Homework 4

Due date: March 9, 2016, 11:55PM.

Bibliography: Course lecture notes Lessons 15-17. Textbook pp. 189-216, 256-267, Sections 4.2-4.4, 5.5.

Feel free to use Octave within the theoretical exercises to avoid tedious arithmetic once you've become familiar with basic procedure.

1. (1 course point) Textbook p.195, Exercise 4.3.15
2. (1 course point) Textbook p.200, Exercise 4.4.4
3. (1 course point) Textbook p.207, Exercise 4.4.13
4. (1 course point) Textbook p.264, Exercise 5.5.15
5. (Computer application 4 course points) We consider another realistic application of linear algebra, this time using electronenchephalograms. Consult the EEG posted tutorial on how to acess data.

   Task 1. (2 course points). Investigate the data for a segment that you suspect represents a large, coordinated perturbation of EEG signals, i.e., a 'wink', $\boldsymbol{w}$. Recall that a segment of length q starting at position p recorded by the i^{th} sensor is accessed as `w=data(p:p+q-1,i)`, $\boldsymbol{w} \in \mathbb{R}^q$. There is no single, "correct" choice. Make a hypothesis on choice of p, q. Let $\boldsymbol{u} \in \mathbb{R}^q$ denote some portion of the EEG data. Identify $\boldsymbol{u}$ as a possible wink if the angle between $\boldsymbol{u}$ and $\boldsymbol{w}$ is less than $\pi/90$ radians. Count the number of possible winks for each sensor channel. Then, identify a wink as occuring if a possible wink was observed in at least 3 channels in a time window of length q.

   Task 2. (2 course points). Consider n portions of brain activity at sensor position i of length q, starting from position p, i.e., `data(p:p+q-1,i)`, `data(p+q:p+2*q-1,i)`,..,`data(p+(n-1)*q, p+n*q-1)`. Organize this data as a matrix $\boldsymbol{A} \in \mathbb{R}^{q\times n}$. Ask the question: is the next sensor recording $\boldsymbol{b}$=`data(p+n*q,p+(n+1)*q-1)`, of length q indicative of normal or abnormal brain activity? You would approach this problem by investigating what part of $\boldsymbol{b} \in C(\boldsymbol{A})$, and what part $\boldsymbol{b} \in N(\boldsymbol{A}^T)$. Make various choices for p, q. Comment on your results.