

GRASS GIS loves lidar

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Vaclav Petras (Vashek)

Anna Petrasova, Helena Mitasova

Center for Geospatial Analytics

NC STATE UNIVERSITY

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available at

wenzeslaus.github.io/grass-lidar-talks

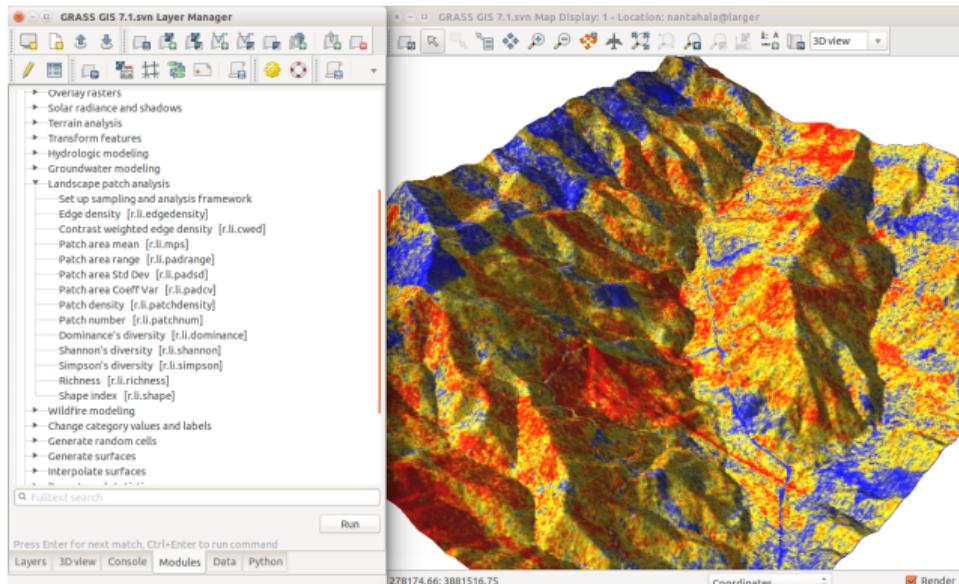
- ▶ longevity
 - ▶ learn now, use forever
 - ▶ over 30 years of development

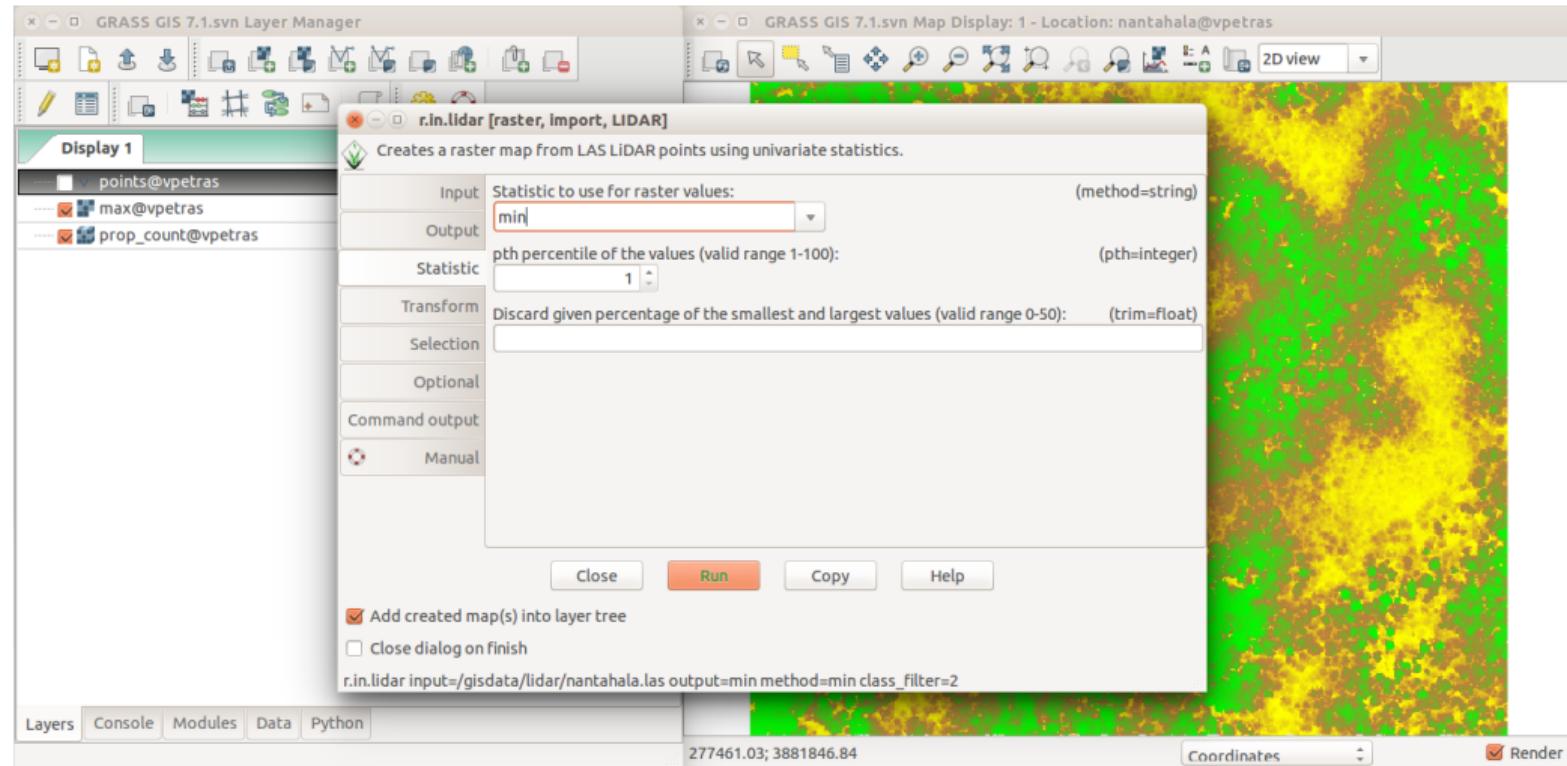


GRASS GIS

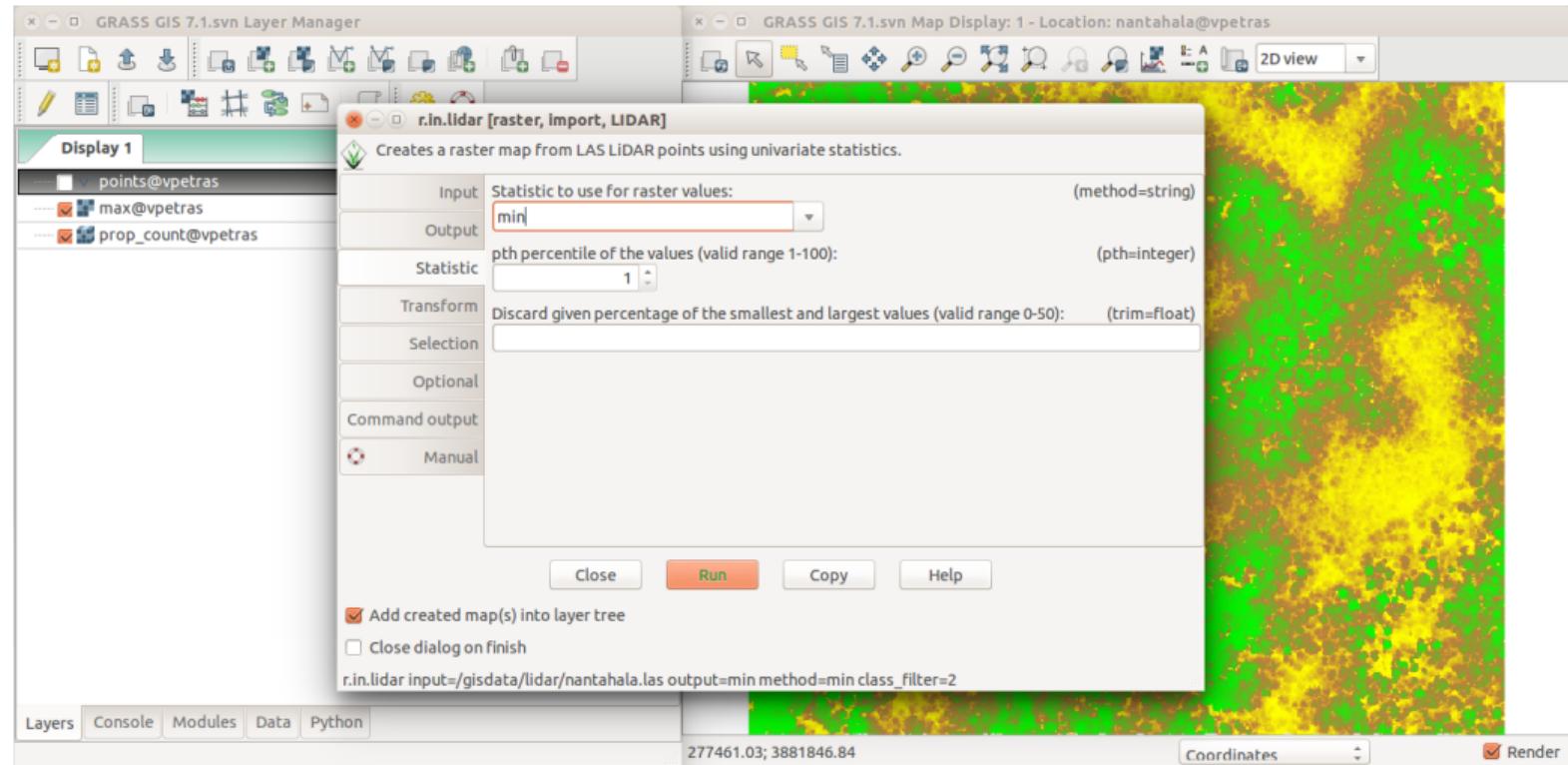
GRASS GIS

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





GUI



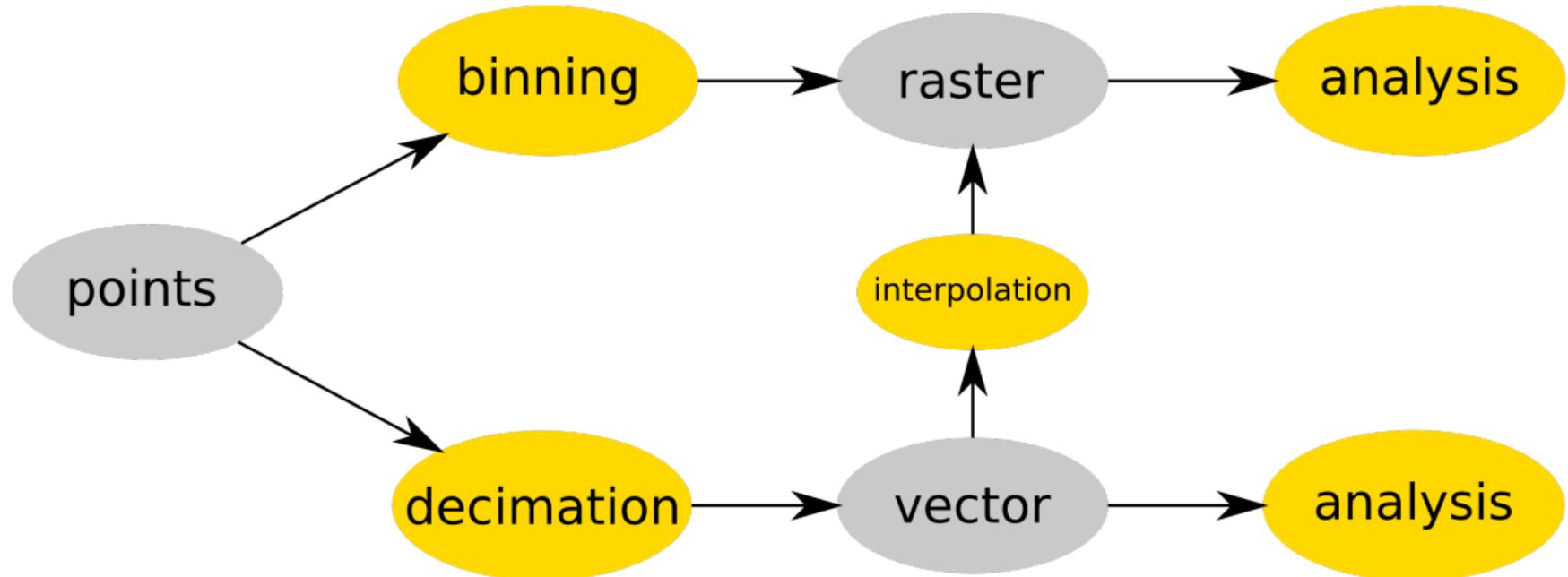
Points

- ▶ collected by lidar
- ▶ generated by Structure from Motion (SfM) from UAV imagery
- ▶ a lot of points



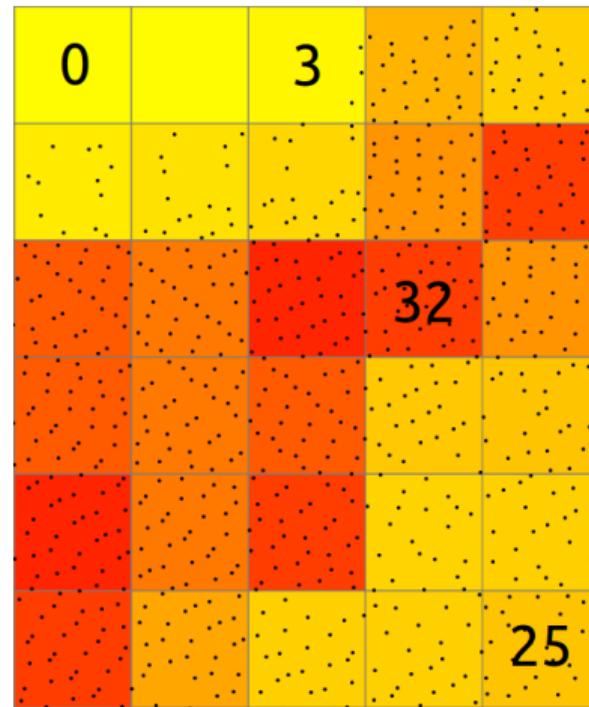
surface interpolated from points from SfM

Workflow overview



Binning as 2D histogram

- ▶ counts 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, ...



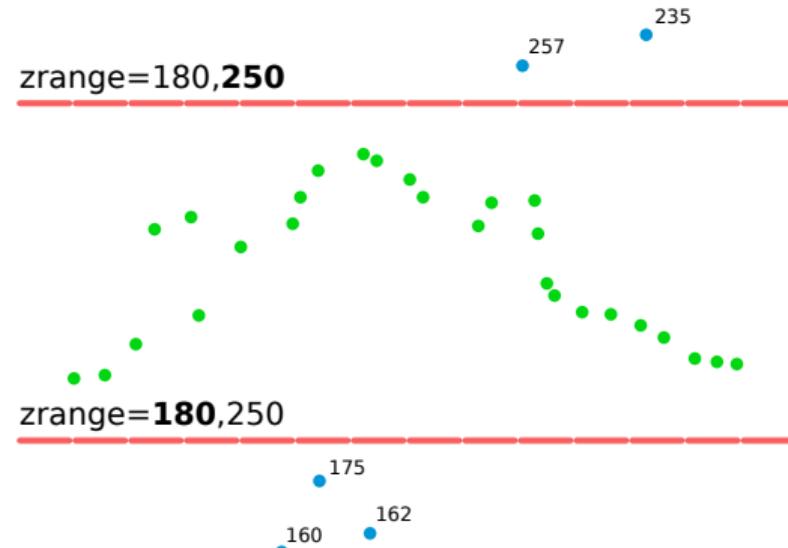
Practical functions

- ▶ analytical and practical functions in *r.in.lidar*
- ▶ read multiple tiles as one
 - ▶ no merging
 - ▶ 0.5 billion points in 90 files in minutes



Filtering points

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

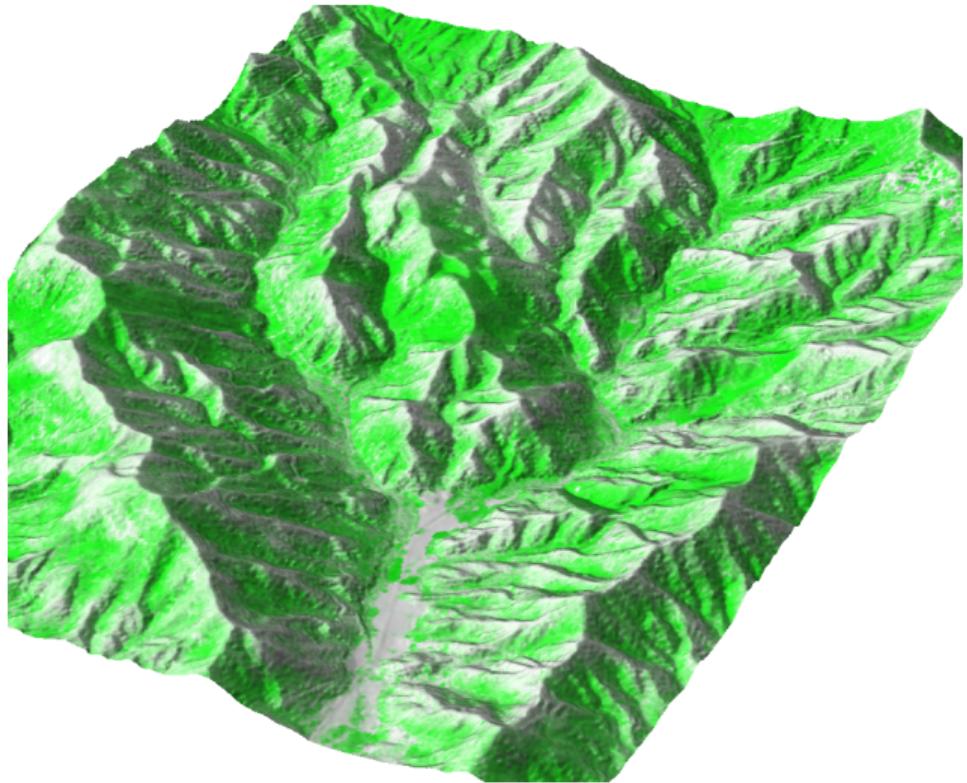


Height above a surface

- ▶ new base raster feature in
r.in.lidar
- ▶ given surface + points cloud
→ height of features

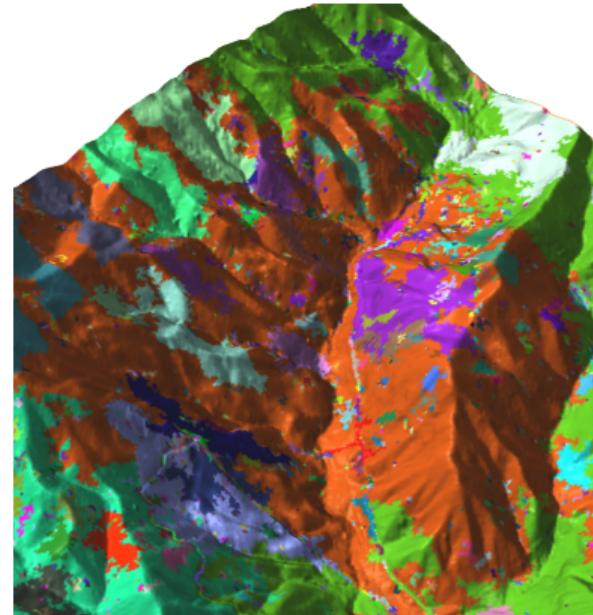


- ▶ not limited by memory



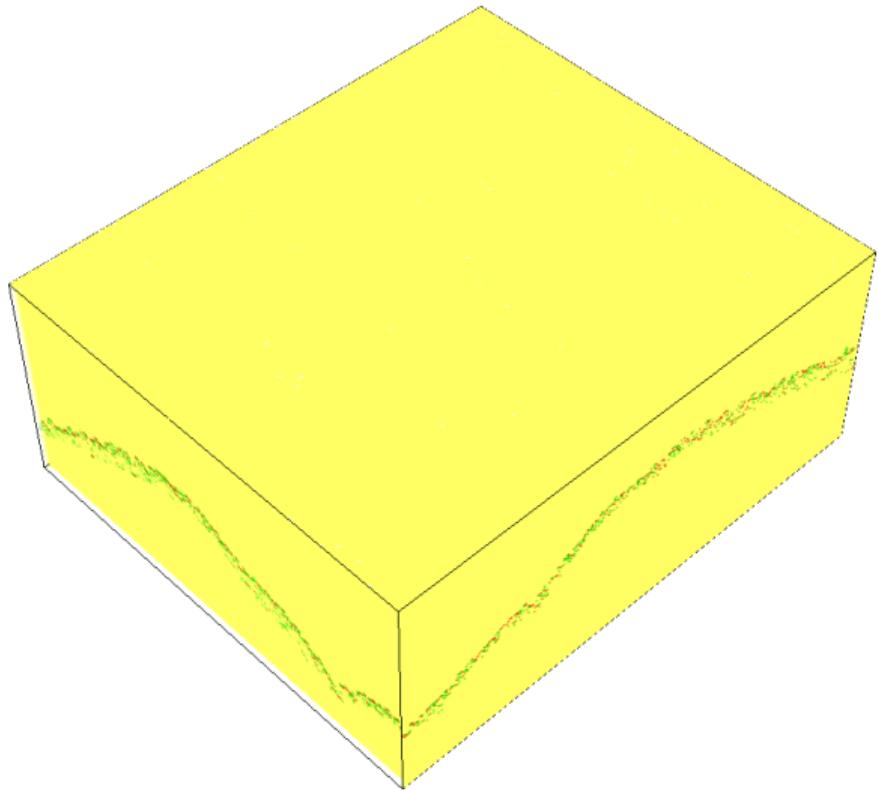
Rasterize early

- ▶ less cells than points
 - ▶ 578 mil points (ground 30 mil)
 - ▶ 15 mil cells in 8km × 7km at resolution 2m
 - ▶ faster to loop through
 - ▶ less disk space
- ▶ raster
 - ▶ natural spatial index
 - ▶ that's what the algorithms use



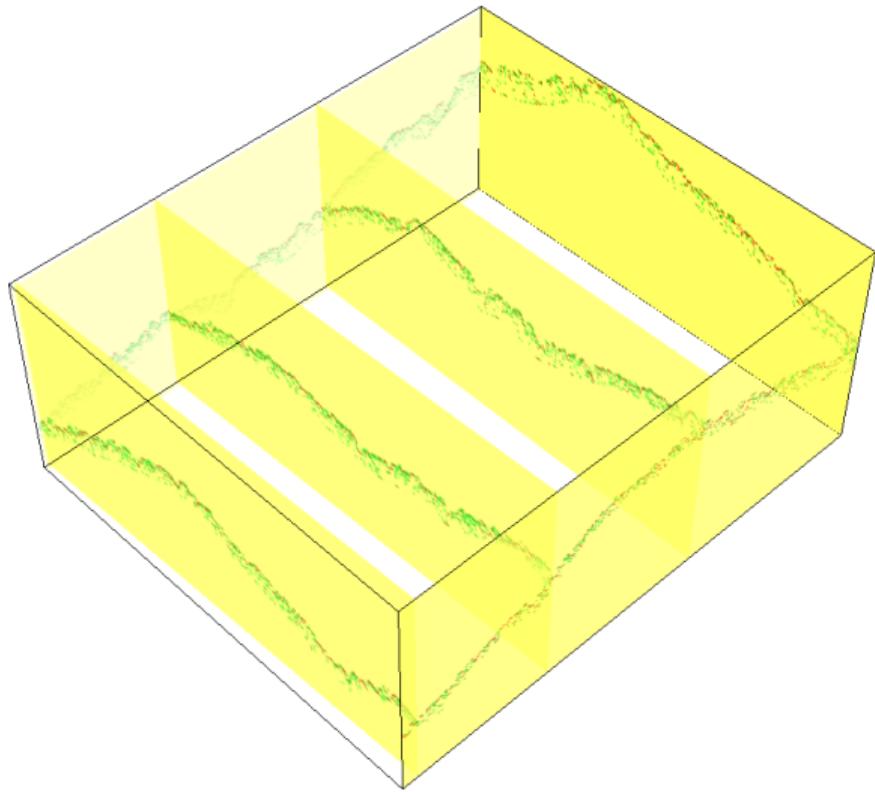
3D raster

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



3D raster

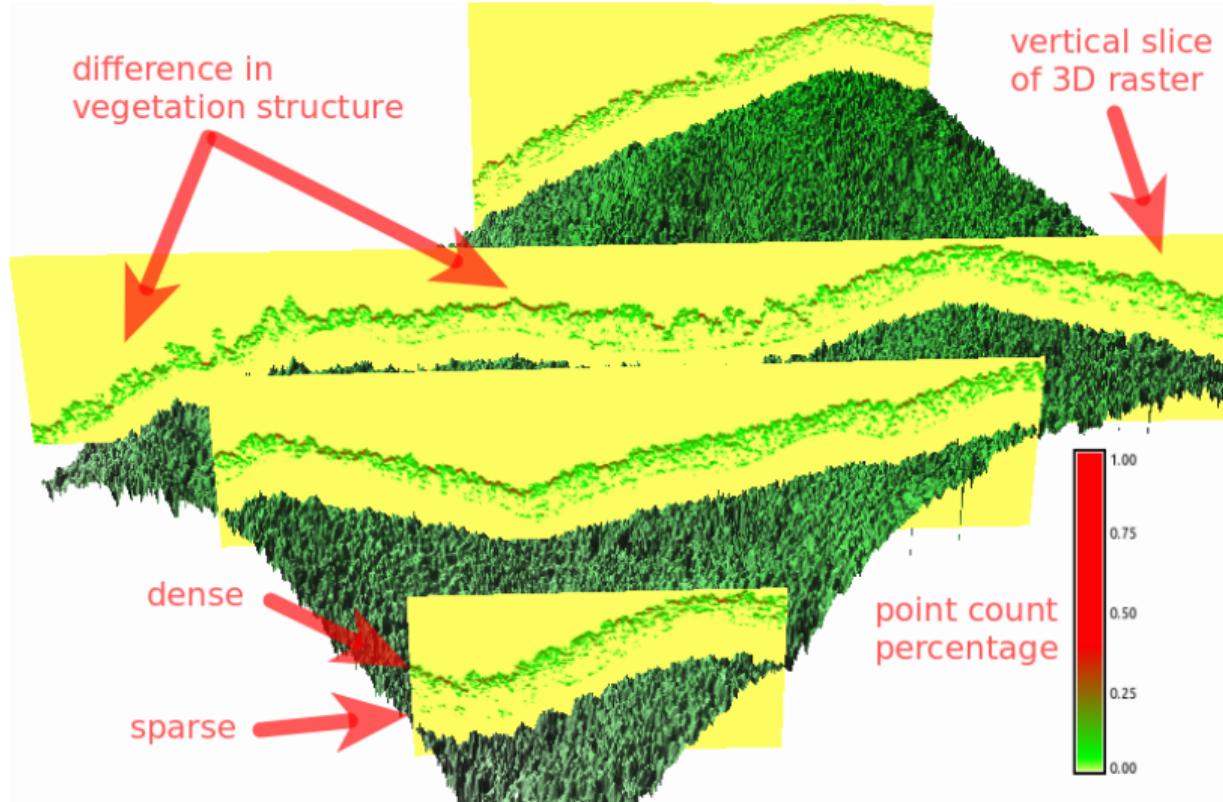
- ▶ stacked 2D rasters
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- ▶ same principles as in 2D
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Binning points to 3D raster

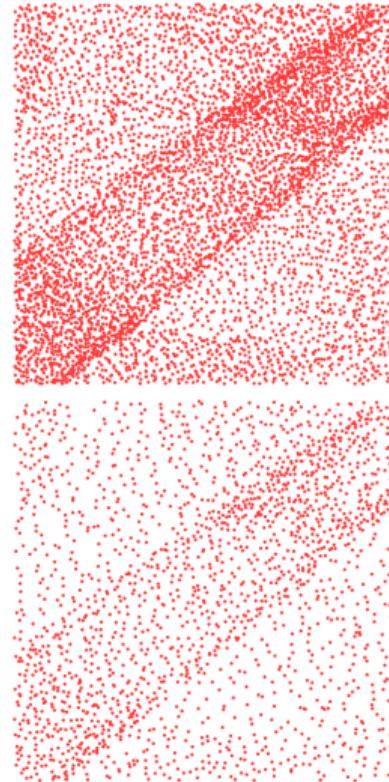
- ▶ *r3.in.lidar*
- ▶ proportional count
 - ▶ count per 3D cell relative to the count per vertical column
- ▶ intensity can be used instead of count

height reduction by base raster under development (analysis and space efficient)



Decimation

- ▶ *v.in.lidar*
 - ▶ filtering same as in *r.in.lidar*
- ▶ often more points than we need
(research shows, Singh et al. 2015, Petras et al. 2016)
- ▶ interpolation, clustering, ... are costly
- ▶ decimation \approx sampling
 - ▶ fast count-based as effective as more advanced decimation



Large point clouds

Rasters (binning of points)

- ▶ trade-off: memory (RAM) or slow
- ▶ 64bit version
 - ▶ your operating system may limit max memory

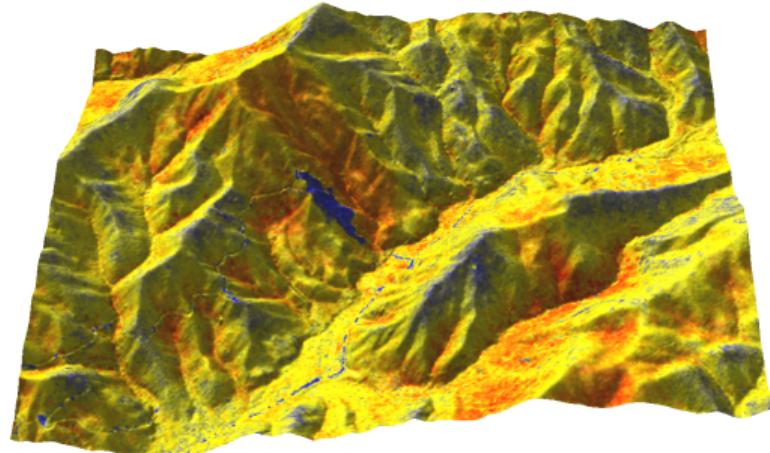
Brunswick county: binning, ≈ 1050 files,
 > 9 billion points

Hyde county: binning, ≈ 950 files, > 4 billion
points, base elevation 5ft raster, 60ft height
raster

$\approx 0.5\text{-}3$ hours, 1-13GB of memory (in-memory mode)

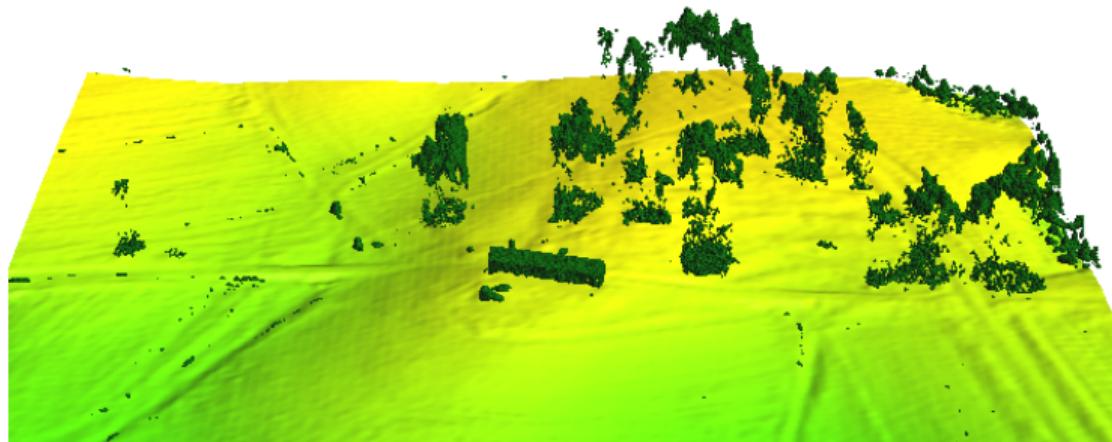
Vectors (points as points)

- ▶ 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

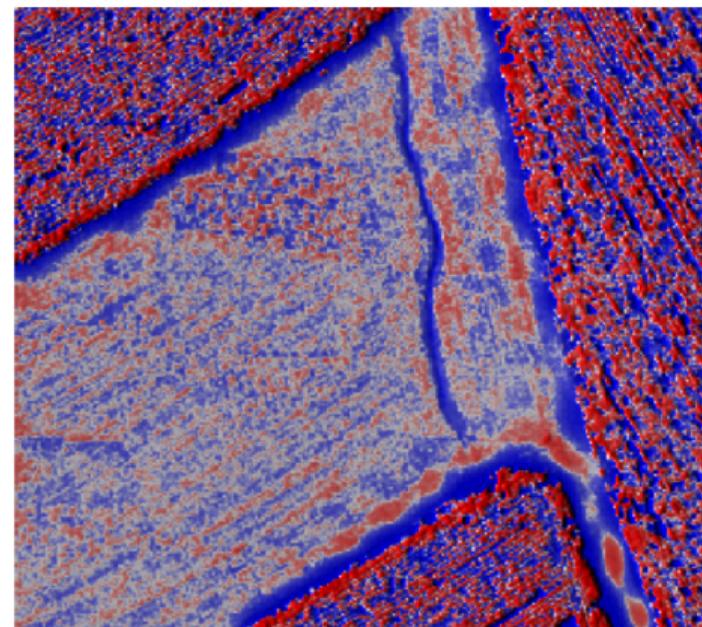
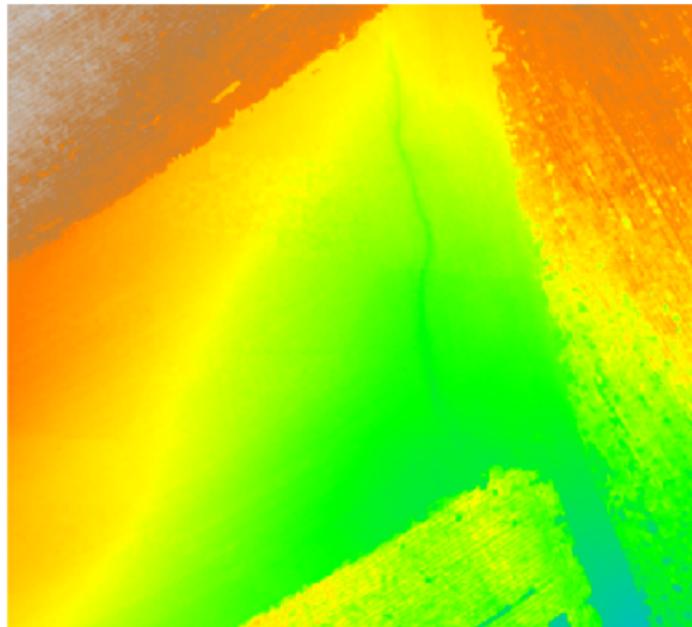
- ▶ *r.skyview* (percentage of visible sky)



comparison of shaded relief and sky-view factor

Local relief model (LRM)

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

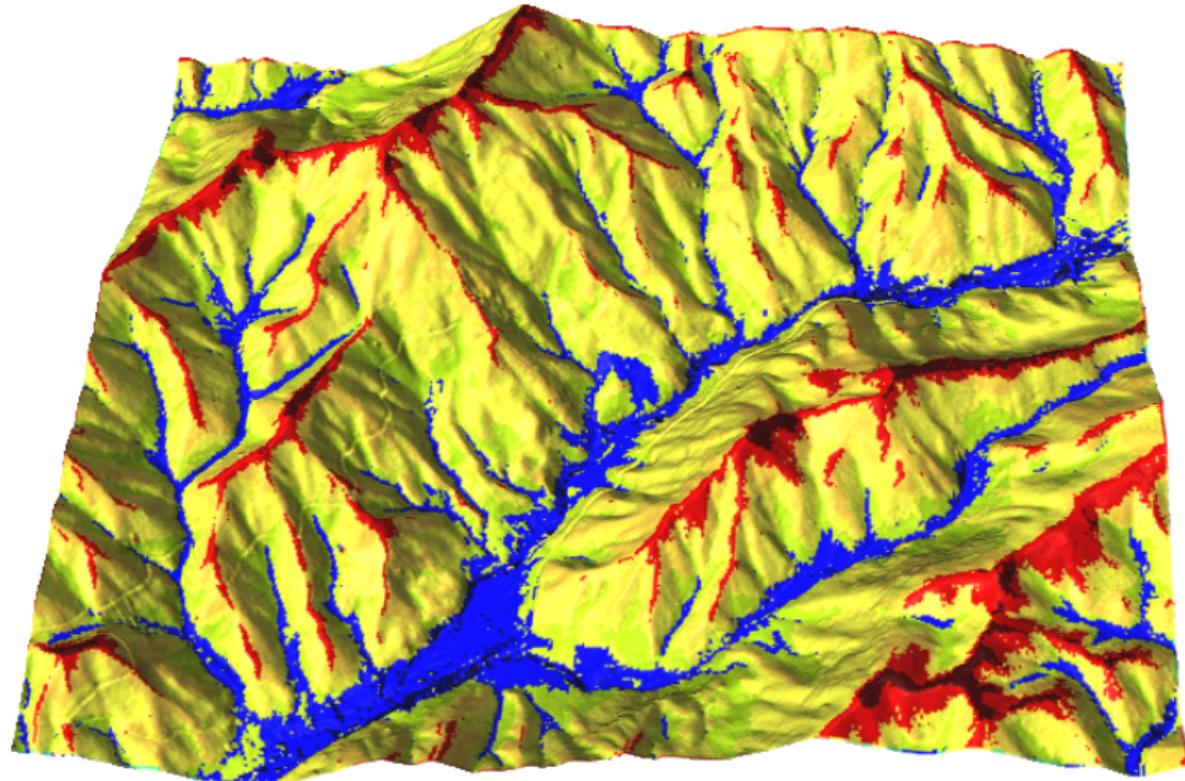


30-60cm wide, 30cm deep, 60m long gully (resolution 30cm)

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*



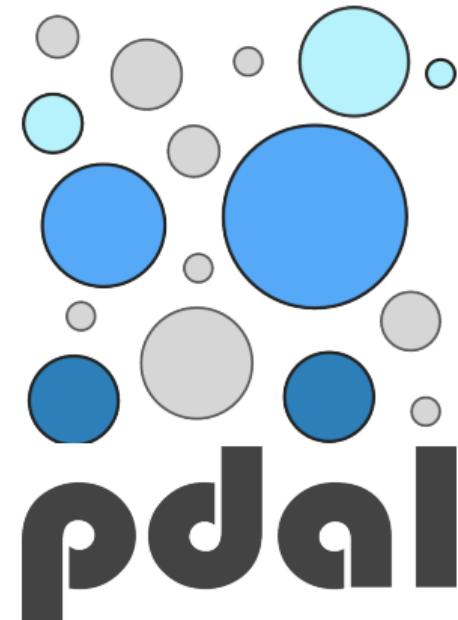
Integration with PDAL

PDAL

- ▶ Point Data Abstraction Library
- ▶ 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



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

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

GRASS user mailing list
lists.osgeo.org/listinfo/grass-user



Acknowledgements

Software

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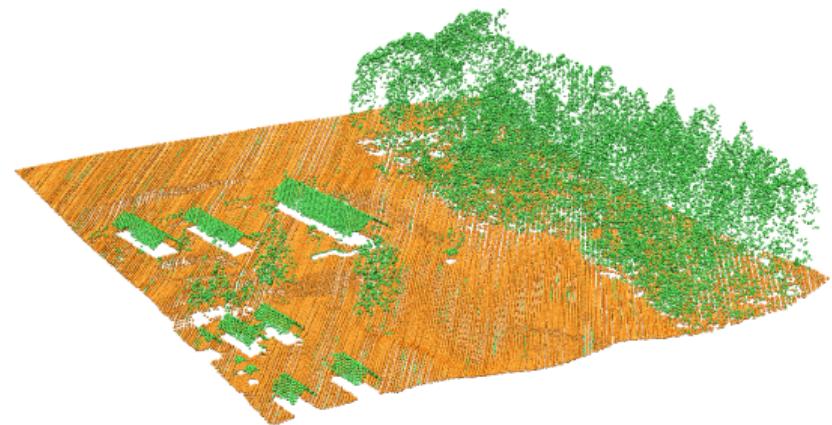
GRASS GIS

Acknowledgements

Datasets

Lidar and UAV Structure from Motion (SfM) data for
GIS595/MEA792: UAV/lidar Data Analytics course

Nantahala NF, NC: Forest Leaf Structure, Terrain and
Hydrophysiology. Obtained from OpenTopography.
<http://dx.doi.org/10.5069/G9HT2M76>



Acknowledgements

Presentation software

Slides were created in L^AT_EX using
the BEAMER *class*.