Overview

More than 60 tools and counting...

- Conversion
- Filtering and Morphology
- Mathematical Transformation
- Combination
- Segmentation
- Geometric Transformation
- Level Set Processing
- Bitwise Boolean Operations
- Bitwise Morphology Operations
- Sparsity Management and Compression
Conversion

From Polygons

**tools::MeshToVolume**

- **IN:** Polygonal models (quads & triangles)
- **OUT:** Produces level set (SDF) or unsigned distance field
- Robust to non-manifold surfaces with internal self-intersections
- Requires closed (watertight) model for level set
Conversion

Polygonal Model

Level Set
Resolution: 1051 x 208 x 863
Active Voxels: 8.9M (188.7M dense)
Memory: 172 MB
Conversion Time 2.7s
Threaded — very fast

internal self-intersections
Conversion

To Polygons

tools::VolumeToMesh

- Mesh any scalar field that has a continuous isosurface
- Threaded dual contouring scheme
- Adaptive, using local curvature
- Supports region masking and adaptivity field

Level Set
1051 x 208 x 863 resolution
172 MB

Uniform Mesh
(4.8M points + 4.8M quads)
129 MB

Adaptive Mesh
(1.7M points + 1.5M quads + 335K triangles)
46 MB
Conversion

Automatic partitioning for distributed meshing
Conversion

From Particles

tools::ParticlesToLevelSet

- Creates a level set from a list of points with position & radius
- Threaded
- Custom attribute transfer
- Optional velocity trails

Particles

Level set

Surface

Velocity trails
More Converters

From SDF to Fog Volume
tools::sdfToFogVolume

Rebuild Level Set
tools::levelSetRebuild

Dense Volume Converters
tools::copyFromDense
tools::copyToDense

Scatter Points
tools::UniformPointScatter
tools::NonUniformPointScatter
Filtering and Morphology

Gaussian
- tools::Filter::gaussian
- tools::LevelSetFilter::gaussian

Offset / Morphological
- tools::Filter::offset
- tools::LevelSetFilter::offset

Median
- tools::Filter::median
- tools::LevelSetFilter::median

Normalize
- tools::normalize
- tools::LevelSetFilter::normalize

Mean
- tools::Filter::mean
- tools::LevelSetFilter::mean

Level set specific
- tools::LevelSetFilter::laplacian
- tools::LevelSetFilter::meanCurvature

Gaussian Filter with Masking
Mathematical Transformation

- **Gradient**
  - `tools::gradient`
  - The implicit surface (zero level set)

- **Mean curvature**
  - `tools::meanCurvature`
  - Buoyant density in an incompressible fluid simulation

- **Closest-point transform**
  - `tools::cpt`

- **Divergence**
  - `tools::divergence`

- **Laplacian**
  - `tools::laplacian`

- **Curl**
  - `tools::curl`
  - Magnitude
    - `tools::magnitude`
Liquid Surfacing

Particle Liquid Simulation

Michael Losure, DreamWorks Animation
Liquid Surfacing

Fast initial surface (using only From Particles)
Liquid Surfacing

Vorticity Magnitude Mask (used for filtering)
Liquid Surfacing

Putting it all together
Combination

Constructive solid geometry

- Hierarchical
- Branch stealing — very fast

![Diagram of constructive solid geometry](image)

- `tools::csgUnion` for union
- `tools::csgIntersection` for intersection
- `tools::csgDifference` for difference
## More Combination Tools

### Pairwise Hierarchical Combination

<table>
<thead>
<tr>
<th>Combination</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td><code>tools::compMax</code></td>
</tr>
<tr>
<td>Minimum</td>
<td><code>tools::compMin</code></td>
</tr>
<tr>
<td>Multiply</td>
<td><code>tools::compMul</code></td>
</tr>
<tr>
<td>Sum</td>
<td><code>tools::compSum</code></td>
</tr>
<tr>
<td>Replace</td>
<td><code>tools::compReplace</code></td>
</tr>
<tr>
<td>Merge</td>
<td><code>Grid::merge</code></td>
</tr>
</tbody>
</table>

### Generic Hierarchical Algorithms

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine</td>
<td><code>Tree::combine</code></td>
</tr>
<tr>
<td></td>
<td><code>Tree::combineExtended</code></td>
</tr>
<tr>
<td></td>
<td><code>Tree::combineZ</code></td>
</tr>
<tr>
<td></td>
<td><code>Tree::combineZExtended</code></td>
</tr>
<tr>
<td>Visit</td>
<td><code>Tree::visitActiveBBox</code></td>
</tr>
<tr>
<td></td>
<td><code>Tree::visit</code></td>
</tr>
<tr>
<td></td>
<td><code>Tree::visitZ</code></td>
</tr>
</tbody>
</table>
Segmentation

Segment
\texttt{tools::segment}

Interior mask
\texttt{tools::sdfInteriorMask}

Narrow band level set

inside
outside
Level Set Fracture

Level Set Conversion

From Polygons

Fracturing

\texttt{tools::LevelSetFracture}

Fracture 1

Cutter Object

Instance Points

Fracture 2

Surfacing

To Polygons

Fractured Model
Geometric Transformation

Advect points

tools::PointAdvect

Advect level set

tools::LevelSetAdvection

tools::ConstrainedPointAdvect
Geometric Transformation

Resample

tools::GridTransformer
tools::GridResampler
tools::resampleToMatch
Level Set Processing

Advection
- tools::LevelSetAdvection
- tools::LevelSetFilter::track

Ray intersection
- tools::LevelSetRayIntersector

Constructive solid geometry
- tools::csgDifference
- tools::csgIntersection
- tools::csgUnion

Conversion
- tools::ParticlesToLevelSet
- tools::MeshToVolume
- tools::VolumeToMesh
- tools::sdfToFogVolume

Filtering
- tools::LevelSetFilter::gaussian
- tools::LevelSetFilter::laplacian
- tools::LevelSetFilter::mean
- tools::LevelSetFilter::meanCurvature
- tools::LevelSetFilter::median

Morphology
- tools::LevelSetFilter::offset

Normalize
- tools::LevelSetFilter::normalize

Platonic primitives
- tools::LevelSetSphere

Rebuild level set
- tools::levelSetRebuild

Segmentation
- tools::LevelSetFracture
- tools::sdfInteriorMask
- tools::internal::segment

Signed flood fill
- Grid::signedFloodFill
Data Structure Manipulation

Bitwise Boolean Operations
- Topology Difference
  LeafNode::topologyDifference
- Topology Intersection
  LeafNode::topologyIntersection
- Topology Union
  Grid::topologyUnion
- Topology Comparison
  Tree::hasSameTopology

Bitwise Morphology Operations
- Topology Dilate
  tools::dilateVoxels
- Topology Erode
  tools::erodeVoxels

Topology Comparison
Tree::topologyDifference

Topology Intersection
LeafNode::topologyIntersection

Topology Union
Grid::topologyUnion

Topology Comparison
Tree::hasSameTopology

Topology Union
Grid::topologyUnion

Sparsity Management and Compression
- Grid::prune
  Tree::pruneOp
  Tree::pruneInactive
  Tree::pruneLevelSet
- Densify
  tree::Tree::voxelizeActiveTiles
More information

Documentation

- FAQ
- Cookbook
- Doxygen

www.openvdb.org/documentation

Forum

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