

New approaches in modelling, analysis and visualization of volume data with GRASS and VTK

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Table of Contents

- 1 Introduction
- 2 Handling volume data with GRASS
 - What is volume data?
 - Existing g3d modules
 - New g3d modules
- 3 Visualization and analysis with VTK
 - What is VTK
 - Volume map export
 - Visualization and analysis
 - Raster and vector map export

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Introduction

The beginning

Grid3D library (g3d) was developed in the 1990's by CERL and GMSL/University of Illinois.

Integration

Since 1999 GRASS supports officially volume data and provides basic capabilities for modeling and visualization.

Improvements

Since the beginning of 2006 the GRASS volume data capabilities have been significantly improved.

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Volume, Voxel or 3d Pixel?

Volume = Voxel

A voxel (a combination of the words volumetric and pixel) is a volume element, representing a value on a regular grid in three dimensional space.

Voxel = 3d pixel

- Voxel is analogous to pixel, which represents 2D image data
- Volume data is implemented in GRASS as voxels
- Volume data is handled in GRASS like raster data but in 3d



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Existing g3d modules

v.vol.rst

regular spline interpolation with tension from vector points

r3.mapcalc

performs arithmetic calculations on 3D grid volume data

nviz

visualization application of GRASS with volume support

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Existing g3d modules

r3.null and r3.mask

providing null value and mask support

r3.in.ascii and r3.out.ascii

for ascii data import and export

r3.in.v5d and r3.out.v5d

for vis5d data import and export



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r3.in.ascii and r3.out.ascii

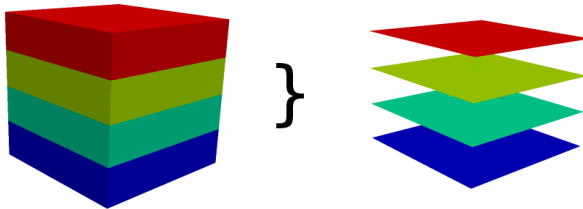
for ascii data import and export

r3.in.v5d and r3.out.v5d

for vis5d data import and export

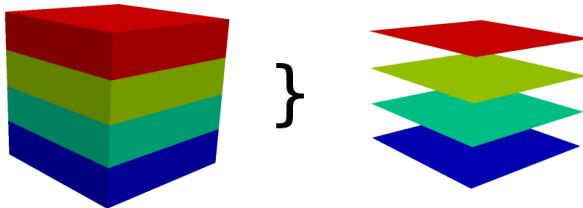
r3.to.rast

- converting a volume map into raster map slices
- input is a volume map
- a stack of raster map slices is created as output



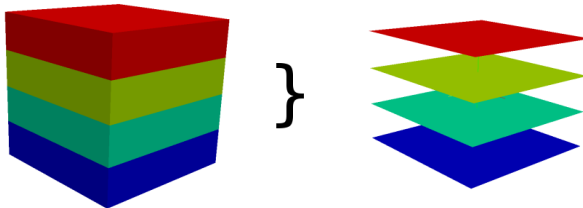
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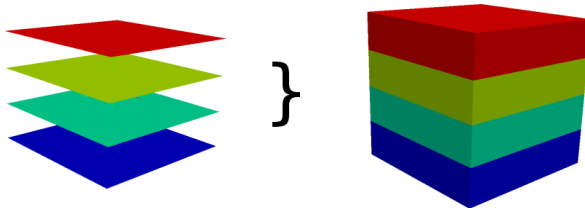
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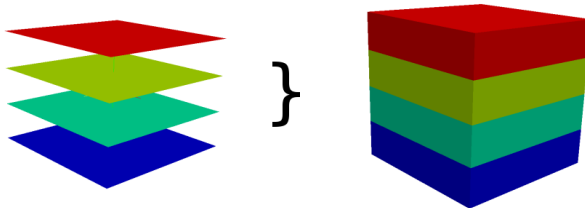
r.to.rast3

- converting raster maps into a volume map
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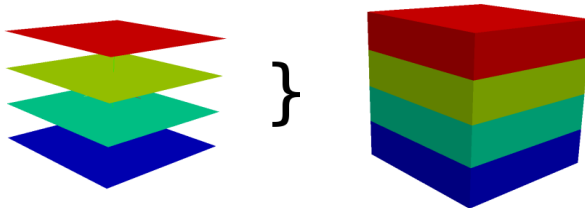
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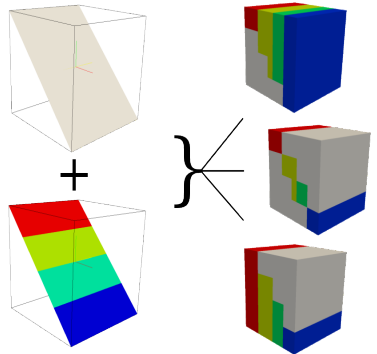
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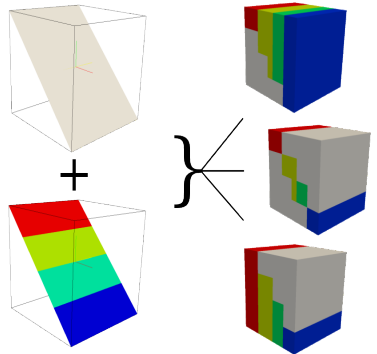
r.to.rast3elev

- creating a volume map based on elevation and value maps
- inputs are elevation and value raster maps
- a volume map is created as output
- support of different upper and lower values



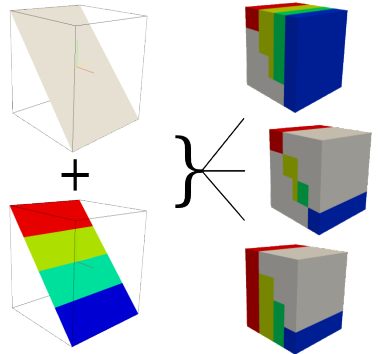
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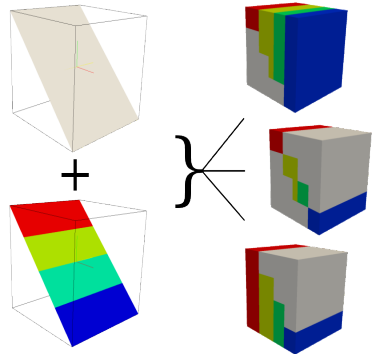
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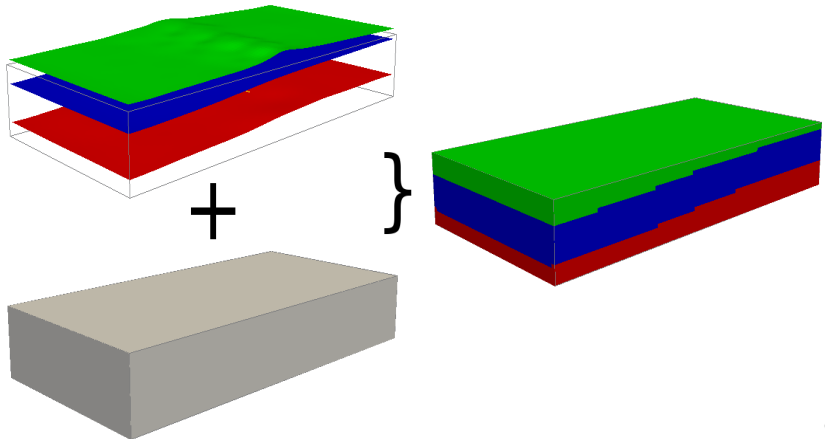


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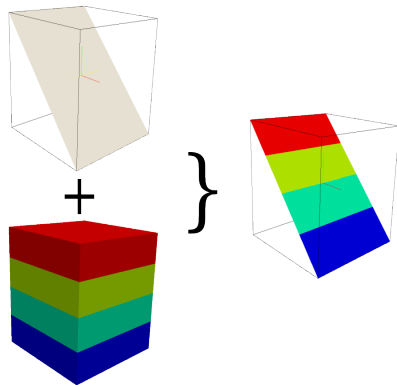


r.to.rast3elev



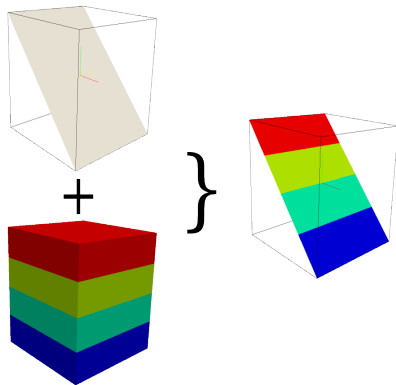
r3.cross.rast

- cross section of volume maps based on elevation maps
- input is an elevation and a volume map
- a raster map is created as output



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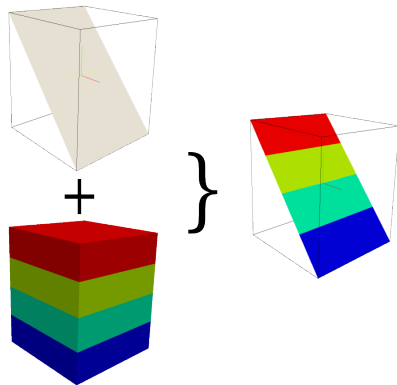


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The Visualization ToolKit (VTK)

- software system for 3D computer graphics, image processing and visualization
- multi-plattform and supports Windows, several Unix's and MacOS X
- written in C++ and bindings for Phyton, Tcl/Tk and Java available
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Why do visualization with VTK

- the most sophisticated visualization toolkit available on the market
- provides leading edge data processing and visualization capabilities
- supports all types of raster, vector and volume data implemented in GRASS
- is actively developed and has an advanced software design
- easy to implement visualization applications with VTK (supports rapid prototype development)



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ParaView

- multi-platform visualization application based on VTK
- designed to visualize large data
- provides many tools of VTK for data processing and visualization
- has a flexible and intuitive user interface
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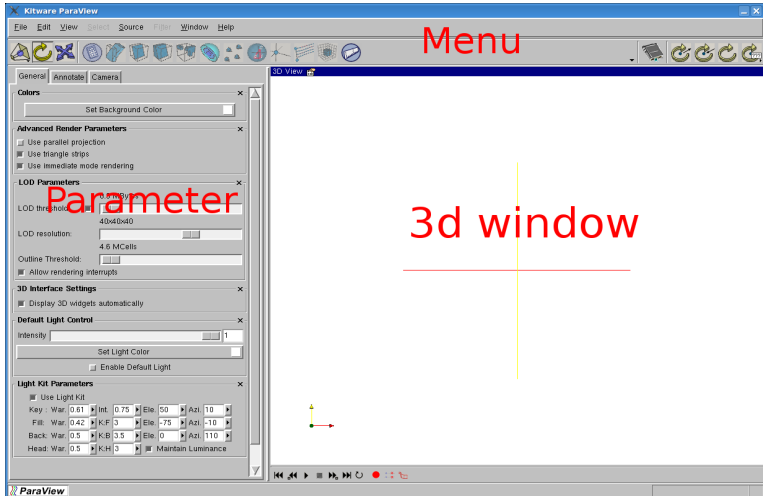


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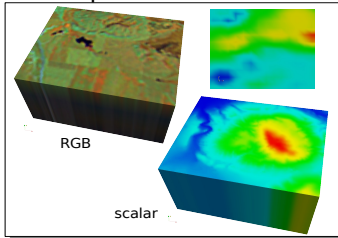
ParaView screenshot



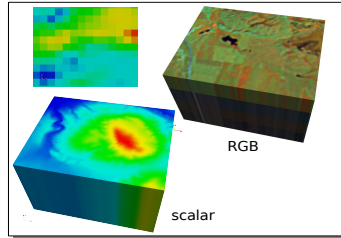
Export features of r3.out.vtk

r3.out.vtk

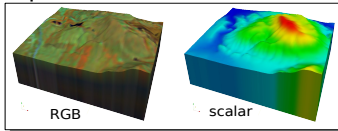
point data



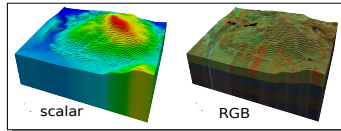
cell data



point data with elevation

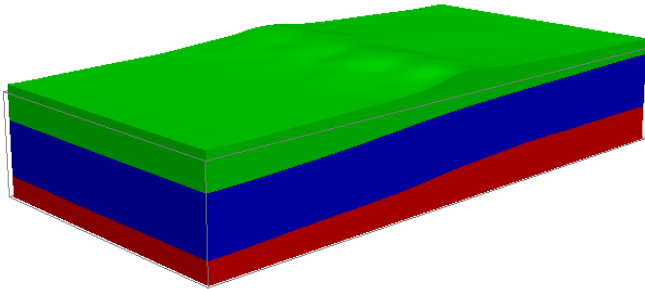


cell data with elevation



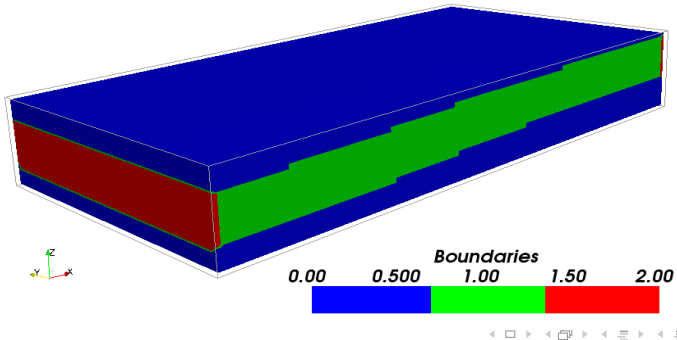
Volume and elevation

Using the top and bottom features of r3.out.vtk to visualize geological structures



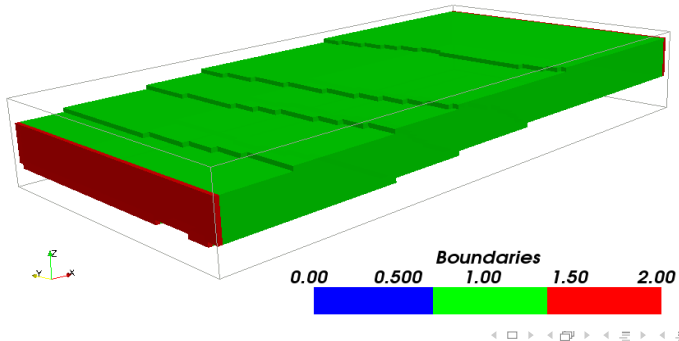
Data extraction

Extracting data within a value range of [1:2]



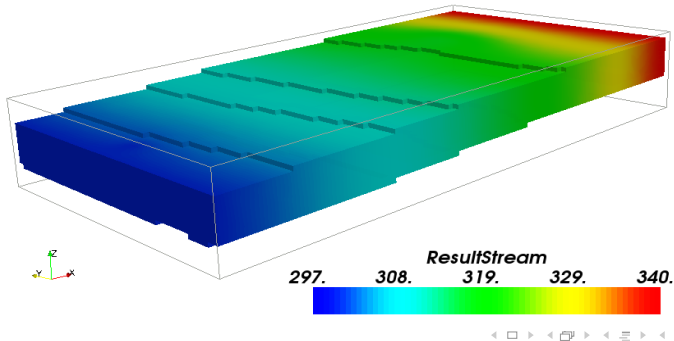
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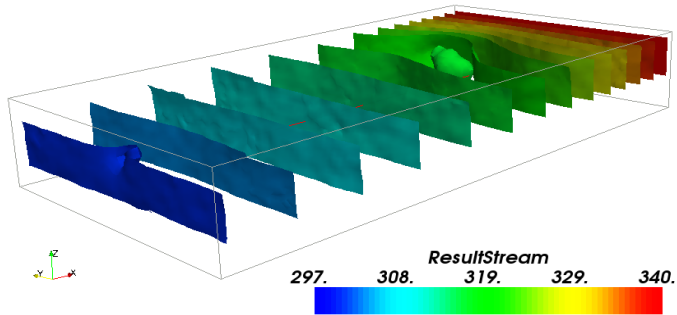
Data extraction

If multiple data in one dataset, all data will be selected



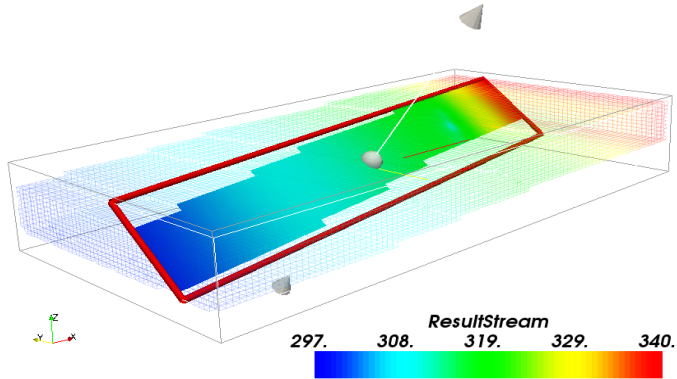
Isosurfaces

Creating isosurfaces with equidistant values



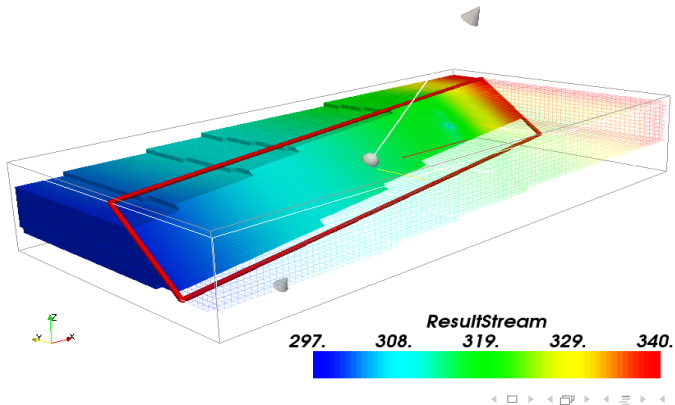
Cutting

Cutting a dataset with an implicit plane



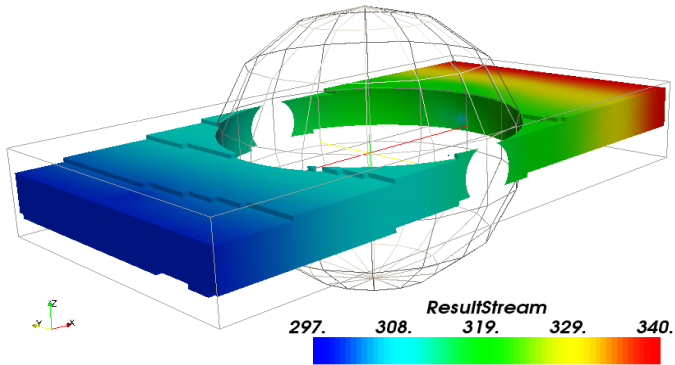
Clipping

Clipping a dataset with an implicit plane



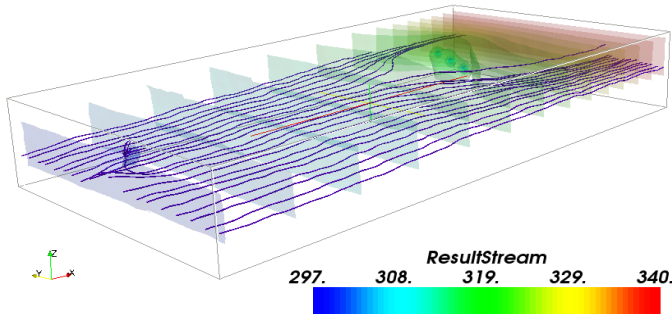
Clipping

Clipping a dataset with a sphere

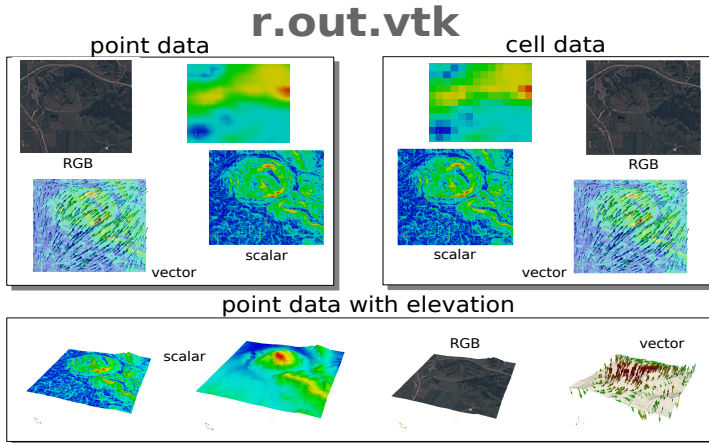


Streamlines and isosurfaces

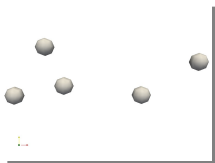
A combination of streamlines and isosurfaces



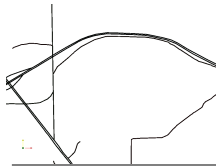
Export features of r.out.vtk



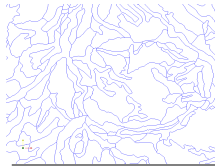
Export features of v.out.vtk



Points



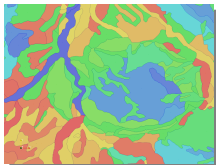
Lines



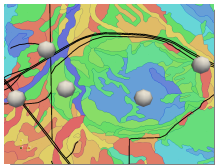
Boundaries

v.out.vtk

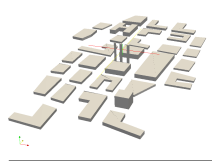
Areas



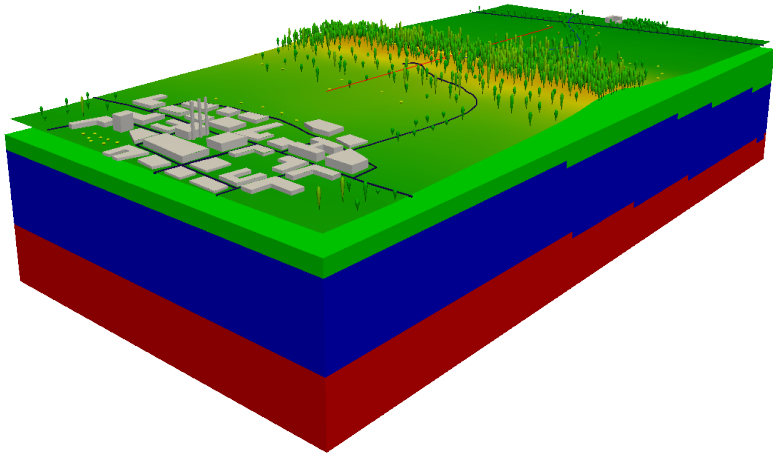
Mixed



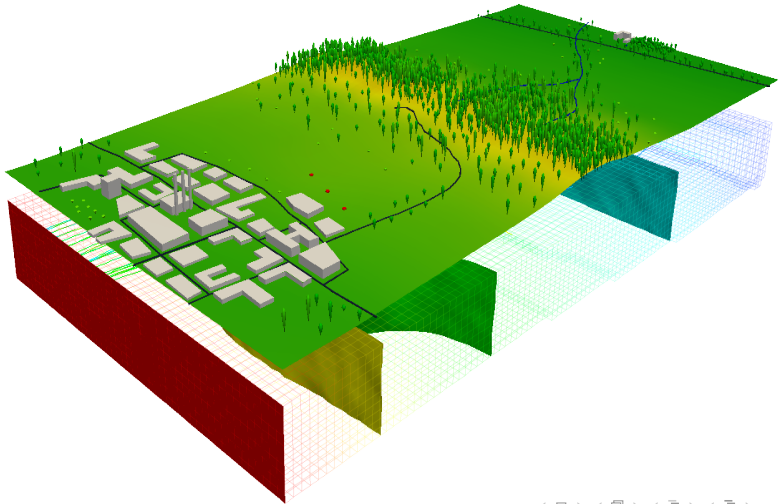
Faces



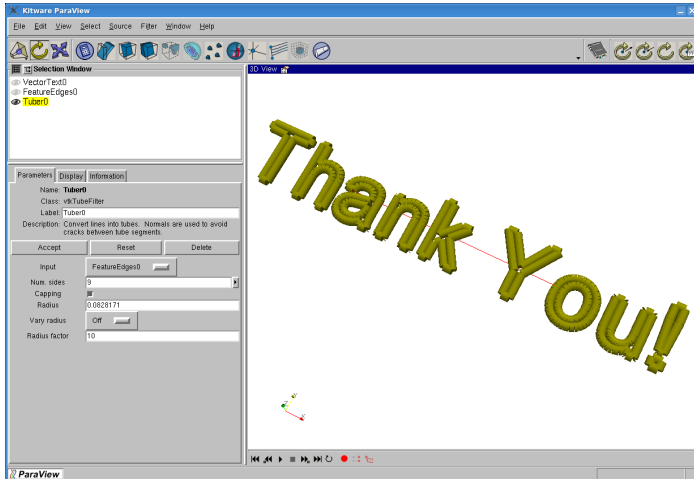
Raster, vector and volume data together



Raster, vector and volume data together



The End



The End

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www-pool.math.tu-berlin.de/~soeren/grass/modules

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