A New Way of Analyzing Vowels: Comparing Formant Contours Using Smoothing Spline ANOVA

This poster demonstrates the use of a smoothing spline (SS) ANOVA for studying differences in vowel acoustics, and shows how this method may both inform and add to the widely-used point-based measurement of formant values in the study of sociophonetic variation. The SS ANOVA is a test that determines whether there are significant differences between the smoothing splines (i.e. curves) that are fitted to the data sets being compared (Gu 2002). By using the SS ANOVA in combination with Bayesian confidence intervals, one can also determine the loci of statistically significant differences along any two compared curves. This method has been successfully applied in linguistic ultrasound research to assess differences between tongue shapes (Davidson 2006). Here we apply the SS ANOVA to the comparison of vowel formant contours drawn from tokens produced by speakers of different dialects.

This method contrasts with the common practice of measuring formant values at single points, such as the vowel midpoint. While the reasoning behind such measurements (i.e. the avoidance of coarticulation effects) is valid, it overlooks the fact that vowels are dynamic, time-varying acoustic events. Consequently, single point measurements suffer from at least two disadvantages. First, they require priori assumptions as to which points in the vowel serve as loci for significant and interesting variation. Second, measurements taken at one point in time preclude an examination of transitional changes within the vowel, which may contain important acoustic cues relevant to creating contrast (Lindblom & Studdert-Kennedy 1967) or conveying sociolinguistic information (Thomas 2000).

To demonstrate how an SS ANOVA works, we use this test to compare formant contours for two data sets: 1) tokens of tense [æ] and lax [ʌ] allophones produced by speakers from New Jersey and Canada, and 2) tokens of /ɑ/ vs. /ɔ/ spoken by speakers from New York City and New Jersey. For this test, the dependent variables are individual formant contours (F1 and F2) of the test vowels as calculated by the LPC formant tier extraction feature in Praat (Boersma & Weenik 2006). Preliminary results reveal a) significant differences in overall F1 and F2 contours between vowel categories for a given dialect and b) differences in overall contours for the same vowel category produced by speakers of different dialects.

We also evaluate the utility of this method by comparing its results with those of a standard single point analysis of variance, in which the dependent variables are single point measurements of F1 and F2 taken at the onset, temporal midpoint and offset of our test vowels. A comparison of these two tests allows us to determine if the analysis of overall formant contours reveals differences in the test vowels that are missed by single point analyses. Our findings confirm that an SS ANOVA can identify differences in transitional acoustic properties that single point measurements are unable to detect. Therefore, we argue that an SS ANOVA can inform a traditional single point analysis and improve upon it by allowing the sociophonetician to compare overall formant contours and identify regions of the contour which show significant differences. We also discuss how a holistic assessment of formant trajectories may be used in the analysis of vowel/liquid transitions, enabling the phonetician to discern more systematically where
and how the transition between these sounds occur.

References


