New shape control tools for rational Bézier curve design

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Bézier curves are indispensable for geometric modeling and computer graphics. They have numerous favourable properties and provide the user with intuitive tools for editing the shape of a parametric polynomial curve, for example, by modifying the control points $P_0, \dots, P_n$. Even more control and flexibility can be achieved by associating a shape parameter α_i with each control point P_i and considering rational Bézier curves, which comes with the additional advantage of being able to represent all conic sections exactly. In this talk, we explore the editing possibilities that arise from expressing a rational Bézier curve in barycentric form [1, 2], defined by a set of triplets (Q_i, β_i, t_i) of interpolation points Q_i, weights β_i, and nodes t_i. In particular, we show how to convert back and forth between the Bézier and the barycentric form, we discuss the effects of modifying the constituents (interpolation points, weights, nodes) of the barycentric form (see Fig. 1), and we study the connection between point insertion in the barycentric form with degree elevation of the Bézier form [3].

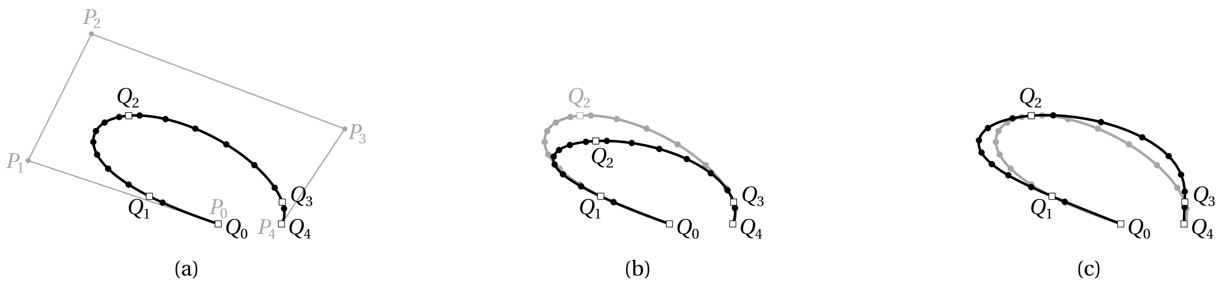

Figure 1: (a) converting a rational Bézier curve to the barycentric form; (b) the effect of moving the interpolation point Q_2; (c) the effect of decreasing the weight β_2 by 50%. The dots visualize the curve points $P(i/16)$ for $i = 0, \dots, 16$.

Joint work with: Kai Hormann.

References

[1] Schneider, C. and Werner, W. Some new aspects of rational interpolation. *Mathematics of Computation* 47, 285–299. 1986.

[2] Berrut, J.P. and Mittelmann, H.D. Lebesgue constant minimizing linear rational interpolation of continuous functions over the interval. *Computers & Mathematics with Applications* 33, 77–86, 1997.

[3] Ramanantoanina A. and Hormann K. New shape control tools for rational Bézier curve design. *Computer Aided Geometric Design*, 88:102003, 2021.