Overview
We use a reconstructed surface based on algebraic spheres to control the mesh decimation.

Curvature estimation
We compute the algebraic sphere $S_i$ for each vertex $x_i$ of the mesh.

Computing the curvature at any point consists in interpolating the spheres along the edges and faces, e.g., for the edge $(x_i, x_j)$, we have:

$$S_a = S_1 + \alpha(S_2 - S_1) \quad (1)$$

Reconstructed APSS curve (blue) from the polyline (black). Interpolated spheres (red).

Context
The use of proxies as a high level control of the surface has been studied for mesh simplification with planes [3] and spheres [4]. We propose as a proxy the reconstructed surface of the input mesh based on algebraic spheres, which handles curvatures as well as sharp features.

Proposition
Mesh simplification algorithm

Input: High resolution mesh  
Output: Coarser mesh

begin
for each vertex $x_i$ do
    $p_{x_i} = \text{curvature estimation of } x_i$;
end
for each pair $(x_i, x_j)$ do
    $(c_{x_i, x_j}, x_{a}) = \text{curvature error metric at } (x_i, x_j)$;
    push $(x_i, x_j, x_{a})$ in a heap keyed on cost $c_{x_i, x_j}$;
end
while heap not empty do
    collapse $(x_i, x_j)$ on $x_{a}$;
    $p_{x_{a}} = p_{x_i} + \alpha(p_{x_j} - p_{x_i})$;
    update cost of $x_{a}$ neighbors in the heap;
end

Conclusion
We present a new error metric for mesh simplification which preserves local curvature. Thanks to the properties of interpolated algebraic sphere, the curvature is easily computed.

Future work
- Finding the 3D optimal position by minimizing the distance face-sphere
- Investigate adaptive kernel size when computing the algebraic spheres w.r.t. the surface features

References
Algebraic point set surfaces.  

Feature Preserving Point Set Surfaces based on Non-Linear Kernel Regression.  

Structure-Aware Mesh Decimation.  

Spheres-meshes: Shape approximation using spherical quadric error metrics.  
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