ABSTRAK

Fakhri Bimo Wicaksono (01112190021)

PENERAPAN MODEL *PHYSICS-INFORMED NEURAL NETWORK* UNTUK MENCARI SOLUSI NUMERIK PADA PERSAMAAN DIFERENSIAL BIASA

Skripsi, Fakultas Sains dan Teknologi (2025)

(xii + 56 halaman, 26 gambar)

Seiring dengan perkembangan sains dan teknologi, semakin dibutuhkan pemodelan matematika yang dapat mengaproksimasi realitas berdasarkan hukum fisika. *Physics-Informed Neural Network* (PINN) merupakan metode *deep learning* yang menggabungkan prinsip fisika melalui persamaan diferensial ke dalam proses pelatihan jaringan saraf. Dalam penelitian ini, PINN digunakan untuk menyelesaikan Persamaan Diferensial Biasa (PDB), baik yang bersifat linier maupun non-linier. Pendekatan ini dilakukan dengan adanya solusi analitik dan menggunakan prediksi dari solusi numerik seperti metode Runge-Kutta, karena *loss function* dalam *training* dikonstruksi dari bentuk persamaan diferensial yang ingin diselesaikan. Model PINN dikembangkan dengan arsitektur jaringan saraf *feedforward* dan dilatih menggunakan kombinasi optimasi Adam. Untuk mengevaluasi performa model, hasil dari PINN dibandingkan dengan solusi numerik dari metode Runge-Kutta Orde 4 (RK4). Hasil eksperimen menunjukkan bahwa PINN mampu menghasilkan solusi yang sangat mendekati solusi aslinya, baik secara visual maupun secara kuantitatif, serta menunjukkan ketahanan terhadap kompleksitas non-linieritas sistem PDB, dengan catatan bahwa terdapat solusi analitik maupun prediksi solusi numerik yang mendekati solusi aslinya. Dengan demikian, penelitian ini mendemonstrasikan bahwa PINN dapat digunakan sebagai metode alternatif dalam menyelesaikan PDB jika terdapat solusi analitik maupun numerik.

Kata Kunci: komputasi ilmiah, *deep learning*, persamaan diferensial biasa, *physics-informed neural network*, solusi numerik, *optimizer*, kinerja model.
Referensi : 13 (1997-2024)

ABSTRACT

Fakhri Bimo Wicaksono (01112190021)

APPLICATION OF PHYSICS-INFORMED NEURAL NETWORK MODEL TO FIND NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

Thesis, Faculty of Science and Technology (2025)

(xii + 56 pages, 26 figures)

With the development of science and technology, there is a need for mathematical modeling that can approximate reality based on the laws of physics. Physics-Informed Neural Network (PINN) is a deep learning method that incorporates physics principles through differential equations into the neural network training process. In this research, PINN is used to solve ordinary differential equations (ODE), both linear and non-linear. This approach is done in the presence of analytical solutions and uses predictions from numerical solutions such as the Runge-Kutta method, because the loss function in the training is constructed from the form of the differential equation to be solved. The PINN model is developed with a feedforward neural network architecture and trained using an Adam optimization. To evaluate the performance of the model, the results of PINN are compared with the analytical and numerical solution of the Fourth Order Runge-Kutta method (RK4). Experimental results show that PINN is able to produce solutions that are very close to the original solution, both visually and quantitatively, and shows robustness to the complexity of the non-linearity of the ODE system, provided that both the analytical solution and the predicted numerical solution are close to the original solution. Thus, this study demonstrates that PINN can be used as an alternative method in solving ODE if both analytical and numerical solutions exist.

Keywords: scientific computing, deep learning, ordinary differential equations, physics-informed neural network, optimizer, numerical solution, model performance evaluation.

References: 13 (1997-2024)