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(G*) Multicomponent T1 Magnetic Resonance Relaxometry with Neural Networks

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Magnetic resonance imaging (MRI) is widely used as a non-invasive diagnostic technique to visualize the internal structure of biological systems. Quantitative analysis of the T1 magnetic resonance (MR) relaxation time could reveal microscopic properties and has significance in the study of biological tissues such as the brain, heart, and tumors. A multicomponent model, with a continuous relaxation spectrum, requires exponential analysis which is an intrinsically ill-posed problem. Traditional methods to determine multicomponent T1 spectra require high quality data and are computationally intensive. With magnitude data, an additional phase correction pre-processing step is required which may lead to large errors with few input data points. A large number of data points and high signal-to-noise ratio (SNR) result in long acquisition times. Extending our previous work using neural networks for exponential analysis, artificial neural networks (ANNs) have been trained to generate the multicomponent T1 distribution spectra with as few as 8 input data points and reduced SNR.

Deep learning with ANNs is a technique for solving complex nonlinear problems. The performance of the optimized ANNs was evaluated across a large parameter range and compared to traditional methods. In addition to superior computation speed, a higher accuracy was achieved. No phase correction or user-defined parameters were required. This improved performance, with a significantly reduced number of input data points, will enable faster multicomponent relaxation experiments.

The proposed method for exponential analysis is not restricted to magnetic resonance. It is readily applicable in other areas with exponential analysis and can be extended to higher dimensional spectra. It can also be adapted to solve other ill-posed problems.

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