4
Fast Volume Rendering of Hexahedral Meshes

In order to improve performance and sacrifice a certain rendering accuracy, we also propose a linear approximation of the scalar field, considering certain integration intervals. In this section, we will focus only in the difference between the two aproaches. More specifically, we will detail our linear ray integration and the differences between the integration intervals.

4.1
Ray integration

Like our previous approach, we also consider the trilinear variation of the scalar field. The difference, however, lies in how we calculate the Ray Equation (2-1). We use a 2D pre-integrated table, first proposed by Moreland et al. (10) to render unstructured tetrahedral meshes. We discuss such table in Appendix B.

In order to use the 2D table, we make the assumption that the trilinear scalar function can be approximated by a piecewise linear function. The piecewise linear functions are composed by the intervals delimited by the maximum and minimum scalar of the hexahedron scalar function, as can be seen in Figure 4.1.

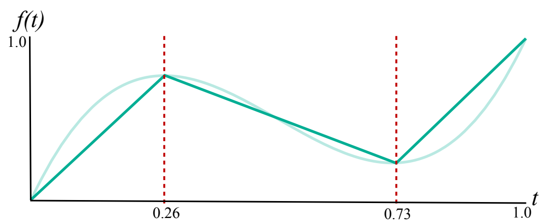

Figure 4.1: Piecewise linear functions, considering the maximum and minimum values of a trilinear scalar function.

It may sound counter intuitive to go back to a piecewise linear scalar function, as the basis of this thesis is to propose something better than the hexahedral division into tetrahedra, also a piecewise linear scalar function. But this is a different approach, as we first consider the trilinear scalar function to find the maximum and minimum values, and only linearizes the scalar function to calculate the color and opacity values. As we will show later, such approximation results in better quality and performance than the hexahedral division approach.

4.2
Integration intervals

The integration intervals are exactly the same as discussed in Section 3.2. The only minor difference is how we find t_{cp}, given s_{cp}. Because we are considering a linear variation inside the integration interval, it is enough to calculate t_{cp} according to Equation (4-1).

$$t_{cp} = t_0 + (t_1 - t_0) * (\frac{|s_{cp} - s_0|}{s_1 - s_0}) \tag{4-1}$$

where t_0 and t_1 are the ray length at the front and back of the integration interval, s_0 and s_1 are the scalar at the front and back of the integration interval.