

Efficient processing of dense point clouds in GRASS GIS

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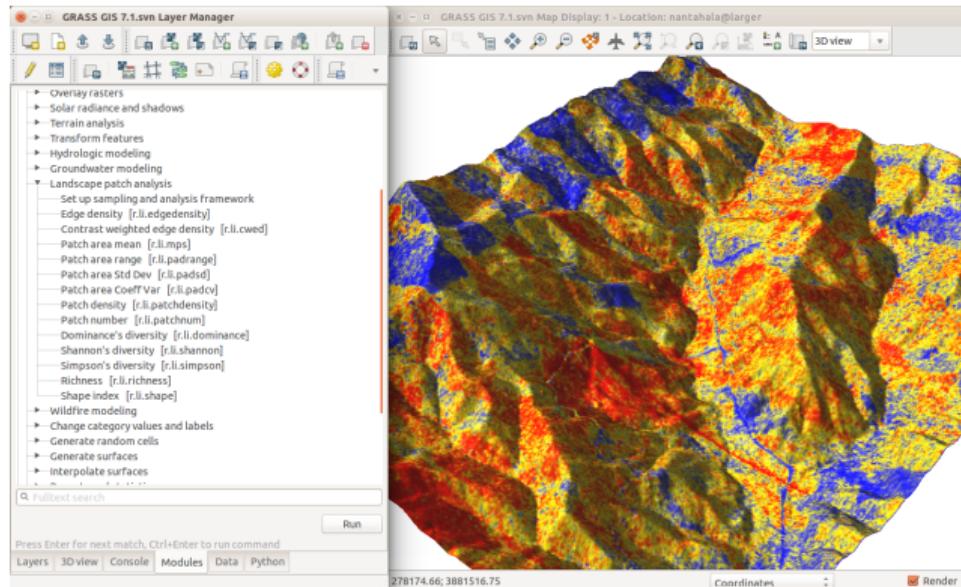


available at

wenzeslaus.github.io/grass-lidar-talks

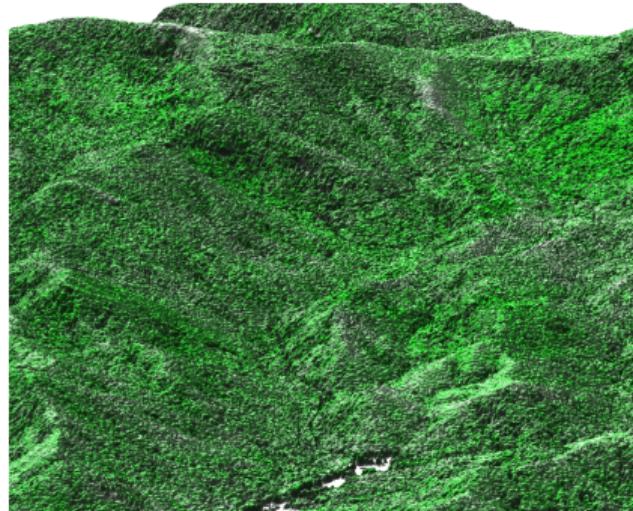
GRASS GIS

- ▶ universal scientific and processing platform
 - ▶ GUI, CLI, API
 - ▶ from small laptops to supercomputers
- ▶ lidar processing included
- ▶ data size and type challenges



Two core modules for lidar processing

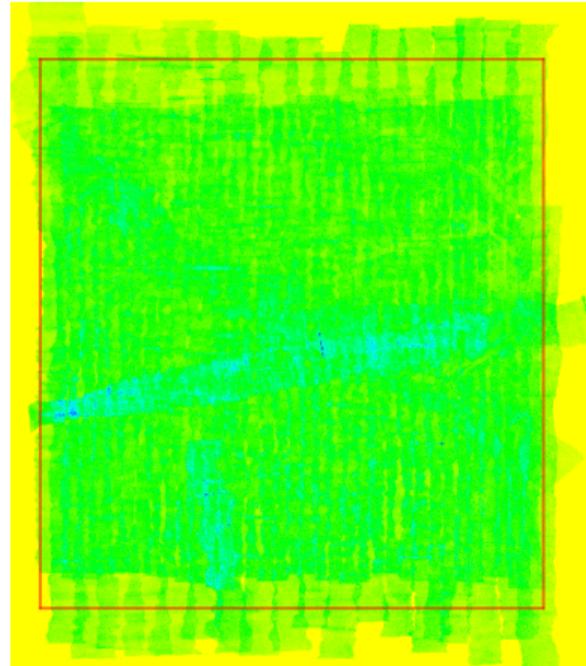
- ▶ *r.in.lidar* – binning and analyses, raster
- ▶ *v.in.lidar* – import of points, vector



r.in.lidar and *r.neighbors*, range smoothed
maximum surface, 551 million points from 90 files
to 8076 x 7223 cells using 480MiB in 4 min

Binning

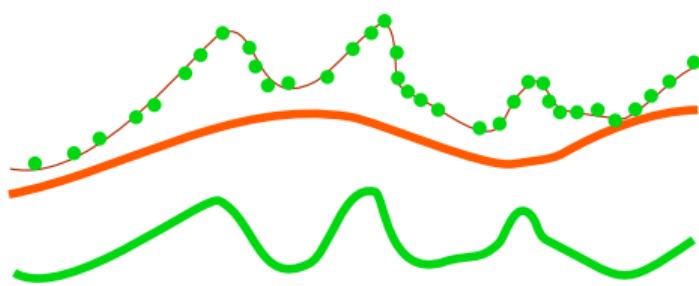
- ▶ analyze with *r.in.lidar*
- ▶ statistics of point counts, height and intensity
- ▶ using different resolutions
- ▶ produces raster from points
 - ▶ n, min, max, sum
 - ▶ mean, range, skewness, ...
- ▶ limits import by
 - ▶ range of Z
 - ▶ return, class
- ▶ multiple input files at once
- ▶ subsequent raster-based processing



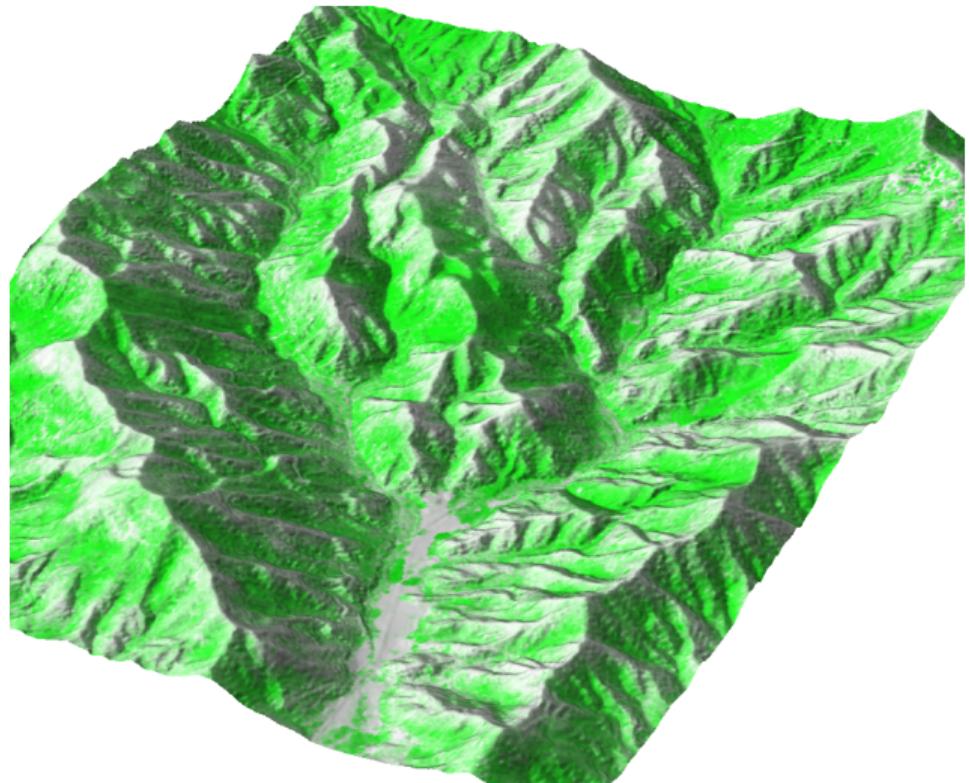
r.in.lidar, 578 million points in 90 files to 1882 × 1651 cells using 50MiB in 2 min

Height above a surface

- ▶ new feature in *r.in.lidar*



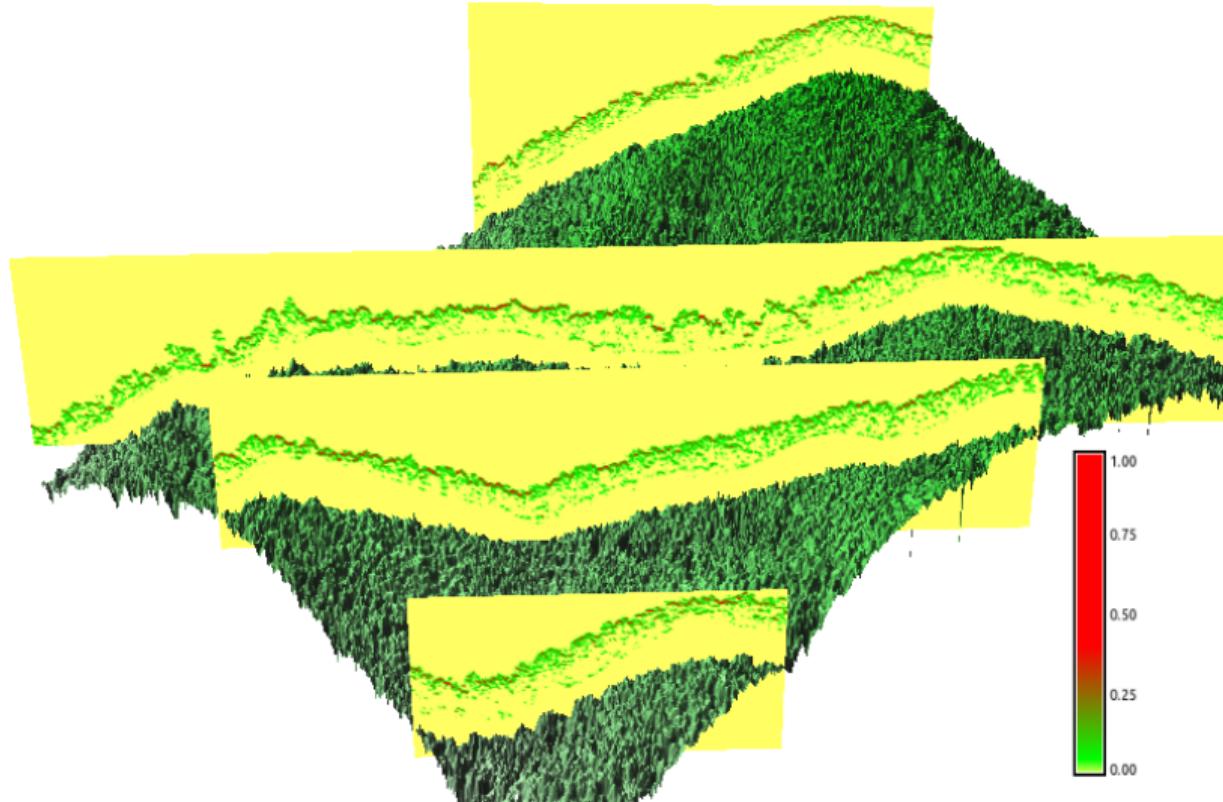
9 min, 480 MiB RAM, 2.7 GHz, SSD,
Ubuntu
578 million points in 90 files



Binning into 3D raster

- ▶ *r3.in.lidar*
- ▶ generally similar to *r.in.lidar*
- ▶ 3D raster
- ▶ proportional count
 - ▶ count per 3D cell relative to the count per vertical column
- ▶ intensity can be used instead of count

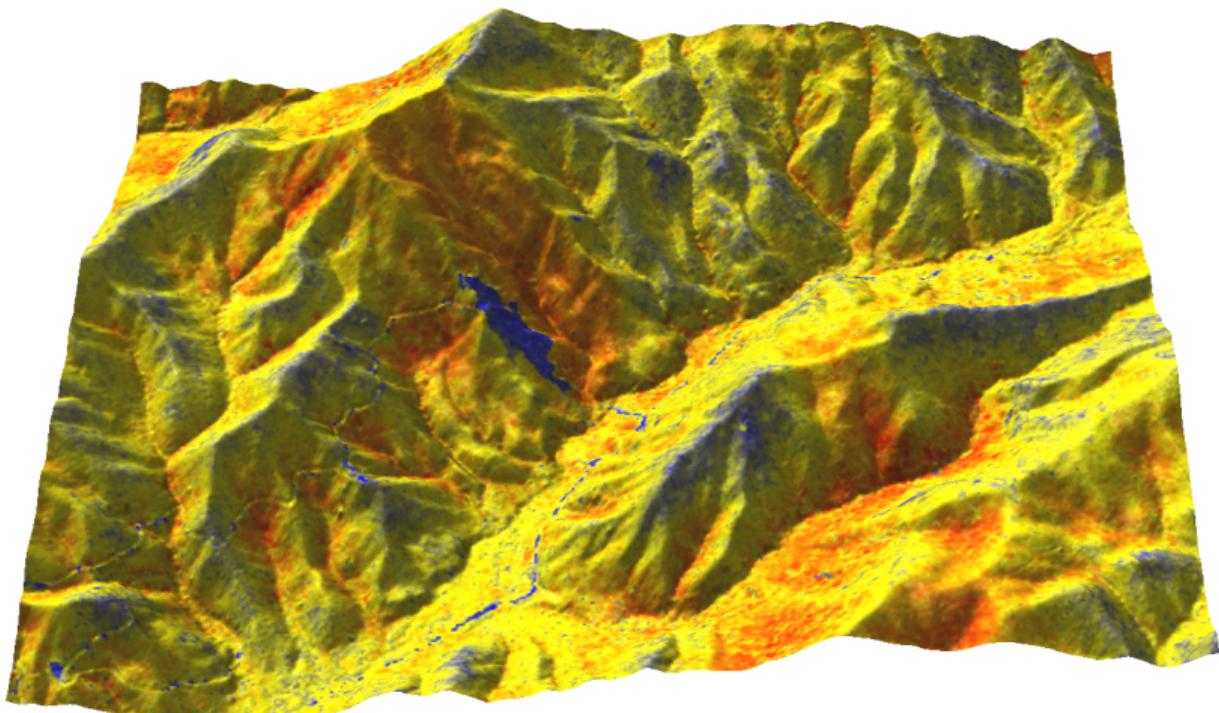
under development



Decimation, interpolation

Create surface with
v.in.lidar and interpolation

- ▶ few/sparse points,
smaller extent
- ▶ interpolate smooth
surface without
NULLs
- ▶ *v.in.lidar*
- ▶ filtering same as in
r.in.lidar
- ▶ interpolation modules
- ▶ decimation
(count-based as

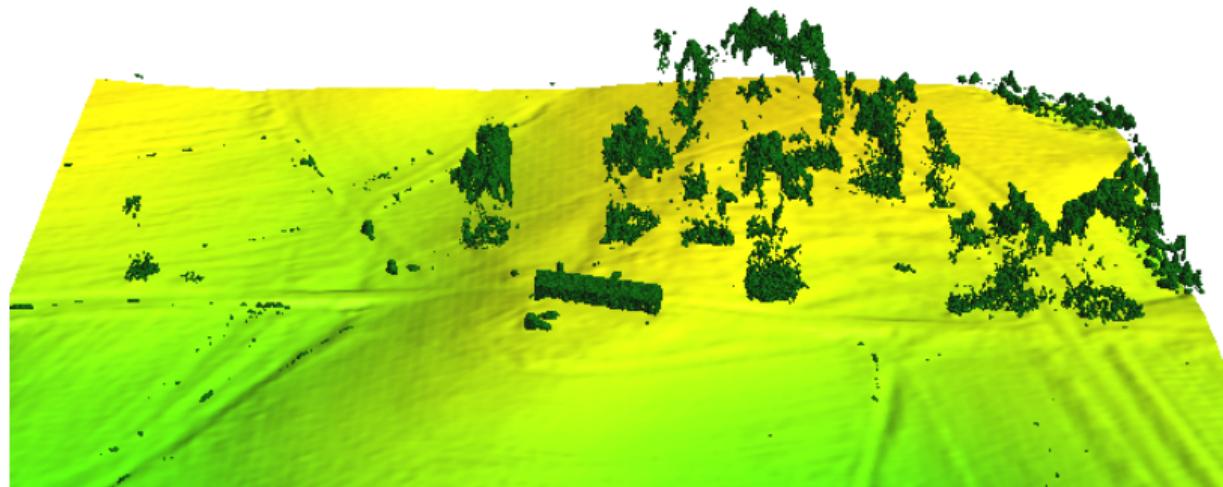


Regional scale

- ▶ trade-off have enough memory to avoid using percent option
- ▶ no IDs (lim of int)
- ▶ -t do not create attribute table
- ▶ -b do not build topology (applicable to other modules as well)
- ▶ -c store only coordinates, no categories or IDs
- ▶ 64bit version

Ground detection

- ▶ *v.lidar.edgedetection*,
v.lidar.growing,
v.lidar.correction
 - ▶ uses returns
- ▶ *v.lidar.mcc*
 - ▶ multiscale
curvature based
classification
algorithm¹



¹ Evans, J. S. & Hudak, A. T. 2007: A Multiscale Curvature Algorithm for Classifying Discrete Return LiDAR in Forested Environments.

Sky-view factor

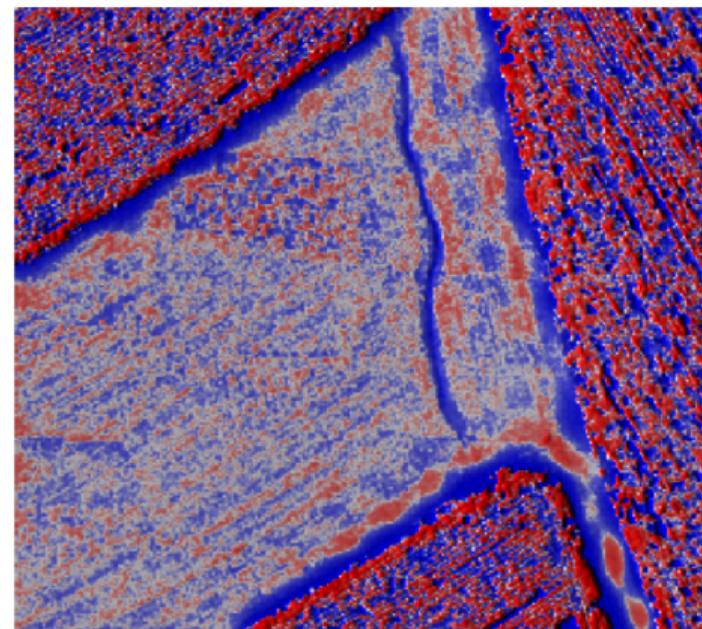
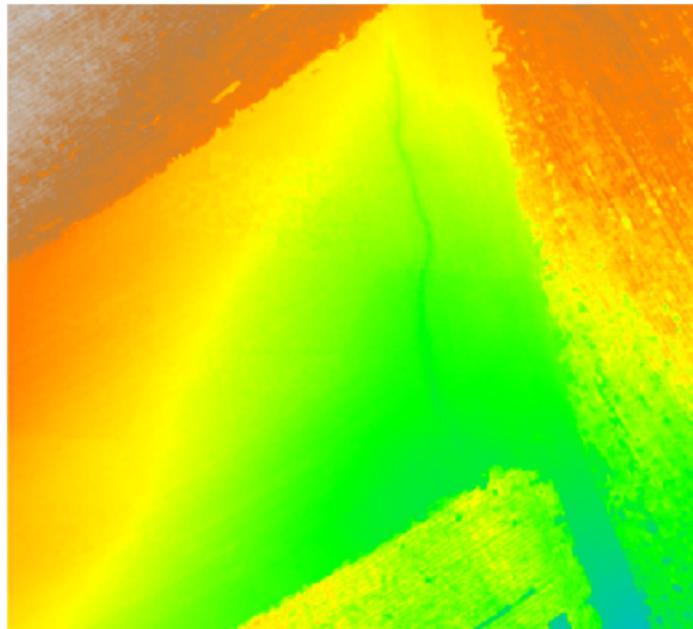
- ▶ *r.skyview* (percentage of visible sky)



comparison of shaded relief and sky-view factor

Local relief model (LRM)

- ▶ `r.local.relief` (micro-topography, features other than trend)



30-60cm wide, 30cm deep, 60m long gully (resolution 30cm)

Analytical shading

- ▶ *r.shaded.pca*
- ▶ relief shades from various directions
- ▶ PCA of shades
- ▶ combined into RGB composition

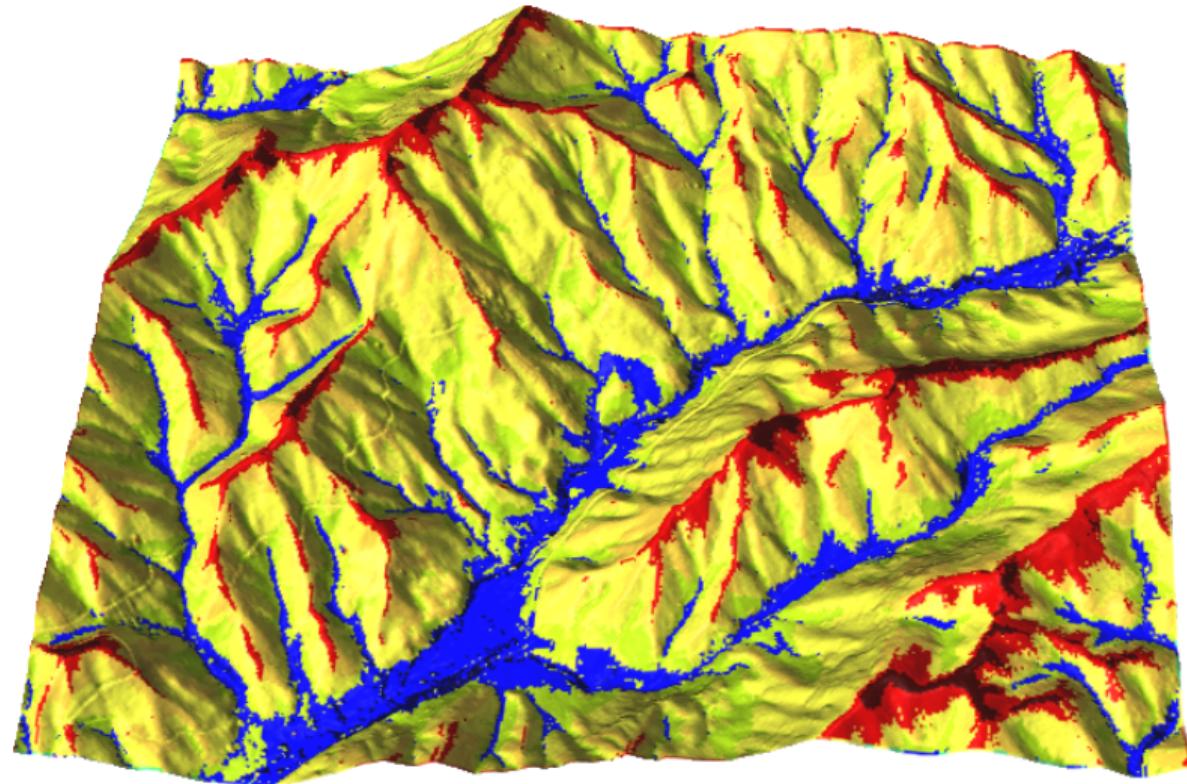
Devereux, B. J., Amable, G. S., & Crow, P. P. (2008). Visualisation of LiDAR terrain models for archaeological feature detection. *Antiquity*, 82(316), 470-479.



Landforms

- ▶ *r.geomorphon*
- ▶ geomorphons - a new approach to classification of landform¹

¹ Jasiewicz, J., Stepinski, T., 2013, Geomorphons - a pattern recognition approach to classification and mapping of landforms, *Geomorphology*



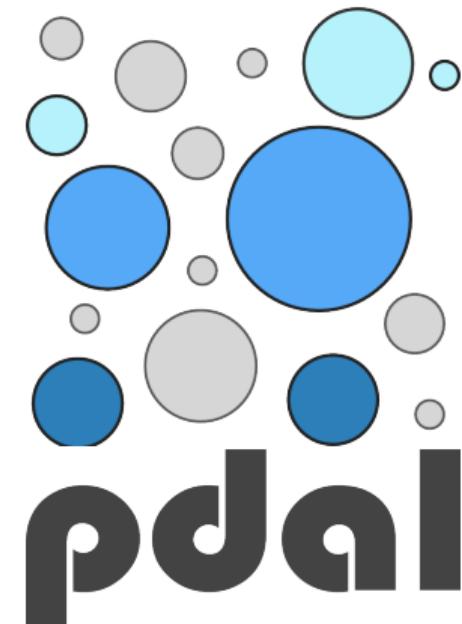
Integration with PDAL

PDAL

- ▶ formats besides LAS/LAZ
- ▶ algorithms, filters, decimations

Experimental integration

- ▶ *v.in.pdal*
- ▶ reprojection during import
- ▶ ground filter
- ▶ compute height as a difference from ground



Acknowledgements

Software: GRASS GIS

Presented functionality is work done by Vaclav Petras, Markus Metz, and the GRASS development team. Thanks to users for feedback and testing, especially to Doug Newcomb, Markus Neteler, Laura Belica, and William Hargrove.

Datasets

Data for GIS595/MEA792: UAV/lidar Data Analytics course

Nantahala NF, NC: Forest Leaf Structure, Terrain and Hydrophysiology: Lidar data acquisition and processing completed by the National Center for Airborne Laser Mapping (NCALM). NCALM funding provided by NSF's Division of Earth Sciences, Instrumentation and Facilities Program. EAR-1043051. Obtained from OpenTopography. <http://dx.doi.org/10.5069/G9HT2M76>

Summary

- ▶ rasterize early
- ▶ make use of existing methods for raster and vector processing
- ▶ 3D rasters, PDAL integration
- ▶ the plan for next 30 years driven by users – grass-user mailing list



GRASSGIS

Get GRASS GIS 7.1 development version at
grass.osgeo.org/download

Slides available at
wenzeslaus.github.io/grass-lidar-talks

