



Marking Adult Vowel-Space Formant Boundaries

The usual SpeechMark[®] vowel-space plot for adults includes a polygon that marks the boundaries of typical formant-frequency (F1, F2) pairs for normal adult speakers. The boundary drawn depends on whether the sex of the actual speaker has been specified as male, female, or unknown. The polygon is intended solely as a “fiducial” reference (an aid to the eye) much like grid lines. Like grid lines, it does not depend on the plotted data: part of its value is that it remains constant across all plots for adults of a given sex.

These polygons are loosely based on published and observed formant data, e.g., from Hillenbrand *et al.* (1995). They are constructed by the MATLAB SpeechMark Toolbox function “plot_quad_limits”. The polygons are defined by their (F1, F2) vertices, which currently are:

- for females: (350,1000), (850,1200), (875,2300), (300,3200) Hz;
- for males: (300,900), (725,1100), (650,1900), (250,2500) Hz;
- for unknown sex: (300,900), (850,1200), (875,2300), (300,3200), (250,2500) Hz.

As can be seen, the polygon is a quadrilateral for male and female speakers. If the speaker’s sex is unknown, a pentagon is used so as to better outline the typical vowel space of both sexes.

In principle, an even smoother shape than a four- or five-sided polygon could represent the bounds of expected formant pairs, in order to encompass more precisely the range of all physiologically possible (F1, F2) combinations for normal oral cavities. While this would be in keeping with the language-independent speech-science focus of SpeechMark, a low-order polygon is computationally easier to describe, and perhaps easier to understand. It is also more conventional within the speech-science community, which often speaks of “the vowel quadrilateral” or of “the four Point Vowels”. The schematic (rather than quantitative) nature of this boundary specification is evident from the alternative practice of referring to the vowel *triangle* or of evaluating the *three* Point Vowels.

Reference

James Hillenbrand, Laura A. Getty, Michael J. Clark, and Kimberlee Wheeler. 1995. “Acoustic characteristics of American English Vowels”, *J. Acoust. Soc. Am.*, 3099-3111.