Efficient processing of dense point clouds in GRASS GIS

at US-IALE 2016 Annual Meeting

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Acknowledgements

Software

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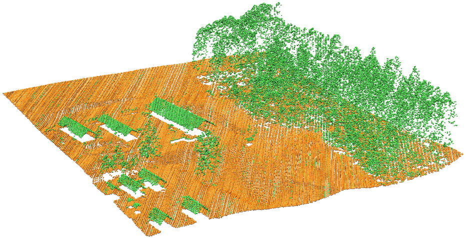
GRASS GIS

Acknowledgements

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`



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

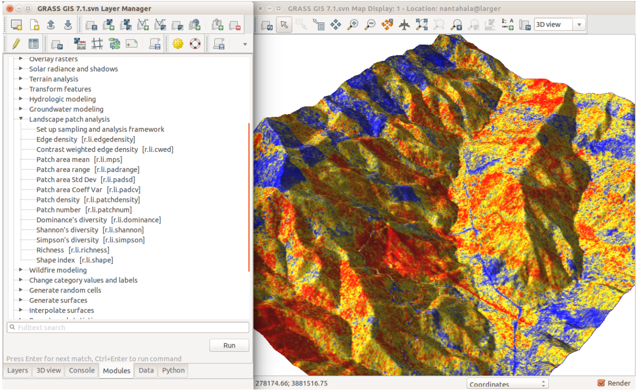
- driven by needs of users
- re-usable
- review
- usable
  - by other people
  - by future myself
- longevity
  - learn now, use forever
  - GRASS GIS over 30 years of development

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

GRASS GIS

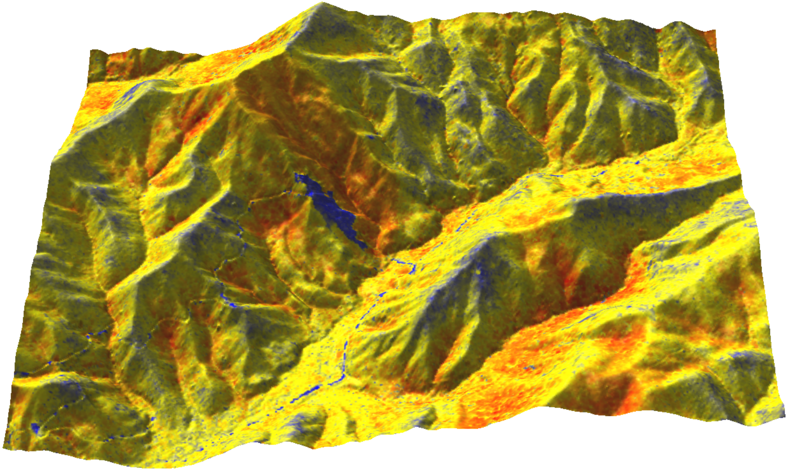
- universal scientific and processing platform
  - GUI, CLI, Python API
  - from small laptops to supercomputers
- lidar processing included
- data size and type challenges

GRASS GIS



Workflow overview

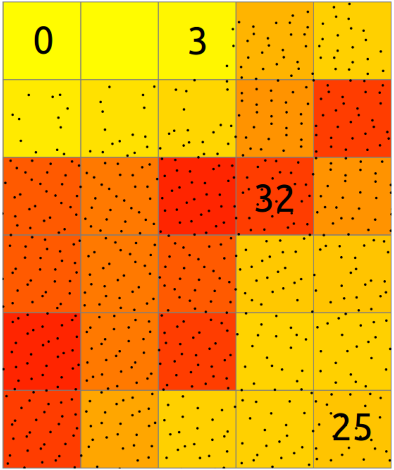
- points → binning → raster → analysis
- points ⟶ decimation ⟶ vector
  - analysis
  - interpolation → raster → analysis



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

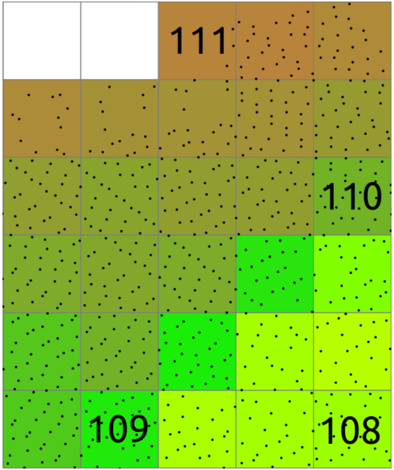
Binning as 2D histogram

- number of points in cell



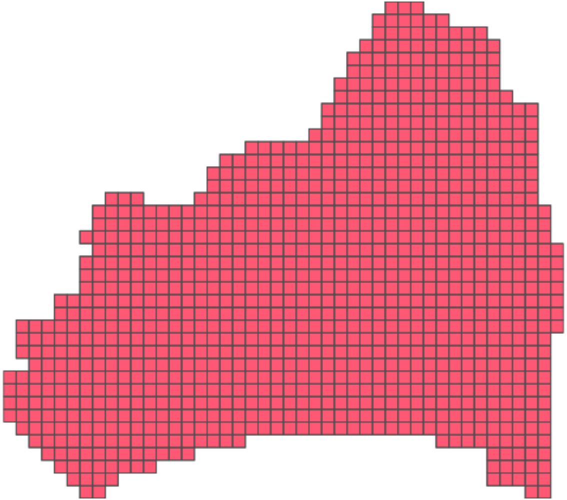
Binning points to raster

- *r.in.lidar* (import and analysis)
- statistics of point counts, height and intensity
  - n, min, max, sum
  - mean, range, skewness, ...



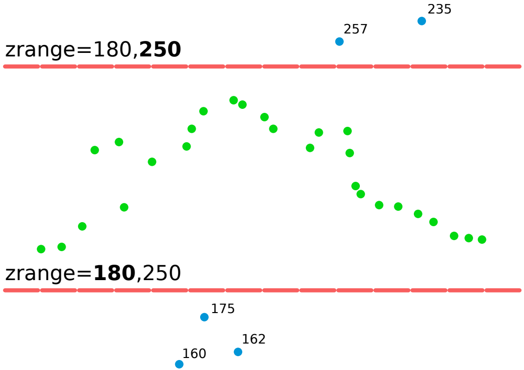
r.in.lidar

- analytical and practical functions
  - multiple tiles at once



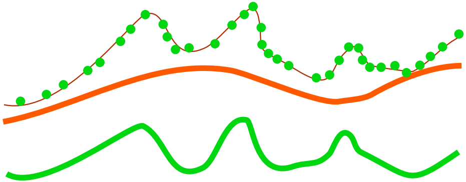
Filtering points

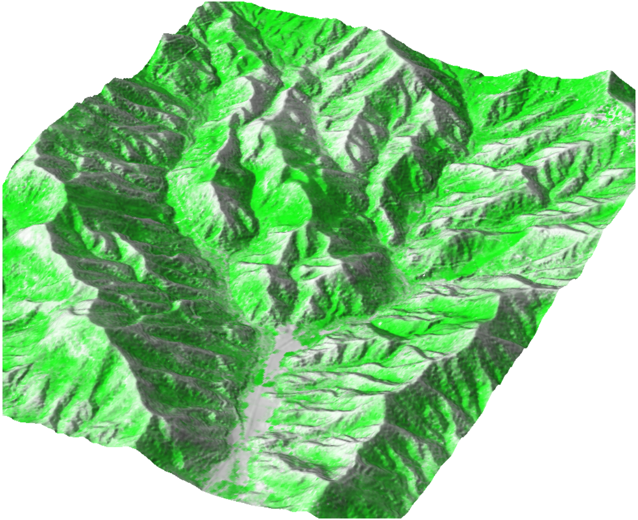
- filter points by
  - range of Z
  - return
  - class
  - ...
- at the time of binning with *r.in.lidar*



Height above a surface

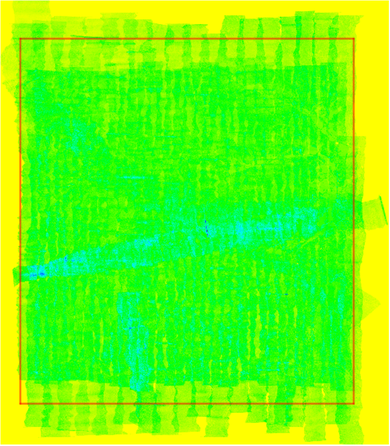
- new feature in *r.in.lidar*
- given surface + points cloud
  $\longrightarrow$ height of features





Rasterize early

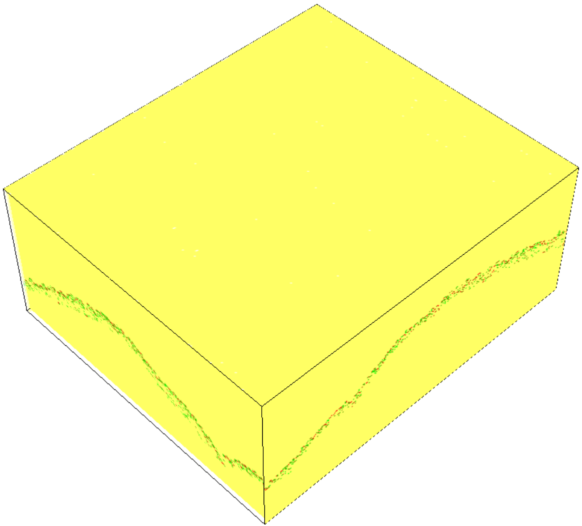
- less cells then points
  - 578 mil points (ground 30 mil)
  - 15 mil cells in 8km $\times$ 7km at resolution 2m
    - faster to loop through
- raster
  - natural spatial index
  - that's what the algorithms use



point density (all classes) at 5m, green $\sim$ 200 points

3D raster

- stacked 2D rasters
- challenging to visualize
- same principles as in 2D
  - e.g. 3D raster map algebra



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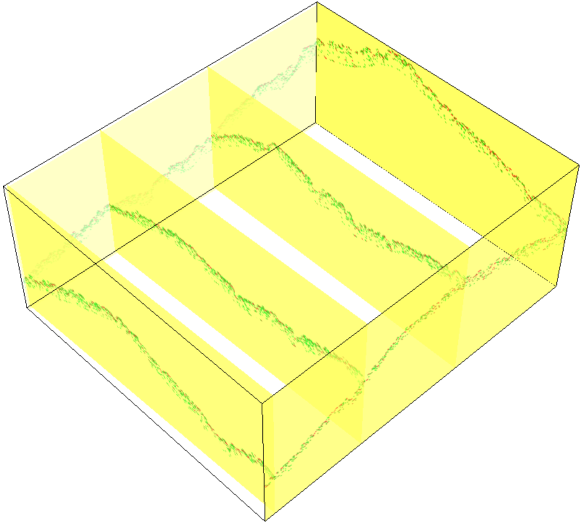
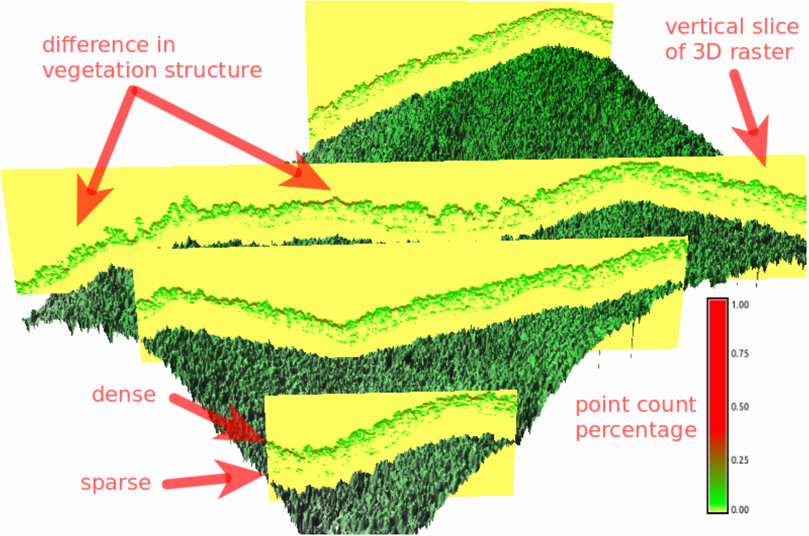


Binning points to 3D raster

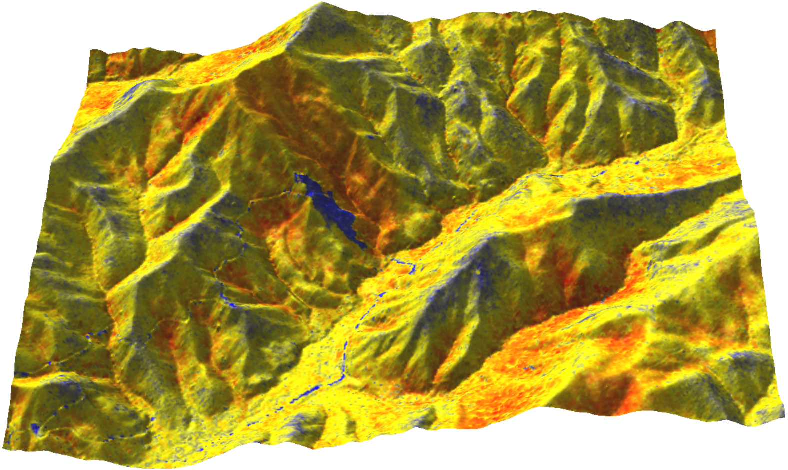
- *r3.in.lidar*
- proportional count
  - count per 3D cell relative to the count per vertical column
- intensity can be used instead of count

under development



Decimation, sampling, interpolation

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



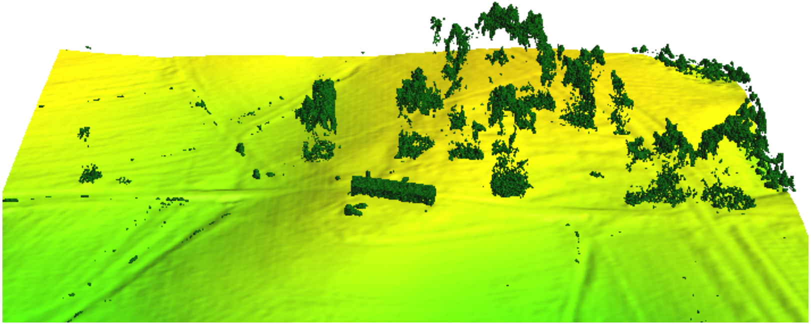
range from *r.in.lidar* on ground obtained from *v.in.lidar* followed by *v.surf.rst*

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

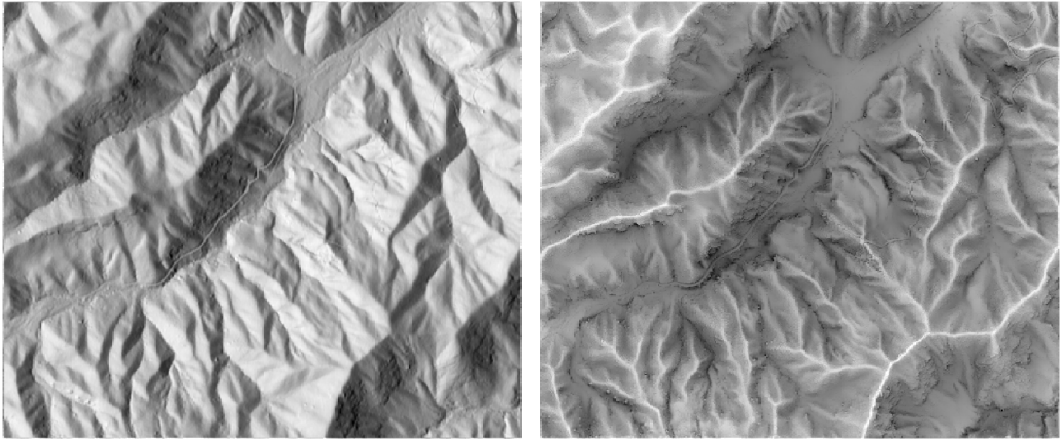
- *v.lidar.edgedetection*, *v.lidar.growing*, *v.lidar.correction*
  - uses returns
- *v.lidar.mcc*
  - multiscale curvature based classification algorithm[1]



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

Sky-view factor

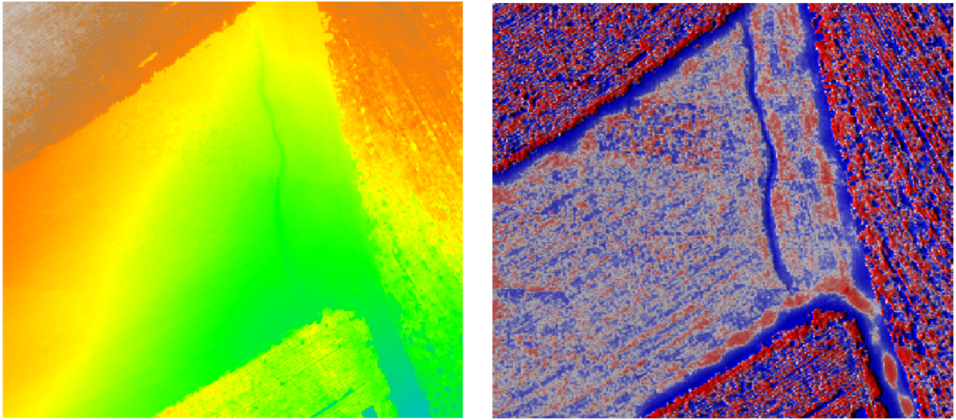
- *r.skyview* (percentage of visible sky)



comparison of shaded relief and sky-view factor

Local relief model (LRM)

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

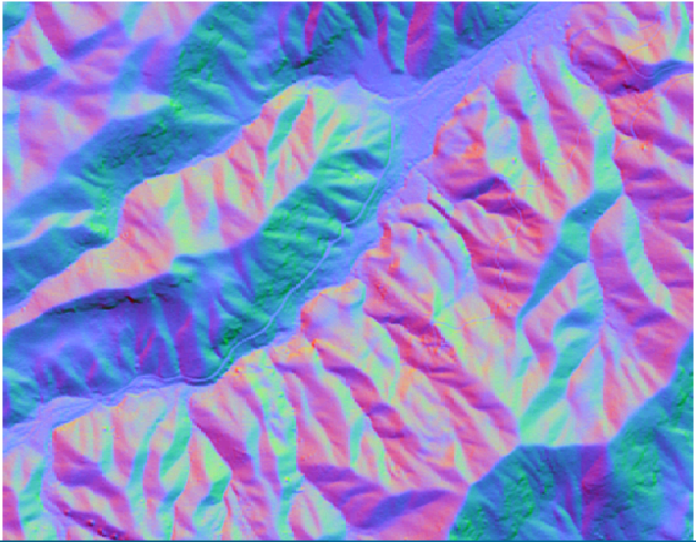


30-60cm wide, 30cm deep, 60m long gully (resolution 30cm)

Analytical shading

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

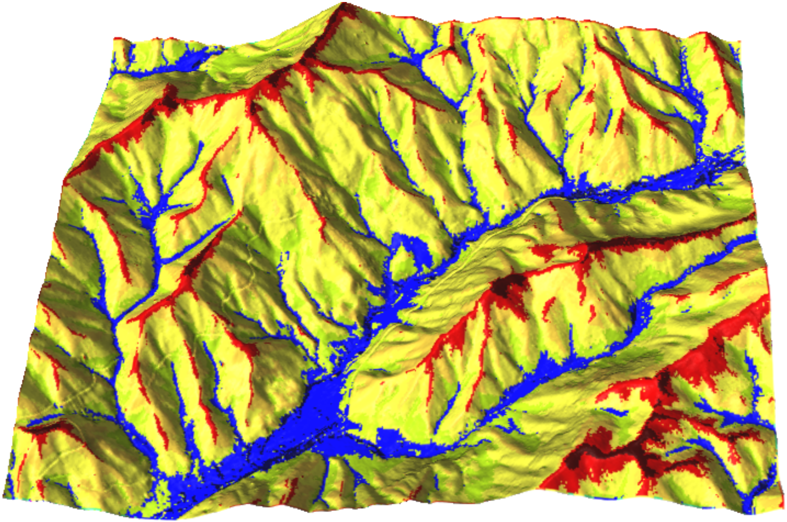
Devereux, B. J., Amable, G. S., & Crow, P. P. (2008). Visualisation of LiDAR terrain models for archaeological feature detection. Antiquity, 82(316), 470-479.



Landforms

- *r.geomorphon*
- geomorphons - a new approach to classification of landform[1]

[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

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

GRASS GIS

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*