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Ameliorating Music Recommendation

Integrating Music Content, Music Context, and User Context for Improved Music Retrieval and Recommendation

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Why is music recommendation important?

- Nowadays users have access to millions of music tracks

- It gets harder and harder to find novel and interesting music ("serendipity")
- Traditionally music recommendation systems rely on collaborative filtering

- Several problems: cold start, popularity bias, community bias, ignores context of users (location, time, activity, mood, etc.)

→ Hybrid recommendation approaches that combine content and context

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Overview

1. Aspects important to human perception of music
2. Extracting, annotating, analyzing, and visualizing music listening events from microblogs
3. Geospatial music recommendation
4. User-aware music playlist generation on smart phones
5. Music recommendation for places of interest

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(1) Aspects that are important to human perception of music

Computational Factors Influencing Music Perception and Similarity

music content

Examples:
- rhythm
- timbre
- melody
- harmony
- loudness

[Schedl et al., IJMIR 2013]

Examples:
- mood
- activities
- social context
- spatio-temporal context
- physiological aspects

user context

music perception

Examples:
- semantic labels
- song lyrics
- album cover artwork
- artist's background
- music video clips

music context

Examples:
- music preferences
- musical training
- musical experience
- demographics

user properties

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Social Media for Music Retrieval and Recommendation

Social media is a valuable source for ***music context*** and ***user-centric context*** features

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(2a) Extracting and annotating music listening events from microblogs

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Listening Pattern Extraction and Analysis

[Schedl, ECIR 2013]

(a) Filter Twitter stream (#nowplaying, #itunes, #np, …)
(b) Multi-level, rule-based analysis (artists/songs) to find relevant tweets (MusicBrainz)
(c) Last.fm, Freebase, Allmusic, Yahoo! PlaceFinder to annotate tweets

„Alice Cooper“
„BB King“
„Prince“
„Metallica“
…

{"id_str":"142338125895696385","place":null,"text":"**#NowPlaying Christmas Tree-Lady Gaga**","in_reply_to_user_id":null,"favorited":false,"geo":null,"retweet_count":0,"in_reply_to_screen_name":null,"in_reply_to_status_id_str":null,"source":"web","retweeted":false,"in_reply_to_user_id_str":null,"coordinates":null,"created_at":"Thu Dec 01 20:23:48 +0000 2011","in_reply_to_status_id":null,"contributors":null,"user":{"id_str":"20209983","profile_link_color":"2caba5","screen_name":"tamse77","follow_request_sent":null,"geo_enabled":false,"favourites_count":26,"location":"Maryland ","following":null,"verified":false,"profile_background_color":"e80e0e","show_all_inline_media":true,"profile_background_tile":true,"follower s_count":309,"profile_image_url":"http:\/\/a1.twimg.com\/profile_images\/1647613274\/392960_10150559294659517_793614516_11700077_1689597400_n_normal.jpg","des cription":"being awesome since 1990. ","is_translator":false,"profile_background_image_url_https":"https:\/\/si0.twimg.com\/profile_background_images\/359728130\/frames.gif","friends_count":148,"profile_sidebar_fill_color":"ffffff","default_profile":false,"listed_count":3,"time_zone":"Central Time (US & Canada)","contributors_enabled":false,"created_at":"Fri Feb 06 01:51:10 +0000 2009","profile_sidebar_border_color":"f5f8ff","protected":false,"notifications":null,"profile_use_background_image":true,"name":"Katie","default_profile_image":false,"statuses_count":22172,"profile_text_color":"615d61","url":null,"profile_image_url_https":"https:\/\/si0.twimg.com\/profile_images\/1647613274\/392960_10150559294659517_793614516_11700077_1689597400_n_normal.jpg","id":20209983,"lang":"en","profile_background_image_url":"http:\/\/a2.twimg.com\/profile_background_images\/359728130\/frames.gif","utc_offset":-21600},"truncated":false,"id":142338125895696385,"entities":{"hashtags":[{"text":"NowPlaying","indices":[0,11]}],"urls":[],"user_mentions":[]}}

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Listening Pattern Extraction and Analysis

[Schedl, ECIR 2013]

last.fm

allmusic

Freebase

{"id_str":"142338125895696385","place":null,"text":"#NowPlaying Christmas Tree-Lady Gaga","in_reply_to_user_id":null,"favorited":false,"geo":null,"retweet_count":0,"in_reply_to_screen_name":null,"in_reply_to_status_id_str":null,"source":"web","retweeted":false,"in_reply_to_user_id_str":null,"coordinates":null,"created_at":"Thu Dec 01 20:23:48 +0000 2011","in_reply_to_status_id":null,"contributors":null,"user":{"id_str":"20209983","profile_link_color":"2caba5","screen_name":"tamse77","follow_request_sent":null,"geo_enabled":false,"favourites_count":26,"location":"Maryland ","following":null,"verified":false,"profile_background_color":"e80e0e","show_all_inline_media":true,"profile_background_tile":true,"followers_count":309,"profile_image_url":"http:\/\/a1.twimg.com\/profile_images\/1647613274\/392960_10150559294659517_793614516_11700077_1689597400_n_normal.jpg","description":"being awesome since 1990. ","is_translator":false,"profile_background_image_url_https":"https:\/\/si0.twimg.com\/profile_background_images\/359728130\/frames.gif","friends_count":148,"profile_sidebar_fill_color":"ffffff","default_profile":false,"listed_count":3,"time_zone":"Central Time (US & Canada)","contributors_enabled":false,"created_at":"Fri Feb 06 01:51:10 +0000 2009","profile_sidebar_border_color":"f5f8ff","protected":false,"notifications":null,"profile_use_background_image":true,"name":"Katie","default_profile_image":false,"statuses_count":22172,"profile_text_color":"615d61","url":null,"profile_image_url_https":"https:\/\/si0.twimg.com\/profile_images\/1647613274\/392960_10150559294659517_793614516_11700077_1689597400_n_normal.jpg","id":20209983,"lang":"en","profile_background_image_url":"http:\/\/a2.twimg.com\/profile_background_images\/359728130\/frames.gif","utc_offset":-21600},"truncated":false,"id":142338125895696385,"entities":{"hashtags":[{"text":"NowPlaying","indices":[0,11]}],"urls":[],"user_mentions":[]}}

```
1342437003804016 64   127821914   11   2   106.83   -6.23   1   1   202085   3529910   0   1 ...
1342438692011540 48   174194590   11   2   -0.142   51.52   2   2   330061   5762915   1   0 ...
```

twitter-id user-id month weekday longitude latitude country-id city-id artist-id track-id <tag-ids>

Datasets available from

- http://www.cp.jku.at/datasets/musicmicro/
- http://www.cp.jku.at/datasets/MMTD/

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Listening Pattern Extraction and Analysis: Some Stats

#nowplaying		#itunes	
country	tweets	country	tweets
Brazil	725,389	USA	78,460
USA	673,839	Japan	30,932
Japan	458,558	Mexico	23,047
Mexico	419,584	Brazil	16,390
Indonesia	284,082	UK	15,134
South Korea	251,132	Canada	11,266
China	183,178	South Korea	8,652
UK	128,744	Australia	5,119
Netherlands	121,134	China	4,492
Venezuela	110,336	Germany	3,157

most active countries

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Listening Pattern Extraction and Analysis: Some Stats

#nowplaying		#itunes	
city	tweets	city	tweets
New York	126,952	New York	13,603
London	96,801	London	9,813
São Paulo	79,317	Los Angeles	9,030
Los Angeles	73,834	San Francisco	5,787
Amsterdam	66,021	San Jose	5,605
Guarulhos	58,453	Chicago	4,413
Osasco	57,512	Birmingham	3,869
São Bernardo	56,946	Toronto	3,363
Rotterdam	55,113	Hamilton	3,279
Mexico City	52,618	Baltimore	3,245

most active cities

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Listening Pattern Extraction and Analysis: Some Stats

most frequently listened artists

#nowplaying		#itunes	
artist	tweets	artist	tweets
Paramore	9,066	The Beatles	939
Drake	7,697	Daft Punk	683
Katy Perry	6,998	Britney Spears	567
Bruno Mars	6,932	Adele	462
Lady Gaga	6,919	Coldplay	428
Coldplay	6,434	Bruno Mars	416
Eminem	6,352	Katy Perry	374
Rihanna	6,038	The Black Eyes Peas	373
Taylor Swift	5,844	Kanye West	367
Usher	5,445	Lady Gaga	358
Muse	5,383	Avril Lavigne	308
Justin Bieber	5,028	Arcade Fire	299
The Beatles	4,579	Radiohead	266
Michael Jackson	4,476	Kings of Leon	240
Linkin Park	4,285	Duran Duran	238
Oasis	4,190	Michael Jackson	229
Kanye West	4,013	Linkin Park	228
Chris Brown	3,943	Eminem	211
Avril Lavigne	3,780	Muse	209
Radiohead	3,756	The Black Keys	203

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(2b) Analyzing music listening events from microblogs

What can this kind of data tell us about the music taste of people around the world?

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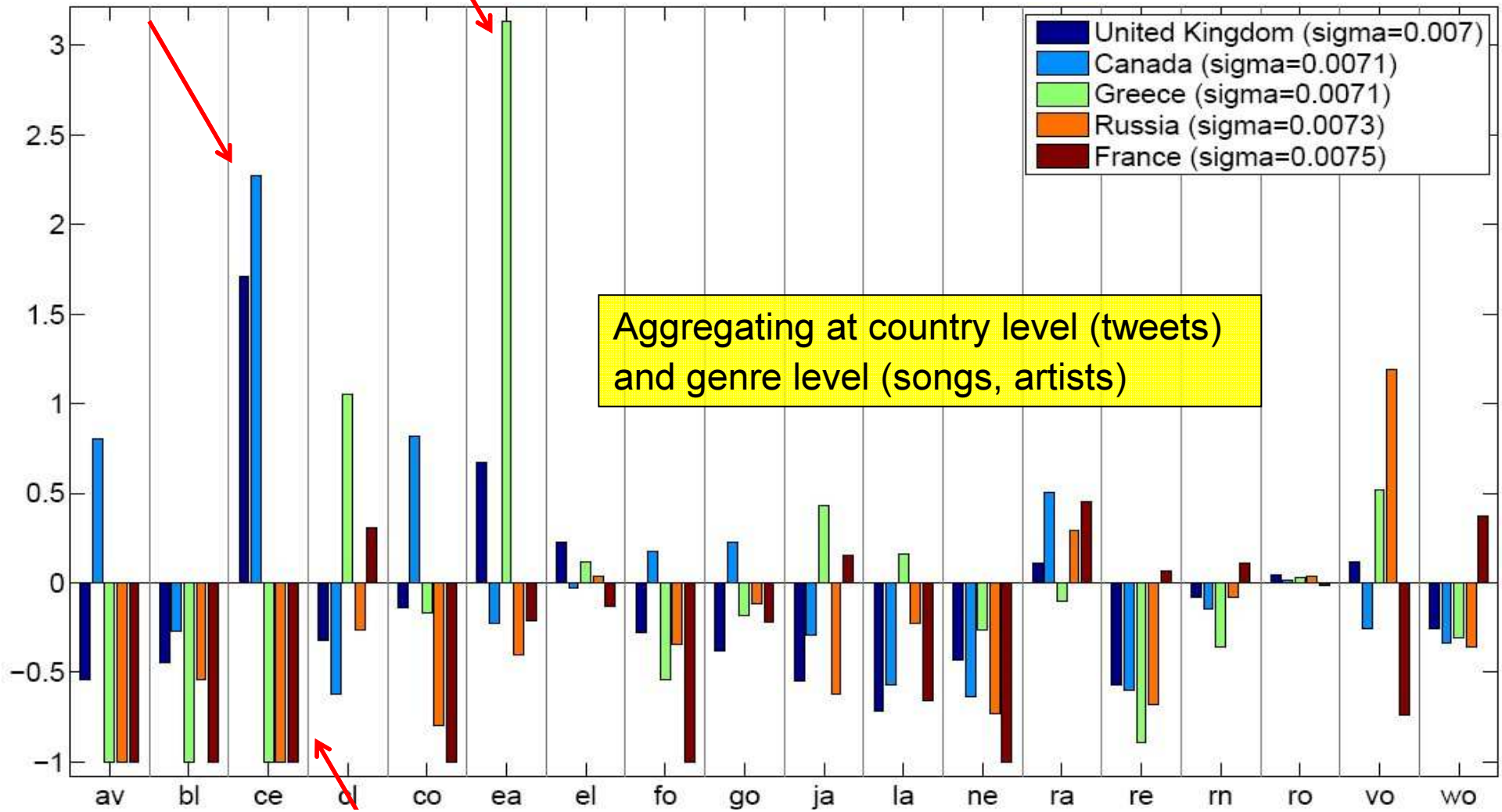
[Schedl and Hauger, WWW: AdMIRe 2012]

Geospatial Music Taste Analysis: Most Mainstreamy



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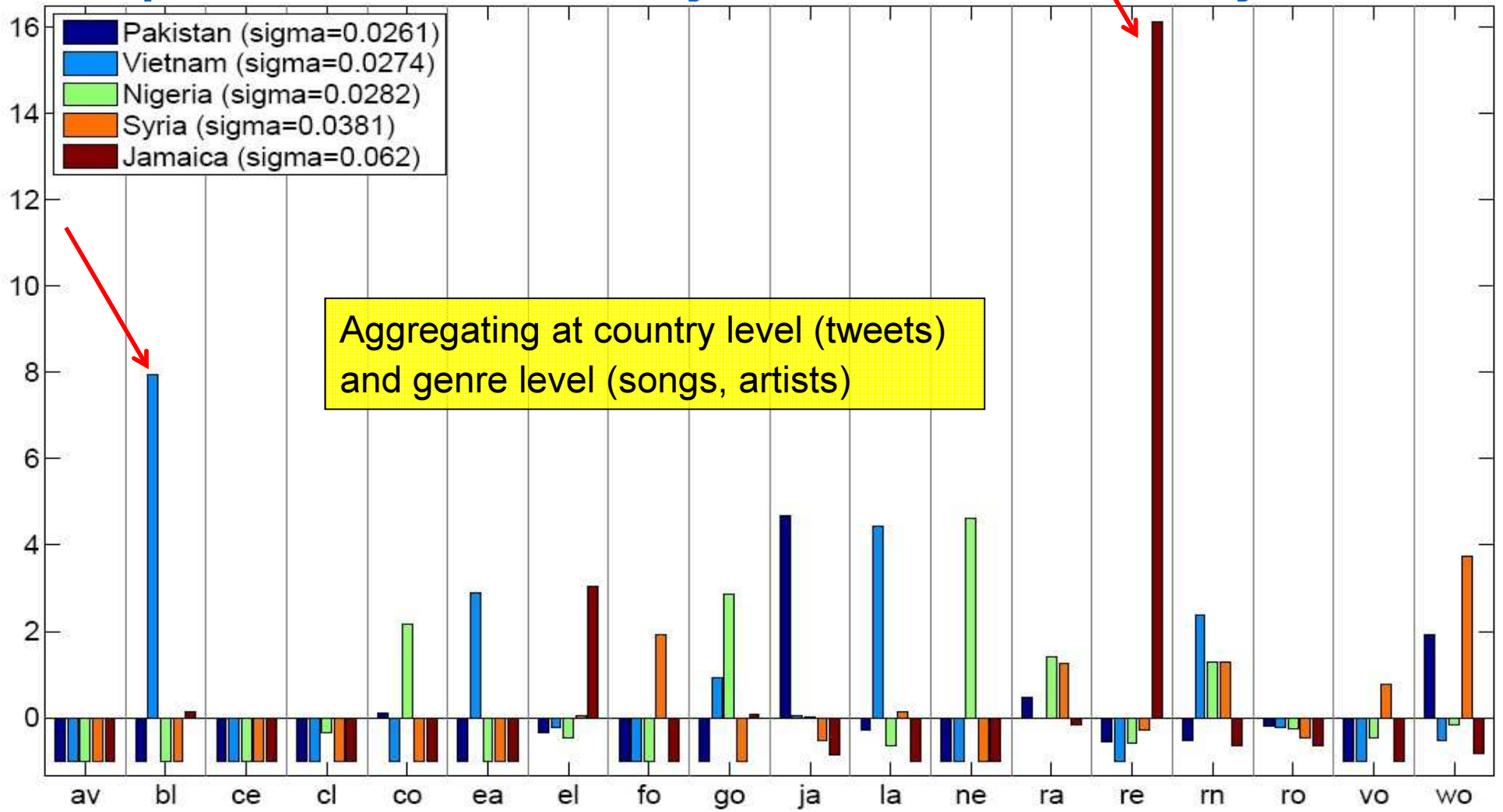
[Schedl and Hauger, WWW: AdMIRe 2012]

Geospatial Music Taste Analysis: Least Mainstreamy



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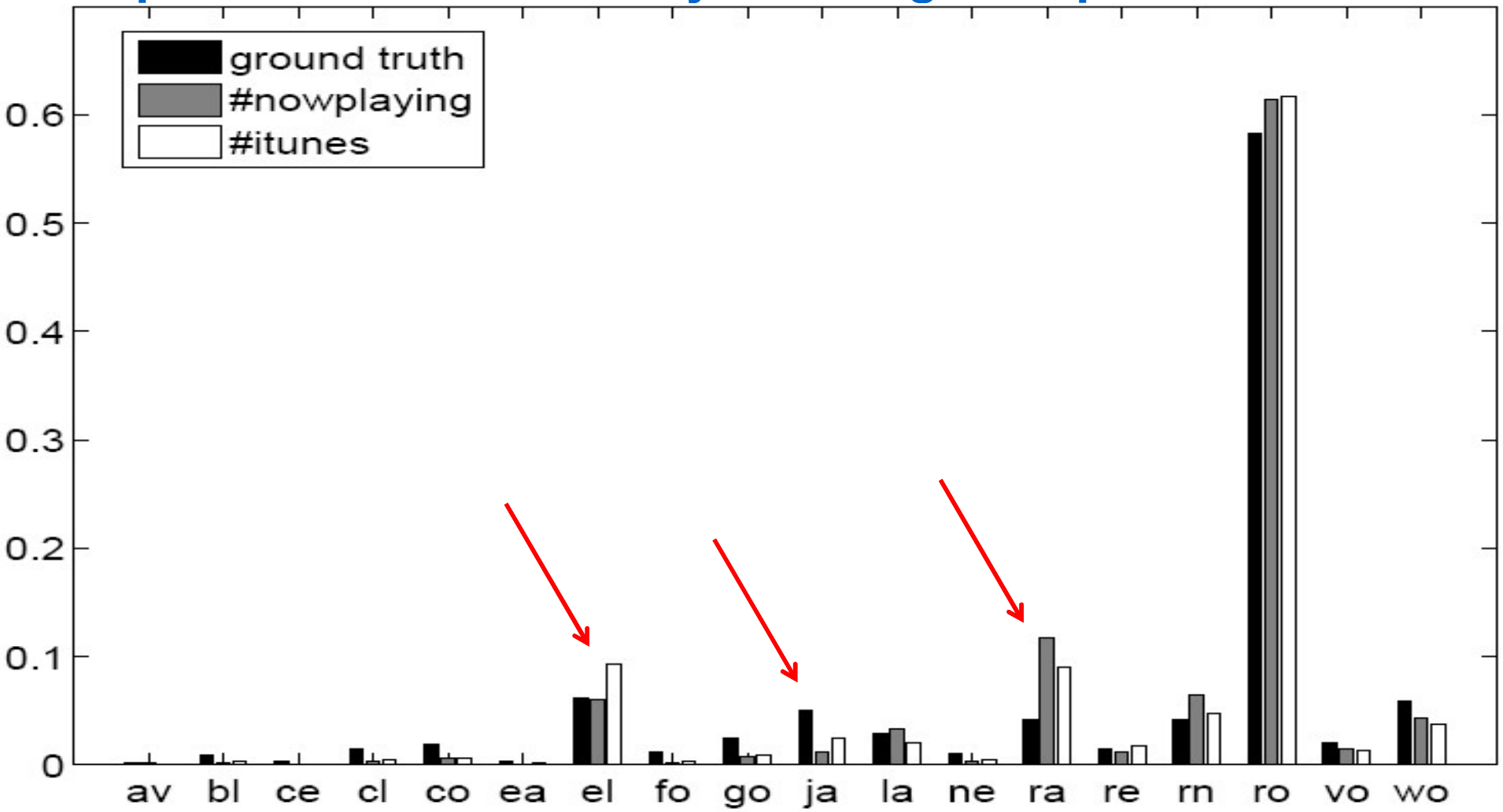
[Schedl and Hauger, WWW: AdMIRe 2012]

Geospatial Music Taste Analysis: Usage of Specific Products



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(2c) Visualizing music listening events from microblogs

How to make accessible music listening data from social media in an intuitive way?

http://www.cp.jku.at/projects/MusicTweetMap/

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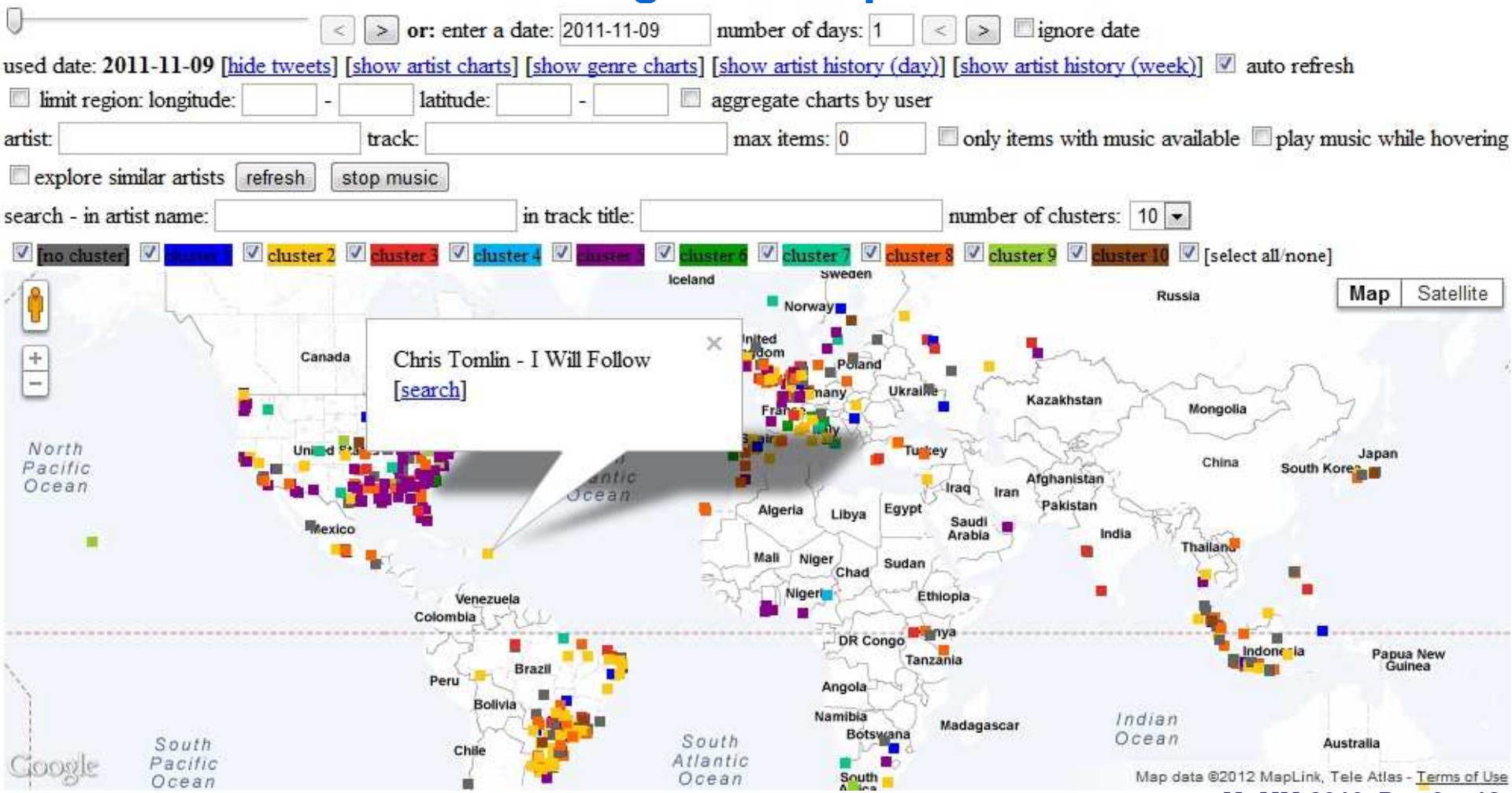
[Hauger and Schedl, AMR 2012]

Visualization and Browsing of Geospatial Music Tastes



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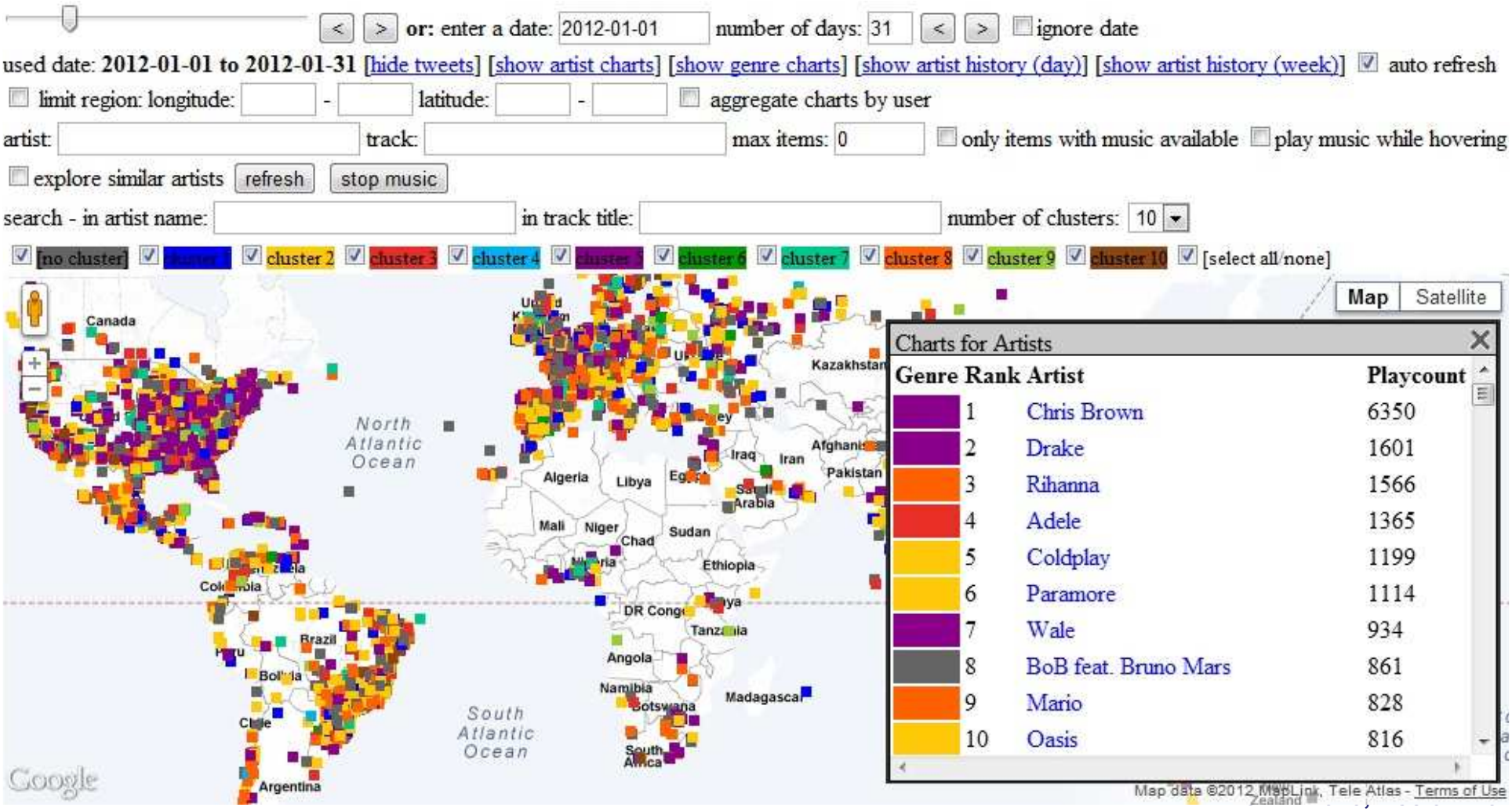
Browsing of Geospatial Music Tastes: 1 month



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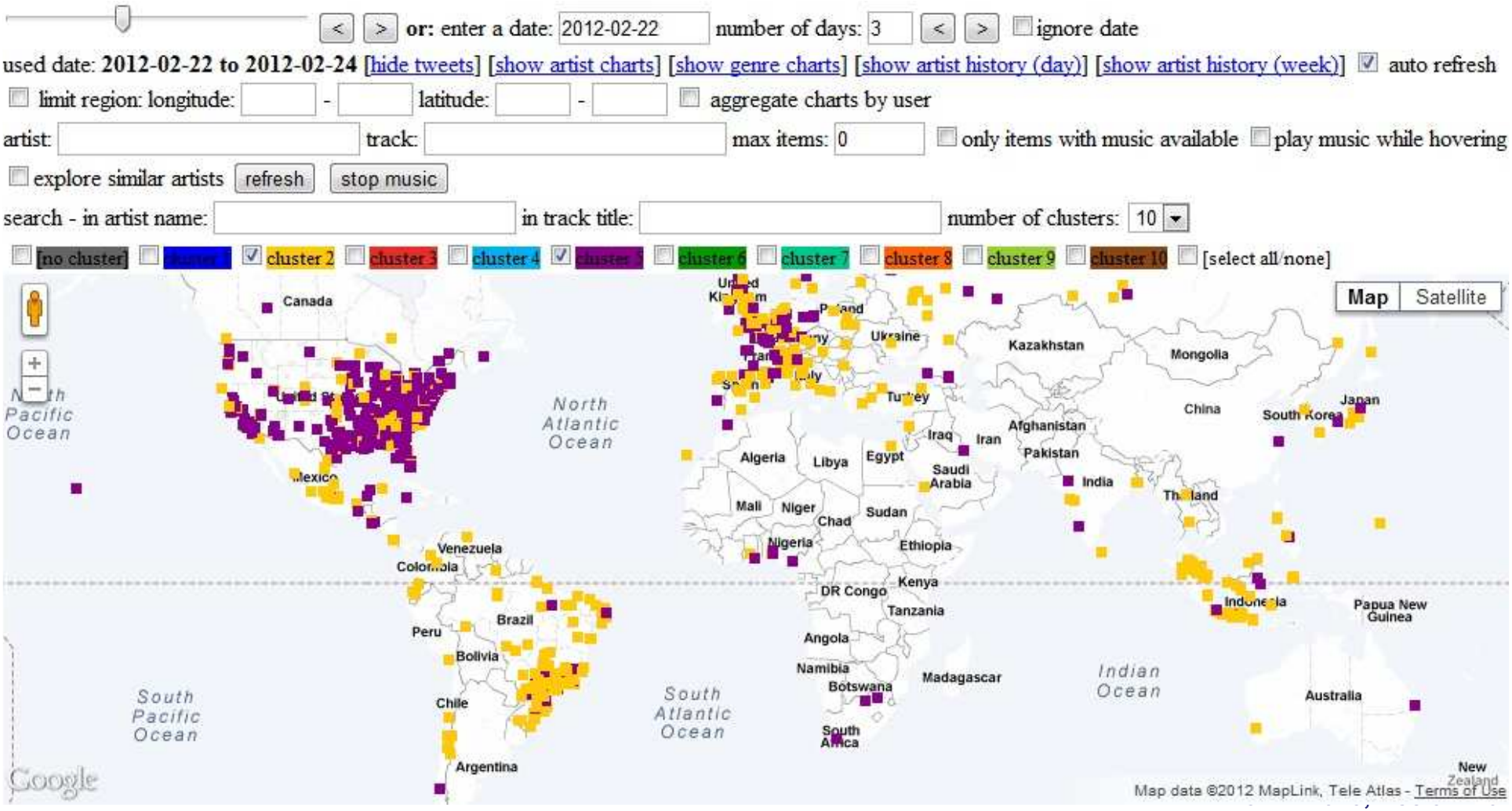
Browsing of Geospatial Music Tastes: "hip-hop" vs. "rock"



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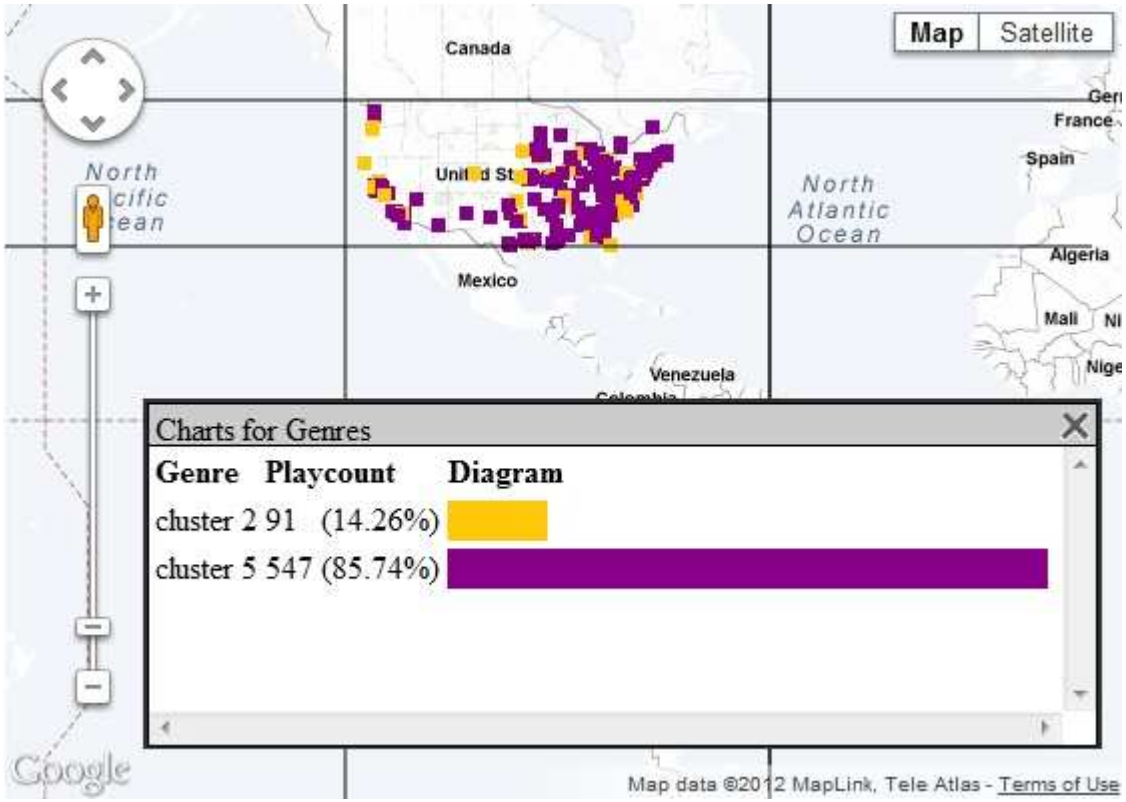

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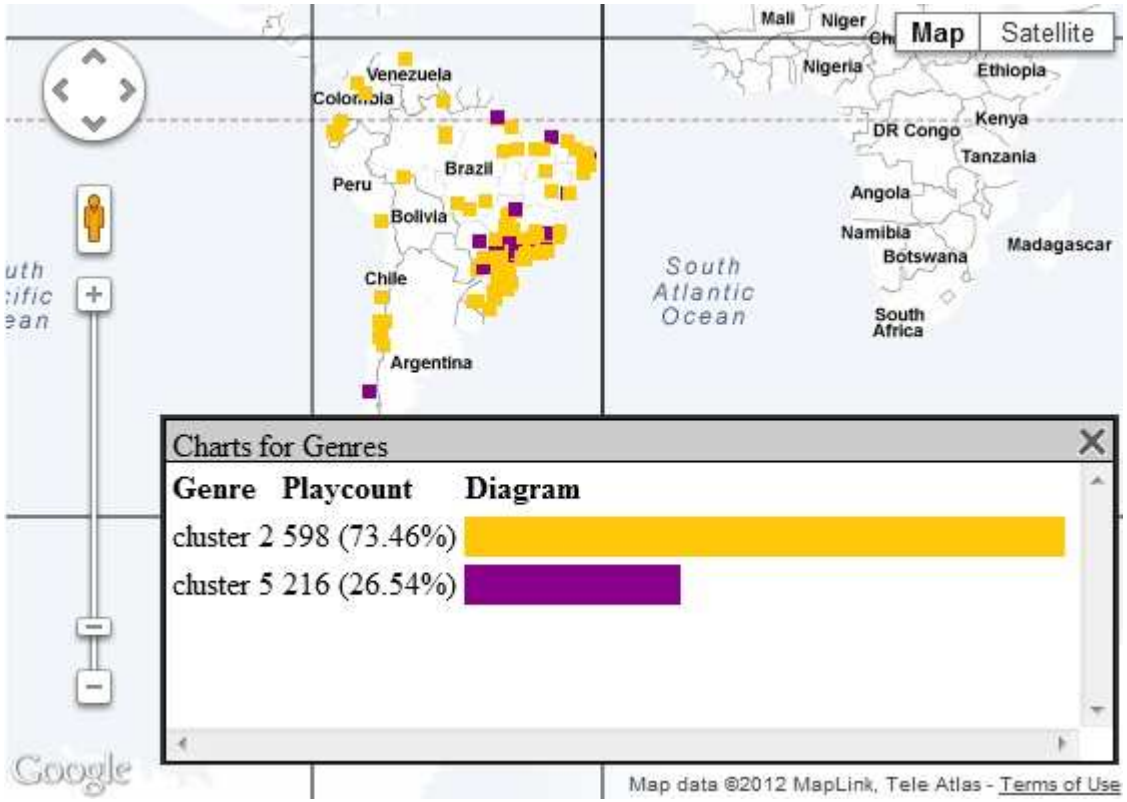
Browsing of Geospatial Music Tastes: "hip-hop" vs. "rock"



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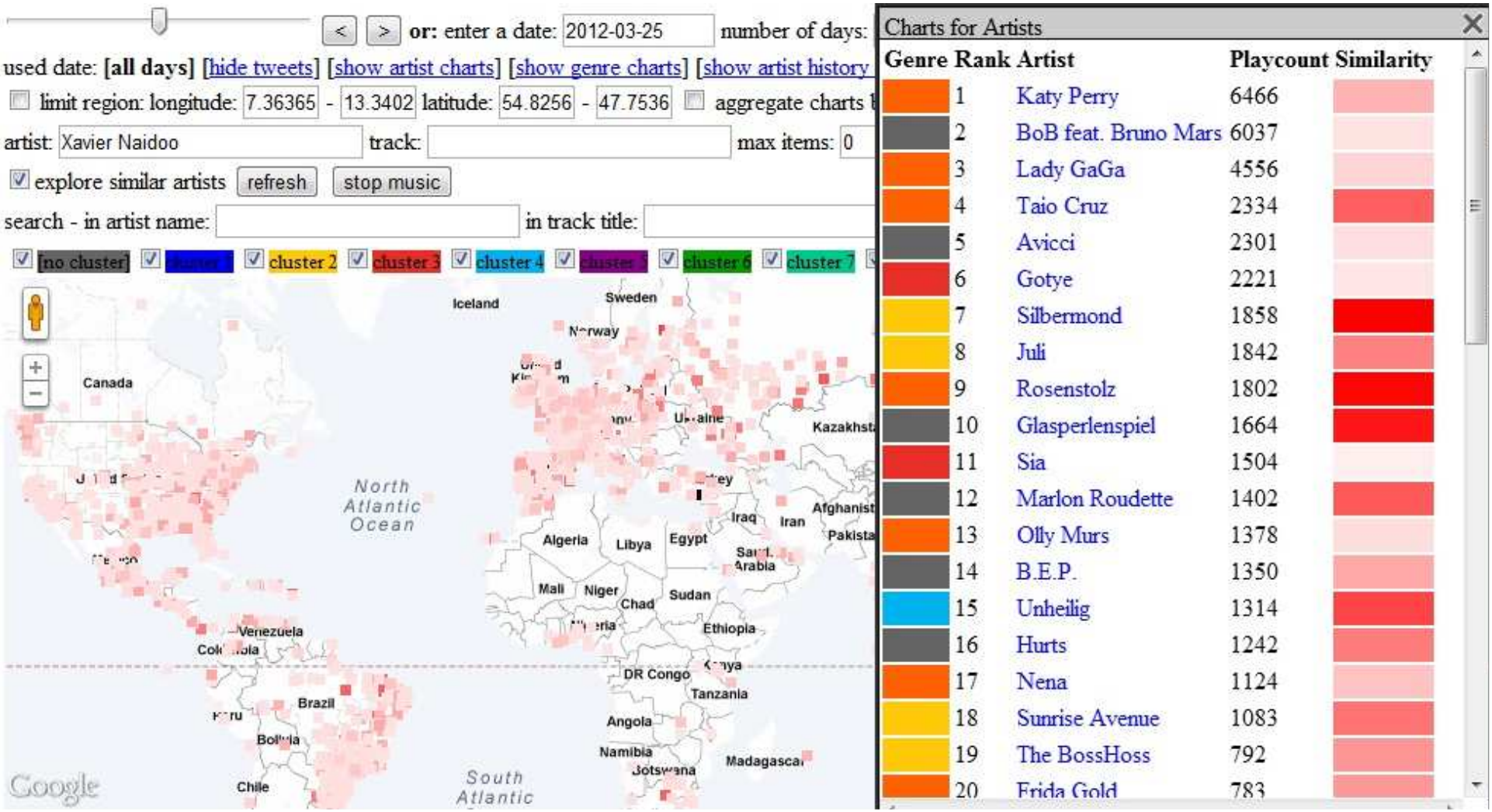
Exploring Similar Artists: Example – "Xavier Naidoo"



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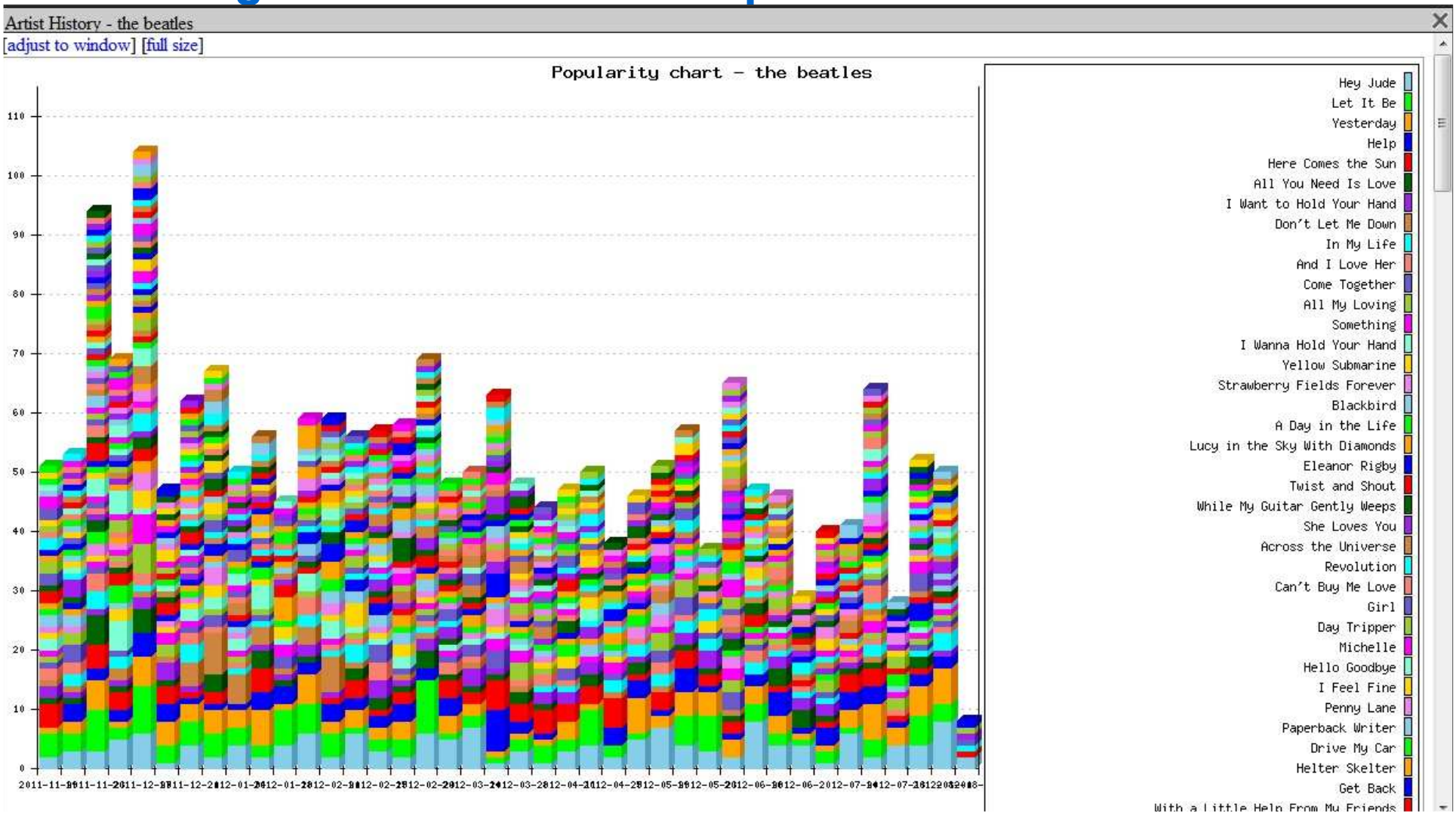
Visualizing Music Trends: Example 1 – "The Beatles"



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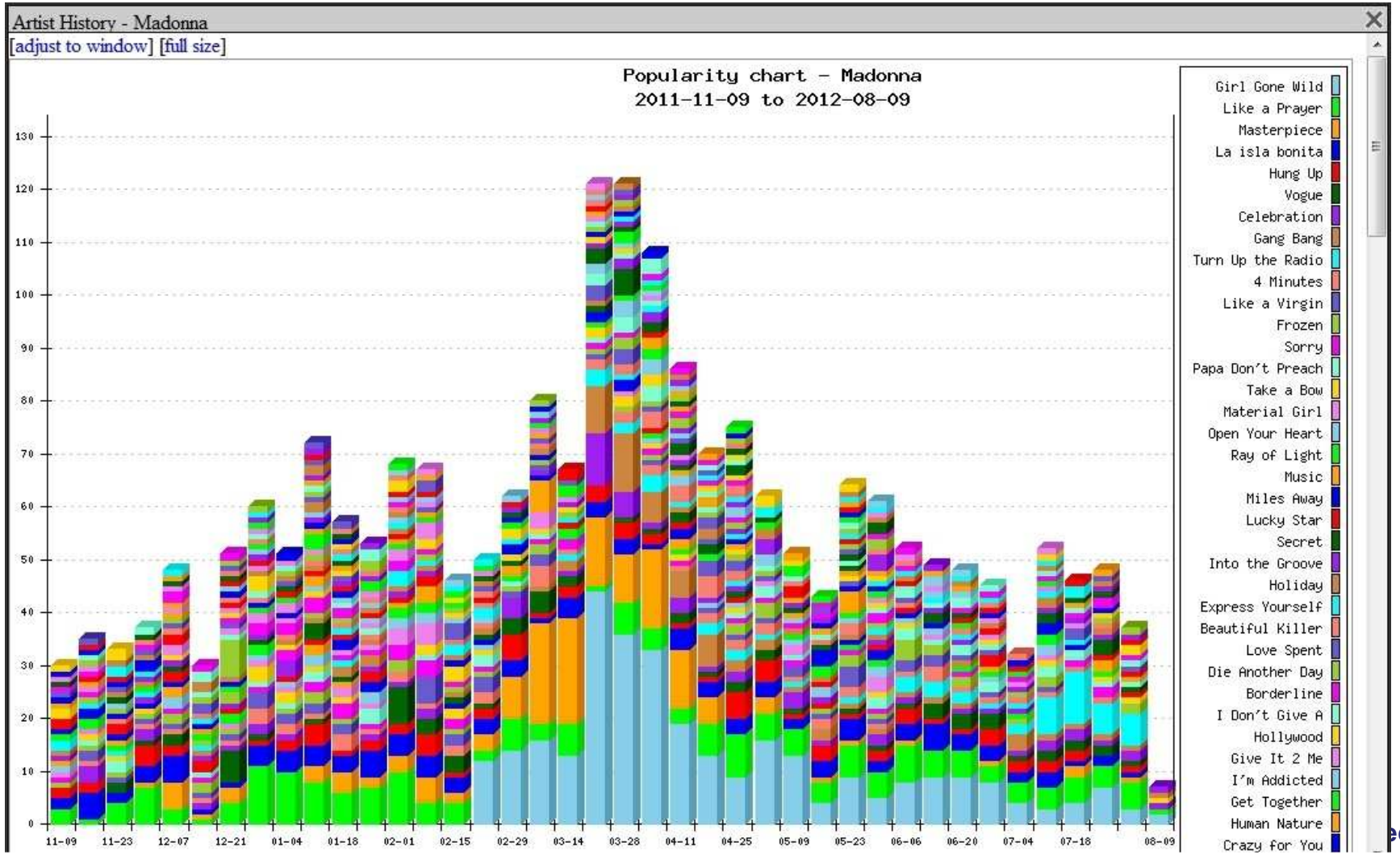
Visualizing Music Trends: Example 2 – "Madonna"



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So what can we do with this data?

Social Media Music Charts

[Schedl et al., ISMIR 2010]

- Looking into other social media data sources: P2P networks (queries and shared folders), user-generated playlists, etc.
- Different sources provide very different popularity estimates and vary strongly: bias, noisiness, coverage, time dependence

[Schedl and Schnitzer, SIGIR 2013]

Improving Music Recommendation

- Geospatial music recommendation
- “Mobile Music Genius”

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(3) Geospatial music recommendation

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Geospatial Music Recommendation

[Schedl and Schnitzer, SIGIR 2013]

- combining music content + music context features
  - audio features: PS09 award-winning feature extractors (rhythm and timbre)
  - text/web: tfidf-weighted artist profiles from artist-related web pages

- using collection of geolocated music tweets (cf. [Schedl, ECIR 2013])

- aims: (i) determining ideal combination of music content and –context
  (ii) ameliorate music recommendation by user's location information

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Ideal combination of music content and –context

[Schedl and Schnitzer, SIGIR 2013]

ξ	$K=1$	$K=3$	$K=5$
web only – 0.00	**.5829**	**.5753**	**.5774**
.05	.6421	.6280	.6257
.15	.6432	**.6286**	**.6261**
.25	**.6433**	.6275	.6258
.35	.6430	.6275	.6257
.45	.6408	.6266	.6252
.55	.6394	.6259	.6244
.65	.6379	.6255	.6232
.75	.6368	.6234	.6221
.85	.6330	.6202	.6188
.95	.6215	.6083	.6059
audio only – 1.00	**.5436**	**.5302**	**.5247**

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Adding user context (different approaches)

[Schedl and Schnitzer, SIGIR 2013]

Abbreviation	Description
BL	random baseline
MU	hybrid music model
CF	collaborative filtering model
CF-GEO-Lin	CF model: geospatial user weighting using linear spatial distances
CF-GEO-Gauss	CF model: geospatial user weighting weighting using a Gauss kernel

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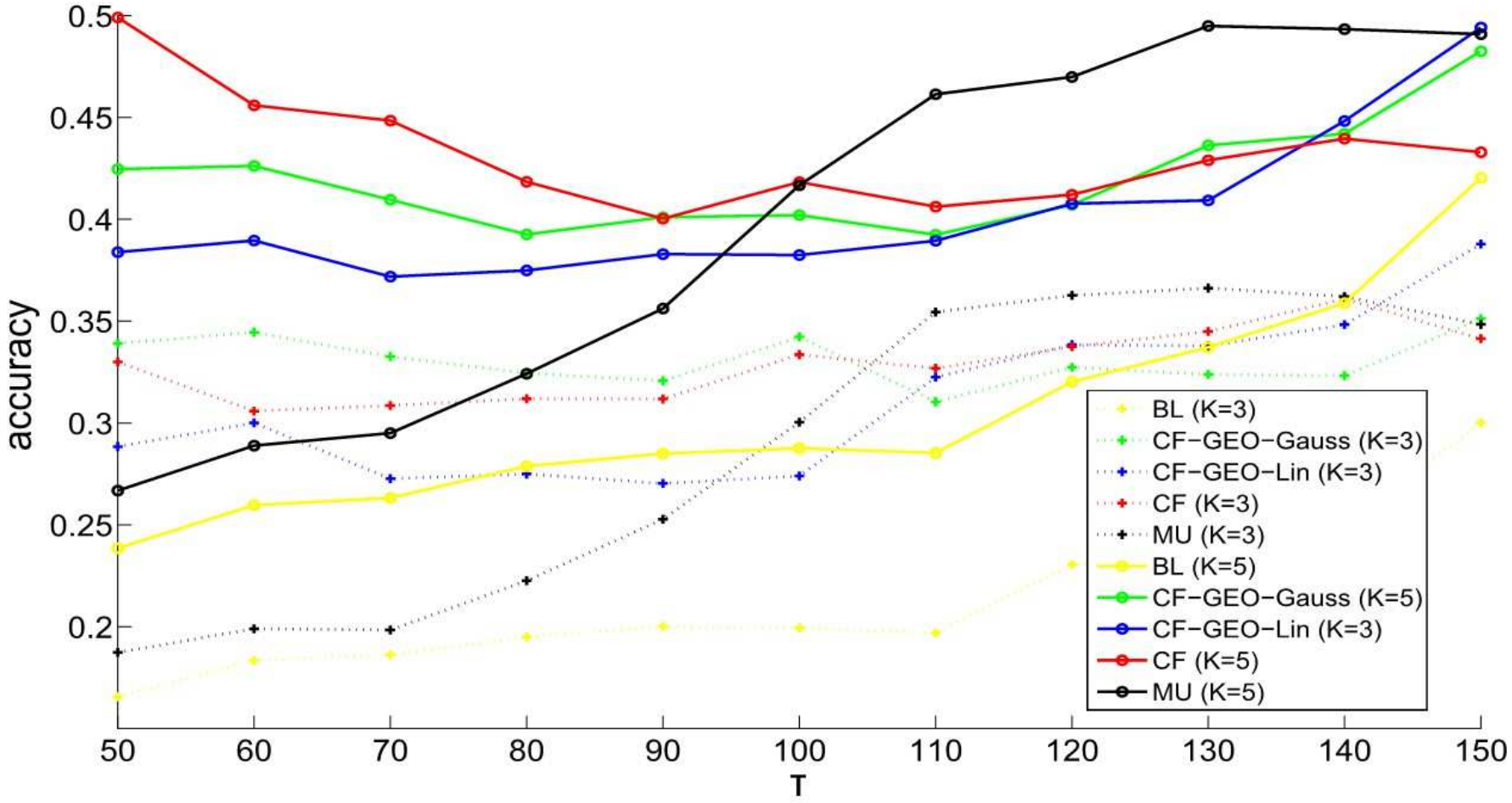
Evaluation Results

[Schedl and Schnitzer, SIGIR 2013]



T: minimum number of distinct artists a users must have listened to to be included

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(4) User-aware music playlist generation on smart phones

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User-Aware Music Recommendation on Android Phones

"Mobile Music Genius": music player for the Android platform

- collecting user context data while playing
- adaptive system that learns user taste/preferences from implicit feedback (player interaction: play, skip, duration played, playlists, etc.)
- ultimate aim: dynamically and seamlessly update the user's playlist according to his/her current context

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User-Aware Music Recommendation on Android Phones

"Mobile Music Genius": music player for the Android platform

- standard, non-context-aware playlists are created using Last.fm tag features (weighted tag vectors on artists and tracks); cosine similarity between linear combination (of artist and track features) used for playlist generation
- learning and adapting a user model via relations
  {user context – music preference}
  on the level of genre, mood, artist, and song
- playlist is adapted when change in similarity between current user context and earlier user context is above threshold

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Some of the considered features

Time:	timestamp, time zone
Personal:	userID/eMail, gender, birthdate
Device:	devideID (IMEI), sw version, manufacturer, model, phone state, connectivity, storage, battery, various volume settings (media, music, ringer, system, voice)
Location:	longitude/latitude, accuracy, speed, altitude
Place:	nearby place name (populated), most relevant city
Weather:	wind direction, speed, clouds, temperature, dew point, humidity, air pressure
Ambient:	light, proximity, temperature, pressure, noise, digital environment (WiFi and BT network information)
Activity:	acceleration, user and device orientation, UI mode (undocked, car, desk), screen on/off, running apps
Player:	artist, album, track name, track id, track length, genre, plackback position, playlist name, playlist type, player state (repeat, shuffle mode) audio output (headset plugged)
	mood and activity (direct user feedback)

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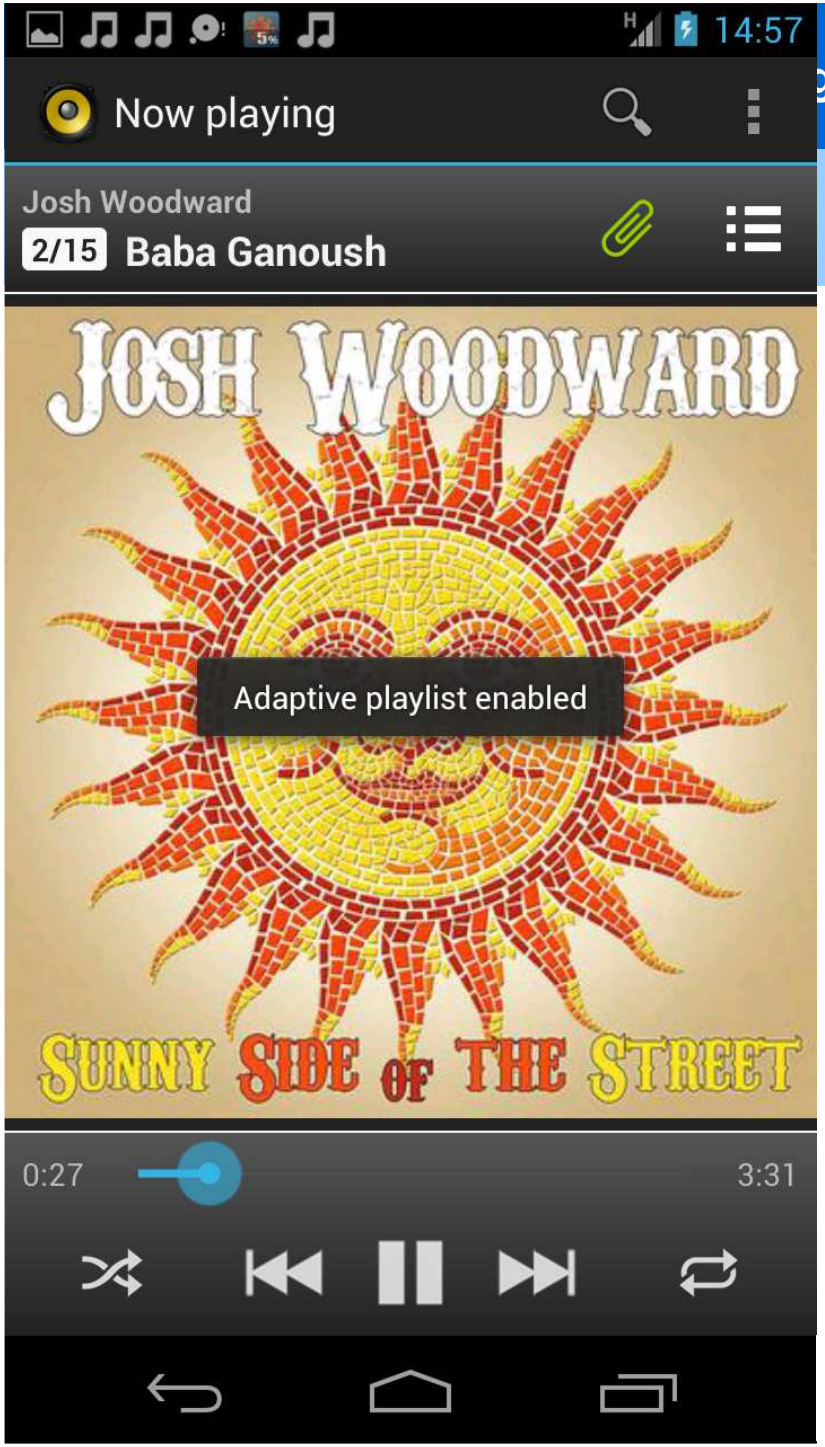

Music player in adaptive playlist generation mode

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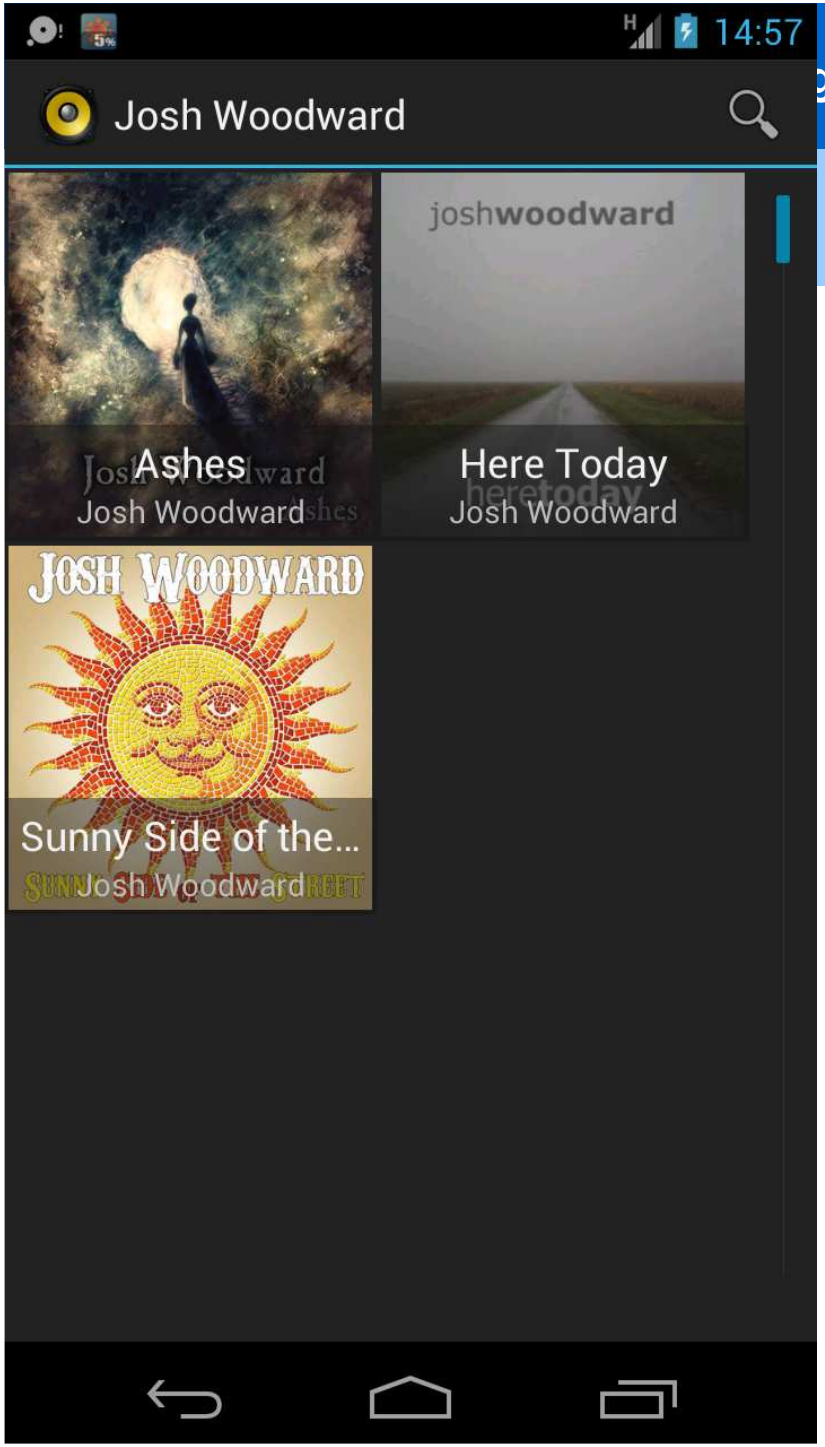
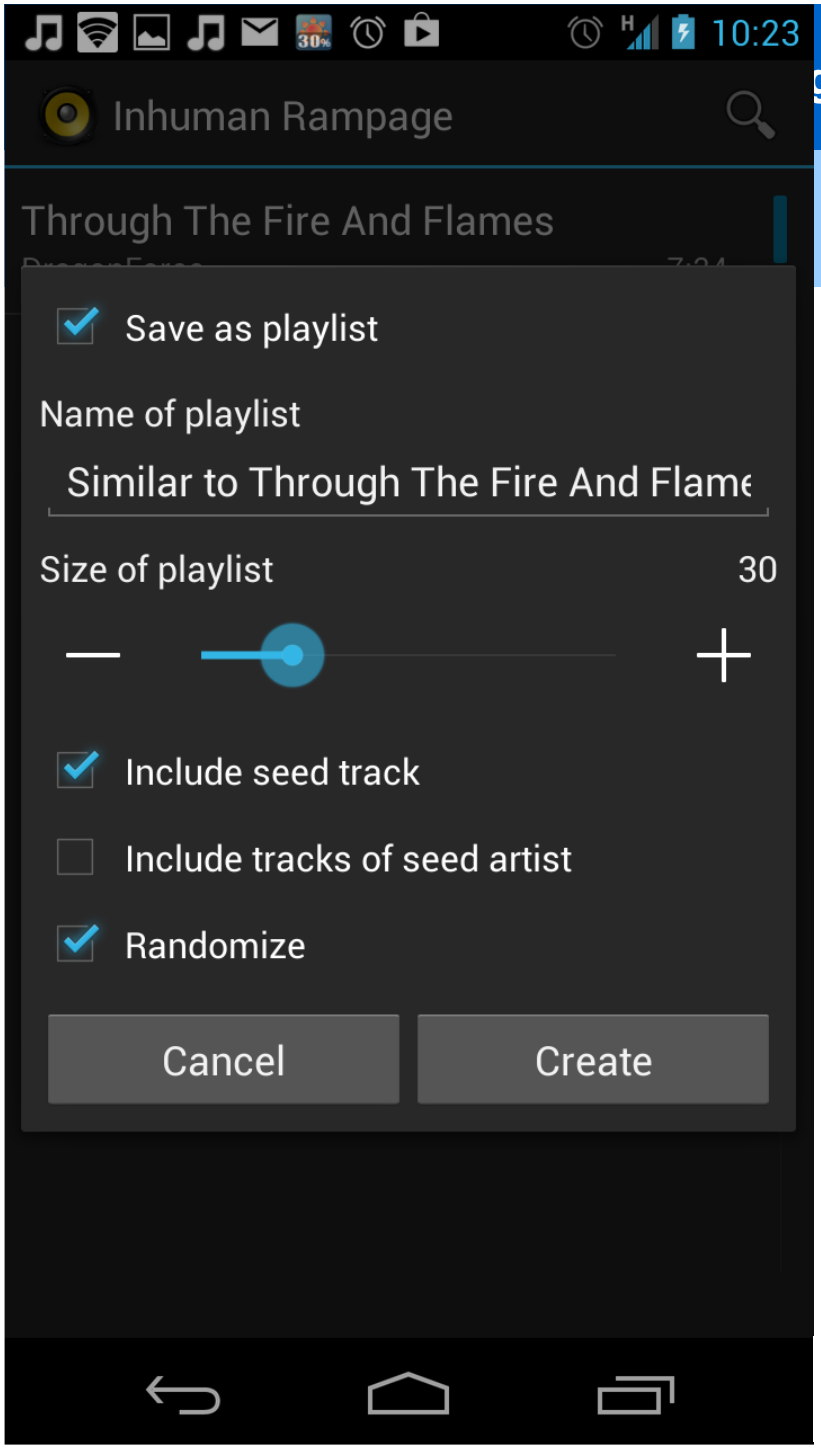


Album browser
in cover view



g Music Recommendation

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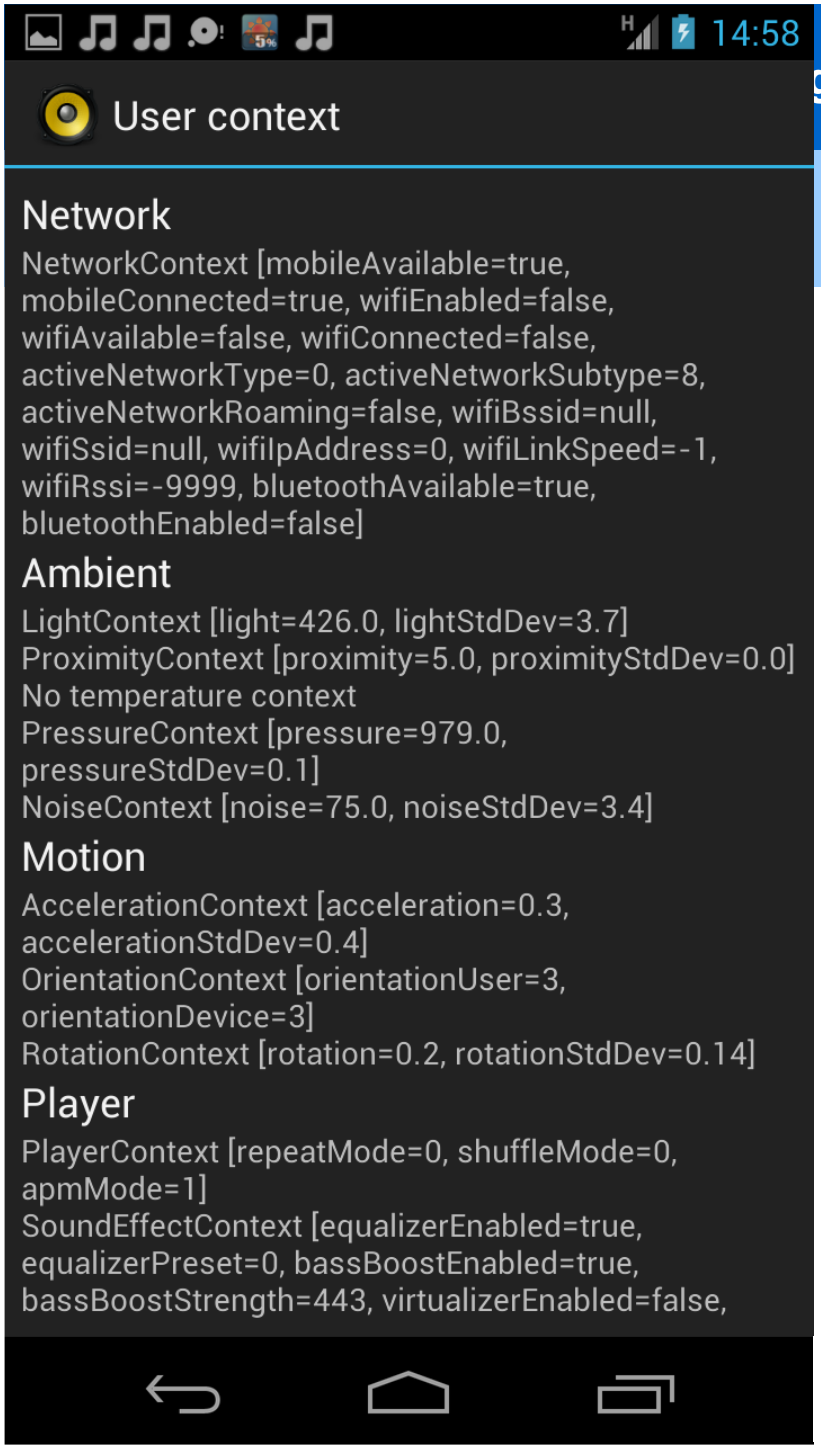
Automatic playlist generation based on music context (features and similarity computed based on Last.fm tags)



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Some user context features gathered while playing

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Preliminary Evaluation

- collected user context data from 12 participants over a period of 4 weeks
- age: 20-40 years
- user context vectors recoded whenever a “sensor” records a change
- assess different classifiers (Weka) for the task of predicting artist/track/genre given a user context vector: k-nearest neighbor (kNN), decision tree (C4.5), Support Vector Machine (SVM), Bayes Network (BN)
- cross-fold validation (10-CV)

Can we predict the music preference of a user only from his/her context?

Ameliorating Music Recommendation

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Predicting class *track*

Results barely above baseline.

Predicting particular tracks is hardly feasible with the amount of data available.

Dataset	0-R	KNN	C4.5	SVM	BN	Max.rel.	Avg.rel.
Time	1.13	1.26	0.90	1.30	1.31	116.04%	105.84%
Location	1.13	1.40	1.57	1.42	1.58	139.76%	132.06%
Location - state	1.13	1.36	1.69	0.96	0.82	150.26%	107.28%
Location - place	1.13	1.31	1.47	1.46	2.23	197.49%	143.46%
Weather	1.13	1.17	0.91	1.19	1.07	105.25%	96.21%
Ambient	1.13	0.79	0.63	1.08	1.12	98.97%	79.99%
Ambient - no n.	1.13	0.64	0.63	0.97	1.10	97.49%	73.97%
Ambient - noise	1.13	0.45	0.67	1.28	1.11	113.38%	77.77%
Motion	1.13	0.54	0.97	1.06	1.32	117.15%	86.25%
Motion - acc.	1.13	0.58	0.58	1.39	1.10	123.50%	80.75%
Motion - orient.	1.13	1.09	1.33	0.94	1.41	124.76%	105.78%
Task	1.13	1.43	1.96	1.57	1.73	173.61%	148.36%
Task - display	1.13	1.75	1.68	1.76	1.76	156.47%	154.21%
Task - tasks	1.13	1.16	1.60	1.13	1.53	141.76%	120.03%
Phone	1.13	1.12	0.97	0.70	0.99	99.41%	83.85%
Network	1.13	1.43	1.34	1.26	1.82	161.79%	129.88%
Network - state	1.13	1.31	1.75	1.58	1.82	161.79%	143.27%
Network - env.	1.05	1.79	1.45	1.44	1.08	170.20%	137.07%
Device	1.13	1.07	1.56	1.12	1.24	138.14%	110.74%
Device - battery	1.13	0.71	1.12	1.23	1.12	109.39%	92.78%
Device - storage	1.13	0.95	1.07	1.44	1.42	127.49%	108.09%
Device - memory	1.13	0.92	0.79	1.24	1.30	115.59%	94.46%
Device - audio	1.13	0.46	0.63	0.96	1.30	114.93%	74.26%
Player	1.13	1.29	1.36	1.35	1.35	120.77%	118.46%
All	1.13	0.90	1.78	1.14	1.14	158.02%	110.05%

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Predicting class *artist*

Best results achieved, significantly outperforming baseline.

Relation {context → artist} seems to be predictable.

Dataset	0-R	KNN	C4.5	SVM	BN	Max.rel.	Avg.rel.
Time	28.54	60.83	57.10	59.68	58.70	213.15%	207.01%
Location	28.54	42.69	41.42	37.80	40.04	149.58%	141.86%
Location - state	28.54	41.71	41.83	33.11	37.05	146.55%	134.64%
Location - place	28.54	35.74	36.99	36.07	36.28	129.62%	127.09%
Weather	28.54	63.46	63.25	56.06	61.34	222.35%	213.84%
Ambient	28.54	34.70	36.83	31.17	35.18	129.03%	120.77%
Ambient - no n.	28.54	33.54	34.87	31.43	34.46	122.19%	117.65%
Ambient - noise	28.54	26.12	30.55	28.75	29.81	107.04%	100.94%
Motion	28.54	35.08	36.10	37.14	35.11	130.15%	125.65%
Motion - acc.	28.54	26.54	27.87	28.93	28.62	101.36%	98.07%
Motion - orient.	28.54	36.22	35.63	36.54	35.17	128.02%	125.75%
Task	28.54	60.75	60.65	59.63	56.20	212.86%	207.81%
Task - display	28.54	28.12	28.31	28.62	28.34	100.29%	99.33%
Task - tasks	28.54	61.35	61.28	60.28	55.23	214.97%	208.60%
Phone	28.54	37.30	38.74	31.33	33.74	135.74%	123.61%
Network	28.54	36.38	36.44	37.93	34.87	132.90%	127.56%
Network - state	28.54	34.95	33.14	34.58	34.17	122.45%	119.86%
Network - env.	21.90	25.01	26.42	27.43	22.69	125.26%	115.92%
Device	28.54	70.42	68.68	54.95	65.31	246.76%	227.20%
Device - battery	28.54	39.10	47.15	36.41	46.02	165.23%	147.76%
Device - storage	28.54	61.17	60.37	40.96	57.92	214.33%	193.08%
Device - memory	28.54	39.22	40.56	32.11	36.53	142.10%	130.01%
Device - audio	28.54	47.92	47.71	41.42	42.76	167.90%	157.50%
Player	28.54	38.18	38.36	38.30	38.25	134.41%	134.10%
All	28.54	69.56	69.01	69.87	67.66	244.83%	241.86%

Ameliorating Music Recommendation

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Predicting class *genre*

Prediction on more general level than for artist.

Still genre is an ill-defined concept, hence results inferior to artist prediction.

Dataset	0-R	KNN	C4.5	SVM	BN	Max.rel.	Avg.rel.
Time	29.80	46.75	44.99	46.46	46.27	156.88%	154.76%
Location	29.80	32.92	34.17	34.45	32.05	115.61%	112.08%
Location - state	29.80	32.25	33.41	32.48	30.44	112.12%	107.87%
Location - place	29.80	29.75	32.54	32.38	32.45	109.19%	106.65%
Weather	29.80	49.68	50.61	43.77	46.70	169.83%	160.03%
Ambient	29.80	28.30	34.12	31.38	33.27	114.50%	106.61%
Ambient - no n.	29.80	31.52	33.39	31.42	33.34	112.04%	108.79%
Ambient - noise	29.80	23.38	29.92	29.67	29.77	100.40%	94.57%
Motion	29.80	32.23	34.34	34.56	34.39	115.98%	113.69%
Motion - acc.	29.80	25.67	28.55	30.50	30.41	102.35%	96.59%
Motion - orient.	29.80	34.49	35.22	34.28	34.39	118.21%	116.10%
Task	29.80	43.89	46.47	44.55	41.85	155.95%	148.29%
Task - display	29.80	28.57	29.04	28.78	28.78	97.44%	96.61%
Task - tasks	29.80	44.71	47.62	44.94	42.31	159.81%	150.66%
Phone	29.80	31.17	33.43	31.33	30.13	112.20%	105.77%
Network	29.80	32.31	31.96	33.93	31.73	113.85%	109.00%
Network - state	29.80	31.70	31.14	32.07	31.26	107.63%	105.85%
Network - env.	26.10	26.17	27.02	29.78	27.28	114.08%	105.58%
Device	29.80	49.65	50.03	43.16	48.00	167.88%	160.11%
Device - battery	29.80	31.58	38.03	33.42	35.85	127.61%	116.51%
Device - storage	29.80	47.76	47.55	37.25	46.56	160.29%	150.28%
Device - memory	29.80	30.79	36.87	31.76	36.60	123.73%	114.11%
Device - audio	29.80	40.19	41.12	38.16	37.02	137.99%	131.29%
Player	29.80	35.79	36.34	36.08	35.59	121.96%	120.65%
All	29.80	46.75	49.22	50.41	48.51	169.15%	163.50%

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(5) Music recommendation for places of interest

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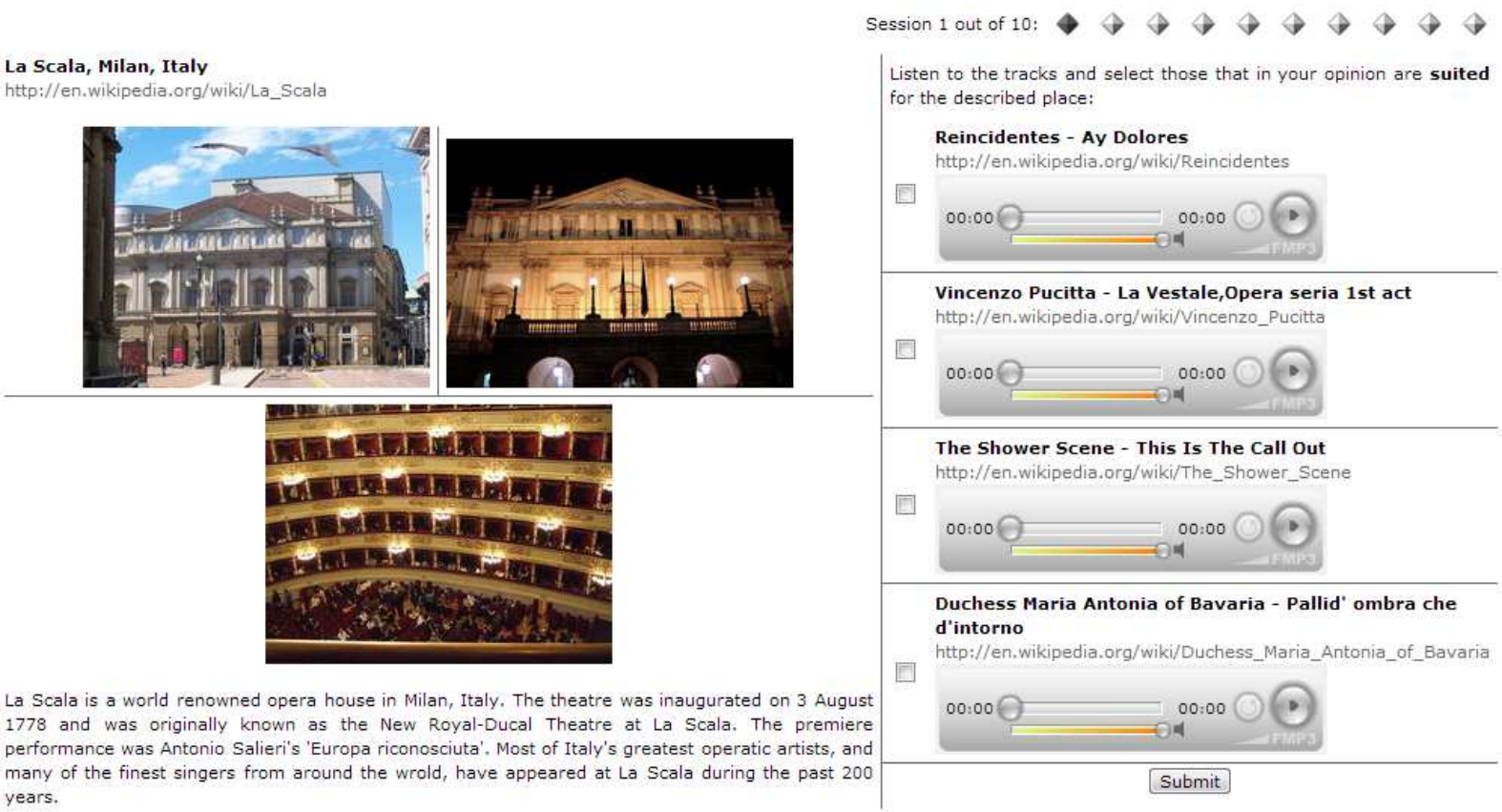
Music Recommendation for Places of Interest

(Kaminskas et al.; RecSys 2013)

Recommend music that is suited to a place of interest (POI) of the user (context-aware)



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Matching Places of Interest and Music

Approaches:

- *genre-based*: only play music belonging to the user's preferred genres (baseline)

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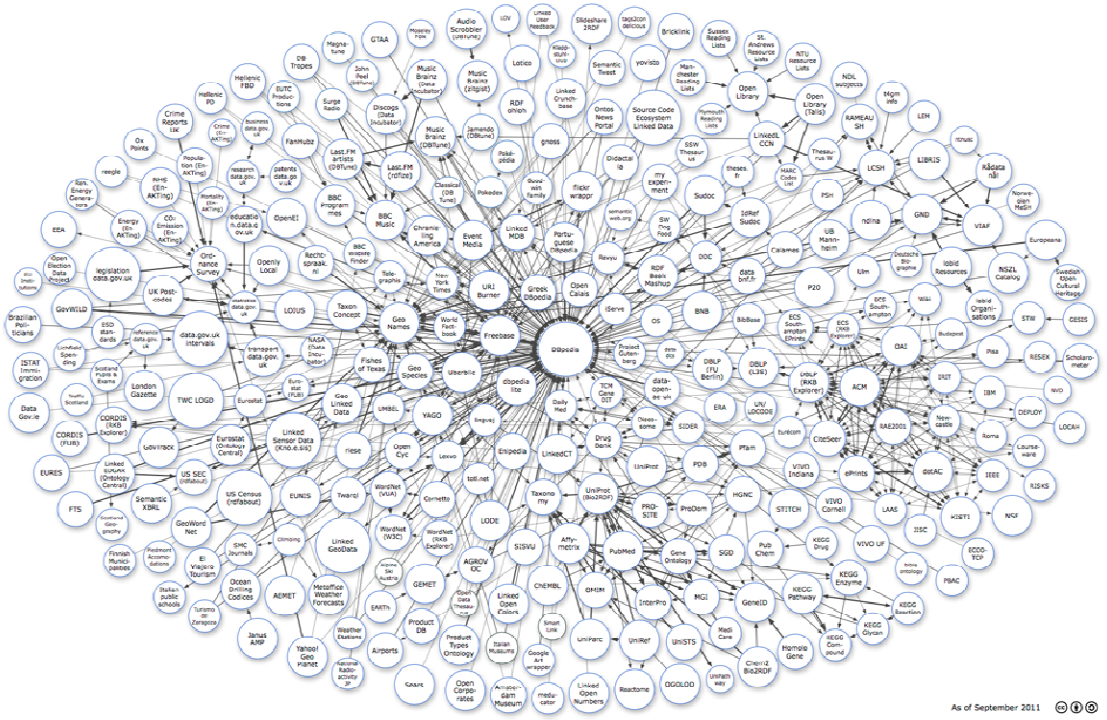
Matching Places of Interest and Music

Approaches:

- *knowledge-based*: use the DBpedia knowledge base (relations between POIs and musicians)



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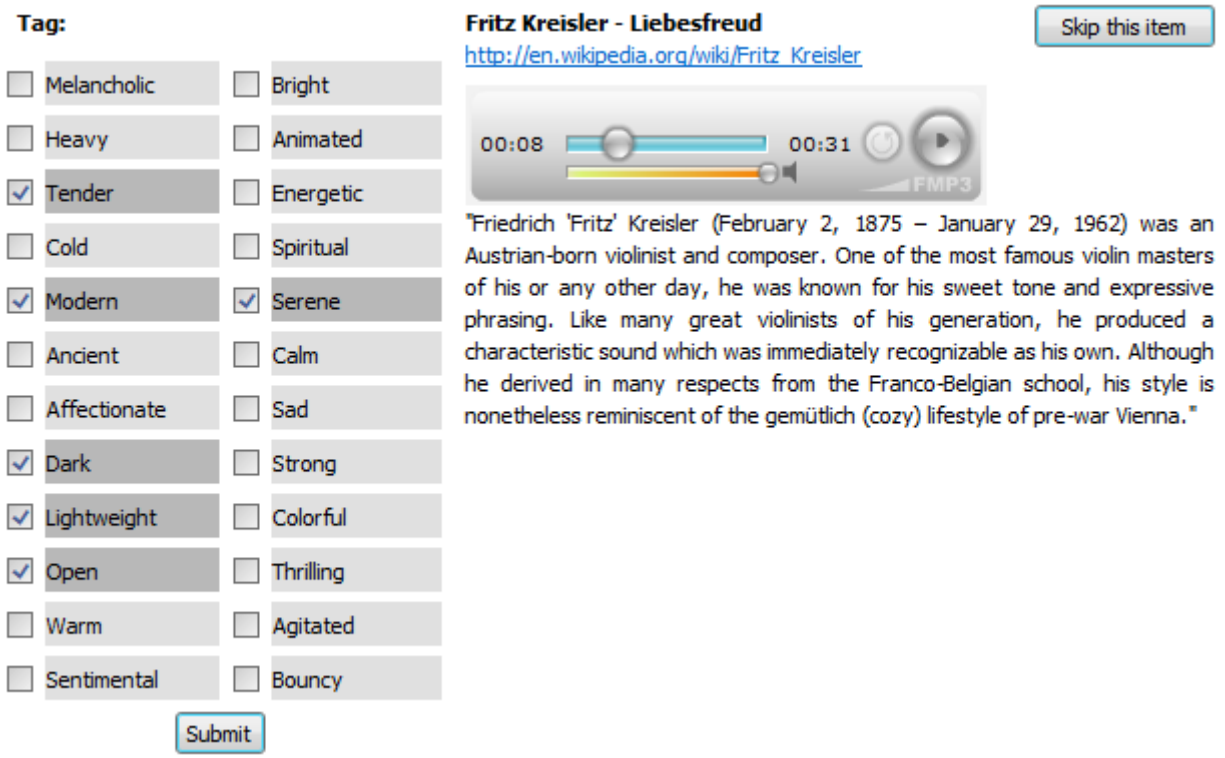
Matching Places of Interest and Music

Approaches:

- *tag-based*: user-assigned emotion tags describing images of POIs and music, Jaccard similarity between music-tag-vectors and POI-tag-vectors



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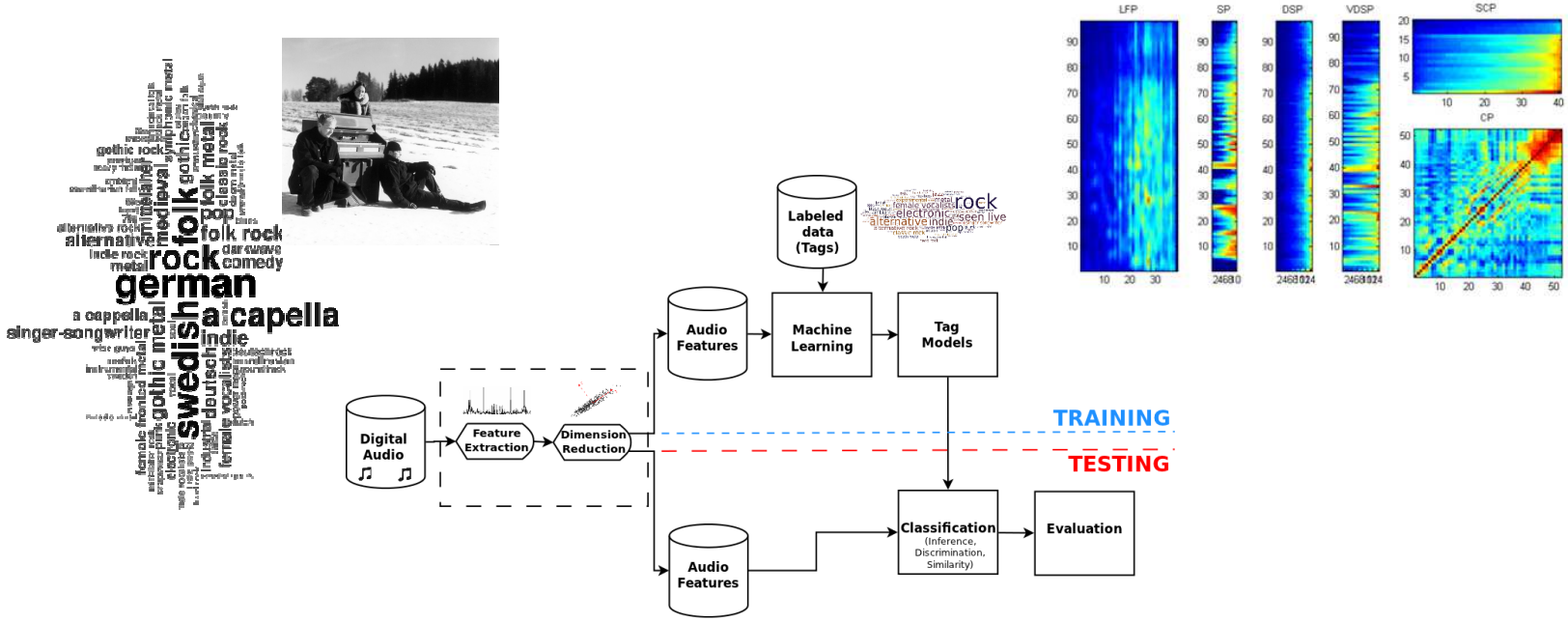
Matching Places of Interest and Music

Approaches:

- *auto-tag-based*: use state-of-the-art music auto-tagger based on the Block-level Feature framework to automatically label music pieces; then again compute Jaccard similarity between music-tag-vectors and POI-tag-vectors



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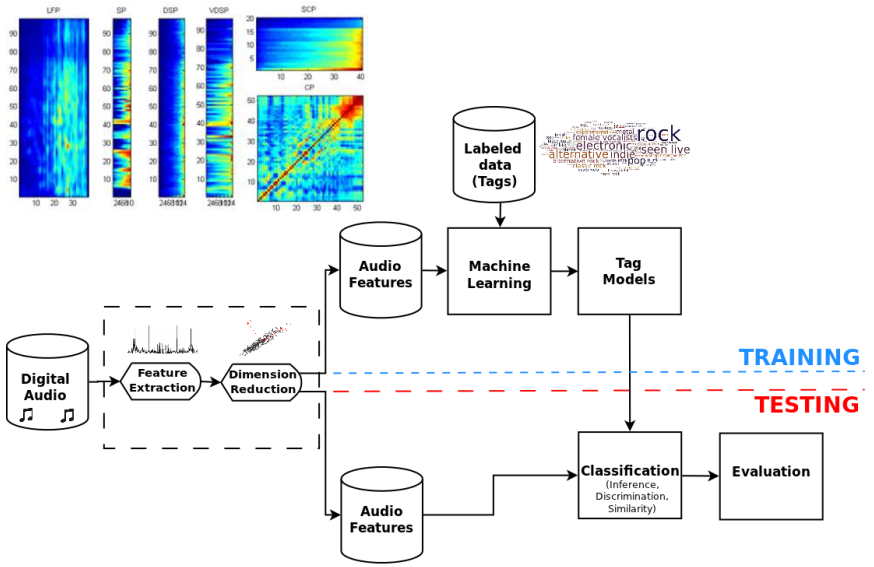
Matching Places of Interest and Music

Approaches:

- *combined*: aggregate music recommendations w.r.t. ranks given by knowledge-based and auto-tag-based approaches



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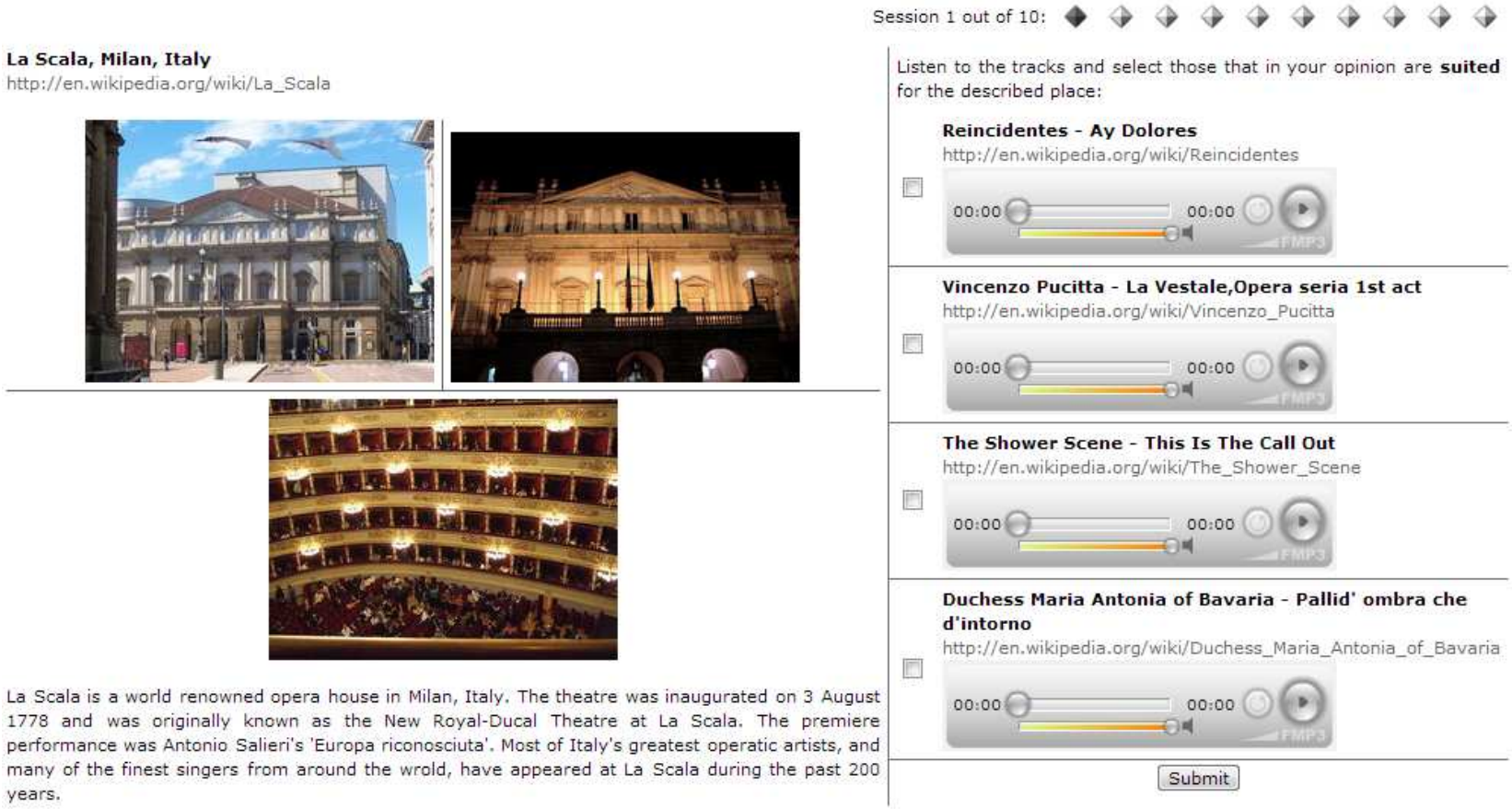
Matching Places of Interest and Music

Evaluation:

- user study via web interface (58 users, 564 sessions)



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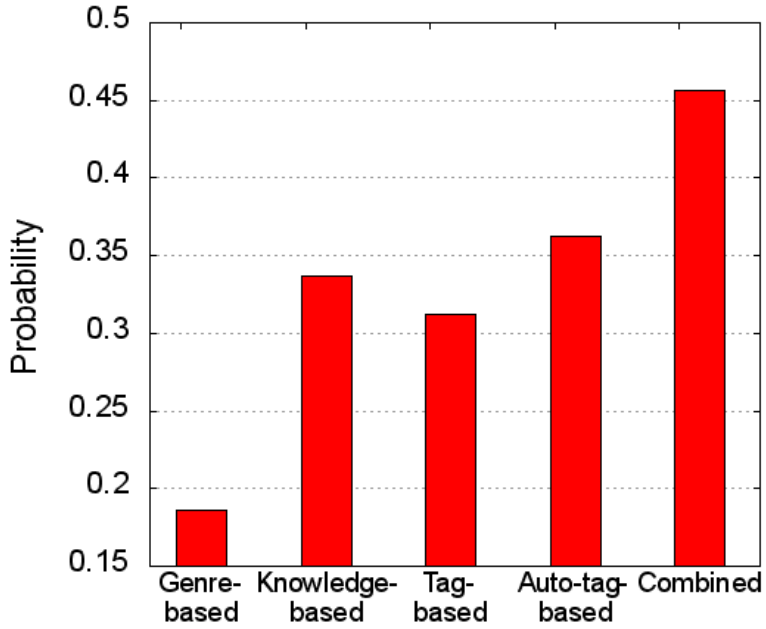
Matching Places of Interest and Music

Evaluation:

- Performance measure: number of times a track produced by each approach was considered as well-suited in relation to total number of evaluation sessions, i.e. probability that a track marked as well-suited by a user was recommended by each approach



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Future Directions in Music Recommendation

- Take a **multimodal view** onto the task of music retrieval and recommendation
- Increase performance of **music similarity measures**
- Model **user properties and -context**
- Elaborate **serendipitous access schemes** to music collections:
  similarity, diversity, familiarity, novelty, recentness
- Improve **personalization** and **context-awareness**
- **User-centric evaluation** strategies for personalized MIR systems

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Thank you!

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More Information

Journals:

(M. Schedl; 2012) **#nowplaying Madonna: A Large-Scale Evaluation on Estimating Similarities Between Music Artists and Between Movies from Microblogs**, Information Retrieval, 15(3-4), 2012.

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More Information

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(D. Hauger, M. Schedl; 2012) **Exploring Geospatial Music Listening Patterns in Microblog Data**, Proceedings of the 10th International Workshop on Adaptive Multimedia Retrieval (AMR 2012), Copenhagen, Denmark, October 2012.

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(M. Schedl, T. Pohle, N. Koenigstein, P. Knees; 2010) **What's Hot? Estimating Country-Specific Artist Popularity**, 11th International Society for Music Information Retrieval Conference (ISMIR 2010), Utrecht, the Netherlands, August 2010.

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Conference/Workshop Proceedings:

(M. Schedl; 2013) **Leveraging Microblogs for Spatiotemporal Music Information Retrieval**, Proceedings of the 35th European Conference on Information Retrieval (ECIR 2013), Moscow, Russia, March 2013.

(M. Schedl, D. Schnitzer; 2013) **Hybrid Retrieval Approaches to Geospatial Music Recommendation**, Proceedings of the 35th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR 2013), Dublin, Ireland, July-August 2013.