Ambiguity Problem

Certain Marching Cubes cases have more than one possible triangulation.

The Problem

Ambiguous Face: a face that has two diagonally opposed points with the same sign.

Connecting either way is possible.

To fix it ...

The goal is to come up with a consistent triangulation.

Solutions

There are many solutions available - we present a method called:

Asymptotic Decider by Nielson and Hamann (IEEE Vis'91)

Asymptotic Decider

Based on bilinear interpolation over faces:

\[ B(s, t) = \begin{cases} 
B_{00} & \text{if } s = 0 \text{ or } t = 0 \\
B_{01} & \text{if } s = 1 \text{ or } t = 1 \\
B_{10} & \text{otherwise}
\end{cases} \]

The contour curves of \( B \):

\[ \{(s, t) \mid B(s, t) = \alpha \} \text{ are hyperbolas} \]

Asymptotic Decider (2)

Where the hyperbolas go through the cell depends on the values at the corners, i.e.,

\( B_{00}, B_{01}, B_{10}, B_{11} \)
Asymptotic Decider (3)

If $\alpha < B(S_\alpha, T_\alpha)$

Asymptotic Decider (4)

If $\alpha > B(S_\alpha, T_\alpha)$

Asymptotic Decider (5)

$S_\alpha = \frac{B_{00} - B_{01}}{B_{00} + B_{11} - B_{01} - B_{10}}$

$T_\alpha = \frac{B_{00} - B_{10}}{B_{00} + B_{11} - B_{01} - B_{10}}$

$B(S_\alpha, T_\alpha) = \frac{B_{00}B_{11} + B_{10}B_{01}}{B_{00} + B_{11} - B_{01} - B_{10}}$

Asymptotic Decider (6)

Based on the result of asymptotic decider, we expand the marching cube case 3, 6, 12, 10, 7, 13 (These are the cases with at least one ambiguous faces).

Let's look at Nielon and Hamann’s paper...