TaylorNet: A Taylor-based Scalable Neural Architecture

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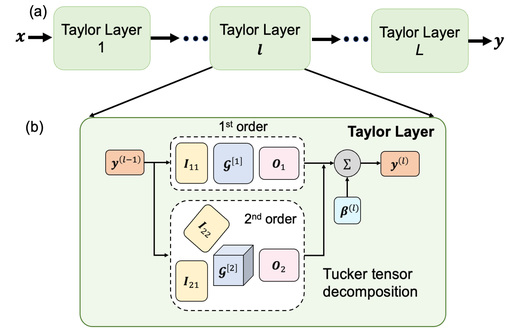
Overview

- Polynomials like Taylor polynomials can approximate any continuous smooth function.
- Developed TaylorNet, a scalable Taylor-based neural architecture that parameterizes Taylor polynomials using tensorized DNNs.
- Introduced a new Taylor initialization method to improve the training accuracy and stability.
- Extensive experiments showed the effectiveness and interpretability of TaylorNet in dynamical systems.



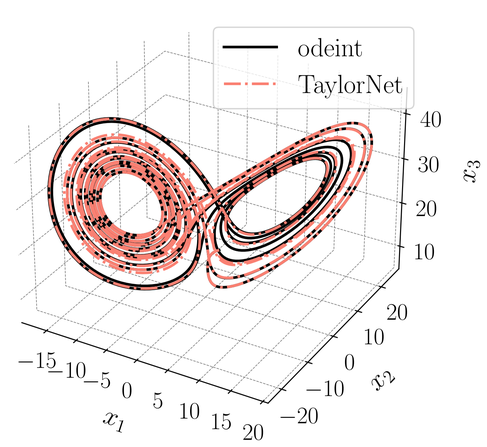
Challenges

- The computational complexity of Taylor polynomials parameterized by DNNs grows exponentially as the order of polynomials increases.
- Higher-order terms often lead to training instability given inappropriate weight initialization.

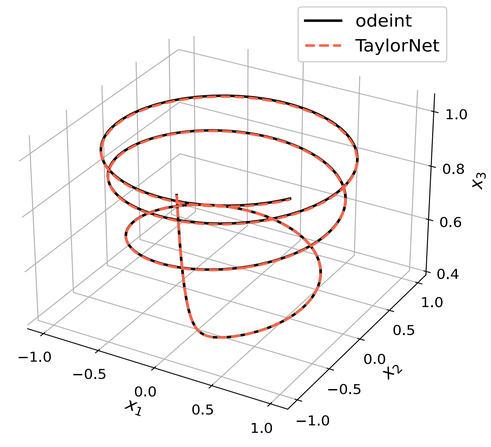
Contributions

- Proposed TaylorNet, a new neural architecture without using activation functions, which can largely improve the interpretability of DNNs.
- Developed a novel Taylor initialization method to help stabilize the model training process.
- TaylorNet can uncover the dynamics of physical systems from observed data, which can better explain and understand the behavior caused by underlying dynamics.

Experiments



(a) Lorenz system



(b) Fluid flow

Scientific/Society Impact

- Facilitate the deployment of AI in high-stakes applications.
- Applied to other areas like systems biology, and neurodegenerative diseases.

Educational Impact

- Engage undergrad students in this research project.
- Integrate developed models into both undergrad and graduate-level courses.

References

[1] Hongjue Zhao, Yizhuo Chen, et al. TaylorNet: A Taylor-based Scalable Neural Architecture, submitted to TNNLS.

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