SGN-14007 Introduction to audio processing - Exercise 6

February 15, 2019

Return deadline: 22.2.2019, at 12:00 PM in Moodle.

Math Question

(0.25 points / item, total 1 point)

In this exercise, you see how features react to different cost functions, that are used e.g. in dynamic time warping, or, as similarity functions between two features.

Let's assume you have two signals $x(t)$ and $y(t)$. You are time-aligning the signals using features obtained from these signals. Your feature dimension is three and let's assume it represents the magnitude spectrum. The first feature vectors of two signals are $\mathbf{x}_1 = [1, 3, 2]^{\mathrm{T}}$ and $\mathbf{y}_1 = [0.5, 1, 2]^{\mathrm{T}}$, where $[\cdot]^{\mathrm{T}}$ denotes transpose.

(a) What is the cosine-based cost between $\mathbf{x}_1$ and $\mathbf{y}_1$? Cosine cost function is defined here as

$$d(\mathbf{x}, \mathbf{y}) = 1 - \frac{\mathbf{x}^{\mathrm{T}}\mathbf{y}}{\|\mathbf{y}\| \cdot \|\mathbf{x}\|}, \tag{1}$$

where $\|\|$ is the L2-norm.

(b) What is the Euclidean distance between $\mathbf{x}_1$ and $\mathbf{y}_1$? Euclidean distance is

$$d(\mathbf{x}, \mathbf{y}) = \|\mathbf{x} - \mathbf{y}\| \tag{2}$$

(c) If you multiply $\mathbf{x}_1$ with 2, does the cosine distance value change? Does the amplification of signal $x(t)$ or $y(t)$ affect this cost?

(d) If you multiply $\mathbf{x}_1$ with 2, does the Euclidean distance value change? Does the amplification of signal $x(t)$ or $y(t)$ affect this cost?

Write your answers in the beginning of the python file (from the programming section) as comments.

Programming Exercise

(1 point)

In this exercise, you will get familiar with different types of features for music signal processing and get to use them in the task of seeking an optimal temporal alignment between two short melodies.

(a) Download the `exercise_6_a.py` and two accompanying audio files (`t2.wav` and `t1_fast.wav`) from Moodle to your local folder 'sgn2017/exercise6'. Edit the None and missing parts in the code file. Answer the questions as comments in the same python file `exercise_6_a.py`.

Return the python code with your solutions (single file named exercise6.py) to Moodle. Please don't forget to *click Submit Assignment link* once you have uploaded the final version. Do not attach any other files.