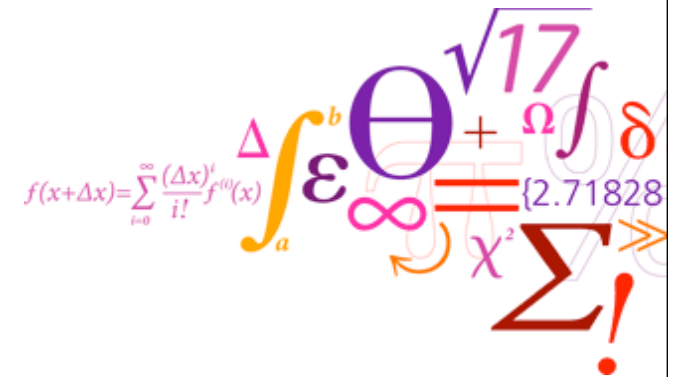


Extracting patterns

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

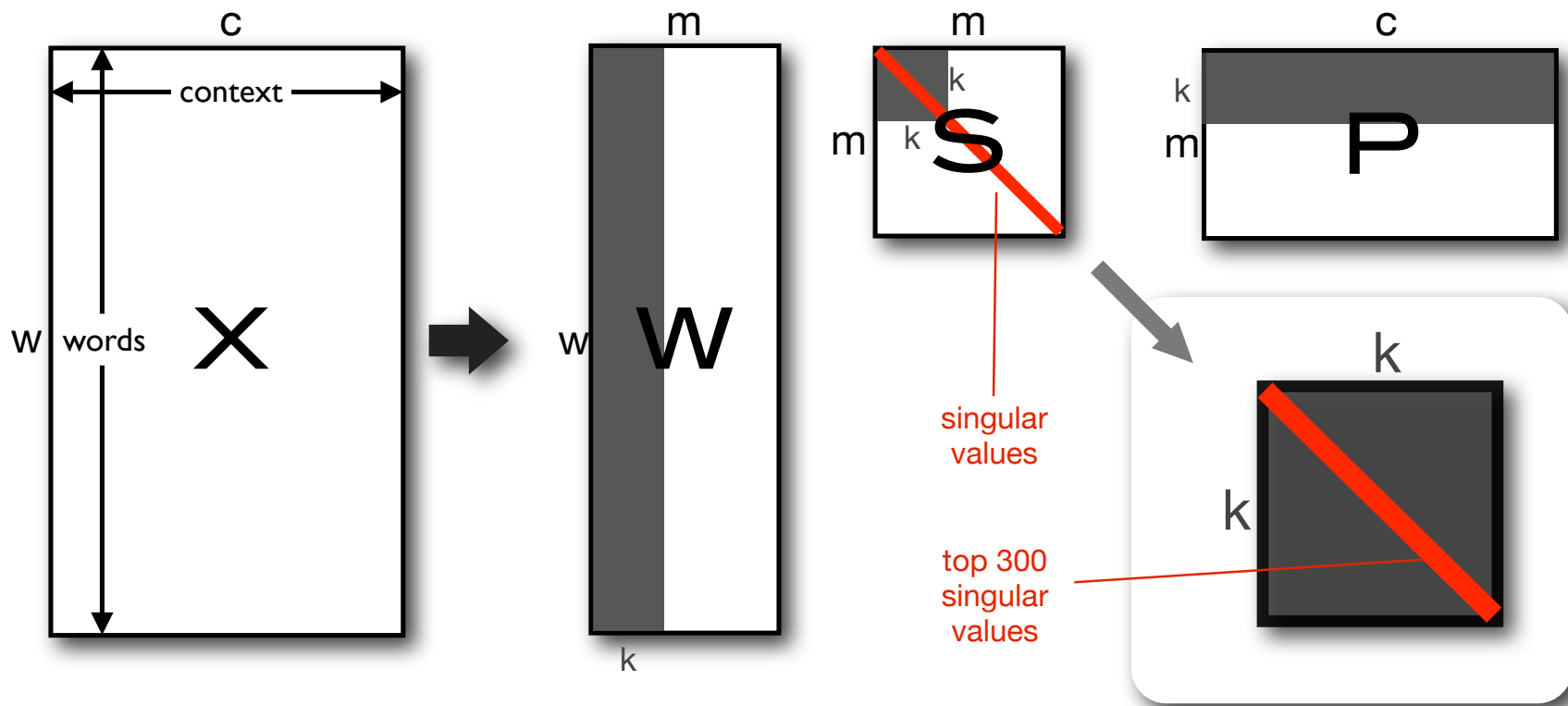
- neuropsychological experiments indicate that **priming effects** on semantic processing can be **identical** for music and language [*Koelsch et al., 2004*]
- supporting findings that **linguistic and melodic** components of songs are processed in interaction [*Schön, Gordon & Besson, 2005*]
- while 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

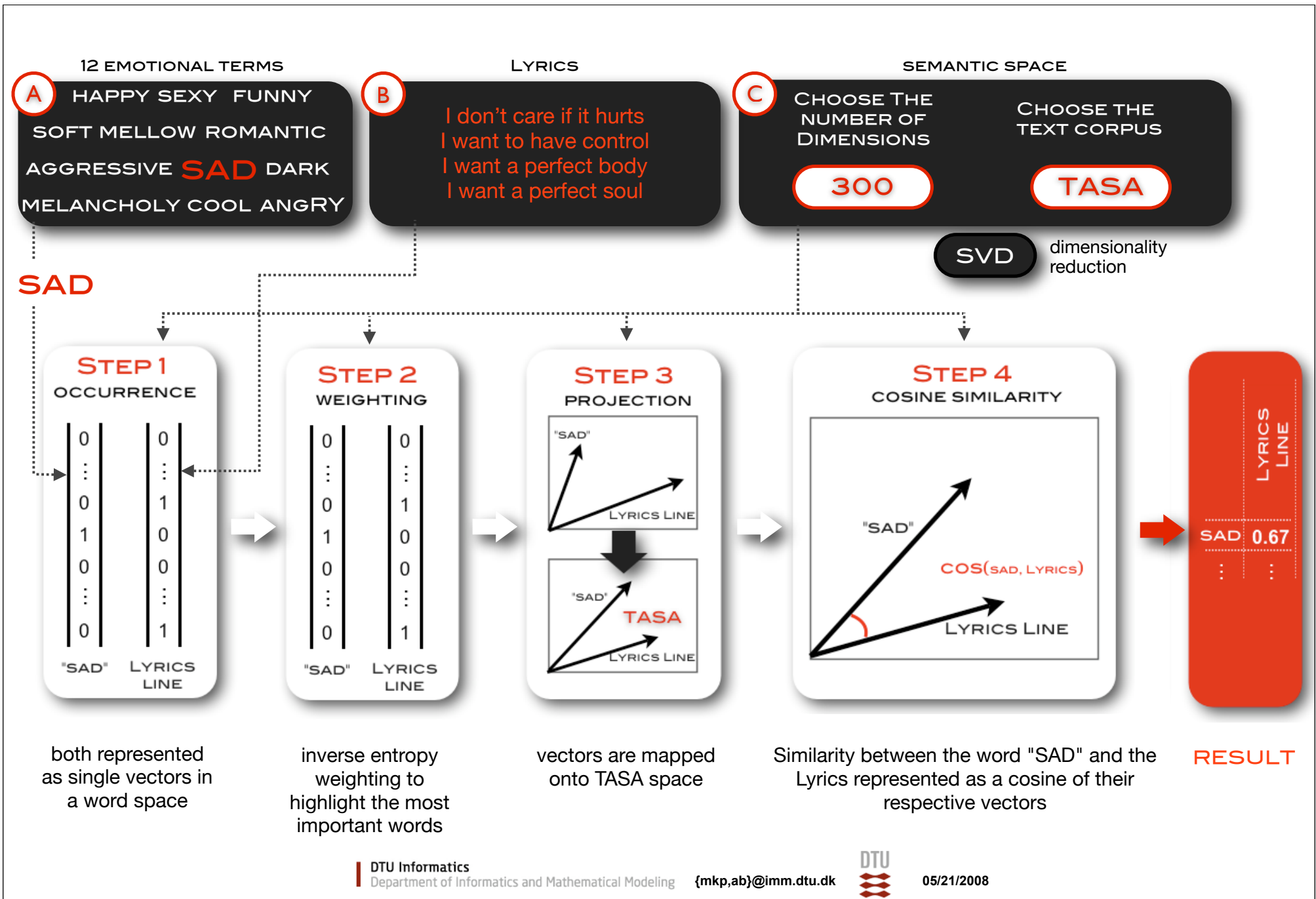
from tracks using emotional tags

- 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



$$X = WSP^T$$

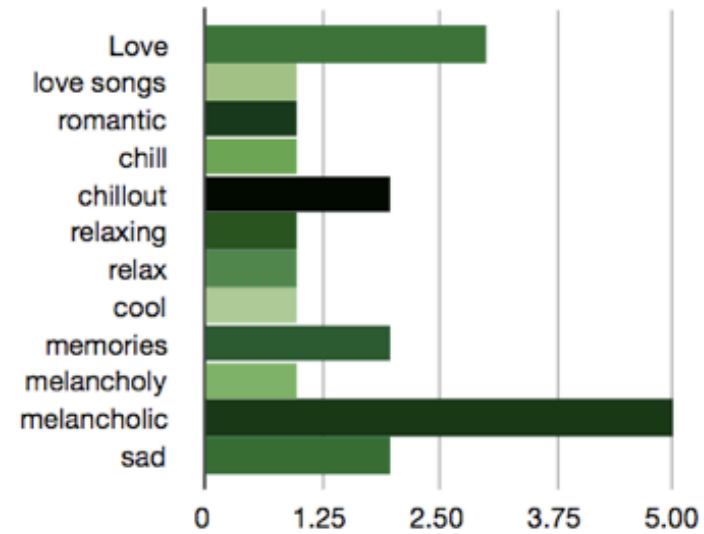
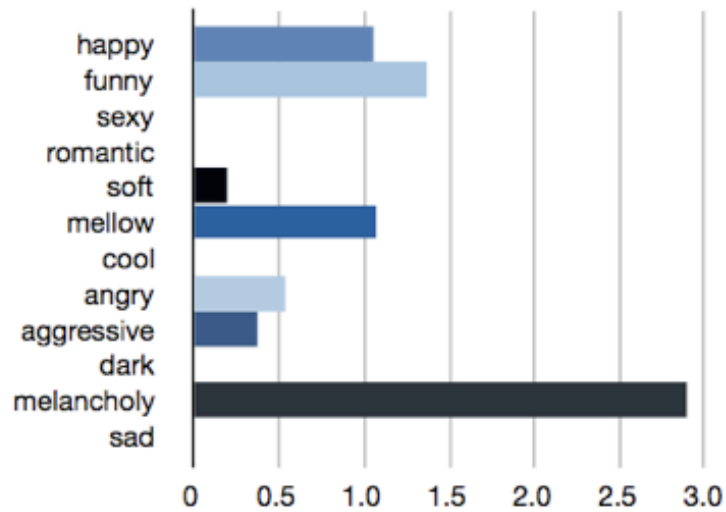
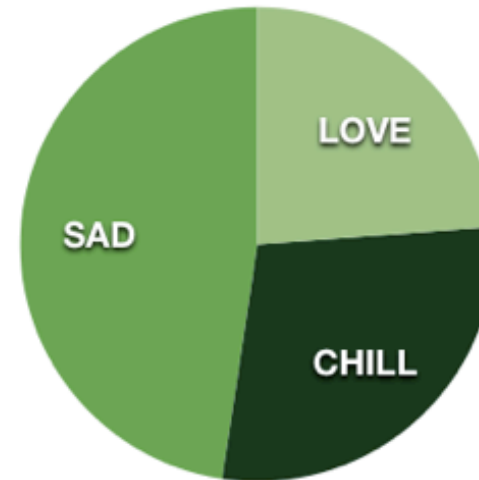
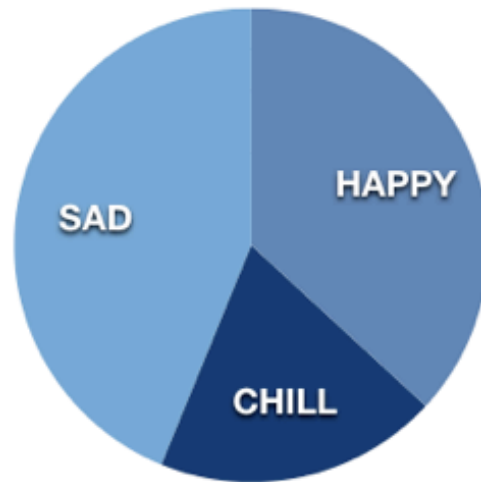


Modeling emotions

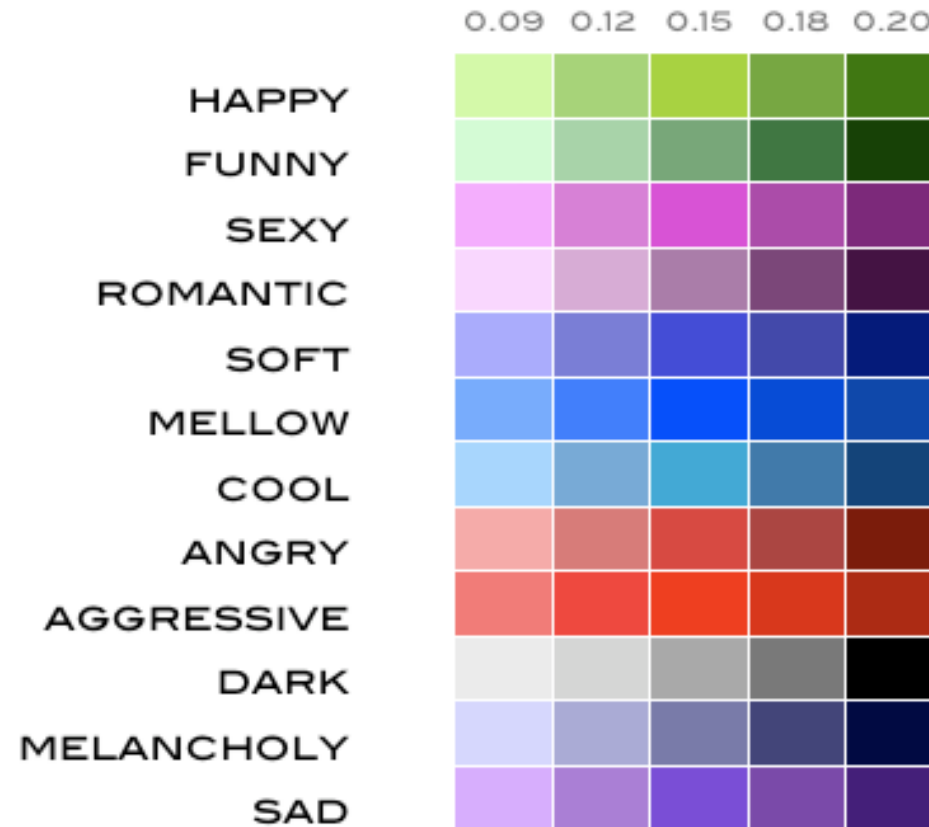
as patterns of tension and release

- 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

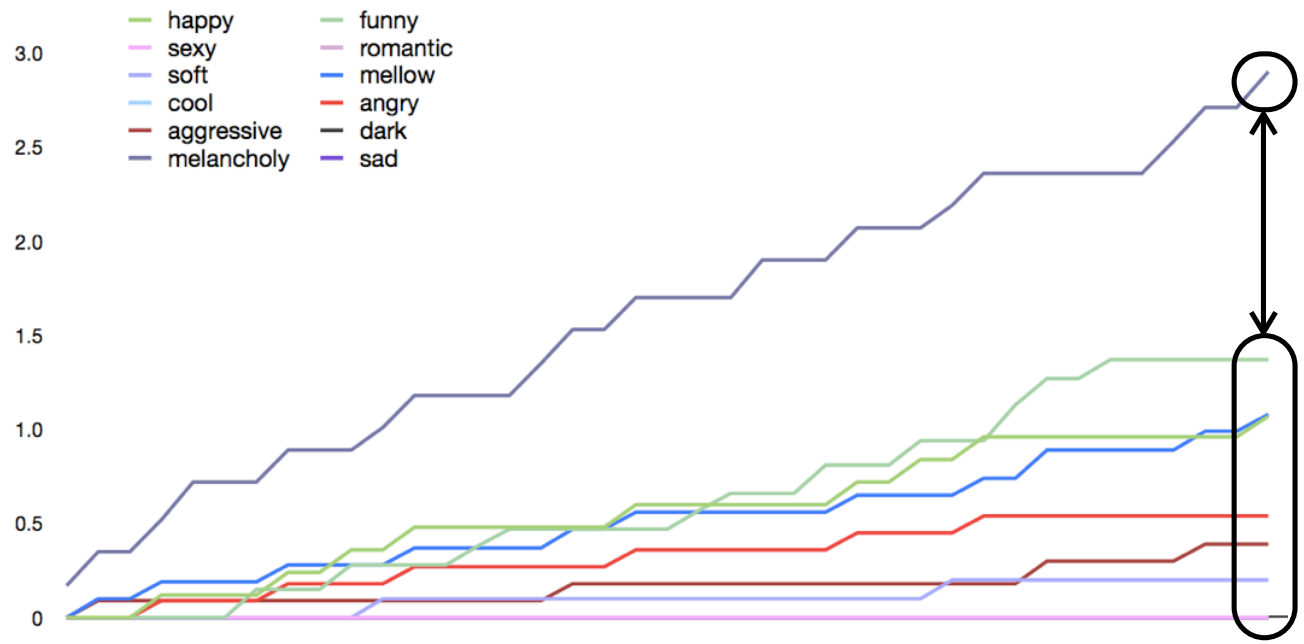
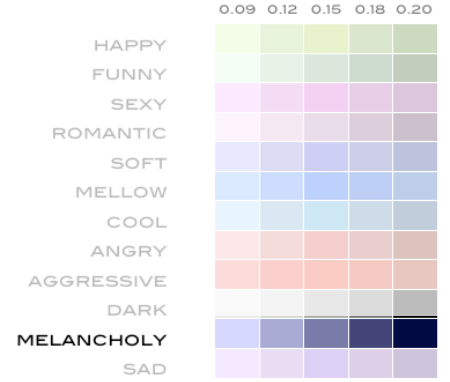
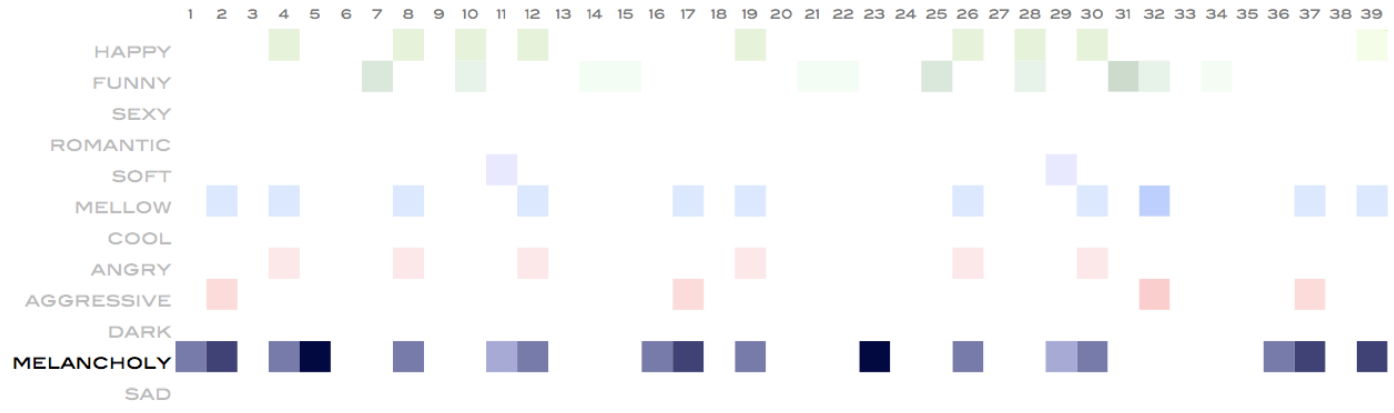


Projecting lyrics against affective terms

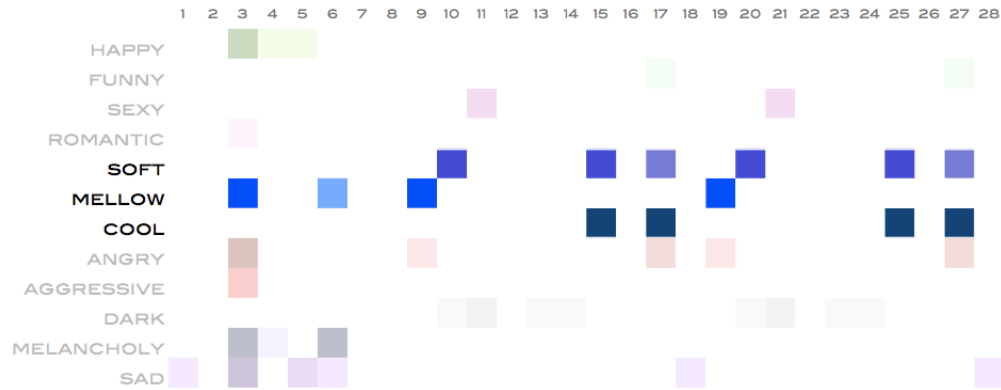


Metallica Nothing Else Matters

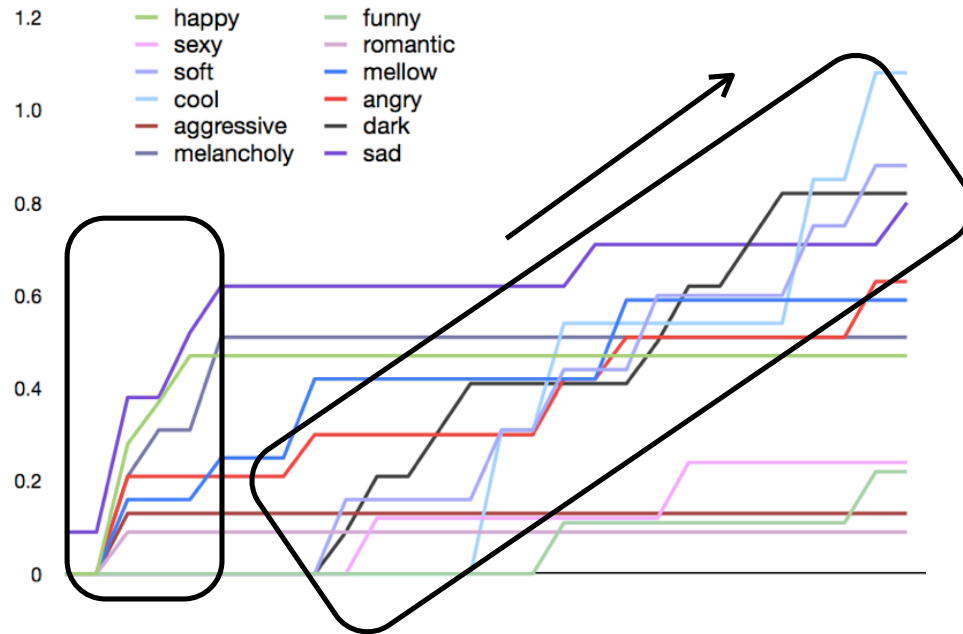
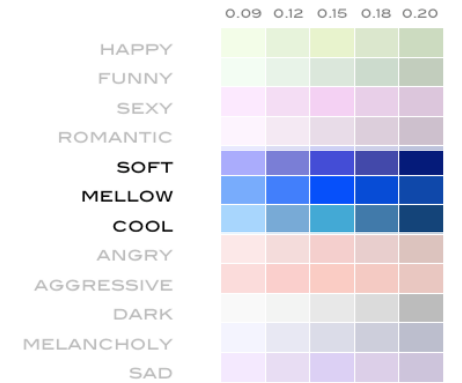
Unbalanced



Feist Now At Last

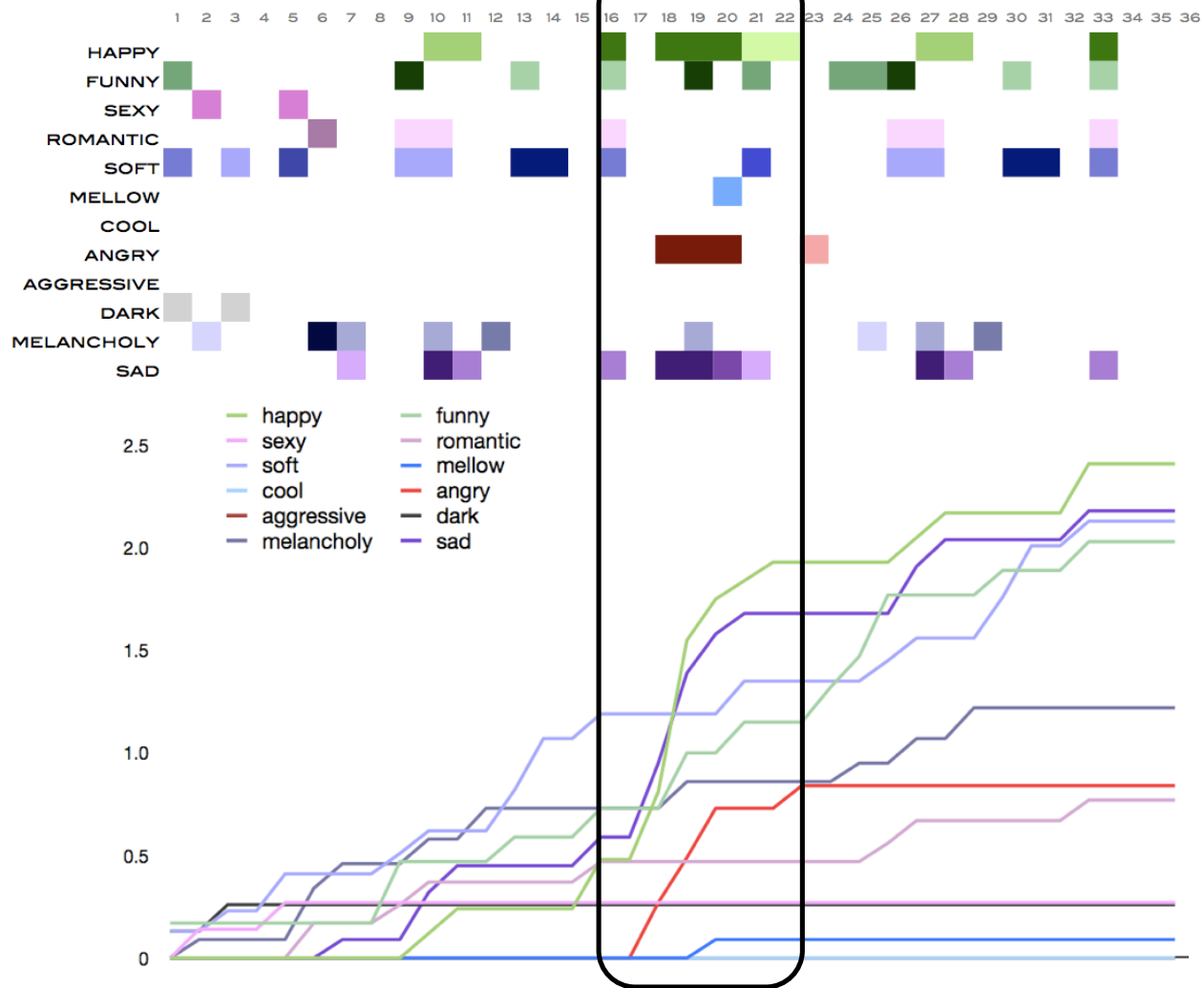


Centered

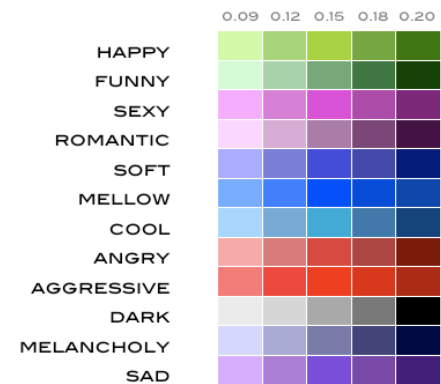


Gary Jules

Mad World



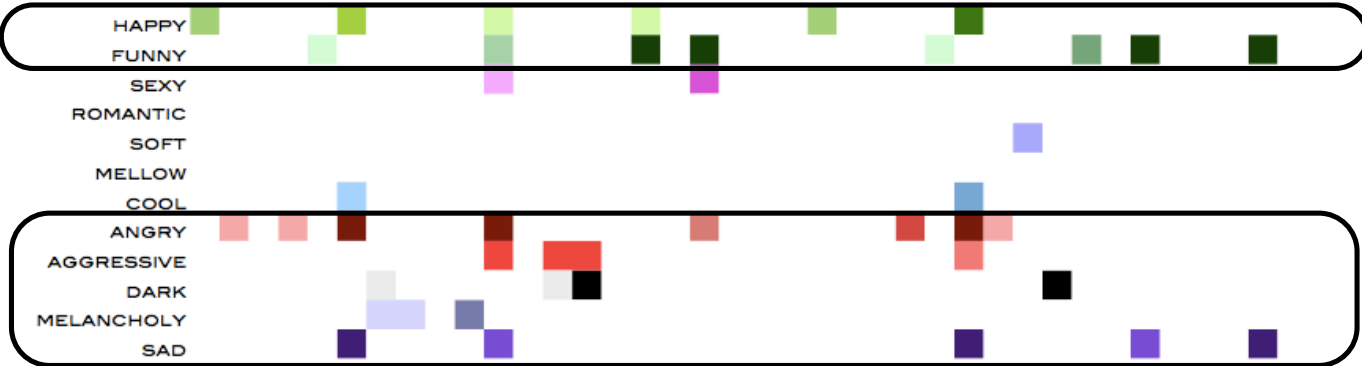
Uniform



Oasis

Wonderwall

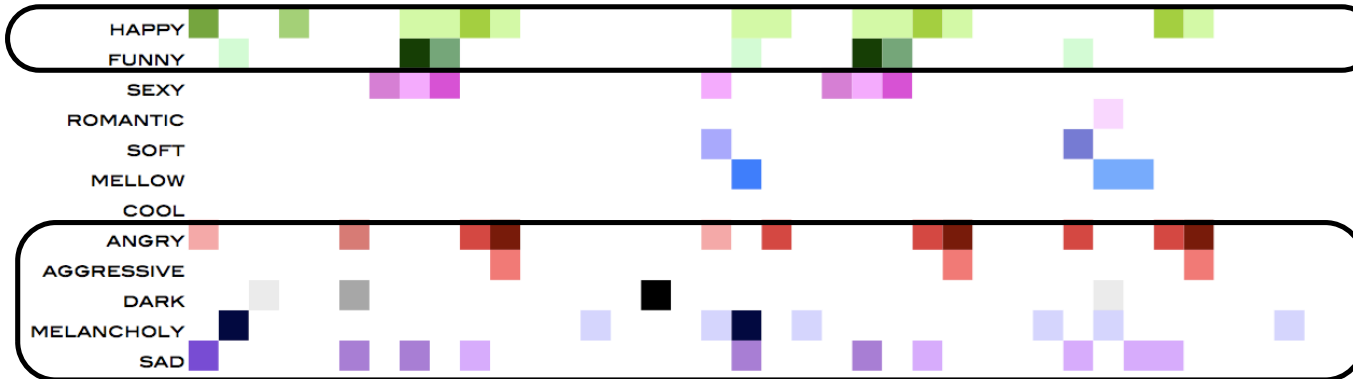
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40



Evanescence

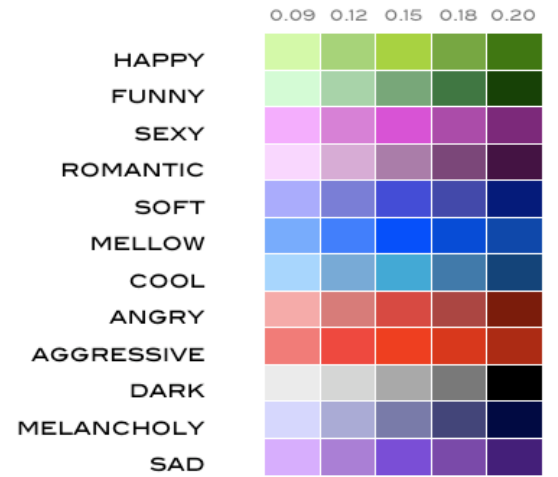
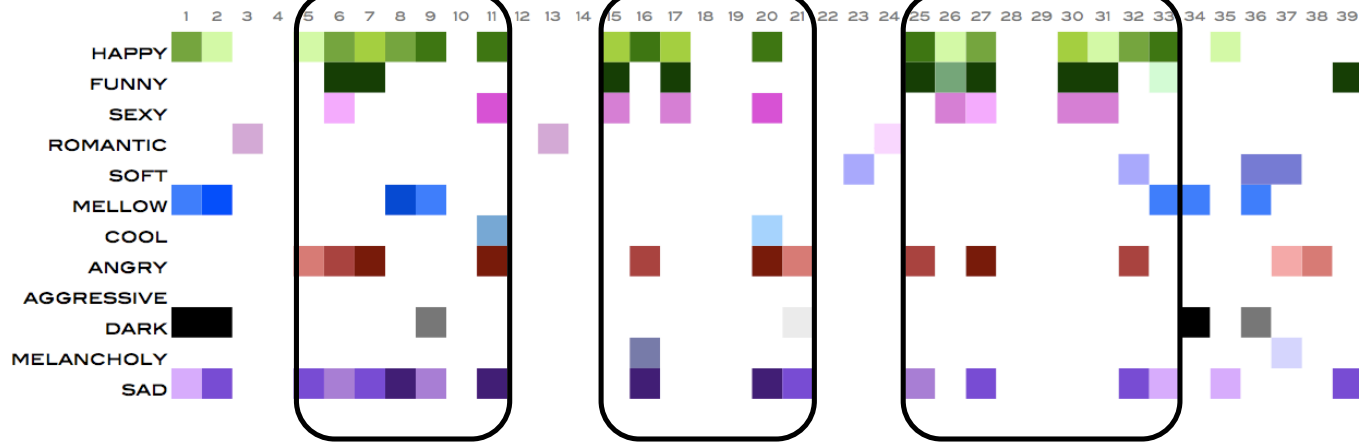
My Immortal

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37



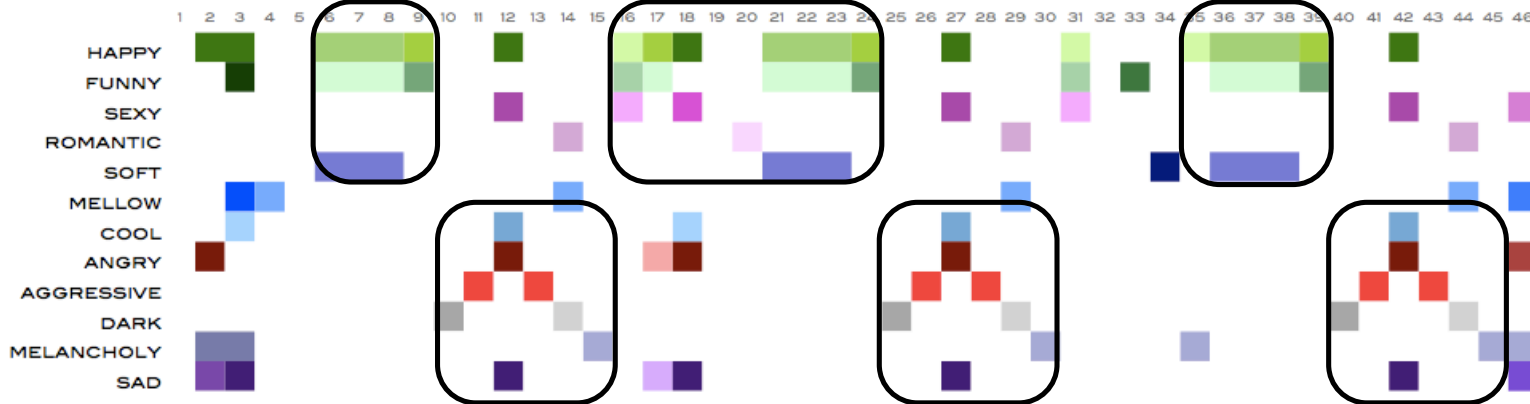
R.E.M.

Everybody Hurts



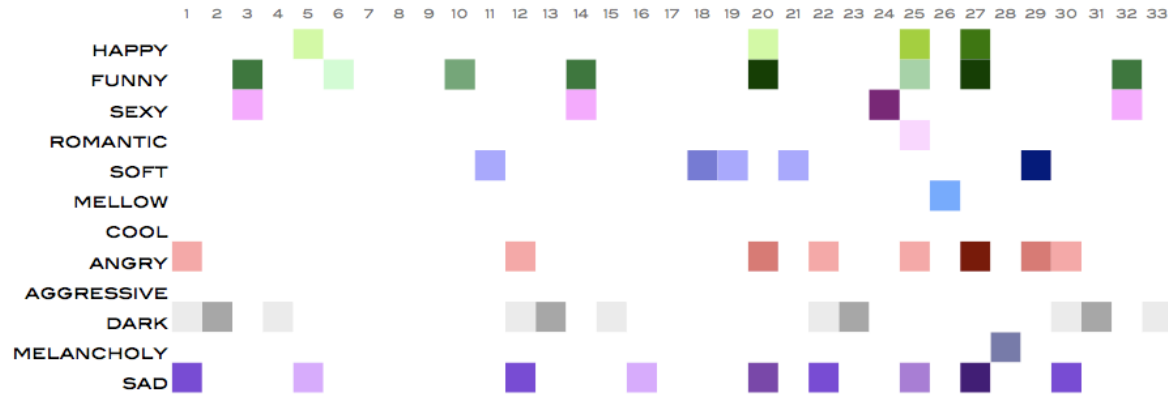
Nirvana

Smells Like Teen Spirit



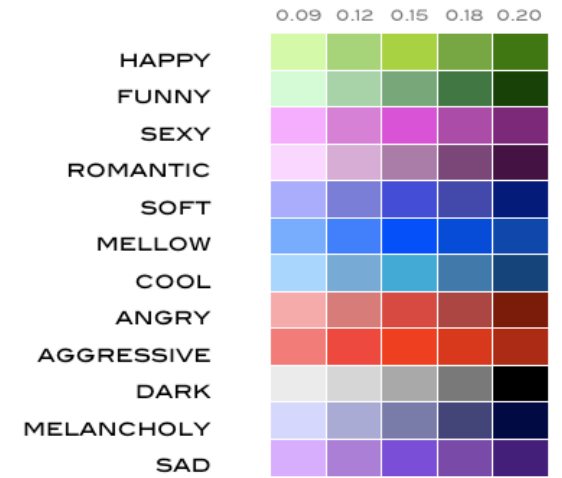
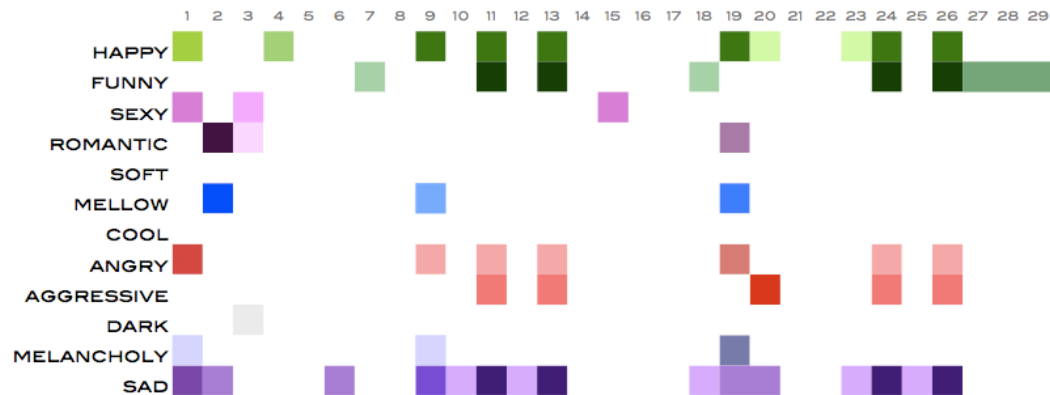
Amy Winehouse

Rehab



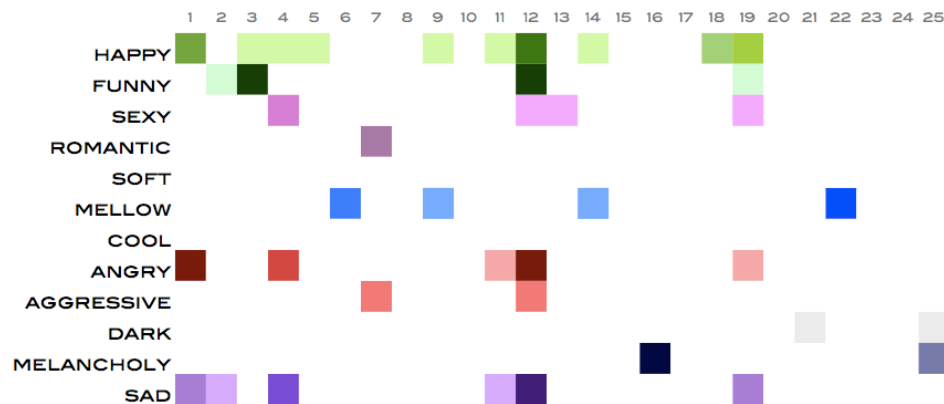
MGMT

Time To Pretend



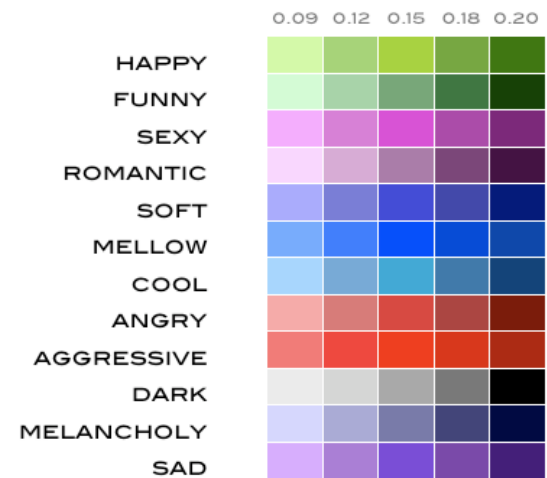
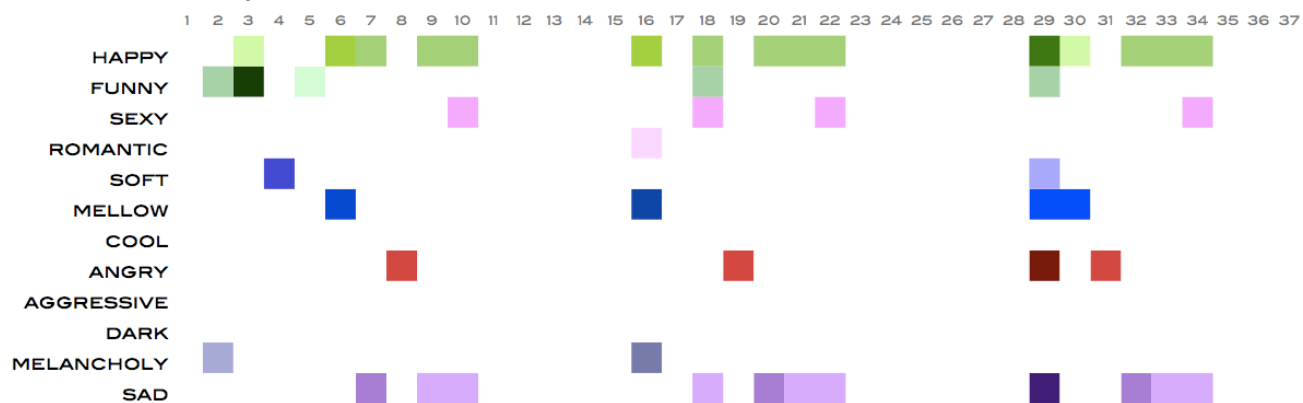
Alanis Morissette

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 Greek letter chi squared χ^2 , the Greek letter sigma Σ , and an exclamation mark $!$. The symbols are rendered in various colors (purple, orange, red, pink) and sizes, creating a dense, artistic composition.