GRASS GIS: A General-purpose Geospatial Research Tool

AGU 2018 Fall Meeting

NS52A: A Tour of Open-Source Software Packages for the Geosciences II

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Scientific Team: GRASS GIS Development Team**

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**Includes over 10 other members of the core team and numerous other contributors

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GRASS GIS

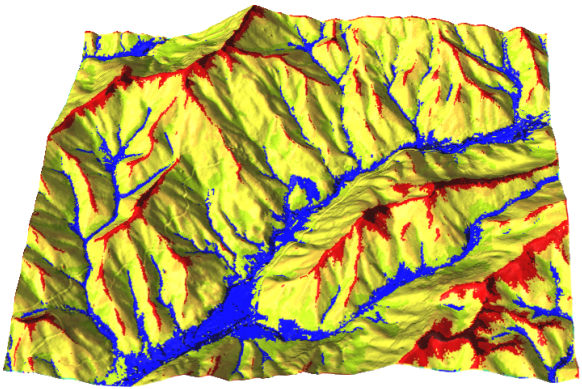
- all in one
  - hydrology, remote sensing, network analysis, …
- driven by needs of users
  - community has a direct access to the development process
- from small laptops to supercomputers
  - Raspberry Pi, Windows, macOS, GNU/Linux, FreeBSD, AIX, …
- learn now, use forever
  - 35 years of development, many old scripts still running, …

GRASS GIS

latest release 7.4.3 (Nov 26, 2018)

Novel methods are published through GRASS GIS

- temporal framework (Gebbert & Pebesma 2014)
- spatio-temporal algebra (Gebbert & Leppelt 2015)
- landform detection with geomorphons (Jasiewicz & Stepinski 2013)

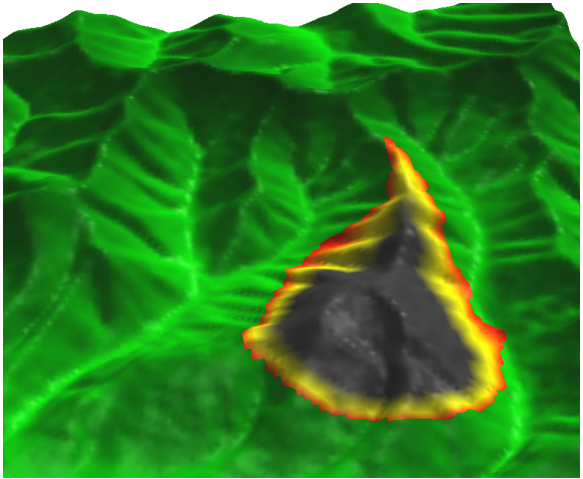


Landforms detected by *r.geomorphon*

Gebbert, S. and Leppelt, T. (2015). GRASS GIS: The first Open Source Temporal GIS. In EGU General Assembly Conference Abstracts, volume 17, page 7296.
Gebbert, S. and Pebesma, E. (2014). A temporal GIS for field based environmental modeling. Environmental Modelling & Software, 53:1–12.
Jasiewicz, J. and Stepinski, T. (2013). Geomorphons - a pattern recognition approach to classification and mapping of landforms, Geomorphology, vol. 182, 147-156. DOI 10.1016/j.geomorph.2012.11.005

Research software is preserved over time

- water flow simulation (Mitasova et al. 2004)
- least cost path watershed and flow tracing (Ehlschlaeger 1989)
- wildfire spread model (Xu 1994)



Wildfire spread simulated by *r.ros* and *r.spread*

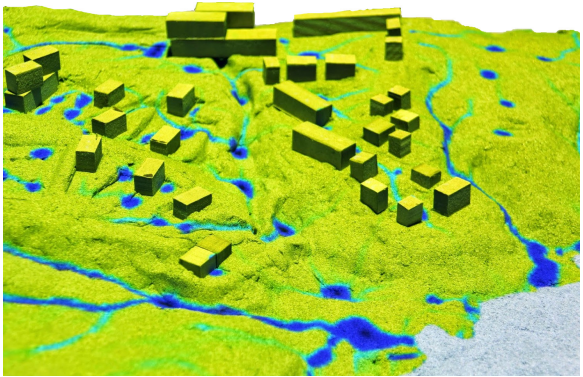
Mitasova, H., Thaxton, C., Hofierka, J., McLaughlin, R., Moore, A., Mitas L. (2004). Path sampling method for modeling overland water flow, sediment transport and short term terrain evolution in Open Source GIS. In: C.T. Miller, M.W. Farthing, V.G. Gray, G.F. Pinder eds., Proceedings of the XVth International Conference on Computational Methods in Water Resources (CMWR XV), June 13-17 2004, Chapel Hill, NC, USA, Elsevier, pp. 1479-1490.

Ehlschlaeger C. (1989). Using the A^T Search Algorithm to Develop Hydrologic Models from Digital Elevation Data, Proceedings of International Geographic Information Systems (IGIS) Symposium '89, pp 275-281 (Baltimore, MD, 18-19 March 1989).

Xu, J. (1994). Simulating the spread of wildfires using a geographic information system and remote sensing. PhD thesis, Rutgers University, New Brunswick, New Jersey.

Published tools are used by other scientists

- water flow simulation (Mitasova et al. 2004) used for emergency routing (Raghavan et al. 2014)
- wildfire spread model (Xu 1994) used for fires in Europe (Rodriguez-Aseretto et al. 2013)



Overland water flow simulated by *r.sim.water* in *Tangible Landscape* environment

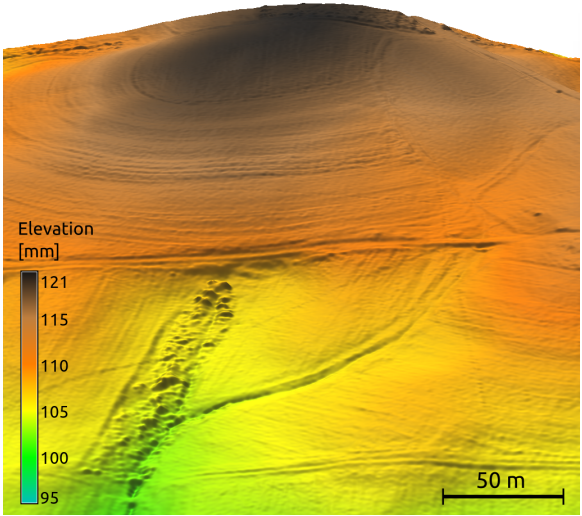
Mitasova, H., Thaxton, C., Hofierka, J., McLaughlin, R., Moore, A., Mitas L. (2004). Path sampling method for modeling overland water flow, sediment transport and short term terrain evolution in Open Source GIS. In: C.T. Miller, M.W. Farthing, V.G. Gray, G.F. Pinder eds., Proceedings of the XVth International Conference on Computational Methods in Water Resources (CMWR XV), June 13-17 2004, Chapel Hill, NC, USA, Elsevier, pp. 1479-1490.

Raghavan, V., Choosumrong, S., Yoshida, D., and Vinayaraj, P. (2014). Deploying Dynamic Routing Service for Emergency Scenarios using pgRouting, GRASS and ZOO. In In Proceedings of FOSS4G Europe, Jacobs University, Bremen, Germany.

D. Rodriguez-Aseretto, D. de Rigo, M. Di Leo, A. Cortés, and J. San-Miguel-Ayanz (2013). A data-driven model for large wildfire behaviour prediction in Europe. Procedia Computer Science, 18:1861–1870.

Code is further developed by other contributors

- least cost path flow tracing (Ehlschlaeger 1989) extended by Markus Metz
- interpolation using splines (Mitasova & Mitas 1993) was parallelized (Hofierka et al. 2017)

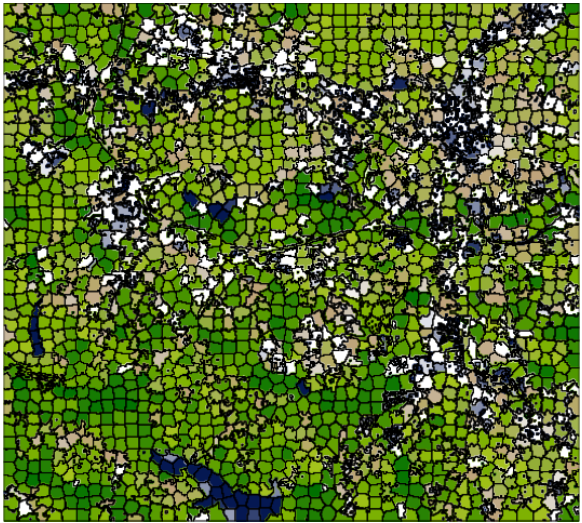


Digital elevation model interpolated by *v.surf.rst*

Ehlschlaeger C. (1989). Using the A^T Search Algorithm to Develop Hydrologic Models from Digital Elevation Data, Proceedings of International Geographic Information Systems (IGIS) Symposium '89, pp 275-281 (Baltimore, MD, 18-19 March 1989).
Mitasova, H. and Mitas, L. (1993) Interpolation by Regularized Spline with Tension: I. Theory and Implementation, Mathematical Geology, 25, 641-655.
Hofierka, J., Lacko, M., and Zubal, S. (2017). Parallelization of interpolation, solar radiation and water flow simulation modules in GRASS GIS using OpenMP. Computers & Geosciences, 107, 20-27.

Algorithms published elsewhere are available

- Multiscale Curvature Classification (Evans & Hudak 2007) implemented by Stefan Blumentrath
- SLIC Superpixels segmentation (Achanta et al. 2012) implemented by Rashad Kanavath and Markus Metz



Superpixels by *i.superpixels.slic* and NDVI by *i.vi*

Evans, J. S. and Hudak, A. T. (2007) A Multiscale Curvature Algorithm for Classifying Discrete Return LiDAR in Forested Environments. IEEE Transactions on Geoscience and Remote Sensing 45(4): 1029 - 1038

Achanta, R., Shaji, A., Smith, K., Lucchi, A., Fua, P., and Süsstrunk, S. (2012). SLIC superpixels compared to state-of-the-art superpixel methods. IEEE transactions on pattern analysis and machine intelligence, 34(11):2274–2282.

Publishing code through GRASS GIS

- Ask for access to GRASS GIS Addons at
  `grass.osgeo.org/development/code-submission`
- Example GRASS GIS module
  `gitlab.com/vpetras/r.example.plus`

Get GRASS GIS at
`grass.osgeo.org`

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

Source files for posters and slides available at
`trac.osgeo.org/grass/browser/grass-promo`

Acknowledgements

Software & community

The GRASS GIS Development Team, contributors, users, ...

Datasets

Nantahala NF, NC: Forest Leaf Structure, Terrain and Hydrophysiology. Obtained from OpenTopography.
`https://doi.org/10.5069/G9HT2M76`
Dataset for North Carolina State University GIS595-005/603; MEA592-004/601: UAS Mapping for 3D Modeling
North Carolina Sample Dataset for GRASS GIS

Presentation software

Slides were created in LaTeX using the BEAMER *class*.