Extended formulations for polygons

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The extension complexity of a polytope P is the smallest integer k such that P is the projection of a polytope Q with k facets. We study the extension complexity of n-gons in the plane. First, we give a new proof that the extension complexity of regular n-gons is $O(\log n)$, a result originating from work by Ben-Tal and Nemirovski (2001). Our proof easily generalizes to other permutahedra and simplifies proofs of recent results by Goemans (2009), and Kaibel and Pashkovich (2011). Second, we prove a lower bound of $\sqrt{2n}$ on the extension complexity of generic n-gons. Finally, we prove that there exist n-gons whose vertices lie on a $O(n) \times O(n^2)$ integer grid with extension complexity $\Omega(\sqrt{n}/\sqrt{\log n})$.

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