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<tr><th>authors</th><td>Hamzehloo, A
Laizet, S
Rizos, G
Schuller, B
Tzirakis, P
Ã–zbay, AG</td></tr>
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<tr><th>volume</th><td></td></tr>
<tr><th>doi</th><td>10.1017/dce.2021.7</td></tr>
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<tr><th>authors</th><td>BjÃ¶rn Schuller
Panagiotis Tzirakis
Sylvain Laizet
Arash Hamzehloo
Ali Girayhan Ã–zbay
Georgios Rizos</td></tr>
<tr><th>title</th><td>Poisson CNN: Convolutional neural networks for the solution of the Poisson equation on a Cartesian mesh</td></tr>
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https://github.com/aligirayhanozbay/poisson_CNN</td></tr>
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<tr><th>abstract</th><td>The Poisson equation is commonly encountered in engineering, for instance in computational fluid dynamics (CFD) where it is needed to compute corrections to the pressure field to ensure the incompressibility of the velocity field. In the present work, we propose a novel fully convolutional neural network (CNN) architecture to infer the solution of the Poisson equation on a 2D Cartesian grid with different resolutions given the right hand side term, arbitrary boundary conditions and grid parameters. It provides unprecedented versatility for a CNN approach dealing with partial differential equations. The boundary conditions are handled using a novel approach by decomposing the original Poisson problem into a homogeneous Poisson problem plus four inhomogeneous Laplace sub-problems. The model is trained using a novel loss function approximating the continuous L^p norm between the prediction and the target. Even when predicting on grids denser than previously encountered, our model demonstrates encouraging capacity to reproduce the correct solution profile. The proposed model, which outperforms well-known neural network models, can be included in a CFD solver to help with solving the Poisson equation. Analytical test cases indicate that our CNN architecture is capable of predicting the correct solution of a Poisson problem with mean percentage errors below 10%, an improvement by comparison to the first step of conventional iterative methods. Predictions from our model, used as the initial guess to iterative algorithms like Multigrid, can reduce the RMS error after a single iteration by more than 90% compared to a zero initial guess.</td></tr>
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