Video: <https://training.incf.org/lesson/multi-scale-entropy-abstract-measure-clinical-application>

Physionet:

<https://archive.physionet.org/physiotools/mse/tutorial/tutorial.pdf>

<https://archive.physionet.org/physiotools/mse/papers/pre-2005.pdf>

RCMFE: <https://link.springer.com/article/10.1007/s11517-017-1647-5>

Matlab code: <https://datashare.ed.ac.uk/handle/10283/2099>

Multivariate entropy: <https://ieeexplore.ieee.org/document/6109316>

Improved multivariate RCMFE and SVM: <https://www.hindawi.com/journals/cin/2019/7529572/#EEq1>

Eye blink artifacft denoising: <https://ieeexplore.ieee.org/document/6843355>

Integrating Optimized Multiscale Entropy Model with Machine Learning for the Localization of Epileptogenic Hemisphere in Temporal Lobe Epilepsy Using Resting-State fMRI: <https://www.hindawi.com/journals/jhe/2021/1834123/>

Multiscale Entropy Analysis of Complex Heart Rate Dynamics: Discrimination of Age and Heart Failure Effects: <https://www.cinc.org/archives/2003/pdf/705.pdf>

On the choice of multiscale entropy algorithm for quantification of complexity in gait data: <https://digitalcommons.unomaha.edu/cgi/viewcontent.cgi?article=1226&context=biomechanicsarticles>

Fractal Dimension of EEG Activity Senses Neuronal Impairment in Acute Stroke: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0100199>

Non-linear Entropy Analysis in EEG to Predict Treatment Response to Repetitive Transcranial Magnetic Stimulation in Depression: <https://www.frontiersin.org/articles/10.3389/fphar.2018.01188/full>

Differential Changes with Age in Multiscale Entropy of Electromyography Signals from Leg Muscles during Treadmill Walking: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5003391/>

Age-related Multiscale Changes in Brain Signal Variability in Pre-task versus Post-task Resting-state EEG: <https://pubmed.ncbi.nlm.nih.gov/26942319/>

Applications of EEG Neuroimaging Data: Event-related Potentials, Spectral  
Power, and Multiscale Entropy: When considering human neuroimaging data, an appreciation of signal variability represents a fundamental innovation in the way we think about brain signal. Typically, researchers represent the brain's response as the mean across repeated experimental trials and disregard signal fluctuations over time as "noise". However, it is becoming clear that brain signal variability conveys meaningful functional information about neural network dynamics. This article describes the novel method of multiscale entropy (MSE) for quantifying brain signal variability. MSE may be particularly informative of neural network dynamics because it shows timescale dependence and sensitivity to linear and nonlinear dynamics in the data.

Source: <https://www.rotman-baycrest.on.ca/files/publicationmodule/@random45f5724eba2f8/jove_76_50131.pdf>

Standard multiscale entropy reflects neural dynamics at mismatched temporal scales: What’s signal irregularity got to do with it? <https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1007885>

Review source for papers below: <https://www.ncbi.nlm.nih.gov/labs/pmc/articles/PMC7517182/pdf/entropy-22-00644.pdf>

Age-Related Differences in Complexity During Handgrip Control Using Multiscale Entropy: <https://ieeexplore.ieee.org/document/8435914>

Multiscale entropy: A tool for understanding the complexity of postural control: <https://www.sciencedirect.com/science/article/pii/S209525461600020X>

Evaluation of Anesthetic Specific EEG Dynamics during State Transitions between Loss and Return of Responsiveness : <https://www.mdpi.com/2076-3425/12/1/37/htm#B25-brainsci-12-00037>

Permutation Entropy: Too Complex a Measure for EEG Time Series? <https://mediatum.ub.tum.de/doc/1439759/file.pdf>

<https://www.mdpi.com/1099-4300/22/2/168>

Harezlak et al. studied eye movement signal characteristics. For this purpose, the authors used several methods: approximate entropy, fuzzy entropy, and the largest Lyapunov exponent. For these three methods, multilevel maps are defined. The results show better accuracy for saccadic latency and saccade, than previous studies using eye movement dynamics.

<https://www.mdpi.com/1099-4300/21/11/1128>

Liau et al. evaluated the changes in the complexity of the center of pressure (COP) during walking at different speeds and for different durations. For this purpose, the MSE was used. The authors show that both the walking speed and walking duration factors significantly affect the complexity of COP.

<https://www.mdpi.com/1099-4300/21/3/314>

Based on ensemble empirical mode decomposition (EEMD) and MSE and using an accelerometer, Nurwulan et al. proposed a measure, the postural stability index (PSI), to distinguish different stability states in healthy subjects. PSI is able to discriminate between normal walking and walking with obstacles in healthy subjects.

<https://www.mdpi.com/1099-4300/21/11/1072>

McDonough et al. were interested by post-encoding memory consolidation mechanisms in a sample of young, middle-aged and older adults. For this purpose, they tested a novel measure of information processing, network complexity and studied if it was sensitive to these post-encoding mechanisms. Network complexity was determined by assessing the irregularity of brain signals within a network over time. This was performed through MSE. The results show that network complexity is sensitive to post-encoding consolidation mechanisms that enhance memory performance.

<https://www.mdpi.com/1099-4300/21/10/995>

Menon and Krishnamurthy mapped neuronal and functional complexities from the MSE of resting-state functional magnetic resonance imaging (rfMRI) blood oxygen-level dependent (BOLD) signals and BOLD phase coherence connectivity.

<https://www.mdpi.com/1099-4300/21/10/936>

De Wel et al. proposed a novel unsupervised method to discriminate quiet sleep from non-quiet sleep in preterm infants, from the decomposition of a multiscale entropy tensor. This was performed according to the difference in the electroencephalography (EEG) complexity between the neonatal sleep stages.

<https://www.mdpi.com/1099-4300/21/8/727>

Jelinek et al. investigated the efficacy of applying multiscale Renyi entropy on heart rate variability (HRV) to obtain information on the sign, magnitude, and acceleration of the signals with time. The results show that their quantification using multiscale Renyi entropy leads to statistically significant differences between the disease classes of normal, early cardiac autonomic neuropathy  
(CAN), and definite CAN.

<https://www.mdpi.com/1099-4300/21/6/594>

El-Yaagoubi et al. studied the dynamics, the consistency and the robustness of MSE, multiscale time irreversibility (MTI), and multifractal spectrum in HRV characterization in long-term scenarios (7 days). The results show that congestive heart failure (CHF) and atrial fibrillation (AF) populations show significant differences at long-term and very long-term scales (thus, MSE is higher for AF while MTI is lower for AF).

<https://www.mdpi.com/1099-4300/21/1/26>

For an early Alzheimer’s disease (AD) diagnosis, Perpetuini et al. used sample entropy and the MSE of functional near infrared spectroscopy (fNIRS) in the frontal cortex of early AD and healthy controls during three tests that were used to assess visuo-spatial and short-term-memory abilities.

<https://www.mdpi.com/1099-4300/21/2/199>

A multivariate analysis revealed promising results (good specificity and sensitivity) in the capabilities of fNIRS and complexity for an early diagnosis.  
Keshmiri et al. studied the effect of the physical embodiment on older people’s prefrontal cortex (PFC) activity when they are listening to stories. For this purpose, they used MSE. Their results show that, in older people, physical embodiment leads to a significant increase of MSE for PFC activity.  
Moreover, this increase reflects the perceived feeling of fatigue

Investigating the discrimination of linear and nonlinear effective connectivity patterns of EEG signals in children with Attention-Deficit/Hyperactivity Disorder and Typically Developing children

<https://www.sciencedirect.com/science/article/abs/pii/S0010482522005583>