A D^{n}PG formulation for minimization problems

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Breaking spaces is inherent to DPG formulations. In classic methods Lagrange multipliers are introduced at the interface of broken spaces to impose continuity of solution across the elements. The discrete Lagrange multiplier problem is a reduced problem as compared to the full global system and therefore computationally cheap. However, in case of large number of discontinuous elements the interface system in itself becomes too large and expensive to solve.

In this work, we propose an extension to the classic methods. We introduce a new set of Lagrange multipliers between the already existing Lagrange multipliers, such that the interface problem in itself becomes a broken space problem. The new set of Lagrange multipliers acts as interface between the first set of Lagrange multipliers and is an even smaller system to solve for. In general, you can add n-layers of Lagrange multipliers with each subsequent layer being cheaper to solve.

Furthermore, we exploit the use of dual spaces as test functions such that the continuity constraint between the elements and the Lagrange multipliers is a local and topological metric free relation. The matrix representations for connections (at all levels) are independent of shape and size of the elements, and consists of 1, 1 and 0s only.

We will illustrate this scheme with a numerical example on mixed formulation of Poisson equation using high order mimetic spectral element method.