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The role of F0 trajectory in the emotion identification

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Two emotional distinction theories

- **The discrete emotion theory**
  - Basic discrete emotions exist:

    (1) surprise, (2) interest, (3) joy, (4) rage (5) fear (6) disgust (7) shame (8) anguish
  - Individual emotions have biological and neurological profiles
- **The dimensional theory**
  - Two emotional dimensional spaces distinguish emotions

  (1) **valence** – how positive or negative an emotion is

  (2) **arousal** – the intensity of an emotion

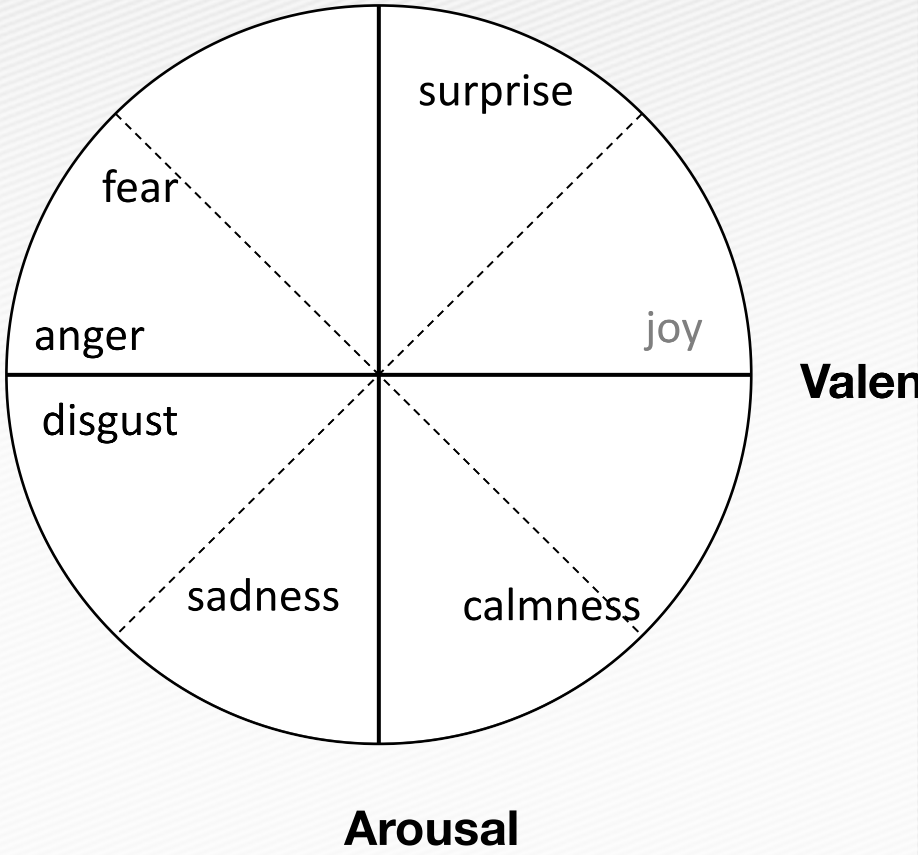
The discrete emotion approach

- Emotions are discrete, measurable, and physiologically distinct.
- Certain emotions appeared to be universally recognized.

→ Many studies have examined the vocal characteristics of speech in hope of defining a vocal signature for each basic emotion (Russell 2003)

The Dimensional approach

- The strongest single association found for vocal acoustic have been with the sender's general **arousal** level.
- High-arousal emotions such as **anger** and **joy** have similar characteristics low arousal emotions such as **sadness**
  - greater loudness,
  - higher pitch
  - faster speech
- Few works have concentrated on distinguishing emotions between positive- and negative- valence emotions such as **anger** and **joy**.



Eerola, T., & Vuoskoski, J. K. (2010). *A comparison of the discrete and dimensional models of emotion in music. Psychology of Music, 39(1), 18–49.* doi:10.1177/0305735610362821

Research topic

- F0 contours contains discriminatory information about emotions.
- Very few can be found in the literature that made the efforts to describe the shape of f0 contours directly in classifying emotions

The Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS)

- The RAVDESS dataset is a multimodal validated English dataset that contains speech, song, and video files that represent 8 emotions.
- The portion of the dataset that I use in this study is the speech audio files that are represented by 1440 wave file.
- Twenty-four professional actors (12 female and 12 male) with 60 trials for each actor produced the 1440 wave files (24×60 =1440).

The Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS)

- The actors vocalized two sentences in a neutral North American accent.
  - “Kids are talking by the door”
  - “Dogs are sitting by the door”
- The emotions
  - neutral, calm, happy, sad, angry, fearful, surprise, and disgust
- Each expression is produced at two levels of emotional intensity (normal and strong) except for the neutral emotion that is recorded in a normal intensity only.

Generalized Additive Mixed Modeling

- In Linear Model, the mean of data is modeled as a sum of linear terms

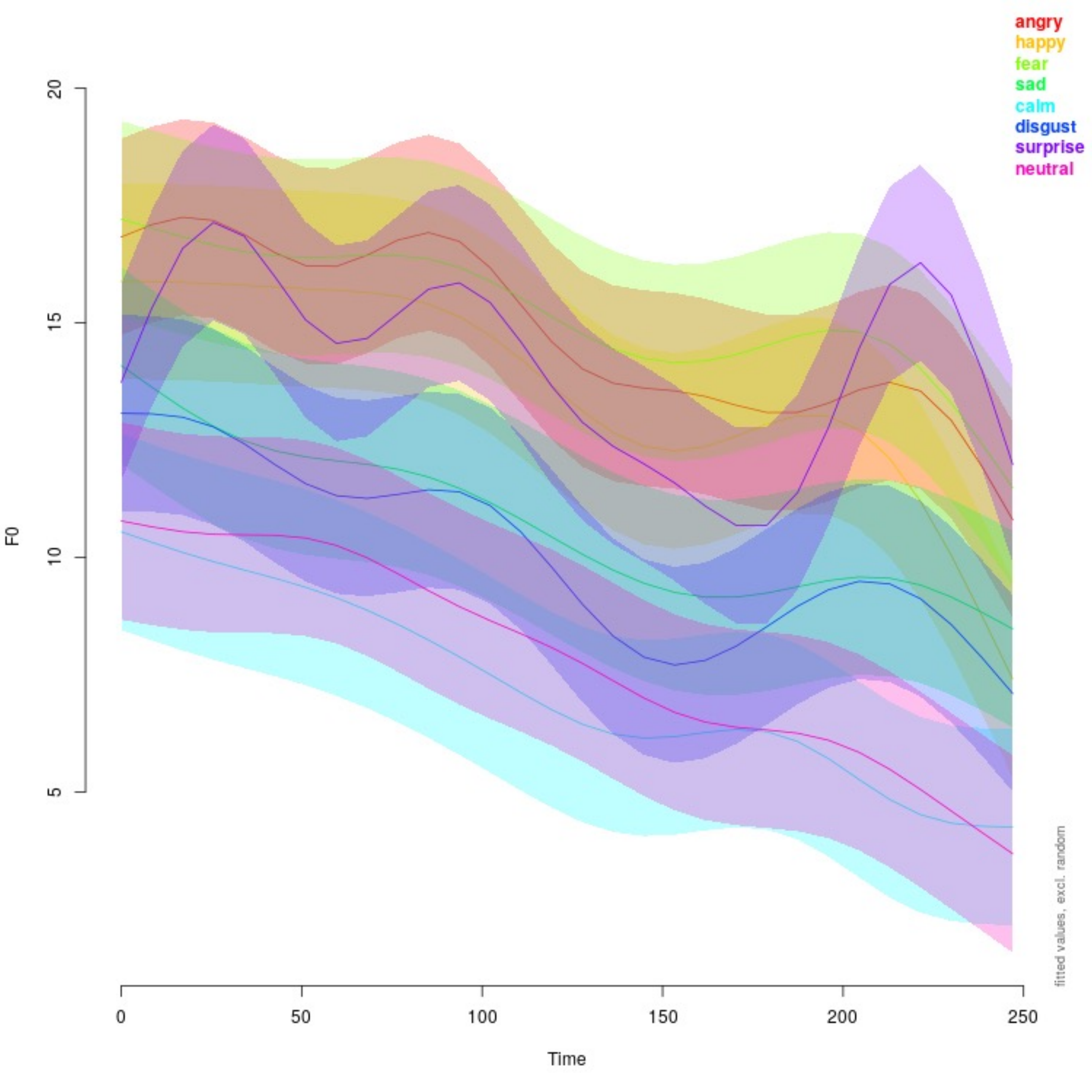
$$y_i = \beta_0 + \sum_j \beta x_{ji} + \varepsilon_i$$

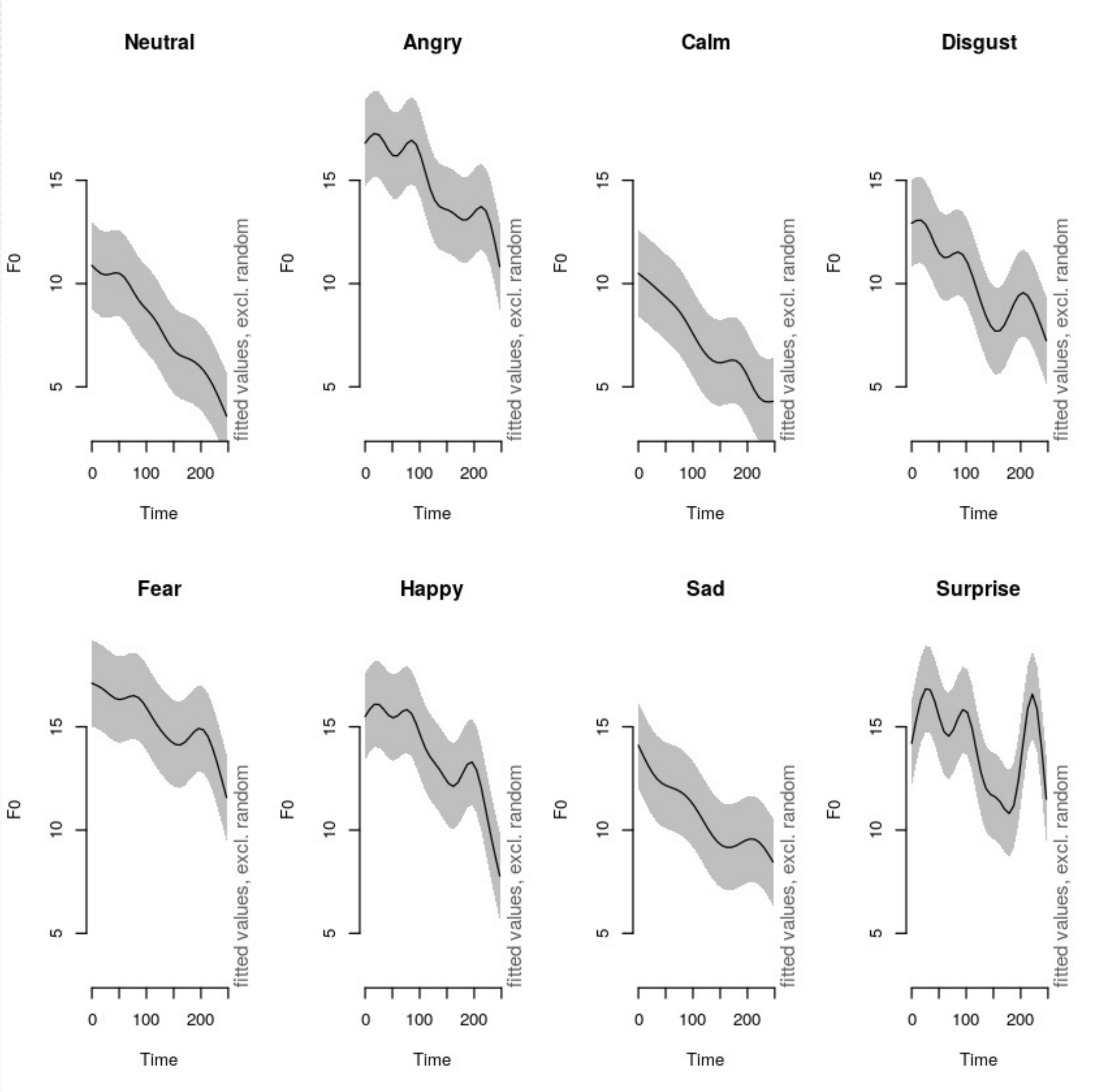
- In Generalized Additive Mixed Model, the mean of data is modeled as a sum of ***smooth*** functions (= smooths)

$$y_i = \beta_0 + \sum_j s_j(x_{ji}) + \varepsilon_i$$

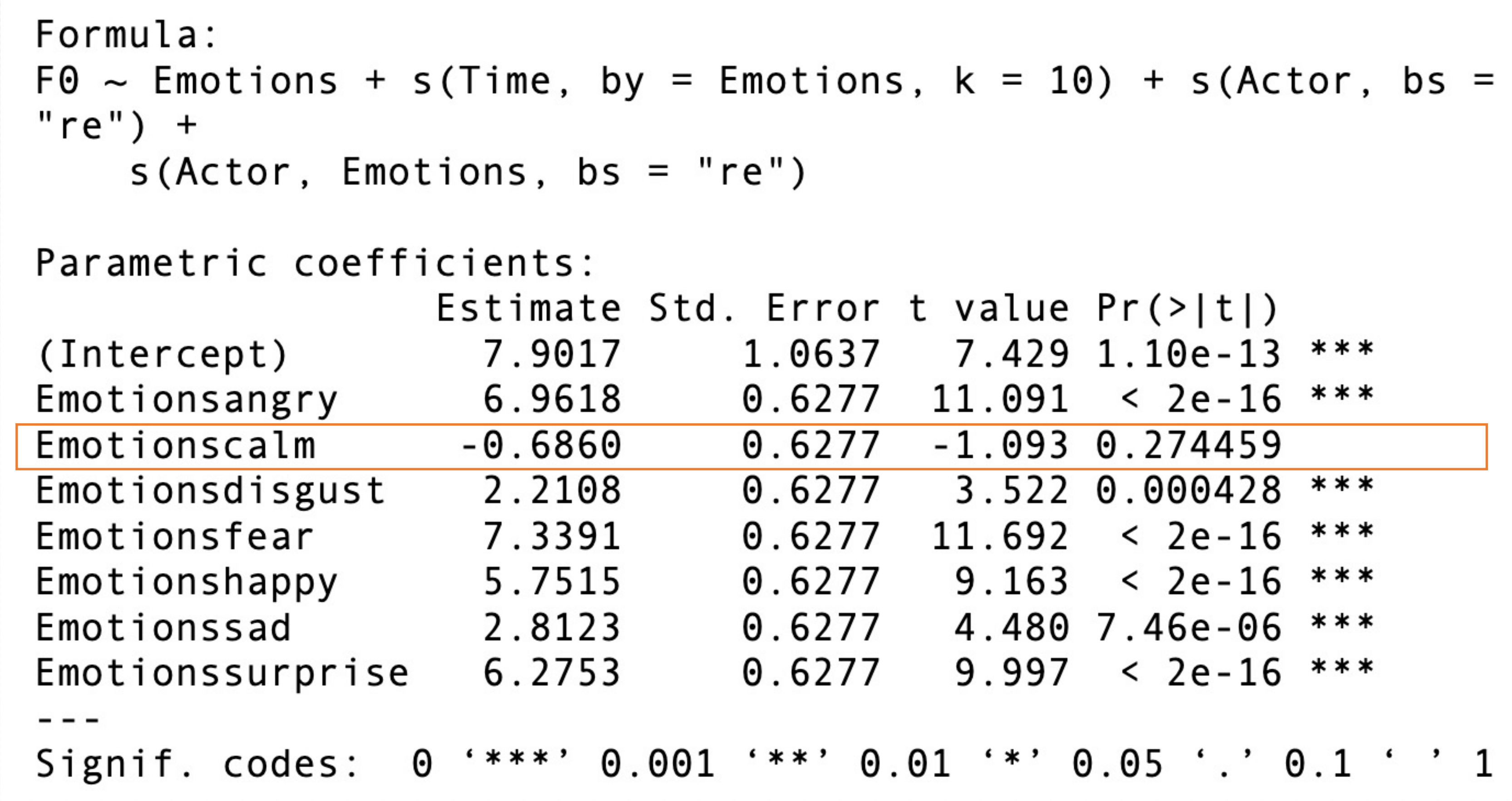
Wood, S. N. (2017). *Generalized additive models: an introduction with R*. CRC press.

GAMM approach to the F0 contour modeling





Gamm Modeling



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Formula:
F0 ~ Emotions + s(Time, by = Emotions, k = 10) + s(Actor, bs =
"re") +
    s(Actor, Emotions, bs = "re")

Parametric coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)         7.9017     1.0637   7.429 1.10e-13 ***
Emotionsangry       6.9618     0.6277  11.091  < 2e-16 ***
Emotionscalm       -0.6860     0.6277  -1.093 0.274459
Emotionsdisgust     2.2108     0.6277   3.522 0.000428 ***
Emotionsfear        7.3391     0.6277  11.692  < 2e-16 ***
Emotionshappy       5.7515     0.6277   9.163  < 2e-16 ***
Emotionssad         2.8123     0.6277   4.480 7.46e-06 ***
Emotionssurprise    6.2753     0.6277   9.997  < 2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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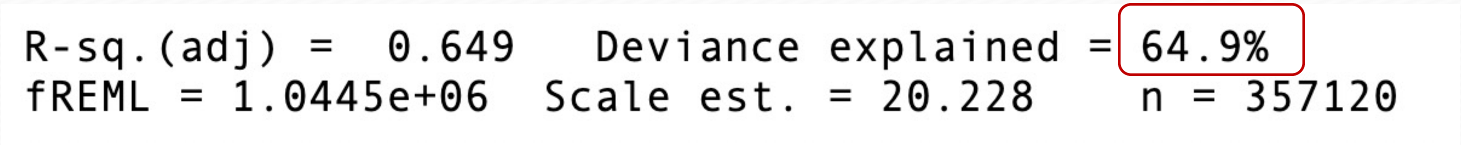

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R-sq.(adj) =  0.649   Deviance explained = 64.9%
fREML = 1.0445e+06  Scale est. = 20.228    n = 357120
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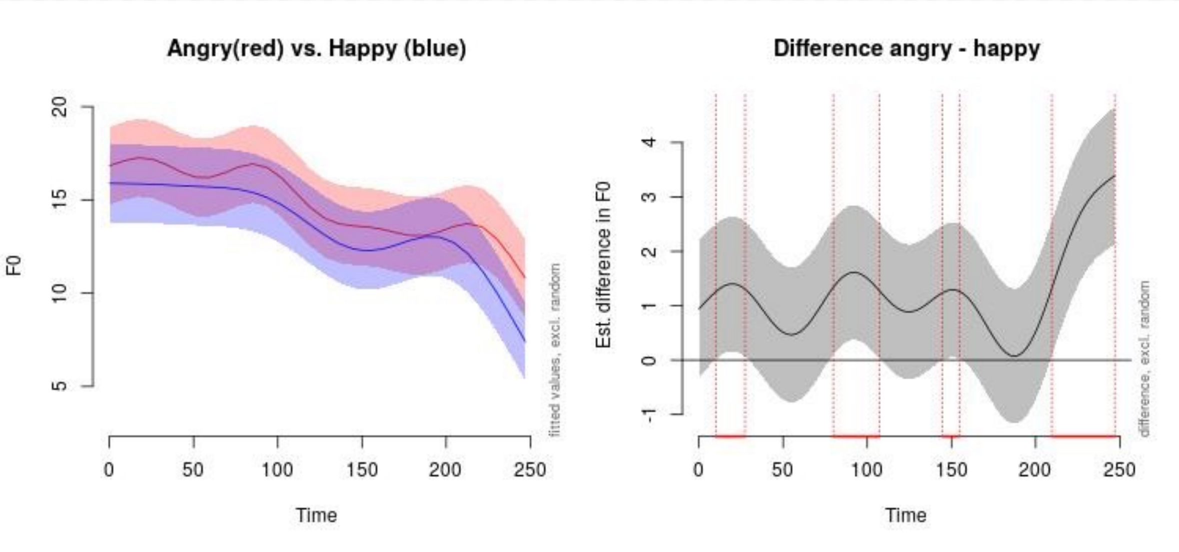
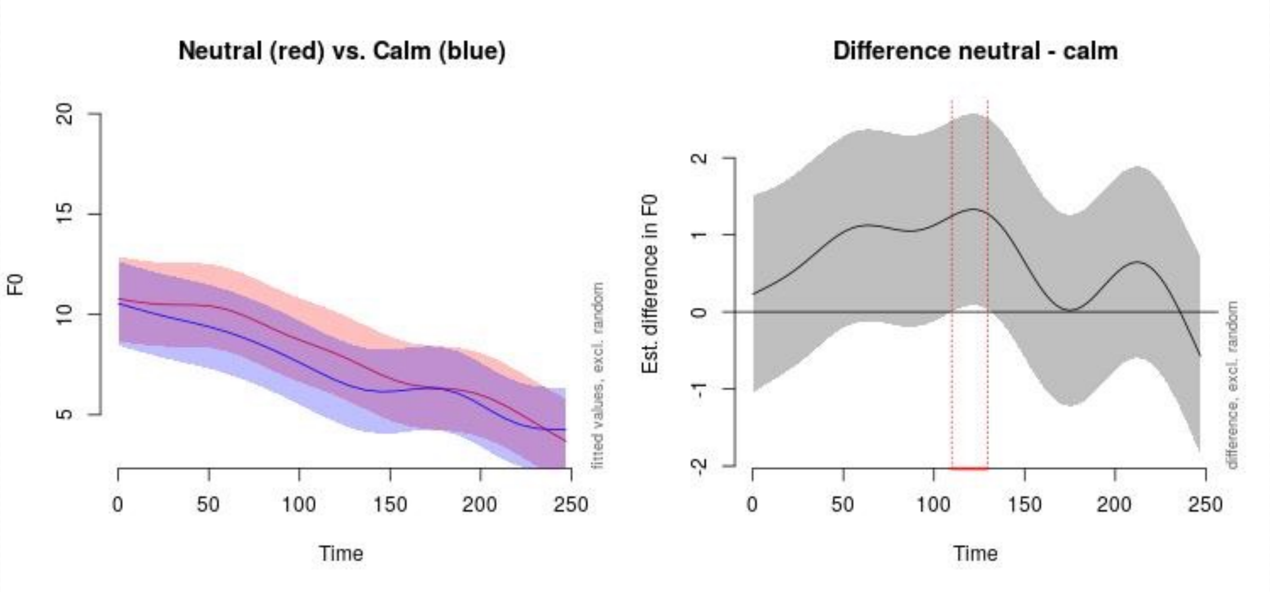
Pair-wise comparison of contours





Conclusion

- I attempted to model Emotions using F0 contours as an input to generalized additive model (GAM)
- The present approach has predictive power (64.9%).
- The additive model provides visualized aids and makes us better understand validity data obtained from human labelers.

THANK YOU