A common practice in improving the accuracy of finite element solutions is to use h-, p- and hp- refinement strategies. When using h-refinement, while keeping the approximation order of the element, p, fixed, the aim is to decrease the truncation error by increasing the number of degrees of freedom ("DoFs").

However, when the number of DoFs becomes larger than a critical number N(p)_opt, as a function of p, computational round-off errors accumulate, and start to exceed the truncation error. Further refinements will even result in less accurate solutions. Focusing on one-dimensional partial differential equations, we investigate this phenomenon and propose a systematic approach to identify N(p)_opt a posteriori, both for the primary variable and its derivatives. We furthermore show that N(p)_opt strongly depends on the approximation order p with N(p)_opt decreasing for increasing p. At the same time, the overall discretization error (truncation + round-off error) that is obtained for the optimal number of DoFs reduces for increasing p, which has led us to develop a practical a posteriori hp-refinement strategy that adjusts both the mesh width h(p) and p simultaneously so that for each p the optimal mesh width h(p)_opt correlates with N(p)_opt.

We also investigate the influence of the finite element formulation and demonstrate by considering several numerical examples that the use of the mixed FEM leads to less severe round-off errors compared to the standard FEM and can, thus, yield more accurate approximations of the solution and its derivatives.