Lab 1 - 2D Bézier Curves

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0 Assignments

1. Draw Bézier curve with the de Casteljau algorithm
2. Drag control points to change their position
3. Draw Bézier curve with the optimized adaptive subdivision method

1 De Casteljau algorithm

The de Casteljau algorithm was implemented in the *deCasteljau*() function taking in input t as parameter value, an *inArray* containing the control points coordinates, an *outArray* containing the algorithm's results (i.e. the curve points) and the *size* of the inArray array.
To support the algorithm, the *lerp*() function was implemented in its 1D version.
The number of curve points drawn is 100 and the resulting curve can be seen in Figure 1.

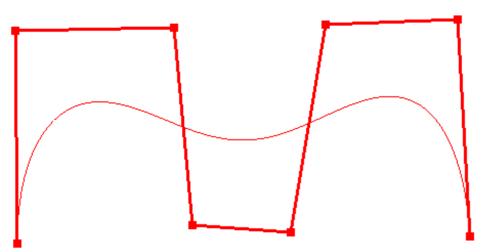


Figure 1: Curve generated with the de Casteljau algorithm.

2 Drag control points to change their position

This functionality was implemented by checking if the clicked point has already a control point in the $isControlPoint()$ function. If yes, this function returns the index of the control point hit, which gets saved in the $SelectedCP$ global variable. Then, the function $myMotionFunc()$ handles the logical and graphical update of the point.

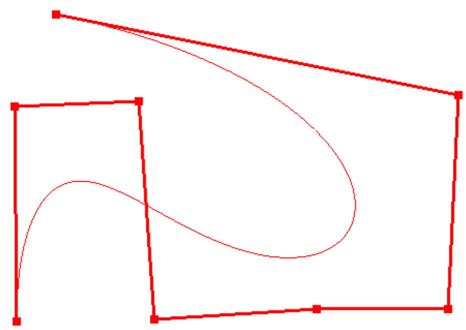


Figure 2: Same points as in Figure 1, but re-positioned.

3 Optimized adaptive subdivision method

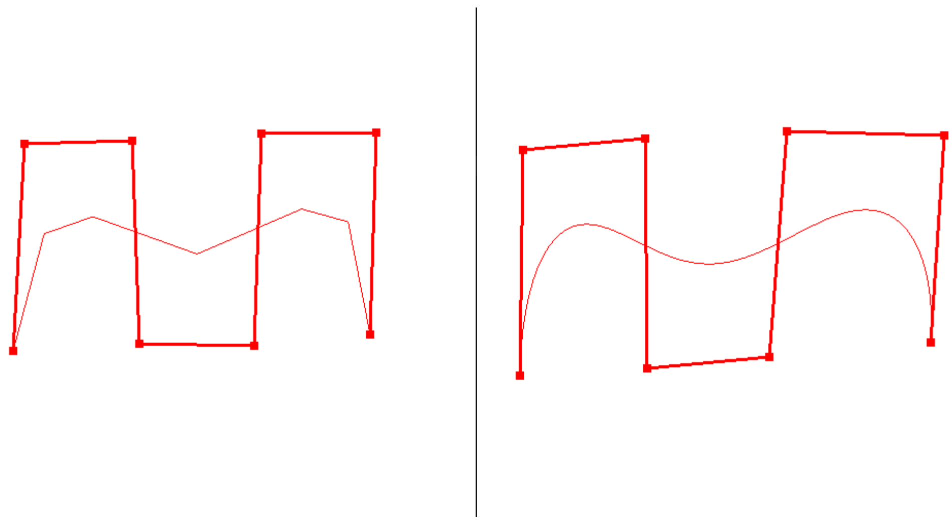
This algorithm was implemented in the recursive function $adaptiveSubdivision()$, which takes in input a $tempArray$ of control points and its $size$.

The **Adaptive Subdivision** algorithm is a recursive algorithm that selects the curve points to draw from a set of control points obtained from splitting the original Bézier curve in two sub-curves of the same degree. To obtain the control points for both the sub-curves, the function $deCasteljauASCP()$ was implemented, which saves in two pre-prepared arrays the intermediate results of the de Casteljau algorithm. Namely, the first one, which should contain the first half of the curve, is populated with the p_0^n results while the second one is populated with the p_1^n results.

Then, for each of the resulting sub-curves we need to check if it passes the so-called Flat Test. The **Flat Test**, checks that the distance between each of the intermediate control points in the current group and the segment resulting from the first and last control points is less than a certain $Tolerance$ value. If the check is passed then the current sub-curve can be approximated with the aforementioned segment and the control points can be added to the curve points, otherwise it can't and the algorithm needs to subdivide the sub-curve once again.

To support all the steps for the Flat Test, the following algorithms were implemented using the glm::vec3 to ease input and output and to use some built in glm function:

- $sub()$, which computed the subtraction between two vectors;
- $magnitude()$, which computed the magnitude of a vector;
- $distPointLine()$, which computed the distance between a point and a segment.



(a) $Tolerance = 0.075$. (b) $Tolerance = 0.00075$.

Figure 3: The visual results of the Adaptive subdivision algorithm with different Tolerance values.