Iasemidis, Leonidas D.; **Pardalos, Panos M.**; **Shiau, Deng-Shan**; **Chaovalitwongse, Wanpracha**; **Narayanan, K.**; **Kumar, Shiv**; **Carney, Paul R.**; **Sackellares, J. Chris**

Prediction of human epileptic seizures based on optimization and phase changes of brain electrical activity. (English) Zbl 1050.92032

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Summary: The phenomenon of epilepsy, one of the most common neurological disorders, constitutes a unique opportunity to study the dynamics of spatiotemporal state transitions in real, complex, nonlinear dynamical systems. We previously demonstrated that measures of chaos and angular frequency obtained from electroencephalographic (EEG) signals generated by critical sites in the cerebral cortex converge progressively (dynamical entrainment) from the asymptomatic interictal state to the ictal state (seizure) [*L. D. Iasemidis* et al., J. Comb. Optim 5, 9–26 (2001; Zbl 1050.92031); and P. M. Pardalos et al. (eds.), Biocomputing Conf., Univ. Forida, Gainesville, 59–84 (2002; Zbl 1026.92027))]. This observation suggests the possibility of developing algorithms to predict seizures. One of the central points of these investigations was the application of optimization theory, specifically quadratic zero-one programming, for the selection of the cortical sites that exhibit preictal dynamical entrainment. We present results from the application of this methodology to the prediction of epileptic seizures. Analysis of continuous, long-term (18–140 h), multielectrode EEG recordings from 5 patients resulted in the prediction of 88% of the impending 50 seizures, on average about 83 min prior to seizure onset, with an average false warning rate of one every 5.26 h. These results suggest that this seizure prediction algorithm performs well enough to be used in diagnostic and therapeutic applications in epileptic patients. Similar algorithms may be useful for certain spatiotemporal state transitions in other physical and biological systems.

MSC:

92C50 Medical applications (general)
92C20 Neural biology
90C90 Applications of mathematical programming
92C55 Biomedical imaging and signal processing

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global optimization; phase change; T-index; automated seizure warning algorithm

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