2004 Paper 7 Question 4

Advanced Graphics

(a) Specify an appropriate knot vector for each of the following NURBS curves.

(i) A uniform cubic NURBS curve defined by six control points.

(ii) Similar to (i) but passing through both endpoints.

(iii) Similar to (i) but passing through the third control point, possibly with lower continuity at that point.

(iv) The cubic Bezier curve defined by four control points. [8 marks]

(b) Give the continuity class for each of:

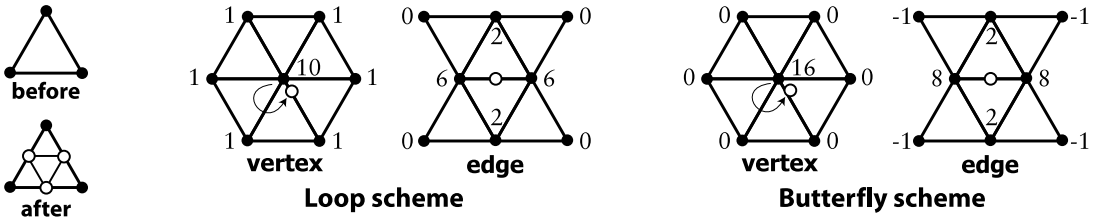
(i) curve (a)(i) *between* the knots;

(ii) curve (a)(ii) *at* the knots;

(iii) curve (a)(iii) at the third control point.

[The continuity class is the highest derivative which is guaranteed to be continuous at the point(s) in question.] [3 marks]

(c) The Loop and Butterfly subdivision schemes can both operate on triangular meshes, in which all of the polygons have three sides. Both schemes subdivide the mesh by introducing new vertices at the midpoints of edges, splitting every original triangle into four smaller triangles, as shown below. Each scheme has rules for calculating the locations of the new "edge" and "vertex" vertices based on the locations of the old vertices. These rules are shown below. All weights should be multiplied by $\frac{1}{16}$.



(i) Which of the two schemes produces a limit surface which interpolates the original data points?

(ii) Which of the four rules must be modified when there is an extraordinary vertex? For each of the four rules either explain why it must be modified or explain why it does not need to be modified.

(iii) Suggest appropriate modifications where necessary to accommodate extraordinary vertices.

[9 marks]