GRASS GIS loves lidar

FOSS4G NA 2016

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

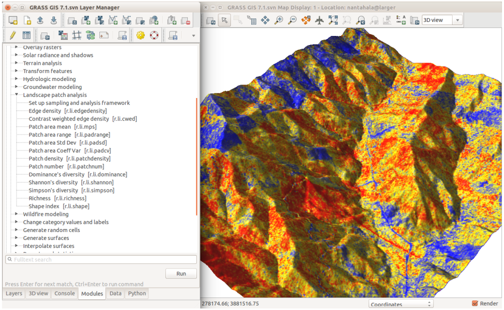
GRASS GIS

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

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

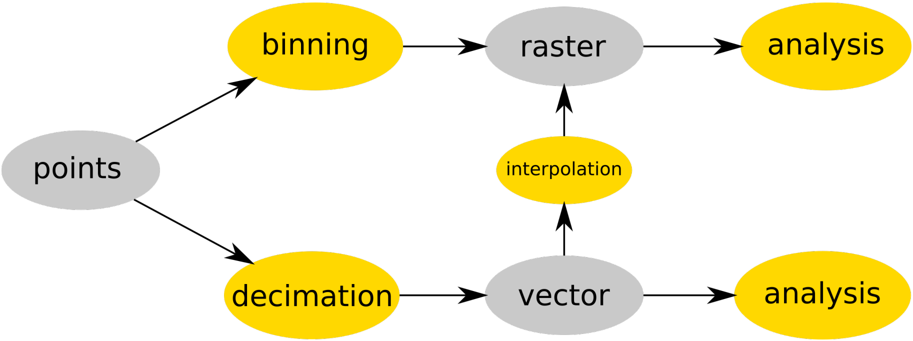


Points

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

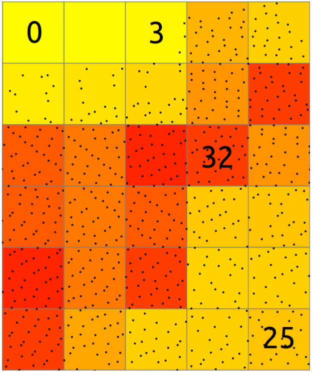
surface interpolated from points from SfM

Workflow overview



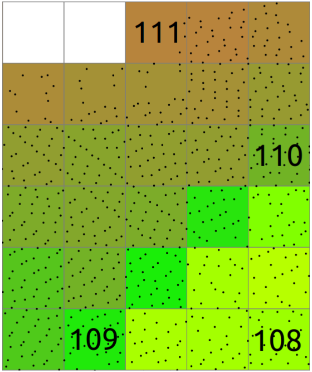
Binning as 2D histogram

- counts number of points in cell



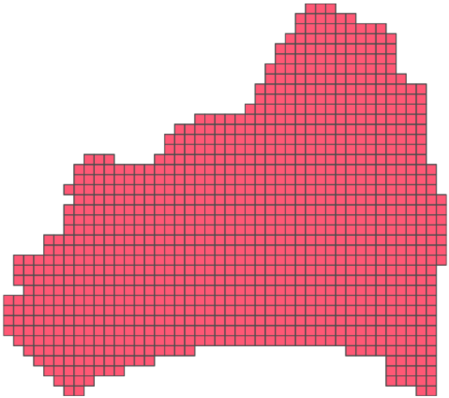
Binning points to raster

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



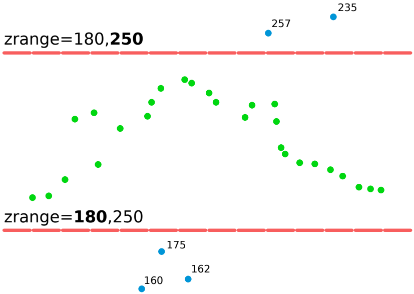
Practical functions

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



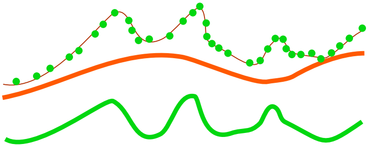
Filtering points

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

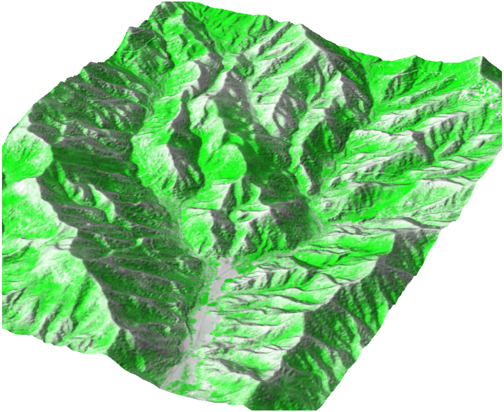


Height above a surface

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

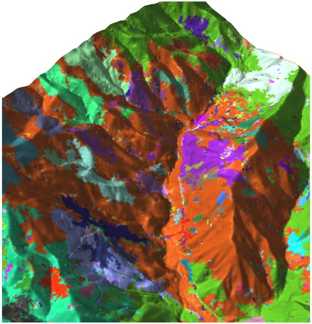


- not limited by memory



Rasterize early

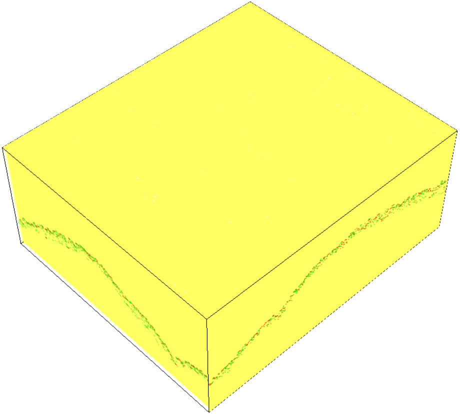
- less cells then points
  - 578 mil points (ground 30 mil)
  - 15 mil cells in 8km $\times$ 7km at resolution 2m
    - faster to loop through
    - less disk space
- raster
  - natural spatial index
  - that's what the algorithms use



i.segment on different point counts

3D raster

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



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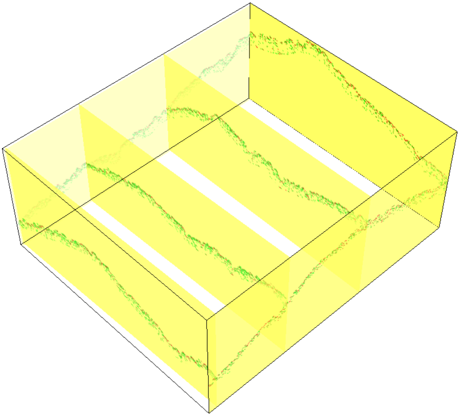
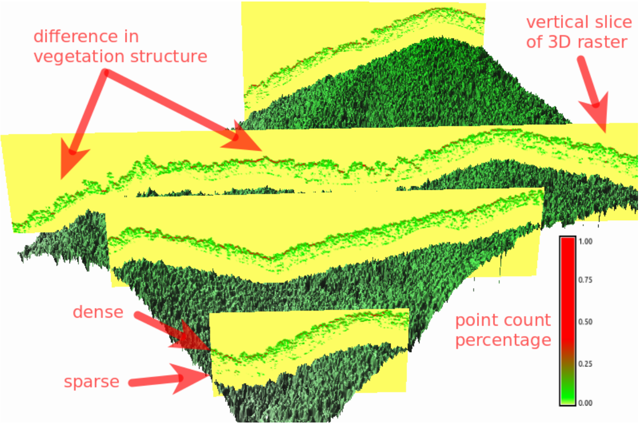


Binning points to 3D raster

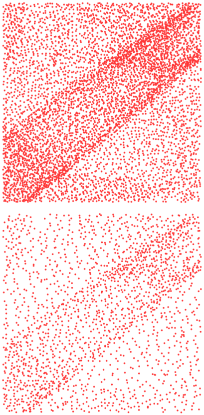
- *r3.in.lidar*
- proportional count
  - count per 3D cell relative to the count per vertical column
- intensity can be used instead of count



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 ≈ 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

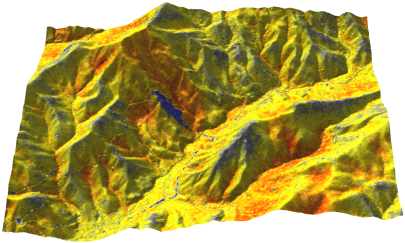
Brunswick county: binning, ≈1050 files, > 9 billion points
Hyde county: binning, ≈950 files, > 4 billion points, base elevation 5ft raster, 60ft height raster

≈0.5-3 hours, 1-13GB of memory

(in-memory mode)

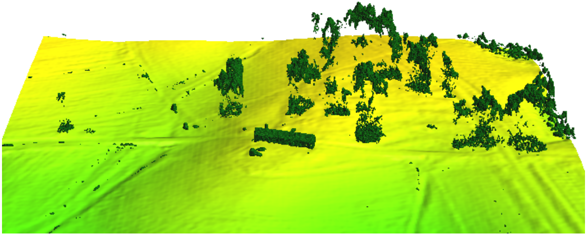
Vectors (points as points)

- point cloud specific optimizations
  - no IDs stored
  - no attribute table
  - no topology created



Ground detection

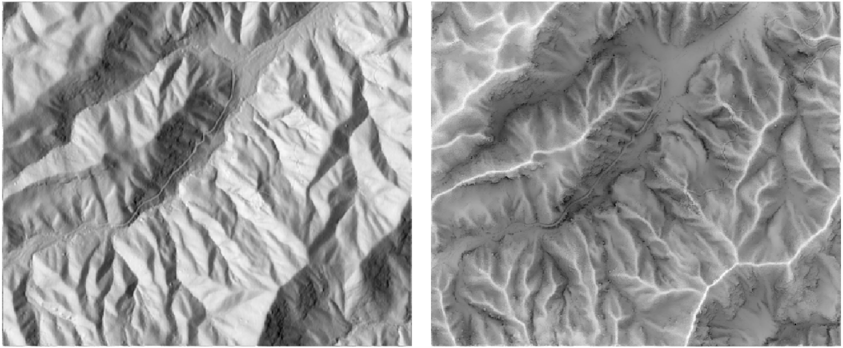
- *v.lidar.edgedetection*, *v.lidar.growing*, *v.lidar.correction*
  - uses returns
- *v.lidar.mcc*
  - multiscale curvature based classification algorithm[1]



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

Sky-view factor

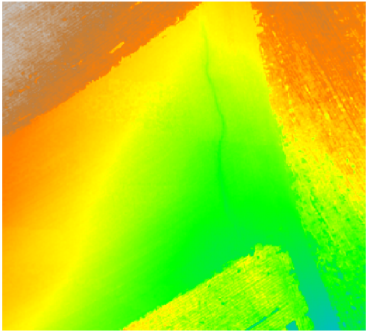
- *r.skyview* (percentage of visible sky)

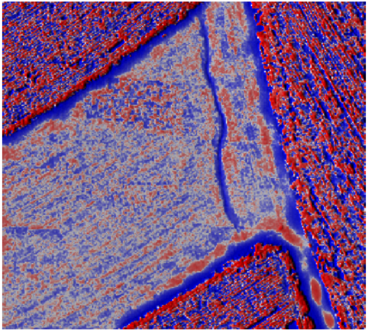


comparison of shaded relief and sky-view factor

Local relief model (LRM)

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

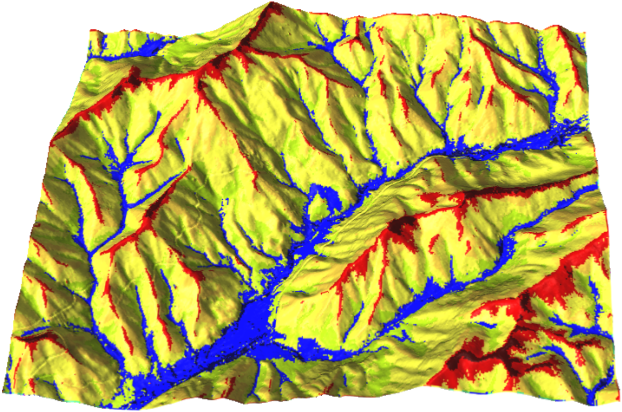




30-60cm wide, 30cm deep, 60m long gully (resolution 30cm)

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

- 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`

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

Acknowledgements

Software

Presented functionality is work done by Vaclav Petras, Markus Metz, and the GRASS development team.

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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`