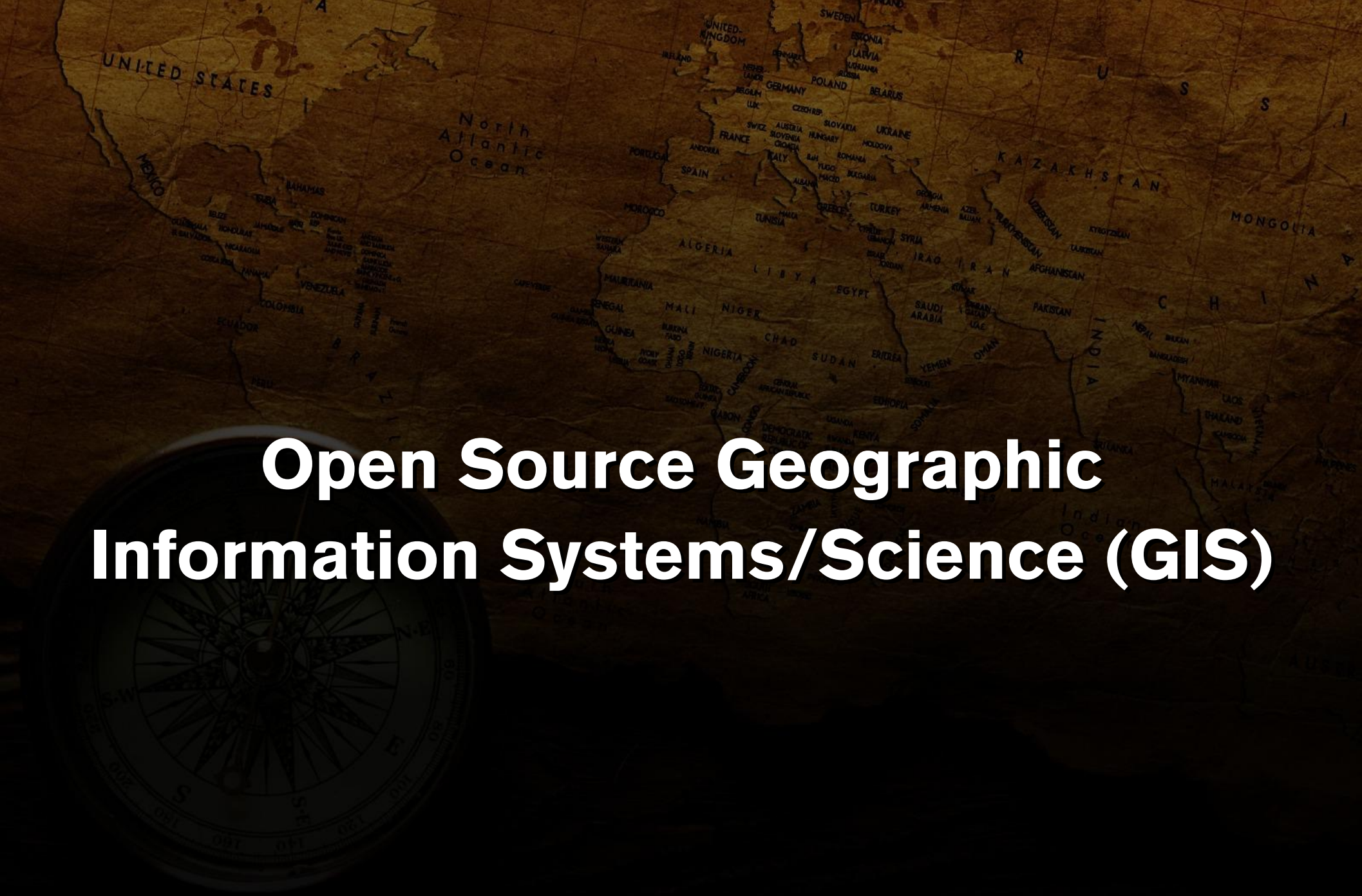


Open Source Geographic Information Systems/Science (GIS)

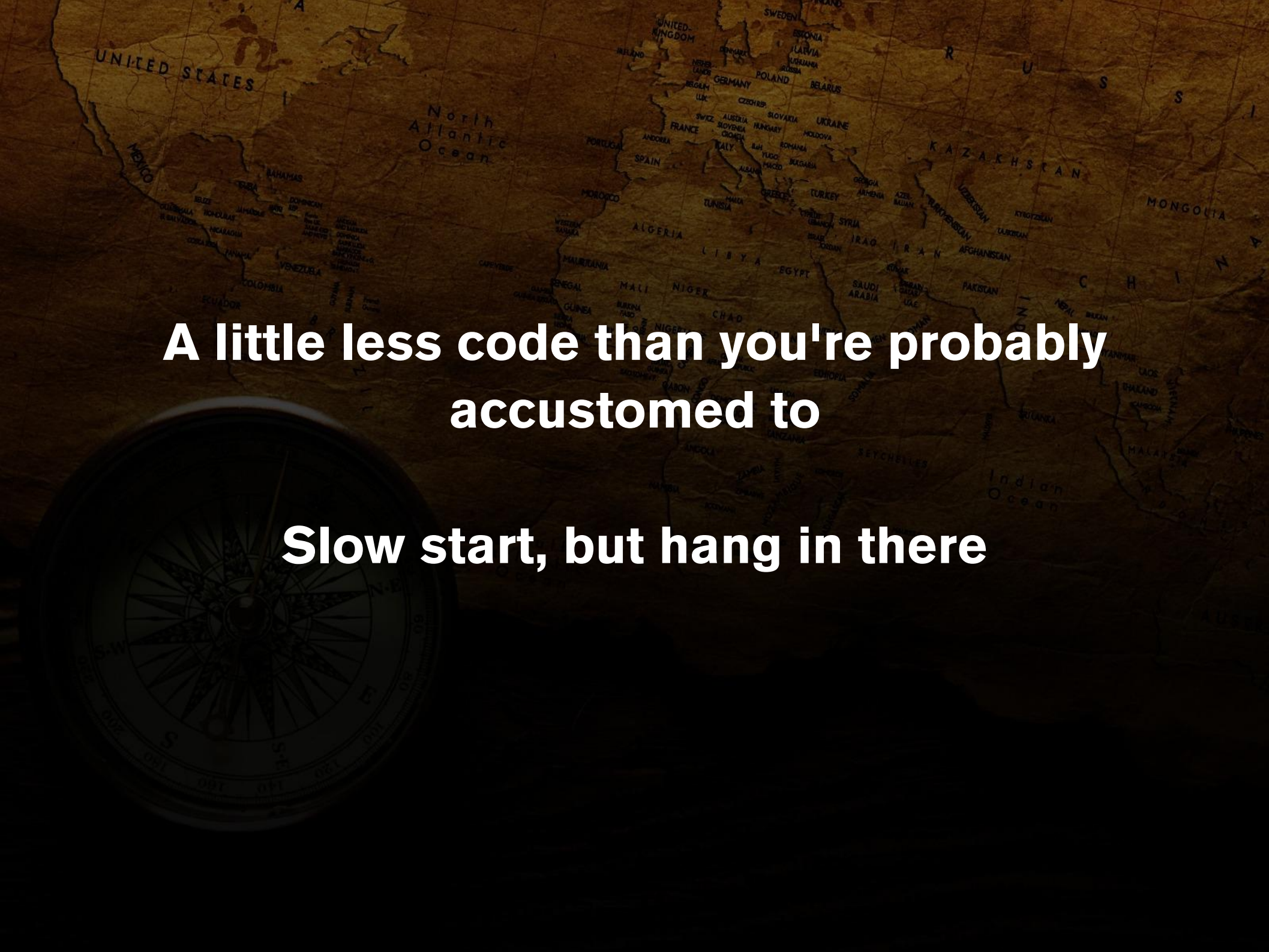
Outline

1) Presenter background
2) Introduction to GIS
3) Proprietary powerhouse: ESRI
4) Open source alternatives
5) Spatial databases
6) LiDAR Project

1. Presenter background

1. Presenter background

- University of Kentucky (1 year - CS/E)
- Northern Kentucky University (4 years - Geology, GIS & CS)
- Employed as a GIS programmer and analyst for CostQuest Associates in Cincinnati, OH
- Projects include
  - Failure envelope approximations (MATLAB)
  - Use of LiDAR-derived DEM's to delineate landslides


A little less code than you're probably accustomed to
Slow start, but hang in there

2. Introduction to GIS

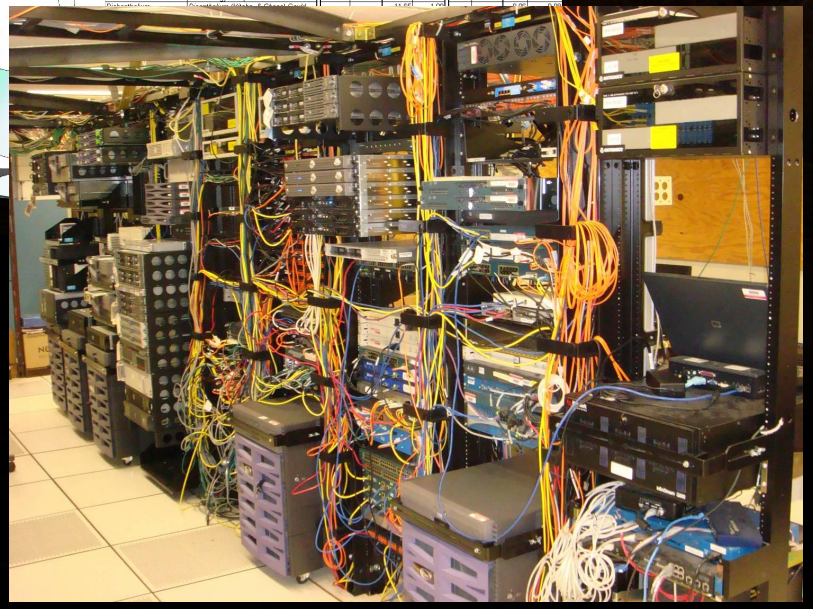
2. Introduction to GIS

- What is GIS?
  - Geographic Information System vs Geographic Information Science
  - A computer system for capturing, storing, querying, analyzing, and displaying geospatial data

2. Introduction to GIS

- Components of a GIS
  - Computer system
  - Software
  - People
  - Data
  - Infrastructure

		Vickers 1987		Yates 1994		Vickers 1987		Yates 1994	
		Frequency		Frequency		Cover		Cover	
Common Name	Genus/Species	Percent	Relative	Percent	Relative	Mean	Relative	Mean	Relative
Switch Grass	*Panicum virgatum L.* *	52.38	11.93	100.00	9.32	2.71	28.97	36.86	40.14
Side Oats Grama	*Bouteloua curtipendula (Michx.) Torr.* *	65.48	14.91	90.29	8.42	4.34	46.97	15.35	20.49
Big Blue Stem	*Andropogon gerardi Vitman* *	1.19	0.27	96.15	8.97	0.05	0.54	11.13	14.85
Canada Goldenrod	*Solidago canadensis L.*			97.09	9.05			6.47	8.63
Little Blue Stem	*Andropogon scoparius Michx.* *	5.36	1.22	75.73	7.06	0.15	1.64	2.24	2.99
Indian Grass	*Sorghastrum nutans (L.) Nash* *	5.36	1.22	73.79	6.88	0.38	3.97	2.24	2.99
Daisy Fleabane	*Erigeron strigosus Muhl. ex Willd.*			82.52	7.69			1.14	1.52
Hairy Aster	*Aster pilosus Willd.*			27.18	2.53			0.66	0.88
Kentucky Blue Grass	*Poa pratensis L.*			26.21	2.44			0.65	0.87
Western Wheat Grass	*Agropyron smithii Rydb.* *	10.12	2.30	68.93	6.43	0.18	1.86	0.59	0.79
Rough Dropseed	*Sporobolus asper (Michx.) Kunth*			21.36	1.99			0.41	0.55
Cottonwood	*Populus deltoides Marsh.*	1.19	0.27	4.85	0.45	0.01	0.06	0.40	0.53
Shining Sumac	*Rhus copallina L.*			1.94	0.18			0.36	0.48
Sweet Clover	*Melilotus P. Mill.*			11.65	1.09			0.33	0.44
Meadow Fescue	*Festuca pratensis Huds.*			9.71	0.91			0.24	0.32
Wedgegrass	*Sphenopholis obtusa (Michx.) Scribn.*			21.36	1.99			0.24	0.32
Maximilian Sunflower	*Helianthus maximiliani Schrad.*			32.04	2.99			0.23	0.30
Eastern Gammagrass	*Tripsacum dactyloides (L.) L.*			5.83	0.54			0.19	0.26
Prairie Lespedeza	*Lespedeza violacea (L.) Pers.*			1.94	0.18			0.19	0.25
Spring Avens	*Geum vernum (Raf.) T. & G.*			26.45	1.72			0.18	0.24
Churchmouse Three-Awn	*Aristida dichotoma Michx.*			1.94	0.18			0.16	0.21
Buffalo Grass	*Buchloe dactyloides (Nutt.) Engelm.* *			7.77	0.72			0.16	0.21
Smooth Sumac	*Rhus glabra L.*			3.88	0.36			0.09	0.12
Sedge	*Carex L. #1*			13.59	1.27			0.09	0.12
Rough-leaved Dogwood	*Cornus drummondii C. A. Mey.*			7.77	0.72			0.09	0.12
White Snakeroot	*Eupatorium rugosum Houtt.*			7.77	0.72			0.09	0.12
Large-flowered Gaura	*Gaura longiflora Spach*			13.59	1.27			0.09	0.12
Sedge	*Carex L. #2*			2.91	0.27			0.09	0.12
Common Witchgrass	*Panicum capillare L.*			6.74	0.63			0.09	0.12
Greyhead Prairie Coneflow	*Ratibida pinnata (Vent.) Barnh.*			7.77	0.72			0.07	0.10
Viscid Euthamia	*Euthamia gymnospermoides Greene*			6.80	0.63			0.06	0.08



2. Introduction to GIS

- Primary functions
  - Input and update spatial information
  - Convert data
  - Store and manage information
  - Manipulate data
  - Present and analyze data

2. Introduction to GIS

- Key components of a GIS
  - Input and output tools
  - DBMS (database management system)
  - Support for queries, analyses, and visualization of geospatial data
  - Graphical User Interface (GUI)

2. Introduction to GIS

- The origins of GIS
  - Has roots in land use management
  - Different sources make different claims on the “first” true GIS
    - Depends on how you define a GIS
    - Surely, there were multiple GIS in the late 60's and into the 70's
    - Modern GIS and theory emerged in the early 80's
  - GIS is now an integral part of many modern technologies such as GPS navigation

2. Introduction to GIS

- Why is GIS important?
  - Relating information geographically is increasingly important
  - The amount of data being collected now exceeds current processing rates
    - There's a lot of data out there!
  - Almost all phenomenon can be examined spatially
    - Many industries are discovering new uses for spatial analysis

3. Proprietary powerhouse: ESRI

3. Proprietary powerhouse: ESRI

- It is estimated that 70% of all GIS users utilize ArcGIS
- Highly expensive
  - Many functions are only available in separate toolboxes
- Closed source
- http://www.esri.com/

3. Proprietary powerhouse: ESRI

- The use of ESRI products are prolific

Academia

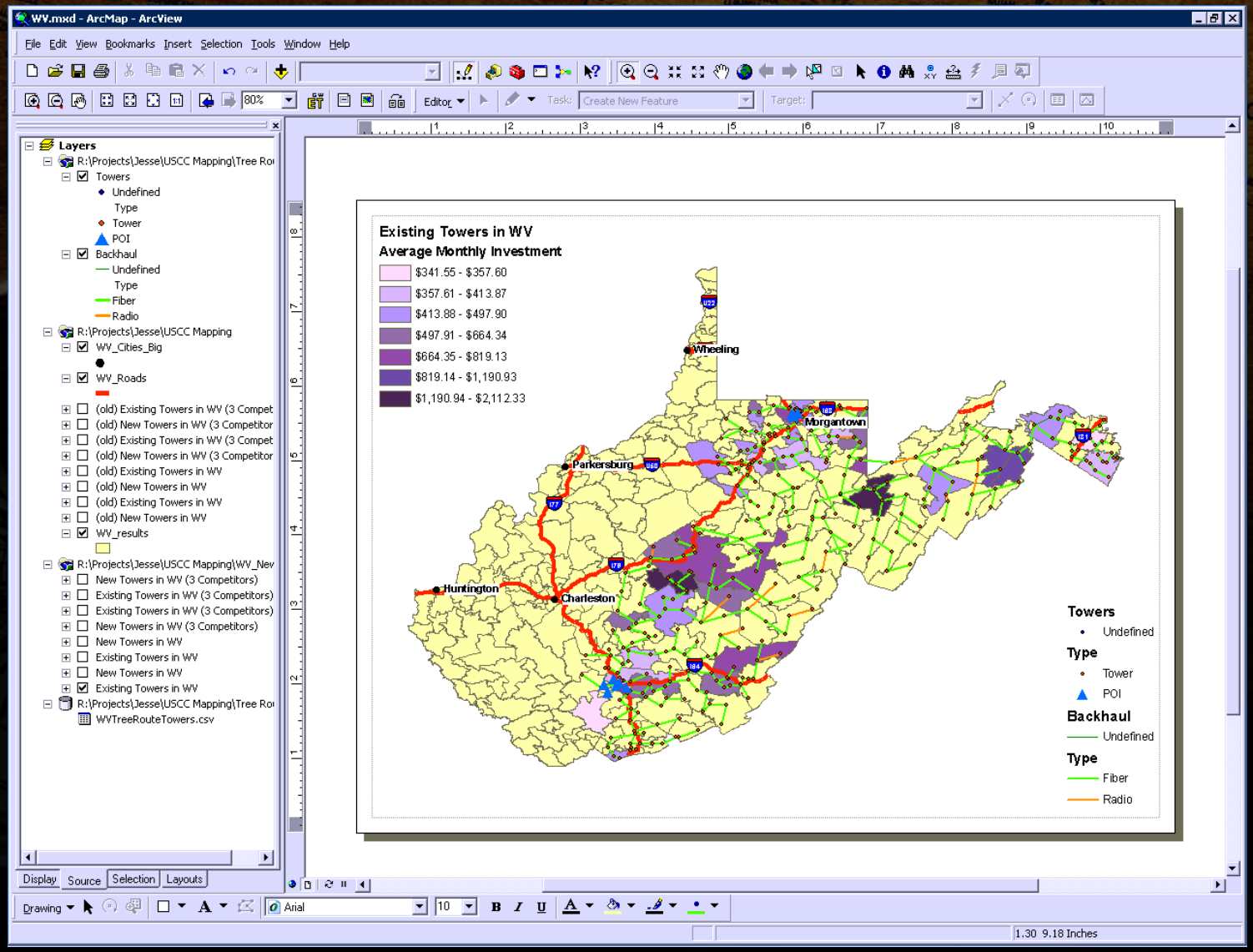
Government

Business

3. Proprietary powerhouse: ESRI

- Provided datasets by public institutions are often distributed in ESRI's native file formats rather than an open format
  - Think of it like Microsoft Office
- ESRI's ArcGIS suite does have some of the most wide-reaching file format support along with more projections than most systems
  - This is a highly important aspect for the end user

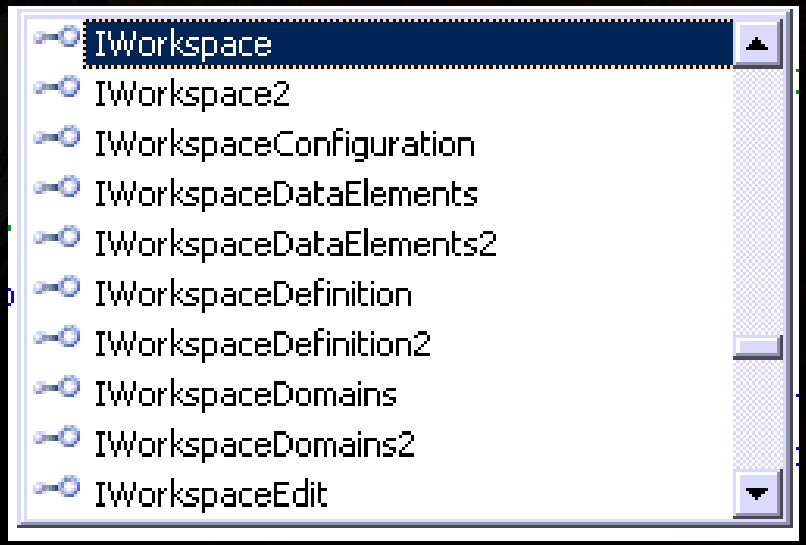
3. Proprietary powerhouse: ESRI

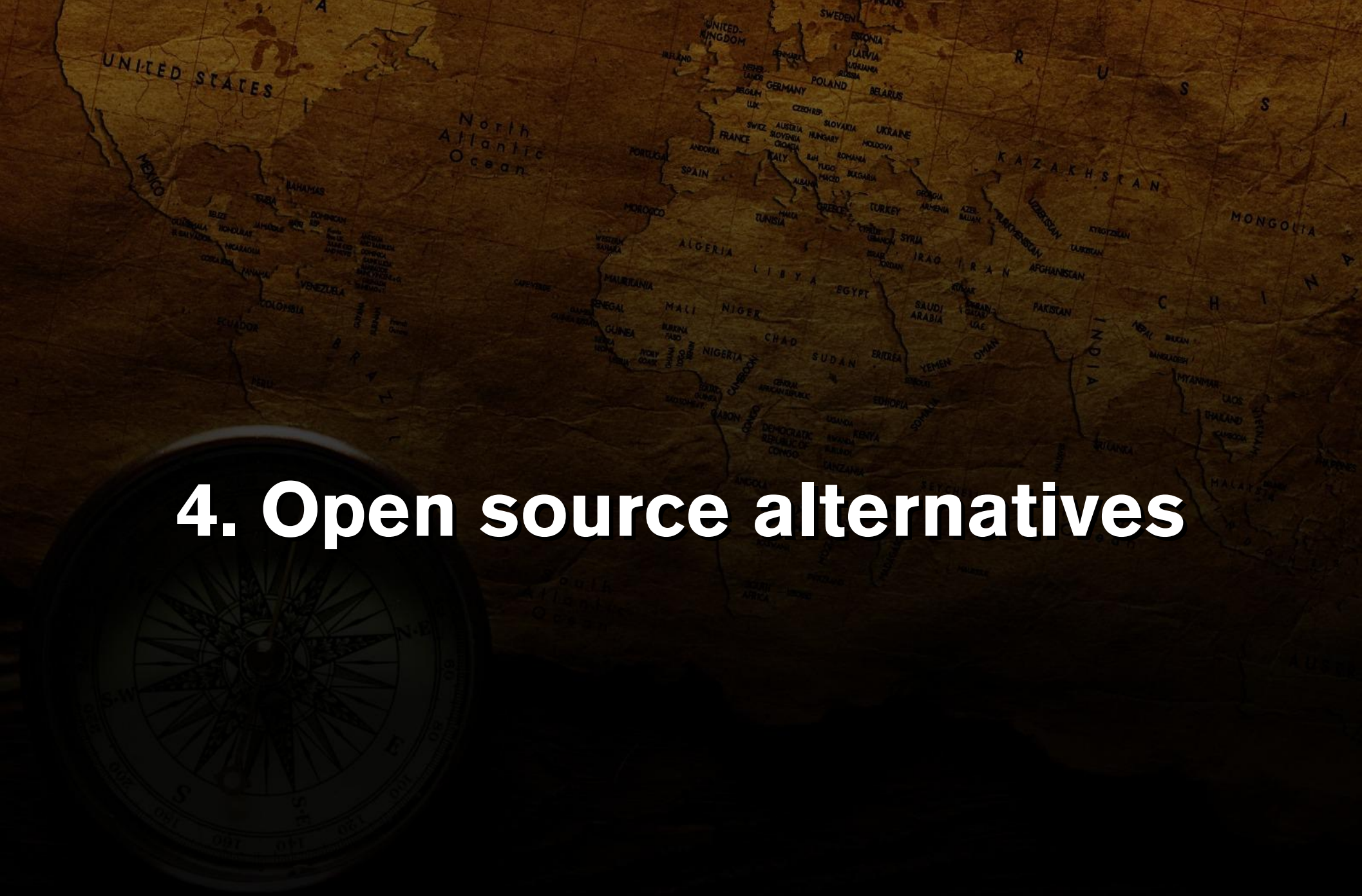


3. Proprietary powerhouse: ESRI

- Developing with the ESRI SDK's
  - Notoriously crippling and convoluted if you choose to use external bindings
    - If at all possible use of the supported geoprocessor object in the python scripting modules is advised
    - Confusing interface names
    - Huge amount of code required to achieve simple tasks

```
public IWorkspace CreateInMemoryWorkspace()
{
    // Create a new workspace in memory rather than on disk
    //  by creating a workspace factory in memory and adding a
    //  blank temporary workspace to it
    workspaceFactoryInMemory = new InMemoryWorkspaceFactoryClass();
    IWorkspaceName workspaceName = workspaceFactoryInMemory.Create("",
"temp", null, 0);
    ESRI.ArcGIS.esriSystem.IName name =
(ESRI.ArcGIS.esriSystem.IName)workspaceName;
    workspace = (IWorkspace)name.Open();

    // Return the reference to the workspace in memory
    return workspace;
}
```

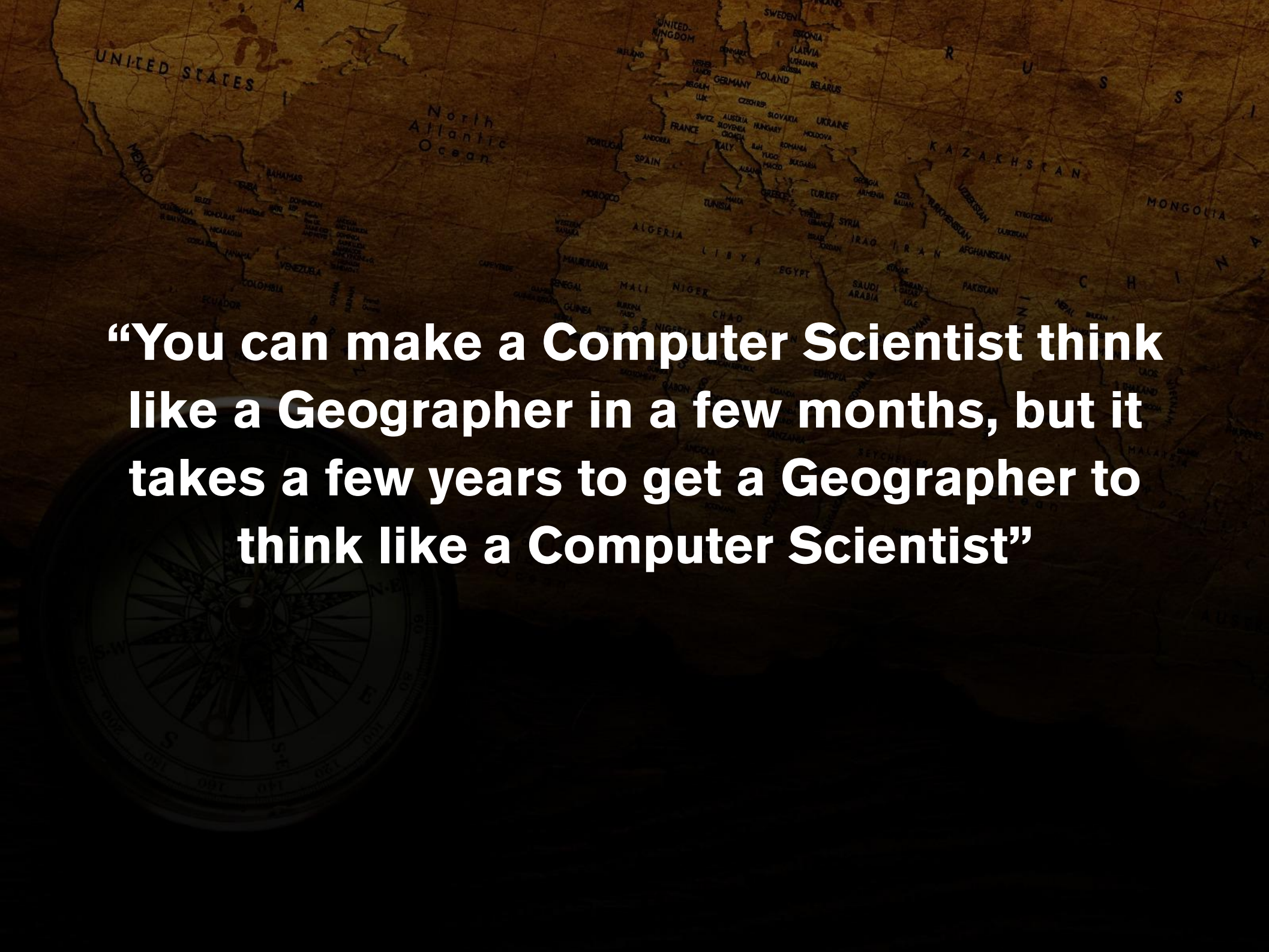




4. Open source alternatives

4. Open source alternatives

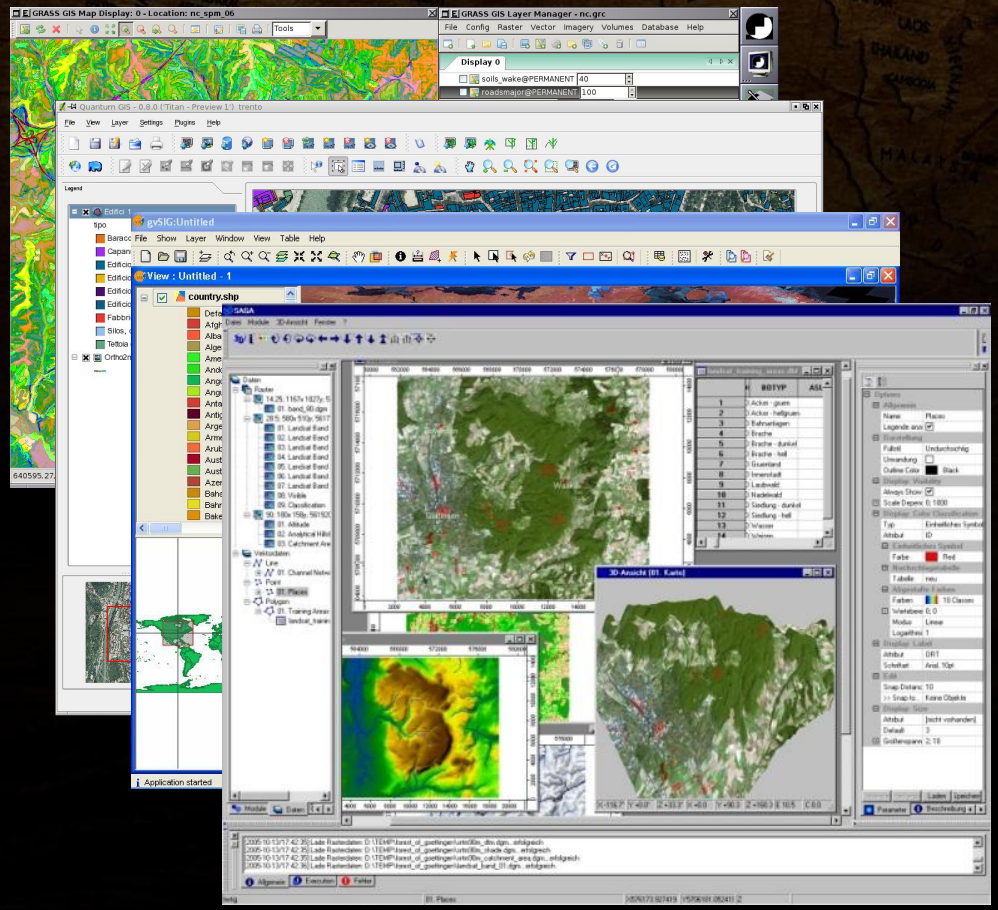
- The demand for free, open source GIS software is high
- Development of many projects are hindered by limited community contribution
- Reliance on and acceptance of proprietary solutions stifles progress



“You can make a Computer Scientist think like a Geographer in a few months, but it takes a few years to get a Geographer to think like a Computer Scientist”

4. Open source alternatives

- There are many open source products being actively developed, some of which include
  - GRASS (http://grass.itc.it/)
  - QGIS (http://www.qgis.org/)
  - SAGA GIS (http://www.saga-gis.org/)
  - GvSIG (http://www.gvsig.org/)

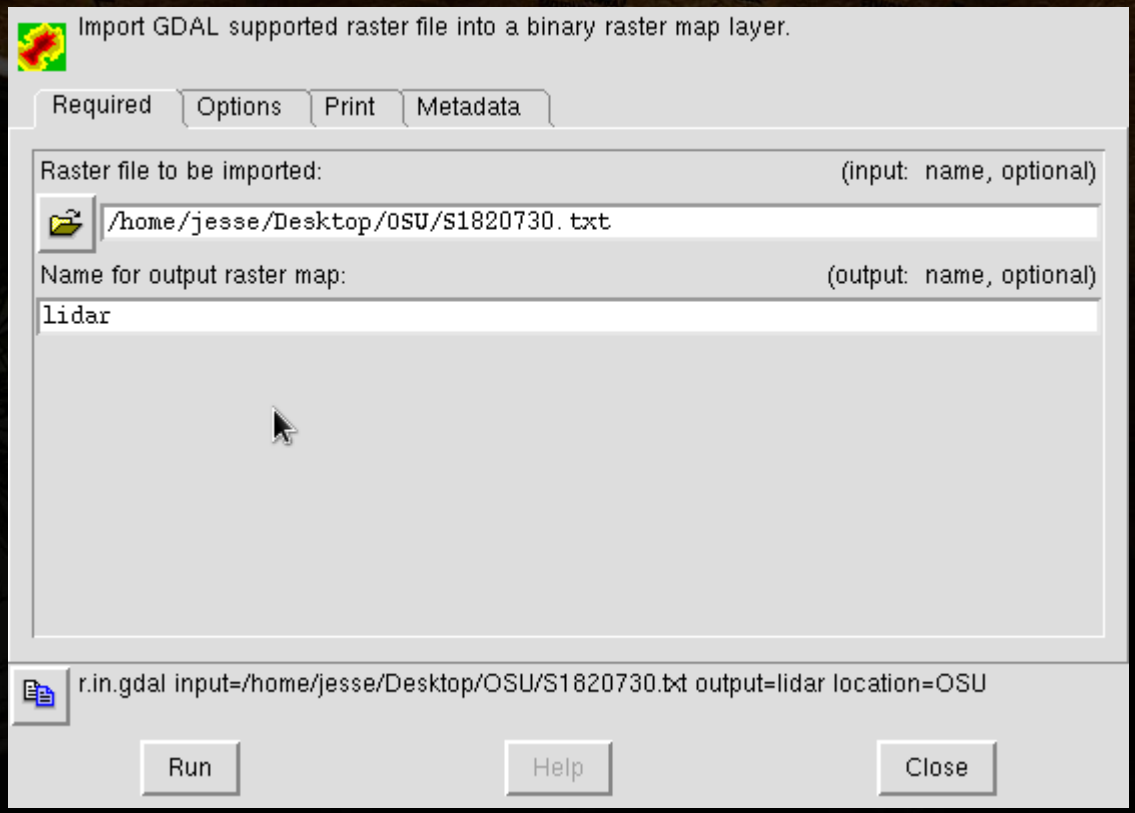


4. Open source alternatives

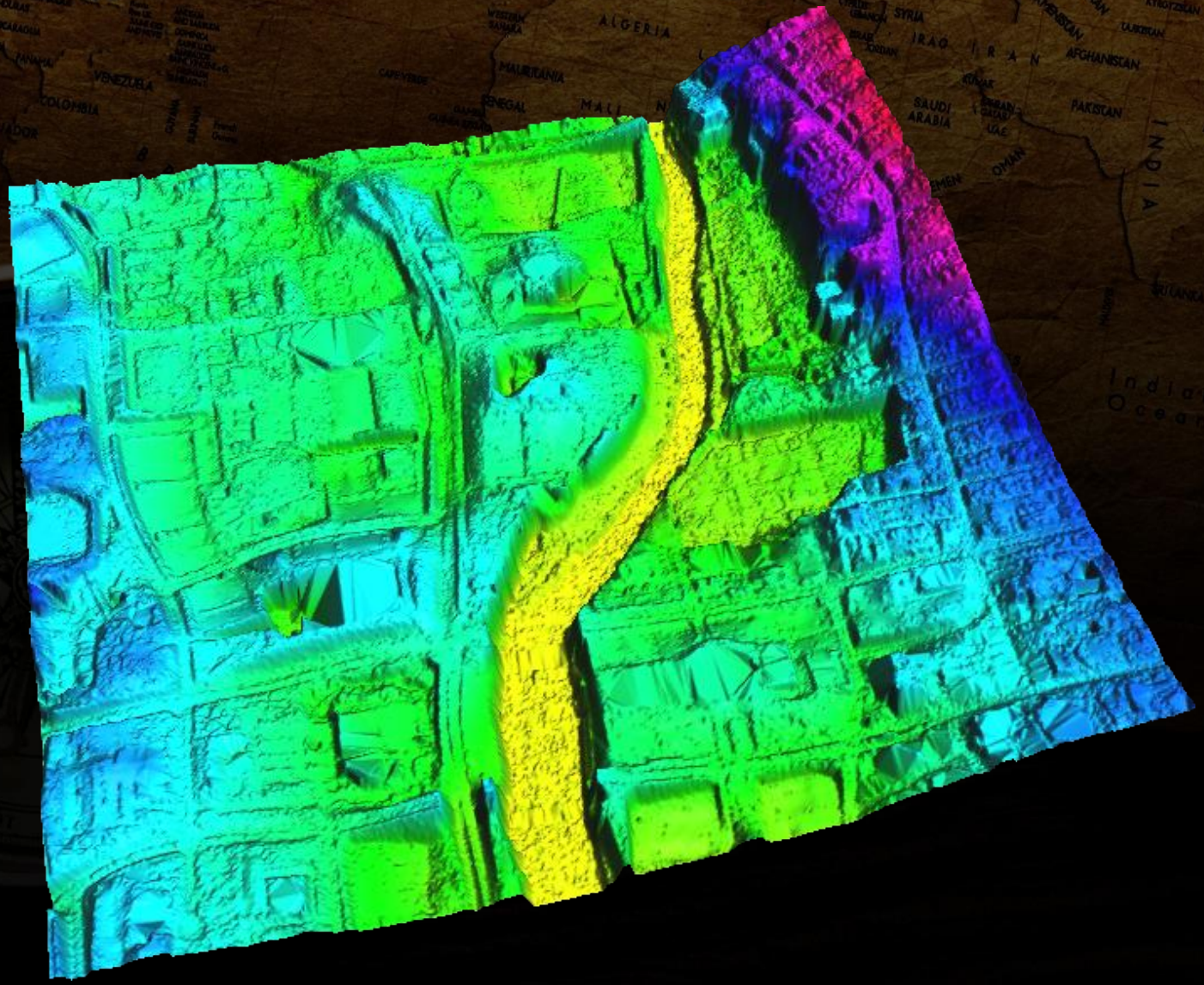
- Geospatial Data Abstraction Library (GDAL/OGR) (http://www.gdal.org/)
  - Developed by the Open Source Geospatial Foundation (http://www.osgeo.org)
  - Major open source project
    - Lots of software depends on it
      - GRASS, gvSIG, QGIS
      - ArcGIS (support), Google Earth, TopoQuest
    - Critical to the success of open source GIS

4. Open source alternatives

```
GRASS 6.4.0RC5 (OSU):~ > r.in.gdal
input=/home/jesse/Desktop/OSU/S1820730.txt output=lidar
location=OSU
```

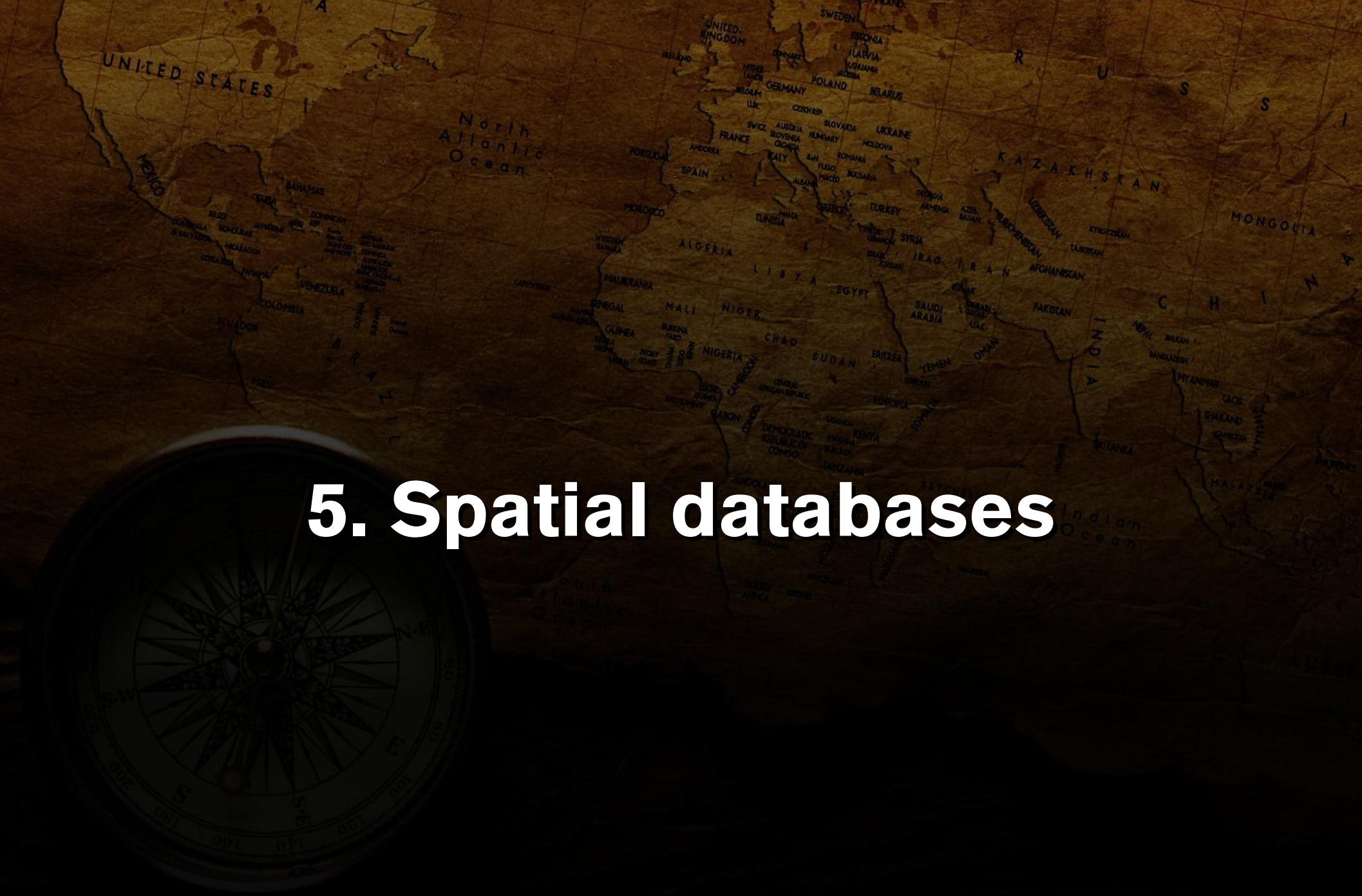


4. Open source alternatives



4. Open source alternatives

- While most common functionality is available in open source GIS, it is often difficult to find the particular piece of software you need
- Most of the critical software is still being actively developed
  - GRASS GIS released the new wxPython GUI to increase user-friendliness and ease-of-access
  - GDAL continues to be maintained by the OGC



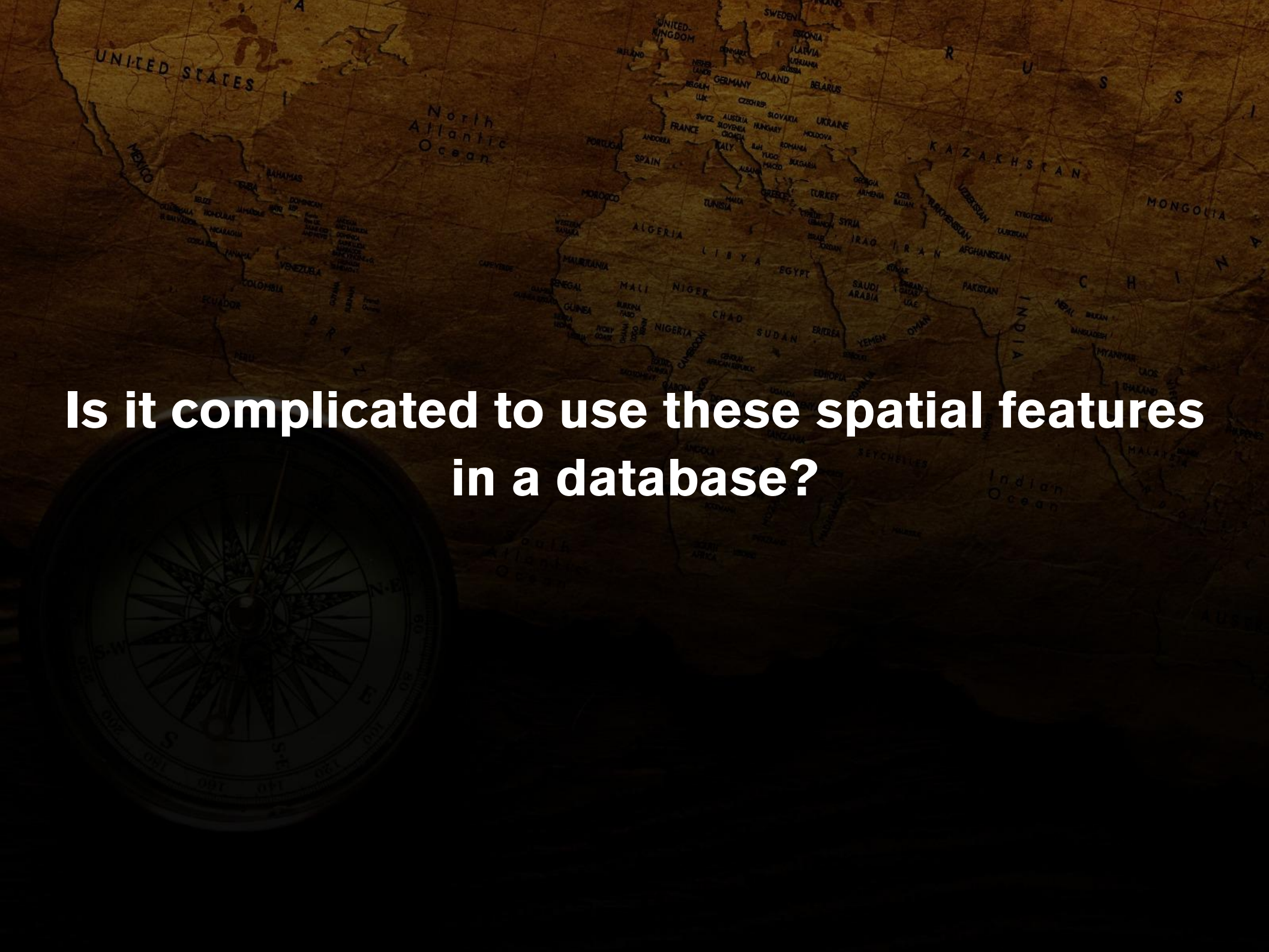
5. Spatial databases

5. Spatial databases

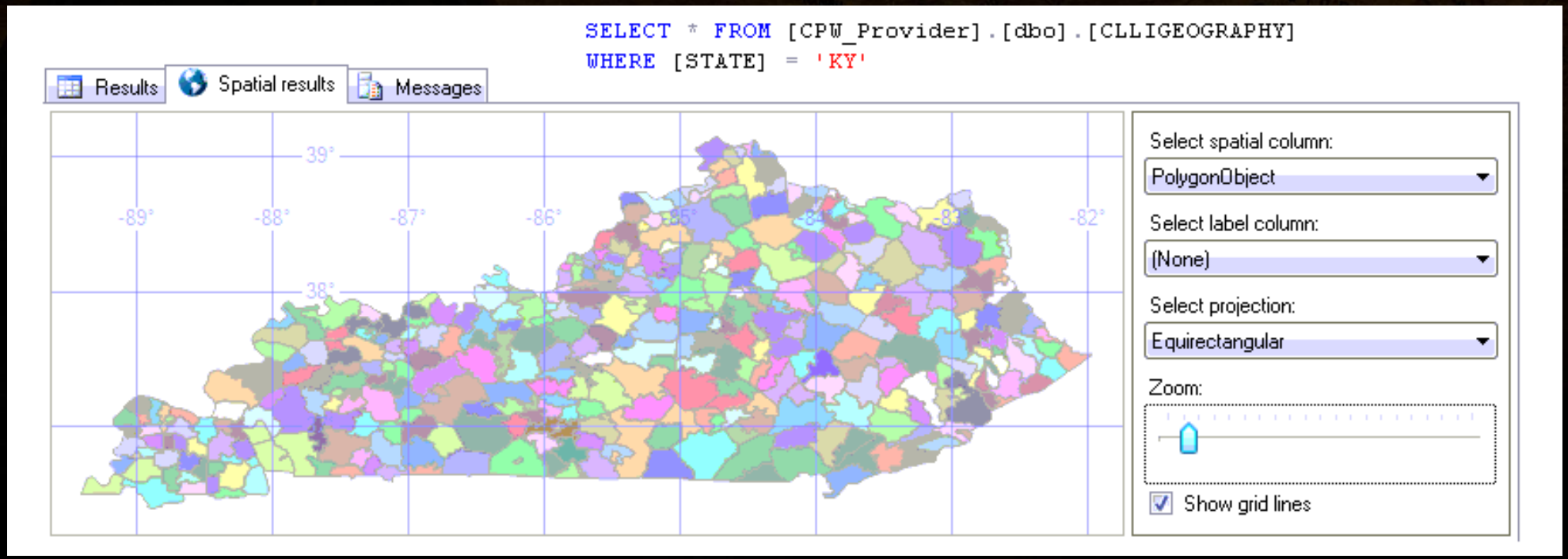
- Establishment of the OGC standards for Simple Features for SQL databases

  (http://www.opengeospatial.org/standards/sfs)

  - A few open source database systems have adopted these standards
    - PostgreSQL (PostGIS, http://postgis.refractions.net/)
    - MySQL (Version 4.1+, http://www.mysql.com/)
  - Even Microsoft SQL Server has adopted the Simple Features standard


Is it complicated to use these spatial features in a database?

```
POINT (10 10)

LINESTRING( 10 10, 20 20, 30 40)

POLYGON ((10 10, 10 20, 20 20, 20 15, 10 10))

MULTIPOINT(10 10, 20 20)

MULTIPOLYGON(((10 10, 10 20, 20 20, 20 15, 10 10)),((60 60, 70
70, 80 60, 60 60)))

GEOMETRYCOLLECTION(POINT (10 10), POINT(30 30), LINESTRING(15
15, 20 20))
```

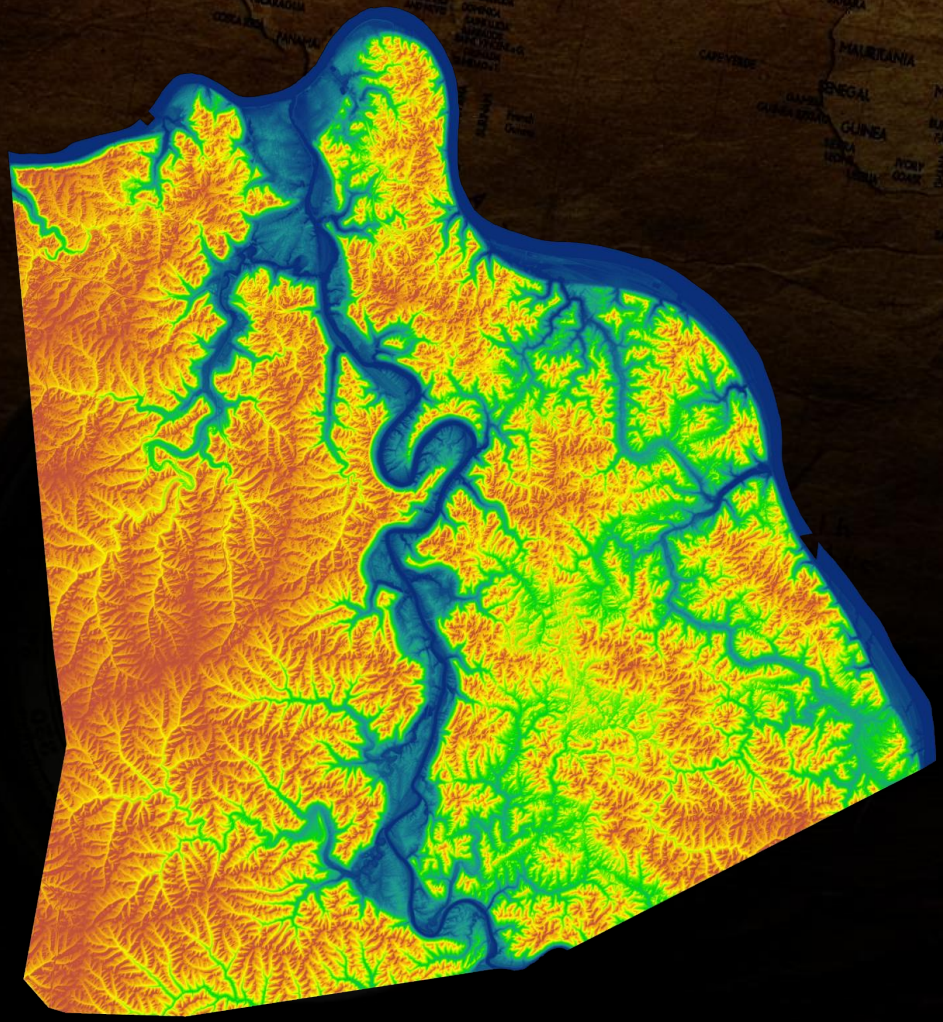


5. Spatial databases

- Developing rapidly in the past few years
- Come with limitations
  - Strictly for storing vector data types at the moment
    - PostGIS WKTRaster is in development (http://trac.osgeo.org/postgis/wiki/WKTRaster)
      - Google SOC 2009: GDAL WKTRaster by Jorge Arevalo
  - Most systems implement spatial functions for geometry objects (plane) rather than geography objects (spherical projection)
    - This can be a huge limitation if your study area is large in size

6. LiDAR Project

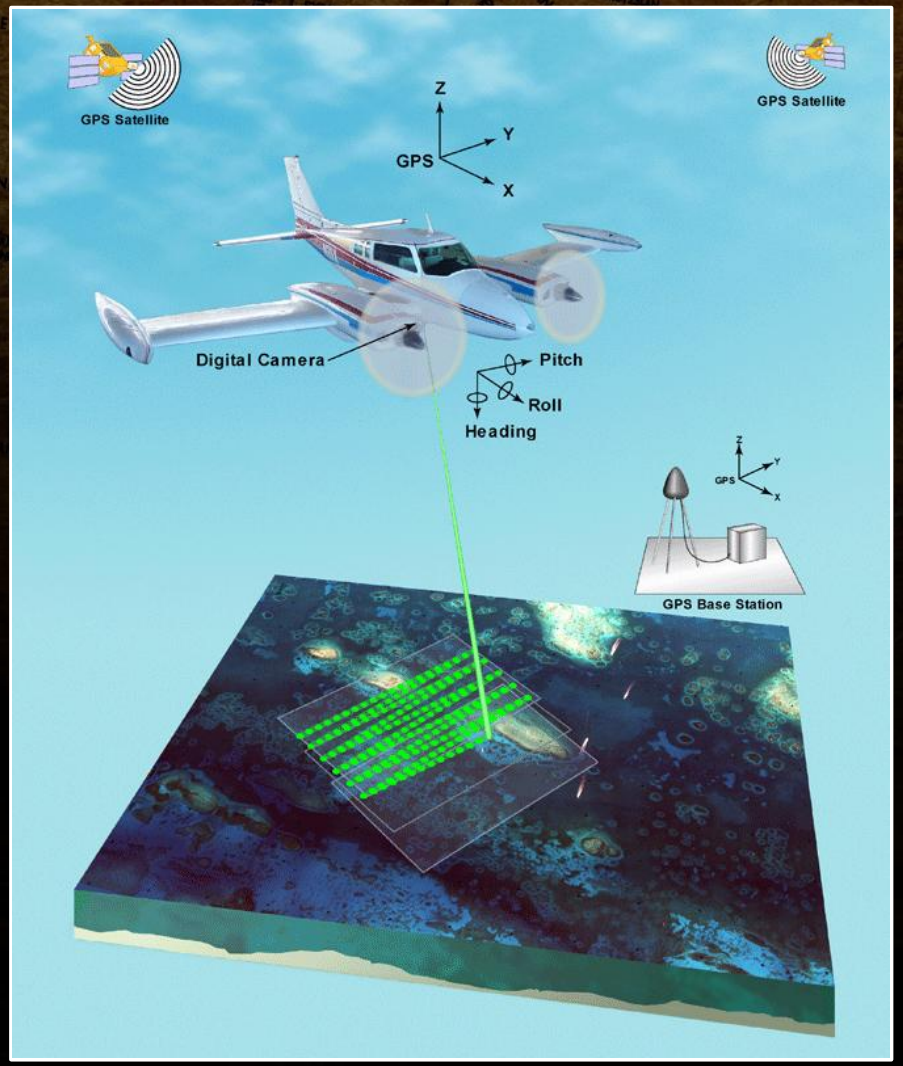
6. LiDAR Project



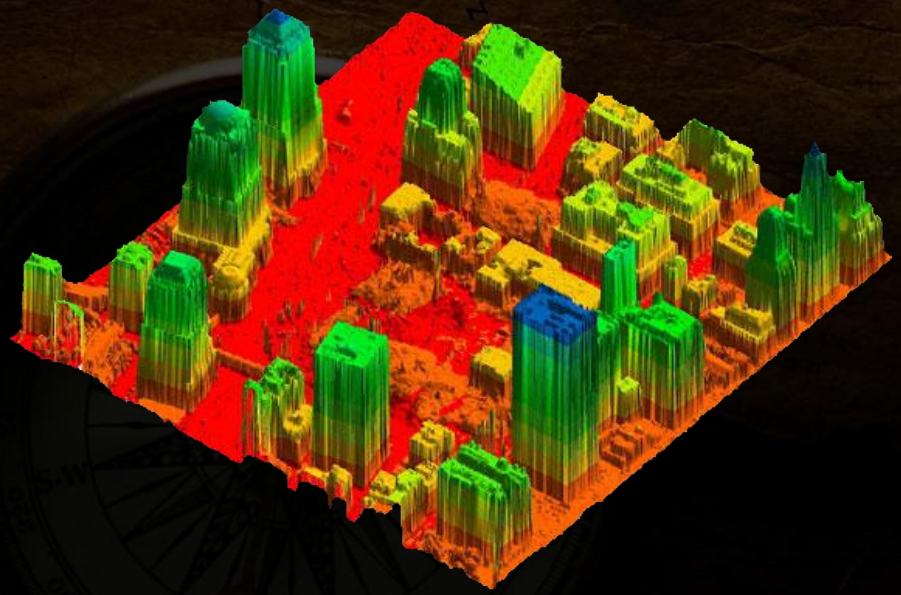
- Using LiDAR-derived DEM's to delineate landslides in Northern Kentucky and Greater Cincinnati
- Done entirely using FOSS (GRASS, libLAS, Linux)

6. LiDAR Project

- The rise of LiDAR
  - LiDAR: **Li**ght **D**etection **a**nd **R**anging
  - Think of it like RADAR, but with light instead of radio waves
  - Advantages:
    - Increased resolving power due to higher frequency and shorter wavelength of light pulses
    - High frequency ($200{,}000s^{-1}$) generates many point returns and can often penetrate even densely vegetated areas



6. LiDAR Project



- High demand
  - Two world-wide datasets
    - Shuttle Radar Topography Mission covers from 56S to 60N (80% surface) at a resolution of 1 arc second (approximately 90m)
    - Advanced Spaceborne Thermal Emission and Reflection Radiometer which covers 99% of the surface at a resolution of 30m
  - Better resolution is a necessity for many projects

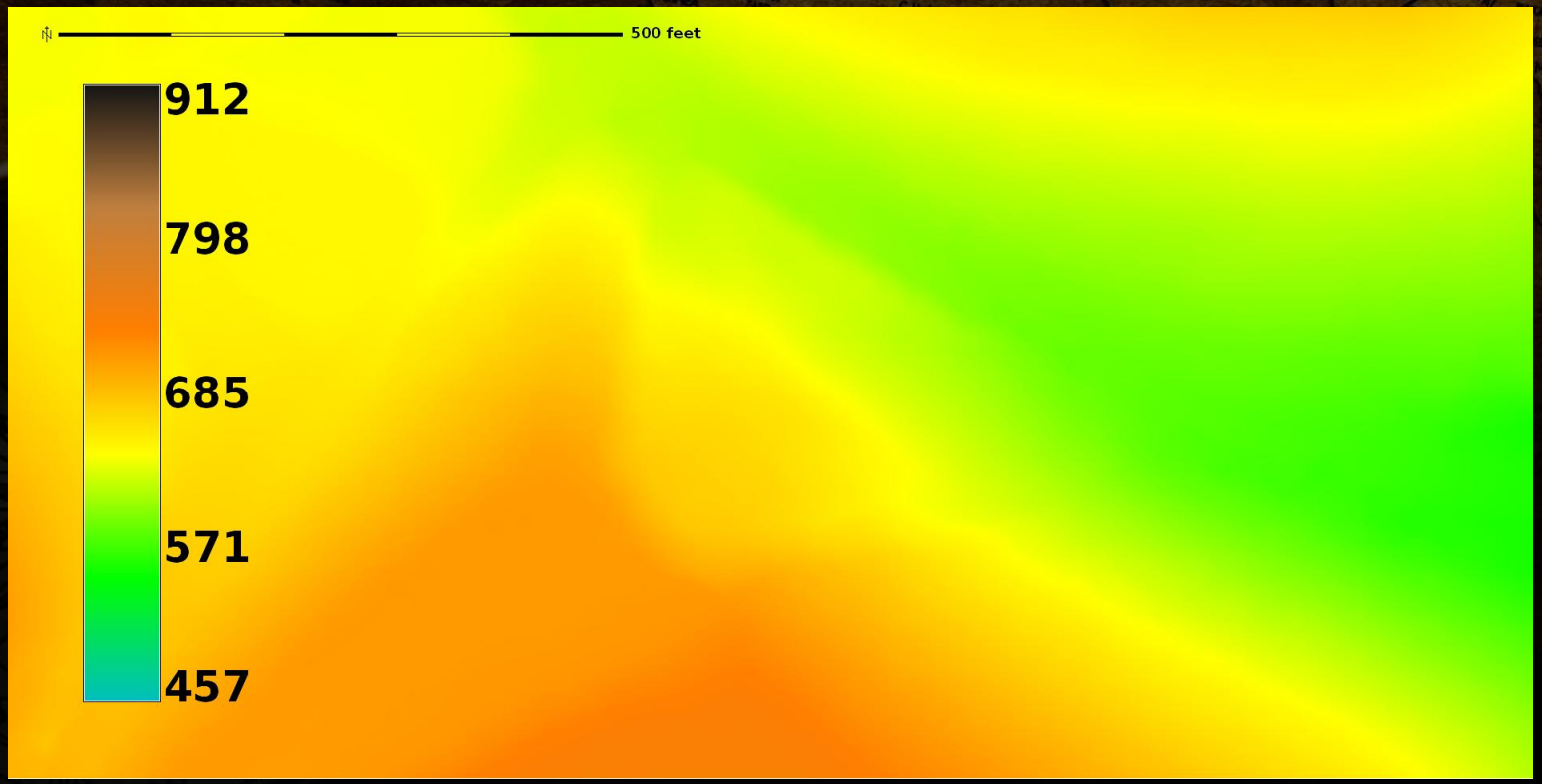
6. LiDAR Project

- LibLAS & LAStools
  - libLAS provides a standard library to handle LAS files (binary LiDAR data) (http://www.liblas.org/)
  - GDAL support for LiDAR is limited, though libLAS is bridging the gap
    - Can pipe output from libLAS tools directly into GIS such as GRASS using stdout/stdin

```
las2txt --stdout "input.las" | r.in.xyz in=- out=output
fs=space method=mean
```

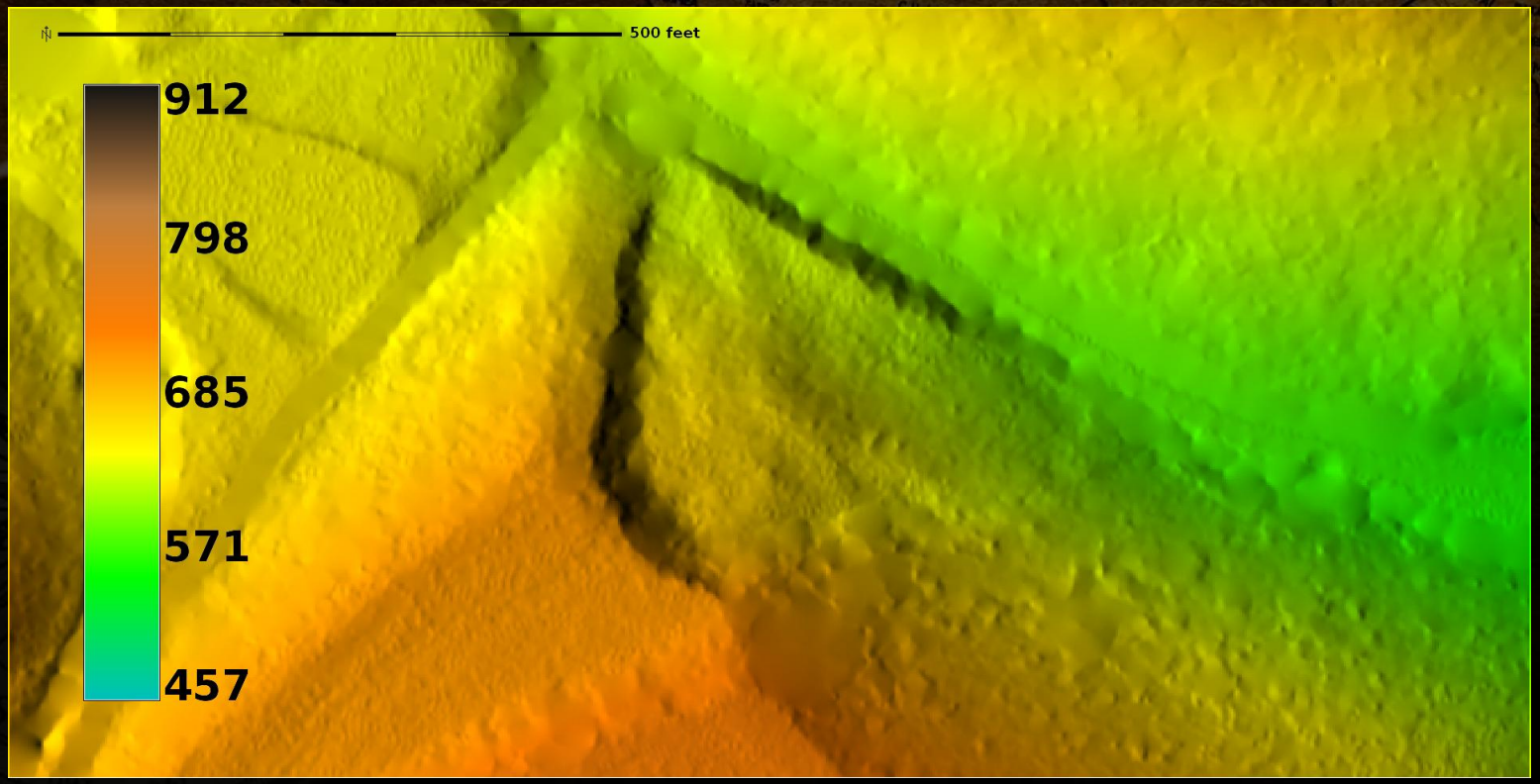
6. LiDAR Project

- LiDAR Data



6. LiDAR Project

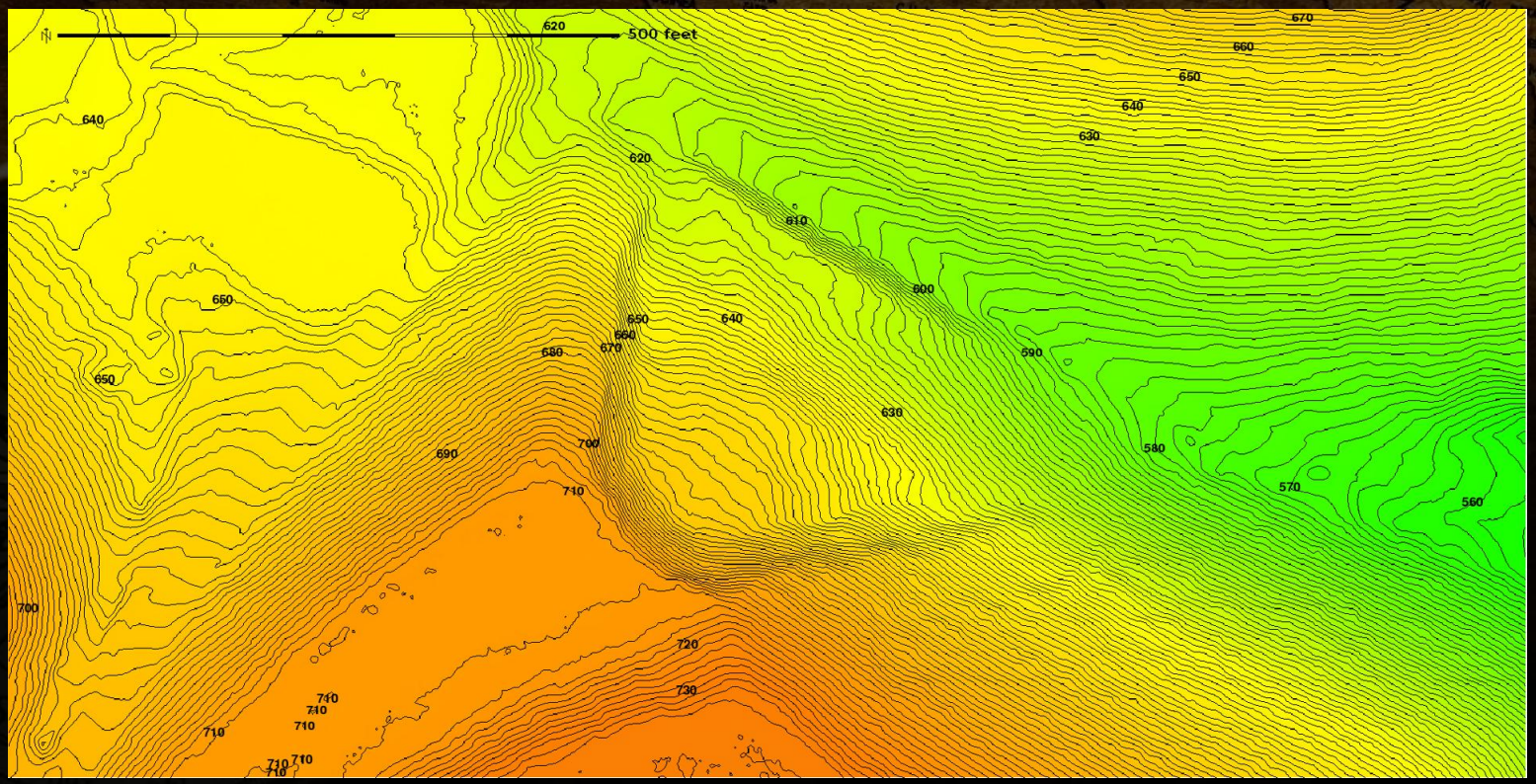
- Hillshade




```
r.shaded.relief map=RR_lidar@PERMANENT
shadedmap=RR_shade_270_30 altitude=30 azimuth=270 zmult=1
scale=1 units=none
```

6. LiDAR Project

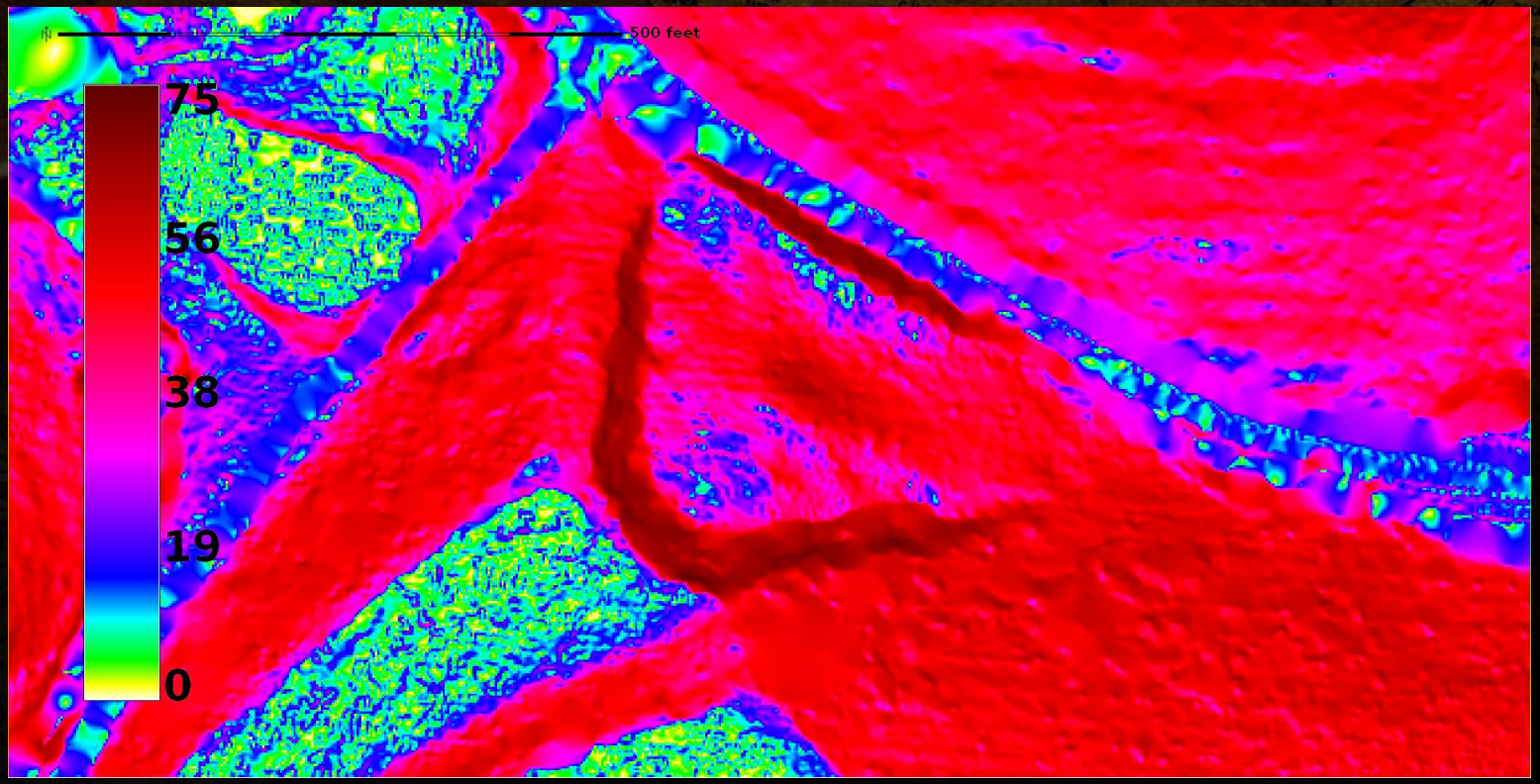
- Topographic contours (vectors)




```
r.contour input=RR_lidar@PERMANENT output=RR_countours_2ft
step=2 cut=0
```

6. LiDAR Project

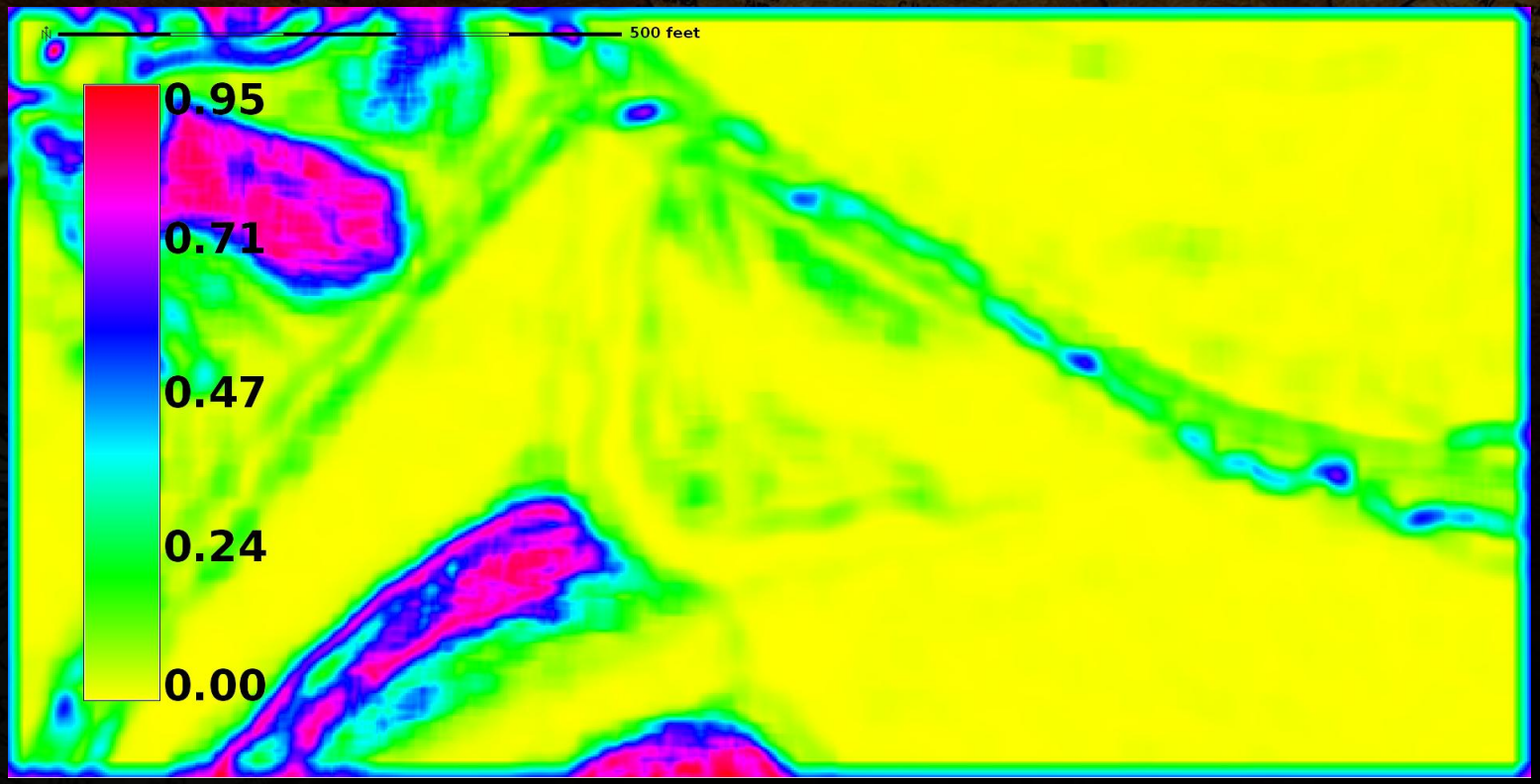
- Slope




```
r.slope.aspect elevation=RR_lidar@PERMANENT slope=RR_slope
aspect=RR_aspect format=degrees prec=float zfactor=1.0
min_slp_allowed=0.0
```

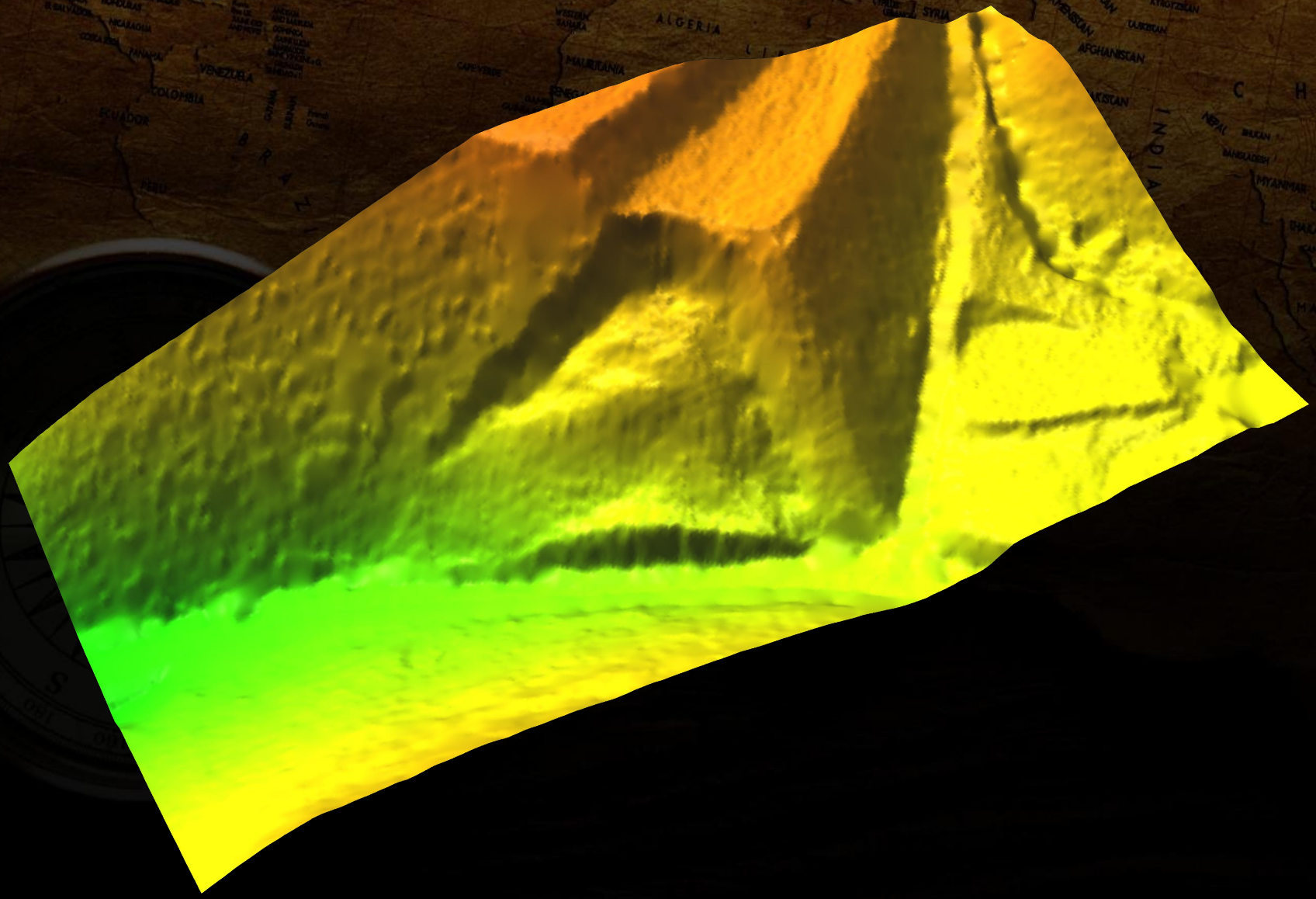
6. LiDAR Project

- Roughness




```
r.roughness.window.vector map=RR_lidar@PERMANENT
slope=RR_slope@PERMANENT aspect=RR_aspect@PERMANENT window=3
strength=RR_roughness_vstrength fisher=RR_roughness_fischerk
```

6. LiDAR Project



Questions & Demonstration

- Questions?
- Download data for OSU campus
- Load into GRASS GIS
- Do some raster analysis and visualizations

amundsenj1@nku.edu & jesse@trishock.com
http://studenthome.nku.edu/~amundsenj1/ & http://www.trishock.com/

Stolen Pictures

- http://www.zastavki.com/pictures/1600x1200/2009/Creative_Wallpaper_Compass_017346_.jpg (modified)
- http://www.eikongraphia.com/wordpress/wp-content/DeathStar.jpg
- http://www.faqs.org/photo-dict/photofiles/list/416/785graduation_cap.jpg
- http://www.bluewaterleasing.com/bigstockphoto_Business_Handshake_257240.jpg
- http://socialmediabloggerguy.com/wp-content/uploads/2009/11/government-social-media.png
- http://gulfsci.usgs.gov/tampabay/data/1mapping/lidar/images/Eaarl1.gif
- http://www.loc.gov/exhibits/911/images/lg-map-lidar2.jpg
- http://www.twinsburglibrary.org/newweb/images/stories/graphics/computer.jpg
- https://id417.van.ca.securedata.net/nivmusic.com/merchantmanager/images/uploads/Compact_Disc.jpg
- http://100musicalfootsteps.files.wordpress.com/2009/04/crowd-of-people.jpg
- http://faculty.pittstate.edu/~jarruda/monadata/images/Table_Veg3_94.gif
- http://wikibon.org/w/images/5/5e/CSUOldServers.jpg