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Katherine Klymko
Johannes Blaschke</td></tr>
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<tr><th>abstract</th><td>GMRES is a powerful numerical solver used to find solutions to extremely large systems of linear equations. These systems of equations appear in many applications in science and engineering. Here we demonstrate a real-time machine learning algorithm that can be used to accelerate the time-to-solution for GMRES. Our framework is novel in that is integrates the deep learning algorithm in an in situ fashion: the AI-accelerator gradually learns how to optimizes the time to solution without requiring user input (such as a pre-trained data set). We describe how our algorithm collects data and optimizes GMRES. We demonstrate our algorithm by implementing an accelerated (MLGMRES) solver in Python. We then use MLGMRES to accelerate a solver for the Poisson equation -- a class of linear problems that appears in may applications. Informed by the properties of formal solutions to the Poisson equation, we test the performance of different neural networks. Our key takeaway is that networks which are capable of learning non-local relationships perform well, without needing to be scaled with the input problem size, making them good candidates for the extremely large problems encountered in high-performance computing. For the inputs studied, our method provides a roughly 2$\times$ acceleration.</td></tr>
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