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# Density of classes of closed convex sets in Sobolev spaces, Fenchel duality and applications

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**Abstract:** A large number of problems in optimization involve, either directly or through Fenchel dualization, constraint sets determined by pointwise bounds (possibly spatially variant) on function values, its gradient or divergence. In order to properly identify dual problems or to maintain the regularity of a solution obtained by a vanishing penalization term, a density question usually arises: Is a set of regular functions satisfying a constraint dense, in some norm, in a set of less regular functions with the same constraint? We address this question, show that (in general) the result does follow from dense embeddings, provide applications and several open problems.