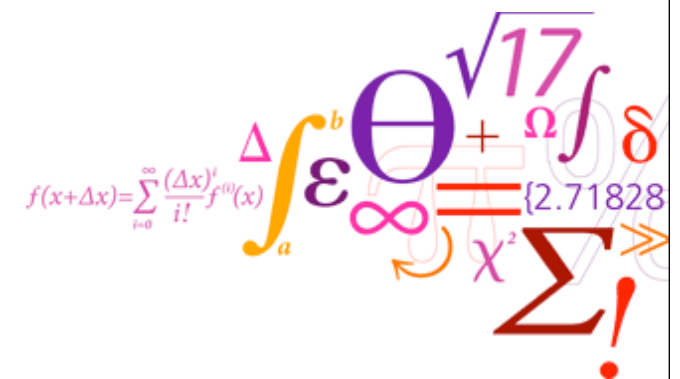


Extracting patterns

from tracks using emotional tags

Michael Kai Petersen & Andrius Butkus



Emotions in music

are dynamically unfolding in time

- can we somehow capture these aspects and **model our perception** ? to facilitate affective categorization beyond traditional divides of genres ? build emotional playlists ?
- meaning is based on the underlying harmonic and rhythmical structures **forming our expectations**
[Meyer, 1957][Temperley, 2007]
- and transform innate responses related to uncertainties into pleasant surprises **evoking emotions** *[Huron, 2006]*
- which we **experience empathetically** as shifting contours of tension and release *[Lerdahl & Jackendoff, 2006]*
- suggesting a common neural substrate for **music, language and motor** integration *[Gallese & Lackoff, 2005]*
[Molnar-Szakacs & Overy, 2006]

Musical structure

is processed in “language” areas

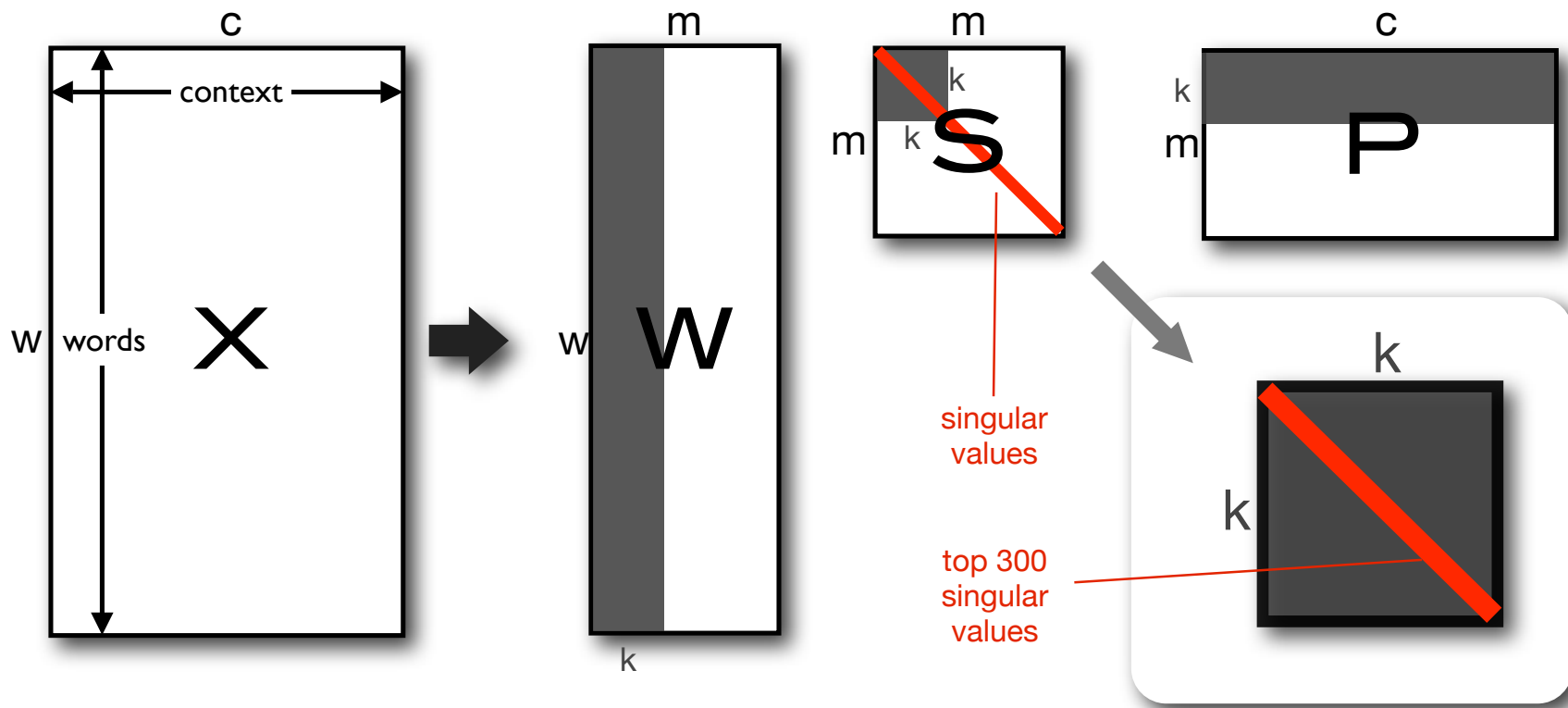
- neuropsychological experiments indicate that **priming effects** on semantic processing can be **identical** for music and language [*Koelsch et al., 2004*]
- supporting findings that **linguistic and melodic** components of songs are processed in interaction [*Schön, Gordon & Besson, 2005*]
- while music and language appears to **share limited processing resources** for integrating incoming elements such as words and chords into syntactic structures [*Sleve, Rosenberg & Patel, 2008*]
- confirmed in neuroimaging experiments where shared neuronal resources between music and language **indicate semantic processing** of musical tension-resolution patterns [*Steinbeis & Koelsch, 2008*]

Extracting patterns

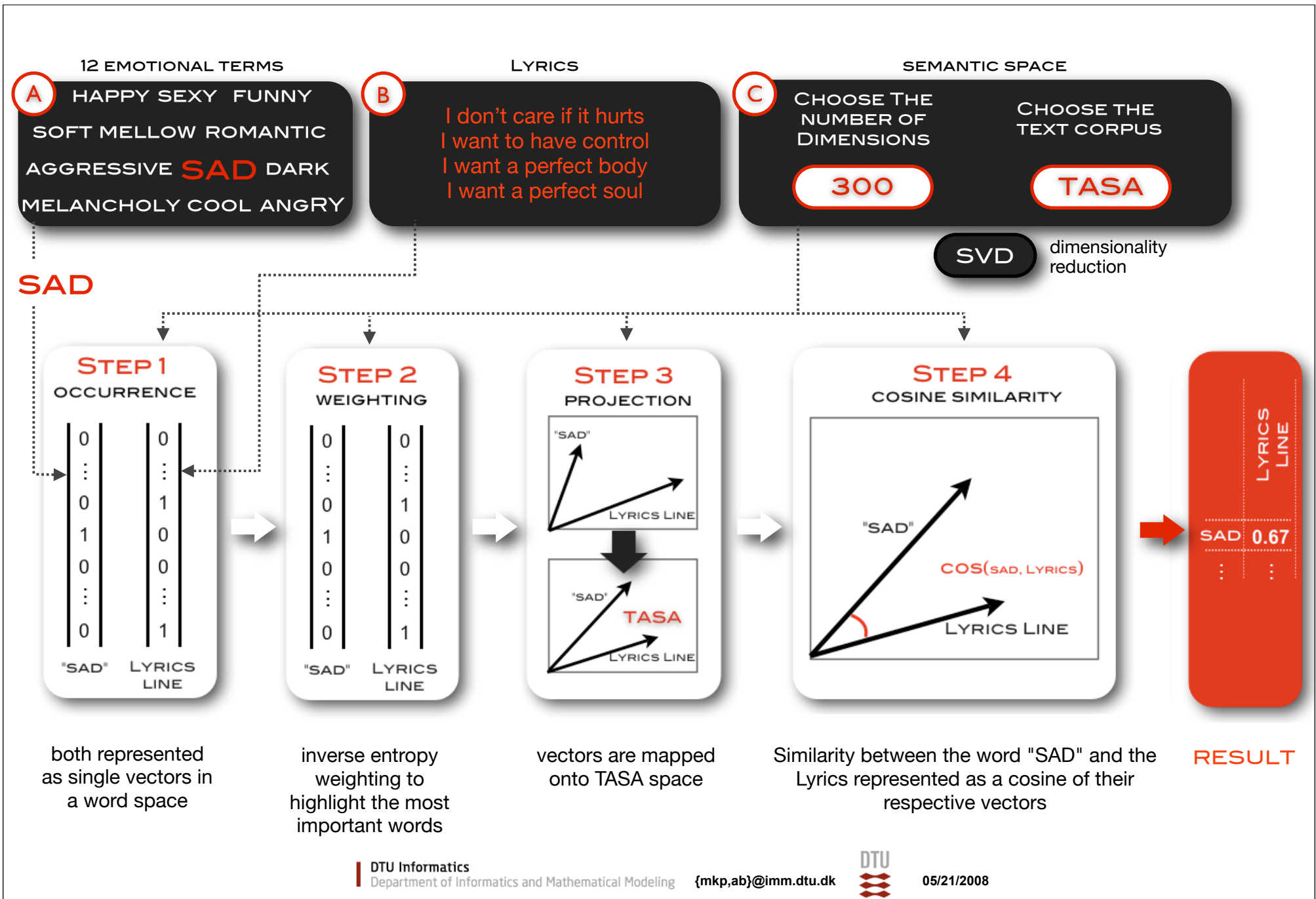
from tracks using emotional tags

- hypothesizing that we can extract patterns reflecting the emotional **structure of songs** by projecting the lyrics into a semantic vector space
- we select twelve frequently occurring last.fm tags as **emotional markers** to define a semantic plane of psychological valence and arousal dimensions
- and **apply LSA**, a linear dimensionality reduction method, to extract meaning by capturing patterns of word usage in multiple contexts
- to **model the correlation** between lyrics and tags as vectors in a semantic space reflecting the emotional context of the songs

DECOMPOSITION OF THE MATRIX "X" USING SVD



$$X = WSP^T$$

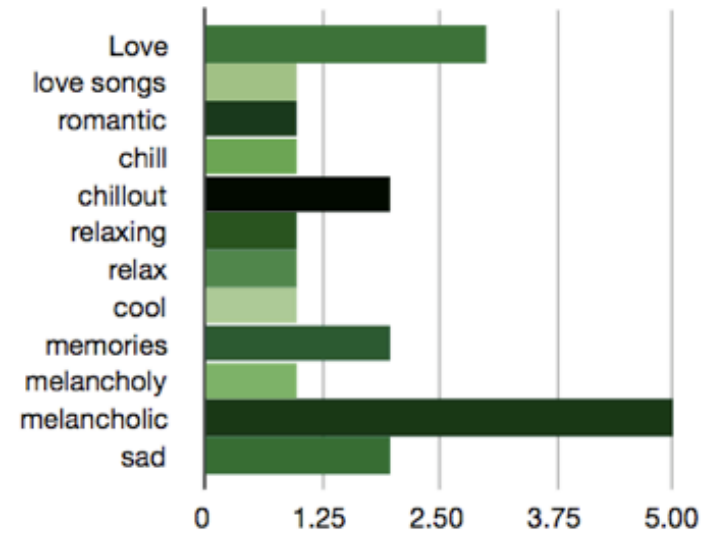
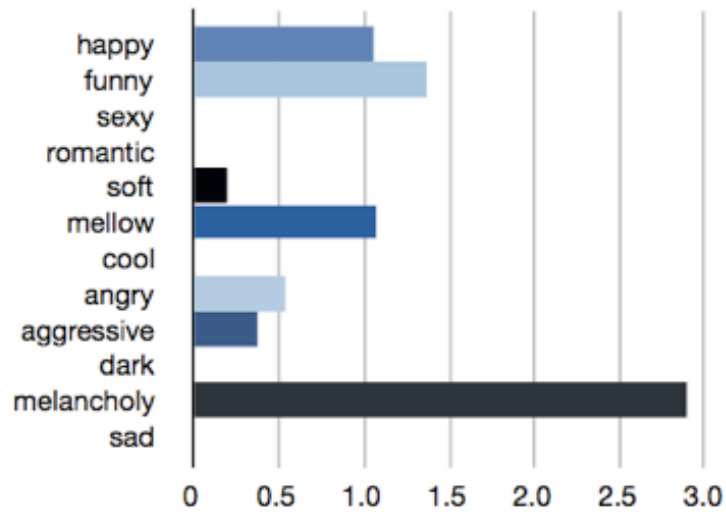
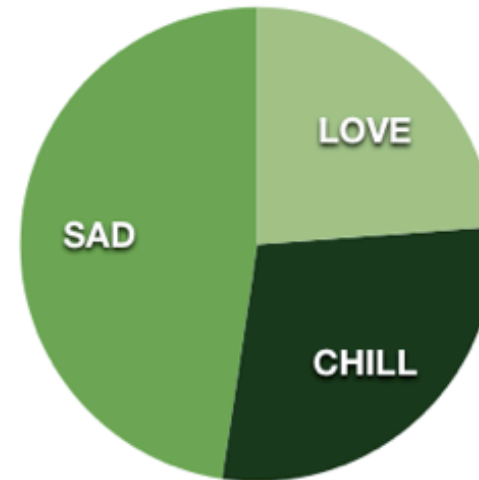
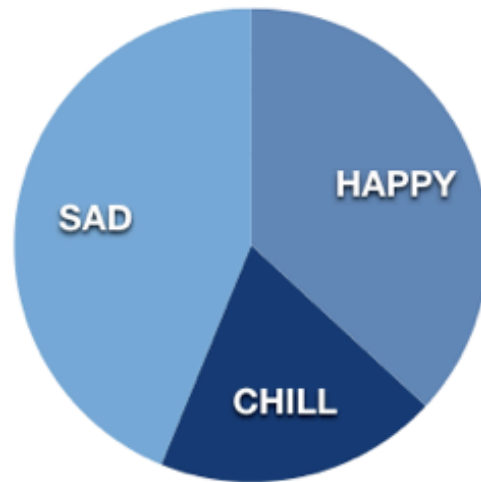


Modeling emotions

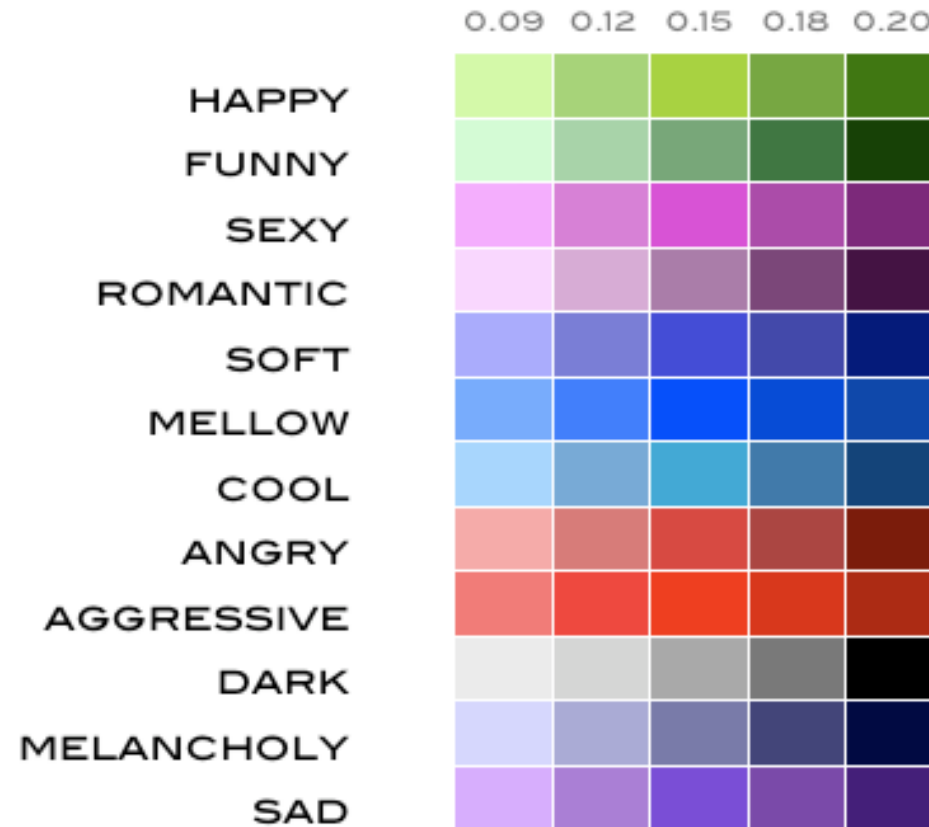
as patterns of tension and release

- frequently chosen emotional last.fm tags form clusters around **prototypical moods** like happy, sad or angry, which describe the song as a whole [*Hu, Bay & Downie, 2007*] [*Levy & Sandler, 2007*]
- wheres we project the **individual lines** of the lyrics one-by-one against the selected affective terms ..
- .. similar to how our brains in temporal integration bind successive events into **perceptual units** at intervals of 3 s duration [*Pöppel, 1997*]
- in order to define a **simplified model** of how each line in the lyrics, depending on their strengths of associations, would activate nodes in working memory [*Kintsch, 1997*]

LSA

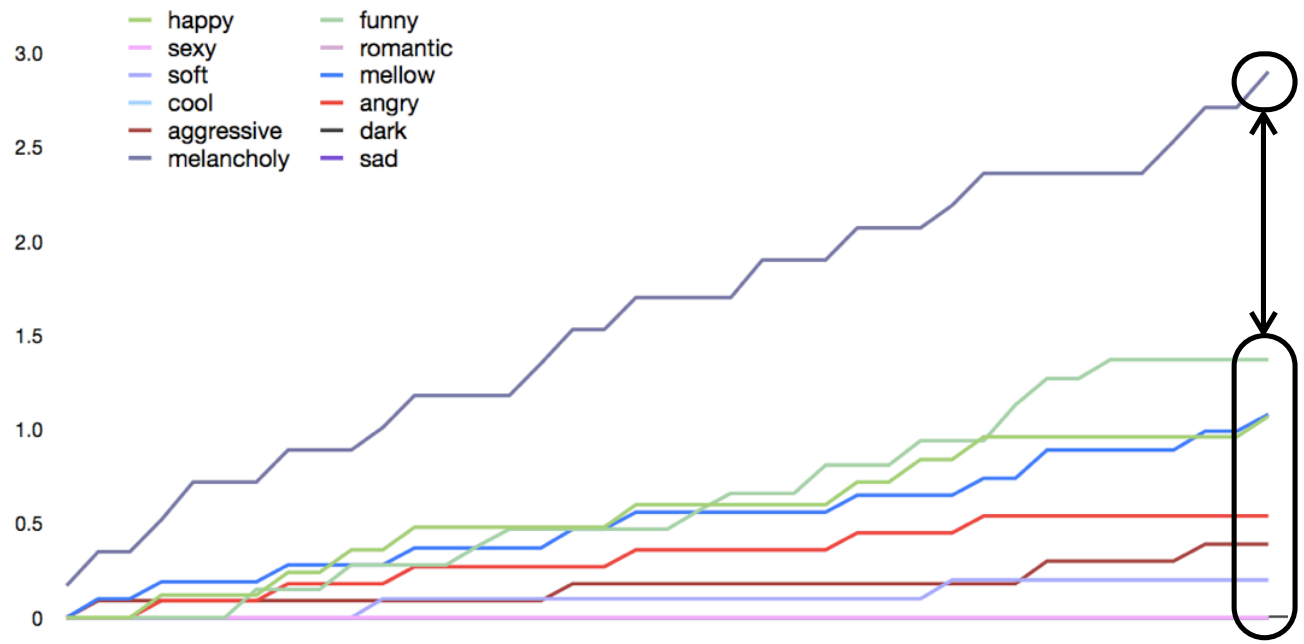
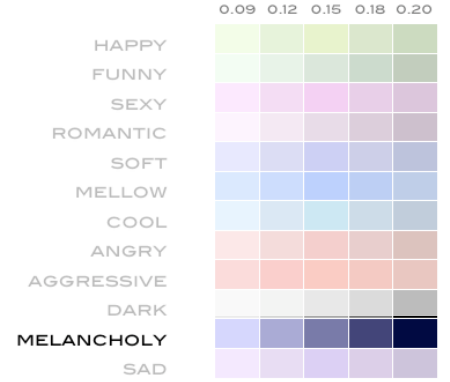
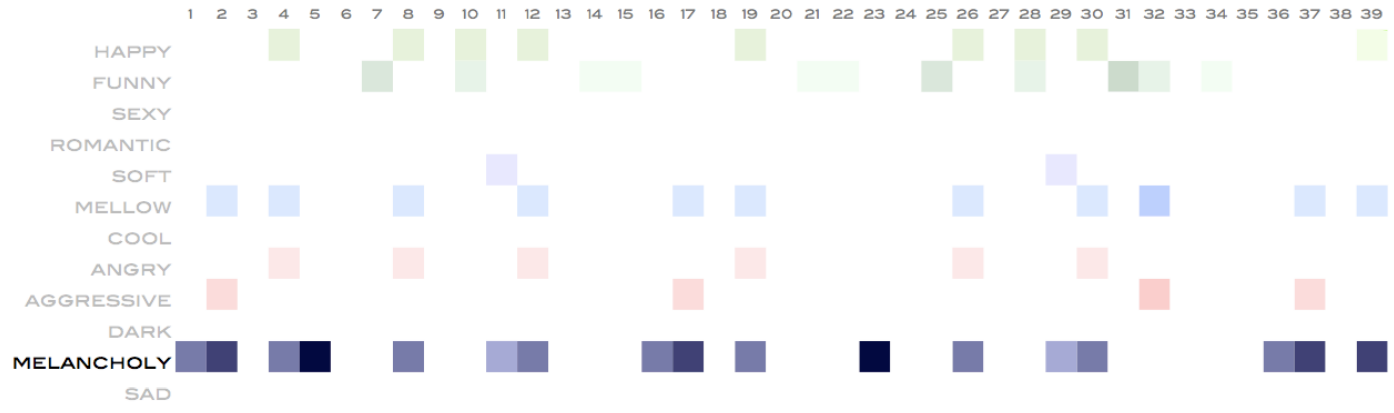


Projecting lyrics against affective terms

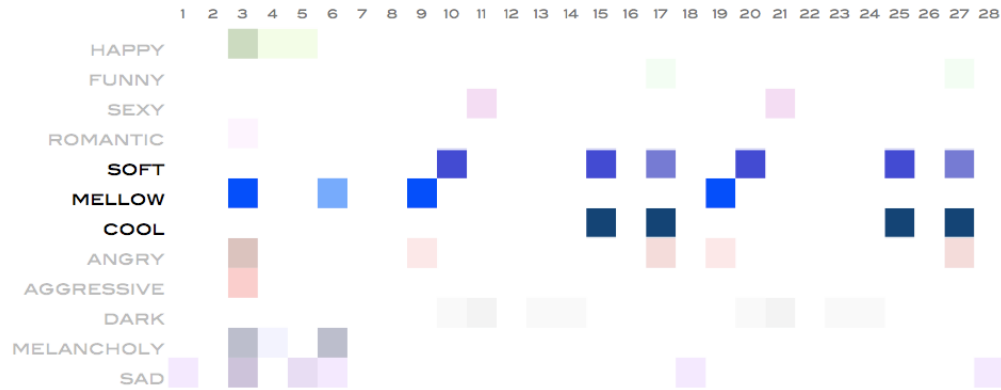


Metallica Nothing Else Matters

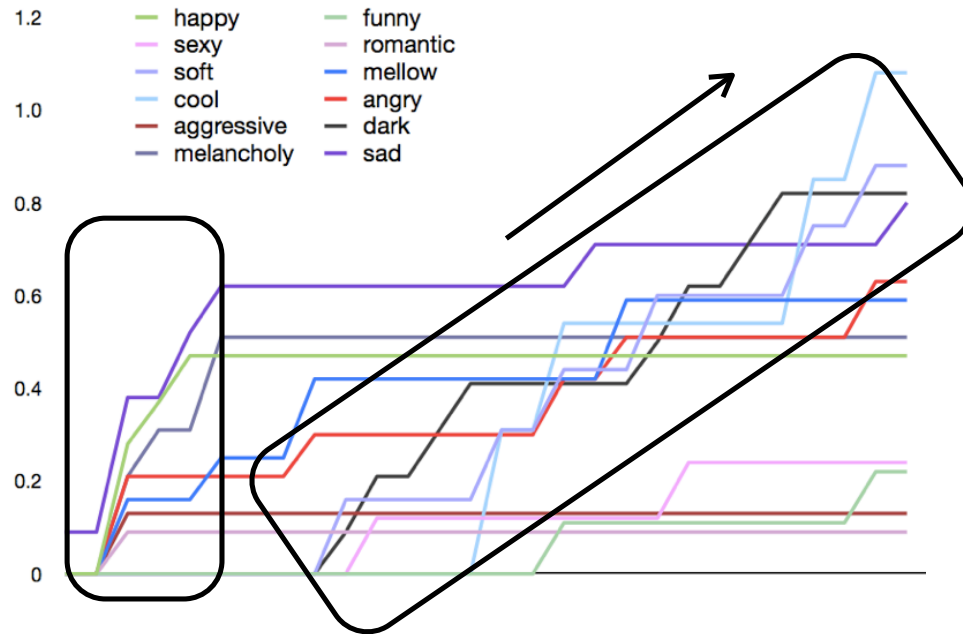
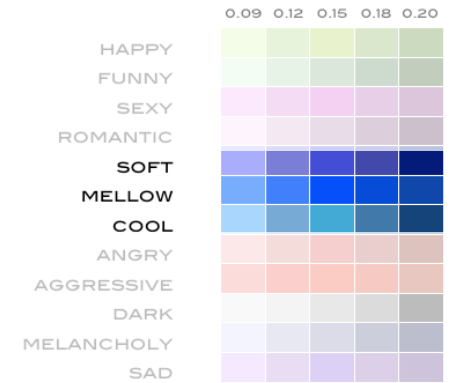
Unbalanced



Feist Now At Last

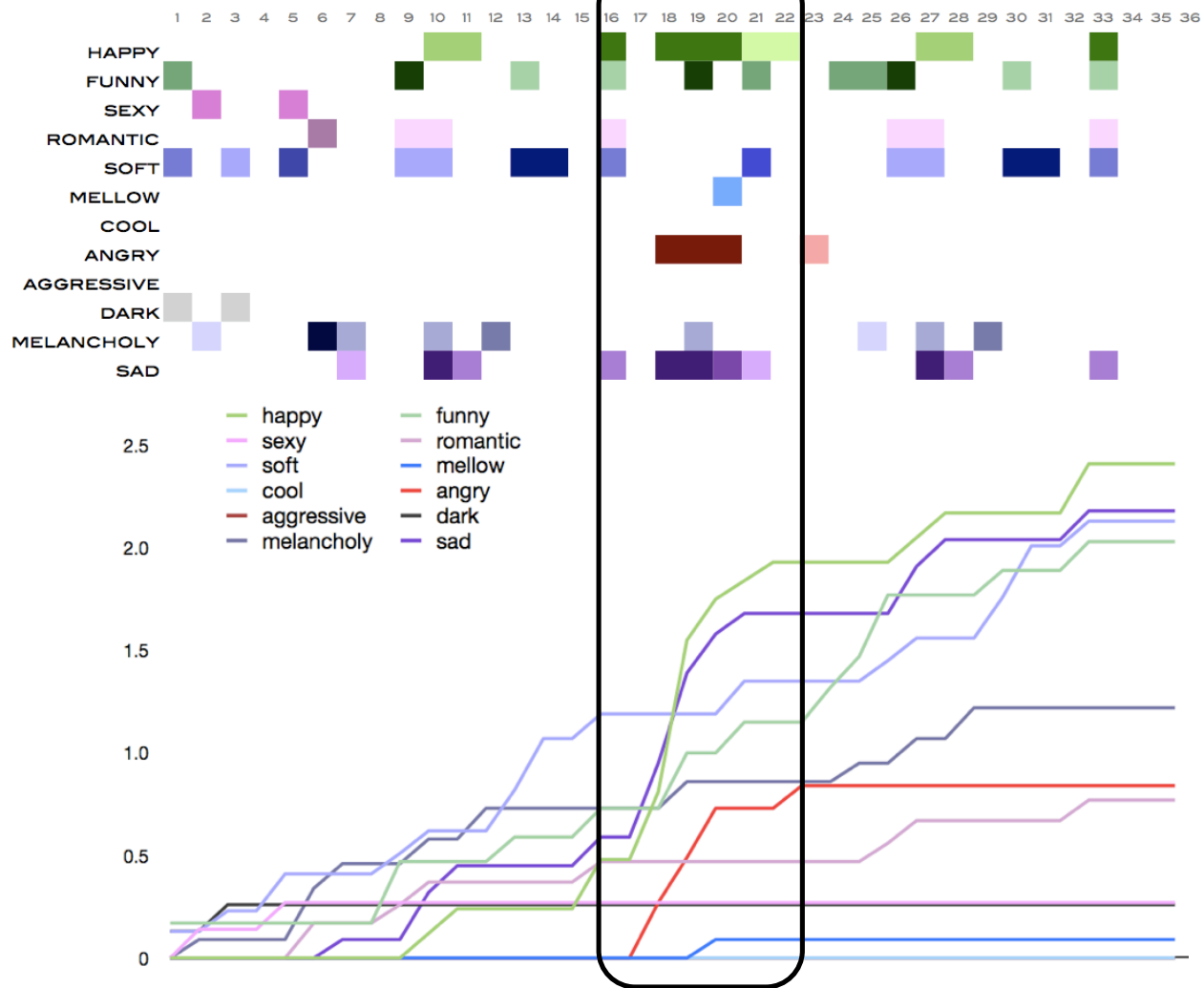


Centered

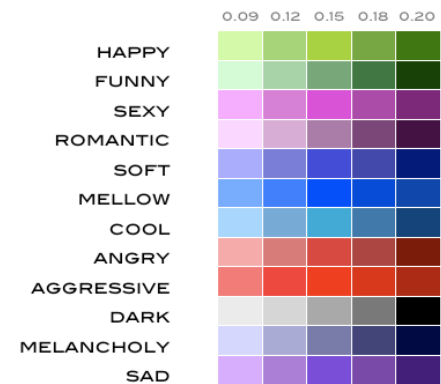


Gary Jules

Mad World

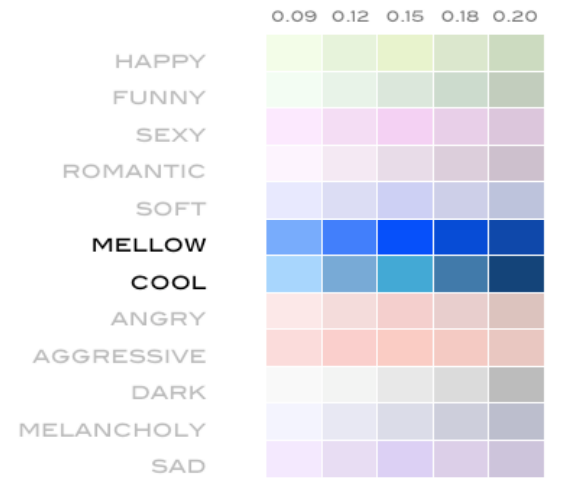
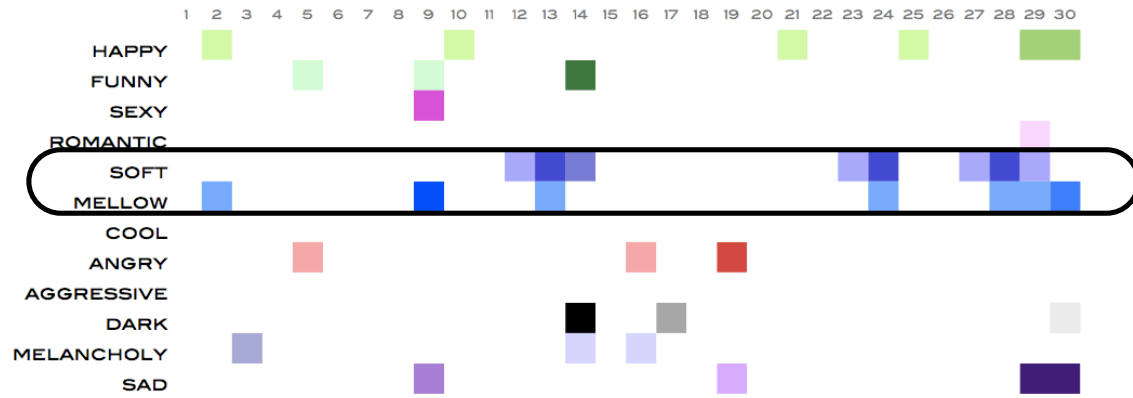


Uniform



Glen Hansard

Falling Slowly



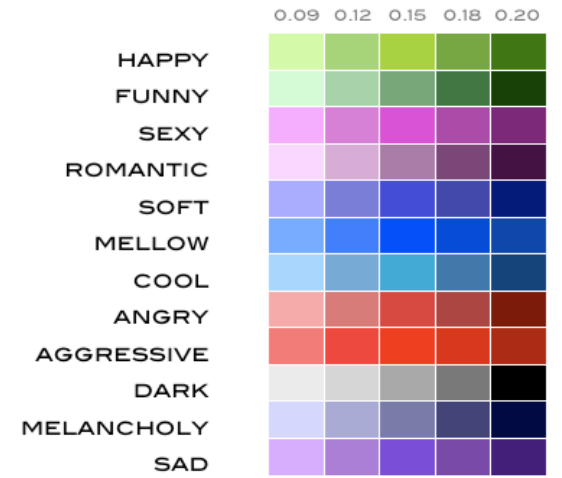
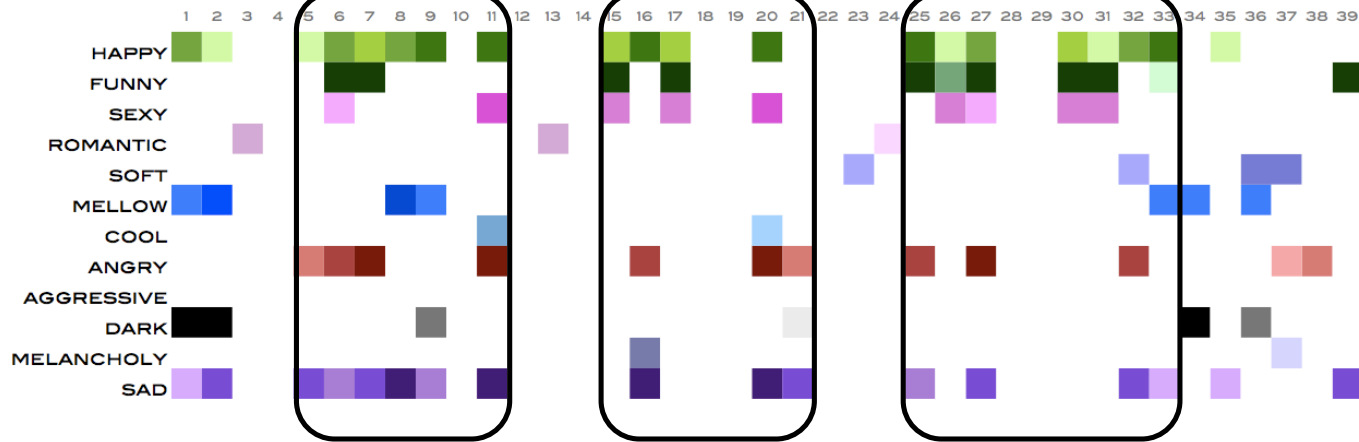
Led Zeppelin

Stairway to Heaven



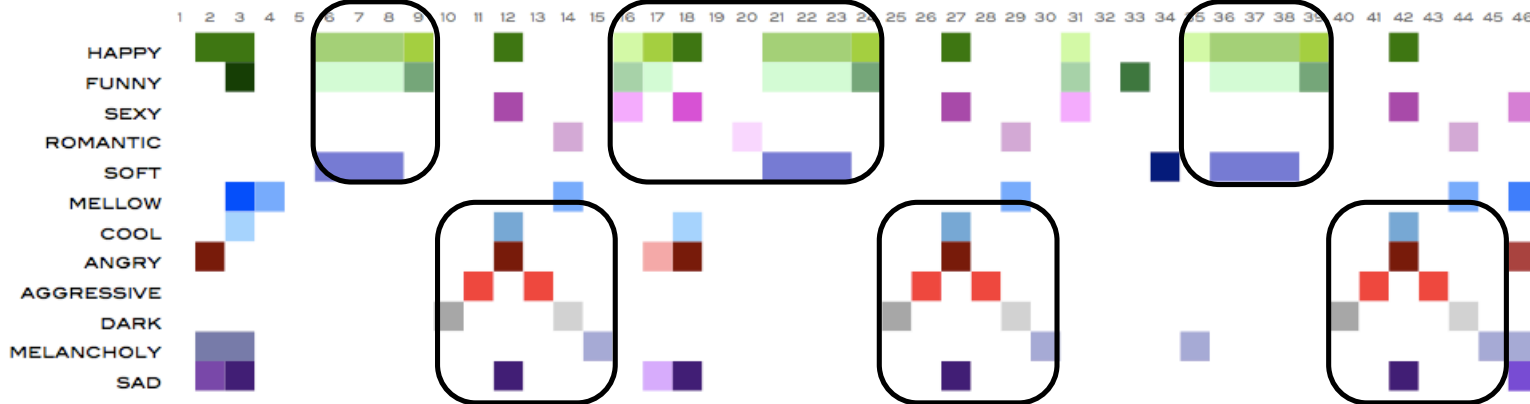
R.E.M.

Everybody Hurts



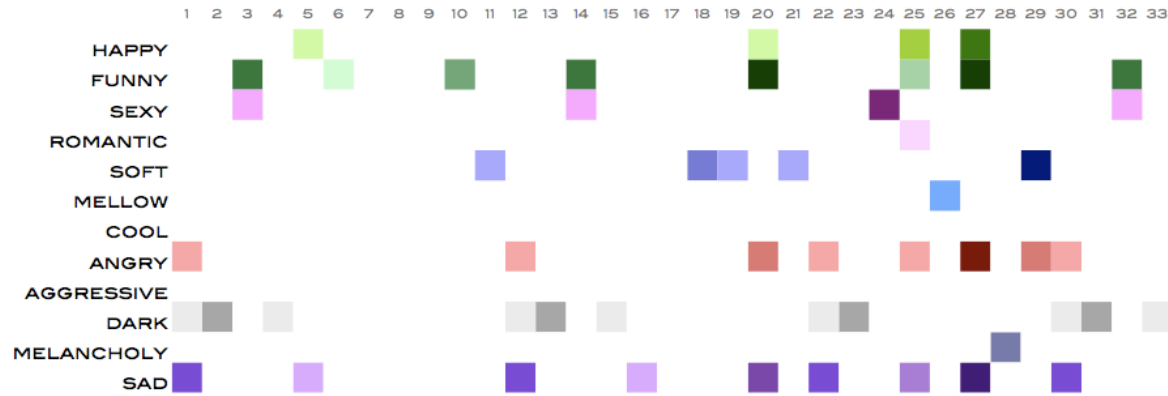
Nirvana

Smells Like Teen Spirit



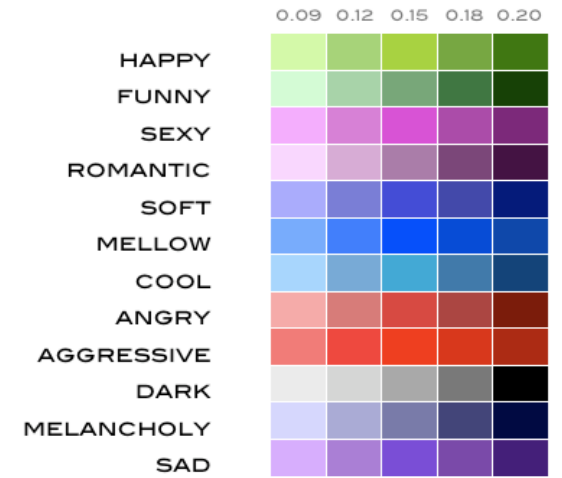
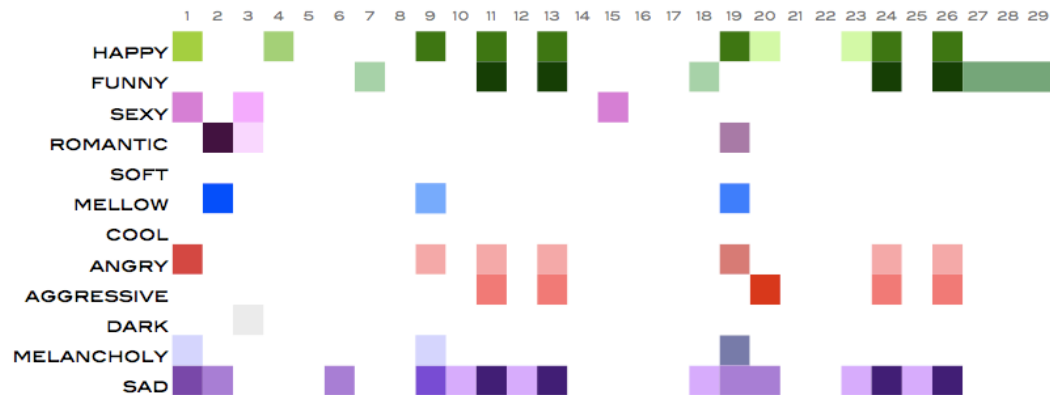
Amy Winehouse

Rehab



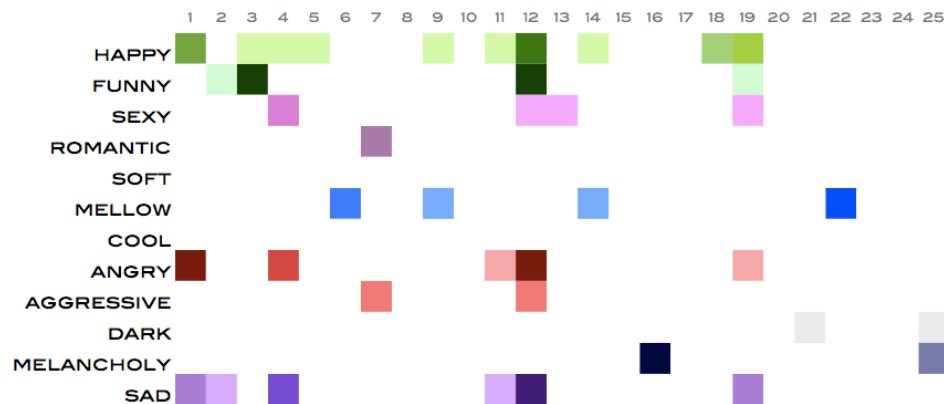
MGMT

Time To Pretend



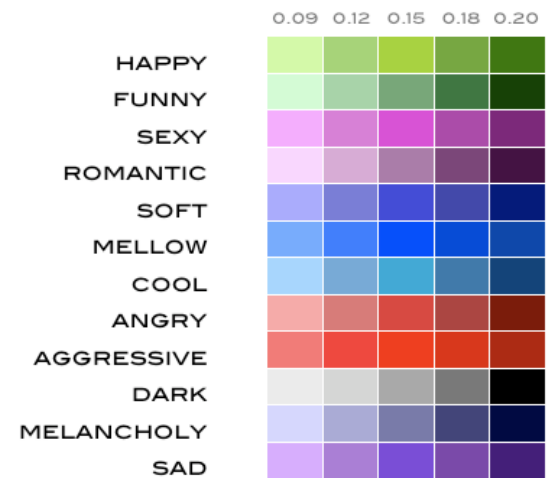
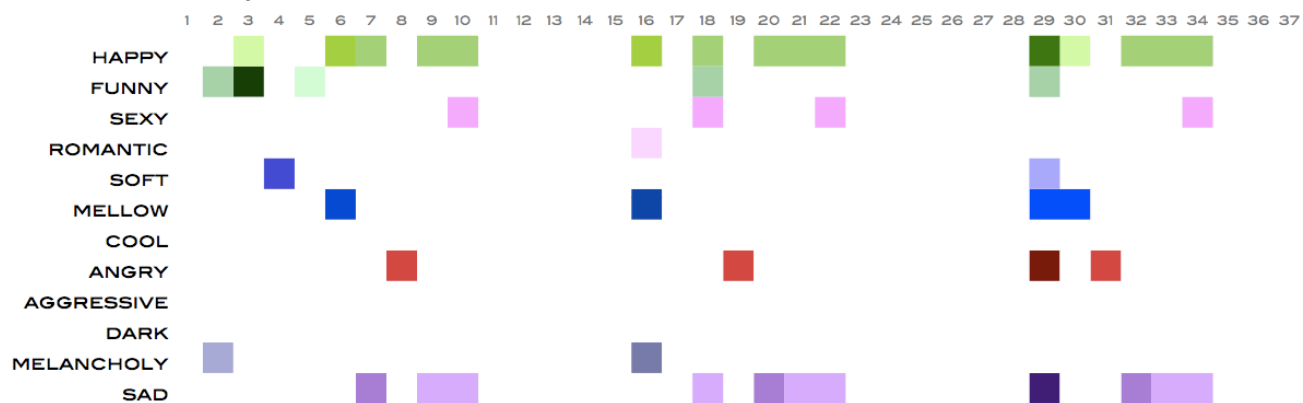
Alanis Morissette

21 Things I Want in a Lover



Radiohead

Creep



Discussion

of early results

- taking into consideration the evidence for shared processing of music and language on both syntax and semantic levels ..
- we hypothesize that LSA analysis of song lyrics projected against emotional terms, could provide high level representations of the emotions evoked when listening to songs
- which might potentially be used as a basis for modeling user preferences and generate emotional playlists

thank you...

A collage of mathematical symbols and formulas. On the left, the Taylor series formula is displayed: $f(x+\Delta x) = \sum_{i=0}^{\infty} \frac{(\Delta x)^i}{i!} f^{(i)}(x)$. To its right is a large integral symbol \int_a^b . Further right are symbols for infinity ∞ , a square root $\sqrt{17}$, a plus sign $+$, a delta symbol δ , the Greek letter pi π , the chi-squared symbol χ^2 , the Greek letter sigma Σ , and a large exclamation mark $!$. The symbols are rendered in various colors including purple, orange, pink, and red.