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Modelling Dynamical Systems Using Neural Networks Coupled with Fractional Differential Equations

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Abstract

Fractional Differential Equations (FDEs) extend classical calculus to non-integer orders, providing a natural way to model systems with memory and non-local effects. This makes them particularly suitable for processes in which the current state is strongly influenced by past dynamics rather than instantaneous changes.

Neural FDEs [1, 2, 3, 4, 5] extend this concept by embedding fractional derivatives within deep neural network architectures, allowing models to learn temporal dependencies and history-dependent behaviour directly from data.

The results obtained indicate that Neural FDEs can capture more complex dynamical patterns than standard Neural Ordinary Differential Equations (Neural ODEs), providing improved accuracy in modelling systems where memory effects play a significant role.

References

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