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An adaptive, higher order multigrid method on cache-efficient data structures
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Modern algorithms in numerical simulation need to combine efficient mathematical methods with concepts from computer science, that are designed for nowadays computer hardware. In the field of high-performance computing, access time to memory turns out to be a crucial factor and even more important than pure cpu power. This so called memory boundedness can be reduced by utilizing the cache hierarchy of modern computer architectures. However, classical multigrid methods based on hierarchical data structures lack the necessary data locality. Here, we use space-filling curves and a system of stacks to process the grid points in a quasi cache-optimal way. Space-filling curves are already known to be quite usefull for parallel processing. Based on an additive multigrid method, an adaptive full multigrid cycle using a posteriori error estimates is developed. Additionally, higher order methods can be integrated by using τ-Extrapolation. Thus, while keeping the cache-efficiency on a very high level, one is able to apply advanced mathematical tools and ideas.