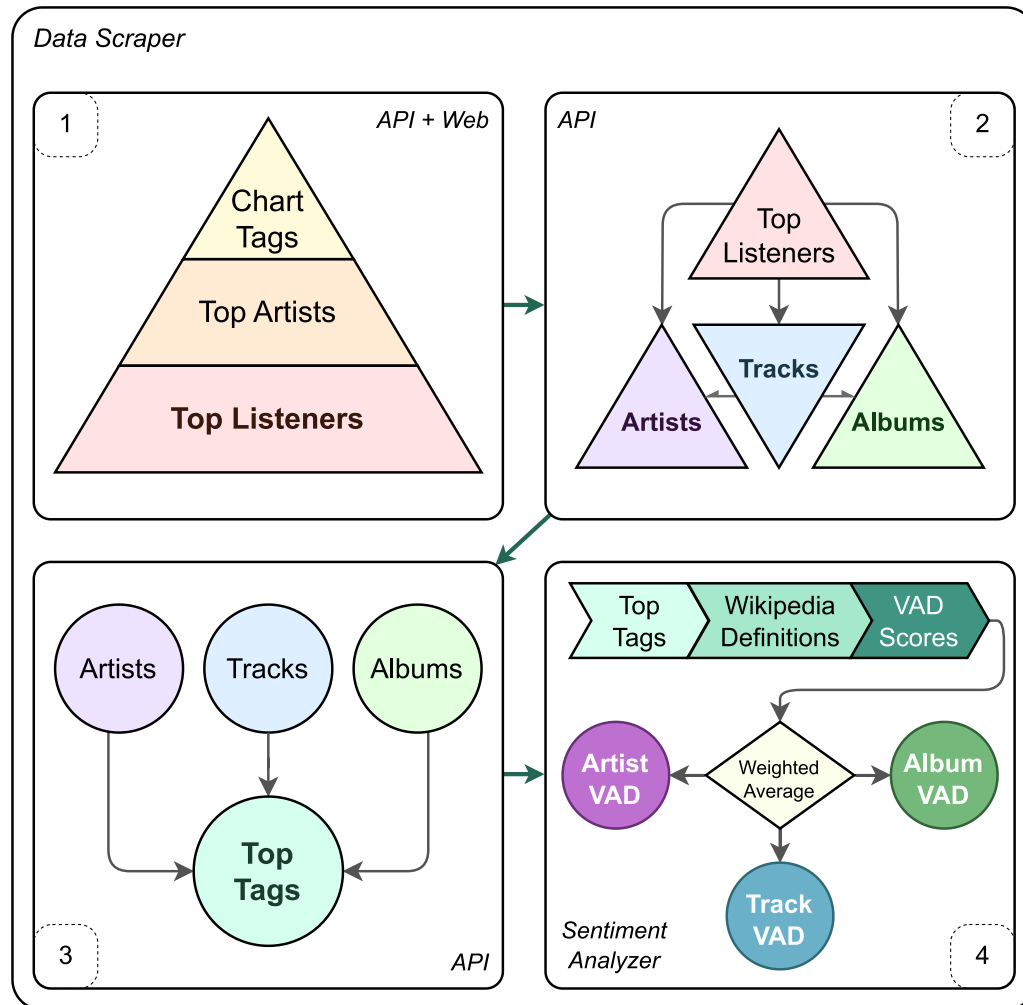
Web Application



Sentiment Analyzer



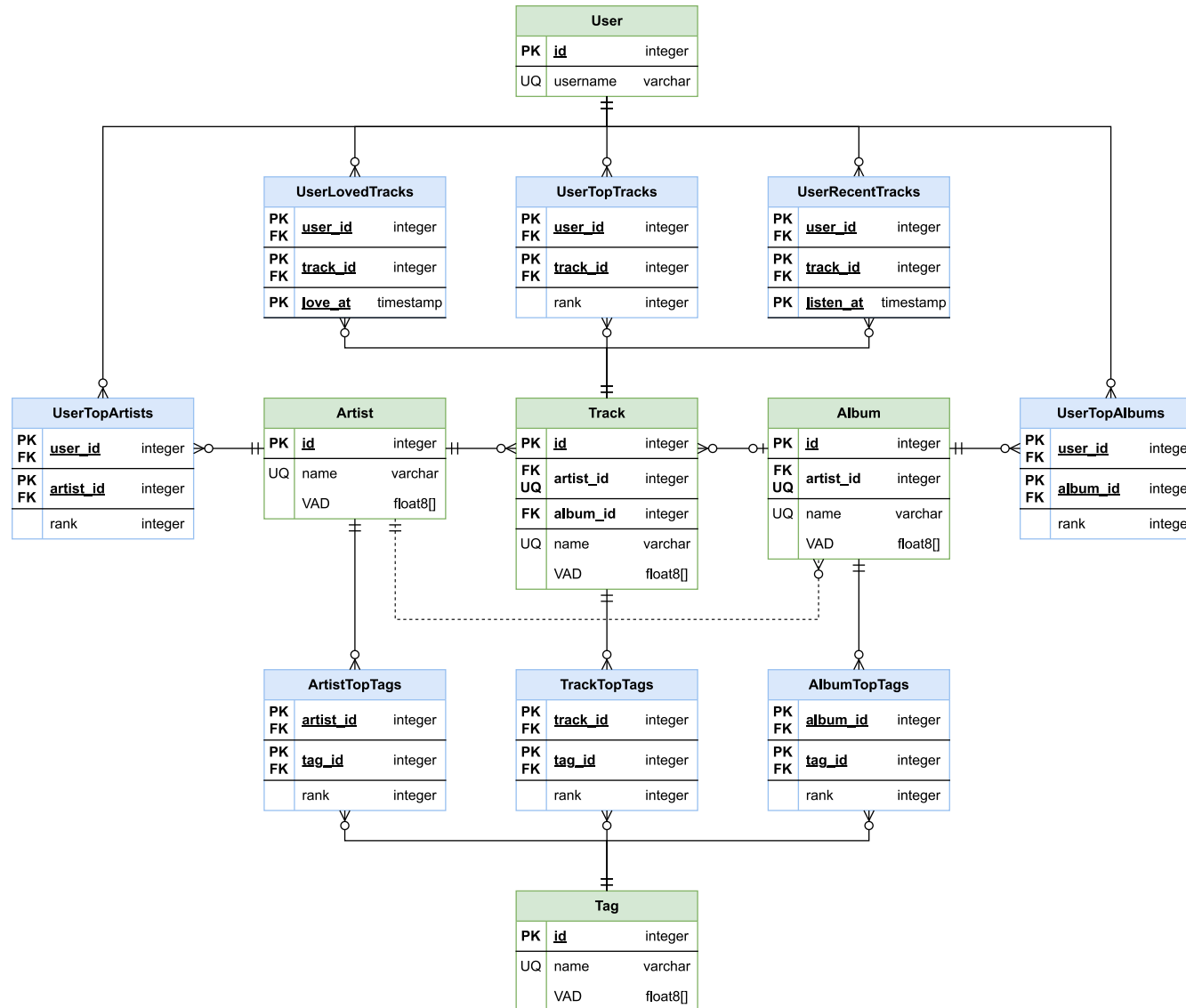
Data Scraper



1. Listeners
2. Items
3. Tags
4. Sentiment Values

- Sparsity?
- Objectivity?

Database



Web Application: Sentiment Analyzer

LastMood

< Text Sentiment Analysis Results	
Home	
Track Previewer	
Text VAD Analyzer	
User Scraper	
Recommendations	
Login	
Register	

Sentence ID	Sentence	Valence	Sentiment Label
0	I really like eating burgers.	0.8908333333333333	positive
1	I don't like eating burgers.	0.2873333333333334	negative
2	I don't really hate burgers.	0.394625	negative

lost.fm



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Sentiment Ratio	Arousal	Dominance	# Words Found	Found Words	All Words
1.0	0.4736666666666666	0.436	3 out of 3	['inc-like', 'inc-eat', 'inc-burger']	['like', 'eat', 'burger']
-1.0	0.5263333333333334	0.5640000000000001	3 out of 3	['neg-like', 'neg-eat', 'neg-burger']	['like', 'eat', 'burger']
0.0	0.685	0.41400000000000003	2 out of 2	['dec-hate', 'dec-burger']	['hate', 'burger']

Web Application: Track Previewer

LastMood

<

Home

Track Previewer

Text VAD Analyzer

User Scraper

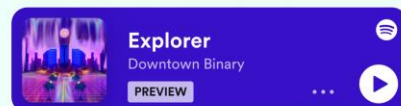
Recommendations

Login

Register

Explorer

By [Downtown Binary](#)



Web Application: User Scraper

LastMood

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de Madrid

- <
- Home
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- Register

Last.FM Data from Random User

Random User's Tracks

Top Tracks

Title	Artist	Album	Tags
Kill This Love	BLACKPINK		kpop, k-pop, trap, pop, electropop
Hollow Crown	Ellie Goulding	For the Throne (Music Inspired by the HBO Series Game of Thrones)	pop, trap, personal favourites, game of thrones, ellie goulding

No loved tracks retrieved

Recent Tracks

Title	Artist	Album	Listened at	Tags
Love Me Like You Do - From "Fifty Shades of Grey"	Ellie Goulding	Love Me Like You Do (From "Fifty Shades of Grey")	Fri, 11 Nov 2022 15:04:09 GMT	love, party, fav888, feelings, 2015
I'll Hold My Breath	Ellie Goulding	Bright Lights	Fri, 11 Nov 2022 15:08:32 GMT	pop, electronic, female vocalists, british, synth pop

Random User's Top Artists



Name	Tags
Ellie Goulding	female vocalists, electronic, british, indie, indie pop
BLACKPINK	k-pop, kpop, pop, korean, blackpink

Random User's Top Albums

Title	Artist	Tags
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Web Application: Recommender

LastMood

lost.fm  

Recommendations for **Random User** by DCN V2 Recommender

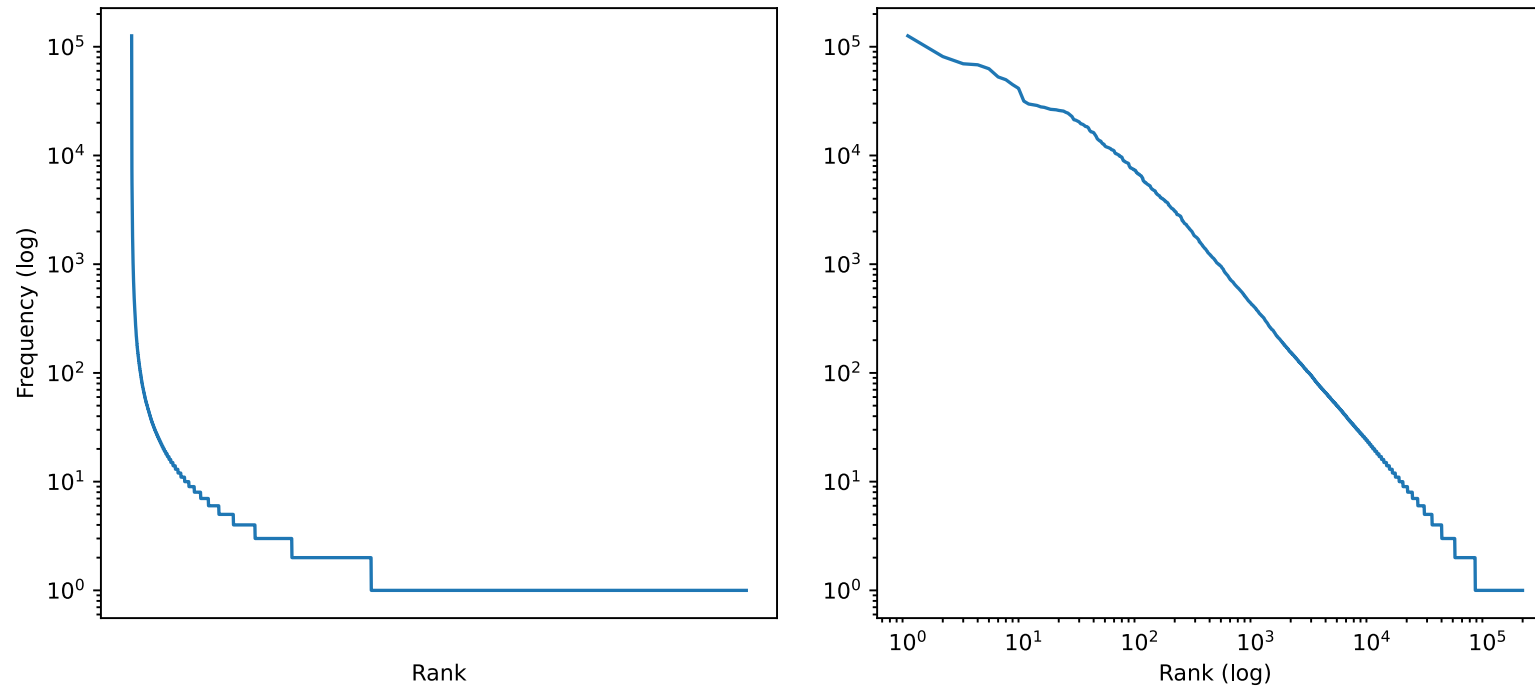
- Home
- Track Previewer
- Text VAD Analyzer
- User Scraper
- Recommendations
- Login
- Register

Glimpse of Us Joji <i>Glimpse of Us</i> Rank 1 Listened by 614 users <i>ballad, pop, piano, adult contemporary...</i> <a>Preview <a>View details	あの夢をなぞって YOASOBI Rank 2 Listened by 60 users <i>No tags</i> <a>Preview <a>View details	Jigsaw Puzzle mafumafu Rank 3 Listened by 2 users <i>j-rock</i> <a>Preview <a>View details	Dramaturgy Eve <i>Bunka</i> Rank 4 Listened by 49 users <i>japanese, j-pop</i> <a>Preview <a>View details	Vita HiiragiKirai <i>VITA</i> Rank 5 Listened by 1 user <i>No tags</i> <a>Preview <a>View details
Nonsense Bungaku Eve <i>Nonsense Bungaku</i> Rank 6 Listened by 15 users <i>japanese</i> <a>Preview <a>View details	Lost Nito <i>Until the End - EP</i> Rank 7 Listened by 5 users <i>No tags</i> <a>Preview <a>View details	SHINOBI-NAI - 雫カリウタ ver. Polkadot Stingray <i>踊る様に</i> Rank 8 Listened by 2 users <i>No tags</i> <a>Preview <a>View details	Shinkai Eve <i>Kaikai Kitan / Ao No Waltz</i> Rank 9 Listened by 17 users <i>japanese</i> <a>Preview <a>View details	Romance YOASOBI Rank 10 Listened by 33 users <i>No tags</i> <a>Preview <a>View details

Previous **1** 2 3 4 5 Next

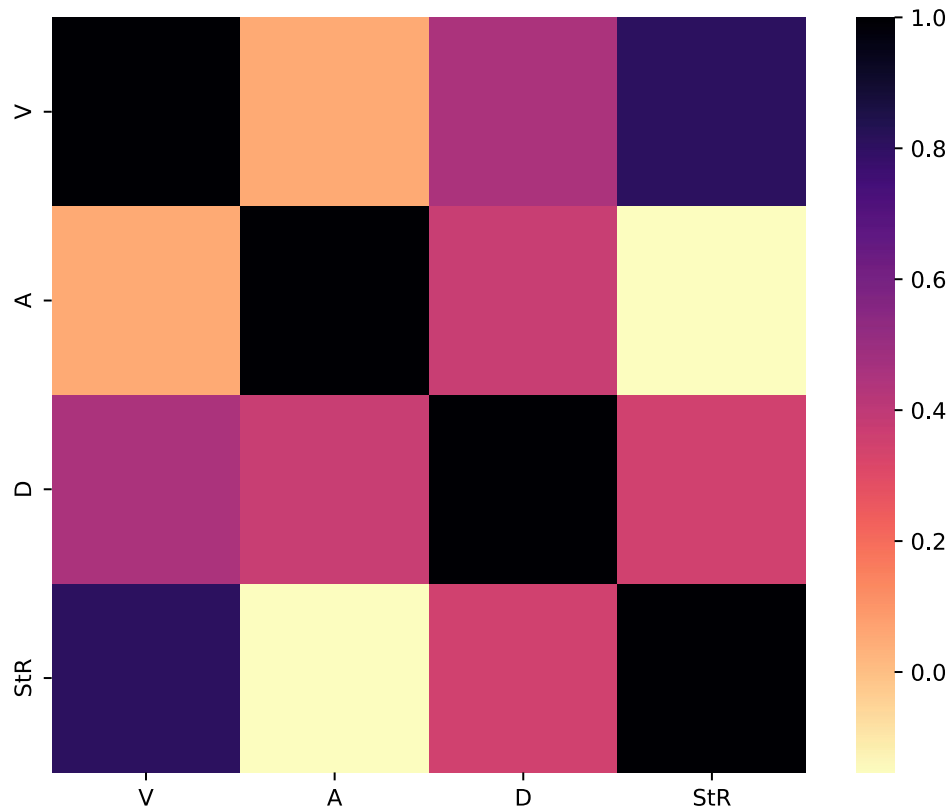
Data analysis: Tag frequency

Last.fm Tag Frequency



- Zipf's Law
- Individual tag sparsity

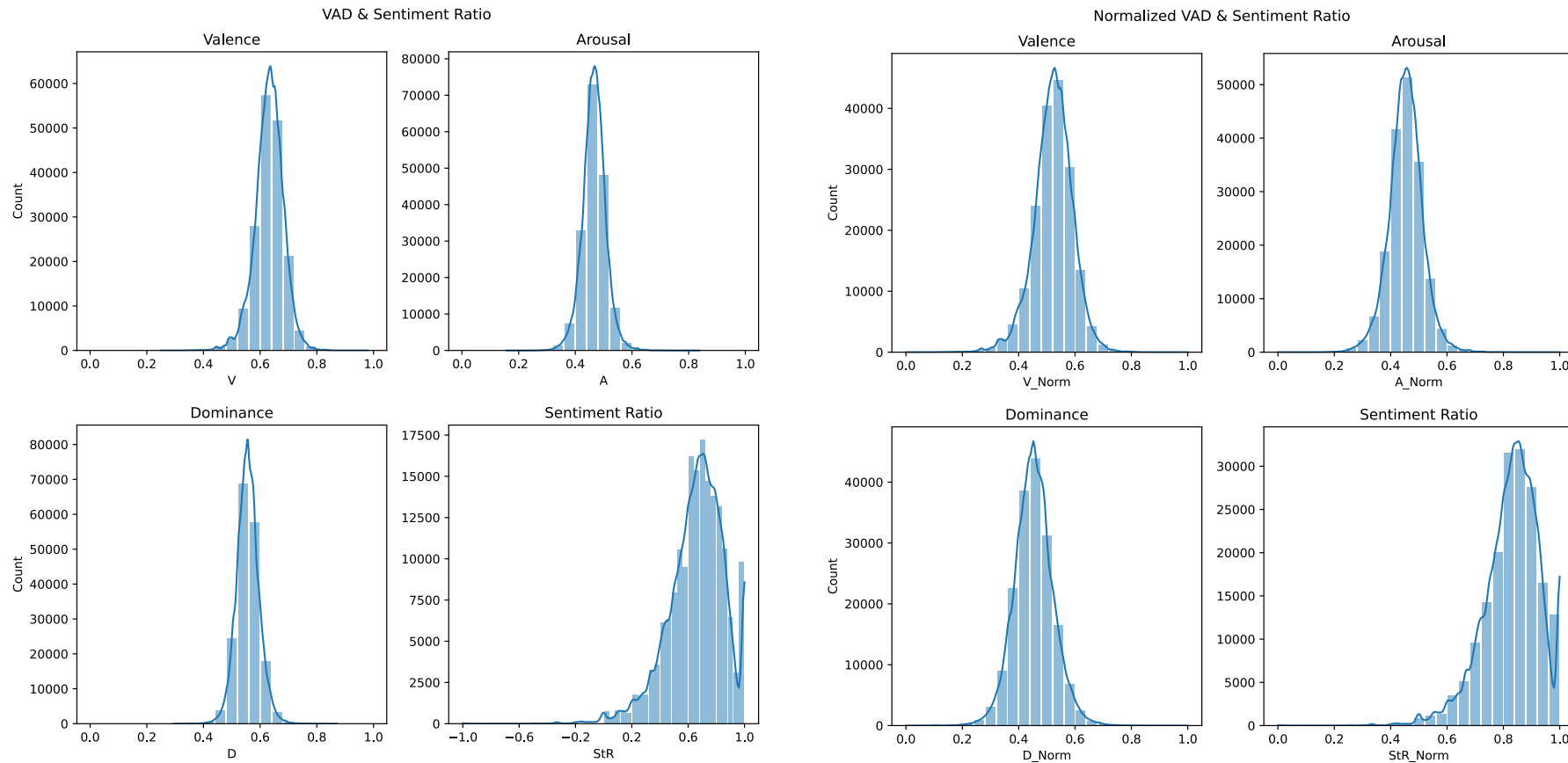
Data analysis: Sentiment correlations



- Valence-Arousal
- St. Ratio-Arousal
- Valence-Dominance
- Arousal-Dominance
- St. Ratio-Dominance
- St. Ratio-Valence

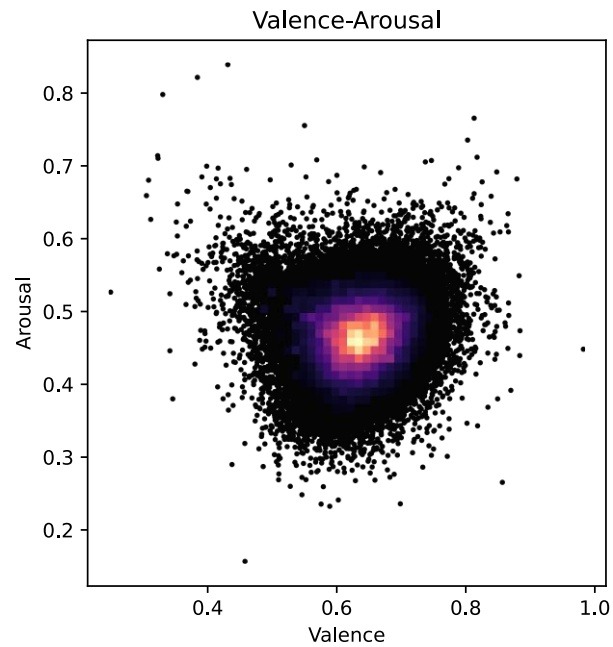
V: Valence A: Arousal D: Dominance StR: Sentiment Ratio

Data analysis: Sentiment distributions

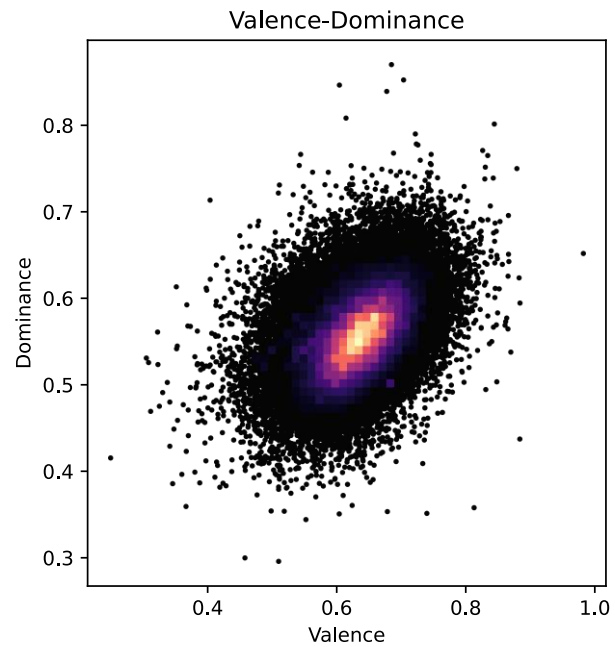


- Narrowly ranged values -> Normalization

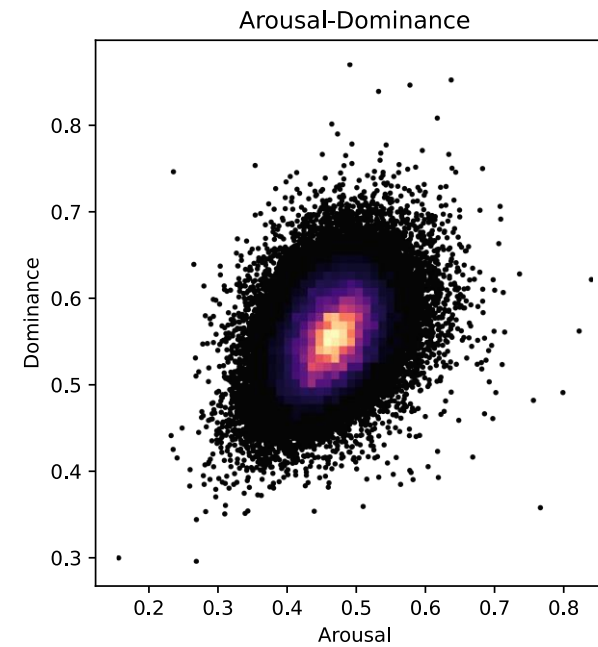
Data analysis: Sentiment distributions



V-shaped



Linear



Linear
Steeper

Testing: Environment

Component	Specifications
CPU	AMD Ryzen 5 5600X
GPU	NVIDIA RTX 3060 Ti 8 GB VRAM
RAM	32 GB
O.S.	Windows 11
Python Environment	Python 3.9.16 (conda)

- Parallel work in separate environment

Testing: Data

- Preprocessing
- Feature selection
- Feature integration
- Testing subset




Testing: Recommendation libraries

surprise

- 👍 Ease of use
- 👍 Dataset adaptability
- 👎 Limited models
- 👎 Documentation & customization

RecBole

- 👍 Many models
 - 👍 Documentation & customization
 - 👍 Optimal (GPU)
 - 👍 Configuration with files
 - 👎 Learning curve
- 

Cornac

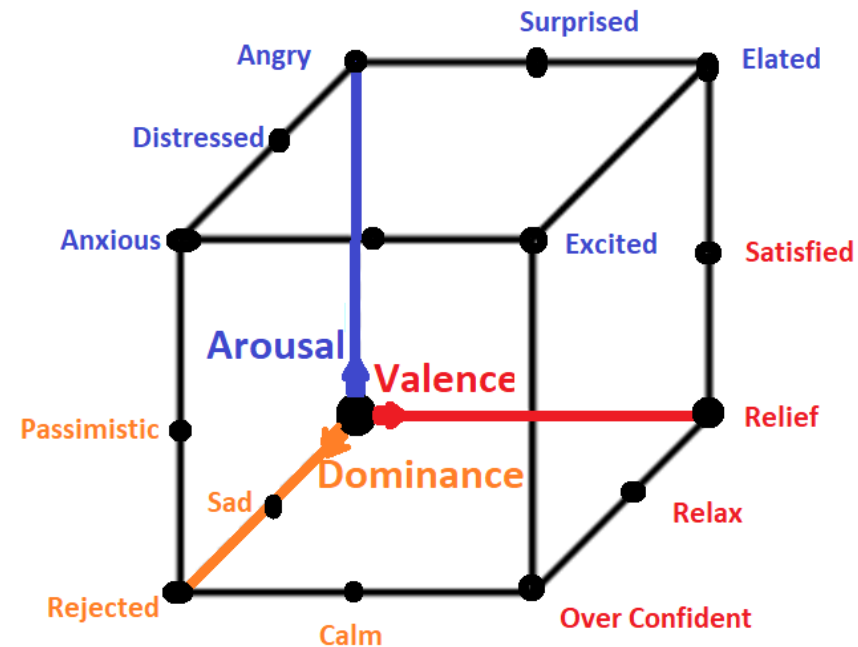
- 👍 Many models
- 👍 Documentation & customization
- 👎 Outdated

Testing: Models

Name	Type
Random	General
CosineSimilarity	General (Content-based)
Pop	General
ItemKNN	General
PNN	Context-aware
xDeepFM	Context-aware
DCN V2	Context-aware

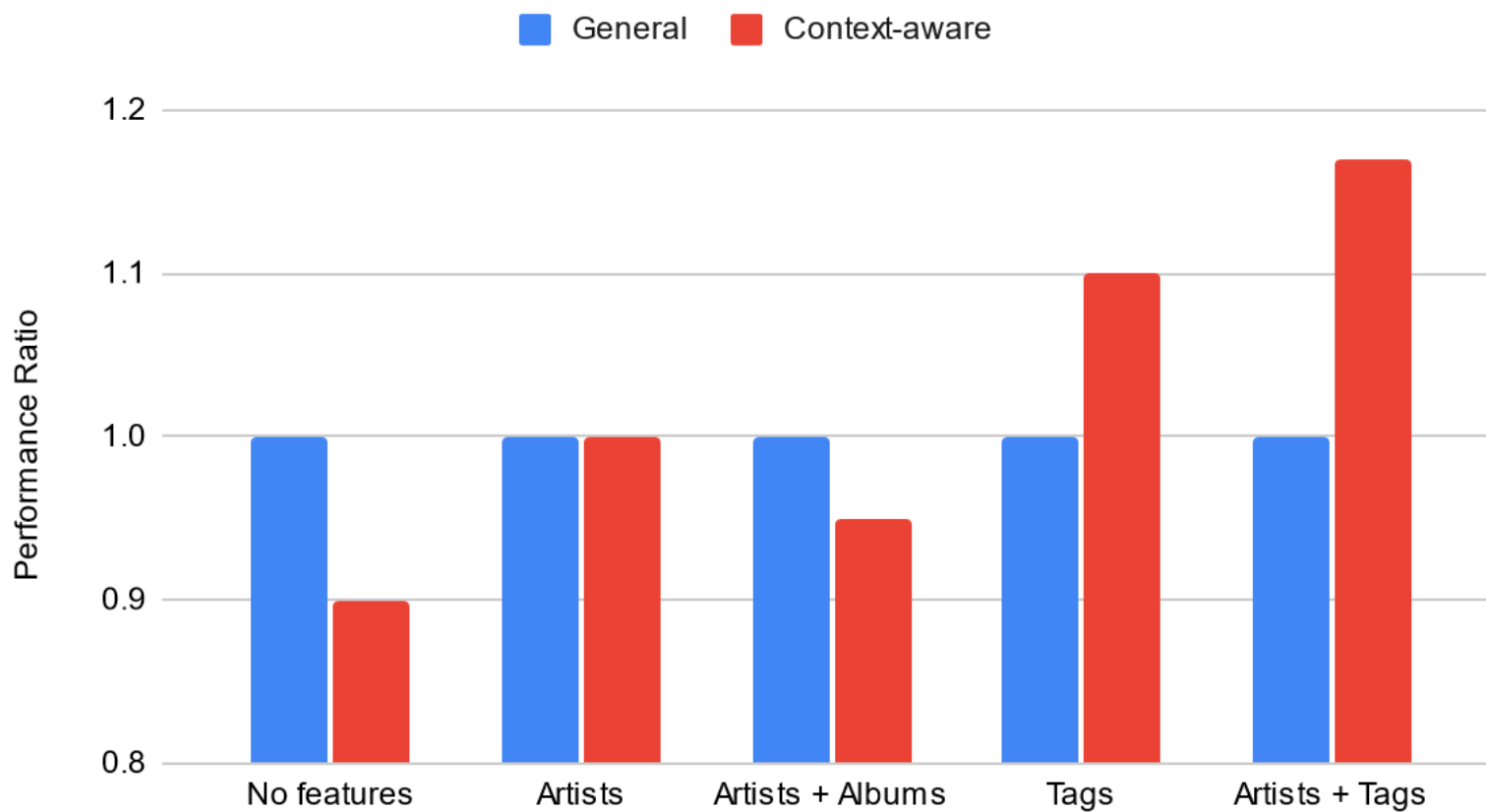
Results: Intuition

- Test with tags AND sentiment attributes



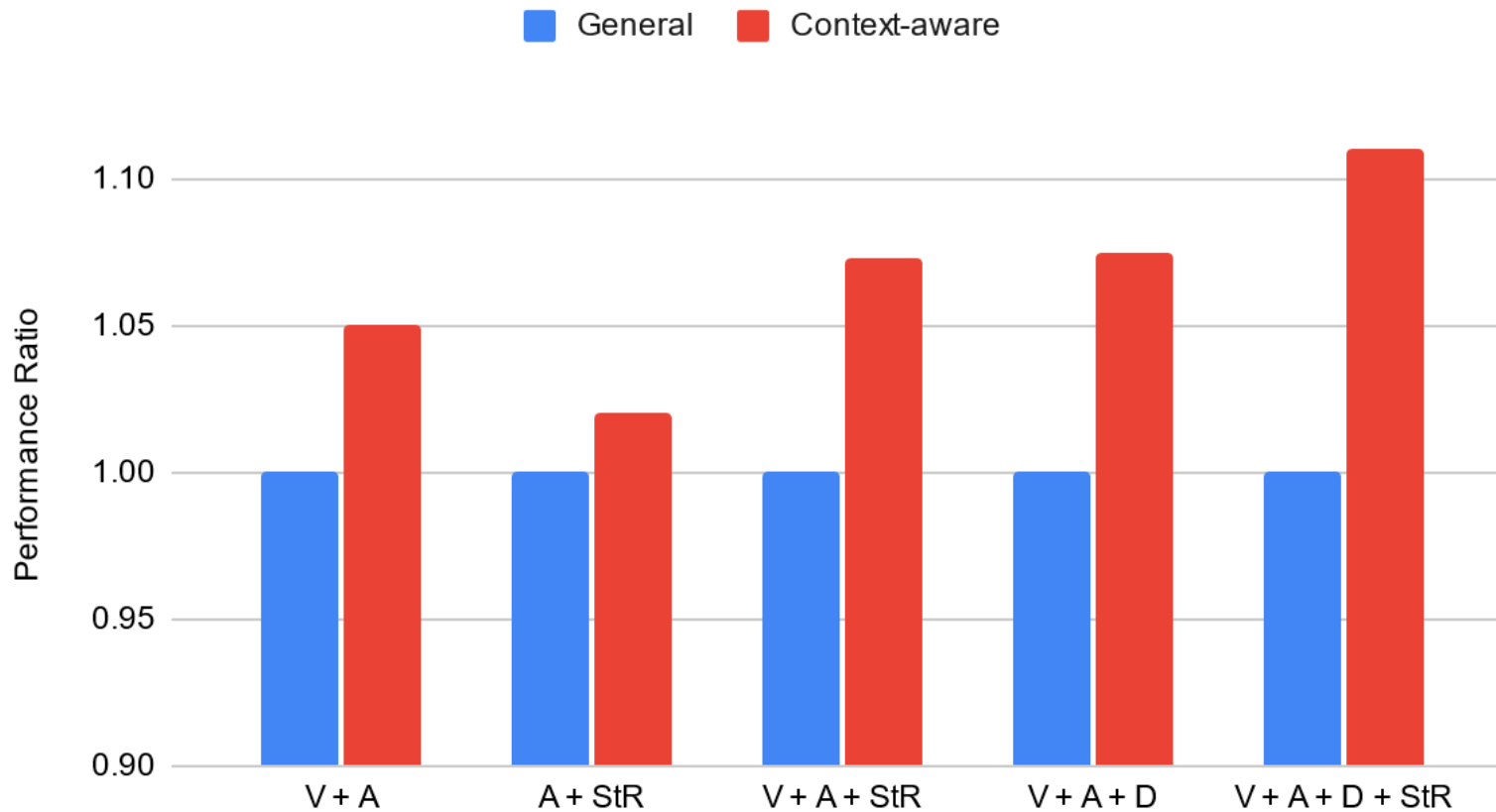
Results: Preliminary features

Preliminary feature testing



Results: Sentiment features

Sentiment feature testing



V: Valence A: Arousal D: Dominance StR: Sentiment Ratio

Results: Final features

Model		Testing Results @ 20									
		Preliminary (Artists + Tags)					Final (Artists + Tags + VAD + St.Ratio)				
		NDCG	Recall	Precision	mAP	MRR	NDCG	Recall	Precision	mAP	MRR
General	Random	0.03	0.06	0.01	0.01	0.04	=	=	=	=	=
	CosineSimilarity	0.14	0.28	0.05	0.06	0.12	=	=	=	=	=
	Pop	0.31	0.42	0.07	0.20	0.39	=	=	=	=	=
	ItemKNN [35]	0.44	0.46	0.08	0.33	0.64	=	=	=	=	=
Context	PNN [36]	0.56	0.68	0.12	0.42	0.67	0.58	0.73	0.13	0.44	0.67
	xDeepFM [37]	0.57	0.67	0.12	0.43	0.68	0.60	0.76	0.13	0.44	0.67
	DCN V2 [38]	0.58	0.71	0.13	0.43	0.66	0.56	0.69	0.12	0.42	0.65

- Artists + Tags + VAD + Sentiment Ratio

Conclusions

Artists, Genres...

Experimental
Avant-garde Alternative post-rock
Classical World Math rock
House Punk Country Metal Shoegaze
Grime Indie Folk Hip-hop R&B
Dubstep Blues Rock Jazz Latin
Post-punk Reggae Pop Rap Soul Dream pop
K-pop Electronic Funk New Age
Emo Reggaeton Gospel Techno
Trance Ambient
Drum and Bass



Emotions



Future Work

- Web application UX / performance testing
- Subjective texts for analysis (lyrics)
- Further research on VAD and other sentiment models

Thank you for your attention

