Instructions for homework submission and data access
Please submit on eCampus a **single pdf** file (no .zip, .ipynb, etc.) containing your answers. The data for this homework are available on the shared **Google Drive**.

Background and outline
This homework will help you apply some of the things that we have discussed in class regarding speech processing and its applications to human behavior analytics. You will use data from the 2017 Interspeech Computational Paralinguistic Challenge, called **Cry Recognition In Early Development (CRIED)** to classify different types of emotions from children's vocalizations. This task serves the broader area of deriving biomarkers for predicting neuro-developmental disorders. The following steps will guide you through this process.

Question 1: Exploring the background of the data
When getting access to new data, we need to explore the motivation of the experimental design and the details behind the acquisition process. Using the corresponding research papers (*ResearchPaper.pdf* and *is2018_compare_paper.pdf*), please **briefly** answer the following questions:

- **(1 point)** What was the motivation behind collecting these data?

- **(1 point)** What are the predicted outcomes (i.e. classes)?

- **(1 point)** What features and machine learning algorithms are being used to classify between the classes of interest?

Question 2: Exploring the literature
Look up 1-2 past research papers of infants' crying and vocalizations and report on the following:

- **(1 point)** What acoustic measures did previous work use to model children's vocalizations and crying? Was there any specific motivation behind the use of these features?

- **(1 point)** What outcomes were found to be correlated with children's vocalizations?

- **(1 point)** Where there any specific machine learning frameworks that performed best?

Question 3: Exploring the data
For this question, you are given 15 files per class (class 0: neutral/positive mood vocalizations, class 1: fussing, class 2: crying) in the data folder. The prefix of each wav file indicates the corresponding class.

- **(2 points)** Using the Praat toolbox, extract the mean intensity and mean formant frequencies (F1, F2) from each file. Plot the histograms of the mean intensity and mean formant frequencies (F1, F2) for each class. **Hint:** Select a non-silence region of each audio signal (as shown in the figure below) and use *Intensity → Get Intensity* to get the mean intensity value, *Formant → Get first formant* to get the mean F1 value, etc.
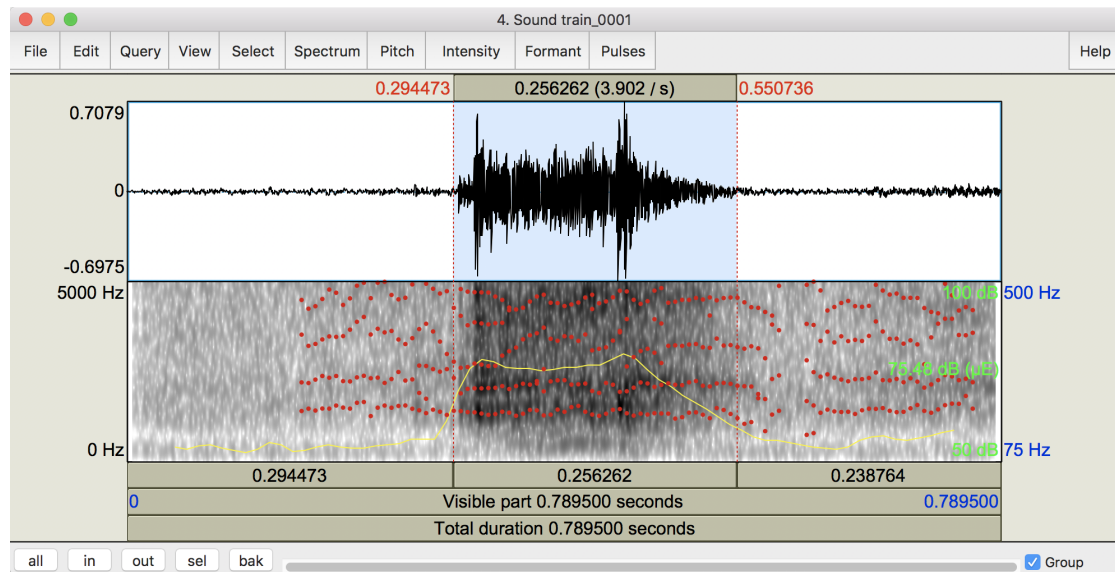
- **(1 point)** Use a 2-sample t-test to identify potential significant differences between: 1) neutral/positive mood vocalizations and fussing, 2) neutral/positive mood vocalizations and crying, and 3) fussing and crying. **Hint:** Use the *scipy.stats.ttest_ind* function.

- **(1 point)** Use a 1-way ANOVA to identify potential significant differences between the three classes. **Hint:** Use the *scipy.stats.f_oneway* function.

- **(2 points) Bonus:** Using a k-means classifier and the three input features (mean intensity, mean F1, mean F2), classify among the three classes. **Hint:** Employ a random 5-fold cross-validation framework.