Machine listening and reading at scale

Brian Whitman
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@bwhitman / brian@echonest.com

Whitman.

n. It's easy to stay updated on an

w @bwhitman.

ing **follow bwhitman** to **40404** in the United States

Codes for other countries

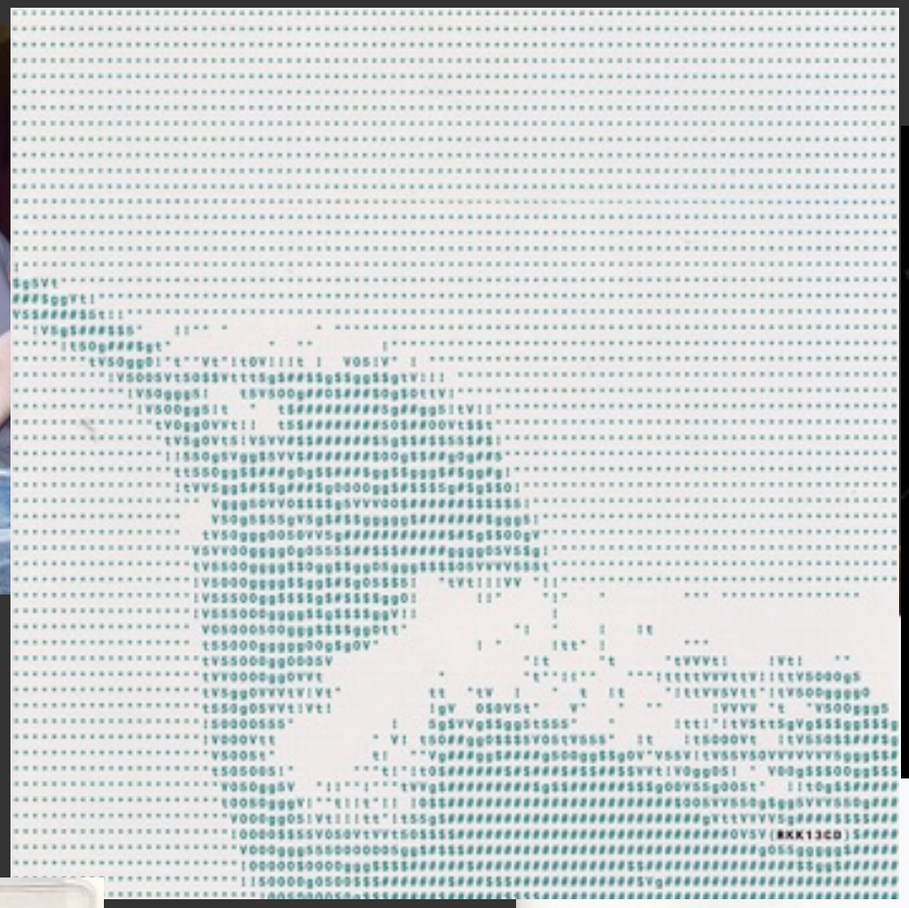
Hello! I "teach computers to listen to music"

Name Brian Whitman

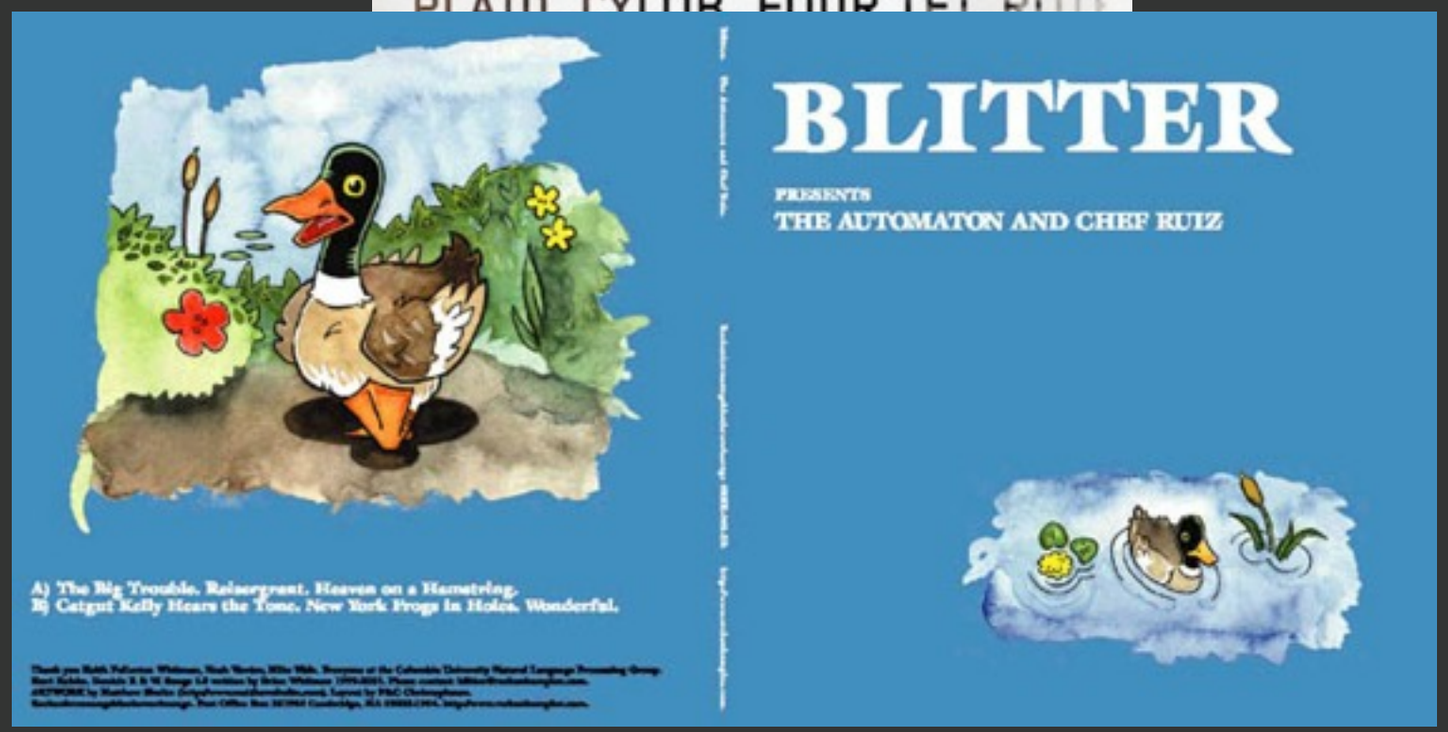
Location Cambridge MA, USA

Web http://notes.vari...

Bio teach computers to listen to music. co-founder of the echo nest



STEREOLAB, SQUAREPUSHER,



Napster v2.0 BETA 10.3

File View Actions Help

Shop for music at CDNOW

Home | Chat | My Files | Search | Hot List | Transfer | Discover | Help

Online
napster060620...
SpanishHay

Offline
jonknibbs
r_kaura

Filename	Filesize	Bitrate	Frequency	Length
Zion I - critical.mp3	3,798,959	128	44100	3:51
Yuji Oniki - paper tigers.mp3	3,505,970	128	44100	3:33
Young Scott Perrie - everytime.mp3	4,957,964	320	44100	2:01
Wonderlick - right crazy rough mix.mp3	4,572,891	128	44100	4:39
Willard Grant Conspiracy - christmas in nevada.mp3	3,579,530	128	44100	3:38
Unknown - coconuts.mp3	4,856,236	128	44100	4:56
Wellwater Conspiracy - of dreams.mp3	3,466,264	128	44100	3:31
Waco Brothers - fox river.mp3	3,903,738	128	44100	3:58
Vivendo de Pao - riso de gilberto.mp3	3,377,656	128	44100	3:26
Vivendo de Pao - jacare.mp3	3,166,169	128	44100	3:13
Virgil Shaw - water cooler.mp3	4,988,928	128	44100	5:04
Virgil Shaw - volvo ff.mp3	3,220,086	128	44100	3:16
Unknown - next degree.mp3	4,062,125	128	44100	4:07
Unknown - are we people.mp3	2,932,736	96	44100	3:58
Trail of Dead - mistakes and regrets merge.mp3	3,631,104	128	44100	3:41
Tom Heyman - bottle full of wishes.mp3	4,008,229	128	44100	4:04
Tom Armstrong - thinking of him.mp3	2,671,723	128	44100	2:43
Tom Armstrong - looking forward to looking back.mp3	3,475,877	128	44100	3:32
tobyslater - the next life.mp3	3,089,870	128	44100	3:08
Unknown - sky is not crying.mp3	6,891,439	128	44100	7:00
The Rosenbergs - sucking on a plum.mp3	3,120,193	128	44100	3:10
The Rosenbergs - soaked in polyester.mp3	4,795,374	128	44100	4:52
The Rosenbergs - secret.mp3	4,147,955	128	44100	4:13
The Rosenbergs - overboard.mp3	6,839,612	128	44100	6:57
The Rosenbergs - little lie.mp3	2,911,214	128	44100	2:57

User: napster06062001 Total Files: 262 File Data: 1,014 megs Ping: N/A

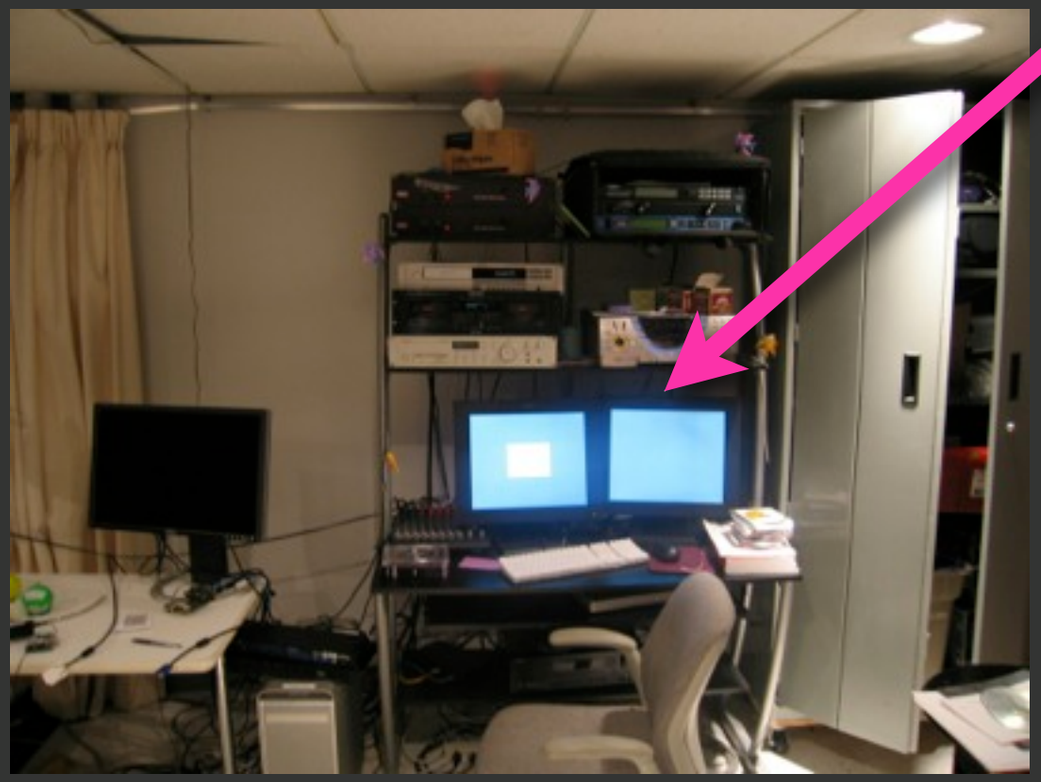
Get Selected Files | Add User to Hot List

Online (rishdeep): Sharing 0 files.

Currently 89,910 users sharing 138,637 files (549 gigs)

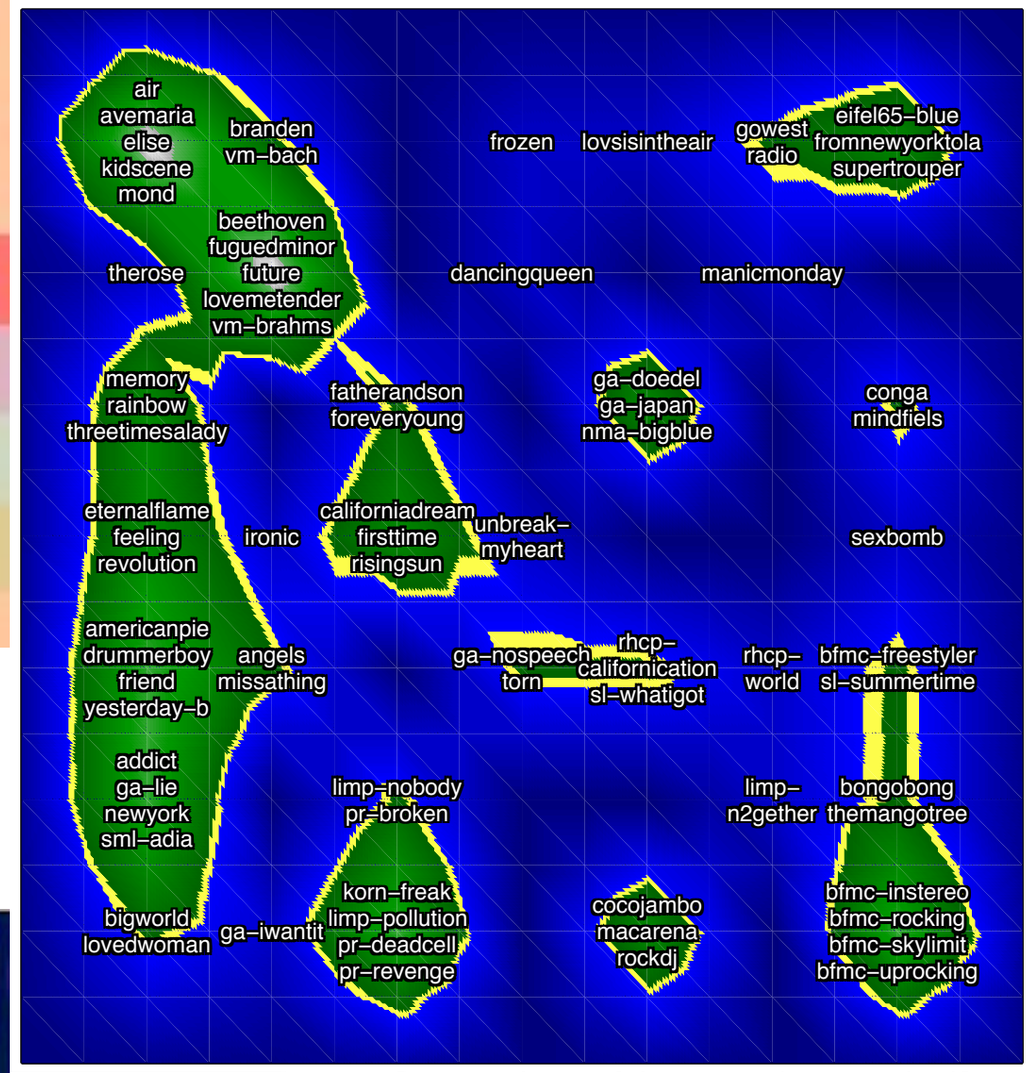
Columbia University, NYC

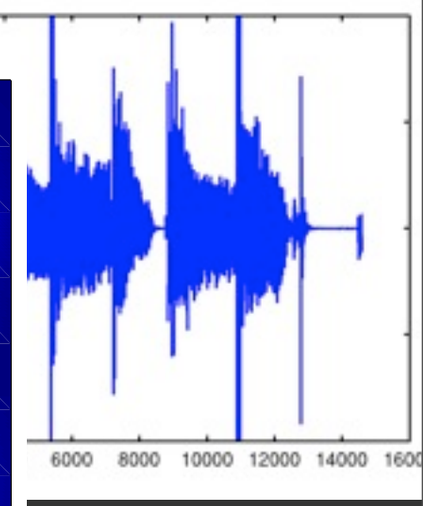
MIT Media Lab



finishing my dissertation

blues
reggae
pop
classical
rock


air
avemaria
elise
kidscene
mond
branden
vm–bach
frozen
lovsisintheair
gowest
radio
eifel65–blue
fromnewyorktola
supertrouper
beethoven
fuguedminor
therose
future
lovemetender
vm–brahms
dancingqueen
manicmonday
memory
rainbow
threetimesalady
fatherandson
foreveryoung
ga–doedel
ga–japan
nma–bigblue
conga
mindfiels
eternalflame
feeling
revolution
ironic
californiadream
firsttime
risingsun
unbreak–
myheart
sexbomb
americanpie
drummerboy
friend
yesterday–b
angels
missathing
ga–nospeech
torn
rhcp–
californication
sl–whatigot
rhcp–
world
bfmc–freestyler
sl–summertime
addict
ga–lie
newyork
sml–adia
limp–nobody
pr–broken
limp–
n2gether
bongobong
themangotree
bigworld
lovedwoman
ga–iwantit
korn–freak
limp–pollution
pr–deadcell
pr–revenge
cocojambo
macarena
rockdj
bfmc–instereo
bfmc–rocking
bfmc–skylimit
bfmc–uprocking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8000
10000
12000
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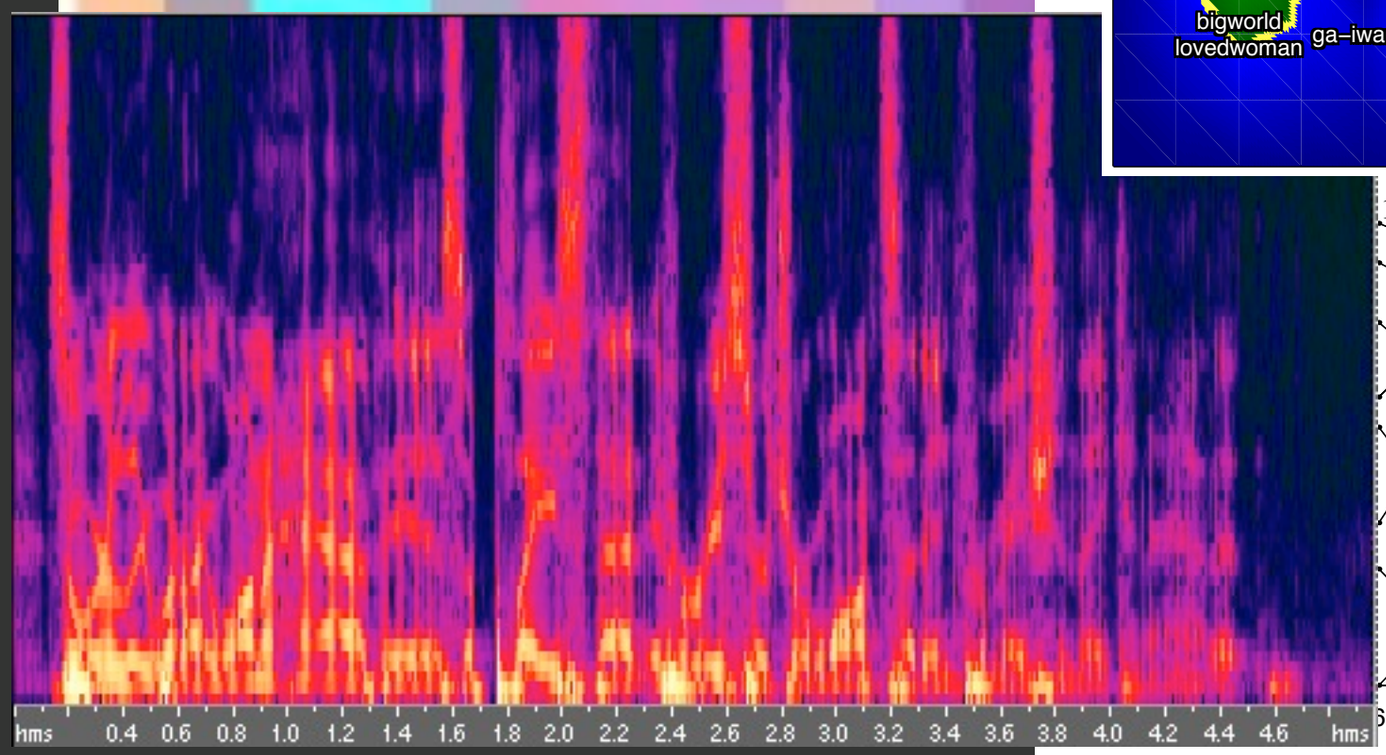
1600


hms
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
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4.0
4.2
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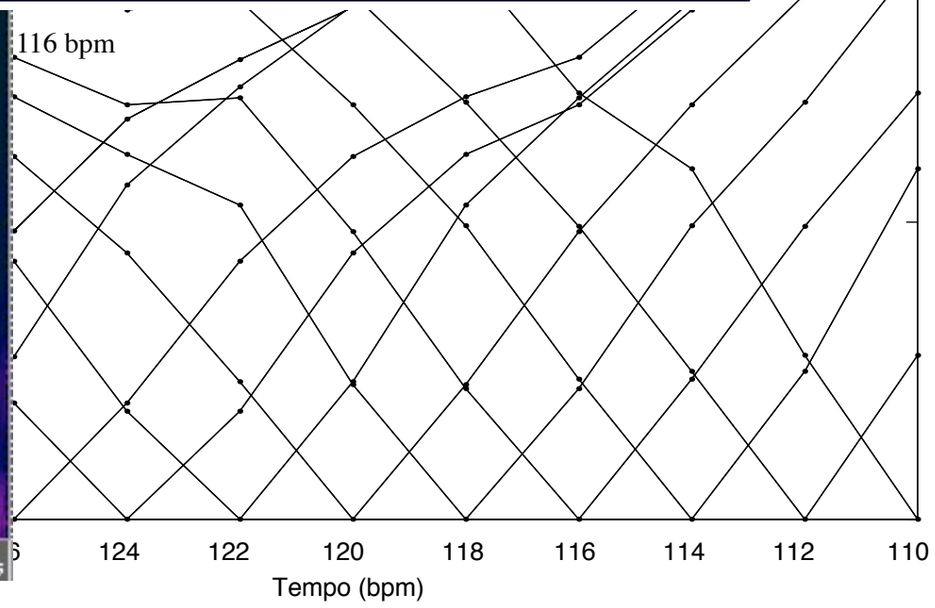
4.6
hms


116 bpm
124
122
120
118
116
114
112
110
Tempo (bpm)

Track #	Name	Time	Artist	Album
8	Combustive	4:56	Arto Lindsay	Salt
9	Make that sound	3:56	Arto Lindsay	Salt
10 of 10	Salt	4:00	Arto Lindsay	Salt
1	Sundown	2:27	Barn Owl	Ancestral Star
2	Visions in Dust	4:01	Barn Owl	Ancestral Star
3	Night's Shroud	2:15	Barn Owl	Ancestral Star
4	Ancestral Star	10:01	Barn Owl	Ancestral Star
5	Cavern Hymn	1:59	Barn Owl	Ancestral Star
6	Flatlands	6:17	Barn Owl	Ancestral Star
7	Twilight	2:36	Barn Owl	Ancestral Star
8	Awakening	2:54	Barn Owl	Ancestral Star
9	Incantation	1:58	Barn Owl	Ancestral Star
10	Light From the Mesa	6:43	Barn Owl	Ancestral Star
3	Pass the Mic	4:17	Beastie Boys	Check Your Head
12	Stand Together	2:47	Beastie Boys	Check Your Head
18	Professor Booty	4:13	Beastie Boys	Check Your Head
1 of 13	E-Pro	3:28	Beck	Guero
2 of 13	Que Onda Guero	3:45	Beck	Guero
3 of 13	Girl	3:54	Beck	Guero
4 of 13	Missing	4:58	Beck	Guero
5 of 13	Black Tambourine	2:52	Beck	Guero
6 of 13	Earthquake Weather	4:37	Beck	Guero
7 of 13	Hell Yeah	3:29	Beck	Guero
		4:26	Beck	Guero
		7:01	Beck	Guero

.43 GB

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Tag Result

Listening...

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jams of t

Track	
Nautilu	
Bassline	Mantronix
Sea Song	Robert Wyatt
Liquid Swords	GZA/Genius
Miami Vice Theme - Miami Vice/Soun...	Jan Hammer
Paid In Full	Eric B. & Rakim
Octopus	Syd Barrett

Music retrieval and “music intelligence” applications

creepy

Hit prediction

Taste / recommendation

Automated composition

Classification, tagging

Feature extraction (key, tempo)

Search & retrieval

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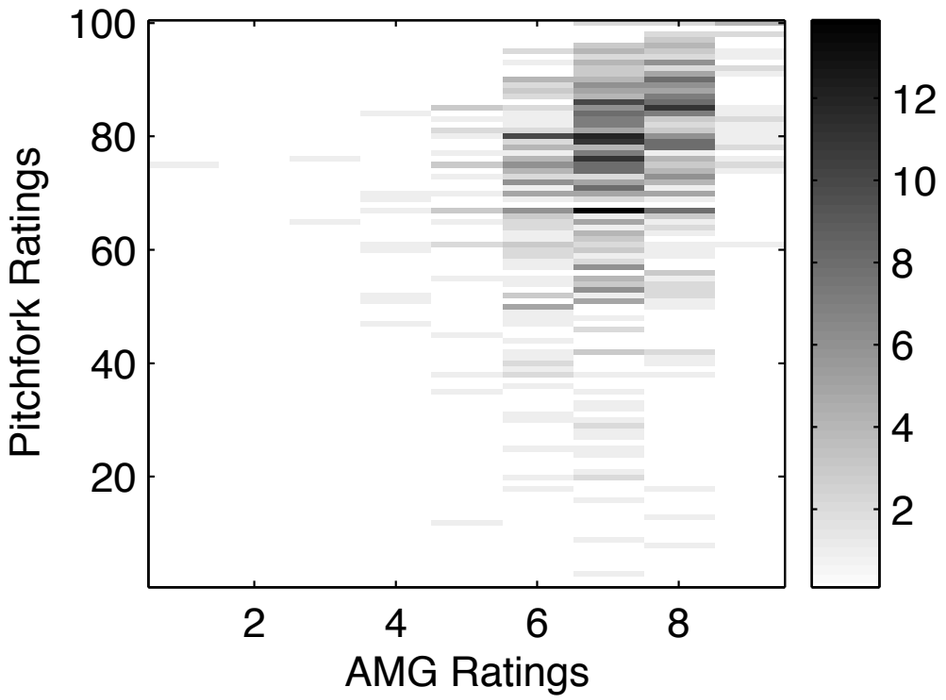
Keith Fullerton Whitman
Playthroughs
[Kranky; 2002]
Rating: 9.7

You probably know Keith Fullerton Whitman as breakcore maven Hrvatski, a man who played in a few bands before developing an obsession with Squarepusher and deciding to probe the most hectic beats possible on labels such as Planet µ and his own Reckankreuzung, as well as falling into the Tigerbeat6 orbit. You also may know Hrvatski by his pithy electronic music write-ups for the Forced Exposure website, penned while he worked in sales for the revered distributor. But the Keith Fullerton Whitman of *Playthroughs* has kept a lower profile. Starting last year with the *21:30 for Acoustic Guitar* EP, Whitman began experimenting with subtle music based on laptop-processed guitar tones. While he's tinkered with this approach here and there, *Playthroughs* is his first sustained exploration of quiet sound.

If you've listened to the more drone-focused side of electronic music in the last few years, you've definitely heard the core elements that make up *Playthroughs*. There is no radical breakthrough in texture here, nothing to make you turn your head and say, "What the hell was that?" *Playthroughs* consists entirely of processed guitar, but the tones are light on harmonics, with many possessing an almost sine wave-level of clarity. As the thin drones hang in the air and shift this way and that, they harmonize with other drones and find themselves poked with fuzzy implements of static. Nothing terribly earth-shattering about this composition method.

It's true that much of *Playthroughs* seems familiar on the surface, but I don't think it an exaggeration to say that this record essentially perfects this particular style of music. It's an album of meticulous balance, Zen focus, and tiny gestures that carry great force, where each individual piece of sound is carefully placed to maximize impact. The first 3½ minutes of "feedback zwei", for example, consists of overlapping blankets of clean, piercing electronic feedback that remain in constant motion, creating new harmonic patterns with each passing second. And an unexpected cloud of pink noise slowly envelops the sound field, bathing the entire track in a warm digital mist and drastically shifting the perspective.


Pitchfork Ratings
AMG Ratings
100
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10
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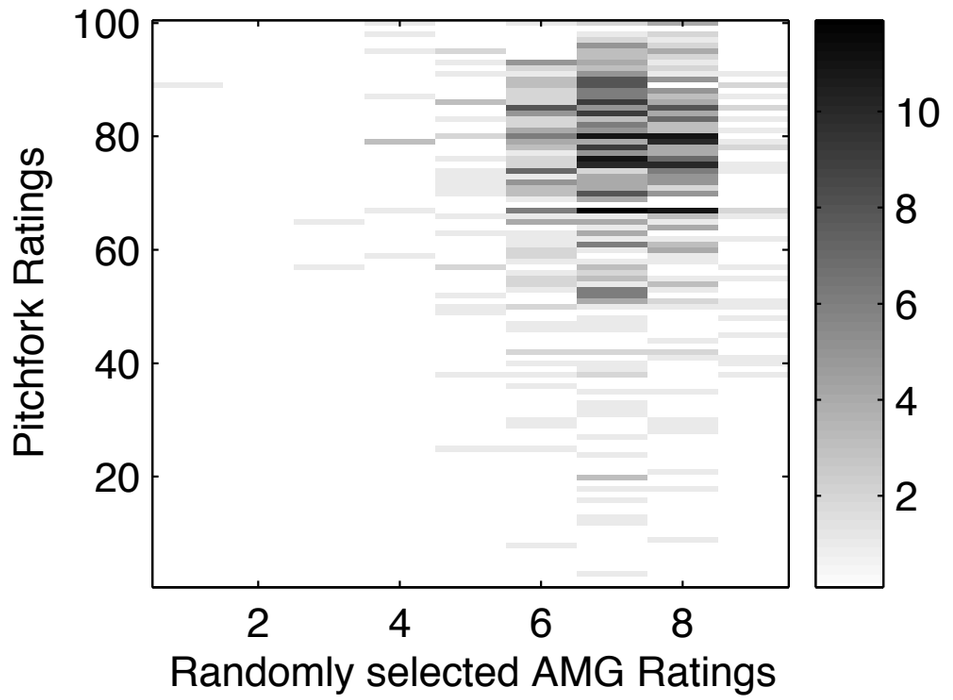
4
2


Pitchfork Ratings
Randomly selected AMG Ratings
100
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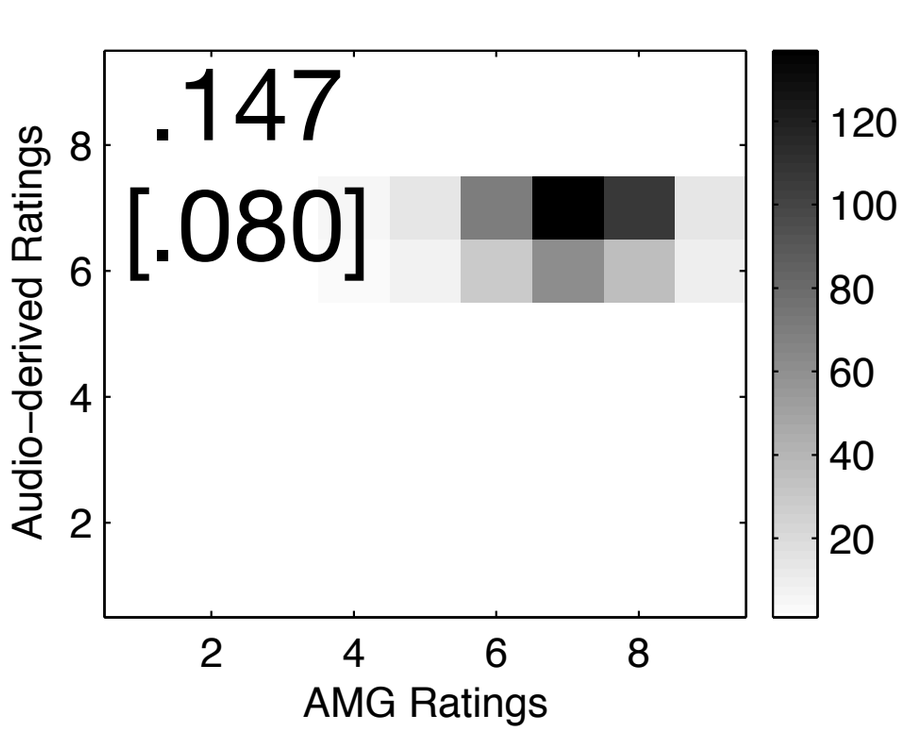
.147
[.080]
Audio−derived Ratings
AMG Ratings
8
6
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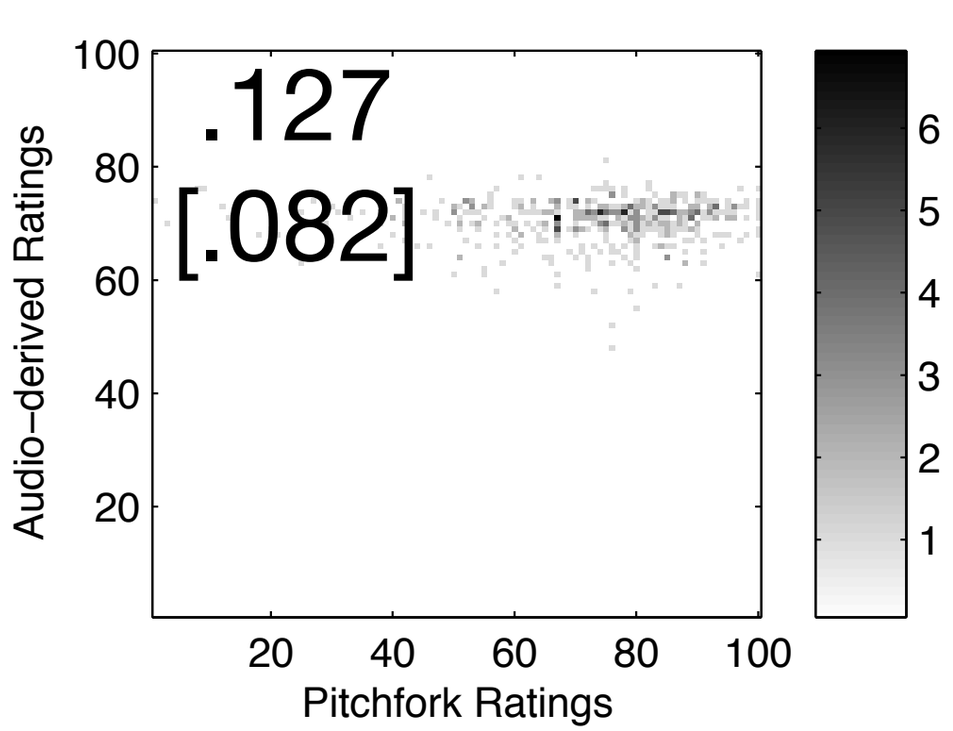
.127
[.082]
Audio−derived Ratings
Pitchfork Ratings
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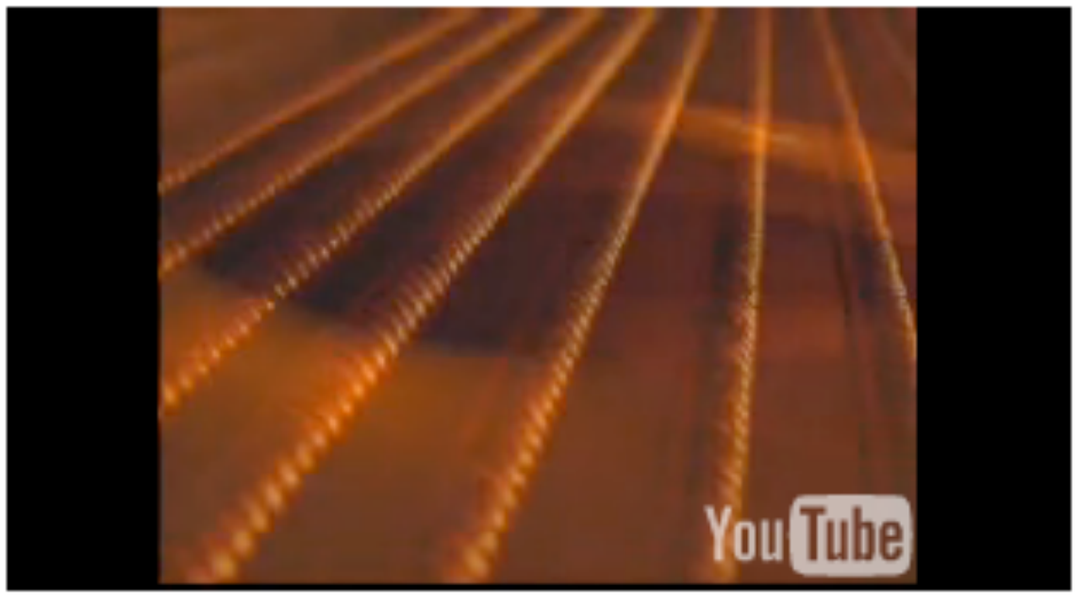
2
1

Avril 14

Aphex Twin

Buy | Ringtone

0:36 / 02:01



- Wax Simulacra by The Mars Volta
- Sound Of A Gun by Buzzcocks
- Rid Of Me by PJ Harvey
- Spitfire by The Prodigy
- grimace by White Panic
- Army Of Me by Björk
- On by Aphex Twin
- Born Slippy by Underworld

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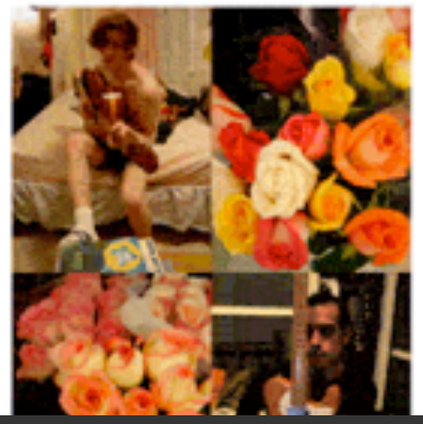
Or try searching Black Diamond Heavies next »

After searching for Sugarplastic another user searched for black diamond heavies, want to try it?



1

cure little bands is The

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Psychic Stunts - Something to Tell My K...

Discovered by ClassyLassy and commented 3 times

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1065

comments | watch video | hearted by | share this | similar

listeners who enjoyed this song also liked:

The End by Laura Jansen	1.000
Ask Me A Question by minipop	0.833
Nattöppet by Detektivbyrån	0.802
Harold T. Wilkins by Fanfarlo	0.796
The Times by Verbal and The Kickdrums	0.794
Your Surrender by Temple Scene	0.756
Home Sweet Home by Detektivbyrån	0.653
Dansbanan by Detektivbyrån	0.653
Lyckans Undulat by Detektivbyrån	0.653
E18 by Detektivbyrån	0.653
Neonland by Detektivbyrån	0.653
Om Du Möter Varg by Detektivbyrån	0.653

Tracks similar to "Stairway to heaven"

BABY I'M A WANT YOU

Artist: Aaron Neville
Album: Tell It Like It Is [Aim]
88 %

Buy
More options

Preview similar tracks

Tubular Bells I (Full Album)

Artist: Mike Oldfield
87 %

Buy
More options

Preview similar tracks

Boo Hoo

Artist: Bert Kaempfert
86 %

Buy
More options

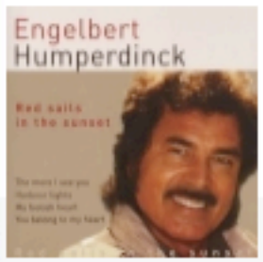
Preview similar tracks

Der Gnom

Artist: Mussorgsky, Modest Peter
86 %

Buy
More options

Preview similar tracks



A Lovely Way To Spend An...

Artist: Engelbert Humperdinck
Album: Red Sails in the Sunset
85 %

Buy
More options

Preview similar tracks

Set A	Set B	Set C
Britney Spears	Alice in Chains	Chris Isaak
Backstreet Boys	Korn	Bob Dylan
Cristina Aguilera	Faith no More	Crowded House

The Echo Nest 2007

Somerville
2 people
2 computers
Lots of ideas
1,000,000 documents
10,000 artists
100,000 songs

The Echo Nest 2011

Somerville, NY, SF, LDN
35 people
300 computers
150m people / month
5,000,000,000 documents
2,000,000 artists
35,000,000 songs

Audio features:

➔ musical features, Jehan ’05++

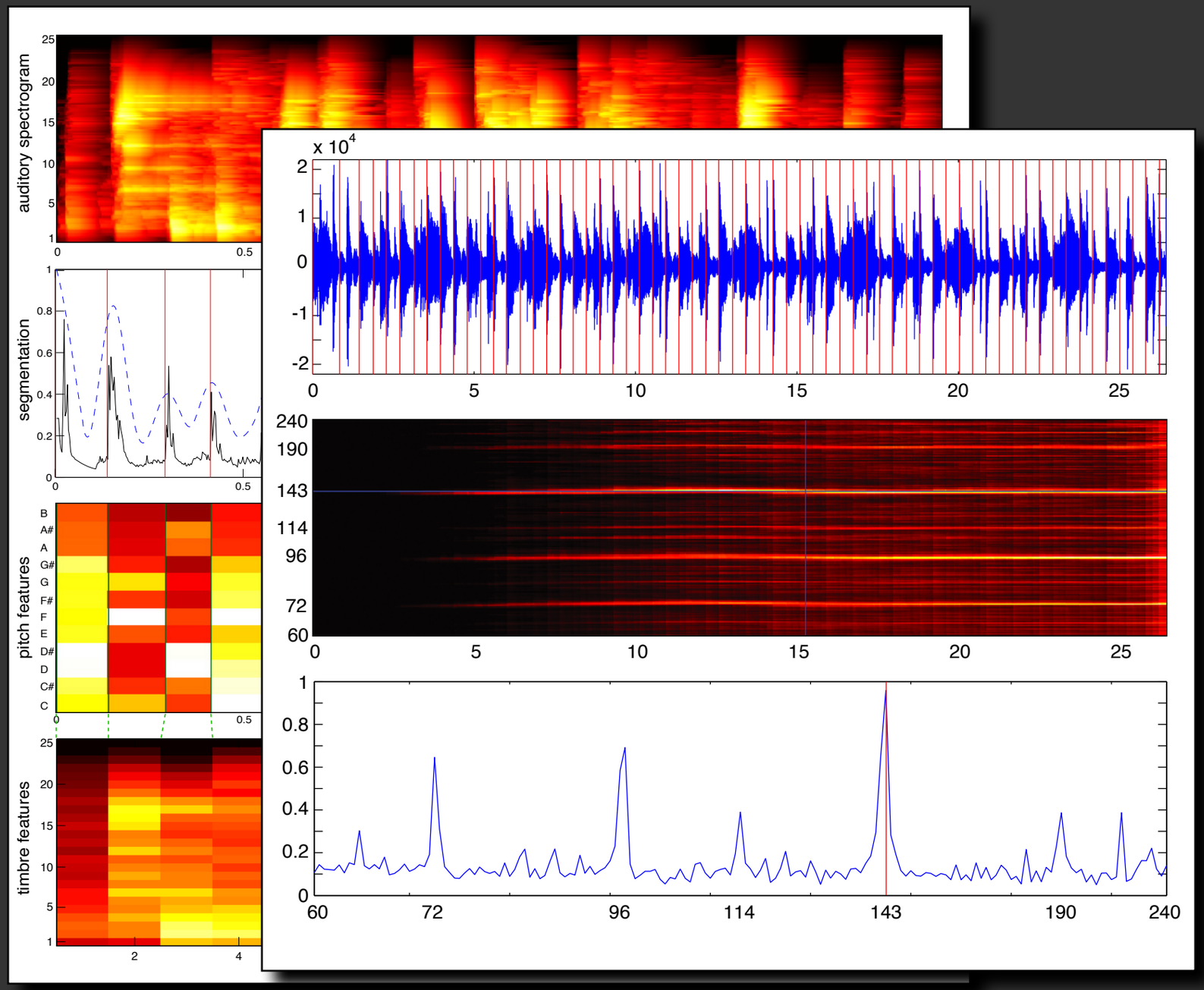
➔ publicly available, ~5s / song on cloud machines

auditory spectrogram

segments

pitch features

timbre features



beat markers

tempogram

tempo spectrum

Text features:

➔ “community metadata” Whitman ’02++

➔ web crawls, blogs, reviews, news: “top terms”

➔ constantly updated, > 1m pages/day

n2 Term	Score	np Term	Score	adj Term	Score
dancing queen	0.0707	dancing queen	0.0875	perky	0.8157
mamma mia	0.0622	mamma mia	0.0553	nonviolent	0.7178
disco era	0.0346	benny	0.0399	swedish	0.2991
winner takes	0.0307	chess	0.0390	international	0.2010
chance on	0.0297	its chorus	0.0389	inner	0.1776
swedish pop	0.0296	vous	0.0382	consistent	0.1508
my my	0.0290	the invitations	0.0377	bitter	0.0871
s enduring	0.0287	voulez	0.0377	classified	0.0735
and gimme	0.0280	something’s	0.0374	junior	0.0664
enduring appeal	0.0280	priscilla	0.0369	produced	0.0616

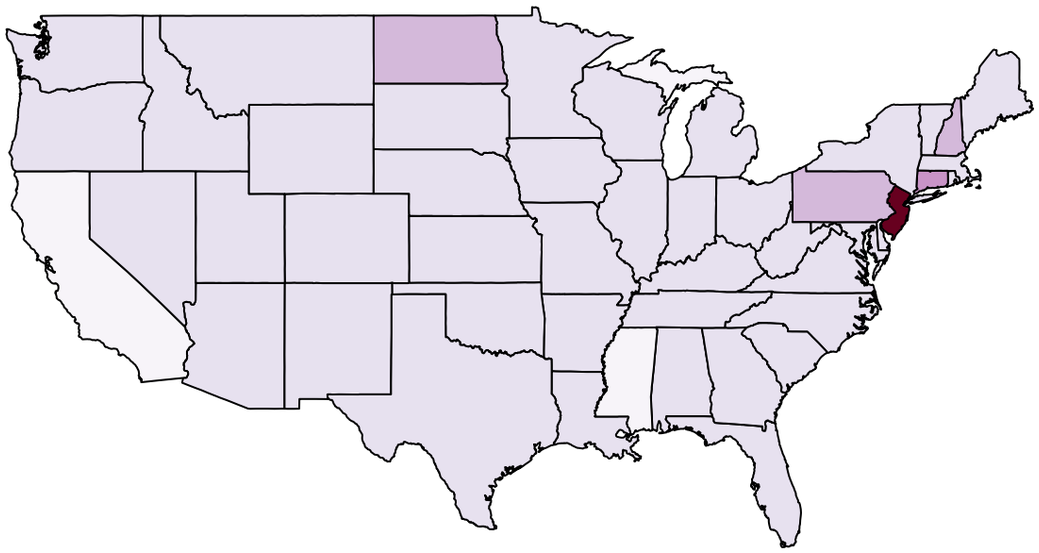
Metadata features:

→ Explicit categories, tags, similars from partners

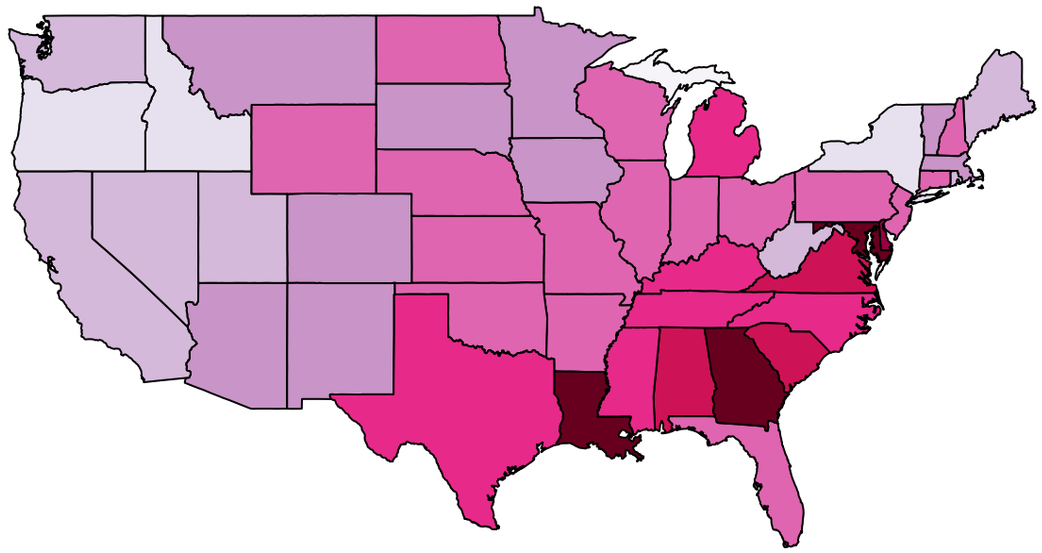
→ Physical sales data

→ Other ontologies

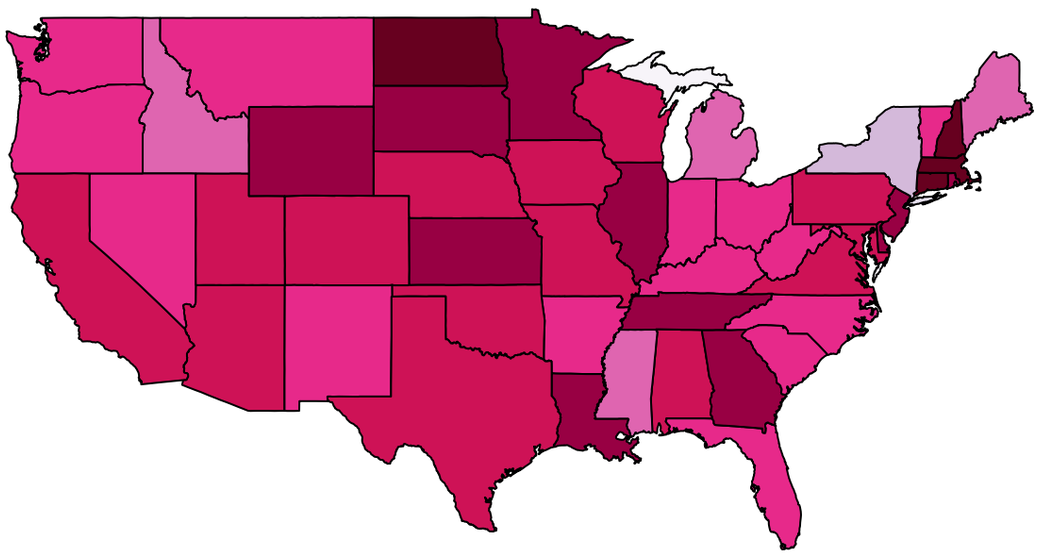
Per capita sales for BON JOVI



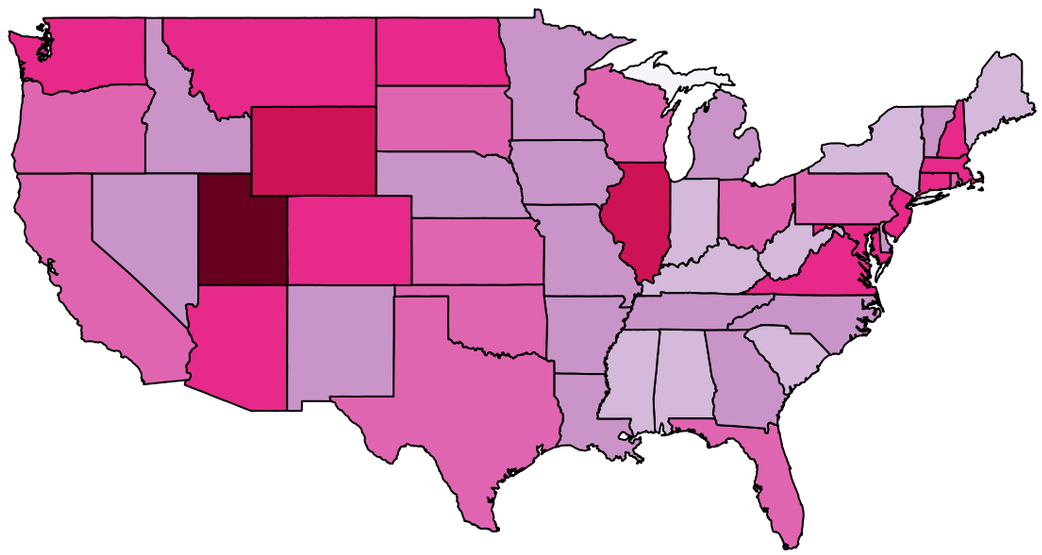
Per capita sales for YOUNG JEEZY



Per capita sales for JUSTIN BIEBER



Per capita sales for NEON TREES



Biggest database of artist data ever:

→ billions of datapoints about artists

→ web crawls: {terms: [(funky,0.34),(jazz:0.95)]}

→ metadata: {style:jazz, location:Boston}

→ user data: {id:LIX2923ND, likes:[Phonat, Apparat]}

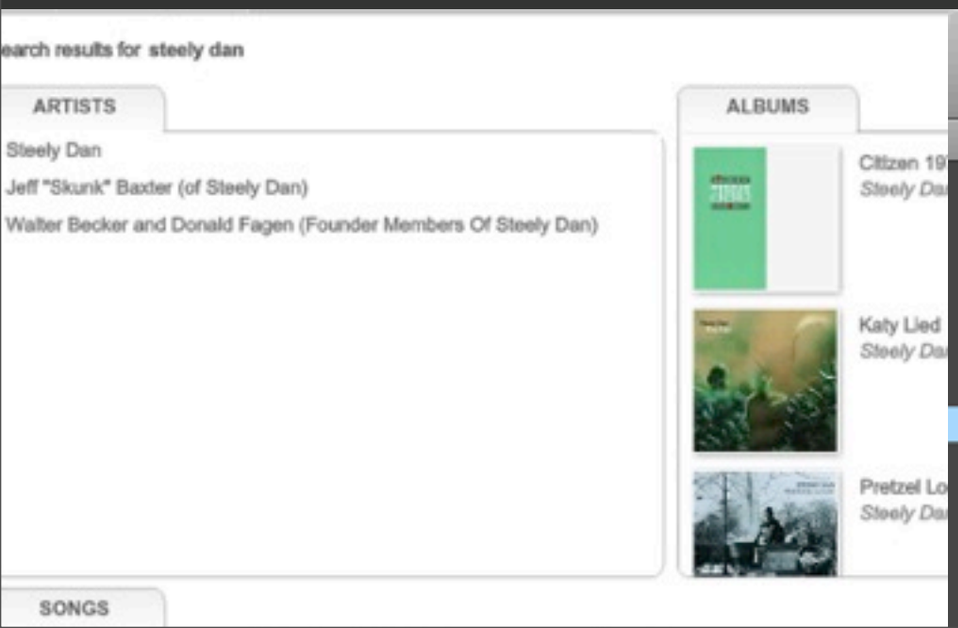
→ analytics: {hotttnesss: 0.45, chart_position... etc}

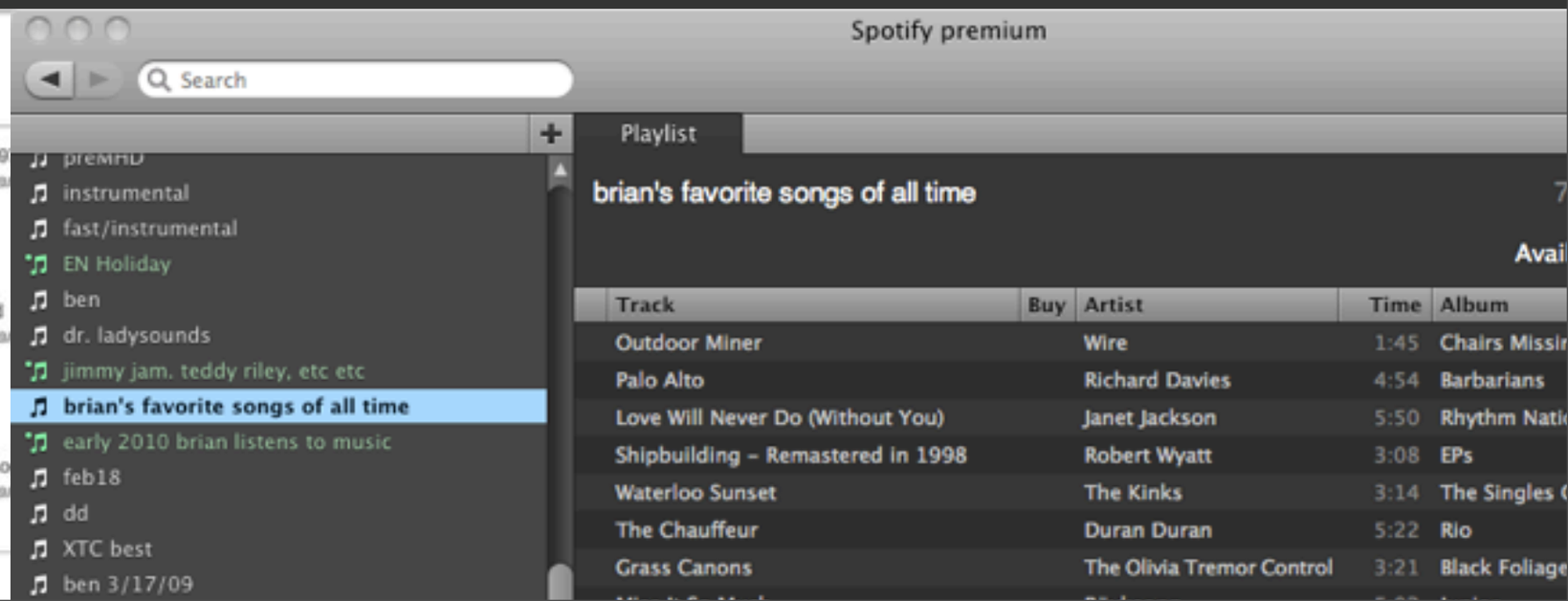
Normalize everything to a “term” in a big index:
→ words get indexed w/ their probabilities as TF
→ artist names gets resolved to IDs in a graph
→ numerical data goes out to a tree or clustered
→ optimizes for fast query, distributed is easy

$$style_i \cdot x + genre_i \cdot y + location_i \cdot z + webtext_i \cdot r...$$

→ “boosts” set in real time per app or trained

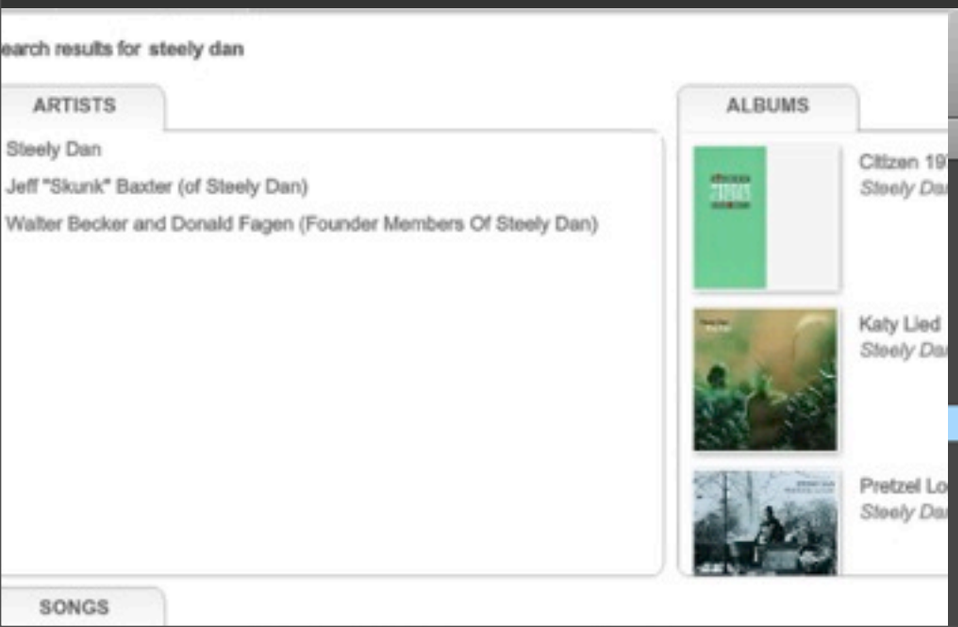
"Song to song" similarity
→ Catalogs at >10m tracks *each* (multiple clients!)
→ Existing cultural metadata coverage 80% ish
→ "Happy birthday to <your name>" x 1,200
→ Turn around live API in < week
→ Bottlenecks all in infrastructure: disk speed, data storage, DB access / inserts, queues

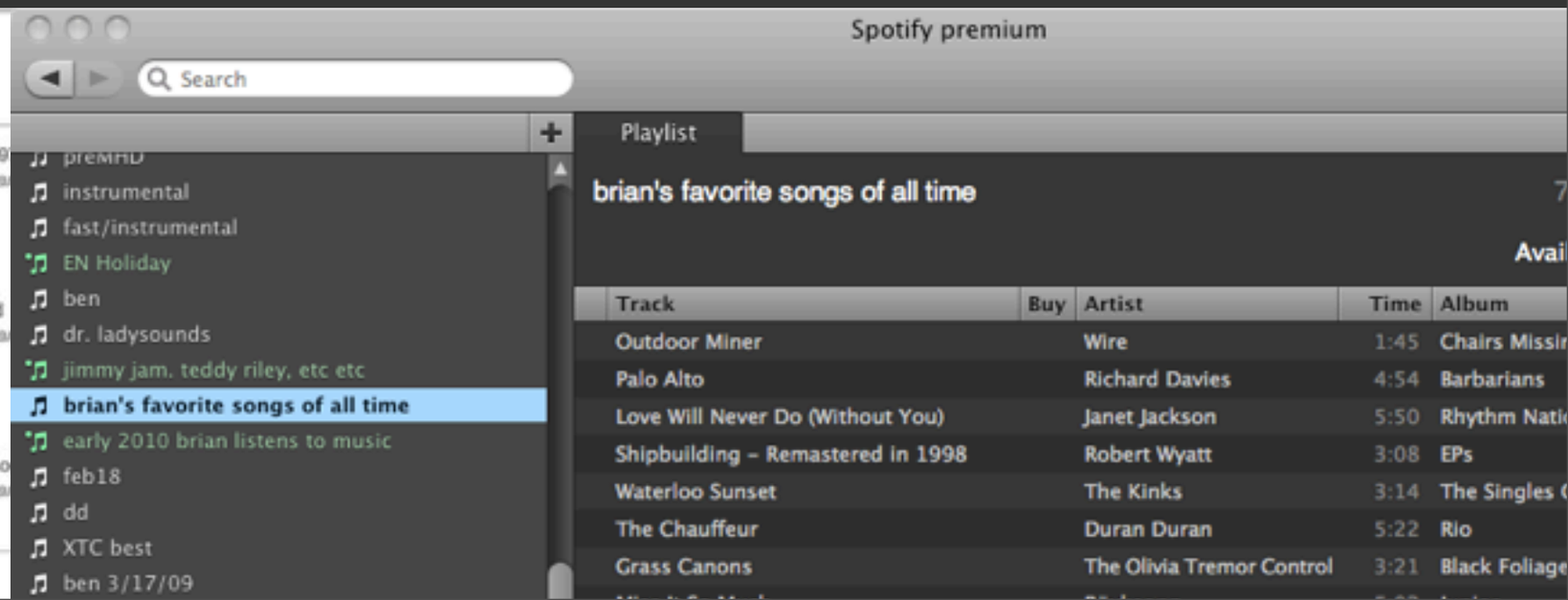




Merge what we know

→ If we have text data, filter on artist similars
→ Sort filtered X,000 tracks in memory, cache
→ Acoustic features use statistics of EN Analyze
→ QA process (interns + spot checks)
→ Evaluation is customer feedback





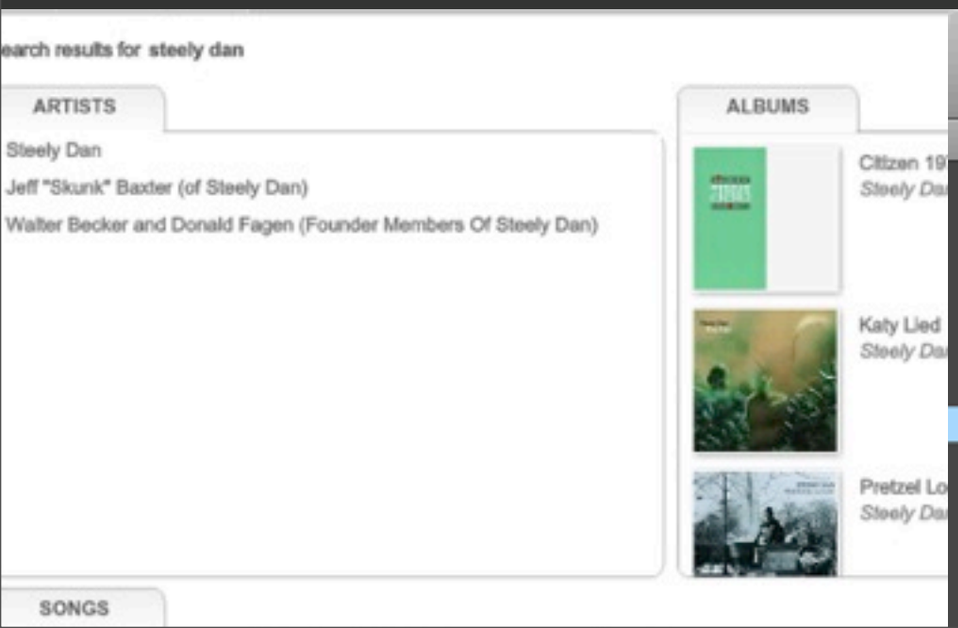
Hardest problem?

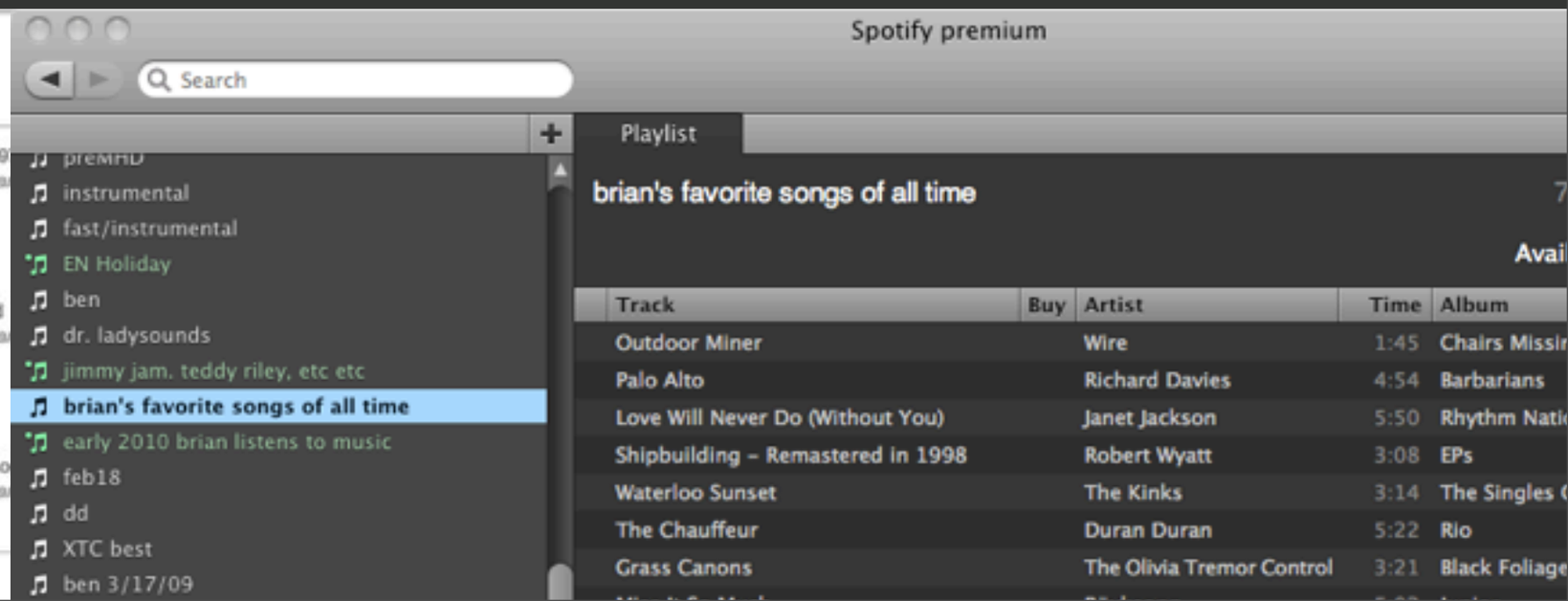
→ Evaluating distance metrics?

→ Selecting audio features?

→ Sharding / replicating key-value stores?

→ Tuning, QA?





Hardest problem?

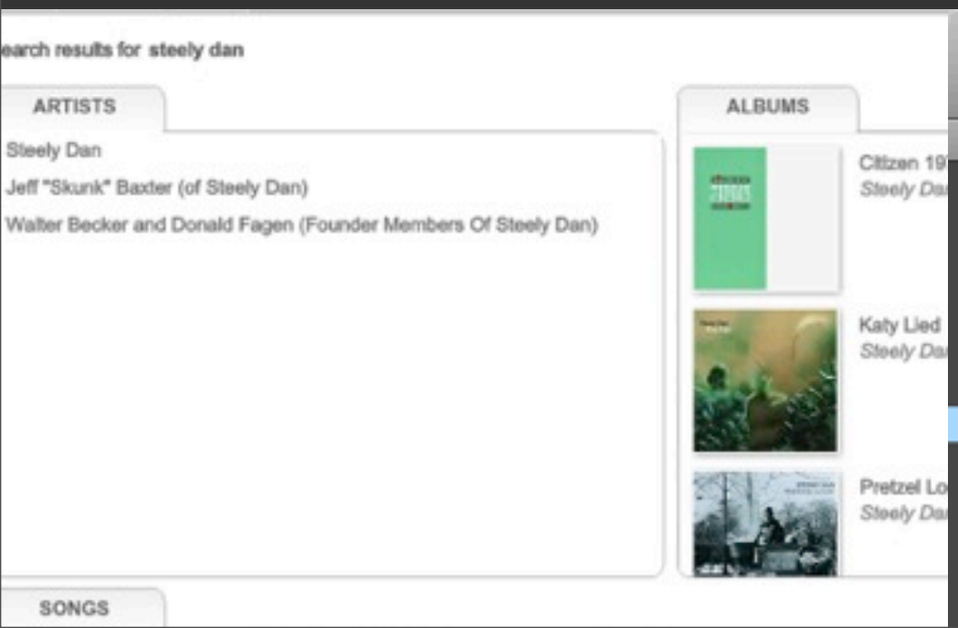
→ Evaluating distance metrics?

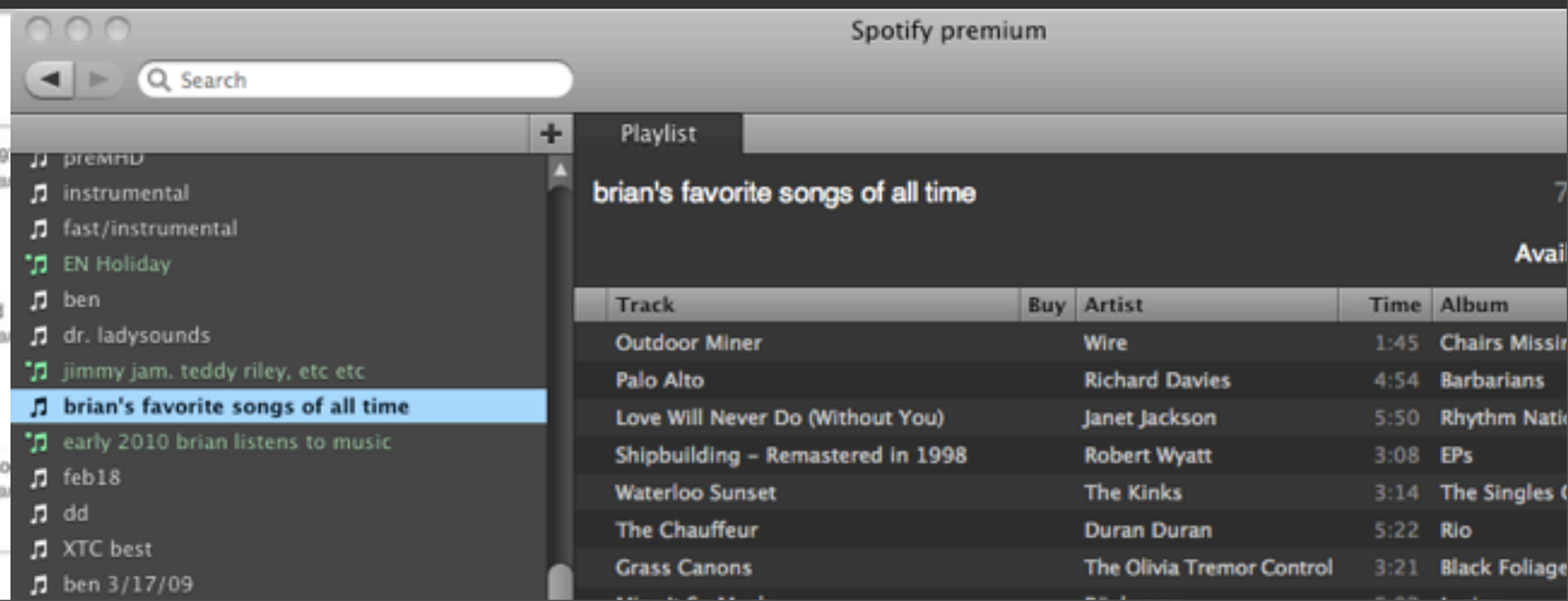
→ Selecting audio features?

→ Sharding / replicating key-value stores?

→ Tuning, QA?

→ Matching artist and track titles

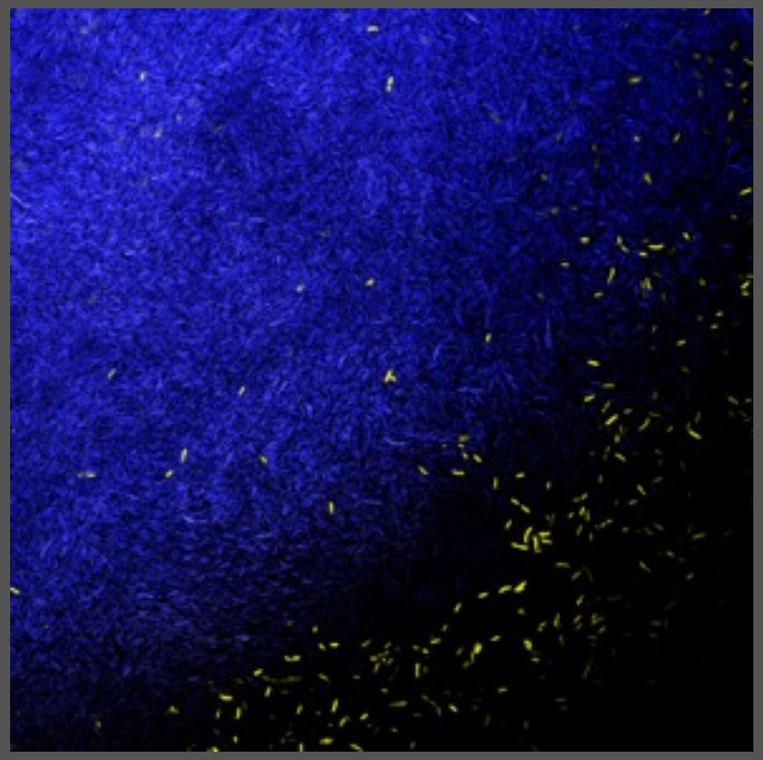


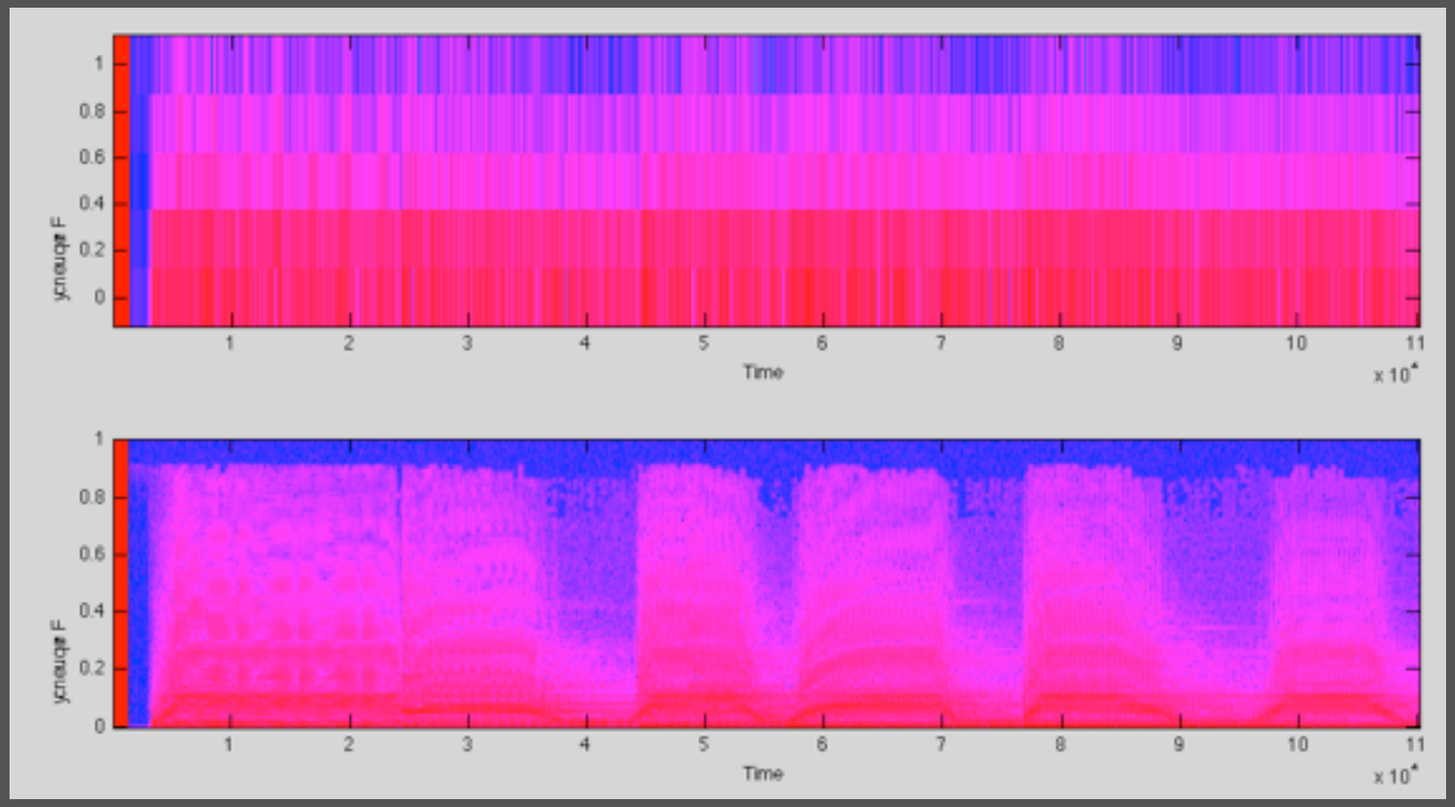


Echoprint & ENMFP

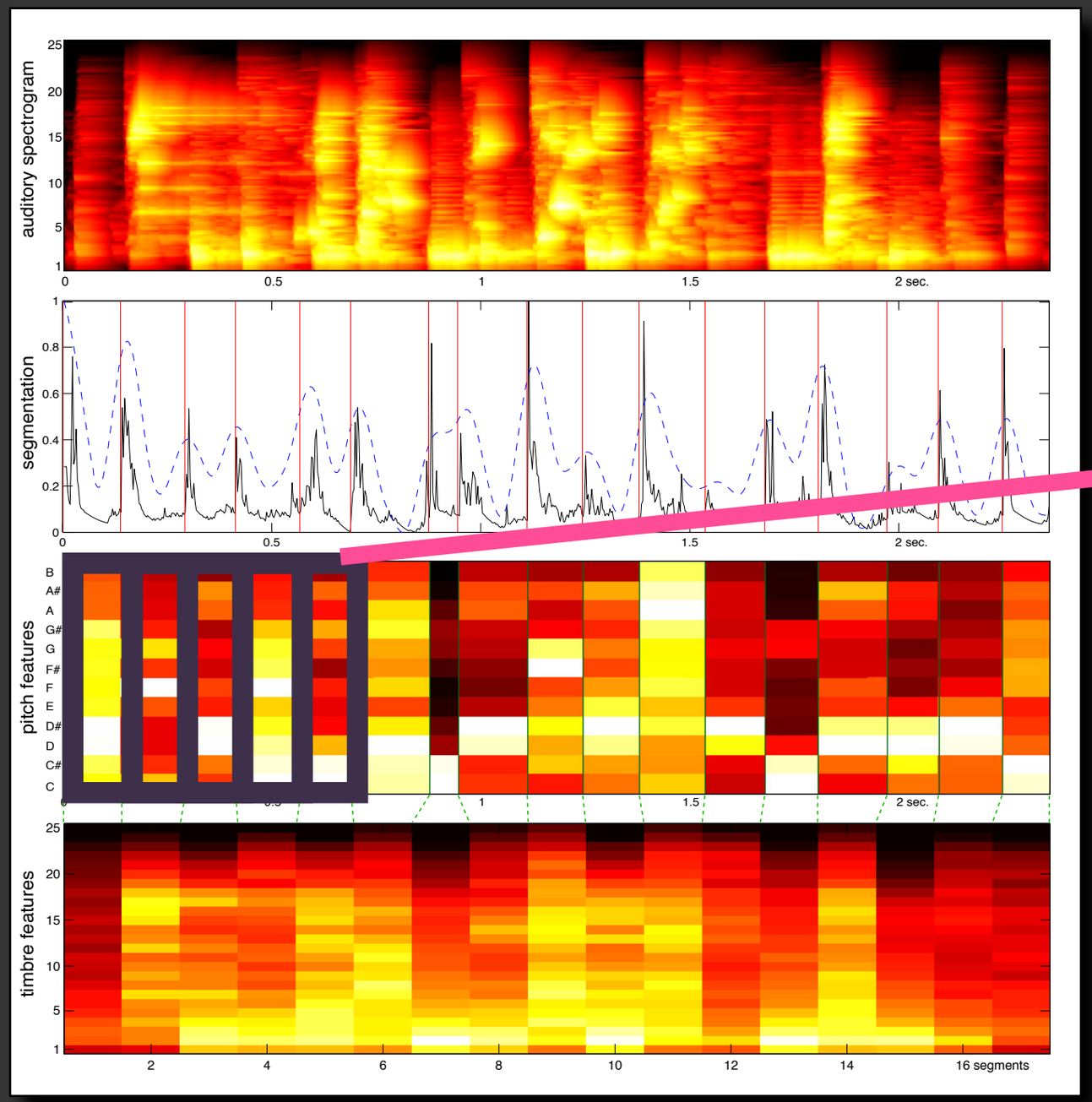
→ Both massive LSH problems

→ Different audio features >> n-bit codes >> DB





ENMFP



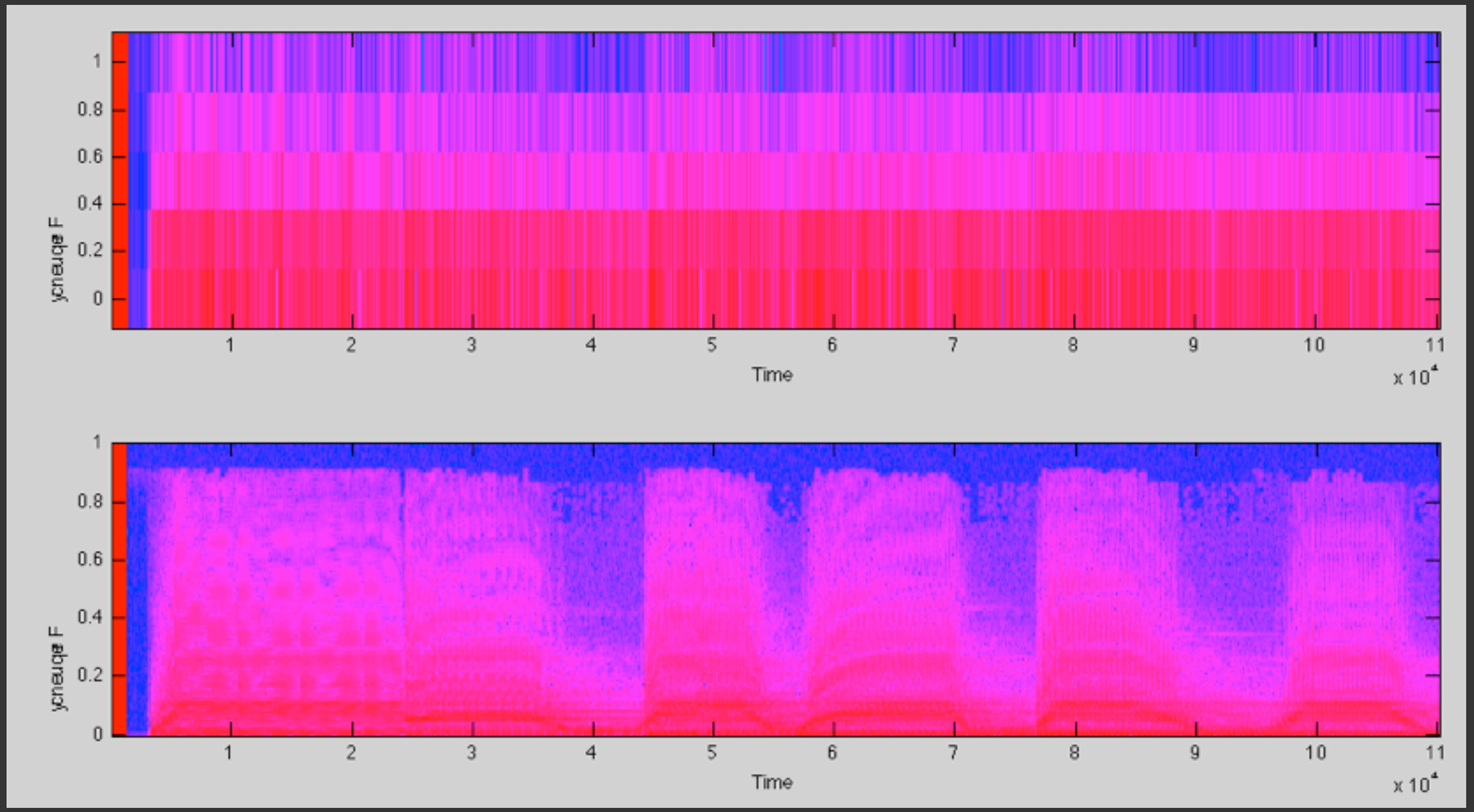
Chroma -> VQ

10-bit # (0-1023)

3 in a row

1 30-bit # per seg

Echoprint



Whitened 8-band subband analysis

Onset detection

Each onset (time + mags)hashed to 20bit key

Server

All codes go into a big inverted index:

123984	6940	21823
TR5904 50ms	TR1283 1840ms	TR1293 680ms
TR1283 120ms	TR7348 860ms	TR5909 650ms

A query pulls out the top ranking TRs that have the most overlapping codes as the query. Does this fast. Time is used for ‘close matches’ (almost all of them)

Evaluation

Our FPs now have >75m tracks, serves hundreds of millions of queries a day

$$P(E) = ((\frac{D}{D+N}) * R_r) + ((\frac{N}{D+N}) * R_a) \quad (1)$$

where

$$R_r = \frac{fp + fn}{tp + fp + fn} \quad (2)$$

$$R_a = \frac{fa}{fa + tn} \quad (3)$$

We have published results [2] of various $P(E)$:

Manipulation	$P(E)$
30 second WAV file	0.0109
60 second WAV file	0.0030
60 second recompressed MP3 file	0.0136
30 second recompressed MP3 file	0.0163
30 second recompressed MP3 file at 96kbps	0.0260

Listener analytics

- Data from our crawlers and partners
- 100m -ish profiles
- Help artists find fans & etc

userID	likes "The Beatles"	smokes	gender	average song tempo	in friend cluster 393	WOEID	...
LI394AXT9	0.8	N	M	139.4			
LI484ART3					1.0	59403	
LI578TR4E	0.4	Y	F				
...							

100m users

1m features

- 100m x 1m matrix **M**
- <1% non-zero
- All operations must be iterative, parallel
- Dream:

[value, confidence] = prediction(listener, feature)

userID	likes "The Beatles"	smokes	gender	average song tempo	in friend cluster 393	WOEID	...
LI394AXT9	0.8	N	M	139.4			
LI484ART3	[0.1, 0.9]	[N, 0.4]	[M, 0.9]	[83, 0.3]	1.0	59403	
LI578TR4E	0.4	Y	F				
...							

RLSC

$$K_f(x_1, x_2) = e^{-\frac{(|x_1 - x_2|)^2}{\sigma^2}}$$

$$(K + \frac{I}{2C})\mathbf{c} = \mathbf{y},$$

$$f(\mathbf{x}_{\text{test}}) = \mathbf{c}K(\mathbf{x}_{\text{test}}, \mathbf{x})$$

- (roughly) an SVM where all datapoints are SVs
- requires inversion of a kernel matrix of all obs
- **new classifiers are simple matrix mults**

through stored K^{-1} inversion: **c** = (**K**+(**I**/C))$^{-1}$ * **y**

But

(1) wait, i can't compute a 100m^2 kernel matrix
    - i mean, I can, but it'll take a while.
(2) the inversion? Fast iterative SPD solvers?
(3) data normalization:
    - 20% of features are probabilities
    - 20% are boolean
    - 30% are indexes
    - the rest are all over the place: tempo, key, term frequencies, age (!) etc

The platform

The power of APIs

API – Last.fm

www.last.fm/api

API Methods

Album

- Album.addTags
- Album.getBuylinks
- Album.getInfo
- Album.getTags
- Album.getTopTags
- Album.removeTag
- Album.search
- Album.share

Geo

- Geo.getEvents
- Geo.getMetroArtistChart
- Geo.getMetroHypeArtistChart
- Geo.getMetroHypeTrackChart
- Geo.getMetroTrackChart
- Geo.getMetroUniqueArtistChart
- Geo.getMetroUniqueTrackChart

Artist

- Artist.addTags
- Artist.getCorrection
- Artist.getEvents
- Artist.getImages
- Artist.getInfo
- Artist.getPastEvents
- Artist.getPodcast
- Artist.getShouts
- Artist.getSimilar
- Artist.getTags
- Artist.getTopAlbums
- Artist.getTopFans

About | News | Products | Search | Edit | Account | Collection | Contribute

Hide side bar

MusicBrainz Sites

Master Server
· Find a Mirror
MetaBrainz
Brainz Blog
Mailing Lists
Forums
Chat Logs
Wiki
Stuff to Buy
Bug Tracker

Not logged in

Login
Create account
Forgot Password
Dashboard
Donate!

Search

Artists

Welcome to MusicBrainz!

What is MusicBrainz?

MusicBrainz is a community music metadatabase that attempts to create a comprehensive music information site. You can use the MusicBrainz data either by browsing this web site, or you can access the data from a client program — for example, a CD player program can use MusicBrainz to identify CDs and provide information about the CD, about the artist or about related information. You can also use the MusicBrainz Tagger to automatically identify and clean up the metadata tags in your digital music collections. Find out more in the introduction.

Use MusicBrainz

You can use Musicbrainz right now to automatically

News

MetaBrain

The MetaBr
California
corporation
project. All
are tax ded

MusicBrain

MusicBrain change —
our main M
repository.
at:
git://git.mu
server.git.

Welcome Developers! – Soun

soundcloud.com/developers

Log In | Sign Up

Home | The Tour | Sign Up | Upload & Send

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rch Sound

Welcome Developers!

This is the starting point if you want to build an app or connect your web service using the SoundCloud API.

Before you start...

the API and third-party development
use the API
ization works on different platforms
PI

API
ical documentation

Developer

Documentatio
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Console
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Mobile
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Scup
Deskto
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tal.net/Developers/7digitalAPIOverview

Search

7digital

7digital API Features

labrosa.ee.columbia.edu/millionsong/

Million Song Dataset

Home | Getting the dataset | Code | Tutorial | Tasks / Demos | Forum | FAQ | Contact us | Blog

Home » Home

Welcome!

The **Million Song Dataset** is a freely-available collection of audio features and metadata for a million contemporary popular music tracks.

Its purposes are:

- To encourage research on algorithms that scale to commercial sizes
- To provide a reference dataset for evaluating research
- As a shortcut alternative to creating a large dataset with The Echo Nest's API
- To help new researchers get started in the MIR field

The core of the dataset is the feature analysis and metadata for one million songs, provided by The Echo Nest. The dataset does not include any audio, only the derived features. Note, however, that sample audio can be fetched from services like 7digital, using code we provide.

The Million Song Dataset is a collaboration between LabROSA and The Echo Nest. It is supported in part by the NSF

Search

Search this site:

Search

News

January 35+i, 2011
We release the dataset!

Main contact

Thierry Bertin-Mahieux:
tb2332@columbia.edu

Quick links

We even give it away

SecondHandSongs
- cover songs

7digital
- 30s audio

Last.fm
- song tags
- similar songs

Echo Nest
API dump

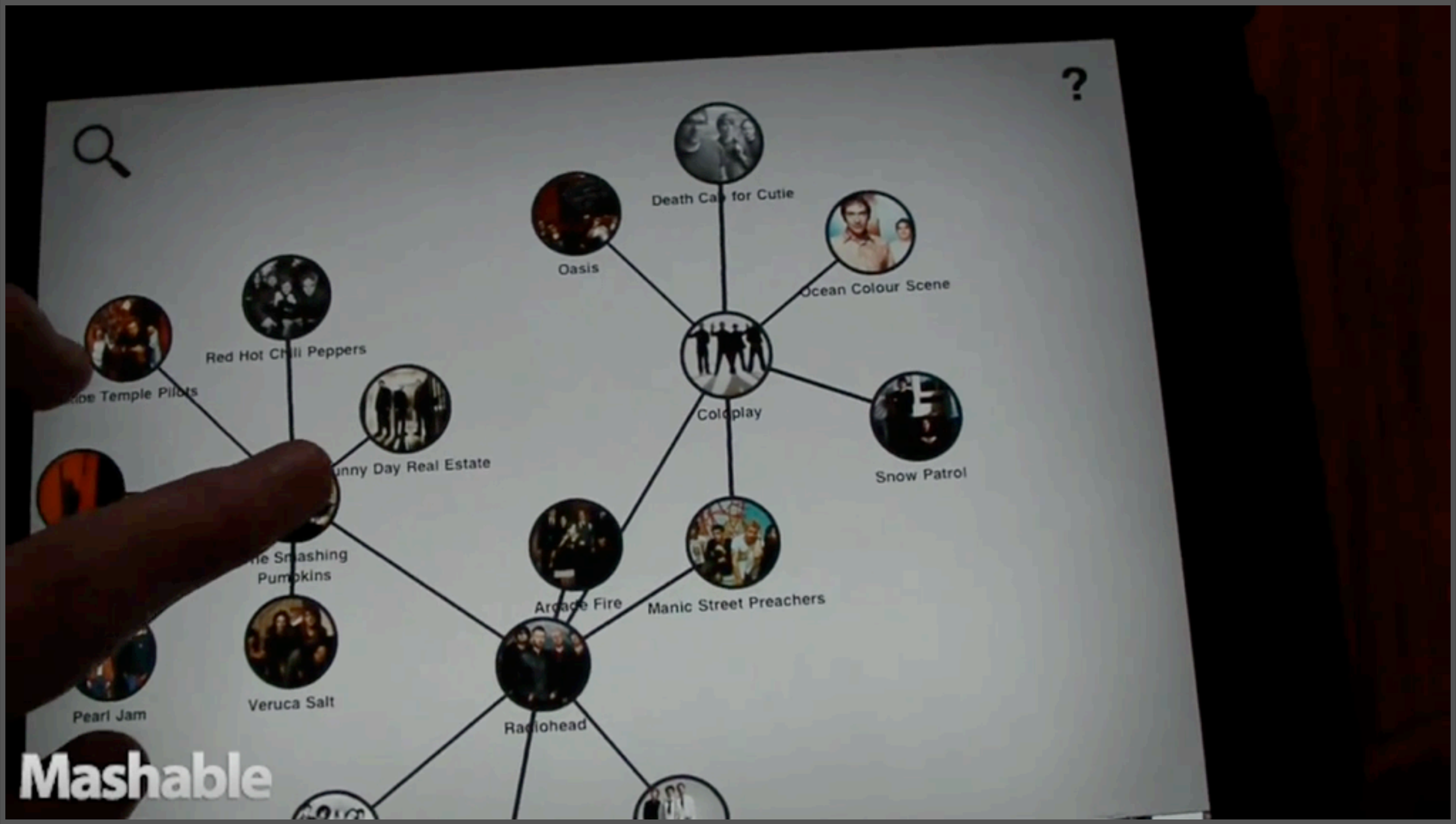
musiXmatch
- lyrics

Musicmetric
- artist popularity
- user location

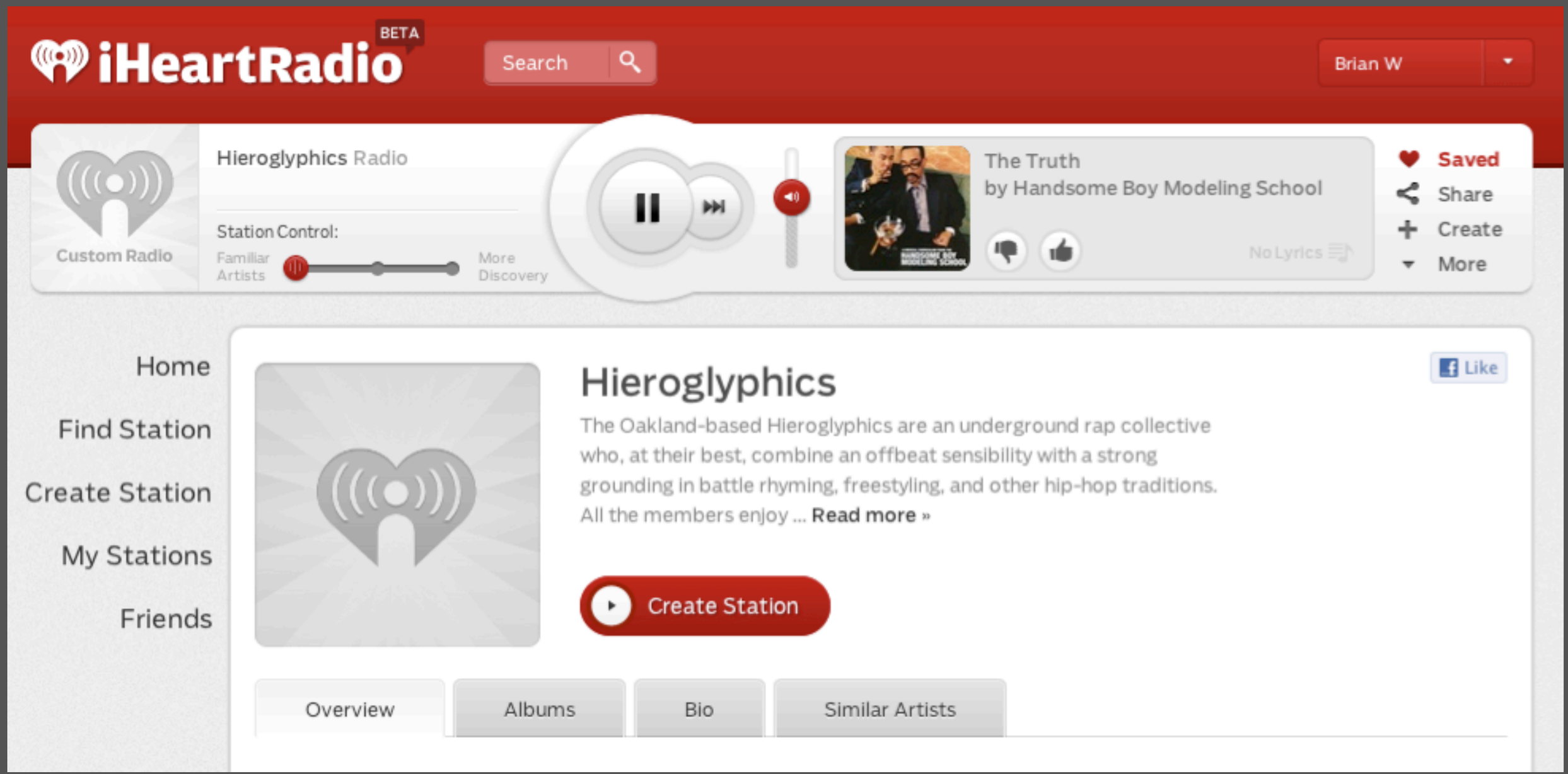
Musicbrainz
- years

- playlists
- playcounts

Discovr


?
Death Ca for Cutie
Oasis
Ocean Colour Scene
Red Hot Chili Peppers
Coldplay
Snow Patrol
Manic Street Preachers
Pearl Jam
Veruca Salt
Radiohead
Mashable

iHeartRadio



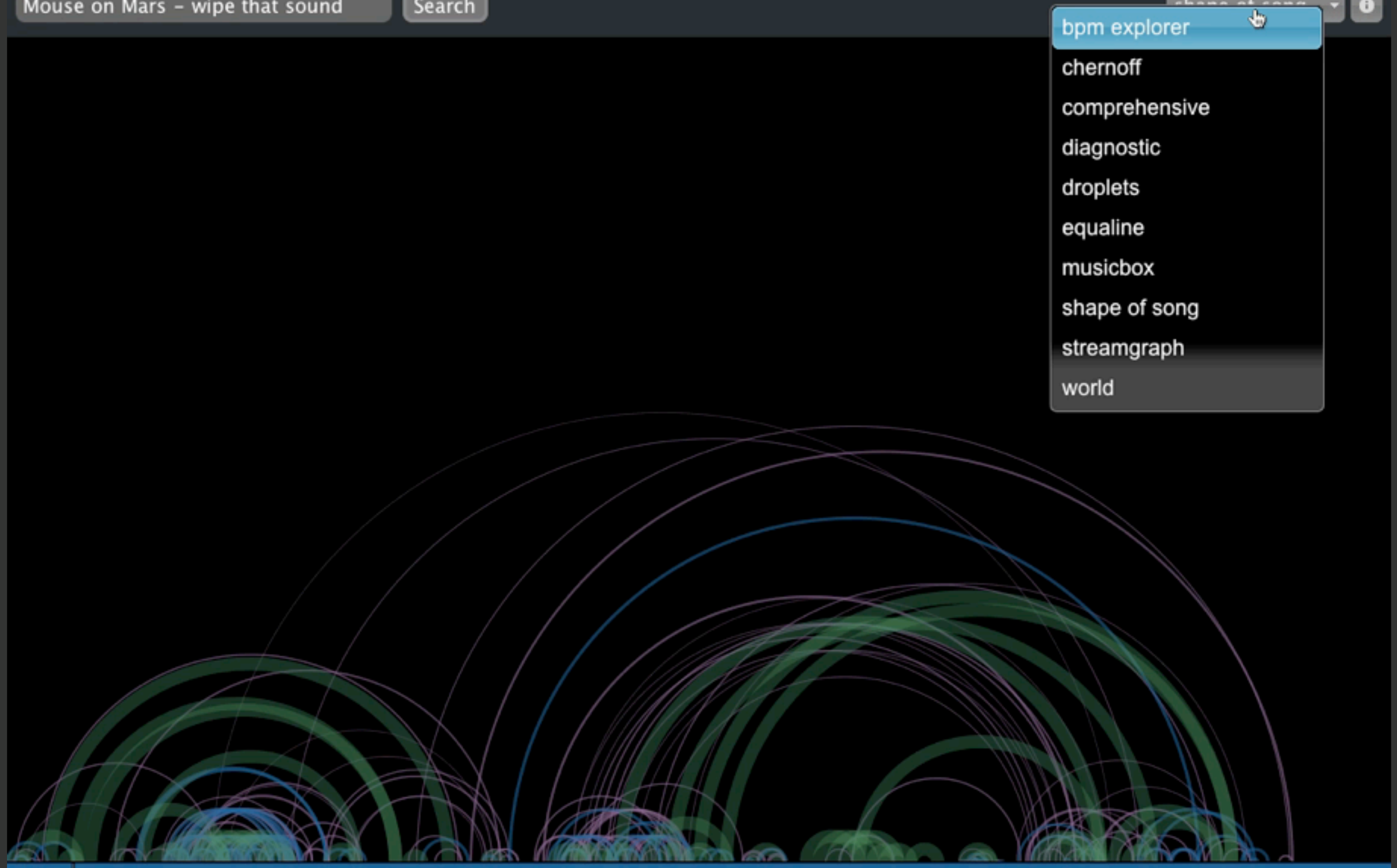
visualizer.fm

visualizer.fm/static/index.html#

Mouse on Mars - wipe that sound

Search

bpm explorer
chernoff
comprehensive
diagnostic
droplets
equaline
musicbox
shape of song
streamgraph
world



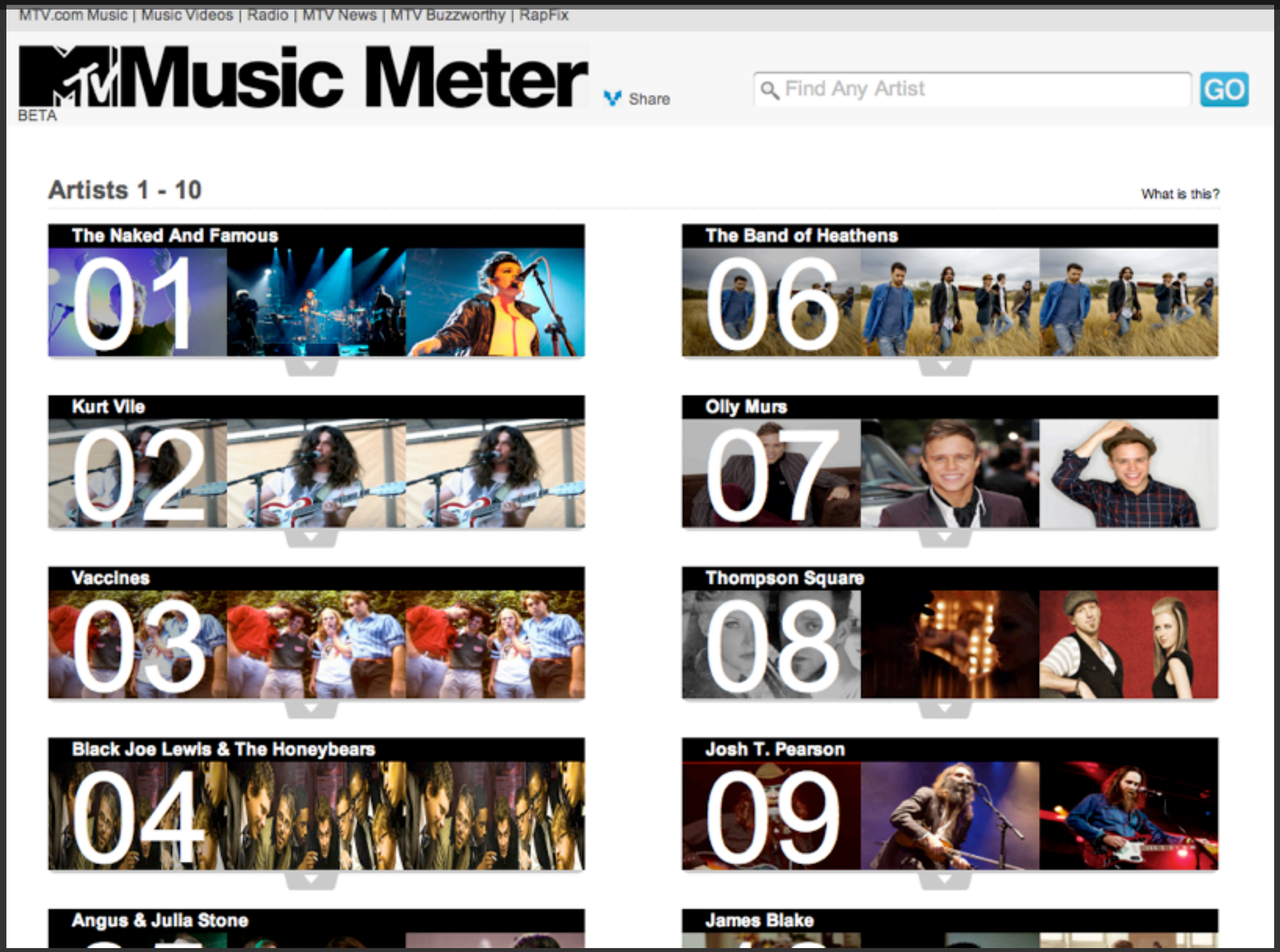
wipe that sound

by Tyler Williams & Jason Sundram

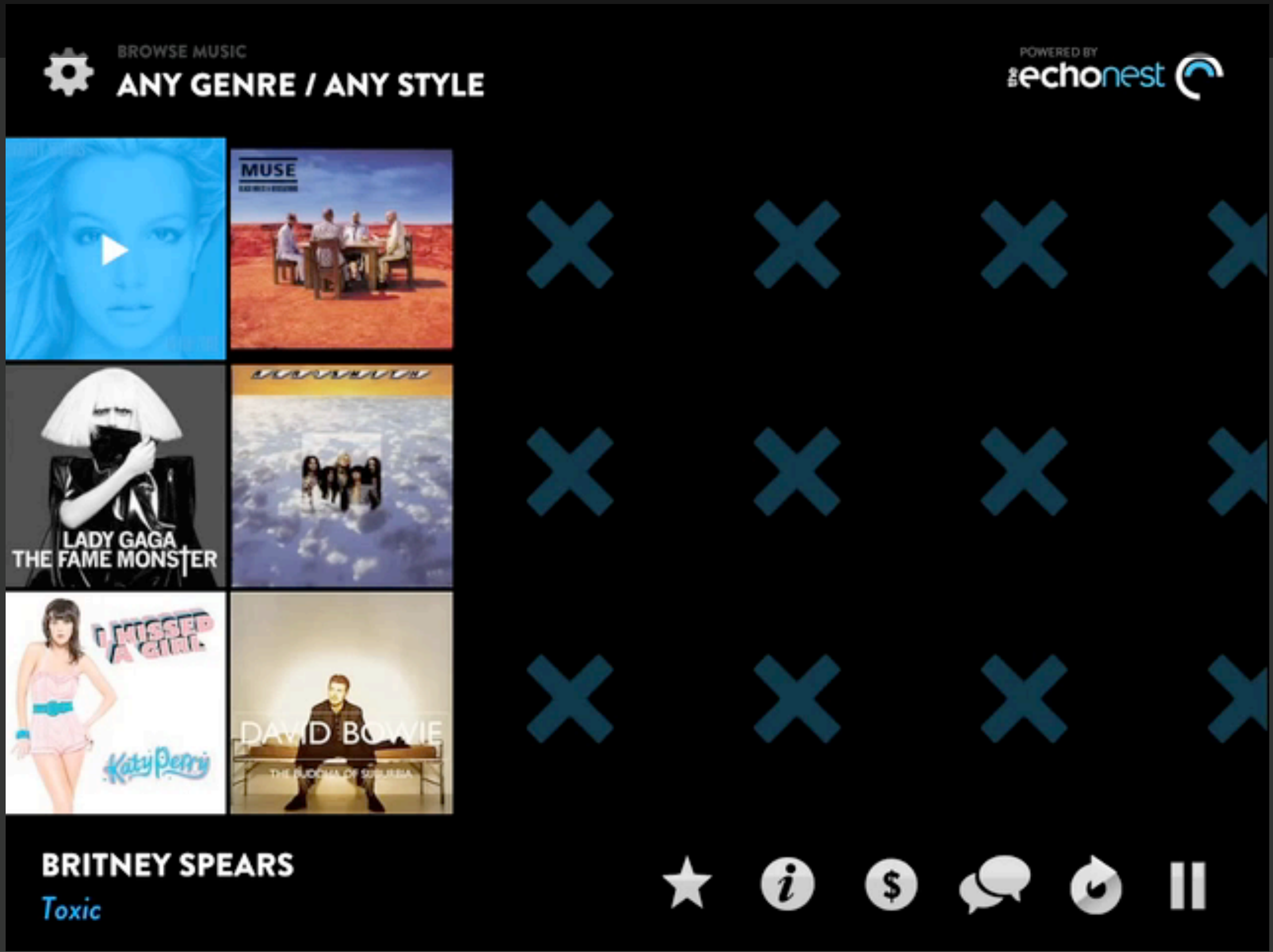
Scrobbyl

tastebuds.fm

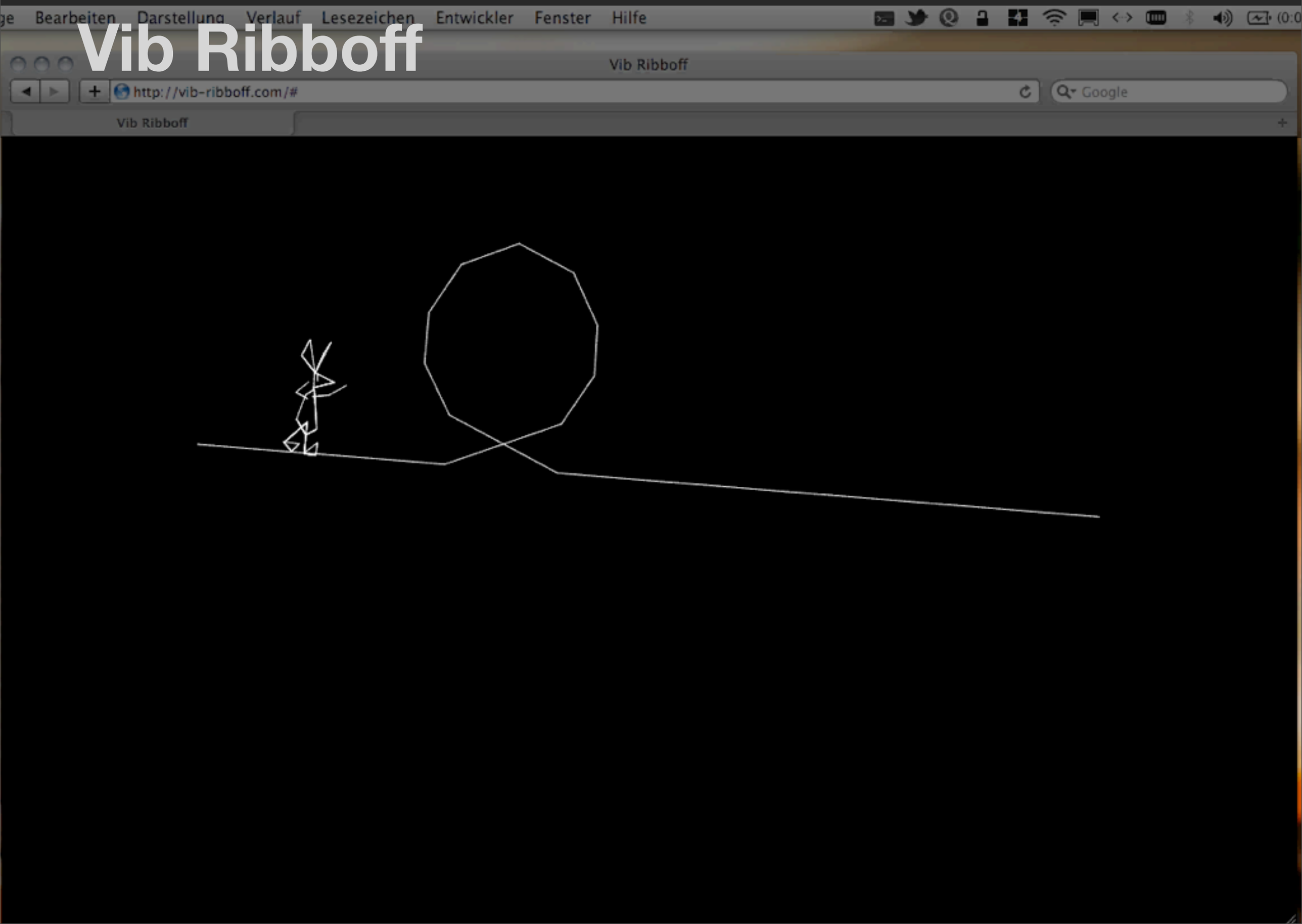
MTV Music Meter



Music Hunter



Vib Ribboff


Bearbeiten
Darstellung
Verlauf
Lesezeichen
Entwickler
Fenster
Hilfe
Vib Ribboff
http://vib-ribboff.com/#
Google
Vib Ribboff

The Swing Thing

"Don't mean a thing if it ain't got that swing"

Uses time-scaling techniques to add a swing beat to your songs!

Search

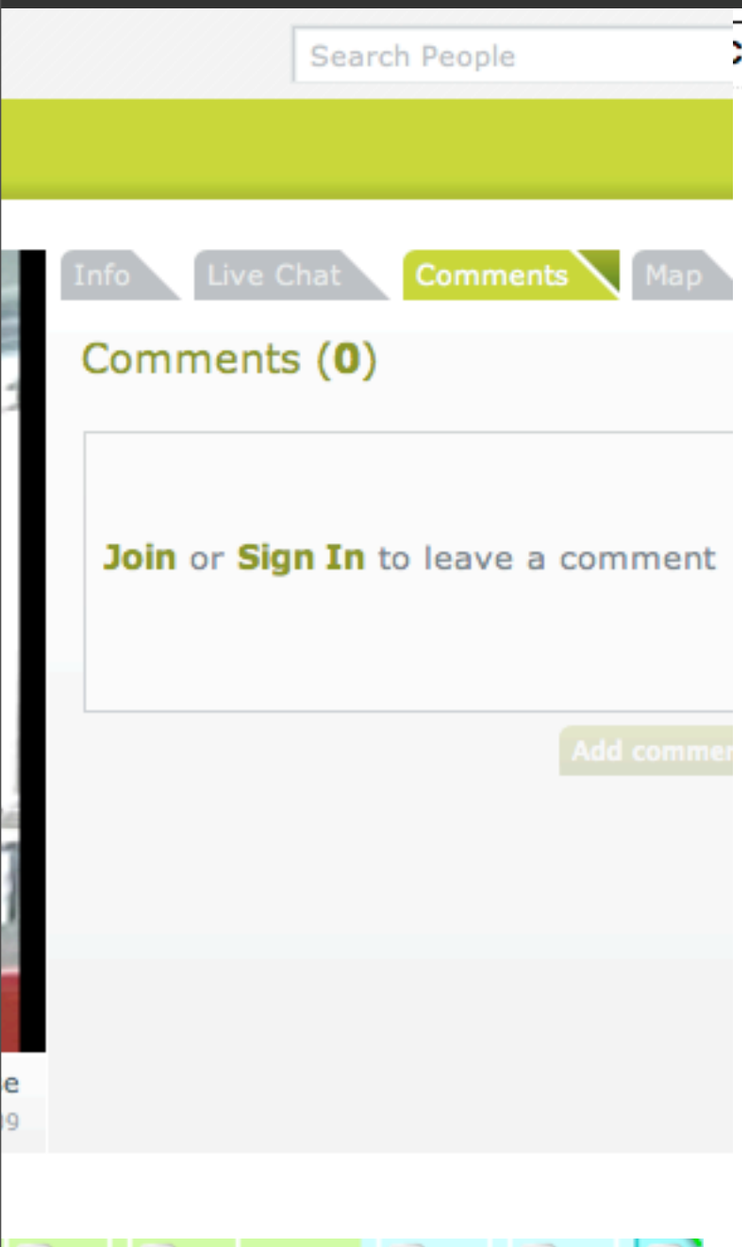
Choose File No file chosen

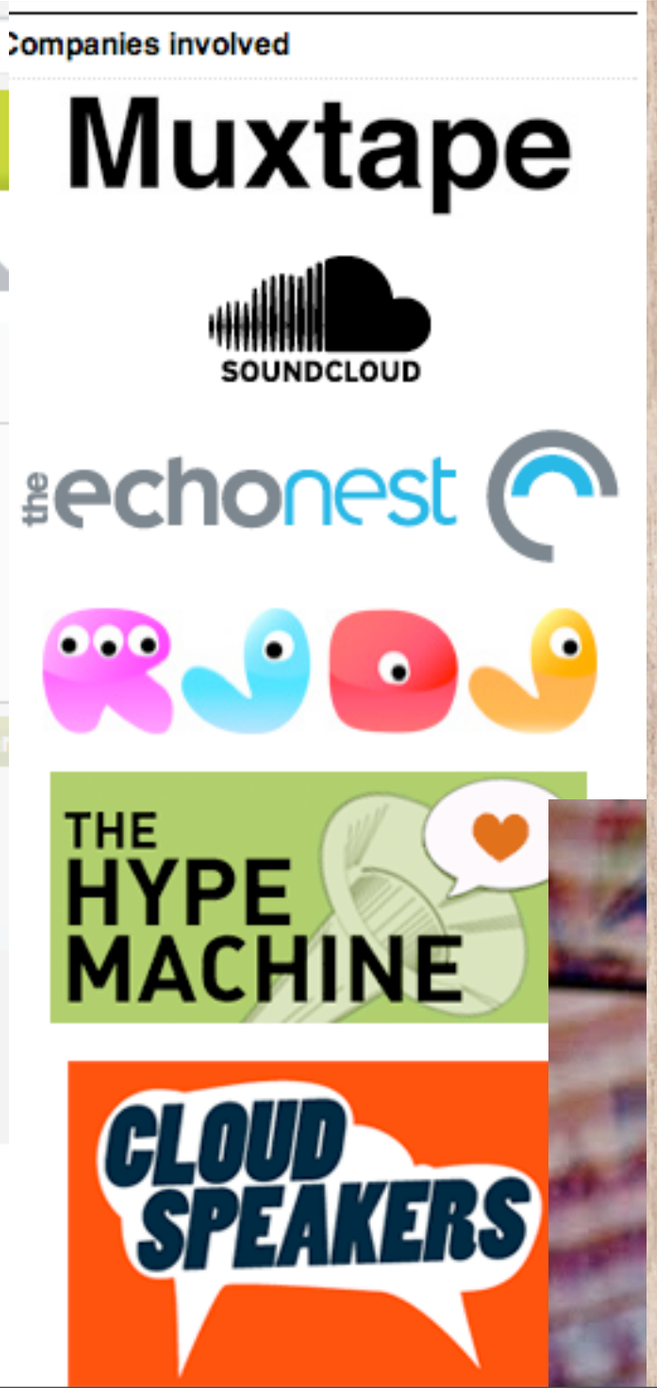
Swing!

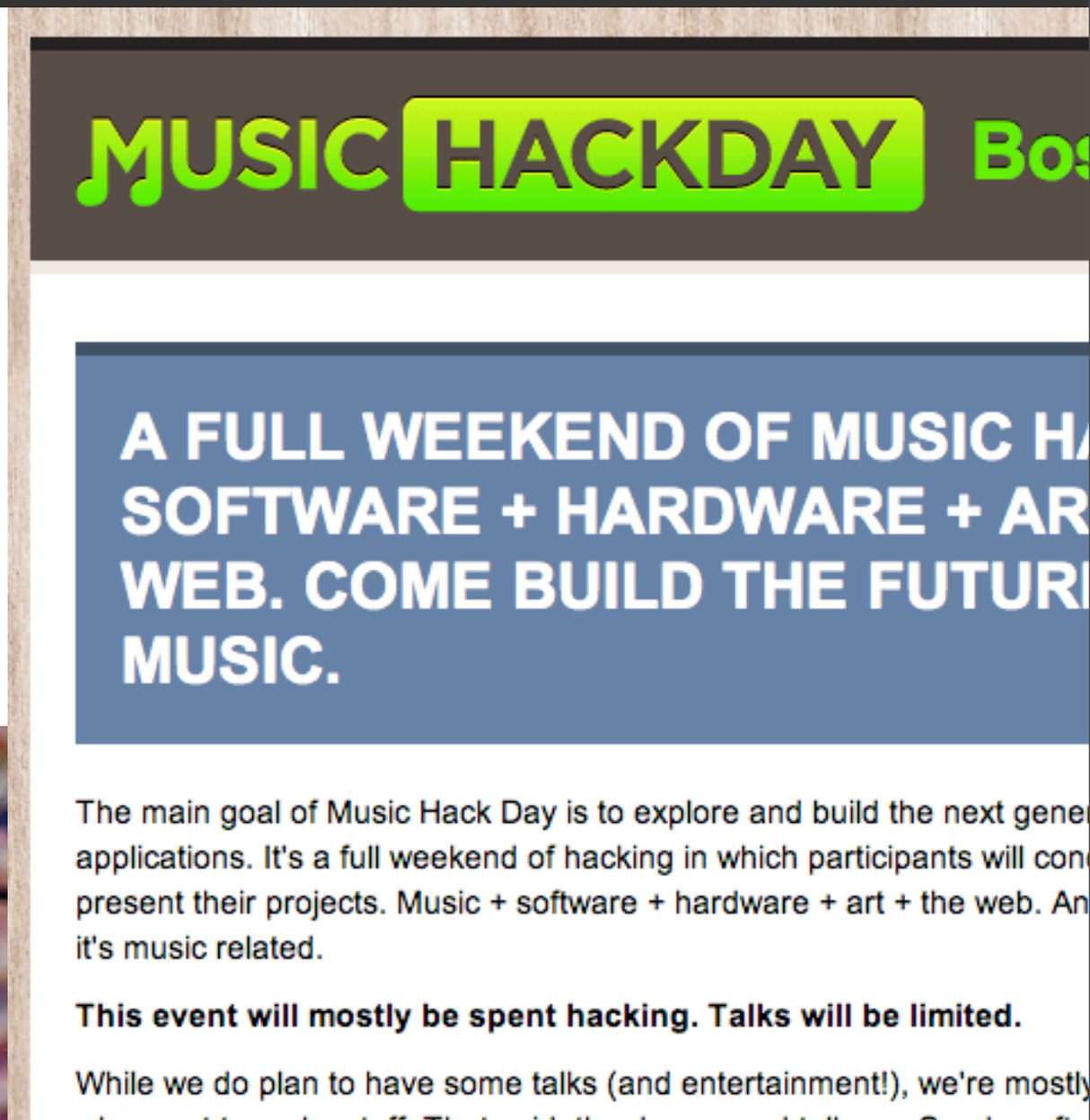
Top Voted

Aha - Take On Me	160 votes
The Blipp-Bloppers - Unloved.mp3	117 votes
Rammstein - Pussy	94 votes
Bon Jovi - Livin' on a prayer	89 votes
Nine Inch Nails - The Hand That Feeds	84 votes
Green Day - American Idiot	84 votes
MC Hammer - U Can't Touch This	83 votes
Lady GaGa - Bad Romance	81 votes
Rick Astley - Never Gonna Give You Up	80 votes
Billy Idol - White Wedding	79 votes

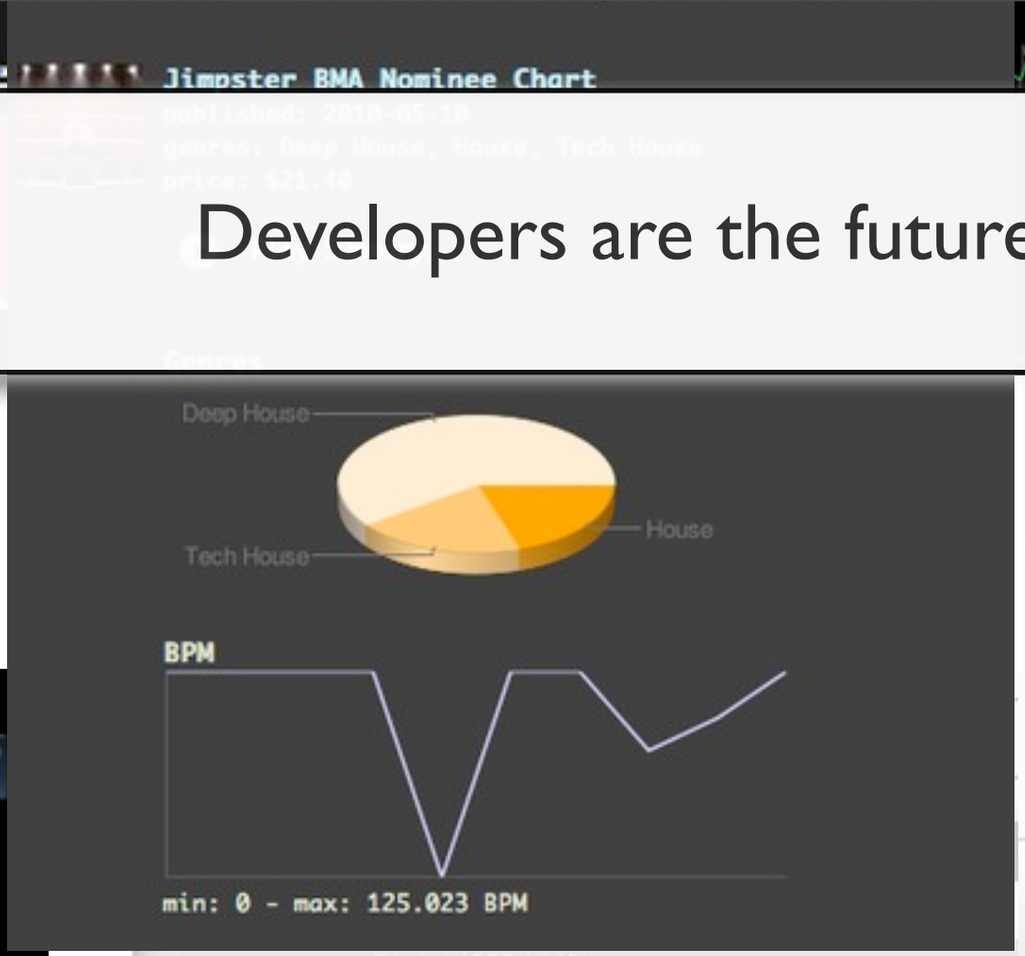
Music Hack Days

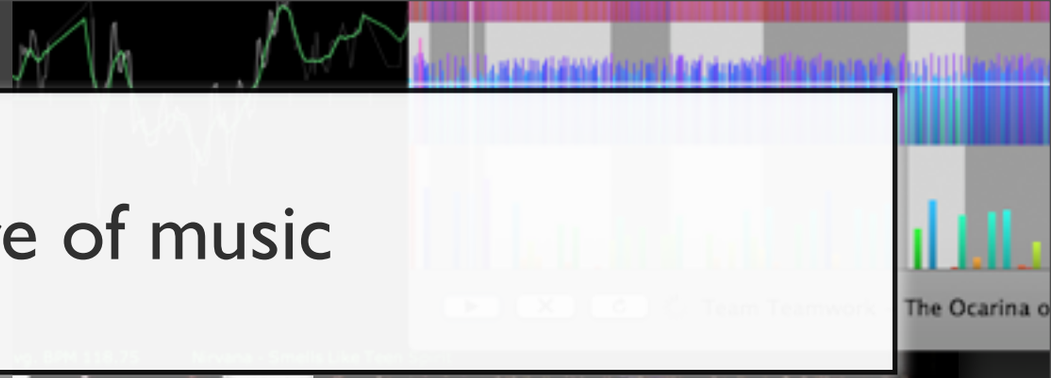


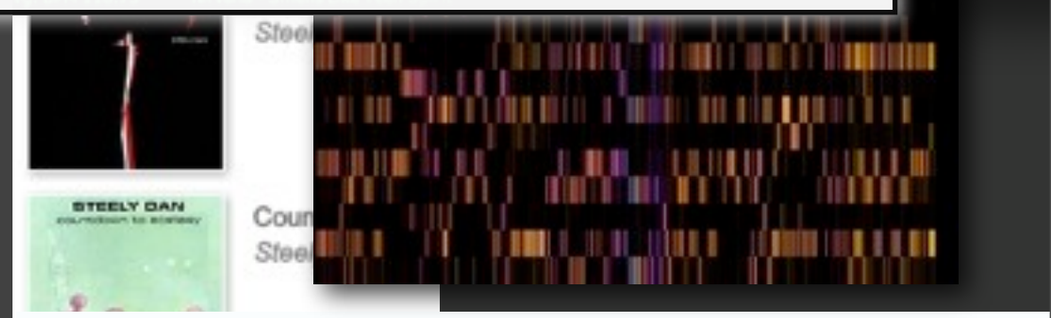


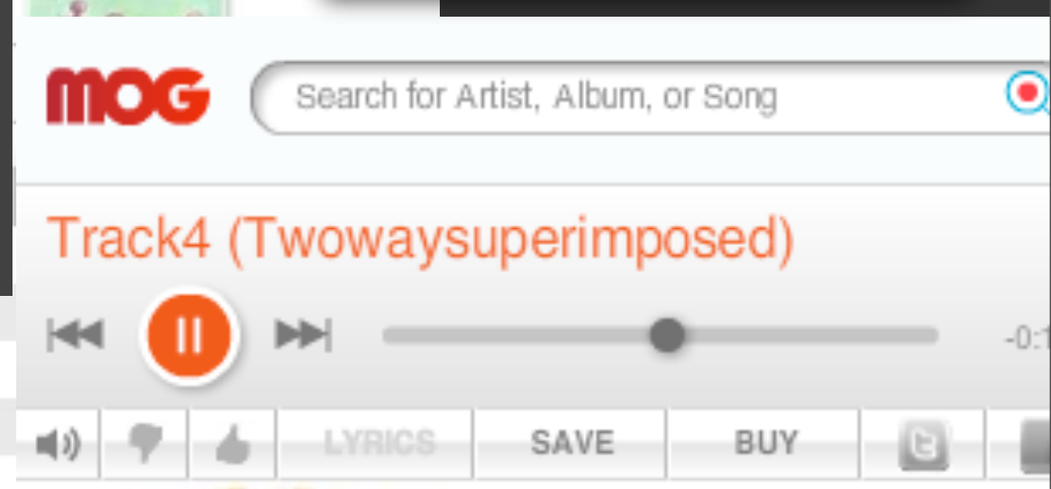


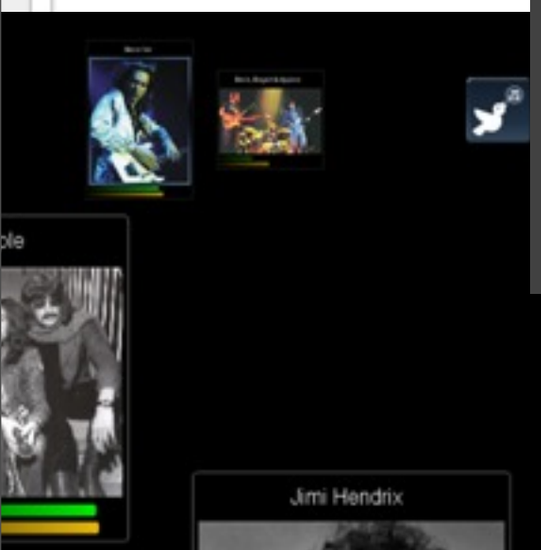
Developers are the future of music

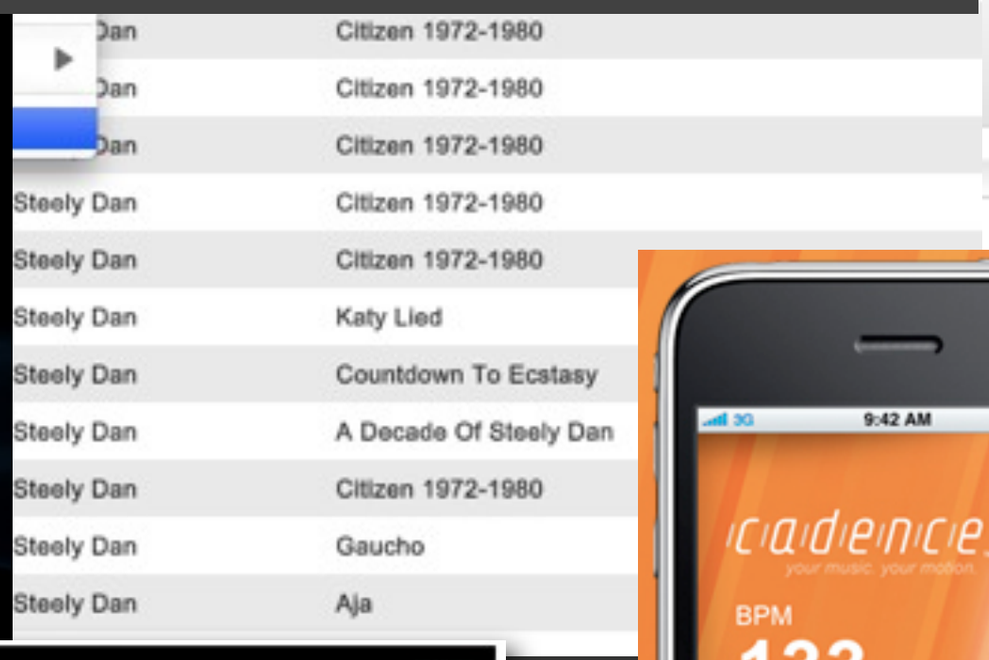


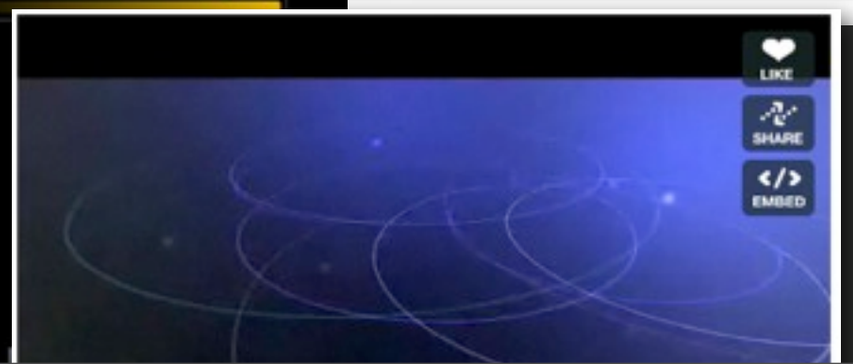


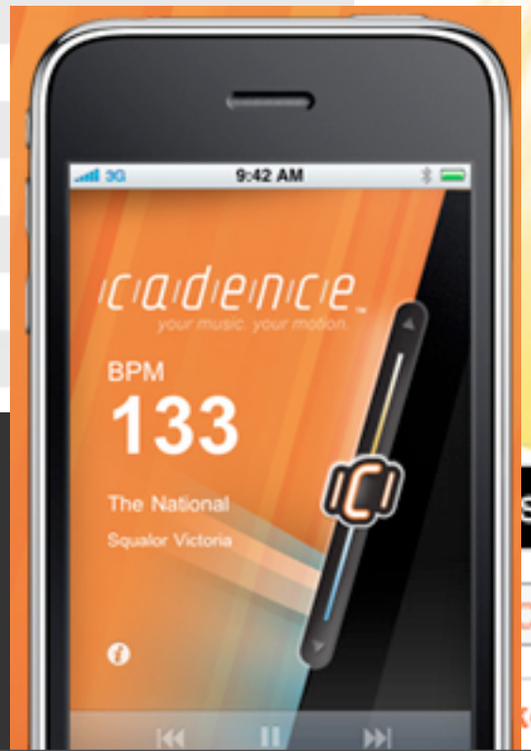


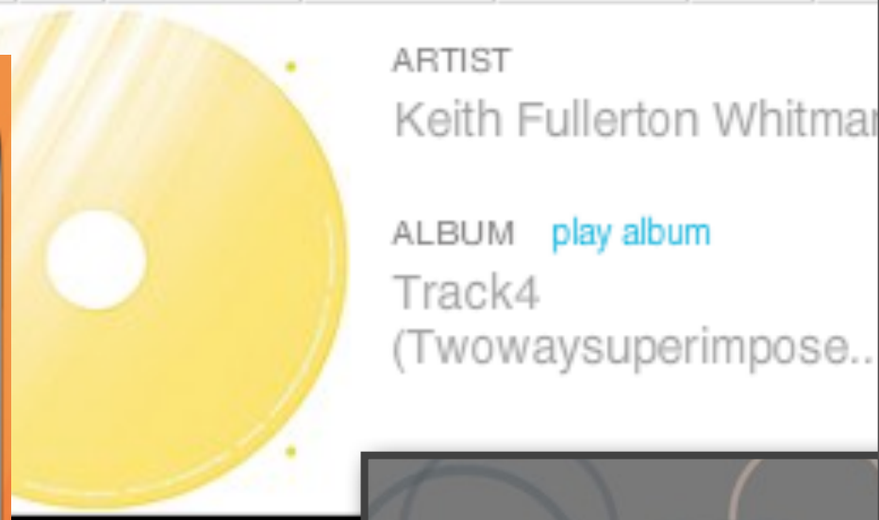












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