Problem 9.1

The vocal tract configuration for an /r/ consonant, in American English, is roughly as follows: the back cavity, behind the tongue tip constriction, has a length of about 15cm, with a relatively large average cross-sectional area (about 10cm$^2$). The front cavity, between the tongue tip constriction and the lips, has a length of about 4cm, and a cross-sectional area of about 6cm$^2$. The side branch, under the tongue, has a length of about 4cm, and a cross-sectional area of about 16.5cm$^2$.

(a) Sketch the three-tube model for /r/. Label all areas and lengths of all tube sections, and be sure to show whether each tube is closed or open.

(b) Find $F_1$ of the /r/ configuration, using the low-frequency approximations given in the lecture notes.

(c) Find $F_1$ of the neighboring vowel: set the length of the side branch to 0cm, and then solve the same equations that you solved in part (b). How does your answer compare to part (b)? How does your answer compare to the first formant of a schwa?

(d) Find the first zero frequency of the /r/.

(e) Assume that the first zero is part of a “pole-zero pair.” In other words, you can imagine that the first zero splits the nearest oral formant into a pole-zero-pole complex, with the first pole about 200Hz below the zero, and the second pole about 200Hz above the zero. In that case, what is the frequency of $F_3$ of an /r/?

Problem 9.2

(a) Create IPA and SAMPA transcriptions of the following sentences.

(1) A bird in the hand is worth two in the bush.
(2) A stitch in time saves nine.
(3) Measure twice, cut once.
(4) How much wood would a woodchuck chuck if a woodchuck could chuck wood?

(b) Write phonological feature matrices for the words “better speech.” Use the feature set in the notes, or a feature set of your own choice – specify which features you’re using if other than the ones in the notes.