

Efficient processing of dense point clouds in GRASS GIS at US-IALE 2016 Annual Meeting

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available at

wenzeslaus.github.io/grass-lidar-talks

Points

- ▶ collected by lidar
- ▶ Structure from Motion (SfM) from UAV imagery
- ▶ a lot of points
 - ▶ often more than we need



surface interpolated from points from SfM

Free, libre and open source

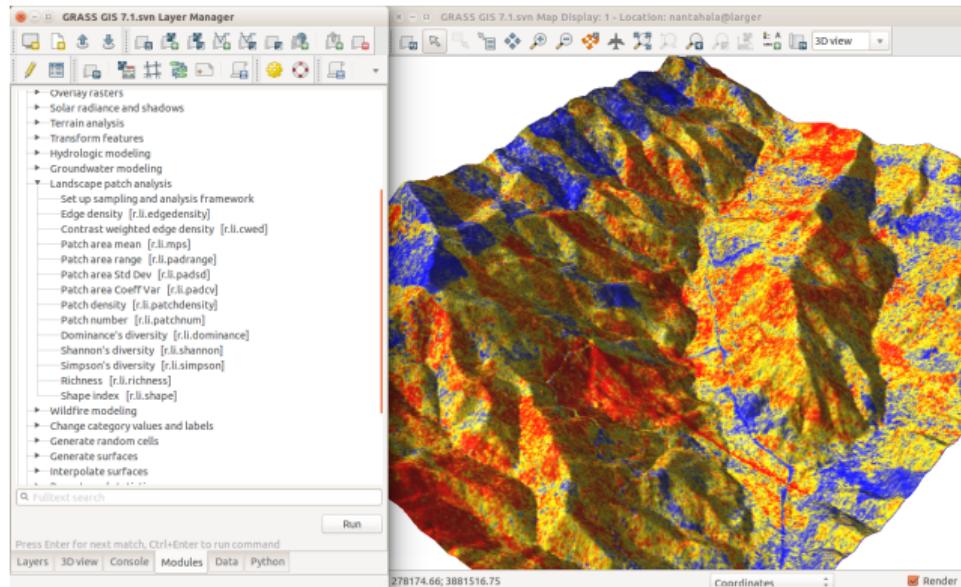
- ▶ driven by needs of users
- ▶ re-usable
- ▶ review
- ▶ usable
 - ▶ by other people
 - ▶ by future myself
- ▶ longevity
 - ▶ learn now, use forever
 - ▶ GRASS GIS over 30 years of development



Open Science Logo, Greg Emmerich,
CC-BY-SA-2.0

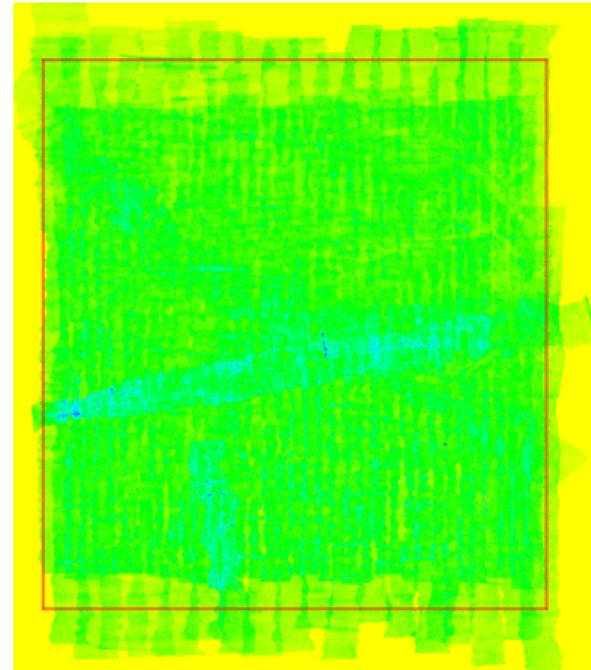
GRASS GIS

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



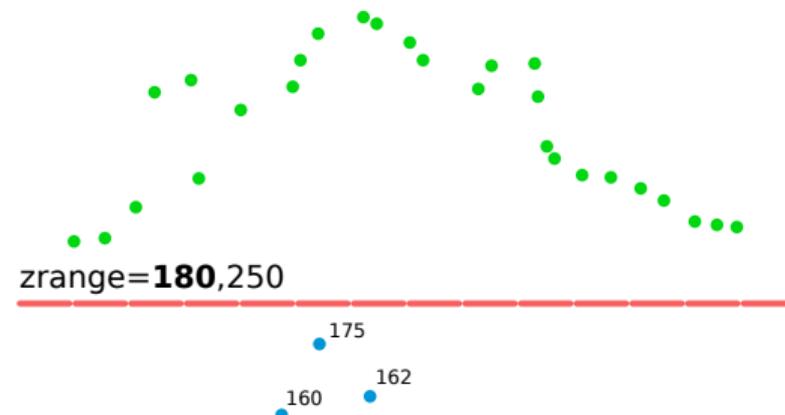
Binning points to raster

- ▶ *r.in.lidar* (import and analysis)
- ▶ statistics of point counts, height and intensity
 - ▶ n, min, max, sum
 - ▶ mean, range, skewness, ...
- ▶ multiple input files at once
- ▶ subsequent raster-based processing



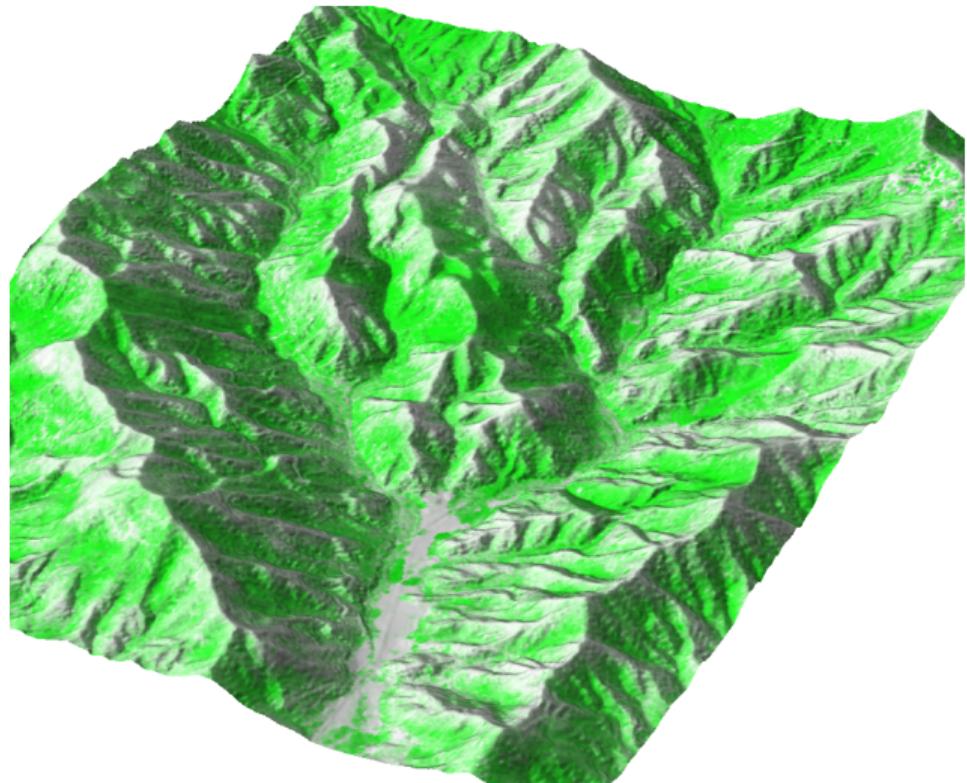
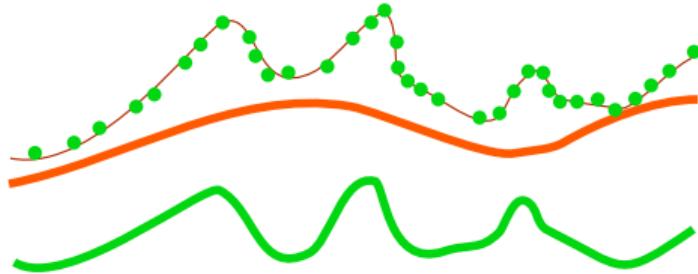
Filtering points

- ▶ filter points by
 - ▶ range of Z
 - ▶ return
 - ▶ class
 - ▶ ...



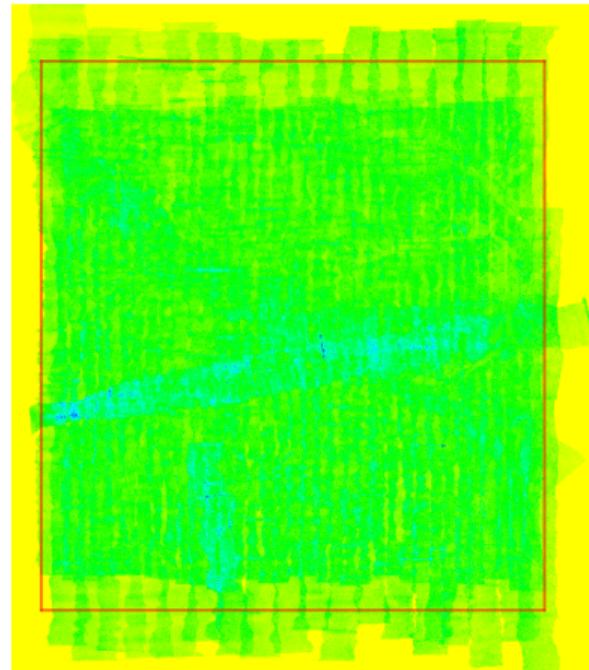
Height above a surface

- ▶ new feature in *r.in.lidar*



Rasterize early

- ▶ less cells then points
 - ▶ 578 mil points (ground 30 mil)
 - ▶ 15 mil cells in $8\text{km} \times 7\text{km}$ at resolution 2m
 - ▶ faster to loop through
- ▶ raster
 - ▶ natural spatial index
 - ▶ that's what the algorithms use

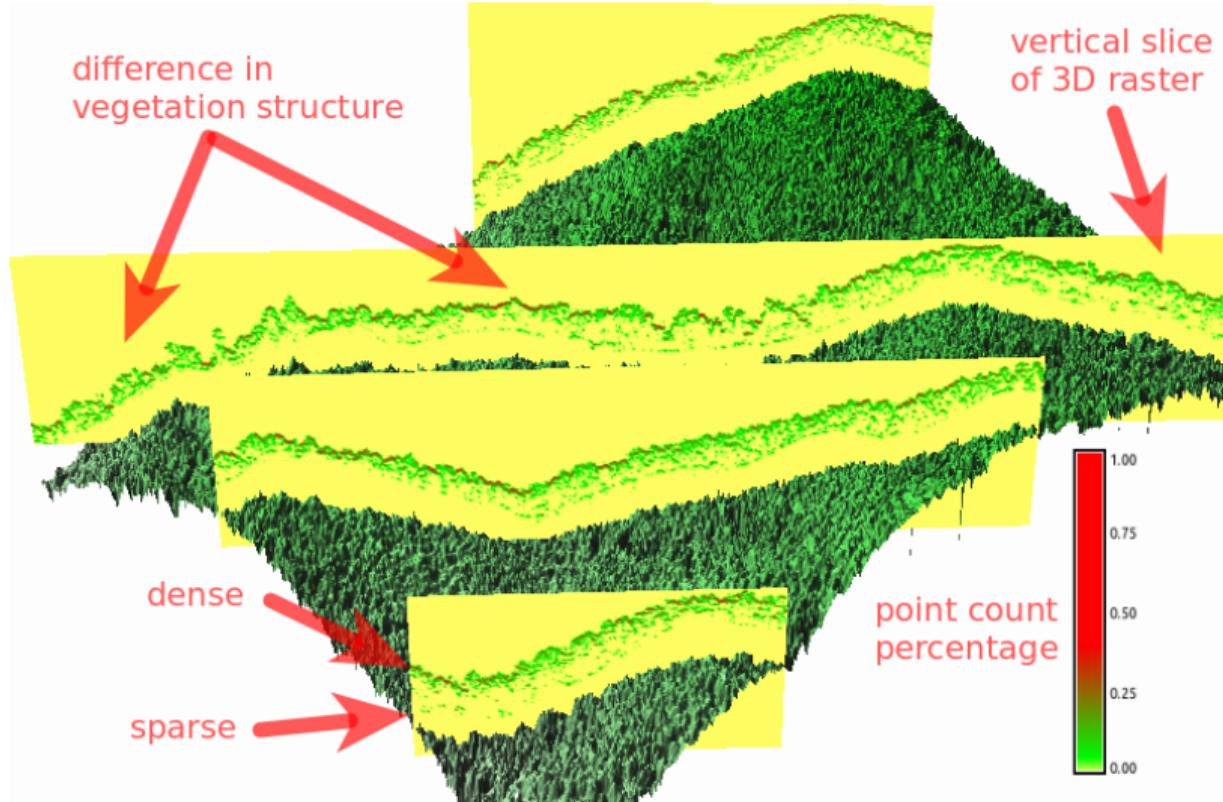


point density (all classes) at 5m, green ~ 200 points

Binning points to 3D raster

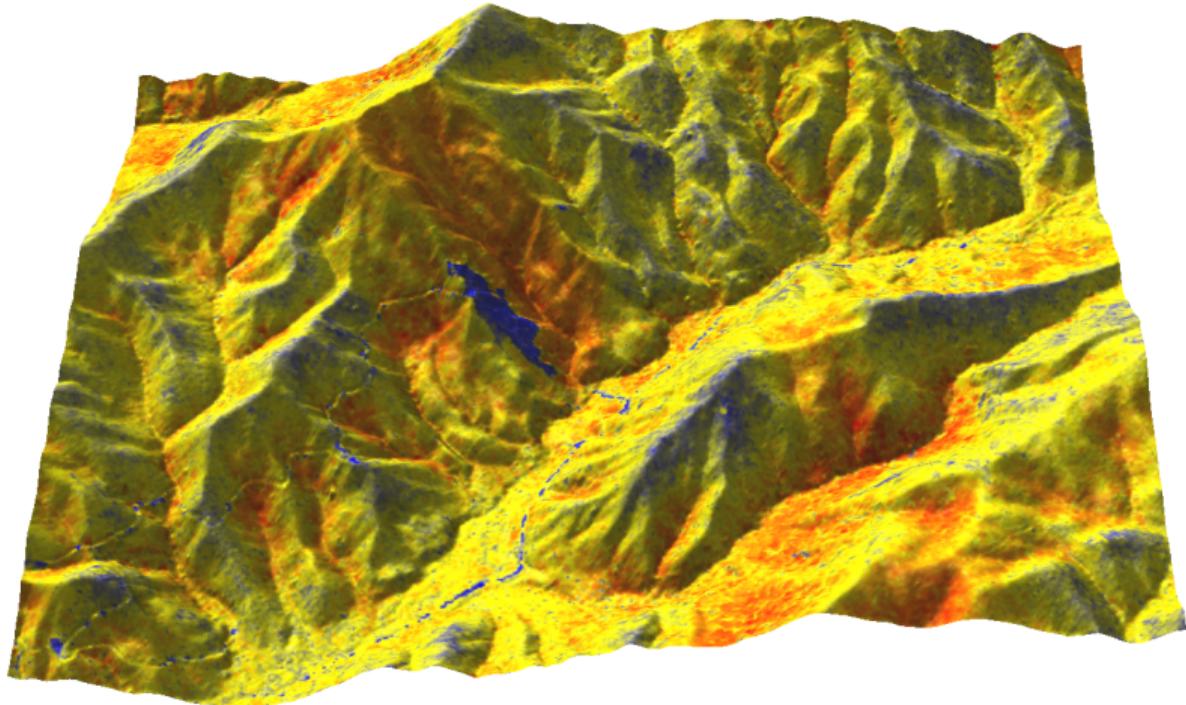
- ▶ *r3.in.lidar*
- ▶ proportional count
 - ▶ count per 3D cell relative to the count per vertical column
- ▶ intensity can be used instead of count

under development



Decimation, sampling, interpolation

- ▶ *v.in.lidar*
- ▶ filtering same as in *r.in.lidar*
- ▶ followed by interpolation (costly)
- ▶ decimation \approx sampling
 - ▶ fast count-based as effective as more advanced decimation



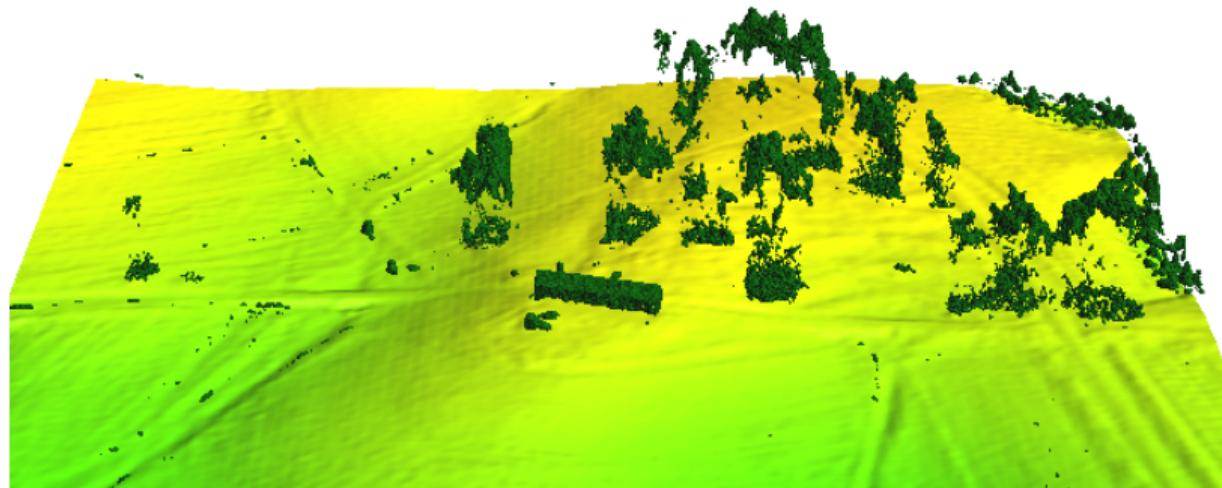
range from *r.in.lidar* on ground obtained from *v.in.lidar* followed by *v.surf.rst*

Large point clouds

- ▶ trade-offs: a lot of memory (RAM) or slow
- ▶ 64bit version
- ▶ point cloud specific optimizations
 - ▶ no IDs stored
 - ▶ no attribute table
 - ▶ no topology created

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

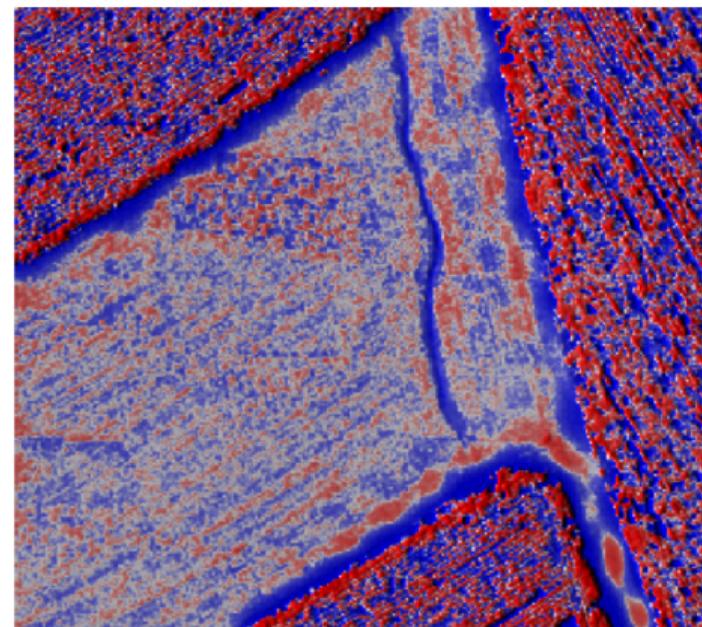
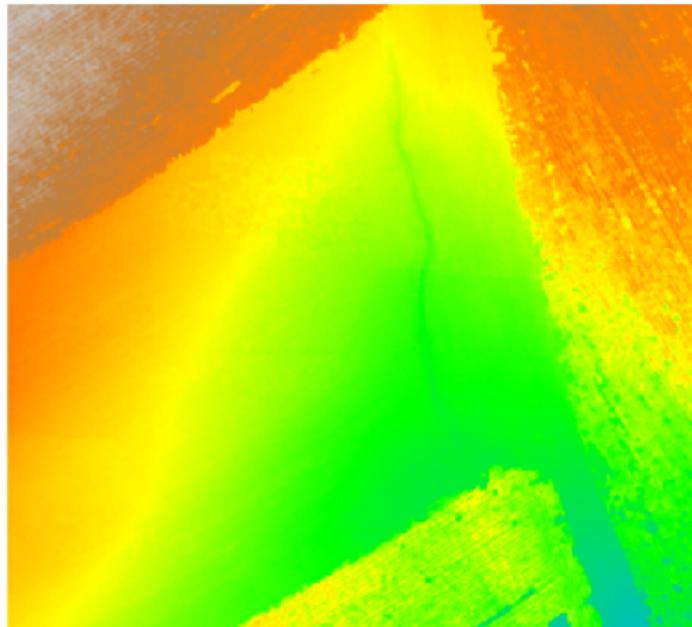
- ▶ *r.skyview* (percentage of visible sky)



comparison of shaded relief and sky-view factor

Local relief model (LRM)

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

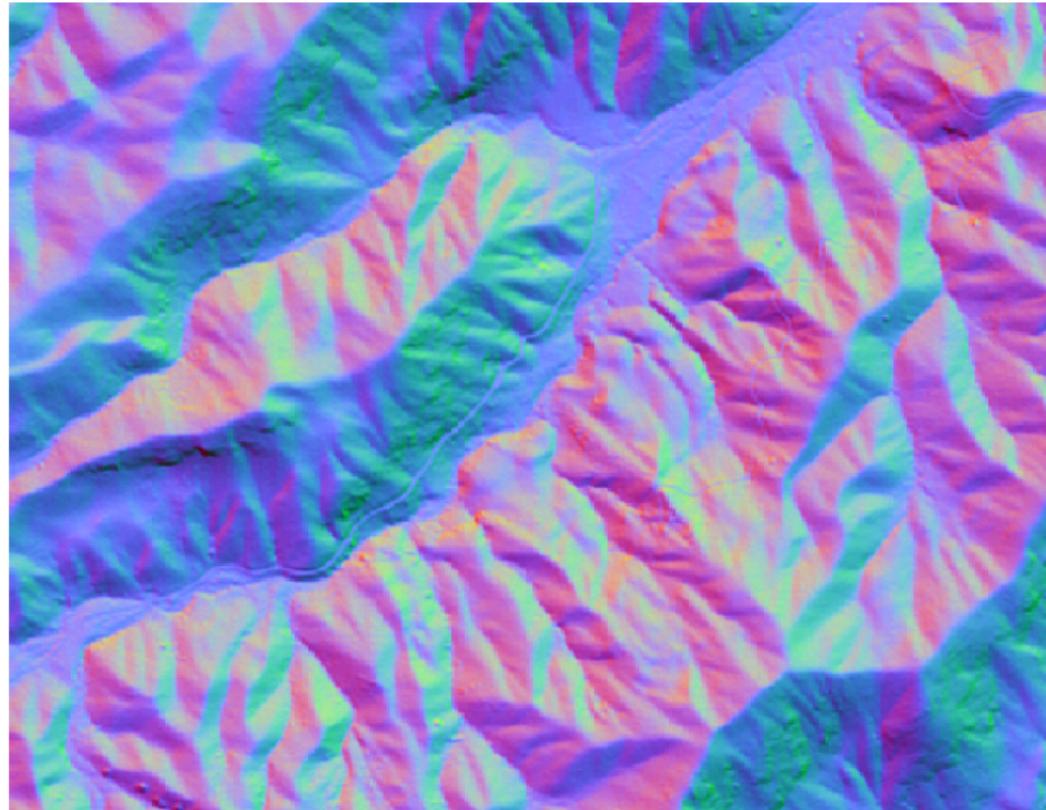


30-60cm wide, 30cm deep, 60m long gully (resolution 30cm)

Analytical shading

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

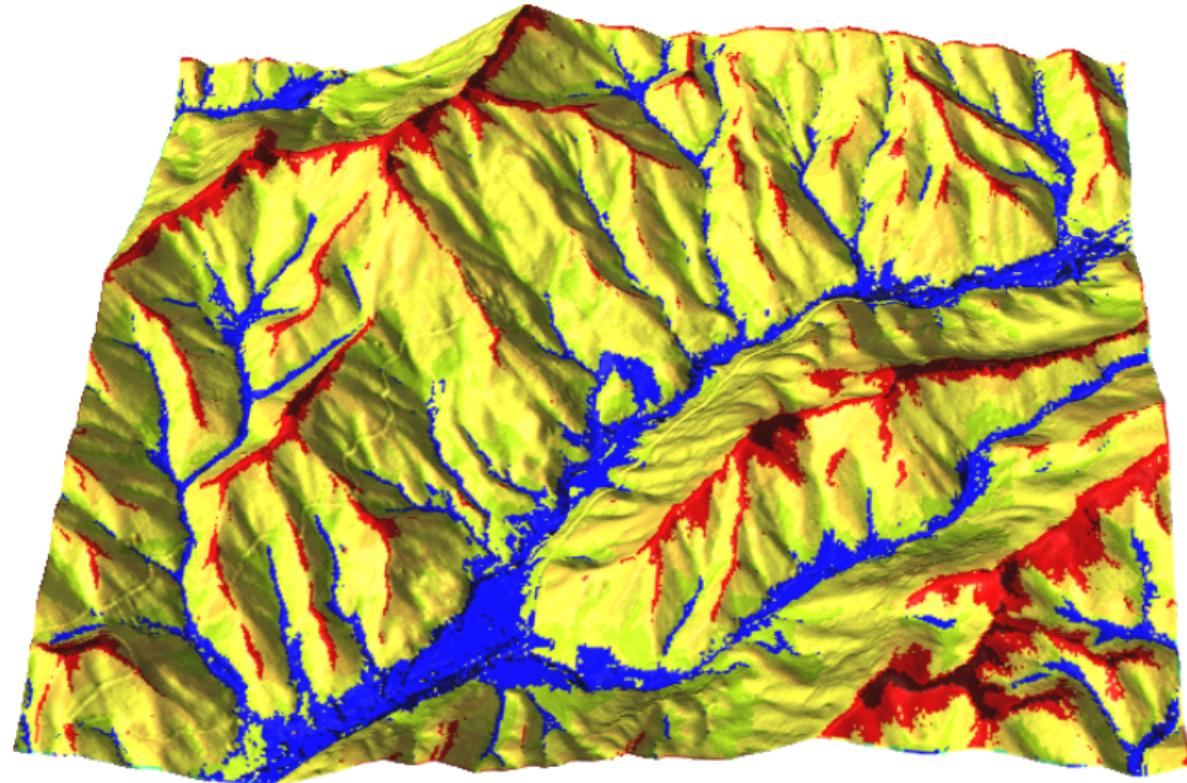
Devereux, B. J., Amable, G. S., & Crow, P. P. (2008). Visualisation of LiDAR terrain models for archaeological feature detection. *Antiquity*, 82(316), 470-479.



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*



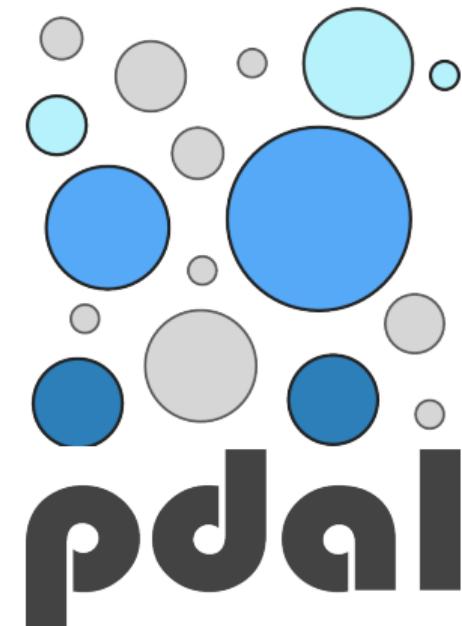
Integration with PDAL

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 Douglas 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



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

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

Paper in preparation: *Processing UAV and lidar point clouds in GRASS GIS*

