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**“Cone-Free” Primal-Dual Path-Following and  
Potential Reduction Polynomial Time Interior-Point  
Methods**

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**Abstract** We present a framework for designing and analyzing primal-dual interior-point methods for convex optimization. We assume that a self-concordant barrier for the convex domain of interest and the Legendre transformation of the barrier are both available to us. We directly apply the theory and techniques of interior-point methods to the given good formulation of the problem (as is, without a conic reformulation) using the very usual primal central path concept and a less usual version of a dual path concept. We show that many of the advantages of the primal-dual interior-point techniques are available to us in this framework and therefore, they are not intrinsically tied to the conic reformulation and the logarithmic homogeneity of the underlying barrier function.

**Keywords** convex optimization, interior-point methods, primal-dual algorithms, self-concordant barriers