TENSOR OF SELF-TRANSFER ENTROPY IN ESTIMATES OF CHANGES IN HEART RHYTHM RELATED TO AGING

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ABSTRACT

Transfer entropy has been proposed as a general framework in which we can quantify dependences between stochastic variables [1]. Accordingly, tensorial self-transfer entropy (TsTE) can be considered as a total of a tensor of self-entropy transfers $\mathbf{TsTE_{jk}}$ as:

$$TsTE(X) = \sum_{j,k} \mathbf{TsTE}_{jk} = - \sum_{j_n,\ldots,j_2} p(\Delta_{j_n},\ldots,\Delta_{j_2},\Delta_j,\Delta_k) \ln \frac{p(\Delta_k|\Delta_j,\Delta_{j_2}\ldots,\Delta_{j_n})}{p(\Delta_k|\Delta_j)}$$

Tensor $\mathbf{TsTE_{jk}}$ is a straight forward generalization of transition rates of a underlying Markov chain from one-step $T_{jk} = p(\Delta_k|\Delta_j) = \frac{p(\Delta_j,\Delta_k)}{p(\Delta_j)}$ to n-step memory $T_{j_1\ldots j_n k} = p(\Delta_k|\Delta_{j_n},\ldots,\Delta_{j_1})$.

By means of TsTE applied to heart beat signals recorded during the nocturnal rest of healthy 198 individuals at different ages, we investigate lost of the information with age, see Fig. 1.
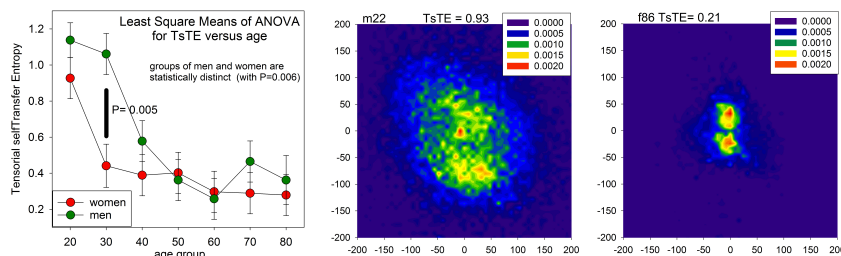
Figure 1. First panel describes the total decay of $TsTE$ with advancing age for males and females separately. Two other panels show tensors $\mathbf{TsTE}_{jk}$ for a young man (left) and an elderly woman (right). Values of a pair (j,k) mean an acceleration (if negative) or decelerations (if positive), colors show how strong a given transition from j to k feels the past.

REFERENCES

[1] T. Schreiber: *Measuring information transfer*, Phys.Rev. Lett. **85** (2000), 461–464.